

**STANDARDIZATION OF LIQUID MANURES FOR
ORGANIC FRENCHBEAN (*Phaseolus vulgaris* L.)
PRODUCTION**

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**DEPARTMENT OF AGRONOMY
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**STANDARDIZATION OF LIQUID MANURES FOR
ORGANIC FRENCHBEAN (*Phaseolus vulgaris* L.)
PRODUCTION**

BASAVARAJ KUMBAR
PALB 3029

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A decorative border surrounds the central text. It features blue flowers, a blue ribbon with a fine grid pattern, and small white sparkles. The background of the border is dark, possibly black or dark blue, with some light-colored speckles.

**Affectionately Dedicated to My
Parents, Brothers and Teachers**

**DEPARTMENT OF AGRONOMY
UNIVERSITY OF AGRICULTURAL SCIENCES
BENGALURU - 560 065**

CERTIFICATE

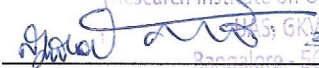
This is to certify that the thesis entitled **STANDARDIZATION OF LIQUID MANURES FOR ORGANIC FRENCHBEAN (*Phaseolus vulgaris* L.) PRODUCTION** submitted in partial fulfillment of the requirements for the award of the degree of **DOCTOR OF PHILOSOPHY** in **AGRONOMY** to the University of Agricultural Sciences, Bengaluru, is a bona-fide record for research work carried out by **Mr. BASAVARAJ KUMBAR, ID No. PALB 3029** during the period of his study in this university under my guidance and supervision and this thesis has not previously formed the basis for the award of any other degree, diploma, associateship, fellowship or any other similar titles.

July, 2016
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With great memories.....

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(Basavaraj Kumbar)

**STANDARDIZATION OF LIQUID MANURES FOR ORGANIC
FRENCHBEAN (*Phaseolus vulgaris* L.) PRODUCTION**

BASAVARAJ KUMBAR

ABSTRACT

Field experiments were conducted during *kharif*, 2014 and 2015 at organic farming Research and development block, UAS, Bengaluru for standardisation of liquid manures for organic frenchbean production under Factorial Randomised Complete Block Design with 12 treatments replicated thrice. The first experiment consisted three factors *viz.*, FYM (100, 150 and 200 % N equivalents through FYM), jeevamrutha (0 and 1000 litre ha⁻¹) and panchagavya (0 and 3 %) levels. Among the treatments, 200 per cent N equivalent through FYM recorded significantly higher frenchbean yield during 2014 and 2015 (135.2 and 168.5 q ha⁻¹) as compared to 100 per cent N equivalent (120.3 and 134.4 q ha⁻¹). Significantly higher pod yield was recorded with soil application of jeevamrutha (141.7 and 168.3 qha⁻¹) as compared to without jeevamrutha (117.0 and 139.5 q ha⁻¹). Foliar spray of panchagavya recorded significantly higher pod yield (138.7 and 164.7 q ha⁻¹) as compared to without panchagavya (120.0 and 143.1 q ha⁻¹) application during both the years. Interaction of these treatments did not differ significantly. Second experiment consisted of two factors *viz.*, jeevamrutha (0, 1000, 1500 and 2000 litre ha⁻¹) and panchagavya (0, 3 and 6 %) levels. Among the jeevamrutha levels, application of 2000 litre ha⁻¹ recorded significantly higher pod yield (134.3 and 156.9 q ha⁻¹) followed by 1500 litre ha⁻¹ (115.0 and 136.5 q ha⁻¹) and 1000 litre ha⁻¹ (106.7 and 123.1 q ha⁻¹) as compared to without jeevamrutha application (99.8 and 112.8 q ha⁻¹) during both the years. Similarly, application of higher level of panchagavya at 6 per cent recorded significantly higher frenchbean yield (124.4 and 142.8 q ha⁻¹) as compared to 3 per cent panchagavya (116.1 and 134.1 q ha⁻¹) and without panchagavya application (101.4 and 120.1 q ha⁻¹) during both the years. There were no significant differences between the treatment interactions effects.

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Department of Agronomy
UAS, GKVK, Bengaluru - 65

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Major Advisor

ಸಾವಯವ ತಿಂಗಳ ಹುರುಳಿ ಬೆಳೆಗೆ ದ್ರವರೂಪ ಗೊಬ್ಬರಗಳ ಬಳಕೆ ಪ್ರಮಾಣ ನಿಗದಿ ಪಡಿಸುವಿಕೆ

ಬಸವರಾಜ ಕುಂಬಾರ

ಪ್ರಬಂಧದ ಸಾರಾಂಶ

ಸಾವಯವ ತಿಂಗಳ ಹುರುಳಿ ಬೆಳೆಗೆ ದ್ರವರೂಪ ಗೊಬ್ಬರಗಳ ಪ್ರಮಾಣ ನಿಗದಿಪಡಿಸಲು ಕೃಷಿ ವಿಶ್ವವಿದ್ಯಾನಿಲಯ, ಜಿ.ಕೆ.ವಿ.ಕೆ, ಬೆಂಗಳೂರಿನ ಸಾವಯವ ಕೃಷಿ ಸಂಶೋಧನಾ ಕೇಂದ್ರದ ತಾಕಿನಲ್ಲಿ, 2014 ಮತ್ತು 2015 ನೇ ಸಾಲುಗಳ ಮುಂಗಾರಿನಲ್ಲಿ ಎರಡು ಕ್ಷೇತ್ರ ಪ್ರಯೋಗಗಳನ್ನು ಕೈಗೊಳ್ಳಲಾಯಿತು. ಒಟ್ಟು 12 ಉಪಚಾರಗಳ ಮೂರು ಪುನರಾವರ್ತನೆಗಳನ್ನೊಳಗೊಂಡ ಅಪವರ್ತನಿಯ ಯಾದೃಚ್ಛಿಕ ಸಂಪೂರ್ಣ ವಿನ್ಯಾಸದಡಿಯಲ್ಲಿ (ಆರ್.ಸಿ.ಬಿ.ಡಿ.) ಪ್ರಯೋಗಗಳನ್ನು ಮಾಡಲಾಯಿತು. ಮೊದಲನೆಯ ಪ್ರಯೋಗವು ನಿಶ್ಚಿತ ವಿವಿಧ ಪ್ರಮಾಣದ ಉಪಚಾರಗಳನ್ನೊಳಗೊಂಡ ಮೂರು ಅಂಶಗಳಿದ್ದು, ಅವುಗಳೆಂದರೆ: ಕೊಟ್ಟಿಗೆ ಗೊಬ್ಬರ (ಬೆಳೆಗೆ ಶಿಫರಸ್ಸು ಮಾಡಿದ ಶೇ 100, 150 ಮತ್ತು 200 ಸಾರಜನಕ ಸಮಾನ ಪ್ರಮಾಣ), ಜೀವಾಮೃತ (0 ಮತ್ತು 1000 ಲೀ/ಹೆ) ಮತ್ತು ಪಂಚಗವ್ಯ (0 ಮತ್ತು 3 %). ಎರಡೂ ವರ್ಷಗಳ ಮುಂಗಾರಿನಲ್ಲಿ, ಶಿಫಾಸ್ಸು ಮಾಡಿದ ಶೇ. 200 ಪ್ರಮಾಣದ ಕೊಟ್ಟಿಗೆ ಗೊಬ್ಬರದ ಉಪಚಾರದೊಂದಿಗೆ ಶೇ. 100 ಸಾರಜನಕ ನೀಡಿದ ಉಪಚಾರಕ್ಕೆ ಹೋಲಿಸಿದಾಗ ಶೇ. 200 ರ ಉಪಚಾರದಲ್ಲಿ ಗಮನಾರ್ಹ ಅಧಿಕ ಇಳುವರಿ ದಾಖಲಾಯಿತು (135.2 ಮತ್ತು 168.5 ಕ್ವಿಂ/ಹೆ). ಶೇ. 100 ಸಾರಜನಕ ಉಪಚಾರದಲ್ಲಿ ಕಡಿಮೆ ಇಳುವರಿ ದಾಖಲಾಯಿತು (120.3 ಹಾಗೂ 134.4 ಕ್ವಿಂ/ಹೆ). ಜೀವಾಮೃತವನ್ನು ಬಳಸಿದ ಹಾಗೂ ಬಳಸಿದ ಉಪಚಾರಗಳಲ್ಲಿ ಇಳುವರಿಯನ್ನು ಹೋಲಿಸಿದಾಗ ಬಳಸದ ತಾಕಿನಲ್ಲಿ ಕಡಿಮೆ ಇಳುವರಿ 117.0 ಮತ್ತು 139.5 ಕ್ವಿಂ/ಹೆ ಹಾಗೂ ಬಳಸಿದ ತಾಕಿನಲ್ಲಿ ಗಮನಾರ್ಹ ಅಧಿಕ ಇಳುವರಿ (141.7 ಮತ್ತು 168.3 ಕ್ವಿಂ/ಹೆ) ದಾಖಲಾಗಿದ್ದು ಕಂಡುಬಂದಿರುತ್ತದೆ. ಸಸ್ಯಗಳಿಗೆ ಪಂಚಗವ್ಯ ಸಿಂಪಡಿಸಿದ (ಇಳುವರಿ 120.0 ಹಾಗೂ 143.3 ಕ್ವಿಂ/ಹೆ), ಪಂಚಗವ್ಯ ಸಿಂಪಡಿಸಿದ ಉಪಚಾರವನ್ನು ಹೋಲಿಕೆ ಮಾಡಿದಾಗ ಪಂಚಗವ್ಯ ಬಳಸಿದ ತಾಕಿನಲ್ಲಿ ಗಮನಾರ್ಹ ಅಧಿಕ ಇಳುವರಿ ದಾಖಲಾಗಿರುವುದು ಕಂಡು ಬಂದಿತು (138.7 ಹಾಗೂ 164.7 ಕ್ವಿಂ/ಹೆ). ಉಪಚಾರಗಳ ಪರಸ್ಪರ ಪ್ರತಿಕ್ರಿಯೆಯಿಂದ ಯಾವುದೇ ಗಮನಾರ್ಹ ಅಧಿಕ ಇಳುವರಿಯು ದಾಖಲಾಗಿದ್ದಿಲ್ಲ. ಎರಡನೆಯ ಪ್ರಯೋಗವು ಎರಡು ಅಂಶಗಳನ್ನು ಒಳಗೊಂಡಿದ್ದು, ಅವುಗಳೆಂದರೆ: ಜೀವಾಮೃತ (0, 1000, 1500 ಮತ್ತು 2000 ಲೀ/ ಹೆ ಪ್ರಮಾಣ) ಮತ್ತು ಪಂಚಗವ್ಯ (0, 3 ಹಾಗೂ 6 %) ಆಗಿರುತ್ತವೆ. ಜೀವಾಮೃತವನ್ನು ಪ್ರತಿ ಹೆಕ್ಟೇರಿಗೆ 2000 ಲೀ ಬಳಸಿದ ಉಪಚಾರದಲ್ಲಿ ಗಮನಾರ್ಹ ಅಧಿಕ ಇಳುವರಿ (134.3 ಮತ್ತು 156.9 ಕ್ವಿಂ/ಹೆ) ದಾಖಲಾಗಿದ್ದು, 1500 ಲೀ ಬಳಸಿದ ಉಪಚಾರದಲ್ಲಿ (115.0 ಮತ್ತು 136.5 ಕ್ವಿಂ/ಹೆ) ಹಾಗೂ 1000 ಲೀ ಬಳಕೆ ಉಪಚಾರದಲ್ಲಿ (106.7 ಮತ್ತು 123.1 ಕ್ವಿಂ/ ಹೆ) ಇಳುವರಿ ದಾಖಲಾಗಿರುತ್ತವೆ. ಸಸ್ಯಗಳಿಗೆ ಶೇ 6 ಪಂಚಗವ್ಯ ಸಿಂಪರಣೆ ಮಾಡಿದ ಉಪಚಾರದಲ್ಲಿ ಗಮನಾರ್ಹ ಅಧಿಕ ಇಳುವರಿ (124.4 ಮತ್ತು 142.8 ಕ್ವಿಂ/ಹೆ) ದಾಖಲಾಗಿದ್ದು, ಶೇ 3 ರಲ್ಲಿ (116.1 ಮತ್ತು 134.1 ಕ್ವಿಂ/ಹೆ) ಹಾಗೂ ಪಂಚಗವ್ಯ ಸಿಂಪರಣೆ ಮಾಡದ (101.4 ಮತ್ತು 120.1 ಕ್ವಿಂ/ಹೆ) ಉಪಚಾರಗಳಲ್ಲಿ ಕಡಿಮೆ ಇಳುವರಿ ದಾಖಲಾಗಿರುತ್ತದೆ ಉಪಚಾರಗಳ ಪರಸ್ಪರ ಪ್ರತಿಕ್ರಿಯೆಯಿಂದ ಗಮನಾರ್ಹ ಅಧಿಕ ಇಳುವರಿಯು ದಾಖಲಾಗಿರುತ್ತಿಲ್ಲ.

ಜುಲೈ, 2016

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ಗಾಕೃಷಿಕೇ., ಕೃ.ವಿ.ವಿ., ಬೆಂಗಳೂರು

(ಎನ್. ದೇವಕುಮಾರ್)

ಪ್ರಧಾನ ಸಲಹೆಗಾರರು

CONTENTS

CHAPTER	TITLE	PAGE No.
I	INTRODUCTION	1-3
II	REVIEW OF LITERATURE	4-26
III	MATERIAL AND METHODS	27-42
IV	RESULTS AND DISCUSSION	43-329
V	SUMMARY	330-335
VI	REFERENCES	336-355
	APPENDICES	356-357
	PUBLICATIONS	358-367

LIST OF TABLES

Table No.	Title	Page No.
1	Initial chemical, physical and biological properties of the soil at experimental site	29
2	Meteorological data of monthly normal and actual for the year 2014 and 2015 during crop growth period at GKVK, Bengaluru	30-31
3	Plant height of frenchbean at different growth stages as influenced by FYM and liquid manures application during <i>kharif</i> 2014	44
4	Plant height of frenchbean at different growth stages as influenced by FYM and liquid manures application during <i>kharif</i> 2015	45
5	Plant height of frenchbean at different growth stages as influenced by FYM and liquid manures application during <i>kharif</i> (Pooled 2014-2015)	46
6	Number of branches of frenchbean at different growth stages as influenced by FYM and liquid manures application during <i>kharif</i> 2014	49
7	Number of branches of frenchbean at different growth stages as influenced by FYM and liquid manures application during <i>kharif</i> 2015	50
8	Number of branches of frenchbean at different growth stages as influenced by FYM and liquid manures application (Pooled 2014 and 2015)	51
9	Number of leaves of frenchbean at different growth stages as influenced by FYM and liquid manures application during <i>kharif</i> 2014	54
10	Number of leaves of frenchbean at different growth stages as influenced by FYM and liquid manures application during <i>kharif</i> 2015	55
11	Number of leaves of frenchbean at different growth stages as influenced by FYM and liquid manures application (Pooled 2014 and 2015)	56
12	Leaf area of frenchbean at different growth stages as influenced by FYM and liquid manures application during <i>kharif</i> 2014	59
13	Leaf area of frenchbean at different growth stages as influenced by FYM and liquid manures application during <i>kharif</i> 2015	60
14	Leaf area of frenchbean at different growth stages as influenced by FYM and liquid manures application (Pooled 2014 and 2015)	61
15	Leaf area index of frenchbean at different growth stages as influenced by FYM and liquid manures application during <i>kharif</i> 2014	65

Table No.	Title	Page No.
16	Leaf area index of frenchbean at different growth stages as influenced by FYM and liquid manures application during <i>kharif</i> 2015	66
17	Leaf area index of frenchbean at different growth stages as influenced by FYM and liquid manures application during (Pooled 2014 and 2015)	67
18	Effect of FYM and liquid manures application on number of nodules, fresh weight and dry weight of nodules at flowering stage of french bean during <i>kharif</i> 2015	71
19	Shoot weight of frenchbean at different growth stages as influenced by FYM and liquid manures application during <i>kharif</i> 2014	73
20	Shoot weight of frenchbean at different growth stages as influenced by FYM and liquid manures application during <i>kharif</i> 2015	74
21	Shoot weight of frenchbean at different growth stages as influenced by FYM and liquid manures application (Pooled 2014 and 2015)	75
22	Leaf weight of frenchbean at different growth stages as influenced by FYM and liquid manures application during <i>kharif</i> 2014	78
23	Leaf weight of frenchbean at different growth stages as influenced by FYM and liquid manures application during <i>kharif</i> 2015	79
24	Leaf weight of frenchbean at different growth stages as influenced by FYM and liquid manures application (Pooled 2014 and 2015)	80
25	Root weight of frenchbean at different growth stages as influenced by FYM and liquid manures application during <i>kharif</i> 2014	83
26	Root weight of frenchbean at different growth stages as influenced by FYM and liquid manures application during <i>kharif</i> 2015	84
27	Root weight of frenchbean at different growth stages as influenced by FYM and liquid manures application (Pooled 2014 and 2015)	85
28	Effect of FYM and liquid manures application on pod dry weight of frenchbean	87
29	Total dry matter production of frenchbean at different growth stages as influenced by FYM and liquid manures application during <i>kharif</i> 2014	89
30	Total dry matter production of frenchbean at different growth stages as influenced by FYM and liquid manures application during <i>kharif</i> 2015	90
31	Total dry matter production of frenchbean at different growth stages as influenced by FYM and liquid manures application (Pooled 2014 and 2015)	91

Table No.	Title	Page No.
31a	Fifty per cent flowering of frenchbean during 2014, 2015 and pooled data as influenced by FYM and liquid manures application	94
32	Plant height of frenchbean at different growth stages as influenced by application of liquid manures during <i>kharif</i> 2014	96
33	Plant height of frenchbean at different growth stages as influenced by application of liquid manures during <i>kharif</i> 2015	97
34	Plant height of frenchbean at different growth stages as influenced by application of liquid manures (Pooled 2014 and 2015)	98
35	Number of branches of frenchbean at different growth stages as influenced by application of liquid manures during <i>kharif</i> 2014	101
36	Number of branches of frenchbean at different growth stages as influenced by application of liquid manures during <i>kharif</i> 2015	102
37	Number of branches of frenchbean at different growth stages as influenced by application of liquid manures (Pooled 2014 and 2015)	103
38	Number of leaves of frenchbean at different growth stages as influenced by application of liquid manures during <i>kharif</i> 2014	106
39	Number of leaves of frenchbean at different growth stages as influenced by application of liquid manures during <i>kharif</i> 2015	107
40	Number of leaves of frenchbean at different growth stages as influenced by application of liquid manures (Pooled 2014 and 2015)	108
41	Leaf area of frenchbean at different growth stages as influenced by application of liquid manures during <i>kharif</i> 2014	111
42	Leaf area of frenchbean at different growth stages as influenced by application of liquid manures during <i>kharif</i> 2015	112
43	Leaf area of frenchbean at different growth stages as influenced by application of liquid manures (Pooled 2014 and 2015)	113
44	Leaf area index of frenchbean at different growth stages as influenced by application of liquid manures during <i>kharif</i> 2014	116
45	Leaf area index of frenchbean at different growth stages as influenced by application of liquid manures during <i>kharif</i> 2015	117
46	Leaf area index of frenchbean at different growth stages as influenced by application of liquid manures (Pooled 2014 and 2015)	118

Table No.	Title	Page No.
47	Effect of liquid manures application on number of nodules, fresh weight and dry weight of nodules at flowering stage of frenchbean during <i>kharif</i> 2015	121
48	Shoot weight of frenchbean at different growth stages as influenced by application of liquid manures during <i>kharif</i> 2014	123
49	Shoot weight of frenchbean at different growth stages as influenced by application of liquid manures during <i>kharif</i> 2015	124
50	Shoot weight of frenchbean at different growth stages as influenced by application of liquid manures (Pooled 2014 and 2015)	125
51	Leaf weight of frenchbean at different growth stages as influenced by application of liquid manures during <i>kharif</i> 2014	128
52	Leaf weight of frenchbean at different growth stages as influenced by application of liquid manures during <i>kharif</i> 2015	129
53	Leaf weight of frenchbean at different growth stages as influenced by application of liquid manures (Pooled 2014 and 2015)	130
54	Root weight of frenchbean at different growth stages as influenced by application of liquid manures during <i>kharif</i> 2014	133
55	Root weight of frenchbean at different growth stages as influenced by application of liquid manures during <i>kharif</i> 2015	134
56	Root weight of frenchbean at different growth stages as influenced by application of liquid manures (Pooled 2014 and 2015)	135
57	Effect of liquid manures application on dry weight of pods per plant of frenchbean during <i>kharif</i> 2015	138
58	Total dry matter of frenchbean at different growth stages as influenced by application of liquid manures during <i>kharif</i> 2014	140
59	Total dry matter of frenchbean at different growth stages as influenced by application of liquid manures during <i>kharif</i> 2015	141
60	Total dry matter of frenchbean at different growth stages as influenced by application of liquid manures (Pooled 2014 and 2015)	142
60a	Fifty per cent flowering of frenchbean during 2014, 2015 and pooled data as influenced by jeevamruta and panchagavya application	145
61	Yield parameters of frenchbean as influenced by FYM and liquid manures application during <i>kharif</i> 2014	147

Table No.	Title	Page No.
62	Yield parameters of frenchbean as influenced by FYM and liquid manures application during <i>kharif</i> 2015	148
63	Yield parameters of frenchbean as influenced by FYM and liquid manures application (Pooled 2014 and 2015)	149
64	Green pod yield of frenchbean during 2014, 2015 and pooled data as influenced by FYM and liquid manures application	153
65	Haulm yield of frenchbean during 2014, 2015 and pooled data as influenced by FYM and liquid manures application	155
66	Yield parameters of frenchbean at different growth stages as influenced by application of liquid manures during <i>kharif</i> 2014	157
67	Yield parameters of frenchbean at different growth stages as influenced by application of liquid manures during <i>kharif</i> 2015	158
68	Yield parameters of frenchbean at different growth stages as influenced by application of liquid manures (Pooled 2014 and 2015)	159
69	Effect of jeevamruta and panchagavya liquid manures application during 2014, 2015 and pooled data on green pod yield of frenchbean	164
70	Effect of jeevamruta and panchagavya liquid manures application during 2014, 2015 and pooled data on haulm yield of frenchbean	166
71	Effect of FYM and liquid manures on quality parameters of frenchbean during <i>kharif</i> 2014	175
72	Effect of FYM and liquid manures on quality parameters of frenchbean during <i>kharif</i> 2015	176
73	Effect of FYM and liquid manures on quality parameters of frenchbean (Pooled 2014 and 2015)	177
74	Effect of liquid manures on quality parameters of frenchbean during <i>kharif</i> 2014	182
75	Effect of liquid manures on quality parameters of frenchbean during <i>kharif</i> 2015	183
76	Effect of liquid manures on quality parameters of frenchbean at harvest (Pooled 2014 and 2015)	184
77	Plant nutrient content of N as influenced by FYM and liquid manures at different growth stage of frenchbean during <i>kharif</i> 2014	189

Table No.	Title	Page No.
78	Plant nutrient content of N as influenced by FYM and liquid manures application at different growth stage of frenchbean during <i>kharif</i> 2015	190
79	Plant nutrient content of N as influenced by FYM and liquid manures application at different growth stage of frenchbean (Pooled 2014 and 2015)	191
80	Plant phosphorus content as influenced by FYM and liquid manures application at different growth stage of frenchbean during <i>kharif</i> 2014	193
81	Plant phosphorus content as influenced by FYM and liquid manures application at different growth stage of frenchbean during <i>kharif</i> 2015	194
82	Plant phosphorus content as influenced by FYM and liquid manures application at different growth stage of frenchbean (Pooled 2014 and 2015)	195
83	Plant potassium content as influenced by FYM and liquid manures application at different growth stage of frenchbean during <i>kharif</i> 2014	198
84	Plant potassium content as influenced by FYM and liquid manures application at different growth stage of frenchbean during <i>kharif</i> 2015	199
85	Plant potassium content as influenced by FYM and liquid manures application at different growth stage of frenchbean (Pooled 2014 and 2015)	200
86	Nitrogen, phosphorus and potassium content of pod as influenced by FYM and liquid manures application during <i>kharif</i> 2014	203
87	Nitrogen, phosphorus and potassium content of pod as influenced by FYM and liquid manures application during <i>kharif</i> 2015	204
88	Nitrogen, phosphorus and potassium content of pod as influenced by FYM and liquid manures application (Pooled 2014 and 2015)	205
89	Plant N content as influenced by liquid manures application at different growth stage of frenchbean during <i>kharif</i> 2014	208
90	Plant N content as influenced by liquid manures application at different growth stage of frenchbean during <i>kharif</i> 2015	209
91	Plant N content as influenced by liquid manures application at different growth stage of frenchbean (Pooled 2014 and 2015)	210
92	Plant phosphorus content as influenced by liquid manures application at different growth stage of frenchbean during <i>kharif</i> 2014	213

Table No.	Title	Page No.
93	Plant phosphorus content as influenced by liquid manures application at different growth stage of frenchbean during <i>kharif</i> 2015	214
94	Plant phosphorus content as influenced by liquid manures application at different growth stage of frenchbean (Pooled 2014 and 2015)	215
95	Plant potassium content as influenced by liquid manures application at different growth stage of frenchbean during <i>kharif</i> 2014	218
96	Plant potassium content as influenced by liquid manures application at different growth stage of frenchbean during <i>kharif</i> 2015	219
97	Plant potassium content as influenced by liquid manures application at different growth stage of frenchbean (Pooled 2014 and 2015)	220
98	Nitrogen, phosphorus and potassium content of pod as influenced by liquid manures application during <i>kharif</i> 2014	223
99	Nitrogen, phosphorus and potassium content of pod as influenced by liquid manures application during <i>kharif</i> 2015	224
100	Nitrogen, phosphorus and potassium content of pod as influenced by liquid manures application (Pooled 2014 and 2015)	225
101	Bacterial population of rhizosphere soil as influenced by FYM and liquid manures application at different growth stages of frenchbean during <i>kharif</i> 2014	228
102	Bacterial population of rhizosphere soil as influenced by FYM and liquid manures application at different growth stages of frenchbean during <i>kharif</i> 2015	229
103	Bacterial population of rhizosphere soil as influenced by FYM and liquid manures application at different growth stages of frenchbean (Pooled 2014 and 2015)	230
104	Fungal population of rhizosphere soil as influenced by FYM and liquid manures application at different growth stages of frenchbean during <i>Kharif</i> 2014	234
105	Fungal population of rhizosphere soil as influenced by FYM and liquid manures application at different growth stages of frenchbean during <i>kharif</i> 2015	235
106	Fungal population of rhizosphere soil as influenced by FYM and liquid manures application at different growth stages of frenchbean (Pooled 2014 and 2015)	236

Table No.	Title	Page No.
107	Actinomycetes population of rhizosphere soil as influenced by liquid FYM and liquid manures application at different growth stages of frenchbean during <i>kharif</i> 2014	240
108	Actinomycetes population of rhizosphere soil as influenced by FYM and liquid manures application at different growth stages of frenchbean during <i>kharif</i> 2015	241
109	Actinomycetes population of rhizosphere soil as influenced by FYM and liquid manures application at different growth stages of frenchbean (Pooled 2014 and 2015)	242
110	N- fixers population of rhizosphere soil as influenced by FYM and liquid manures application at different growth stages of frenchbean during <i>kharif</i> 2014	246
111	N- fixers population of rhizosphere soil as influenced by FYM and liquid manures application at different growth stages of frenchbean during <i>kharif</i> 2015	247
112	N- fixers population of rhizosphere soil as influenced by FYM and liquid manures application at different growth stages of frenchbean (Pooled 2014 and 2015)	248
113	P- Solubaliser population of rhizosphere soil as influenced by FYM and liquid manures application at different growth stages of frenchbean during <i>kharif</i> 2014	252
114	P- Solubaliser population of rhizosphere soil as influenced by FYM and liquid manures application at different growth stages of frenchbean during <i>kharif</i> 2015	253
115	P- Solubaliser population of rhizosphere soil as influenced by FYM and liquid manures application at different growth stages of frenchbean (Pooled 2014 and 2015)	254
116	Bacterial population of rhizosphere soil as influenced by liquid manures application at different growth stages of frenchbean during <i>kharif</i> 2014	259
117	Bacterial population of rhizosphere soil as influenced by liquid manures application at different growth stages of frenchbean during <i>kharif</i> 2015	260
118	Bacterial population of rhizosphere soil as influenced by liquid manures application at different growth stages of frenchbean (Pooled 2014 and 2015)	261
119	Fungal population of s rhizosphere oil as influenced by liquid manures application at different growth stages of frenchbean during <i>kharif</i> 2014	262

Table No.	Title	Page No.
120	Fungal population of rhizosphere soil as influenced by liquid manures application at different growth stages of frenchbean during <i>kharif</i> 2015	265
121	Fungal population of rhizosphere soil as influenced by liquid manures application at different growth stages of frenchbean (Pooled 2014 and 2015)	266
122	Actinomycetes population of rhizosphere soil as influenced by liquid manures application at different growth stages of frenchbean during <i>kharif</i> 2014	268
123	Actinomycetes population of rhizosphere soil as influenced by liquid manures application at different growth stages of frenchbean during <i>kharif</i> 2015	269
124	Actinomycetes population of s rhizosphere oil as influenced by liquid manures application at different growth stages of frenchbean (Pooled 2014 and 2015)	270
125	N- fixers population of rhizosphere soil as influenced by liquid manures application at different growth stages of frenchbean during <i>kharif</i> 2014	273
126	N- fixers population of rhizosphere soil as influenced by liquid manures application at different growth stages of frenchbean during <i>kharif</i> 2015	274
127	N- fixers population of rhizosphere soil as influenced by liquid manures application at different growth stages of frenchbean (Pooled 2014 and 2015)	275
128	P- solubaliser population of rhizosphere soil as influenced by liquid manures application at different growth stages of frenchbean during <i>kharif</i> 2014	277
129	P- solubaliser population of rhizosphere soil as influenced by liquid manures application at different growth stages of frenchbean during <i>kharif</i> 2015	278
130	P- solubaliser population of rhizosphere soil as influenced by liquid manures application at different growth stages of frenchbean (Pooled 2014 and 2015)	279
131	Dehydrogenase activity of soil as influenced by FYM and liquid manures application at different growth stages of frenchbean during <i>kharif</i> 2014	285
132	Dehydrogenase activity of soil as influenced by FYM and liquid manures application at different growth stages of frenchbean during <i>kharif</i> 2015	286

Table No.	Title	Page No.
133	Dehydrogenase activity of soil as influenced by FYM and liquid manures application at different growth stages of frenchbean (Pooled 2014 and 2015)	287
134	Dehydrogenase activity of soil as influenced by liquid manures application at different growth stages of frenchbean during <i>kharif</i> 2014	290
135	Dehydrogenase activity of soil as influenced by liquid manures application at different growth stages of frenchbean during <i>kharif</i> 2015	291
136	Dehydrogenase activity of soil as influenced by liquid manures application at different growth stages of frenchbean (Pooled 2014 and 2015)	292
137	Available N, P ₂ O ₅ and K ₂ O of soil as influenced by FYM and liquid manures application at harvest stage of frenchbean during <i>kharif</i> 2014	296
138	Available N, P ₂ O ₅ and K ₂ O of soil as influenced by FYM and liquid manures application at harvest stage of frenchbean during <i>kharif</i> 2015	297
139	Available N, P ₂ O ₅ and K ₂ O of soil as influenced by FYM and liquid manures application at harvest stage of frenchbean (Pooled 2014 and 2015)	298
140	Available N, P ₂ O ₅ and K ₂ O of soil as influenced by liquid manures application at harvest stage of frenchbean during <i>kharif</i> 2014	301
141	Available N, P ₂ O ₅ and K ₂ O of soil as influenced by liquid manures application at harvest stage of frenchbean during <i>kharif</i> 2015	302
142	Available N, P ₂ O ₅ and K ₂ O of soil as influenced by liquid manures application at harvest stage of frenchbean (Pooled 2014 and 2015)	303
143	pH, EC and OC of soil as influenced by FYM and liquid manures application at harvest stage of frenchbean during <i>kharif</i> 2014	307
144	pH, EC and OC of soil as influenced by FYM and liquid manures application at harvest stage of frenchbean during <i>kharif</i> 2015	308
145	pH, EC and OC of soil as influenced by FYM and liquid manures application at harvest stage of frenchbean (Pooled 2014 and 2015)	309
146	Maximum water holding capacity and Bulk density of soil as influenced by FYM and liquid manures application during <i>kharif</i> 2014	312
147	Maximum water holding capacity and Bulk density of soil as influenced by FYM and liquid manures application during <i>kharif</i> 2015	313

Table No.	Title	Page No.
148	Maximum water holding capacity and Bulk density of soil influenced by FYM and liquid manures application (Pooled 2014 and 2015)	314
149	pH, EC and OC of soil as influenced by liquid manures application at harvest stage of frenchbean during <i>kharif</i> 2014	316
150	pH, EC and OC of soil as influenced by liquid manures application at harvest stage of frenchbean during <i>kharif</i> 2015	317
151	pH, EC and OC of soil as influenced by liquid manures application at harvest stage of frenchbean (Pooled 2014 and 2015)	318
152	Maximum water holding capacity and Bulk density of soil as influenced by liquid manures application during <i>kharif</i> 2014	320
153	Maximum water holding capacity and Bulk density of soil as influenced by liquid manures application during <i>kharif</i> 2015	321
154	Maximum water holding capacity and Bulk density of soil as influenced by liquid manures application (Pooled 2014 and 2015)	322
155	Cost of cultivation, gross returns, net returns and B:C ratio of frenchbean as influenced by FYM and liquid manures	325
156	Cost of cultivation, gross returns, net returns and B:C ratio of frenchbean as influenced by jeevamrutha and panchagavya application	326

LIST OF FIGURES

Fig. No.	TITLE	Between Pages
1	Plan of lay out of the field experiment I	32-33
2	Plan of lay out of the field experiment II	32-33
3	Influence of FYM, jeevamruta and panchagavya application on number of pods per plant of frenchbean	160-161
4	Influence of FYM, jeevamruta and panchagavya application on fresh pod weight per plant of frenchbean	160-161
5	Influence of FYM, jeevamruta and panchagavya application pod length of frenchbean	162-163
6	Influence of jeevamruta and panchagavya application number of pods per plant of frenchbean	162-163
7	Influence of jeevamruta and panchagavya application on fresh pod weight per plant of frenchbean	162-163
8	Influence of jeevamruta and panchagavya application on pod length of frenchbean	162-163
9	Influence of FYM, jeevamruta and panchagavya application on total dry matter per plant of frenchbean	170-171
10	Influence of jeevamruta and panchagavya application on total dry matter accumulation per plant of frenchbean	170-171
11	Influence of FYM, jeevamruta and panchagavya application on pod yield of frenchbean	172-173
12	Influence of jeevamruta and panchagavya application on pod yield of frenchbean	172-173
13	Influence of FYM, jeevamruta and panchagavya application on shelf life (days) of frenchbean	186-187
14	Influence of jeevamruta and panchagavya application on shelf life (days) of frenchbean	186-187

Fig. No.	TITLE	Between Pages
15	Influence of FYM, jeevamruta and panchagavya application on soil N fixers at 40 DAS of frenchbean	282-283
16	Influence of jeevamruta and panchagavya application on N fixers at 40 DAS of frenchbean	282-283
17	Influence of FYM, jeevamruta and panchagavya application on soil P-solubilizes at 40 DAS of frenchbean	282-283
18	Influence of jeevamruta and panchagavya application on P- solubilisers at 40 DAS of frenchbean	282-283

LIST OF PLATES

Plate No.	TITLE	Between Pages
1a	General view of the field experiments	34-35
1	General view of the field experiments	34-35
2	Shelf life studies of frenchbean	40-41
3	Soil microbial count studies	40-41
4	Crop performance in 200 per cent N equivalent through FYM + jeevamrutha at 1000 litres ha ⁻¹ + panchagavya 3 per cent	168-169
5	Crop performance in 100 per cent N equivalent through FYM + jeevamrutha without + without panchagavya	168-169
6	Crop performance in Jeevamrutha at 2000 litres ha ⁻¹ + panchagavya 6 per cent	168-169
7	Crop performance in without jeevamrutha + without panchagavya	168-169
8	Effect of FYM, jeevamruta and panchagavya on root nodulation	174-175
9	Effect of jeevamruta and panchagavya on root nodulation	174-175

ABBREVIATIONS USED IN THESIS

Symbol	Abbreviations
%	Per cent
₹	Rupees
°C	Degree Celsius
C.D.	Critical difference
Cfu	Colony forming units
Cm	Centimeter
DAS	Days after sowing
Ds m ⁻¹	Desi Simons per meter
G	Gram
K	Potassium
Kg ha ⁻¹	Kilogram per hectare
N	Nitrogen
NS	Non significant
P	Phosphorus
S.Em	Standard error of mean
t ha ⁻¹	Tonne per hectare
<i>Viz.,</i>	Namely
FYM	Farm Yard Manure
UAS	United States of America
UK	United Kingdom

I INTRODUCTION

Frenchbean (*Phaseolus vulgaris* L.) is also known as snap bean, kidney bean, garden bean or string bean and in India locally known as rajmash, belongs to the family leguminosae. Frenchbean is considered to be a native of South and Central America. It is an important pulse-cum-vegetable crop of India, cultivated for its tender and mature pods, seeds and fodder. It is a nutritious vegetable and can be grown in all types of soils ranging from light sandy loam to clay soils and can be cultivated round the year in the country (Rana *et al.*, 2009). Frenchbean green pods are used as green vegetable which supplies 1.7 g protein, calcium 132 mg, thiamin 0.08 mg, riboflavin 0.06 mg, vitamin C 24.0 mg per 100 g of edible pods and also contain iron, potash, phosphorus, sulphur, vitamin 'A' in large quantity (Broughton *et al.*, 2003). They are rich source of minerals, vitamins, fibre and contain a fair amount of protein as well as carbohydrates. Green pods contain high level of vitamin 'A' which is beneficial for the controlling night blindness in human being (Birajdar, 2006). Globally frenchbean is cultivated on an area of 29.92 m. ha with an annual production of 23.23 million tons while, in India it is cultivated on an area of about 10.80 million hectares with an annual production of 4.87 million tons (Anon., 2013). Major frenchbean growing states in India are Maharashtra, Andhra Pradesh and Punjab. However, it is grown in Karnataka mainly as vegetable purpose in all the districts.

Green revolution technologies involving greater use of synthetic agrochemicals such as fertilizers and pesticides with adoption of nutrient-responsive, high-yielding varieties of crops have boosted the production output per hectare in most cases. However, this increase in production has slowed down and in some cases there are indications of decline in productivity and production. Moreover, the success of industrial agriculture and the green revolution in recent decades has often masked significant externalities, affecting natural resources and human health as well as agriculture itself (Yadav *et al.*, 2013).

Organic agriculture is not a new concept to India and traditionally Indian farmers were organic. But, gradually changed to chemical based cultivation since 1960's and chemicals were increasingly applied during the green revolution period. Organic farming is an age old traditional practice evolved by our fore fathers wherein, only organic manures or natural inputs available on the farm is used. Thus reduces the cost of production against chemical inputs. Organic agriculture is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects (IFOAM). General acceptance of organic farming is not only due to the greater demand for pollution-free food but also due to natural advantage of organic farming in supporting the sustainability in agriculture. The natural inputs used in organic farming are easily available, releases nutrients slowly, supplies macro and micro nutrients and provides favourable soil environment for microbial population (Shashidhara, 2000, Devakumar *et al.*, 2011).

Organic farming has gained popularity in recent years not only in India, but also in Australia, Argentina, USA, UK, Germany, South Africa, China, Japan and other Asian countries like Srilanka and Pakistan. The essence of practicing organic farming lies in the use of naturally available resources like organic wastes, predators, parasites in conjunction with natural processes like decomposition, biological nitrogen fixation and resistance to achieve the needs of crop production.

In organic agriculture nutrients are supplied through FYM, Compost, vermicompost etc. and micronutrients and growth promoting substances were provided through panchagavya and jeevamruta and other liquid formulations. The panchagavya and jeevamruta are eco-friendly organic preparations made from cow products. Use of organic liquid products such as beejamrutha, jeevamrutha and panchagavya results in higher growth, yield and quality of crops and improve the soil physico-chemical and biological properties. They contain macro nutrients, essential micro nutrients, vitamins, essential amino acids, growth promoting factors like IAA, GA and beneficial microorganisms (Devakumar *et al.*, 2008 and Tharmaraj *et al.*, 2011). Farmyard manure is a rich source of nutrients having inherent ability to improve the soil health and aeration, water holding capacity and substrate for beneficial microbial population. Decomposition of farmyard manure by microorganisms results in release of carbon dioxide, water and mineral plant nutrients such as nitrogen, phosphorus, potassium and micronutrients (Castillo Joergensen, 2001). Farm Yard Manure adds organic carbon to soil which increases water holding capacity and reduce the bulk density due to humic substances penetrated the inter lamella space of clay minerals and improves the texture and structure of the soil, contributes to its buffering capacity, increase the water holding capacity of the soil (Singh *et al.*, 2006).

Jeevamruta is a product of naturally available farm wastes like cattle dung and cattle urine along with other ingredients like jaggery, pulse flour and water. A survey of organic farmers in Karnataka during 2006-07 revealed that more than 70 per cent of organic farmers use jeevamruta as an important organic input for successful organic cultivation (Joshi, 2008) because of easy availability of ingredients on farm, ease in preparation and application. Jeevamruta application has been observed to benefit crop production in irrigated and dry districts of Karnataka. Most of the farmers have adopted widely the varying methods of its preparation and application, apparently due to the lack of scientific study on this subject. Jeevamrutha is a plant growth promoting substance containing beneficial micro organisms which promotes growth and yield of crop. Microorganisms are well activated in the soil by the addition of jeevamrutha. The microorganisms such as nitrogen fixers, *Azotobacter*, *Azospirillum* and phosphorus solubilizing bacteria like *Pseudomonas* and potash solubilizing bacteria like *Bacillus silicus* are present in the cow dung that is used to prepare jeevamrutha (Devakumar *et al.*, 2008 and Ramprasad *et al.*, 2009).

Panchagavya has got reference in the scripts of Vedas (divine scripts of Indian wisdom) and Vrskhayurveda (Vrskha means plant and ayurveda means health system). The texts on Vrskhayurveda as systematization of the practices that the farmers followed at field level, placed in a theoretical frame work and it defined certain plant growth

stimulants; among them Panchagavya was an important one that enhanced the biological efficiency of crop plants and quality of fruits and vegetables (Natarajan, 2002; Somasundaram *et al.*, 2007).

Panchagavya is a foliar nutrition prepared by cow products and used widely for various agricultural and horticultural crops. In Sanskrit, Panchagavya means a combination of five products *viz.*, cowdung, urine, milk, curd and gee obtained from cow. When suitably mixed and used, these have miraculous effects. Panchagavya is used in different means such as foliar spray, soil application along with irrigation water, seed or seedling treatment *etc.* enhances the growth vigour of crops, resistance to pest and diseases and improvement of keeping quality of fruits and vegetables (Natarajan, 2002, Mohamed *et al.*, 2010 and Tharmaraj *et al.*, 2011).

Farm yard manure is a decomposed organic matter obtained by the action of microbial population in a warm and moist aerobic environment using cow dung, cow urine and other waste materials available from backyard cattle (Ramprasad *et al.*, 2009).

Individual application of organic sources could not produce significant effect thus the diversification of organic sources of plant nutrients is becoming popular in these days. Use of farm yard manure and organic liquid formulations like Panchagavya, cow urine and jeevamruta are potential sources of organic nutrients. Hence, the present experiment was conducted to study the combined effect of FYM, Panchagavya and Jeevamrutha on growth and yield of frenchbean. Keeping this in view the present studies were undertaken to find out the response of frenchbean to liquid manures, farmyard manure and their different combination treatments under irrigated condition during *Kharif* season of 2014 and 2015 with the following objectives.

Objectives of Investigation

1. To study the effect of different levels of FYM, panchagavya and jeevamrutha liquid manure on growth & yield of frenchbean.
2. To study the interaction effect of FYM, panchagavya and jeevamrutha on growth and yield of frenchbean
3. To study the chemical and microbial population as influenced by FYM and liquid manure application.
4. To study the nutrients uptake pattern by frenchbean
5. To work out the economics of different organic manurial practices

II REVIEW OF LITERATURE

Literature pertaining to the investigation entitled “Standardization of liquid manure for organic frenchbean (*Phaseolus vulgaris* L.) production” and the literature pertaining to effect of nutrient management practices through organics on crop growth, yield and soil health has been reviewed and presented in this chapter.

- 2.1 Composition of organic manures
- 2.2 Effect of organic manures on crop growth and yield
- 2.3 Effect of organic manures on quality parameters
- 2.4 Effect of organic manures on nutrient uptake by plants
- 2.5 Effect of organic manures on soil properties
- 2.6 Liquid organic formulation as bio control agents
- 2.7 Effect of organics on economics

2.1 Composition of organic manures

2.1.1 Composition of Farm Yard Manure

Farm yard manure is the most commonly used organic manure in India. It consists of a mixture of animal shed wastes containing dung, urine, bedding material and some left over straw. The nutrient content of FYM varies with the constitutes or composition of FYM. It occupies an important position among bulky organic manures. The estimated potential and the availability of nutrients from cattle based FYM in India is about 3.4 to 5.7 and 1.0 to 1.7 million tonnes of $N + P_2O_5 + K_2O$ per year, respectively (Subash and Chauhan, 2004).

At Bhopal, Muneshwar Singh *et al.* (2001) reported that the nutrient content of farm yard manure was 0.62 per cent nitrogen, 0.13 per cent phosphorus, and 0.71 per cent potassium. Further, Singh and Chauhan (2002) stated that the nutrient content of NPK in farm yard manure was 1.73, 0.28 and 1.02 per cent, respectively. In addition to these, it also contain Sulper 0.34 per cent and Calcium 0.79 per cent. From Uttaranchal, Ghosh and Singh (2003) reported that farm yard manure contained 0.6 per cent N, 0.25 per cent P_2O_5 and 0.30 per cent K_2O on dry weight basis.

Anand (2003) analysed the farm yard manure which was produced at farmer's field in Manchiganhalli, Kolar district of Karnataka and he found that FYM contained 0.8 per cent nitrogen, 0.4 per cent phosphorus, 0.6 per cent potassium and 20.2 per cent carbon.

Halemani *et al.* (2004) analyzed different organic manures for their nutrient composition and found that the FYM contained 0.64 per cent N, 0.31 per cent P_2O_5 and 0.55 per cent K_2O .

Ravi Kumar (2009) reported the composition of FYM prepared at farmer's field at Hosahalli, Chikkaballapur district of Karnataka consists of 10.86 per cent organic carbon, 0.62 per cent N, 0.3 per cent P₂O₅, 0.4 per cent K₂O, 2.3 per cent Ca, 0.92 per cent Mg, 0.44 per cent S and 40, 91, 1169 & 698 ppm Cu, Zn, Fe & Mn, respectively.

Reddy *et al.* (2010) analysed composition of farm yard manure at different research stations (Research Institute on Organic Farming) of University of Agricultural Sciences, Bangalore. At ARS, Baljigapade it consisted of 0.8 per cent nitrogen, 0.63 per cent phosphorus 0.8 per cent potassium, 8036 ppm Fe, 13.2 ppm Mn, 30.4 ppm Cu and 132.4 ppm Zn. FYM consisted of 0.58 per cent N, 0.32 per cent P₂O₅ and 0.52 per cent K₂O at ZARS, Mandya. At ARS, Chintamani, farmyard manure consisted of 0.42 per cent nitrogen, 0.30 per cent phosphorus, 0.40 ppm Zn, 698 ppm Mn and 40.4 ppm Cu. While at OFRC, Naganahalli, cow dung consisted of 0.48 per cent N, 0.26 P₂O₅, 0.34 per cent K₂O on dry weight basis (Reddy *et al.*, 2011).

Baik *et al.* (2011) from Bhubaneswar reported that FYM contains 0.52, 0.18 and 0.23 per cent N, P and K, respectively.

Aswal *et al.* (2012) reported that farmyard manure possessed 0.8 per cent nitrogen, 0.25 per cent phosphorus and 0.54 per cent potassium. Further, Choudhary *et al.* (2013) stated that the nutrient content of NPK in farm yard manure was 0.50, 0.25 and 0.40 per cent, respectively

Nutrient concentrations in FYM are usually vary and greatly depending upon source, conditions, and duration of storage. The N, P, and K contents of fresh FYM range widely from 0.01 to 1.9 percent on dry weight basis due to variable nature of manure production and storage. On an average, well-rotted FYM contains 0.5 per cent N, 0.2 per cent P₂O₅, and 0.5 per cent K₂O (Yadav *et al.*, 2013).

2.1.2 Composition of liquid manures

Reddy *et al.* (2011) in their studies found that cattle urine, beejamrutha, jeevamrutha and panchagavya are being used in organic farming and these liquid manures varied in their composition with type of breed, feeds and quantity of ingredients used in the preparation of liquid organic manures. Further, they also reported composition of cattle urine varies with type of feed and breed for e.g. Cross breed jersey and HF cow urine was rich in N (0.61 – 1.47 %), P (0.027 – 0.048 %) and K (1.49 – 1.9 %) besides it contains nutrients like Ca (1.2-2.81 meq/l), Mg (6-9.6 meq/l), Zn (3.76-8.28 ppm), Cu (1.01-1.18 ppm), Mn (0.46-1.14 ppm) & Fe (2.78-6.81ppm).

2.1.2.1 Composition of jeevamrutha

Jeevamrutha is an organic preparation made from products like cow dung, cow urine, pulse flour, jaggery or molasses and hand full of farm soil. Jeevamrutha popularized by Shri SubhashPalekar, is considered to be a panacea for the prosperity of small farmers. It is important to provide a congenial environment to microorganisms that help in making the essential nutrients available for plant growth *viz.*, nitrogen, phosphorus and potassium. Jeevamrutha provides good environment to beneficial

microbes. Application of jeevamrutha to the soil improves the soil fertility considerably. It also encourages microbial activity in the soil (Palekar, 2006). Jeevamrutha is a fermented liquid product prepared by mixing up cow dung with cow urine, jaggery, pulse flour and handful of soil brought from the bunds of the fields where cultivation is to be taken up. Jeevamrutha also contains enormous amount of microbial load which multiply and act as a soil tonic. It is said to enhance microbial activity in soil and ultimately ensuring the availability and uptake of nutrients by the crops (Palekar, 2006).

Vasanthkumar (2006) reported that jeevamrutha is not a source of nutrients, but it is a fermented liquid product containing huge quantity of microbial load which enhances soil bio-mass upon its application to the soil even at very lesser rate as it act as a tonic to soil besides improving soil health.

Devakumar *et al.* (2008) reported that maximum microbial population was observed between 9th and 12th day of the preparation of jeevamrutha. This might have enhanced the decomposition process in the soil which might have resulted in relatively quick release of nutrients from compost than without application of jeevamrutha.

Kasbe *et al.* (2009) noticed that incubation of jeevamrutha for a longer period reduced the N and P content of jeevamrutha, because of longer incubation might have allowed volatilization of nitrogen and phosphorous.

Neelima and Sreenivasa (2011) analyzed jeevamrutha for their composition and found that the jeevamrutha contained pH 7.07, EC 3.40 dsm^{-1} , nitrogen 770 ppm, phosphorus 166 ppm, Potassium 126 ppm and micronutrients like zinc 4.29 ppm, Copper 1.58 ppm, Iron 282 ppm, Manganese 10.7 ppm and also beneficial microbes like bacteria, fungi, actinomycetes, N fixers and phosphate solubilizers.

Aulakh *et al.* (2013) observed that fungal count was highest in the jeevamrutha solution prepared from the excreta of hybrid cow (1.35×10^4 Colony Forming Unit (cfu) ml^{-1}) followed by Indian cow (1.30×10^4 cfu ml^{-1}) and buffalo (1.10×10^4 cfu ml^{-1}). The nutrient contents were 0.22, 0.04 and 0.60 g nitrogen, 0.11, 0.04 and 0.06 g phosphorous, 1.09, 0.28 and 0.75 g potassium and 0.46, 0.43 and 0.39 g sulphur in each litre of jeevamrit prepared from Buffalo, Indian cow and Hybrid cow, respectively.

Devakumar *et al.* (2014) reported that nutrient composition of jeevamrutha formulation having a pH of 4.92, nutrients like Nitrogen 1.96 per cent, Phosphorus 0.280 per cent and Potassium 0.173 per cent and also contains micronutrient like Mg 46 ppm and Cu 51 ppm.

Devakumar *et al.* (2014) reported that presence of beneficial microorganisms in jeevamrutha might be due to its constituents such as cow dung, cow urine, legume flour and jaggery which contain both macro and micro nutrients, vitamins, essential amino acids, growth promoting substances like Indole Acetic Acid (IAA), Gibberlic Acid (GA) and beneficial microorganisms. Similar results were reported by Palekar (2006); Sreenivasa and Nagaraj (2011) and Swaminathan (2005).

Devakumar *et al.* (2014) revealed that there was less microbial load on the day of jeevamrutha preparation and later it reaches to maximum on the 10th day of its preparation. After that it starts to decline as the day passes. Maximum CFU of bacteria (855×10^5), Fungi (29×10^5) Actinomycetes (8×10^4), N-fixers (69×10^5) and P-solubilizer (80×10^5) were recorded on the 10th day of its preparation.

2.1.2.2 Composition of Panchagavya

Panchagavya is a term used in Ayurveda to describe five important substances obtained from cow namely urine, dung, milk, ghee and curd. A number of formulations mentioned in Ayurveda described the use of panchagavya components either alone or in combination with drugs of herbal, animal or mineral origin.

The presence of Effective Micro Organisms (EMO) in panchagavya, EMO were the mixed culture of naturally occurring, beneficial microbes mostly lactic acid bacteria (*Lactobacillus* sp.), yeast (*Saccharomyces*), actinomyces (*Streptomyces*), photosynthetic bacteria (*Rhodospirillum rubrum*) and certain fungi (*Aspergillus*) that improved the soil quality and growth and yield of sweet corn (Xu, 2001).

Ammonia and nitrite oxidizers were found in panchagavya to colonize the leaves and increased the ammonia uptake and total N supply of spruce trees (Papen *et al.*, 2002).

Solaiappan (2002) reported that panchagavya, proven bio fertilizers which contain *Azospirillum*, *Azotobacter*, *Phosphobacterium* and *Pseudomonas* were found besides *Lactobacillus*. Presence of growth hormones viz., IAA and GA in substantial quantities in panchagavya was reported by Somsundaram (2003).

Panchagavya is an organic formulation prepared with five products of cow viz., milk, curd, dung and urine (Natarajan, 2002). It consists of macro (N, P, K and Ca) and micro (Zn, Fe, Cu, Mn) nutrients (Papen *et al.*, 2002), biofertilizers such as *Azospirillum*, *Azotobacter*, *Phosphobacteria* and *speudomonas* (Yadav and Louduraj, 2006a), growth promoting enzymes along with essential plant nutrients (Vasumathi, 2001, Perumal *et al.*, 2006 and Sanjutha, *et al.*, 2008) .

Somasundaram and Singaram (2006) analyzed panchagavya and quantified the composition of N (302.00 mg/kg), total P (218.00 mg/kg), total K (355.00 mg/kg), total sugars (205.00 g/ml), glucose (6.00 mg/dl), sodium (96.00 mg/kg), calcium (27.00 mg/kg), total organic carbon (0.80%), IAA (9.15 mg/kg), GA (4.00 mg/kg), phenols (0.75 g/ml) bacteria (34×10^6 cfu/ml), fungi (22×10^4 cfu/ml), *Actinomycetes* (3×10^{12} cfu/ml), *Pseudomonas* (45×10^3 cfu/ml), yeast (35×10^4 cfu/ml), lactic acid bacteria (22×10^6 cfu/ml), methylotrophs (5×10^3 cfu/ml), *Azospirillum* (2×10^2 cfu/ml), *Azotobacter* (43×10^3 cfu/ml), ammonium oxidizers (24×10^5 cfu/ml), nitrite oxidizers (2×10^2 cfu/ml), Zn (0.26 mg/kg), Fe (0.83 mg/kg), Mn (0.23 mg/kg) and Cu (0.2 mg/kg). The pH and Ec were 5.62 and 10.3 dS/m, respectively.

Selvaraja *et al.* (2007) analysed biochemical properties of panchagavya and revealed that it possesses almost all the major nutrients like N, P, K and micronutrients

necessary for plant and growth hormones like IAA and GA required for crop growth as well as the predominance of fermentative microorganisms like yeast, *Azotobactor*, phosphobacteria and *Lactobacillus*.

Panchagavya preparation includes tender coconut water which contains kinetin which plays a role in enhancing chlorophyll content of plant leaves, thus enhancing photosynthetic activity, growth and yield. The fermented liquid organic manures also contain microbial load and plant growth-promoting substances in addition to nutrients that help in improving plant growth, metabolic activities and resistance to pest and diseases (Geetha and Devaraj, 2013).

The chemical properties of panchagavya which have acidic pH (5.45-5.70), increased EC (9.20-10.22 dSm²) nutrients like N (229- 310ppm), P (209-2015 ppm), K (232- 325 ppm), Na 90 ppm, Ca 25 ppm, Fe 217 ppm, Mg 27 ppm, Cu 41.6 ppm. It contains total organic carbon 0.85 per cent and growth promoters like IAA 8.5 ppm and GA 3.3 ppm, it also contains biological components like fungi, bacteria, actinomycetes, *Pseudomonas*, *Lactobacillus*, acidofomers and methanogens (Suresh *et al.*, 2001 and Patel *et al.*, 2014).

2.2 Effect of organic manures on crop growth and yield

2.2.1 Effect of FYM on crop growth and yield

Rayar (1986) noticed that farmyard manure application increased the nodulation whereas nitrogen and phosphorus application decreased the nodulation.

Sarkar *et al.* (1997) observed significantly higher yield attributing characters of pigeon pea with the application of 10 t ha⁻¹ of FYM as compared to control. The grain yield (12.23 q ha⁻¹) followed the same trend when compared to control (10.40 q ha⁻¹) and mean grain yield recorded with 10 t ha⁻¹ of FYM was 18 per cent higher than the control.

Thakur *et al.* (1999) recorded higher values of yield attributes in wheat with the application of FYM 10 tonnes ha⁻¹ viz., number of ears m⁻¹ row length (74.22), ear head length (8.22 cm), grains ear head⁻¹ (43.33), test weight (35.11 g) and grain yield (30.62 q ha⁻¹) than without organic manure application.

Prabhakar Reddy and Narayana Swamy (2000) noticed that a significant increase in the dry matter plant⁻¹ (7.65 g), pods plant⁻¹ (14.83) and yield (866 kg ha⁻¹) of blackgram when 10 t ha⁻¹ of FYM was added as compared to control. The dry matter plant⁻¹ (7.08 g), pods plant⁻¹ (13.69) and yield (793 kg ha⁻¹) were recorded from treatment which did not receive FYM application.

Application of FYM at 20 t ha⁻¹ recorded significantly higher pod yield and haulm yield of rainfed groundnut over no fertilization and it was comparable with that of 50 per cent RDF (Kachot *et al.*, 2001). Whereas, application of FYM at 24 t ha⁻¹ and vermicompost at 10.8 t ha⁻¹ as single application, found on par with each other with

respect to yield and yield parameters. Further in case of maize, FYM applied at 24 tonnes ha^{-1} recorded higher yield over vermicompost at 10.8 t ha^{-1} (Nanjappa *et al.*, 2001).

A field experiment conducted during *Kharif* 2003 at Allahabad showed that application of FYM at 10 t ha^{-1} recorded significantly higher seed yield of black gram (17.4 q ha^{-1}) as compared to control (no-FYM application). However, it also increased pods per plant, seeds per pod and seed yield by 20, 12 and 7 per cent, respectively over control (no FYM) (Sharma and Thomas, 2010).

Yadav and Chipa (2007) revealed that grain and straw yield of wheat increased significantly with the successive in the level of FYM and consequently, the application of FYM at 30 t ha^{-1} recorded the highest grain (2.76 t ha^{-1}) and straw (4.3 t ha^{-1}) yield over FYM at 10 t ha^{-1} (2.29 and 3.50 t ha^{-1} grain and straw yield, respectively) and FYM at 20 t ha^{-1} (2.60 and 4.00 t ha^{-1} grain and straw yield, respectively). Also found that N, S and Fe content of soil increased with the application of FYM up to 30 t ha^{-1} . Whereas P and K content increased significantly with the application of FYM up to 30 t ha^{-1} .

Muneshwar Singh *et al.* (2008) concluded that among all four nutrient supplying system, the seed yield of soybean (3.86 and 3.88 t ha^{-1} in FYM and poultry manure, respectively) was at par with in a year which suggests that soybean can be grown by using the organic sources of nutrient alone without any loss in yield.

Devakumar *et al.* (2011) reported that combination of compost + poultry manure + press mud (1:1:1 by weight equivalent to 7.5 t of FYM + 25 kg N equivalent compost ha^{-1}) produced higher seed yield of fieldbean (12.8 q ha^{-1}) which was on par with compost + poultry manure (1:1) (12.2 q ha^{-1}).

Dadgale *et al.* (2011) revealed that the growth and yield of green gram was significantly higher with the application of RDF as compared to application of FYM and vermicompost equivalent to RDN.

Guriqbal Singh *et al.* (2012) noticed that application of 5 t FYM ha^{-1} improved chickpea grain yield by 14.89 per cent over no application of FYM. It improved the plant growth parameters *viz.*, plant height (54.1 cm), branches plant^{-1} (7.92) and yield attributes *viz.*, number of pods (48.2 plant^{-1}) and 100-seed weight (13.5 g).

Devakumar *et al.* (2016) reported that application of N equivalent compost with beejamruta and jeevamruta resulted in increasing the yield of organic fieldbean compared to individual application of different N equivalent compost and beejamruta.

Ramesh *et al.* (2012) studied the response of soybean to nutrient management options under soybean cropping systems for three seasons (2004 to 2006) and reported that 100 per cent organic nutrient management through well composted cattle dung manure which could supply 30 kg N ha^{-1} , resulted in significantly lower seed yield of soybean which was 7.8 per cent less than 100 per cent inorganic nutrient management. In

the second year, the yield reduction was 5.3 per cent and in subsequent third year, the yields under organic management were found superior over inorganic management

2.2.2 Effect of Panchagavya on crop growth and yield

Various types of fermented organics prepared from plant and animal origin mainly dung, urine, butter milk, plant extracts, jaggery *etc.*, come under this category. Which includes panchagavya, jeevamrut, beejamrut, sasyamrut, vermiwash, amritpani *etc.* Use of fermented organics prepared from cow dung, cow urine, leguminous leaves or vermiwash are effective in promotion of growth and fruiting. Although, these manures may not provide enough nutrients in the area of application, but they help in the quick build up of soil fertility through enhanced activity of soil micro-flora and fauna (Yadav and Mowade, 2004).

Liquid organic manures are the fermented preparations obtained by active fermentation of plant or animal residues. It is prepared using cow dung and cow urine as base material. Panchagavya is considered to be highly effective liquid organic manure. It has multiple functions and can effectively replace chemical fertilizers and pesticides. The use of fermented organics may improve nutrient status and biological activities. Spraying of panchagavya induce quick flowering, high seed setting percentage and also it increases the growth and yield components with growth promoting activity and it is a low cost technology.

Presence of naturally occurring, beneficial, effective micro organisms (EMO's), in panchagavya predominantly, lactic acid bacteria, yeast, actinomycetes, photosynthetic bacteria and certain fungi besides beneficial and proven fertilizers such as *Azotobacter*, *Azospirillum* and *Phosphobacterium* were detected which have the beneficial effect especially in improving soil quality, growth and yield of crops (Xu, 2001).

Xu (2001) reported that Effective Micro Organism (EMO) cultures could synthesize phytohormones *i.e.*, auxins and other growth regulators that stimulated maize plant growth and they contained proactive substances that could significantly affect leaf stomatal response in maize. Leaf stomata of the EMO treated maize opened more rapidly than water treated control plants and when leaves were subjected to dehydration, the stomata closed more slowly (*i.e.*, remained open longer) thus showed that, EMO contained bioactive substances that could have significantly affected leaf stomata response and led to increased LAI. The Panchagavya is rich in such EMOs.

Somasundaram *et al.* (2003a) reported that 3 per cent panchagavya (formulation prepared out of cow dung + cow urine + cow ghee + cow milk + cow curd with incubation) was the ideal concentration for foliar spray on green gram variety CO-4. They also stated that foliar application of panchagavya at 3 per cent on 15, 25, 40 and 50 DAS with no inorganic was the effective low cost technology in terms of grain yield of green gram.

Somasundaram *et al.* (2003a) observed that foliar application of panchagavya @ 3 per cent on 15, 25, 40 and 50 DAS of green gram resulted in on par values in plant

height, LAI, grain yield, number of pods plant⁻¹, number of seeds plant⁻¹ and 100 grain weight with RDF application.

Somasundaram *et al.* (2003b) observed that the biogas slurry with panchagavya combination is adjudged as the best organic nutritional practice for the sustainability of maize-sunflower-green gram system by its overall performance on growth, productivity, quality of crops, soil health and economics. In another study, it was concluded that foliar application of panchagavya at 3 per cent on 15, 25, 40 and 50 DAS without RDF was the most effective low cost technology in terms of growth and yield of green gram. This has resulted in higher and on par values in plant height (80.3 cm), leaf area index (8.65), grain yield (17.71 q ha⁻¹), number of pods plant⁻¹ (79.25), seeds plant⁻¹ (12.1) and grain weight plant⁻¹ (3.99 g) with that of recommended dose of fertilizers (77.7 cm, 8.17, 17.87 q ha⁻¹, 76.75 plant⁻¹, 12.9 pod plant⁻¹ and 3.87 g plant⁻¹, respectively).

Lourduraj *et al.* (2005) observed that panchagavya at 3 per cent spray 4 times for bhendi augmented the yield level in treatments supplemented with poultry manure (10.27 t ha⁻¹) which was comparable to inorganic supplementation with pesticide spray (10.39 t ha⁻¹).

Boomathi *et al.* (2005) reported that the increase in uptake of nutrients and fruit yield with foliar spray of panchagavya was ascribed to increased biological efficiency of crop plants and creating greater source and sink in the plant system.

Ramanathan (2006) recorded significantly higher grain yield (5430 kg ha⁻¹) with 3 per cent foliar spray of panchagavya at 30 and 50 days after sowing in case of rice over no panchagavya spray (4990 kg ha⁻¹) with different organic manure treatments.

Yadav and Lourduraj (2006a) at Coimbatore showed that foliar spray of Panchagavya recorded significantly higher values of all the yield parameters of rice compared to without Panchagavya spray. Further, milling quality of rice grain improved significantly by Panchagavya spray (Yadav and Lourduraj, 2006 b).

De Britto and Girija (2006) reported that use of panchagavya improved plant growth parameters in black gram and green gram. They also reported that cow dung in panchagavya acts as a medium for the growth of beneficial microbes and cow urine provides nitrogen which is essential for crop growth.

Selvaraj *et al.*, (2007) have reported that plants sprayed with panchagavya invariably produce bigger leaves and develop denser canopy. Also, the photosynthetic system is activated for enhanced biological efficiency, enabling synthesis of maximum metabolites and photosynthates.

Swaminathan *et al.* (2007) concluded that foliar application of panchagavya at 3.0 per cent at first appearance of flowering and 15 days later in black gram recorded higher values of growth and yield parameters over inorganic nutrition treatment (2 % DAP spray) under rainfed conditions. In another study, it was reported that the presence of

naturally occurring beneficial microorganisms predominantly lactic acid bacteria, yeast, actinomycetes, photosynthetic bacteria and certain fungi in panchagavya.

Birendra and Christopher (2007), foliar spray of panchagavya at 3 per cent resulted in significant increase in yield attributes. Kalarani (1991) reported that the action of growth regulators in plant system stimulated the necessary growth and development in plants and better yield. The preparation of panchagavya includes coconut water, which contains kinetin which increases the biomass and yield (Mamaril and Lopez, 1997).

Seed treated with beejamruta and panchagavya has enhanced the yield of maize compared to control. Panchagavya (3 %) sprayed at 30 and 60 DAS has resulted in higher maize grain and stover yield under different fertility management systems. Similar findings were reported in bhendi, fieldbean and finger millet crops (Devakumar *et al.*, 2008).

The presence of auxin in panchagavya controls the water regulation in developing fruits of okra. Regular and uniform water supply to the developing fruits resulted in increased ascorbic acid content, Barletts index and crude protein content (Vennila and Jayanthi, 2008).

Ravi Kumar (2009) revealed that application of FYM at 7.5 t ha⁻¹ along with Rhizobium, Phosphate Solubilizing Bacteria (PSB) and 3 per cent panchagavya spray equivalent to 25 kg N ha⁻¹ recorded higher pod yield (2304 kg ha⁻¹) and haulm yield (2695 kg ha⁻¹) in groundnut compared to control (FYM at 7.5 t ha⁻¹).

Kumaravelu and Kadamban (2009) revealed that the greengram seedlings showed significant growth increase at 4 per cent panchagavya treatment, whereas under panchagavya irrigation, growth was promoted at 2 per cent. In a pot study, 3 per cent panchagavya spray at 10 DAS significantly increased the growth of greengram plants. The lateral roots, number of nodules, fresh and dry matter of the plants and total leaf area of the plant were increased significantly at 3 per cent panchagavya spray.

Malarvizhi *et al.* (2009) reported that different organic and inorganic growth promoters were applied as foliar sprays in paprika cv. Kt-P1-19. From the investigation, it could be inferred that the pre harvest spray of panchagavya at 2 per cent had positive effect on plant growth and yield. The possible reason for this acceleration of crop growth might be due to the increased content of nitrogen, the chief constituent of protein, essential for the formation of protoplasm, which leads to cell division and cell enlargement.

Sreenivasa and Nagaraj Naik (2011) opined that presence of beneficial microbial biomass in panchagavya resulted in improved seed germination, seedling length and seedling vigour in wheat and soybean and noted panchagavya as efficient plant growth stimulant.

Patil *et al.* (2012) studied the response of chickpea to soil application of organic manures along with foliar spray of liquid organic manure at flower initiation and 15 days after flowering and reported that among nutrient combinations, application of enriched compost (1/3) + vermicompost (1/3) + *glyricidia* leaf manure (1/3) equivalent to 100 per cent RDN and foliar spray of 3 per cent panchagavya recorded significantly higher grain yield (2400 kg ha⁻¹), haulm yield (3423 kg ha⁻¹), number of pods plant⁻¹ (66.38) and 100 seed weight (20.91 g) when compared to RDF and other treatments.

Rajanna *et al.* (2012) concluded that continuous application of liquid organic manures along with bulky manures helped in improving the soil fertility and found essential in order to achieve the sustainability in terms of ecosystem.

Tripathi *et al.* (2012) obtained that significantly higher baby corn yield (897 kg ha⁻¹) and green fodder yield (4972 kg ha⁻¹) with foliar application of 3 per cent panchagavya at 30 days, knee high and pre-tasseling stage as compared to water spray.

Application of enriched biodigested liquid organic manure (EBDLM) at 25 kg N equivalent ha⁻¹ + 3 spray of panchagavya at 3 per cent resulted in significantly higher pod and kernel yields and total system productivity (2.34, 1.78, 10.1 and 12.4 t ha⁻¹, respectively) and yield attributes like number of pods per plant and shelling out turn (47.2 and 76.0 % respectively) of groundnut (Latha and sharanappa, 2014)

Pradeep Gopakkali and sharanappa (2014) revealed that significantly higher plant height, number of branches, leaf area index, total dry matter production, number of fruits plants⁻¹, 100 fruit weight, fruit length and fruit yield with the application of EBDLM at 125 kg N equivalent ha⁻¹ + spray of panchagavya 3 per cent as compared recommended dose of fertilizer.

Swain *et al.* (2015) reported that foliar application of panchagavya 3 per cent concentration at 10 days interval produce highest plant height (80.17 cm), early 50 per cent flowering (44.33 days), highest number of flowers (301.73), number of fruits (169.45) and highest yield ha⁻¹ (21.95 q).

The possible reason for higher growth characters and increased height might be due to the growth enzymes present in panchagavya which favoured rapid cell division and multiplication. Panchagavya is an organic formulation that enhances the biological efficiency of crop plants and quality of fruits and vegetables (Sivakumar, 2014).

2.2.3 Effect of Jeevamrutha on crop growth and yield

Kesarwani (2007) proved that application of organic mixture according to Subhash Palekar's method (beejamruta (seed treatment) + jeevamruta (soil application) + Straw mulch) to sweet sorghum improved the earhead weight, 100 grain weight and total biomass production (81.91 g, 34.0 g and 39.49 t ha⁻¹, respectively) and they were on par with 100 per cent RDF (100:75:40 kg N: P₂O₅: K₂O ha⁻¹) (84.14g, 35.50g and 62.66 t ha⁻¹).

Kasbe *et al.* (2009) reported that the application of jeevamruta formulation (10638 litre ha⁻¹) in rice-black gram cropping sequence recorded significantly higher total dry matter (163.05 g plant⁻¹) over other treatments except jeevamruta formulation 27777 litre ha⁻¹ which was on par with jeevamruta formulation 10638 litre ha⁻¹ (150.67 g).

Manjunatha *et al.* (2009) reported that application of FYM at 7.5 t ha⁻¹ + 100 per cent RDF recorded significantly higher seed yield of sunflower (1774 kg ha⁻¹) which was on par with the application of FYM at 7.5 t ha⁻¹ + jeevamruta (1733 kg ha⁻¹) and it was significantly superior over treatment FYM at 3.75 t ha⁻¹ + jeevamruta application (1551 kg ha⁻¹).

Neelima and Sreenivasa (2011) revealed that application of RDF + beejamruta + jeevamruta + panchagavya resulted in significantly higher number of tomato fruits per plant (23.50) and fruit weight (316.6 g) as compared to RDF (11.12 and 167.23 g, respectively) due to adequate supply of required nutrients through chemical fertilizers at early stage of plant growth. Application of liquid manures has improved the soil physical and chemical properties.

Boraiah (2013) reported that application of jeevamruta resulted in 7.98 to 26.20 per cent increase in fruit yield of capsicum as compare to without jeevamruta application. This might be due to higher number of fruits per plant (43.99 to 56.31), fruit length (6.82 to 7.43 cm), total dry matter per plant (10.46 to 15.67 g), fruit girth (16.81 to 17.19 cm) and fruit weight (126.12 to 125.67g).

Yogananda *et al.* (2015) reported that application of 100 per cent N equivalent compost along with recommended dose of FYM, jeevamruta and beejamruta has significantly increased the plant height (70.13 cm), number of leaves (63.53), number of branches (8.47), grain yield (1740 kg ha⁻¹) and stover yield (1864 kg ha⁻¹) of cowpea when compared to application of compost and liquid manures.

Devakumar *et al.* (2016) reported that application of N equivalent compost with beejamruta and jeevamruta resulted in increasing the yield of organic fieldbean compared to individual application of different N equivalent compost and beejamruta.

Reshma *et al.* (2016) reported that combined application of jeevamruta (1000 litre ha⁻¹) and panchagavya (7.5 %) resulted in better growth, yield and yield attributing characters in cowpea besides conserving soil health. Similarly, application of jeevamruta (400 litre acre⁻¹) and panchagavya (7.5 %) resulted in multiplication of different beneficial microbes in fieldbean (Lavanya *et al.*, 2016).

2.3 Effect of organic manures on quality parameters

The term quality implies the degree of excellence of a product or its suitability for a particular use. Quality of produce encompasses appearance, texture, nutritive values, chemical constituents, mechanical properties, functional properties and defects. Shelf life affects food quality, which in turn influences the consumer's buying decisions. Product

quality is very important to growers because it determines marketable yield and can affect price.

Beulah (2001) reported that, the quality parameters *viz.*, crude fibers, protein, ascorbic acid, carotene content and shelf life were also higher under organic manure applied with panchagavya spray in rice.

Singh (2002) reported that combination of organic manures *viz.*, farm yard manure and dense organic manure and neemax accounted for higher yield, higher protein and vitamin C content with prolonged shelf life in french bean under ambient storage conditions.

Sankar *et al.* (2005) reported with the organic treatment combinations consisting of 3 per cent panchagavya + 50 per cent FYM + 50 per cent poultry manure registered the lowest total loss (30.57 %) in onion at 120 days after storage over inorganic treatment combination of 100 per cent NPK (39.84 %).

Sanwal *et al.* (2005) noted that foliar spray of panchavkavya and amritpani at 10 per cent and use of natural growth promoters resulted in higher dry matter content, pH, ascorbic acid content, total soluble solids, reducing sugars and total sugars, but lower fiber contents in stems and flowers of broccoli than NPK treatment.

Yadav and Lourduraj (2006b) revealed that foliar spray of panchagavya and organic manures recorded higher cooking qualities and physical characteristics of rice as well as higher sensory score as compared to recommended N, P and K through fertilizers. Noted that milling quality of rice grain was also improved significantly by panchagavya spray.

Vennila and Jayanthi (2008) revealed that application of 100 per cent recommended dose of fertilizer along with panchagavya spray (2 %) in okra resulted in higher crude protein, ascorbic acid and Barletts index. The presence of auxin in panchagavya controls the water regulation in developing fruits. Regular and uniform water supply to the developing fruits resulted in increased ascorbic acid content, Barletts index and crude protein content.

Dasappa *et al.* (2011) reported that significant improvement in the leaf quality traits in mulberry *viz.*, leaf moisture, available nitrogen, Phosphorus and potassium with the application of organic manure alone (Sericompost 10 t + vermicompost 10 t + VAM 100 kg + *Azotobacter chroococcum* 23 kg + PSB 5 kg + green manure seeds 40 kg + neem oil cake 1000 kg/ha/year + FYM 20 t/ha/year).

Jayaram Reddy and Reddy (2011) analyzed the organically grown fieldbean (Hebbal avare - 4) seeds for its quality parameters and found that the seeds contain protein, fat, fiber, ash, Ca and Fe to the extent of 25.2 , 0.57, 8.97, 3.2, 49.7 and 1.62 g per 100 g of seed respectively.

Siddaram (2012) revealed that protein yield of fieldbean differed significantly with higher protein yield of 289.6 and 275.3 kg ha⁻¹ were obtained by the application of recommended practice of FYM 7.5 t + 25:50:25 kg ha⁻¹ N: P₂O₅: K₂O ha⁻¹ and FYM 10 t + BDLME equivalent to 35 kg N ha⁻¹, respectively as compared to other treatment combinations.

Shanmugaraju *et al.* (2014) reported that application of FYM along with *Rhizobium*, *Phosphobacteria* and *Azospirillum* recorded significantly higher reducing sugar content and amino acids content in frenchbean (5.43 mg g⁻¹ and 18.46 mg g⁻¹) as compared to control (1.8 mg g⁻¹ and 2.25 mg g⁻¹). Similarly significantly higher protein content and carbohydrate content in frenchbean (12.36 mg g⁻¹ and 23.8 mg g⁻¹) as compared to control (0.25 mg g⁻¹ and 11 mg g⁻¹).

Kiran (2014) reported that application of beejamrutha along with jeevamrutha, vermicompost and panchagavya recorded higher protein content (21.23 %) followed by beejamrutha along with jeevamrutha, FYM, vermicompost and panchagavya (21.06 %). The treatment received with beejamrutha + jeevamrutha alone registered lower protein content in chick pea seeds (20.15 %).

Application of EBDLM at 25 kg N equivalent/ha + 3 spray of 3 per cent panchagavya for groundnut, EBDLM at 125 kg N equivalent ha⁻¹ + 3 spray of 3 per cent panchagavya for onion improved significantly parameters like oil and protein yield (875 and 364 kg/ha) in groundnut and total soluble solids, reducing and non-reducing sugars, ascorbic and pyruvic acid (16.93, 3.66 and 8.66 %, 25.27 mg 100/g and 12.82 μ moles/g, respectively) of onion bulb (Latha and Sharanappa, 2014).

Siddappa (2015) reported that application of FYM and jeevamrutha improved the quality parameters *viz.*, moisture content, ash content, protein content, fat content, crude fibre content and carbohydrate content of fieldbean over FYM at 100 per cent N equivalent + no- jeevamrutha application.

2.4 Effect of organic manures on nutrient up take by plants

Liquid organic manure influences the availability of nutrients in soil which was reflected in crop uptake. Phosphorus and ammonium in soil was increased in the upper layer of soil with the application of sheep urine (Powell *et al.*, 1998).

Panchagavya along with poultry manure and neem cake application in *Moringa olifera* increased the Ca, S and Fe as well as NPK content of leaves and pods. Nutrient uptake and nutrient use efficiency was higher both in main and ratoon crop of *Moringa olifera* (Beulah, 2001).

Presence of macro (N, P, K and Ca) and micro (Zn, Fe, Cu, Mn) nutrients besides total reducing sugars (glucose) were observed in panchagavya. Chemolithotrops and autotrophic nitrifiers (ammonifiers and nitrifiers) present in panchagavya which colonize in the leaves increase the ammonia uptake and enhance the total N supply (Papen *et al.*, 2002).

Shete *et al.* (2011) revealed that significantly higher total nitrogen uptake (55.1 kg ha⁻¹) and phosphorous uptake (188.7 kg ha⁻¹) by green gram was observed with the application of FYM at 5 t ha⁻¹ over control.

Chandrakala *et al.* (2007) recorded significantly higher uptake of N, P and K (60.61, 12.98, 58.47 and 102.74, 11.99, 98.65 kg ha⁻¹, respectively) by combined application of beejamrutha + jeevamrutha + panchagavya and panchagavya and increased dry fruit yield of chilli (8.52 and 8.01 q ha⁻¹, respectively) as compare to beejamrutha + jeevamrutha application. Who have also reported that combined application of FYM and beejamrut + jeevamrut + panchagavya recorded significantly higher *dehydrogenase* activity (30.00 and 25.67 mg TPF/g soil day at 120 and 160 DAT, respectively) in capsicum. This might be due to favorable effects of both FYM and liquid manures that help in proliferating microbial population by providing greater amount of nutrients particularly carbon as energy source.

Neelima and Sreenivasa (2011) reported that application of RDF along with beejamrutha, jeevamrutha and panchagavya recorded significantly higher nutrient uptake viz., N, P and K in tomato crop (4.38 kg ha⁻¹, 0.43 kg ha⁻¹ and 1.03 kg ha⁻¹ respectively.) as compared to application of Beejamrutha, jeevamrutha and Panchagavya (3.36 kg ha⁻¹, 0.35 kg ha⁻¹ and 1.087 kg ha⁻¹, respectively). Significantly lower uptake was observed with control (2.4 kg ha⁻¹, 0.23 kg ha⁻¹ and 0.76 kg ha⁻¹, respectively).

Pradeep Gopakkali *et al.* (2011) revealed that the nutrient uptake of nitrogen (107.6 kg ha⁻¹), phosphorus (26 kg ha⁻¹) and potassium (78.7 kg ha⁻¹) was significantly higher with application of FYM at 10 t ha⁻¹ along with cow urine equivalent to 100 kg N ha⁻¹.

Siddaram (2012) revealed that higher total N, P₂O₅ and K₂O (92.3, 15.45 and 82.2 kg ha⁻¹, respectively) were taken up by finger millet when applied with FYM 10 t ha⁻¹ + Bio-digester liquid manure (BDLME) equivalent to 35 kg N ha⁻¹ which was no-par with FYM at 10 t ha⁻¹ + BDLME equivalent to 30 kg N ha⁻¹ (91.0, 15.22 and 82.6 N, P₂O and K₂O kg ha⁻¹, respectively) and recommended practice i.e FYM at 7.5 t + 25:50:25 N: P₂O: K₂O kg ha⁻¹ (996.0, 15.96 and 86.1 kg ha⁻¹, respectively).

Rajkhowa *et al.* (2012) reported that significant increase in yield, nutrient (N and P) uptake and nodulation in combined use of fertilizer and vermicompost. Soil organic carbon, available N, P and K status in soil improved significantly with vermicompost alone or in combination with fertilizer and there is a possibility of saving 25 to 50 per cent fertilizer through the addition of vermicompost at 2.5 t ha⁻¹.

Application of FYM at 200 per cent N equivalent recorded significantly higher plant nitrogen content at 40 DAS, 55 DAS, 75DAS and at harvest (3.23, 2.38, 2.18 and 4.33 %, respectively), phosphorous (0.354, 0.341, 0.334 and 0.390 %, respectively) and potassium (3.029, 2.443, 2.181 and 4.234, respectively) over FYM at 150 per cent N equivalent and FYM at 100 per cent N equivalent. Similarly, application of jeevamrutha

at 1500 L ha⁻¹ recorded significantly higher plant N, P and K content in fieldbean at harvest over without jeevamrutha application (Siddappa, 2015).

2.5 Effect of organic manures on soil properties

The use of organic manure had shown beneficial effect by direct, residual and cumulative effect on soil conditions by influencing the physico-chemical and biological properties of soil (Anon., 1992). Many researchers reported that in an organically managed field, activity of earth worm is higher than in inorganic agriculture (Edwards and Lofty, 1974). In the biodegradation process earthworms and microbes work together and produce vermicompost, which is the worm fecal matter with worm casts.

2.5.1 Effect of organic manures on soil physical and chemical properties

Application of FYM gradually and significantly reduced the bulk density, increased water holding capacity and improved the water stable aggregates of the soils (Lal and Mathur, 1989).

Organic carbon content of soil changes rapidly with addition of organic manures. Immobilization and mineralization of nutrients are two important processes that take place simultaneously in soil with the addition of organic manures. The slight but consistent increase in organic carbon even under tropical condition that had been reported by Sundara Rao and Anoop Krishnan (1963).

Patil *et al.* (2003) reported that application of FYM (15 to 30 t ha⁻¹) decreased the soil pH from 7.93 to 7.71 and increased the electrical conductivity and organic carbon content in soil. They also noticed that there was decrease in the calcium carbonate content with increase in the levels of farmyard manure. On the contrary, FYM prepared out of animal wastes (dung, urine) from animals fed with concentrated feeds rich in proteins, salts *etc.* increased the soil EC, besides N, P, K and other nutrients.

In a long term field experiment with different manurial treatments, decline in soil pH and EC was observed in maize-mustard cropping system. Maximum reduction was recorded in the plot receiving 100 per cent recommended N through FYM in rainy season (maize) and 100 per cent recommended N, P₂O₅ through fertilizer in winter season (mustard) which may be ascribed to the formation of acid during decomposition of organic matter (Kumpawat, 2004).

Bonde *et al.* (2004) observed that all the organic residues significantly lowered the bulk density over the control. Among different organic residues, FYM recorded greater value of availability of nitrogen, phosphorus and potassium in soil as compared to other treatments (wheat straw and pressmud compost treatments) including control, in cotton-soybean cropping system.

Varalakshmi *et al.* (2005) reported that organic carbon content of soil was higher in the treatment which received 100 per cent nitrogen through FYM as compared to

control. In the same line Yadav *et al.* (2005) reported that application of 20 t FYM ha⁻¹ showed significant increase in EC, pH, ESP and increase in organic carbon content, N, P₂O₅ and K₂O and exchangeable Ca and Mg of soil.

Gajanan *et al.* (2005) reported that there was reduction in the bulk density of the soils receiving organic manure alone or combined application of organic manure and fertilizers. The decrease in bulk density was higher in FYM applied plots compared to the plots receiving integrated nutrient management practices. On the contrary to this the bulk density remained unaltered in fertilizer applied plots because of mild compaction and loss of organic matter.

Water holding capacity of the soil was progressively improved with the application of organic manure as compared to inorganic fertilizers. Among the organic manures, application of FYM recorded the highest water holding capacity of the soil, followed by poultry manure and pig manure as observed by Laxminarayana (2006).

Pandey *et al.* (2006) reported that application of manures, irrespective of sources and rates, recorded significantly higher soil organic carbon, available N, P₂O₅, and K₂O compared to control. Higher content of organic carbon in soil may be due to increased yield of roots and plant residues, and external application of organic manures.

The organic carbon content increased from 22.9 to 27.4 per cent over the initial level (5.1 g kg⁻¹) and from 27.5 to 31.2 per cent over control by continuous application of farmyard manure/rice straw or green manure over the years. The bulk density of soil decreased significantly with the application of farmyard manure or *Sesbania aculeata* either alone or in combination with inorganic fertilizers (Bajpai *et al.*, 2006).

Manjunatha (2010) reported that application of FYM at 10.0 t ha⁻¹ + bio-digester liquid manure 150 kg ha⁻¹ improved BD, PD and MWHC in soil. While, Veeresh (2010) reported that application of FYM at 12.5 t ha⁻¹ + cattle urine at 34300 l ha⁻¹ increased the water holding capacity of soil under irrigated condition.

An organic farming system trial conducted for 30 years at Rodale Institute, USA, involving organic compost equivalent to 190 kg N ha⁻¹ for maize and 120 kg for oats was applied and then rotated with legumes like soybean and alfalfa. Results clearly revealed that soil aggregation, water holding capacity, soil aeration were improved. Further, ground water recharge was increased and run off was reduced (Anon., 2011a).

Rajanna *et al.* (2012) did not find significant influence of different organic sources on the soil organic carbon content, pH and EC of soil after harvest of the aerobic rice. However, the available nitrogen (272.7 kg ha⁻¹), phosphorus (37.2 kg ha⁻¹) and potassium (211.6 kg ha⁻¹) content of soil after harvest of the crop was significantly higher with FYM 10 t ha⁻¹ as a basal dose + cattle urine at 100 per cent N equivalent basis as compared to recommended practices.

Yogananda *et al.* (2012) studied the effect of organic nutrient management practices on transplanted rice and recorded higher available nutrient status in soil *viz.*, soil organic carbon content (0.53 %), available nitrogen (353 kg ha⁻¹), available phosphorus (45.45 kg ha⁻¹) and available potassium (230 kg ha⁻¹) with application of 12.5 t FYM ha⁻¹ with bio-digester equivalent to 125 kg N ha⁻¹ compared to control.

Siddappa (2015) revealed that application of farmyard manure at 200 per cent N equivalent recorded significantly higher organic carbon content, lower pH and EC values of soil after harvest of field bean over FYM at 150 100 per cent N equivalent. Whereas, jeevamrutha application did not influence the organic carbon, pH and EC.

From the above literature cited it can be concluded that, organic manures added to soil have been found to improve the physical properties of the soil especially the structure, water holding capacity, infiltration rate, porosity and bulk density.

2.5.2 Effect of organic manures on soil microbial activity

Microflora of soil play an important role in soil health. The microorganisms present in the rhizosphere environment around the roots influence the plant growth and crop yield. The beneficial microorganisms in panchagavya and jeevamrutha their establishment in the soil play a major role in improving crop yield and sustainability of agriculture.

The dehydrogenase are very useful for the assessment of soil microbial responses to manuring because they are believed to be linked primarily with microbial activities that are associated with the initial break down of organic materials (Bolton *et al.*, 1985).

Marinari *et al.* (2000) reported that a higher level of dehydrogenase activity was observed in soil treated with the compost and FYM as compared to soil treated with mineral fertilizers.

Badole and More (2001) opined that application of FYM at 25 t ha⁻¹ recorded higher population of *Azotobacter* (0.38×10^3 cells g⁻¹ soil), *Rhizobium* (10.5×10^3 cells g⁻¹ soil), actinomycetes (14.9×10^4 cells g⁻¹ soil), fungi (6.7×10^3 cells g⁻¹ soil), bacteria (62.5×10^4 cells g⁻¹ soil) and PSB (29.1×10^4 cells g⁻¹ soil) as compared to control treatment.

Vasanthkumar (2006) opined that jeevamrutha is a fermented liquid product rather than source of nutrients, containing huge quantity of microbial load which enhances soil bio-mass upon its application to soil even at very lesser rate as it act as a tonic to soil besides improving soil health.

Kulvinder Kaur *et al.* (2005) reported that application of farmyard manure (15 t ha⁻¹) influenced the microbial biomass carbon, microbial biomass nitrogen and biomass C N ratio. Adegunloye *et al.* (2007) recorded varying microbial loads between 1.6×10^6 and 1.2×10^7 cfu per ml for bacteria, 5.0×10^4 and 5.0×10^7 cfu per ml for fungi in the compost made of cow dung.

Organic manures not only supplies a higher amount of different nutrient elements but also contains beneficial microbes like nitrogen fixing bacteria, mycorrhizae and growth promoting substances for betterment of crops (Barik *et al.*, 2006).

Palekar (2006) reveals that jeevamrutha application to soil promotes immense biological activity in the soil and makes the nutrients available to the crop. Jeevamrutha is not to be considered as a nutrient for the crop but it is only a catalytic agent to promote biological activity in the soil.

Swaminathan *et al.* (2007) concluded that foliar application of panchagavya at 3.0 per cent at first appearance of flowering and 15 days later in balckgram recorded the presence of naturally occurring beneficial microorganisms predominantly lactic acid bacteria, yeast, actinomycetes, photosynthetic bacteria and certain fungi in panchagavya.

Reddy *et al.* (2010) from Kathalagere observed that maximum population of total bacteria (63.6×10^6 cfu g⁻¹ soil), fungi (34×10^4 cfu g⁻¹), actinomycetes (53.7×10^4 cfu g⁻¹), nitrogen fixers (59.2×10^5 cfu g⁻¹) and P - solubilizers (51.9×10^5 cfu g⁻¹) were noticed with FYM 12.5 t ha⁻¹ + cattle urine equivalent to 125 kg ha⁻¹ and minimum population was found with recommended practice (FYM at 10 t ha⁻¹ + 100:50:50 kg NPK ha⁻¹).

Govindaraju and Reddy (2011) conducted field trial at OFRS, Naganahalli to know the microbial biomass and reported that the end of third year of organic farming, there was phenomenal increment in the population of PSB's, *Azotobactor*, *Azospirillum* and *Rhizobium*. Mean increase in *Azospirillum* from 4 to 6 cfu $\times 10^6$ per g soil. Similarly *Rhizobium*, *Azotobactor* and PSB's increment was 0 to 6, 1 to 1, 4 to 6 and 1 to 4 cfu $\times 10^6$ per g soil, respectively in M block. Similarly, at Navile Research Station (Shivamoga) highest population of total bacteria ($58 \text{ cfu} \times 10^5$ g⁻¹ soil), nitrogen fixers ($45 \text{ cfu} \times 10^3$ g⁻¹ soil) and P solubilizers ($32 \text{ cfu} \times 10^3$ g⁻¹ soil) were observed with the application of cow urine (5000 l ha⁻¹) and panchagavya to finger millet crop as compared to without cow urine and panchagavya (Devakumar *et al.*, 2010).

Significantly higher microbial population *viz.*, bacteria, fungi, actinomycetes, N fixers and P solubilizers (63.6×10^6 , 34.0×10^4 , 53.7×10^4 , 59.2×10^5 and 51.9×10^5 cfu/g soil, respectively) was recorded in soil with the application of FYM at 12.5 t ha⁻¹ + cattle urine equivalent to 125 kg N/ha (Pradeep Gopakkali *et al.*, 2011).

In maize-chickpea cropping system, it was observed that higher microbial load in panchagavya *viz.*, bacteria (26.1×10^5 cfu per ml), fungi (18×10^4 cfu g⁻¹ of soil) and PSB (5.70 cfu g^{-1} of soil), free living nitrogen fixers (5 cfu g^{-1} of soil) and Actinomycetes (4.20 cfu g^{-1} of soil) (Anon., 2011).

Sudheendra Saunshi (2012) reported that significantly higher population of bacteria ($54.2 \text{ cfu} \times 10^6$ g⁻¹ soil) were found with FYM 10 t ha⁻¹ + BDLM enriched with poultry manure and rock phosphate equivalent to 60 kg N ha⁻¹ and FYM 10 t ha⁻¹ + BDLM enriched with neem cake and rock phosphate equivalent to 60 kg N ha⁻¹ ($51.8 \text{ cfu} \times 10^6$

g^{-1} soil). These treatments were on par with FYM 10 t ha^{-1} + BDLM enriched with poultry manure equivalent to 60 kg N ha^{-1} ($52.6 \text{ cfu} \times 10^6 \text{ g}^{-1}$ soil) and FYM 10 t ha^{-1} + BDLM enriched with neem cake equivalent to 60 kg N ha^{-1} ($50.2 \text{ cfu} \times 10^6 \text{ g}^{-1}$ soil). Significantly lowest population of bacteria was observed with recommended practice FYM $7.5 \text{ t} + 50:40:25 \text{ kg NPK ha}^{-1}$ ($30.5 \text{ cfu} \times 10^6 \text{ g}^{-1}$ soil).

Latha *et al.*, (2016) studied the microbial diversity in organic conversion field and noticed that there was increase in bacteria ($19 \times 10^6 \text{ cfu g}^{-1}$ of soil), fungi ($3 \times 10^4 \text{ cfu g}^{-1}$ of soil), actinomycete ($17 \times 10^3 \text{ cfu g}^{-1}$ of soil), N fixers ($20 \times 10^5 \text{ cfu g}^{-1}$ of soil) and P solubilisers ($21 \times 10^6 \text{ cfu g}^{-1}$ of soil) application of FYM has greater influence on microbial population in the organic conversion field.

2.5.3 Combined effect organic manures and liquid manures on physical and chemical properties of soil

Application of organic manures like neem cake, biocompost and vermicompost harboured more microbes in soil than the NPK application. Bacteria, fungi and actinomycetes counts were maximum under organic treatments (Naidu *et al.*, 1999).

Mathan (1999) reported that application of organic amendments such as FYM, poultry manure, maize straw and cotton waste significantly reduced the bulk density of soil from 1.3 Mg m^{-3} to 1.06 Mg m^{-3} .

Kandeler *et al.* (1999) reported that long term application of organic amendments increased the capacity of the small-sized soil fractions to protect soil microorganisms. Farmyard manure increased the microbial biomass, N-mineralization, urease, arginine deaminase and alkaline xylanase activity and they produced some enzymes to adsorb and bind onto mineral and organic particles.

Application of 10 tonnes of fly ash ha^{-1} and 15 tonnes of FYM ha^{-1} decreased the bulk density significantly and increased the soil porosity, infiltration rate and water holding capacity of *Vertisols* at Coimbatore (Birajdar *et al.*, 2001). Similarly, Patil *et al.* (2003) and Patidar and Mali (2004) reported that application of FYM ($10\text{-}15 \text{ t ha}^{-1}$) showed significant decrease in bulk density and increase in water holding capacity, porosity and infiltration rate of black soils. Further, Sarkar *et al.* (2003) reported that application of organic materials increased organic carbon, aggregate stability, moisture retention capacity and infiltration rate of the surface soil while reducing the bulk density. Application of inorganic fertilizer alone decreased the stability of macro aggregates and moisture retention capacity but increased the bulk density values. Treatment effects on moisture retention were more pronounced in the higher (0.3-1.5 MPa) suction range. In the same line, Ghuman and sur (2006) reported that at 0.075 m depth, bulk density was lowered by the application of FYM (1.36 Mg m^{-3}) compared to control (1.43 Mg m^{-3}) plots. Increased organic carbon in manured plots caused reduction in bulk density.

Chandrakala *et al.* (2007) recorded significantly higher uptake of N, P and K (60.61, 12.98, 58.47 and 102.74, 11.99, 98.65 kg ha^{-1} , respectively) by combined application of beejamrutha +jeevamrutha +panchagavya and panchagavya as compare to

beejamrutha + jeevamrutha application in chilli. Who have also reported that combined application of FYM and beejamrutha + jeevamrutha + panchagavya recorded significantly higher *dehydrogenase* activity (30.00 and 25.67 mg TPF g⁻¹ soil day at 120 and 160 DAT, respectively) in capsicum. This might be due to favourable effects of both FYM and liquid manures that help in proliferating microbial population by providing greater amount of nutrients particularly carbon as energy source.

Upperi *et al.* (2008) studied the application of FYM at the rate of 7.5 t ha⁻¹, 3.75 t ha⁻¹ along with 100 per cent RDF and use of jeevamrutha significantly reduced the bulk density and increased the water holding capacity. Organic carbon content and cation exchange capacity of the soil increased significantly due to application of FYM at the rate of 7.5 t ha⁻¹ + jeevamrutha compared to control and 100 per cent RDF. Incorporation of organics treated with jeevamrutha improved the physical, chemical, biological properties, available nutrients status of soil and yield of sunflower crop.

Naidu *et al.* (2009) observed the major and micro nutrient uptake of chilli was significantly influenced by the effect of combined application of organic and inorganic source of nutrients. The highest uptake of major nutrients N (78.46 kg ha⁻¹), P (16.69 kg ha⁻¹), K (75.20 kg ha⁻¹) and micronutrients Viz., Zn (119.69 g ha⁻¹), Fe (367.18 g ha⁻¹), Cu (48.91 g ha⁻¹), Mn (103.71 g ha⁻¹) were noticed with the application of 50 per cent RDN +50 per cent N through FYM + biofertilizers + panchagavya compared to other treatments. The highest available major nutrients N (324.9 kg ha⁻¹), P (29.7 kg ha⁻¹) and micronutrients, Zn (0.63 mg kg⁻¹), Fe (3.88 mg kg⁻¹), Cu (0.68 mg kg⁻¹) and Mn (2.94 mg kg⁻¹) were noticed with the application of 50 per cent RDN + 50 per cent N through FYM + BF + panchagavya compared to other treatments. The combined use of organics (Farmyard manure, vermicompost, biofertilizers and panchagavya) along with the inorganic fertilizers increased nutrient use efficiency, apparent nutrient recovery and the available nutrient status of the soil. Integrated use of organic manures along with chemical fertilizers not only produced highest and sustainable crop yields but also enhanced the efficiency of added fertilizers as well as fertility status of the soil.

2.6 Liquid organic formulation as bio control agents

Meena *et al.* (2000) reported that during the entire course of two years of investigation, no pest and disease were found in crops sprayed with panchagavya. Panchagavya contained *Pseudomonas* (21 × 10⁴ cfu ml⁻¹) and saprophytic yeasts (15 × 10⁴ cfu ml⁻¹) which might have contributed to plant protection because *pseudomonas* on plant surfaces have been found to induce pathogenesis related protein, siderophores, antibiotics and HCN in ground nut and rice thus, enabled its use as a bio-controlling agent.

Subhasini *et al.* (2005) reported that in annual moringa, panchagavya spray doubled the fruit yield besides giving resistance to pests and diseases. Panchagavya sprayed on chilli produced dark green leaves and new growth within 10 days.

Kannan *et al.* (2007) reported that total phenol and ortho-dihydroxy phenol contents were profoundly influenced by animal urine. That significantly increased

peroxidases, poly phenol oxidase and phenylalanine ammonia-lyase enzyme activities, the phenomenon of induced systematic resistance observed due to induction of phenolic content and enzyme activity, which were involved in plant defence mechanism for diseases.

Three vegetable (Tomato, Chilli and Cowpea) crops treated with panchagavya showed enhance induction of defence related enzymes such as polyphenol oxidase (PPO) which could have enhanced the induced systemic resistance (ISR) of these vegetables, which in turn would have reduced the disease incidence (Sarkar *et al.*, 2014)

2.7 Effect of organics on economics

Organic farming is initially a soil building process. Organic farming systems ensures in- built capacity to maintain and increase soil health and fertility leading to sustained increase in yield and production and low variability of crops. This resulted in a stabilization of yield, increase in income and sustainability in agriculture. The farm wastes and local organic wastes can be used as inputs for crop production. *In-situ* manuring can also avoid the use of external inputs as in the conventional farming.

Application of biogas slurry at 10 t ha⁻¹ for maize, 3 t ha⁻¹ for sunflower and 2 t ha⁻¹ for greengram with 3 per cent of panchagavya foliar spray four times at different growth stages of respective crops has been found to viable with highest net returns for the organic production of maize, sunflower and greengram cropping system (Somasundaram *et al.*, 2003b).

Esther Skekinah (2004) recorded highest net returns of ₹ 23,763 ha⁻¹ and B:C ratio of 1.35 in the treatment supplemented with 100 per cent composted buffalo manure. Recycling of manure produced in the system to the crop enterprise also reduced the cost of cultivation.

In a study at Majhera, Uttar Pradesh, Singh (1999) found that return per rupee investment in FYM application to finger millet at 0.5, 7.5 and 10 t FYM per ha were 0.97, 1.07 1.15 and 1.17 respectively. Ananda *et al.* (2004) noticed that FYM at 13 t ha⁻¹ recorded lower cost of cultivation (₹ 12,385 ha⁻¹), higher gross returns (₹ 38,686 ha⁻¹), higher net returns (₹ 26,301 ha⁻¹) and higher B:C ratio followed by urban garbage compost at 11.5 t ha⁻¹. While, application of 50 per cent N through composted poultry manure + 50 per cent N through green leaf manure along with 3 per cent panchagavya spray recorded higher net returns (₹ 17822 ha⁻¹) in rice (Yadav and Lourduraj, 2006a).

Pandey *et al.* (2006) reported that irrespective of application rates, FYM and poultry manure noticed marked increase in the net returns and benefit: cost ratio from garden pea cultivation. FYM at 20 t per ha gave the highest net returns (₹ 74202 ha⁻¹) followed by 15 t per ha (₹ 70718 ha⁻¹).

Panchagavya spray recorded significantly higher gross returns (₹ 37608 ha⁻¹), net returns (₹ 17,822 ha⁻¹) and benefit cost ratio (1.92) as compared to without panchagavya spray (₹ 34,612 ha⁻¹, ₹ 15,586 ha⁻¹ and 1.84, respectively). Application of 50 per cent N

through composted poultry manure + 50 per cent N through green leaf manure along with panchagavya spray recorded higher net returns (₹ 17,822 ha⁻¹), followed by recommended NPK through panchagavya spray (₹ 15,586 ha⁻¹) in rice (Yadav and Lourduraj, 2006a).

Shwetha (2008) in transitional tract of Dharwad, in soybean-wheat cropping system, observed higher net returns and B: C ratio with combined application of compost + vermicompost + GLM (₹ 17167 ha⁻¹ and 2.3, respectively) and which was comparable with that of RDF + FYM (₹ 17017 ha⁻¹ and 2.1, respectively) and vermicompost + GLM + Beejamrut + Jeevamrut + panchagavya (₹ 14385 ha⁻¹).

Kasbe (2008) reported that application of jeevamruta was found to be cost effective when used at 2000 litre ha⁻¹ in different combinations than jeevamruta used on N basis. It was observed that application of jeevamruta is one of the cheap and efficient organic substitutes for other organic manures like vermicompost in integrated approach for high crop yield and profitability, besides improving the nutrient status of soil.

Gill and Kamta Prasad (2009) revealed that at Karaj, in rice – cucumber cropping system, application of FYM (1/3rd) + rice straw (1/3rd) + *Glyricidia* leaves (1/3rd) to *kharif* rice and neemcake (1/3rd) + vermicompost (1/3rd) to *rabi* cucumber gave highest additional net returns of ₹ 19485/- as compared to other nutrient supply stands with the B: C ratio of 1.24.

Sangshetty and Babalad (2010) while studying the role of organics in cotton production observed significantly higher net monetary returns and B: C ratio (₹10412 ha⁻¹ and 2.15) with integrated application of RDF (45:25:25 kg NPK ha⁻¹) and FYM (7.5 t ha⁻¹) over treatments which received RDF (₹ 9512 ha⁻¹ and 2.16) and organic manures when supplemented to 100 per cent RDN through FYM (₹ 7912 ha⁻¹ and 1.90, respectively), vermicompost (₹ 7694 ha⁻¹ and 1.85) and FYM + *Glyricidia* (₹ 7535 ha⁻¹ and 1.75).

In Maize-chickpea cropping system, net returns of ₹ 90648 ha⁻¹ and higher B: C ratio (7.21) in the treatment receiving enriched compost + vermicompost + Green leaf manure + panchagavya spray + biodynamic spray and this was followed by application of enriched compost + vermicompost + Green leaf manure + panchagavya spray (₹ 84090 ha⁻¹ and 6.35) when compared to control (₹ 54518 ha⁻¹) (Anon, 2011a).

Akbari *et al.* (2011) reported that the use of bio (*Rhizobium* + PSM) and organics (FYM, castor cake) enhanced total income (₹ 84,358 ha⁻¹) and net realization (₹ 59,974 ha⁻¹) of groundnut-wheat cropping system.

Pradeep Gopakkali *et al.* (2011) studied that the application of FYM at 12.5 t ha⁻¹ + cattle urine equivalent to 125 kg N ha⁻¹ recorded significantly higher net returns (₹ 34,732 ha⁻¹) and B: C ratio (2.57) compared to other treatments in onion crop.

Deshmukh *et al.* (2012) revealed that application of 100 per cent RDN through vermicompost, FYM and compost along with jeevamrutha found beneficial in increasing economic returns (₹ 78501 ha⁻¹, ₹ 69588 ha⁻¹ and ₹ 71369 ha⁻¹, respectively) and B:C (2.61, 2.82 and 2.82, respectively) in soybean wheat cropping sequence under irrigated condition.

Patil *et al.* (2012) recorded significantly higher B: C ratio (3.69), net Returns (₹ 48344 ha⁻¹) with application of enriched compost (1/3) + vermicompost (1/3) + *glyricidia* leaf manure (1/3) equivalent to 100 per cent RDN along with 3 per cent panchagavya spray at flower initiation and 15 days after flowering (DAF) of chickpea compared to RDF and other treatments.

Sharma *et al.* (2012) studied that application of 50 per cent N through vermicompost + 50 per cent N through decomposed organic wastes in bajra gave significantly higher net returns (₹ 30,625 ha⁻¹) and B: C ratio (2.97) over control (₹ 43,460 ha⁻¹ and 2.41, respectively).

Pradeep and Shranappa (2014) reported that with the application of enriched biodigested liquid manure at 125 kg N equivalent/ha + 3 per cent panchagavya spray given higher gross return (₹ 1,51,668 ha⁻¹), net returns (₹ 96,281ha⁻¹) and benefit:cost ratio (2.74) in chilli.

Siddappa (2015) observed that higher gross returns, net returns and B:C ratio were recorded with application of FYM at 200 per cent N equivalent + jeevamrutha at 1500 L ha⁻¹ (₹ 56,635, ₹ 30,430 and 2.16, respectively) over FYM at 100 per cent N equivalent + no- jeevamrutha application (₹ 30745, ₹ 10055 and 1.49, respectively).

III MATERIAL AND METHODS

Field Experiments were conducted for two years during *kharif* season of 2014 and 2015 in sandy loam soil of University of Agricultural Sciences, GKVK, Bengaluru to study the (i): Effect of jeevamrutha and panchagavya on growth and yield of frenchbean (*Phaseolus vulgaris* L.) and (ii): Influence of solid and liquid manures on growth and yield of french bean (*Phaseolus vulgaris* L.) under irrigated condition. The details of the material used and techniques adopted during the investigation are presented in this chapter.

3.1 Location of the experimental site

Field experiments were conducted at organic farming research and demonstration “J” block of Research Institute on Organic Farming (RIOF), Gandhi Krishi Vignana Kendra (GKVK), University of Agricultural Sciences, Bengaluru, which is situated at eastern dry zone of Karnataka at a latitude of 12° 58' North, longitude of 75° 35' East and at an altitude of 930 m above mean sea level.

3.2 Soil characteristics of experimental site

The soil of the experimental site was red sandy clay loam grouped under the class of *alfisols*. Composite soil samples were drawn in the experimental area before the imposition of treatments and were analyzed for physical, chemical and biological properties of soil. The values obtained along with the methods employed for their estimation are presented in Table 1.

3.3 Climatic conditions

The meteorological data pertaining to monthly total rainfall, maximum and minimum temperature, relative humidity and bright sunshine hours recorded during the cropping period at Gandhi Krishi Vignana Kendra (GKVK), ZARS, UAS, Bengaluru is presented in Table 2.

3.3.1 Normal climatic conditions

The normal annual rainfall of GKVK is 926.4 mm and major portion of rainfall is received during May to November with two peaks in the months of May and September.

The mean maximum air temperature ranged from 26.80 °C to 34.10 °C and mean minimum air temperature ranged between 15.05 °C to 20.80 °C. The highest mean temperature (34.10 °C) was recorded during April and it was followed by March (33.15 °C).

The mean monthly relative humidity ranged from 78.2 per cent in March to 90.9 per cent during August month. The mean monthly maximum bright sunshine hour was maximum during February (9.45 hr day⁻¹) followed by March (9.20 hr day⁻¹).

3.3.2 Actual climatic conditions

The total annual rainfall was more during 2014 (994.5 mm) and 2015 (1070.5 mm) as compared to normal rainfall (917.6 mm). The total annual rainfall was more during 2015 as compared to 2014. The crop growth period was from July to September in both the years. During the crop growth period, August month during 2014 (117.4 mm) and 2015 (71.0 mm) recorded lower rainfall as compared to normal rainfall (134.0 mm). Higher rainfall was recorded during the month of September in 2015 (254.6 mm) and lower in 2014 (128.6 mm) as compared to normal during these months (189.2 mm).

The mean maximum air temperature was higher in the month of September during 2014 (28.5 °C) and July, August and October in 2015 (29.3 °C). The mean minimum temperature was more than normal for most of the months. The mean monthly bright sunshine hour ranged from 3.8 hrs in August to 4.5 hrs in September during 2014, while it ranged from 5.5 hrs in September to 6.2 hrs in August during 2015. The mean monthly relative humidity ranged from 91 per cent in September to 93 per cent in July and August during 2014, while it ranged from 91 per cent during September to 92 per cent in August during 2015.

3.4 Experimental details

To study the effect of organic liquid manures (Jeevamrutha and panchagavya) and FYM on growth, yield attributes and yield of frenchbean, two field experiments were conducted during *kharif* 2014 and 2015 details are as follows.

A. EXPERIMENT I: Influence of solid and liquid manures on growth and yield of frenchbean (*Phaseolus vulgaris* L.)

FACTORS : Three

Factor A: Farm Yard Manure (FYM - F)

F₁ – 100 % N equivalent through FYM

F₂ – 150 % N equivalent through FYM

F₃ – 200 % N equivalent through FYM

Factor B: Jeevamrutha (J) (15, 30 and 45 DAS)

J₀- Control

J₁ – 1000 litres ha⁻¹

Factor C: Panchagavya (P) (15, 30 and 45 DAS)

P₀ – Control

P₁ – 3 per cent

Table 1: Initial Chemical, physical and biological properties of the soil at experimental site

	Particulars	Values	Remarks	Method adopted
I. Soil physical properties				
1	Coarse sand (%)	35.8	Red sandy clay loam	International pipette method (Piper,1966)
2	Fine sand (%)	34.2		
3	Silt (%)	12.2		
4	Clay (%)	17.8		
5	Bulk density (g/cc)	1.38		
II. Soil chemical Properties				
1	Soil pH (1:2.5)	6.66	Slightly acidic	pH meter (Piper, 1966)
2	EC (dS m ⁻¹ at 25 °C)	0.24	Normal	Conductivity meter (Jackson, 1967)
3	Organic carbon (%)	0.46	Medium	Walkey and Black's wet oxidation method (Jackson, 1967)
4	Available N (kg ha ⁻¹)	328	Medium	Alkaline potassium permanganate method(Subbaiah and Asija,1956)
5	Available P ₂ O ₅ (kg ha ⁻¹)	36	Medium	Bray's extractant method (Jackson,1973)
6	Available K ₂ O (kg ha ⁻¹)	258	Medium	Flame photometric method (Jackson, 1973)
III. Soil biological properties				
1	P-Solublizers (No. 10 ⁵ × CFU g ⁻¹ soil)	8.5		Serial dilution plate count technique (Aneja, 2003)
2	N- Fixers (No. 10 ⁵ × CFU g ⁻¹ soil)	10.0		
3	Bacteria (No. 10 ⁶ × CFU g ⁻¹ soil)	10.0		
4	Fungi (No. 10 ⁴ × CFU g ⁻¹ soil)	6.8		
5	Actinomycetes (No. 10 ³ × CFU g ⁻¹ soil)	8.0		

Table 2: Meteorological data of monthly normal and actual for the year 2014 during crop growth period at GKVK, Bengaluru

Month	Rainfall (mm)			Temperature (°C)						Sunshine Hours (hrs.)			Relative humidity (%)		
	N	A	D	Max			Min			N	A	D	N	A	D
				N	A	D	N	A	D						
January	1.3	0.00	-1.3	27.6	27.6	0	14.1	14.60	0.5	9.05	9.1	-0.05	87.9	92.0	4.1
February	9.3	0.00	-9.3	30.1	29.9	-0.2	15.3	16.30	1.0	9.45	8.6	0.85	83.1	87.0	3.9
March	16.2	10.0	-6.2	33.1	32.2	-0.9	18.2	18.20	0.0	9.20	8.6	0.60	78.2	78.0	-0.2
April	46.2	25.5	-20.7	34.1	34.7	0.6	20.8	21.10	0.3	8.60	8.2	0.40	80.5	80.0	-0.5
May	99.5	81.4	-18.1	33.1	33.2	0.1	20.7	21.20	0.5	7.95	8.2	-0.25	84.4	86.0	1.6
June	77.8	92.0	14.2	30.3	30.9	0.6	19.9	20.60	0.7	5.75	7.3	-1.55	87.8	88.0	0.2
July	102.9	80.8	-22.1	28.4	28.3	-0.1	19.3	19.70	0.4	4.40	4.2	0.20	90.4	93.0	2.6
August	134.0	117.4	-16.6	28.0	28.2	0.2	19.0	19.50	0.5	4.55	3.8	0.75	90.9	93.0	2.1
September	189.2	128.6	-60.6	28.6	28.5	-0.1	19.1	19.40	0.3	5.75	4.5	1.25	90.3	91.0	0.7
October	172.4	428.4	256	28.1	28.1	0.0	18.5	18.80	0.3	5.90	4.4	1.50	88.9	94.0	5.1
November	56.5	29.4	-27.1	26.9	26.9	0.0	16.4	16.30	-0.1	6.80	6.8	0.00	87.4	90.0	2.6
December	12.3	1.00	-11.3	26.8	26.6	-0.2	15.1	16.20	1.1	7.65	6.3	1.35	87.4	90.0	2.6
Total	917.60	994.50													

A: Actual for the year 2014 and 2015

N: Normal for previous 37 years (1975-2013)

D: Deviation

Table 2a: Meteorological data of monthly normal and actual for the year 2015 during crop growth period at GKVK, Bengaluru

Month	Rainfall (mm)			Temperature(°C)						Sunshine Hours (hrs.)			Relative humidity (%)		
	N	A	D	Max			Min			N	A	D	N	A	D
				N	A	D	N	A	D						
January	1.3	10.0	8.7	27.6	27.4	-0.20	14.1	15.2	1.1	9.05	8.2	0.85	87.9	91.0	3.1
February	9.3	0.0	-9.3	30.1	29.9	-0.20	15.3	15.3	0.0	9.45	12.6	-3.15	83.1	86.0	2.9
March	16.2	21.2	5.0	33.1	32.2	-0.89	18.2	18.9	0.7	9.20	8.7	0.50	78.2	85.0	6.8
April	46.2	142.1	95.9	34.1	32.1	-2.00	20.8	21	0.2	8.60	7.9	0.70	80.5	84.0	3.5
May	99.5	140.2	40.7	33.1	31.4	-1.70	20.7	20.6	-0.1	7.95	6.8	1.15	84.4	87.0	2.6
June	77.8	100.0	22.2	30.3	29.1	-1.20	19.9	19.8	-0.1	5.75	5.2	0.55	87.8	90.0	2.2
July	102.9	66.0	-36.9	28.4	29.3	0.90	19.3	19.5	0.2	4.40	6.2	-1.80	90.4	91.0	0.6
August	134.0	71.0	-63.0	28.0	29.3	1.30	19.0	19.6	0.6	4.55	5.7	-1.15	90.9	92.0	1.1
September	189.2	254.6	65.4	28.6	28.7	0.10	19.1	19.2	0.1	5.75	5.5	0.25	90.3	91.0	0.7
October	172.4	80.8	-91.6	28.1	29.3	1.20	18.5	19.1	0.6	5.90	6.6	-0.70	88.9	89.0	0.1
November	56.5	180.4	123.9	26.9	25.3	-1.60	16.4	17.9	1.5	6.80	3.3	3.50	87.4	94.0	6.6
December	12.3	4.2	-8.1	26.8	27.6	0.80	15.1	19.9	4.8	7.65	6.5	1.15	87.4	91.0	3.6
Total	917.60	1070.5													

A: Actual for the year 2014 and 2015

N: Normal for previous 37 years (1975-2013)

D: Deviation

Treatment combination

T₁ : F ₁ J ₀ P ₀	T₇ : F ₂ J ₁ P ₀
T₂ : F ₁ J ₀ P ₁	T₈ : F ₂ J ₁ P ₁
T₃ : F ₁ J ₁ P ₀	T₉ : F ₃ J ₀ P ₀
T₄ : F ₁ J ₁ P ₁	T₁₀ : F ₃ J ₀ P ₁
T₅ : F ₂ J ₀ P ₀	T₁₁ : F ₃ J ₁ P ₀
T₆ : F ₂ J ₀ P ₁	T₁₂ : F ₃ J ₁ P ₁

Design: Factorial Randomized Complete Block Design (FRCBD)

Replication: 3

B. EXPERIMENT II: Effect of jeevamrutha and panchagavya on growth and yield of frenchbean (*Phaseolus vulgaris* L.)

Experimental details:

Factors : Two

Factor A: Jeevamrutha (J) (15, 30 and 45 DAS)

J₀– Control

J₁ – 1000 litres ha⁻¹

J₂ – 1500 litres ha⁻¹

J₃– 2000 litres ha⁻¹

Factor B: Panchagavya (P) (15, 30 and 45 DAS)

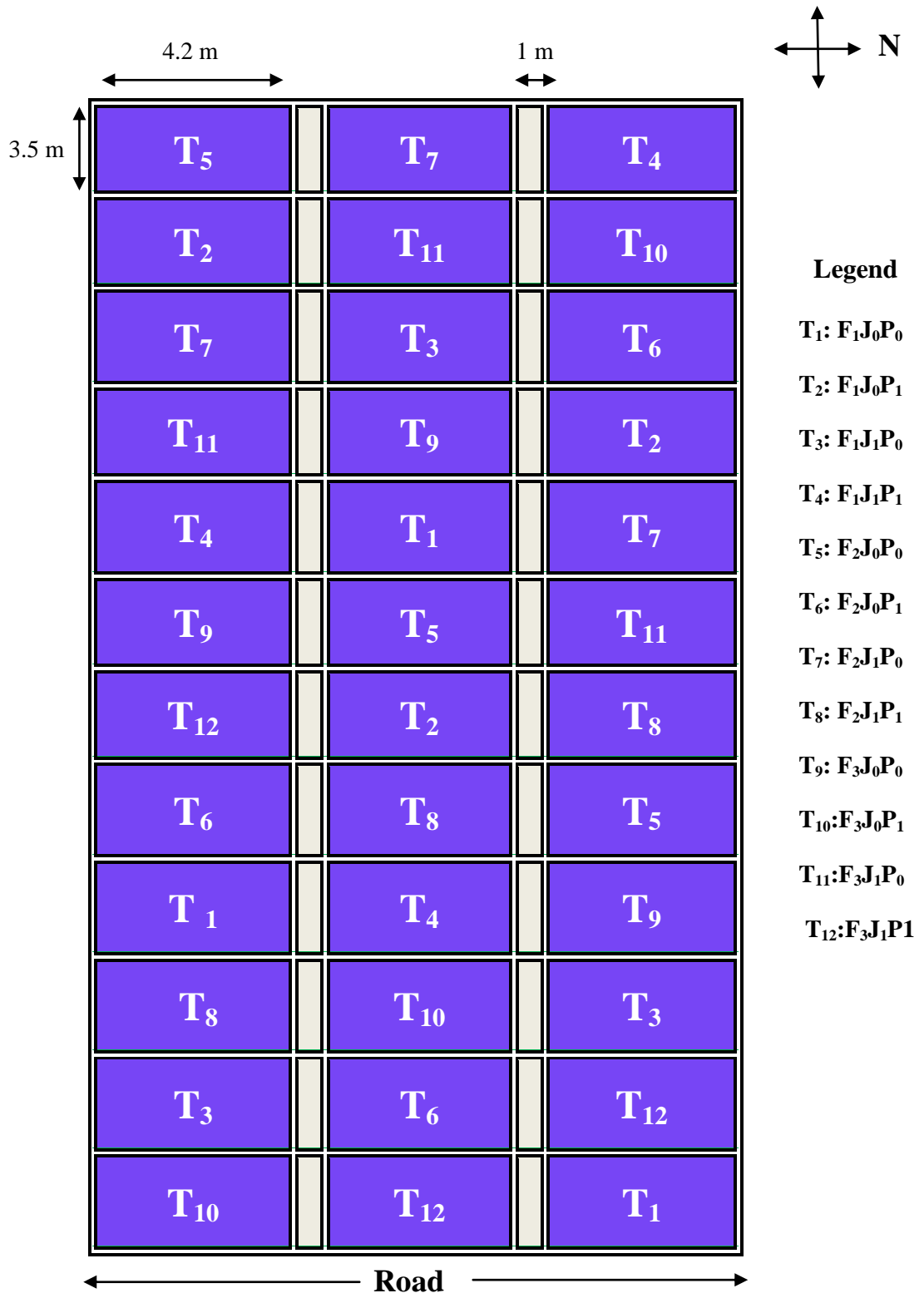
P₀– Control

P₁ – 3 per cent

P₂ – 6 per cent

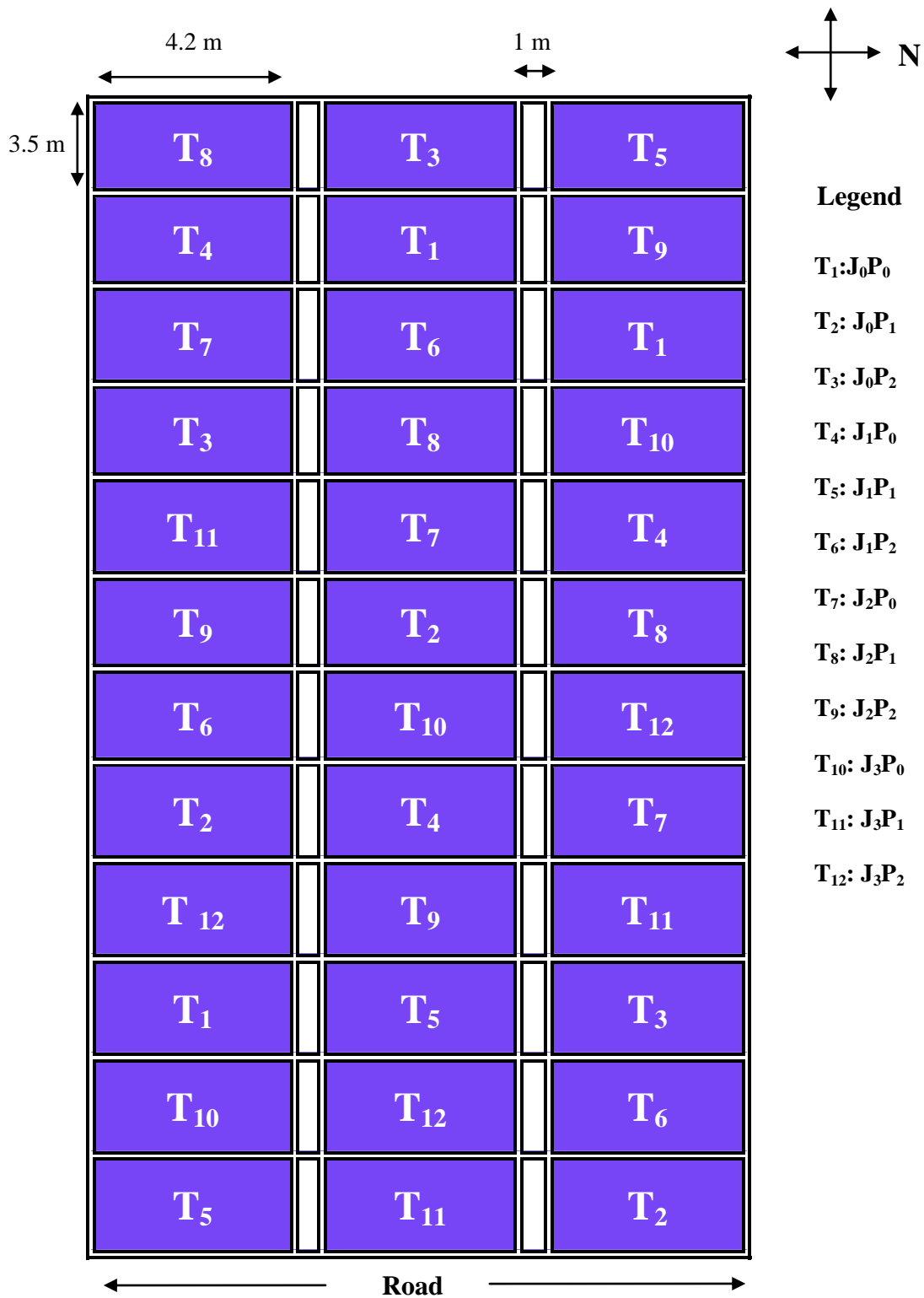
Treatment combination

T₁ :J ₀ P ₀	T₇ : J ₂ P ₀
T₂ : J ₀ P ₁	T₈ : J ₂ P ₁
T₃ : J ₀ P ₂	T₉ : J ₂ P ₂
T₄ : J ₁ P ₀	T₁₀ : J ₃ P ₀
T₅ : J ₁ P ₁	T₁₁ : J ₃ P ₁
T₆ : J ₁ P ₂	T₁₂ : J ₃ P ₂



Farm Yard Manure (F)- F₁ – 100 % N, F₂- 150 % N, F₃- 200 % N equivalent through FYM
Jeevamrutha (J) - J₀- Control, J₁ – 1000 l ha⁻¹
Panchagavya (P) - P₀ – Control, P₁ – 3 %

Fig. 1: Plan of lay out of the field experiment I



Jeevamrutha (J) - J₀ - Control, J₁ - 1000, J₂ - 1500, J₃ - 2000 l ha⁻¹
Panchagavya (P) - P₀ - Control, P₁ - 3%, P₂ - 6%

Fig. 2: Plan of lay out of the field experiment II

Design: Factorial Randomized Complete Block Design (FRCBD)

Replication: 3

Experimental details for frenchbean

Location : Research and demonstration block of RIOF

Design : Factorial Randomized Complete Block Design (FRCBD)

Plot size : Gross plot $3.5 \text{ m} \times 4.2 \text{ m} = 14.7 \text{ m}^2$
Net plot $2.9 \text{ m} \times 3.0 \text{ m} = 8.7 \text{ m}^2$

Season : *Kharif* 2014 and 2015

Variety : Arka Suvidha

RDF : 63:100:75 NPK kg ha^{-1} + Compost at 25 t ha^{-1}

Spacing : $30 \text{ cm} \times 15 \text{ cm}$

3.4.1 Salient features of the cultivar

Arka Suvidha frenchbean variety was released from Indian Institute of Horticultural Research, Bengaluru. It was developed through Pedigree selection method from the cross between Blue Crop \times Contender. It is resistant to rust, plants are bushy, photo insensitive in nature. Pods are straight, oval, light green, fleshy, stringless, fibre less and crisp. The duration of crop is 60-70 days.

3.4.2 Preparation of organic liquid formulations and application

Jeevamrutha

Procedure for preparation of Jeevamrutha

Jeevamrutha was prepared by mixing 10 kg of desi cow dung, 10 liter of cow urine, 2 kg of jaggery, 2 kg of pigeonpea flour and hand full of soil collected from the field. All these were put in 200 litre plastic drum and mixed thoroughly and volume was made up to 200 litres by adding water. The mixture was stirred well in clock wise direction and plastic drum was kept in shade covered with wet jute bag. Jeevamrutha fermented for 10 days was applied to base of the plants manually at 15, 30 and 45 days after sowing (DAS) as per treatments.

Application of jeevamrutha

Jeevamrutha was applied when the soil is wet near the root zone of the crop. Four jeevamrutha levels were maintained (0, 1000, 1500 and 2000 litres ha^{-1}) and applied manually at regular intervals of 15, 30 and 45 days after sowing as per the treatments.

Preparation of Panchagavya

In Sanskrit, panchagavya means the blend of five products viz., ghee, milk, curd, cow dung and cows urine obtained from cow. All these five products are individually called as gavya and collectively termed as panchagavya.

Panchagavya was prepared by mixing 7 kg fresh cow dung and 1 kg ghee were mixed well and incubated in a container for 2 days. On third day, 10 litres cow urine and 10 litres water were added, mixed thoroughly and incubated for fermentation for 13 days. Then, 3 litres milk, 2 litres curd, 3 litres tender coconut water, 3 kg jaggary and 12 ripened Cavendish banana were added and contents were incubated for 6 days. The mixture was stirred thoroughly thrice a day at morning, afternoon and evening. Container was kept in shade and it was covered with wet jute bag. After 21 days of fermentation mixture was filtered through a cotton cloth and used for spraying. It was applied by diluting 30 ml panchagavya in 1 litre of water (3 %) and 60 ml in 1 litres of water (6 %) and was sprayed at 15, 30 and 45 days after sowing as per treatments during *kharif* 2014 and 2015.

3.5 Cultivation practices

3.5.1 Land preparation

The land was disc ploughed with tractor twice and harrowed twice to break the clods. The stubbles and weeds were removed from the experimental area and the soil was brought to fine tilth. Before sowing, the plots were laid out (4.2 m × 3.5 m) as per the plan and bunds were formed around each plot.

3.5.2 Manure application

Initially the farm yard manure was treated with *Trichoderma viridae* and *Pseudomonas floescence*. As per treatment, well decomposed FYM was applied in terms of N recommendation (63 kg ha⁻¹) i.e., 100, 150 and 200 per cent and basal dose of FYM 25 t ha⁻¹ was incorporated three weeks prior to sowing and mixed well with soil. Nutrient content of the farmyard manure, jeevamrutha and panchagavya formulation used in the experiment is given in Appendix I.

3.5.3 Sowing

Frenchbean variety Arka Suvidha seeds were sown with recommended seed rate of 65 kg ha⁻¹. In each plots rows were opened at 30 cm interval. One seed was dibbled per hill at 15 cm spacing and covered with soil immediately after sowing. Sowing was done on 28th July in 2014 and 15th July in 2015.

3.5.4 Irrigation

As the crop was raised during rainy season, the crop was given irrigation at weekly interval depending on soil conditions to avoid moisture stress.



Plate 1a: General view of the experimental plots during *Kharif* 2014



Plate 1: General view of the experimental plots during *Kharif* 2015

3.5.5 Gap filling

Gap filling was taken one week after sowing in order to maintain required plant population in all plots.

3.5.6 Weeding

Hand weeding was done twice (20 and 40 DAS) in order to keep the plots weed free.

3.5.7 Earthing up

Earthing up was done at 25 days after sowing to support plant and to avoid lodging.

3.5.8 Plant protection

At seedling stage *Pseudomonas* and *Trichoderma* were drenched to avoid the root rot disease. To avoid aphids, thrips and mites during crop growth, spraying of neem oil (25 ml litre⁻¹) followed by Nimbecidin (2 ml litre⁻¹) and spinosad (0.10 ml litre⁻¹) were given at two intervals. At pod formation stage H-NPV was sprayed to avoid pod borers.

3.5.9 Harvesting

The green frenchbean pods were harvested when it attained maturity. Total yield obtained from each net plot was harvested individually from different treatments and converted to hectare. Total pod yield per hectare was calculated and expressed as total pod yield per hectare in quintals.

3.6 Collection of experimental data

Observations were recorded from five randomly selected and tagged plants in each treatment at different intervals. Details of observations recorded and the methods followed are presented below.

3.6.1 Observation on growth parameters

Different growth parameters such as plant height, number of branches plant⁻¹, number of leaf plant⁻¹, leaf area plant⁻¹, leaf area index, nodule counts, days taken for 50 per cent flowering, dry matter production and its distribution were recorded at 20, 40 DAS and at harvest of frenchbean.

3.6.1.1 Plant height (cm)

Plant height of five randomly selected tagged plants was measured from base of the plant to the tip of the main stem at 20, 40 DAS and at harvest. The mean height was computed and expressed in centimetres.

3.6.1.2 Number of primary branches plant⁻¹

Number of branches were counted from five randomly selected tagged plants at 20, 40 DAS and at harvest, their mean was worked out and expressed as number of primary branches per plant.

3.6.1.3 Number of leaves per plant

Total number of fully opened leaves were counted at 20, 40 DAS and at harvest from five randomly selected plants and the average was recorded as number of leaves per plant.

3.6.1.4 Dry matter production (g plant⁻¹)

Five plants were selected randomly at different growth stages and they were uprooted. The plant parts were separated into stem, leaves and roots. These samples were dried at 60 °C in hot air oven. The dried samples were weighed and the dry weight of different plant parts was expressed in grams per plant at 20, 40 DAS and at harvest.

3.6.1.5 Leaf area (cm² plant⁻¹)

Leaf area per plant was worked out by using leaf area meter (INC/LI-COR Ltd., Nebraska, USA) at 20, 40 DAS and at harvest.

3.6.1.6 Leaf Area Index (LAI)

Leaf area index was calculated at 20, 40 DAS and at harvest by formula as suggested by Watson (1952).

$$\text{LAI} = \frac{\text{Leaf area per plant (cm}^2\text{)}}{\text{Land area (cm}^2\text{)}}$$

3.6.1.7 Nodules count

Five plants were uprooted from each plot at 40 DAS, roots of plants were washed in water to remove adhered soil. Fully grown nodules were counted from each plant and expressed as number of nodules plant⁻¹.

3.6.1.8 Days taken for 50 per cent flowering

When plants attained flowering, the number of plants attaining flowering were counted on alternate days from the net plot area. From this, days taken for 50 per cent of the plant population attaining flowering in each plot was assessed and expressed in days.

3.6.2 Yield components of frenchbean

The same five plants, selected randomly from the net plot area used for recording the growth observations, were harvested separately and utilized for recording observations on the yield components.

Observations on yield parameters

Yield parameters such as number of pods per plant, pod yield per plant, pod length and pod yield were recorded after harvest of frenchbean.

3.6.2.1 Number of pods plant⁻¹

Total number of pods were counted from five randomly selected plants at harvest and the mean was recorded as number of pods plant⁻¹.

3.6.2.2 Pod length (cm)

Mature green pods were harvested for recording number of pods per plant from different treatments and were used for measuring individual length of pod. It was measured from the end of pedicel to the tip of the pod using scale and mean length of pod was calculated and expressed as pod length in centimetres.

3.6.2.3 Pod yield (q ha⁻¹)

The green frenchbean pods were harvested when they attained maturity. Total yield obtained from each net plot was harvested individually from different treatments was recorded and converted to hectare. Total pod yield per hectare was calculated and expressed as total pod yield per hectare in quintals.

3.6.2.4 Haulm yield (q ha⁻¹)

Plants from the net plots after harvest were sun dried for 10 days and their weight was recorded as haulm yield per plot and then converted into quintals per hectare.

3.6.3 Quality parameters

3.6.3.1 Shelf life (days)

Green pods harvested from different treatments were kept in ambient condition and observed for their freshness. Number of days taken to reach the end of consumer preference stage was recorded based on the physical appearance, viz., fading of freshness or colour, shrinking and fruit had become soft and were neither fit for consumption nor marketing. The days taken to reach this stage is referred as shelf life and expressed in days.

3.6.3.2 Protein content (%)

Nitrogen content in pods of frenchbean was estimated by Kjeldhal's method (Jackson, 1967). The protein per cent in pods was calculated by multiplying the nitrogen content by a factor of 6.25.

$$\text{Crude protein (\%)} = \% \text{ of N} \times 6.25$$

3.6.3.3 Carbohydrate

Carbohydrate content in frenchbean pod was quantitatively measured by following Anthrone Reagent method (Ranganna, 1986). For estimation of carbohydrates content, 0.2 g pod samples of frenchbean were grinded in distilled water with the help of pestle and mortar. Then pod samples were centrifuged at 5000 rpm for 10 minute. The clear supernatants were collected in test tubes and added 4 ml of Anthrone reagent to obtain green colour. The absorbance of green colour was recorded to estimate the carbohydrate content by using U-V Spectrophotometer at 625 nm wavelength. The carbohydrate content was calculated against standard sugar solutions (Dextrose L) and was expressed in mg g^{-1} .

3.7 Chemical Analysis of soil and plant

3.7.1 Soil analysis

Collection of soil samples

During the field experiment, a composite soil sample was collected from each plot before sowing and also after harvest of the crop. The collected soil samples were dried under shade, powdered using wooden pestle and mortar and passed through 2 mm sieve and preserved for analysis. For organic carbon analysis, 2 mm sieved soil samples were subjected for further grinding and passed through 0.2 mm sieve.

3.7.1.1 Soil pH

Soil pH was determined in 1: 2.5 soil to water suspension after stirring the contents intermittently for half an hour. The pH value was recorded using pH meter (Jackson, 1973).

3.7.1.2 Electrical conductivity

The soil water suspension used for measuring pH was kept overnight to get a clear solution. The electrical conductivity of the supernatant solution was measured with the help of Conductivity Bridge and expressed in dS m^{-1} (Jackson, 1973).

3.7.1.3 Available Nitrogen

Available nitrogen in the soil (kg ha^{-1}) was determined through alkaline potassium permanganate method (Subbaiah and Asija, 1956) by digestion, distillation and collection of NH_3 in 2 per cent boric acid and titrating it against standard sulphuric acid. The available nitrogen in soil is expressed as kg per ha.

3.7.1.4 Available Phosphorus

Available phosphorus in soil (kg ha^{-1}) was extracted with the help of Bray's No.1 extract (0.03 N ammonium fluoride + 0.025 N ammonium chloride). Further, phosphorus in the extract was determined by chlorostannous reduced molybdophosphoric blue colour method. The intensity of the blue colour was read on spectrophotometer at 690 nm wavelength (Jackson, 1973). The available phosphorus in soil is expressed as kg per ha.

3.7.1.5 Available Potassium

Available potassium was extracted from soil using neutral 1 Normal ammonium acetate at 1:5 soil : extract ratio and the concentration of potassium present in the extract was determined by flame photometry as described by Jackson (1973). The available potassium in soil is expressed as kg per ha.

3.7.1.6 Organic carbon

Organic carbon content of soil samples was determined by Walkley and Black wet digestion method. The soil (0.5 mm sieved) was treated with chromic acid to oxidize organic carbon to CO₂ and untreated K₂Cr₂O₇ was back titrated against standard ferrous ammonium sulphate using diphenylamine indicator (Jackson, 1973). Organic carbon content in the soil was expressed as per cent.

3.7.1.7 Per cent nutrient uptake in crop

Frenchbean plant samples collected from each plot at the time of harvest were oven dried at 60°C and then ground in a Willey mill to pass through 40 mesh sieve. The ground material was collected in butter paper bags and later used for chemical analysis.

Nitrogen

Nitrogen content in plant samples was determined by digesting the sample in concentrate sulphuric acid with K₂SO₄ + CuSO₄ + Se mixture and distilling in alkaline medium (Jackson, 1973) and expressed in percentage.

Phosphorus and Potassium

For analysis of phosphorus and potassium, samples of plant and pods were pre digested with concentrated HNO₃ and triacid mixture (HNO₃: HClO₄: H₂SO₄ at 10:4:1). Phosphorus content in samples was determined by Vanado molybdo-phosphoric yellow colour method using spectro photometer at 470 nm (Jackson, 1973) Where as potassium content in plant sample was determined by flame photometric method (Jackson, 1973) and was expressed in percentage on dry weight basis.

3.7.2 Bulk density (g/cc)

Bulk density of soil was determined by core sampler technique (Black, 1965) recording the fresh weight in the field and dry weight in the laboratory. Drying of soil was done in hot air oven to constant weight. Bulk density was calculated as dry weight of soil per unit volume of the core used to sample in the field.

$$\text{Bulk Density} = \frac{\text{Oven dry weight of the soil}}{\text{Volume of the air dry soil}}$$

3.7.3 Maximum water holding capacity (MWHC)

Keen Raczkowaski cups were used for measurement of maximum water holding capacity of soil.

$$\text{Maximum Water Holding Capacity} = \frac{b - c - d}{c - a} \times 100$$

- a- Weight of cup + filter paper (g)
- b- Wet weight of soil + filter paper + cup (g)
- c- Dry weight of soil + Weight of cup + filter paper (g)
- d- Weight of filter papers (g)

3.8 Soil microbial studies

Microbial populations of N-fixer, P- solubilizer, bacteria, fungi and actinomycete in rhizosphere soil was enumerated by following standard microbiological methods at 20, 40 DAS and at harvest of crop during *Kharif* 2014 and 2015.

Enumeration of microbial population

The enumeration of total bacteria, fungi, actinomycetes, free living N₂ fixer's and P- solubilizer's in fresh rhizosphere soil samples was carried out at 20, 40 DAS and at harvest by following serial dilution plate count technique using Nutrient agar for bacteria, Martin's Rose Bengal agar for fungi (Martin, 1950), Kuster's agar (Kuster and Williams, 1964) for actinomycetes, Waksman No. media for free living N₂ fixer's and Pikovaskaya's medium for P- solubilizer's.

Procedure for serial dilution plate count technique

The soil from experimental site was powdered and 10 gram was mixed in 90 ml sterilized water to give 10⁻¹ dilution. Subsequently dilutions upto 10⁻⁶ were made by transferring serially 1 ml of the dilution into 9 ml water blank. The inoculated plates added with appropriate media were kept for incubation at 30 ± 1 °C for a week and emerged colonies were counted.

3.8.1 P-solubilizer and free living N-fixers in rhizosphere soil

Soil samples were collected from the rhizosphere of the soil profile for counting microbial load present in the soil. Ten gram of soil was serially diluted up to 10⁻⁶ by using sterilized distilled water and cell count per gram of rhizosphere soil was enumerated for P-solubilizer (10⁵) and free living N-fixers (10⁵) by Pikovaskaya's media and Jonson agar media, respectively (Allen, 1959) by following serial dilution plate count technique.

3.8.2 Total Bacterial Count (TBC), Total Fungal Count (TFC) and Actinomycetes Count

Soil samples collected for counting P-solubilizer and free living N-fixers were used for enumerating bacteria, fungi and actinomycetes load in rhizosphere. Ten gram of soil was serially diluted upto 10⁻⁶ by using sterilized distilled water and cell count was



Plate 2: Shelf life studies of frenchbean

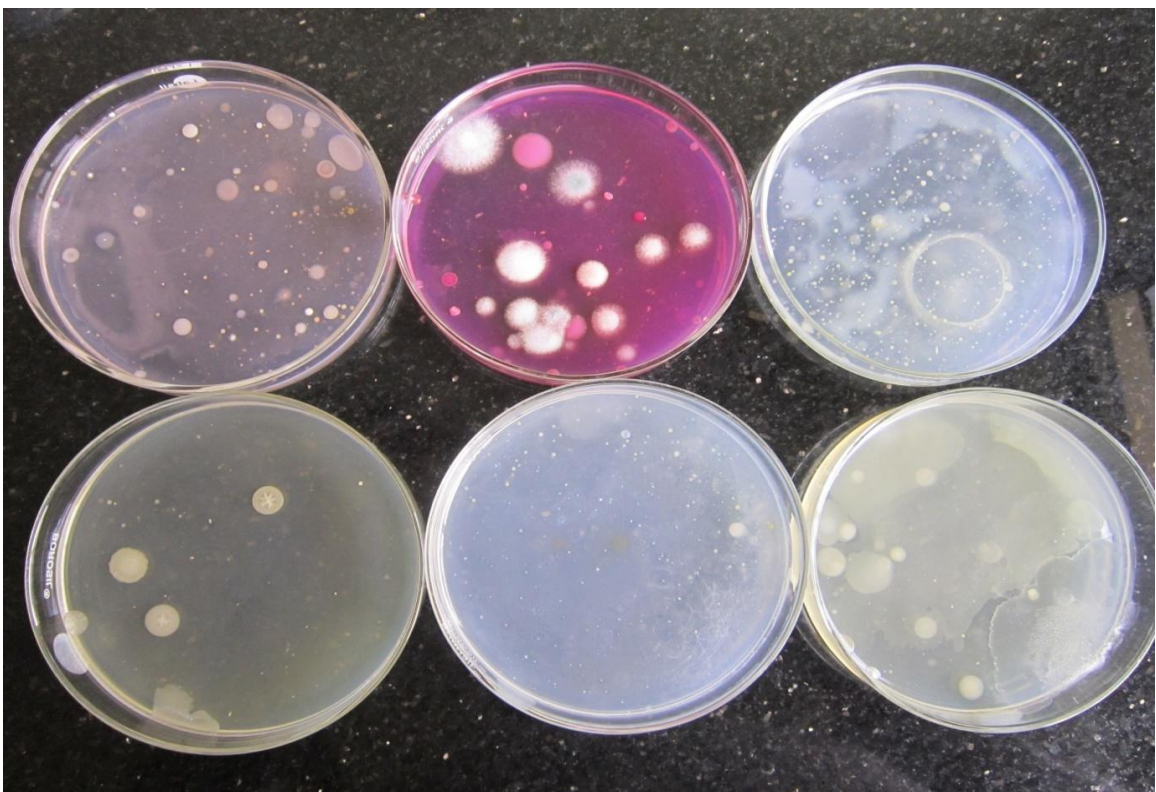


Plate 3: Soil microbial count studies

enumerated. The population of soil bacteria was estimated at 10^{-6} dilution, fungi at 10^{-4} and actinomycetes at 10^{-3} dilution. Soil extract agar, Martin's rose bengal agar and Kurster's agar media were used to isolate bacteria, fungi and actinomycetes, respectively.

3.8.3 Dehydrogenase activity

The dehydrogenase activity was determined by procedure as given by Casida *et al.* (1964). Two grams of air-dried soil (<2 mm) was thoroughly mixed with 0.2 g of CaCO_3 , to each sample tube, 1ml of 3 per cent aqueous solution of 2, 3, 5-triphenyl tetrazolium chloride (TTC) and 2.5 ml of distilled water were added. The contents of each tubes were mixed with a glass rod and the tubes were stoppered and incubated at 37 °C. After 24 hours, the stoppers were removed and 10 ml of methanol was added to the tube and shaken for 1min. Then, the suspension was filtered through a glass funnel plugged with absorbent cotton, into a 100 ml volumetric flask. The soil in the tube was washed repeatedly till the filtrate coming from the tip of the funnel was colourless. Then, the volume was made to 100 ml with methanol. The intensity of reddish colour was read using spectrophotometer at a wavelength of 485 nm with the methanol as the blank. The amount of TPF (2, 3, 5-triphenyl formazan) produced was calculated using a standard graph prepared by using different concentrations of TPF standards. For this, 10 ml of the TPF standard solution containing 1000 $\mu\text{g/ml}$ was diluted to 100 ml with methanol (100 $\mu\text{g ml}^{-1}$ of TPF ml^{-1}). Aliquots of 5, 10, 15 and 20 ml were pipette into 100 ml volumetric flasks (500, 1000, 1500 and 2000 $\mu\text{g ml}^{-1}$ of TPF/100 ml). The volume was made to 100 ml with methanol and mixed thoroughly. Then, the intensity of red colour of TPF was measured as described earlier.

3.9 Cost of cultivation

In computing the economics different components of cost of cultivation were considered. The cost of components includes land preparation, seed, manure, materials required for jeevamrutha preparation and labour charges at market price prevailing during crop production 2014 and 2015. The price of input and output used for calculating cost of cultivation is provided in appendix- II.

3.9.1 Returns

Utility of adopting different practices was computed by using the following formulae.

3.9.2 Gross return

$$\text{Gross return} = \text{Market price} \times \text{Total pod yield}$$

Market price – Price of frenchbean exist during the sale of produce

(2014- 30 and 2015- 40 Rs. Kg^{-1})

3.9.3 Net return

The net return per hectare was calculated by deducting the cost of cultivation per hectare from gross return per hectare.

3.9.4 Benefit cost ratio

The benefit cost ratio was calculated by using the following formula

$$\text{Benefit : Cost ratio} = \frac{\text{Gross returns (₹/ha)}}{\text{Cost of cultivation (₹/ha)}}$$

3.10 Statistical analysis

Experimental data collected was subjected to statistical analysis by adopting Fisher's method of analysis of variance (ANOVA) as outlined in Gomez and Gomez (1984). Critical difference (CD) values were calculated whenever the "F" test was significant at 5 per cent level.

IV RESULTS AND DISCUSSION

Results of the field experiment entitled “**Standardization of liquid manures for organic frenchbean (*Phaseolus vulgaris* L.) production**” conducted at organic farming Research and Development Block of RIOF, University of Agricultural Sciences (UAS), Gandhi Krishi Vignana Kendra (GKVK), Bengaluru, during *Kharif* season of 2014 and 2015 are presented and discussed in this chapter. The results pertaining to growth, yield, quality and nutrient uptake of frenchbean are discussed in this chapter with following sub headings.

Experiment I: Influence of solid and liquid manures on growth and yield of french bean (*Phaseolus vulgaris* L.)

4.1 Growth parameters

Growth parameters *viz.*, plant height, number of leaves, number of branches, leaf area, leaf area index, number of nodules plant⁻¹ of frenchbean were significantly influenced by various levels of FYM, panchagavya and jeevamruta application .

4.1.1 Plant height (cm)

Plant height at different stages of growth as influenced by solid and liquid manures is presented in the Tables 3, 4 and 5. Plant height differed significantly due to treatments effect at all crop growth stages except at 20 DAS.

Experiment conducted during *kharif* 2014

20 days after sowing

Plant height did not differ significantly due to the application of FYM, jeevamruta and panchagavya. However, higher plant was observed with FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent and it was lower with FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya application.

40 days after sowing

Plant height varied significantly due to the application of FYM, jeevamruta and panchagavya. Significantly higher plant height was observed with FYM at 200 per cent N equivalent (26.12 cm) which was on par with FYM at 150 per cent N equivalent (25.79 cm) and it was lower with FYM at 100 per cent N equivalent (24.08 cm). Maximum plant height was observed with application of jeevamrutha at 1000 litre ha⁻¹ (26.29 cm) whereas, minimum plant height was observed in without jeevamrutha (24.37 cm). Significantly higher plant height of 26.10 cm (3 % panchagavya spray) and lower plant height of 24.55 cm was recorded in without panchagavya spray.

At harvest

Plant height differed significantly due to the application of FYM, jeevamruta and panchagavya. Higher plant height was observed with FYM at 200 per cent N equivalent

Table 3: Plant height of frenchbean at different growth stages as influenced by FYM and liquid manures application during Kharif 2014

Treatments	Plant height (cm)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
FYM levels (F)									
F ₁	11.17	11.35	11.26	22.72	25.44	24.08	23.82	26.01	24.92
F ₂	11.26	11.64	11.45	25.14	26.44	25.79	25.56	26.66	26.11
F ₃	11.72	12.03	11.88	25.26	26.98	26.12	25.64	27.29	26.46
Mean	11.38	11.68		24.37	26.29		25.01	26.65	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.31	NS		0.55	1.60		0.38	1.13	
J	0.25	NS		0.45	1.31		0.31	0.92	
F × J	0.44	NS		0.77	NS		0.54	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	11.19	11.33	11.26	23.08	25.08	24.08	23.99	25.85	24.92
F ₂	11.32	11.58	11.45	25.32	26.26	25.79	25.64	26.58	26.11
F ₃	11.76	11.99	11.88	25.27	26.97	26.12	25.67	27.25	26.46
Mean	11.42	11.64		24.55	26.10		25.10	26.56	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.25	NS		0.45	1.31		0.31	0.92	
F × P	0.44	NS		0.77	NS		0.54	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	11.25	11.51	11.38	23.65	25.10	24.37	24.28	25.74	25.01
J ₁	11.59	11.76	11.68	25.46	27.11	26.29	25.93	27.38	26.65
Mean	11.42	11.64		24.55	26.10		25.10	26.56	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.36	NS		0.63	NS		0.44	NS	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁ J ₀	11.01	11.32		21.05	24.39		22.26	25.39	
F ₁ J ₁	11.36	11.35		25.10	25.77		25.71	26.31	
F ₂ J ₀	11.21	11.31		25.04	25.24		25.33	25.79	
F ₂ J ₁	11.44	11.85		25.60	27.29		25.96	27.37	
F ₃ J ₀	11.54	11.91		24.85	25.67		25.24	26.04	
F ₃ J ₁	11.99	12.08		25.65	24.27		26.11	27.38	
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	0.62	NS		1.09	NS		0.77	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 4: Plant height of frenchbean at different growth stages as influenced by FYM and liquid manures application during Kharif 2015

Treatments	Plant height (cm)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	11.67	11.85	11.76	23.60	26.33	24.97	25.56	28.88	27.22
F ₂	11.77	12.17	11.97	25.97	27.30	26.63	28.13	29.34	28.74
F ₃	12.25	12.55	12.40	26.03	27.92	26.98	28.54	30.50	29.52
Mean	11.89	12.19		25.20	27.18		27.41	29.57	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.25	NS		0.55	1.61		0.50	1.45	
J	0.74	NS		0.45	1.31		0.40	1.19	
F × J	0.36	NS		0.78	NS		0.70	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	11.70	11.83	11.76	23.97	25.97	24.97	25.68	28.76	27.22
F ₂	11.83	12.10	11.97	26.15	27.12	26.63	28.23	29.24	28.74
F ₃	12.27	12.53	12.40	26.07	27.88	26.98	28.52	30.52	29.52
Mean	11.93	12.15		25.39	26.99		27.48	29.50	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.21	NS		0.45	1.31		0.40	1.19	
F × P	0.36	NS		0.78	NS		0.70	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	11.77	12.02	11.90	24.47	25.93	25.20	26.16	28.66	27.41
J ₁	12.10	12.28	12.20	26.32	28.04	27.18	28.80	30.35	29.57
Mean	11.93	12.15		25.69	26.99		27.48	29.50	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.29	NS		0.63	NS		0.57	NS	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁ J ₀	11.53	11.80		21.90	25.30		22.83	28.28	
F ₁ J ₁	11.87	11.83		26.03	26.63		28.53	29.23	
F ₂ J ₀	11.73	11.80		25.87	26.07		27.60	28.67	
F ₂ J ₁	11.93	12.40		26.43	28.17		28.87	29.81	
F ₃ J ₀	12.03	12.47		25.63	26.43		28.04	29.03	
F ₃ J ₁	12.50	12.60		26.50	29.33		29.00	32.00	
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	0.50	NS		1.10	NS		0.99	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 5: Plant height of frenchbean at different growth stages as influenced by FYM and liquid manures application (Pooled 2014 and 2015)

Treatments	Plant height (cm)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	11.42	11.60	11.51	23.16	25.89	24.52	24.69	27.45	26.07
F ₂	11.52	11.90	11.71	25.55	26.87	26.21	26.85	28.00	27.42
F ₃	11.99	12.29	12.14	25.65	27.45	26.55	27.09	28.89	27.99
Mean	11.64	11.93		24.79	26.73		26.21	28.11	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.25	NS		0.49	1.43		0.37	1.10	
J	0.20	NS		0.40	1.17		0.31	0.90	
F × J	0.35	NS		0.69	NS		0.53	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	11.44	11.57	11.51	23.52	25.53	24.52	24.84	27.30	26.07
F ₂	11.58	11.84	11.71	25.73	26.69	26.21	26.94	27.91	27.42
F ₃	12.01	12.26	12.14	25.67	27.42	26.55	27.10	28.89	27.99
Mean	11.68	11.89		24.97	26.55		26.29	28.03	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.20	NS		0.40	1.17		0.31	0.90	
F × P	0.35	NS		0.69	NS		0.53	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	11.51	11.77	11.64	24.06	25.52	24.79	25.22	27.20	26.21
J ₁	11.85	12.02	11.93	25.89	27.58	26.73	27.36	28.86	28.11
Mean	11.68	11.89		24.97	26.55		26.29	28.03	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.28	NS		0.69	NS		0.43	NS	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁ J ₀	11.27	11.56		21.48	24.85		25.55	26.84	
F ₁ J ₁	11.61	11.59		25.57	26.20		27.12	27.77	
F ₂ J ₀	11.47	11.56		25.45	25.65		24.46	27.23	
F ₂ J ₁	11.68	12.12		26.02	27.73		27.41	28.59	
F ₃ J ₀	11.79	12.19		25.24	26.05		26.64	27.54	
F ₃ J ₁	12.24	12.34		26.09	28.80		27.55	30.23	
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	0.49	NS		0.97	NS		0.75	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre ha⁻¹, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

(26.92 cm) which was on par with FYM at 150 per cent N equivalent (26.11 cm) and it was lower with FYM at 100 per cent N equivalent (24.46 cm). Maximum plant height was observed with application of jeevamrutha at 1000 litres ha⁻¹ (26.65 cm) whereas, lower plant height was observed in without jeevamrutha (25.01 cm). Higher plant height of 26.56 cm was recorded in 3 % panchagavya spray and lower plant height of 25.10 cm was recorded in without panchagavya spray.

Experiment conducted during *kharif* 2015

20 days after sowing

Plant height did not vary significantly due to the application of FYM, jeevamrutha and panchagavya. However, higher plant height was observed with FYM at 200 per cent N equivalent, jeevamrutha at 1000 litres ha⁻¹ and panchagavya at 3 per cent and it was lower with FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya application.

40 days after sowing

Plant height differed significantly due to the application of FYM, jeevamrutha and panchagavya. Higher plant height was observed with FYM at 200 per cent N equivalent (26.98 cm) which was on par with FYM at 150 per cent N equivalent (26.63cm) and it was lower with FYM at 100 per cent N equivalent (24.97 cm). Maximum plant height was observed with application of jeevamrutha at 1000 litres ha⁻¹ (27.18) whereas, minimum plant height was observed in without jeevamrutha application (25.20 cm). Panchagavya spray (3 %) recorded higher plant height of 26.99 cm and lower plant height of 25.39 cm was recorded in without panchagavya spray.

At harvest

Plant height varied significantly due to the application of FYM, jeevamrutha and panchagavya. Higher plant height was recorded with FYM at 200 per cent N equivalent (29.52 cm) which was on par with FYM at 150 per cent N equivalent (28.74 cm) and it was lower with FYM at 100 per cent N equivalent (27.22 cm). Maximum plant height was observed with application of jeevamrutha at 1000 litre ha⁻¹ (29.57) whereas, lower plant height was observed in without jeevamrutha (27.41 cm). Higher plant height of 29.50 cm was recorded in 3 % panchagavya spray and lower plant height of 27.48 cm was recorded in without panchagavya spray.

Interaction effect

Plant height did not vary significantly due to the interaction effect of FYM and jeevamrutha, FYM and Panchagavya, jeevamrutha and panchagavya, FYM, jeevamrutha and panchagavya at 20, 40 DAS and at harvest during both the years.

Pooled data

At 40 DAS and at harvest, plant height varied significantly due to the application of various levels of FYM, jeevamrutha and panchagavya. At 40 DAS and at harvest FYM at 200 per cent N equivalent recorded significantly higher plant height (26.5 and 27.99

cm) which was on par with FYM at 150 per cent N equivalent (26.21 and 27.42 cm) and it was lower with FYM at 100 per cent N equivalent (24.5 and 27.42 cm). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher plant height (26.73, 26.55 and 28.11, 28.03 cm, respectively) as compared to without jeevamrutha and without panchagavya application (24.79, 24.97 and 26.21, 26.29 cm, respectively). Significant increase in plant height of frenchbean in higher levels of N equivalent FYM might be due to greater availability and steady release of nutrients from organic sources (FYM), which perhaps enabled the recovery of plant height towards reproductive stage.

Plant height did not differ significantly due to the interaction effect of FYM and jeevamrutha, FYM and Panchagavya, jeevamrutha and panchagavya, FYM, jeevamrutha and panchagavya.

4.1.2 Number of branches per plant

Number of branches per plant at different growth stages as influenced by different levels of FYM, liquid formulations and their interaction effects are presented in Tables 6, 7 and 8. The number of branches per plant differed significantly due to treatment effects at all stages of crop growth except at 20 DAS.

Experiment conducted during *kharif* 2014

20 days after sowing

Number of branches per plant did not differ significantly due to the application of FYM, jeevamrutha and panchagavya.

40 days after sowing

Number of branches per plant varied significantly due to the application of FYM, jeevamrutha and panchagavya. More number of branches were observed with FYM at 200 per cent N equivalent (4.0) which were on par with FYM at 150 per cent N equivalent (3.9) and it was lower with FYM at 100 per cent N equivalent (3.52). Maximum number of branches per plant were observed with application of jeevamrutha at 1000 litre ha⁻¹ (4.18) whereas, minimum number of branches per plant was observed in without jeevamrutha (3.43). More number of branches per plant 4.12 was recorded in 3 % panchagavya spray and lower number of branches per plant 3.49 was recorded in without panchagavya spray.

Number of branches per plant did not differ significantly due to the interaction effect of FYM and jeevamrutha, FYM and Panchagavya, jeevamrutha and panchagavya, FYM, jeevamrutha and panchagavya. However, more number of branches per plant were observed with FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent and it was lower with FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya application.

Table 6: Number of branches of frenchbean at different growth stages as influenced by FYM and liquid manures application during *Kharif* 2014

Treatments	Number of branches plant ⁻¹								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	0.97	0.93	0.95	3.10	3.93	3.52	5.90	6.57	6.23
F ₂	0.93	0.97	0.95	3.57	4.23	3.90	6.37	7.00	6.68
F ₃	0.87	0.97	0.92	3.63	4.37	4.00	6.57	7.20	6.88
Mean	0.92	0.96		3.43	4.18		6.28	6.92	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.04	NS		0.13	0.37		0.12	0.35	
J	0.03	NS		0.10	0.31		0.10	0.29	
F × J	0.06	NS		0.18	NS		0.17	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	1.00	0.90	0.95	3.03	4.00	3.52	5.83	6.63	6.23
F ₂	0.93	0.97	0.95	3.70	4.10	3.90	6.50	6.87	6.68
F ₃	0.90	0.93	0.92	3.73	4.27	4.00	6.60	7.17	6.88
Mean	0.94	0.93		3.49	4.12		6.31	6.89	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.03	NS		0.10	0.31		0.10	0.29	
F × P	0.06	NS		0.18	NS		0.17	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	0.93	0.91	0.92	3.11	3.76	3.43	5.96	6.60	6.28
J ₁	0.96	0.96	0.96	3.87	4.49	4.18	6.67	7.18	6.92
Mean	0.94	0.93		3.49	4.12		6.31	6.89	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.05	NS		0.15	NS		0.14	NS	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁ J ₀	1.00	0.93		2.60	3.60		5.27	6.53	
F ₁ J ₁	1.00	0.87		3.47	4.40		6.40	6.73	
F ₂ J ₀	0.93	0.93		3.40	3.73		6.27	6.47	
F ₂ J ₁	0.93	1.00		4.00	4.47		6.73	7.27	
F ₃ J ₀	0.87	0.87		3.33	3.93		6.33	6.80	
F ₃ J ₁	0.93	1.00		4.13	4.60		6.87	7.53	
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	0.08	NS		0.25	NS		0.24	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre ha⁻¹, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 7: Number of branches of frenchbean at different growth stages as influenced by FYM and liquid manures application during *Kharif* 2015

Treatments	Number of branches plant ⁻¹								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F₁	0.93	0.97	0.95	3.28	4.13	3.71	6.47	7.17	6.82
F₂	0.93	0.97	0.95	3.77	4.43	4.10	6.97	7.57	7.27
F₃	0.90	0.97	0.93	3.83	4.60	4.22	7.17	7.73	7.45
Mean	0.92	0.97		3.63	4.39		6.87	7.49	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.04	NS		0.13	0.37		0.14	0.41	
J	0.03	NS		0.10	0.30		0.11	0.33	
F × J	0.05	NS		0.18	NS		0.20	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F₁	0.93	0.97	0.95	3.22	4.20	3.71	6.40	7.23	6.82
F₂	0.93	0.97	0.95	3.90	4.30	4.10	7.10	7.43	7.27
F₃	0.90	0.97	0.93	3.93	4.50	4.22	7.20	7.70	7.45
Mean	0.92	0.97		3.68	4.33		6.90	7.46	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.03	NS		0.10	0.3		0.11	0.33	
F × P	0.05	NS		0.18	NS		0.20	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J₀	0.91	0.93	0.92	3.30	3.96	3.63	6.53	7.20	6.87
J₁	0.93	1.00	0.97	4.07	4.71	4.39	7.27	7.71	7.49
Mean	0.92	0.97		3.68	4.33		6.90	7.46	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.04	NS		0.15	NS		0.16	NS	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F₁ J₀	0.93	0.93		2.77	3.80		5.80	7.13	
F₁ J₁	0.93	1.00		3.67	4.60		7.0	7.33	
F₂ J₀	0.93	0.93		3.60	3.93		6.87	7.07	
F₂ J₁	0.93	1.00		4.20	4.67		7.33	7.80	
F₃ J₀	0.87	0.93		3.53	4.13		6.93	7.40	
F₃ J₁	0.93	1.00		4.33	4.87		7.47	8.00	
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	0.08	NS		0.25	NS		0.28	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre ha⁻¹, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 8: Number of branches of frenchbean at different growth stages as influenced by FYM and liquid manures application (Pooled 2014 and 2015)

Treatments	Number of branches plant ⁻¹								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	0.95	0.95	0.95	3.19	4.03	3.61	6.18	6.87	6.53
F ₂	0.93	0.97	0.95	3.67	4.33	4.00	6.67	7.28	6.98
F ₃	0.88	0.97	0.93	3.73	4.48	4.11	6.87	7.47	7.17
Mean	0.92	0.96		3.53	4.28		6.57	7.21	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.02	NS		0.13	0.37		0.13	0.37	
J	0.02	NS		0.10	0.30		0.10	0.30	
F × J	0.03	NS		0.18	NS		0.18	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	0.97	0.93	0.95	3.13	4.10	3.61	6.12	6.93	6.53
F ₂	0.93	0.97	0.95	3.80	4.20	4.00	6.80	7.15	6.98
F ₃	0.90	0.95	0.93	3.83	4.38	4.11	6.90	7.43	7.17
Mean	0.93	0.95		3.59	4.23		6.61	7.17	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.02	NS		0.10	0.30		0.10	0.30	
F × P	0.03	NS		0.18	NS		0.18	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	0.92	0.92	0.92	3.21	3.86	3.53	6.24	6.90	6.57
J ₁	0.94	0.98	0.96	3.97	4.60	4.28	6.97	7.44	7.21
Mean	0.93	0.95		3.59	4.23		6.61	7.17	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.03	NS		0.15	NS		0.15	NS	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁ J ₀	0.97	0.93		2.68	3.70		5.53	6.83	
F ₁ J ₁	0.97	0.93		3.57	4.50		6.70	7.03	
F ₂ J ₀	0.93	0.93		3.50	3.83		6.57	6.77	
F ₂ J ₁	0.93	1.00		4.10	4.57		7.03	7.53	
F ₃ J ₀	0.87	0.90		3.43	4.03		6.63	7.10	
F ₃ J ₁	0.93	1.00		4.23	4.73		7.17	7.77	
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	0.05	NS		0.25	NS		0.25	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre ha⁻¹, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

At harvest

Number of branches per plant differed significantly due to the application of FYM, jeevamrutha and panchagavya. More number of branches were observed with FYM at 200 per cent N equivalent (6.88) which was on par with FYM at 150 per cent N equivalent (6.68) and it was lower with FYM at 100 per cent N equivalent (6.23). There was significant difference in number of branches per plant were observed with application of jeevamrutha. Maximum number of branches per plant was observed with application of jeevamrutha at 1000 litre ha⁻¹ (6.92) whereas, minimum number of branches per plant was observed in without jeevamrutha (6.28). Panchagavya spray influenced significantly on number of branches per plant. More number of branches per plant 6.89 observed in 3 % panchagavya spray and lower number of branches per plant 6.31 was recorded in without panchagavya spray.

Experiment conducted during *kharif* 2015

20 days after sowing

Number of branches did not differ significantly due to the application of FYM, jeevamrutha and panchagavya.

40 days after sowing

Number of branches per plant differed significantly due to the application of FYM, jeevamrutha and panchagavya. More number of branches were observed with FYM at 200 per cent N equivalent (4.22) which was on par with FYM at 150 per cent N equivalent (4.10) and it was lower with FYM at 100 per cent N equivalent (3.71). There was significant difference in number of branches per plant were observed with application of jeevamrutha. Maximum number of branches per plant were observed with application of jeevamrutha at 1000 litre ha⁻¹ (4.39) whereas, minimum number of branches per plant were observed in without jeevamrutha (3.46). Panchagavya spray influenced significantly on number of branches per plant. More number of branches per plant 4.33 (3 % panchagavya spray) and lower number of branches per plant 3.68 was recorded in without panchagavya spray.

At harvest

Number of branches per plant differed significantly due to the application of FYM, jeevamrutha and panchagavya. More number of branches were observed with FYM at 200 per cent N equivalent (7.42) which was on par with FYM at 150 per cent N equivalent (7.27) and it was lower with FYM at 100 per cent N equivalent (6.82). There was significant difference in number of branches per plant were observed with application of jeevamrutha. Maximum number of branches per plant were observed with application of jeevamrutha at 1000 litre ha⁻¹ (7.49) whereas, minimum number of branches per plant was observed in without jeevamrutha (6.87). Panchagavya spray influenced significantly on number of branches per plant. More number of branches per plant 7.46 were observed in 3 % panchagavya spray and lower number of branches per plant 6.90 was recorded in without panchagavya spray.

Interaction effect

Number of branches did not differ significantly due to the interaction effect of FYM and jeevamrutha, FYM and panchagavya, jeevamrutha and panchagavya, FYM, jeevamrutha and panchagavya at 20, 40 DAS and at harvest during both the years.

Pooled data

The number of branches per plant differed significantly among treatment application at all stages except at 20 DAS (Table 8).

At 40 DAS and harvest number of branches per plant differed significantly due to the application of various levels of FYM, jeevamrutha and panchagavya. FYM at 200 per cent N equivalent recorded significantly higher number of branches (4.11 and 7.17) which was on par with FYM at 150 per cent N equivalent (4.00 and 6.98) and it was lower with FYM at 100 per cent N equivalent (3.61 and 6.53). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher number of branches (4.28, 7.21 and 4.23, 7.17, respectively) as compared to without jeevamrutha and without panchagavya application (3.53, 6.57 and 3.59, 6.61, respectively).

4.1.3 Number of leaves per plant

Number of leaves per plant at different growth stages as influenced by different levels of FYM, liquid formulations and their interaction effects were presented in Table 9, 10 and 11. The variation in the number of leaves per plant due to different treatment application was significant at 40 DAS and at harvest except at 20 DAS.

Experiment conducted during *kharif* 2014

20 days after sowing

Number of leaves did not differ significantly due to the application of FYM, jeevamrutha and panchagavya. However, more number of leaves per plant were observed with FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent and it was lower with FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya application.

40 days after sowing

Number of leaves per plant differed significantly due to the application of FYM, jeevamrutha and panchagavya. More number of leaves per plant were observed with FYM at 200 per cent N equivalent (34.98) which was on par with FYM at 150 per cent N equivalent (33.48) and it was lower with FYM at 100 per cent N equivalent (31.85). There was significant difference in number of leaves per plant were observed with application of jeevamrutha. Maximum number of number of leaves per plant was observed with application of jeevamrutha at 1000 litre ha⁻¹ (35.90) whereas, minimum number of leaves per plant were observed in without jeevamrutha (30.98). Panchagavya spray influenced significantly on number of leaves per plant. More number of number of leaves per plant 35.03 (3 % panchagavya spray) and lower number of number of leaves per plant 31.84 was recorded in without panchagavya spray.

Table 9: Number of leaves of frenchbean at different growth stages as influenced by FYM and liquid manures application during Kharif 2014

Treatments	Number of leaves plant ⁻¹								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	8.20	8.13	8.17	29.37	34.33	31.85	29.93	34.60	32.27
F ₂	8.03	8.30	8.17	31.17	35.80	33.48	32.10	35.63	33.87
F ₃	8.23	8.47	8.35	32.40	37.57	34.98	31.63	37.87	34.75
Mean	8.16	8.30		30.98	35.90		31.33	36.03	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.23	NS		0.63	1.85		0.66	1.94	
J	0.18	NS		0.51	1.51		0.54	1.58	
F × J	0.32	NS		0.89	NS		0.94	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	8.20	8.13	8.17	30.13	33.57	31.85	30.63	33.90	32.27
F ₂	8.03	8.30	8.17	32.17	34.80	33.48	32.90	34.83	33.87
F ₃	8.23	8.47	8.35	33.23	36.73	34.98	32.67	36.83	34.75
Mean	8.16	8.30		31.84	35.03		32.07	35.19	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.18	0.54		0.51	NS		0.54	1.58	
F × P	0.32	NS		0.73	NS		0.94	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	8.02	8.29	8.16	29.84	32.11	30.98	30.07	32.38	31.22
J ₁	8.29	8.31	8.30	33.84	37.6	35.90	34.07	38.00	36.03
Mean	8.16	8.30		31.84	35.03		32.07	35.19	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.26	NS		0.73	NS		0.76	NS	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁	J ₀	8.20	8.20	27.87	30.87		28.60	31.27	
	J ₁	8.20	8.07	32.40	36.27		32.67	36.53	
F ₂	J ₀	7.93	8.13	30.33	32.00		31.87	32.33	
	J ₁	8.13	8.47	34.00	37.60		33.93	37.33	
F ₃	J ₀	7.93	8.53	31.33	33.47		29.73	33.53	
	J ₁	8.53	8.40	35.13	40.00		35.60	40.13	
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	0.45	NS		1.26	NS		1.32	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre ha⁻¹, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 10: Number of leaves of frenchbean at different growth stages as influenced by FYM and liquid manures application during Kharif 2015

Treatments	Number of leaves plant ⁻¹								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	8.17	8.23	8.20	30.73	37.77	34.25	31.10	38.53	34.82
F ₂	8.33	8.40	8.37	35.03	39.43	37.23	35.33	41.03	38.18
F ₃	8.40	8.73	8.57	37.10	41.93	39.52	36.60	42.97	39.78
Mean	8.30	8.46		34.29	39.71		34.34	40.84	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.20	NS		0.77	2.26		0.91	2.68	
J	0.16	NS		0.63	1.84		0.75	2.19	
F × J	0.28	NS		1.09	NS		1.29	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	8.17	8.23	8.20	31.57	36.93	34.25	32.30	37.33	34.82
F ₂	8.30	8.43	8.37	35.73	38.73	37.23	36.73	39.63	38.18
F ₃	8.43	8.70	8.57	38.00	41.03	39.52	37.50	42.07	39.78
Mean	8.30	8.46		35.10	38.90		35.51		
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.16	NS		0.63	1.84		0.75	2.19	
F × P	0.28	NS		1.09	NS		1.05	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	8.20	8.40	8.30	32.78	35.80	34.29	32.51	36.18	34.34
J ₁	8.40	8.51	8.46	37.42	42.00	39.71	38.51	43.18	40.84
Mean	8.30	8.46		35.10	38.90		35.51	39.68	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.23	NS		0.89	NS		1.05	NS	
Interaction	P₀	P₁		P₀	P₁		P₀	P₁	
F × J × P									
F ₁ J ₀	8.13	8.20		27.53	33.93		27.60	34.60	
F ₁ J ₁	8.20	8.27		35.60	39.93		37.00	40.07	
F ₂ J ₀	8.27	8.40		34.07	36.00		34.40	36.27	
F ₂ J ₁	8.33	8.47		37.40	41.47		39.07	43.00	
F ₃ J ₀	8.20	8.60		36.73	37.47		35.53	37.67	
F ₃ J ₁	8.67	8.80		39.27	44.60		39.47	46.67	
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	0.40	NS		1.54	NS		1.83	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre ha⁻¹, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 11: Number of leaves of frenchbean at different growth stages as influenced by FYM and liquid manures application (Pooled 2014 and 2015)

Treatments	Number of leaves plant ⁻¹								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F₁	8.18	8.18	8.18	30.05	36.05	33.05	30.52	36.57	33.54
F₂	8.18	8.35	8.27	33.10	37.62	35.36	33.72	38.33	36.03
F₃	8.32	8.60	8.46	34.75	39.75	37.25	34.12	40.42	37.27
Mean	8.23	8.38		32.63	37.81		32.78	38.44	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.21	NS		0.59	1.73		0.74	2.16	
J	0.17	NS		0.48	1.41		0.60	1.77	
F × J	0.29	NS		0.83	NS		1.04	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F₁	8.18	8.18	8.18	30.85	35.25	33.05	31.47	35.62	33.54
F₂	8.17	8.37	8.27	33.95	36.77	35.36	34.82	37.23	36.03
F₃	8.33	8.58	8.46	35.62	38.88	37.25	35.08	39.45	37.27
Mean	8.23	8.38		33.47	36.97		33.79	37.43	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.17	NS		0.48	1.41		0.60	1.77	
F × P	0.29	NS		0.83	NS		1.04	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J₀	8.11	8.34	8.23	31.31	33.96	32.63	31.29	34.28	32.78
J₁	8.34	8.41	8.38	35.63	39.98	37.81	36.29	40.59	38.44
Mean	8.23	8.38		33.47	36.97		33.79	37.43	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.24	NS		0.68	NS		0.85	NS	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F₁	J₀	8.17	8.20	27.70	32.40	28.10	32.93		
	J₁	8.20	8.17	34.00	38.10	34.83	38.30		
F₂	J₀	8.10	8.27	32.20	34.00	33.13	34.30		
	J₁	8.23	8.47	35.70	39.53	36.50	40.17		
F₃	J₀	8.07	8.57	34.06	35.47	32.63	35.60		
	J₁	8.60	8.60	37.20	42.30	37.53	43.30		
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.	S.Em ±	C.D.		
	0.42	NS		1.18	NS	1.48	NS		

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre ha⁻¹, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

At harvest

Number of leaves per plant differed significantly due to the application of FYM, jeevamruta and panchagavya. More number of leaves were observed with FYM at 200 per cent N equivalent (34.75) which was on par with FYM at 150 per cent N equivalent (33.87) and it was lower with FYM at 100 per cent N equivalent (32.27). There was significant difference in number of leaves per plant was observed with application of jeevamrutha. Maximum number of leaves per plant were observed with application of jeevamrutha at 1000 litres ha⁻¹ (36.03) whereas, minimum number of leaves per plant were observed in without jeevamrutha (31.33). Panchagavya spray influenced significantly on number of leaves per plant. More number of branches per plant 35.19 (3 % panchagavya spray) and lower number of leaves per plant 32.07 was recorded in without panchagavya spray.

Experiment conducted during *kharif* 2015

20 days after sowing

Number of leaves did not differ significantly due to the application of FYM, jeevamruta and panchagavya. However, more number of leaves per plant were observed with FYM at 200 per cent N equivalent, jeevamrutha at 1000 litres ha⁻¹ and panchagavya at 3 per cent and it was lower with FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya application.

40 days after sowing

Number of leaves per plant differed significantly due to the application of FYM, jeevamruta and panchagavya. More number of leaves were observed with FYM at 200 per cent N equivalent (39.52) followed by FYM at 150 per cent N equivalent (37.23) and it was lower with FYM at 100 per cent N equivalent (34.25). There was significant difference in number of leaves per plant were observed with application of jeevamrutha. Maximum number of leaves per plant were observed with application of jeevamrutha at 1000 litre ha⁻¹ (39.71) whereas, minimum number of leaves per plant were observed in without jeevamrutha (34.29). Panchagavya spray influenced significantly on number of leaves per plant. More number of leaves per plant 38.90 (3 % panchagavya spray) and lower number of leaves per plant 35.10 was recorded in without panchagavya spray.

At harvest

Number of leaves per plant differed significantly due to the application of FYM, jeevamruta and panchagavya. More number of leaves were observed with FYM at 200 per cent N equivalent (39.78) which was on par with FYM at 150 per cent N equivalent (38.18) and it was lower with FYM at 100 per cent N equivalent (34.82). There was significant difference in number of branches per plant were observed with application of jeevamrutha. Maximum number of leaves per plant were observed with application of jeevamrutha at 1000 litre ha⁻¹ (40.84) whereas, minimum number of branches per plant was observed in without jeevamrutha (34.34). Panchagavya spray influenced significantly on number of leaves per plant. More number of leaves per plant 39.68 (3 % panchagavya spray) and lower number of leaves per plant 35.51 was recorded in without panchagavya spray.

Interaction effect

Number of leaves did not differ significantly due to the interaction effect of FYM and jeevamrutha, FYM and panchagavya, jeevamrutha and panchagavya, FYM, jeevamrutha and panchagavya at 20, 40 DAS and at harvest during both the years.

Pooled data

At 40 DAS FYM at 200 per cent N equivalent recorded significantly higher number of leaves (37.25) followed by FYM at 150 per cent N equivalent (35.36) as compared to FYM at 100 per cent N equivalent (37.25). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher number of leaves (37.81 and 36.97) as compared to without jeevamrutha and without panchagavya application (32.63 and 33.47).

At harvest, FYM at 200 per cent N equivalent recorded significantly higher number of leaves (37.27) which was on par with FYM at 150 per cent N equivalent (36.03) and it was lower with FYM at 100 per cent N equivalent (33.54). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher number of leaves (38.44 and 37.43) as compared to without jeevamrutha and without panchagavya application (32.78 and 33.79).

4.1.4 Leaf area (cm²)

The data pertaining to the leaf area per plant of frenchbean as influenced by application of solid and liquid manures were significant at 40 and at harvest except at 20 DAS and presented in Tables 12, 13 and 14.

Experiment conducted during *kharif* 2014

20 days after sowing

Leaf area per plant did not differ significantly due to the application of FYM, jeevamrutha and panchagavya. However, higher leaf area per plant was observed with FYM at 200 per cent N equivalent, jeevamrutha at 1000 litres ha⁻¹ and panchagavya at 3 per cent and it was lower with FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya application.

40 days after sowing

Leaf area per plant differed significantly due to the application of FYM, jeevamrutha and panchagavya. Higher leaf area was observed with FYM at 200 per cent N equivalent (1103.2) followed by FYM at 150 per cent N equivalent (997.5) and it was lower with FYM at 100 per cent N equivalent (924.8). Maximum leaf area per plant was observed with application of jeevamrutha at 1000 litres ha⁻¹ (1136.3) whereas, lower leaf area per plant was observed in without jeevamrutha (880.7). Higher leaf area per plant 1097.8 was observed in 3 % panchagavya spray and lower leaf area per plant 919.2 was recorded in without panchagavya spray.

Table 12: Leaf area of frenchbean at different growth stages as influenced by FYM and liquid manures application during *Kharif* 2014

Treatments	Leaf area plant ⁻¹ (cm ²)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	298.2	309.2	303.7	800.9	1,048.6	924.8	941.7	1236.4	1089.0
F ₂	326.3	317.6	321.9	908.0	1,086.9	997.5	989.2	1282.6	1135.9
F ₃	326.6	348.4	337.5	933.2	1,273.3	1,103.2	1039.7	1457.5	1248.6
Mean	317.0	325.1		880.7	1,136.3		990.2	1325.5	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	18.73	NS		21.91	64.26		38.15	111.91	
J	15.29	NS		17.89	52.47		31.15	91.37	
F × J	26.48	NS		33.14	NS		53.96	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	304.9	302.5	303.7	847.2	1,002.3	924.8	996.3	1181.8	1089.0
F ₂	308.9	335.0	321.9	917.1	1,077.8	997.5	1041.6	1230.1	1135.9
F ₃	319.9	355.1	337.5	993.2	1,213.3	1,103.2	1120.3	1376.9	1248.6
Mean	311.2	330.9		919.2	1,097.8		1052.7	1263.0	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	15.29	NS		17.89	52.47		31.15	91.37	
F × P	26.48	NS		30.98	NS		53.96	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	301.3	332.8	317.0	853.4	908.0	880.7	943.3	1037.1	990.2
J ₁	321.2	329.0	325.1	984.9	1287.6	1136.3	1162.1	1488.8	1325.5
Mean	311.2	330.9		919.2	1097.8		1052.7	1263.0	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	21.62	NS		25.30	74.20		44.06	129.22	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁	J ₀	294.8	301.5		769.3	832.6		901.1	982.4
	J ₁	314.9	303.5		925.2	1171.9		1091.4	1381.3
F ₂	J ₀	310.9	341.7		883.4	932.6		961.1	1017.2
	J ₁	306.9	328.3		950.8	1223.1		1122.1	1443.1
F ₃	J ₀	298.2	355.1		907.6	958.7		967.7	1111.7
	J ₁	341.7	355.1		1078.7	1467.9		1272.9	1642.1
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	37.46	NS		43.82	NS		76.31	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 13: Leaf area of frenchbean at different growth stages as influenced by FYM and liquid manures application during *Kharif* 2015

Treatments	Leaf area plant ⁻¹ (cm ²)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	409.0	438.2	423.6	982.7	1285.6	1134.2	1058.5	1414.2	1236.4
F ₂	450.7	478.5	464.6	1030.8	1333.6	1182.2	1216.3	1573.6	1395.0
F ₃	444.6	486.8	465.7	1081.5	1507.7	1294.6	1361.1	1900.5	1630.8
Mean	434.8	467.8		1031.7	1375.6		1212.0	1629.4	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	14.7	NS		36.56	107.23		43.90	128.76	
J	12.0	NS		29.85	87.55		35.84	105.14	
F × J	20.8	NS		51.70	NS		62.09	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	415.8	431.3		1039.1	1229.2	1134.2	1120.6	1352.2	1236.4
F ₂	457.2	472.0		1084.1	1280.3	1182.2	1279.2	1510.8	1395.0
F ₃	448.8	482.6		1165.0	1424.2	1294.6	1467.0	1794.5	1630.8
Mean	440.6	462.0		1096.1	1311.2		1288.9	1552.5	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	11.9	NS		29.85	87.55		35.84	105.14	
F × P	20.8	NS		51.70	NS		62.09	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	421.5	448.0	434.8	983.7	1079.6	1031.7	1146.3	1277.7	1212.0
J ₁	459.7	476.0	467.8	1208.4	1542.8	1375.6	1431.6	1827.2	1629.4
Mean	440.6	462.0		1096.1	1311.2		1288.9	1552.5	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	16.9	NS		42.21	123.82		50.69	148.68	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁	J ₀	403.2	414.8		943.3	1022.2		992.7	1124.4
	J ₁	428.4	447.9		1134.9	1436.3		1248.4	1579.9
F ₂	J ₀	443.8	457.6		1001.5	1060.1		1181.7	1250.9
	J ₁	470.6	486.5		1166.7	1500.5		1376.7	1770.6
F ₃	J ₀	417.5	471.7		1006.3	1156.7		1264.3	1457.9
	J ₁	480.1	493.5		1323.7	1691.7		1669.7	2131.2
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	29.4	NS		73.12	NS		87.80	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 14: Leaf area of frenchbean at different growth stages as influenced FYM and liquid manures application (Pooled 2014 and 2015)

Treatments	Leaf area plant ⁻¹ (cm ²)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels									
F ₁	353.59	373.68	363.63	891.84	1,167.08	1,029.46	1,000.13	1,325.26	1,162.70
F ₂	388.48	398.05	393.26	969.42	1,210.27	1,089.84	1,102.76	1,428.11	1,265.43
F ₃	385.61	417.62	401.61	1,007.34	1,390.50	1,198.92	1,200.39	1,678.97	1,439.68
Mean	375.89	396.45		956.20	1,255.95		1,101.09	1,477.45	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	12.06	NS		26.00	76.39		40.21	117.95	
J	9.85	NS		21.26	62.37		32.84	96.31	
F × J	17.06	NS		36.86	NS		56.87	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	360.34	366.92	363.63	943.17	1,115.75	1,029.46	1,058.40	1,266.99	1,162.70
F ₂	383.02	403.51	393.26	1,000.60	1,179.08	1,089.84	1,160.41	1,370.46	1,265.43
F ₃	384.36	418.86	401.61	1,079.10	1,318.74	1,198.92	1,293.64	1,585.72	1,439.68
Mean	375.90	396.43		1,007.62	1,204.52		1,170.82	1,407.72	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	9.85	NS		21.36	62.37		32.84	96.31	
F × P	17.06	NS		36.83	NS		56.87	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	361.38	390.40	375.89	918.57	993.82	956.20	1044.77	1157.41	1101.09
J ₁	390.43	402.46	396.45	1096.67	1415.23	1255.95	1296.86	1658.03	1477.45
Mean	375.90	396.43		1007.62	1204.52		1170.82	1407.72	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	13.93	NS		30.07	88.20		46.44	136.20	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁	J ₀	349.0	358.17	856.28	927.4		946.89	1053.38	
	J ₁	371.67	375.68	1030.1	1304.1		1169.91	1480.61	
F ₂	J ₀	377.32	399.63	942.45	996.38		1071.44	1134.08	
	J ₁	388.71	407.39	1058.74	1361.79		1249.37	1606.84	
F ₃	J ₀	357.81	413.41	956.98	1057.69		1115.99	1284.79	
	J ₁	410.91	424.32	1201.21	1579.79		1471.29	1886.65	
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	24.13	NS		52.10	NS		80.43	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Interaction effect

Panchagavya and jeevamruta interaction gave significantly higher leaf area. Panchagavya at 3 per cent and jeevamruta at 1000 litre/ha interaction produced significantly higher leaf area (1287.6) as compared to other treatments and lower was with without panchagavya and jeevamruta application. Leaf area per plant did not differ significantly due to the interaction effect of FYM and jeevamrutha, FYM and Panchagavya, FYM, jeevamrutha and panchagavya. However, higher leaf area per plant was observed with FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent and it was lower with FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya application.

At harvest

Leaf area per plant varied significantly due to the application of FYM, jeevamruta and panchagavya. Higher leaf area was observed with FYM at 200 per cent N equivalent (1248.6) and it was lower with FYM at 100 per cent N equivalent (1089.0). Maximum leaf area per plant was observed with application of jeevamrutha at 1000 litre ha⁻¹ (1325.5) whereas, minimum leaf area per plant was observed in without jeevamrutha (990.2). Panchagavya at 3 per cent recorded higher leaf area per plant (1263.0) and lower leaf area per plant was recorded in without panchagavya spray (1052.7).

Interaction effect

Panchagavya at 3 per cent and jeevamruta at 1000 litre ha⁻¹ interaction gave significantly higher leaf area (1488.8 cm²) and lower leaf area was in without panchagavya and without jeevamruta application (943.3 cm²). Leaf area per plant did not differ significantly due to the interaction effect of FYM and jeevamrutha, FYM and Panchagavya, FYM, jeevamrutha and panchagavya. However, higher leaf area per plant was observed with FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent and it was lower with FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya application.

Experiment conducted during *kharif* 2015

20 days after sowing

Leaf area per plant did not vary significantly due to the application of FYM, jeevamruta and panchagavya. However, higher leaf area per plant was observed with FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent and it was lower with FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya application.

40 days after sowing

Leaf area per plant varied significantly due to the application of FYM, jeevamruta and panchagavya. Significantly higher leaf area was observed with FYM at 200 per cent N equivalent (1294.6) and it was lower with FYM at 100 per cent N equivalent (1134.2). Maximum leaf area per plant was observed with application of jeevamrutha at 1000 litre ha⁻¹ (1375.6) whereas, minimum leaf area per plant was observed in without jeevamrutha

(1031.7). Panchagavya at 3 per cent given significantly higher leaf area per plant (1311.2) and lower leaf area per plant was recorded in without panchagavya spray (1096.1).

Interaction effect

Panchagavya at 3 per cent and jeevamruta at 1000 litre ha⁻¹ interaction given significantly higher leaf area (1542.8) followed by alone application jeevamruta (1208.4 cm²) and lower leaf area was in without panchagavya and without jeevamruta application (983.7 cm²). Leaf area per plant did not differ significantly due to the interaction effect of FYM and jeevamrutha, FYM and Panchagavya, jeevamrutha and panchagavya, FYM, jeevamrutha and panchagavya. However, higher leaf area per plant was observed with FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent and it was lower with FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya application.

At harvest

Leaf area per plant differed significantly due to the application of FYM, jeevamruta and panchagavya. Higher leaf area was observed with FYM at 200 per cent N equivalent (1630.8) followed by FYM at 150 per cent N equivalent (1395.0) and it was lower with FYM at 100 per cent N equivalent (1236.4). Maximum leaf area per plant was observed with application of jeevamrutha at 1000 litre ha⁻¹ (1629.4) whereas, lower leaf area per plant was observed in without jeevamrutha (1212.0). Higher leaf area per plant recorded in panchagavya at 3 per cent (1552.5) and lower leaf area per plant 1288.9 was recorded in without panchagavya spray.

Interaction effect

Panchagavya and jeevamruta, FYM and jeevamruta interaction resulted in significantly higher leaf area. Panchagavya at 3 per cent and jeevamruta at 1000 litre ha⁻¹ interaction given significantly higher leaf area (1542.8) followed by alone application jeevamruta (1208.4 cm²) and panchagavya (1079.6 cm²) as compared to without panchagavya and jeevamruta application. Leaf area per plant did not differ significantly due to the interaction effect of FYM and jeevamruta, FYM and Panchagavya and FYM, jeevamrutha and panchagavya. However, higher leaf area per plant was observed with FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent and it was lower with FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya application.

Pooled data

At 40 DAS, FYM at 200 per cent N equivalent recorded significantly higher leaf area (1198.92 cm²) followed by FYM at 150 per cent N equivalent (1089.84 cm²) as compared to FYM at 100 per cent N equivalent (1029.46 cm²). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher leaf area (1255.95 and 1204.52 cm²) as compared to without jeevamrutha and without panchagavya application (956.20 and 1007.62 cm²). Panchagavya and jeevamruta interaction resulted in significantly higher leaf area. Panchagavya at 3 per cent and jeevamruta at 1000 litres ha⁻¹ interaction gave significantly higher leaf area (1415.23

cm²) followed by alone application jeevamruta (1096.67 cm²) and panchagavya (993.82 cm²) as compared to without panchagavya and jeevamruta application.

At harvest, FYM at 200 per cent N equivalent recorded significantly higher leaf area (1439.68 cm²) as compared to FYM at 150 per cent N equivalent (1265.43 cm²) and FYM at 100 per cent N equivalent (1162.70 cm²). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher leaf area (1477.45 and 1407.72 cm²) as compared to without jeevamrutha and without panchagavya application (1101.09 and 1170.82 cm²). Panchagavya at 3 per cent and jeevamruta at 1000 litre ha⁻¹ interaction given significantly higher leaf area (1658.03) followed by alone application jeevamruta (1296.83 cm²) as compared to panchagavya (1157.41 cm²) and without panchagavya and without jeevamruta application (1044.77 cm²).

4.1.5 Leaf Area Index (LAI)

The data pertaining to the leaf area index per plant of frenchbean as influenced by various levels of FYM, jeevamrutha and panchagavya application was significant at 40 DAS and harvest except at 20 DAS presented in Tables 15, 16 and 17.

Experiment conducted during *kharif* 2014

20 days after sowing

Leaf area index did not differ significantly due to the application of FYM, jeevamruta and panchagavya. However, higher plant was observed with FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent and it was lower with FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya application.

40 days after sowing

Leaf area index varied significantly due to the application of FYM, jeevamruta and panchagavya. Significantly higher leaf area index was observed with FYM at 200 per cent N equivalent (2.45) followed by FYM at 150 per cent N equivalent (2.22) and it was lower with FYM at 100 per cent N equivalent (2.06). Maximum leaf area index was observed with application of jeevamrutha at 1000 litre ha⁻¹ (2.53). Whereas, lower leaf area index was observed in without jeevamrutha (1.96) application. Panchagavya spray influenced significantly on leaf area index. Higher leaf area index 2.44 was observed in 3 % panchagavya spray) and lower leaf area index 2.04 was recorded in without panchagavya spray.

Interaction effect

Panchagavya and jeevamrutha interaction given significantly higher leaf area index. Panchagavya at 3 per cent and jeevamruta at 1000 litre/ha interaction resulted in significantly higher leaf area index (2.86) as compared to other treatments and lower was with without panchagavya and jeevamrutha application (1.90). Leaf area index did not differ significantly due to the interaction effect of FYM and jeevamrutha, FYM and panchagavya and FYM, jeevamrutha and panchagavya. However, higher leaf area index

Table 15: Leaf area index of frenchbean at different growth stages as influenced by FYM and liquid manures application during *Kharif* 2014

Treatments	Leaf area index								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels									
F ₁	0.66	0.69	0.67	1.78	2.33	2.06	2.09	2.75	2.42
F ₂	0.73	0.71	0.72	2.02	2.42	2.22	2.20	2.85	2.52
F ₃	0.73	0.77	0.75	2.07	2.83	2.45	2.31	3.24	2.77
Mean	0.70	0.72		1.96	2.53		2.20	2.95	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.04	NS		0.05	0.14		0.08	0.25	
J	0.03	NS		0.04	0.12		0.07	0.20	
F × J	0.06	NS		0.07	NS		0.12	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	0.68	0.67	0.67	1.88	2.23	2.06	2.21	2.63	2.42
F ₂	0.69	0.74	0.72	2.04	2.40	2.22	2.31	2.73	2.52
F ₃	0.71	0.79	0.75	2.21	2.70	2.45	2.49	3.06	2.77
Mean	0.69	0.74		2.04	2.44		2.34	2.81	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.03	NS		0.04	0.12		0.07	0.20	
F × P	0.06	NS		0.07	NS		0.12	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	0.67	0.74	0.70	1.90	2.02	1.96	2.10	2.30	2.20
J ₁	0.71	0.73	0.72	2.19	2.86	2.53	2.58	3.31	2.95
Mean	0.69	0.74		2.04	2.44		2.34	2.81	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.05	NS		0.06	0.16		0.10	0.29	
Interaction									
F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁	J ₀	0.66	0.67		1.71	1.85		2.00	2.18
	J ₁	0.70	0.67		2.06	2.60		2.43	3.07
F ₂	J ₀	0.69	0.76		1.96	2.07		2.14	2.26
	J ₁	0.68	0.73		2.11	2.72		2.49	3.21
F ₃	J ₀	0.66	0.79		2.02	2.13		2.15	2.47
	J ₁	0.76	0.79		2.40	3.26		2.83	3.65
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	0.08	NS		0.10	NS		0.17	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 16: Leaf area index of frenchbean at different growth stages as influenced by FYM and liquid manures application during *Kharif* 2015

Treatments	Leaf area index								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels									
F₁	0.91	0.97	0.94	2.18	2.86	2.52	2.35	3.14	2.75
F₂	1.00	1.06	1.03	2.29	2.96	2.63	2.70	3.50	3.10
F₃	0.99	1.08	1.03	2.40	3.35	2.88	3.02	4.22	3.62
Mean	0.97	1.04		2.29	3.06		2.69	3.62	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.03	NS		0.08	0.24		0.10	0.29	
J	0.03	NS		0.07	0.19		0.08	0.23	
F × J	0.05	NS		0.11	NS		0.14	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F₁	0.92	0.96	0.94	2.31	2.73	2.52	2.49	3.00	2.75
F₂	1.02	1.05	1.03	2.41	2.85	2.63	2.84	3.36	3.10
F₃	1.00	1.07	1.03	2.59	3.16	2.88	3.26	3.99	3.62
Mean	0.98	1.03		2.44	2.91		2.86	3.45	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.03	NS		0.07	0.19		0.08	0.23	
F × P	0.05	NS		0.11	NS		0.14	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J₀	0.94	1.00	0.97	2.19	2.40	2.29	2.55	2.84	2.69
J₁	1.02	1.06	1.04	2.69	3.43	3.06	3.18	4.06	3.62
Mean	0.98	1.03		2.44	2.91		2.86	3.45	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.04	NS		0.09	0.28		0.11	0.33	
Interaction	P₀	P₁		P₀	P₁		P₀	P₁	
F × J × P									
F₁	J₀	0.90	0.92		2.10	2.27		2.21	2.50
	J₁	0.95	1.00		2.52	3.19		2.77	3.51
F₂	J₀	0.99	1.02		2.23	2.36		2.63	2.78
	J₁	1.05	1.08		2.59	3.33		3.06	3.93
F₃	J₀	0.93	1.05		2.24	2.57		2.81	3.24
	J₁	1.07	1.10		2.94	3.76		3.71	4.74
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	0.07	NS		0.16	NS		0.20	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS - Days After Sowing, RDF - 63:100:75 NPK kg ha⁻¹

Table 17: Leaf area index of frenchbean at different growth stages as influenced by FYM and liquid manures application during (Pooled 2014 and 2015)

Treatments	Leaf area index								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels									
F₁	0.79	0.83	0.81	1.98	2.59	2.29	2.22	2.95	2.58
F₂	0.86	0.88	0.87	2.15	2.69	2.42	2.45	3.17	2.81
F₃	0.86	0.93	0.89	2.24	3.09	2.66	2.67	3.73	3.20
Mean	0.84	0.88		2.12	2.79		2.45	3.28	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.03	NS		0.06	0.17		0.09	0.26	
J	0.02	NS		0.05	0.14		0.07	0.21	
F × J	0.04	NS		0.08	NS		0.13	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F₁	0.80	0.82	0.81	2.10	2.48	2.29	2.35	2.82	2.58
F₂	0.85	0.90	0.87	2.22	2.62	2.42	2.58	3.05	2.81
F₃	0.85	0.93	0.89	2.40	2.93	2.66	2.87	3.52	3.20
Mean	0.84	0.88		2.24	2.68		2.60	3.13	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.02	NS		0.05	0.14		0.07	0.21	
F × P	0.04	NS		0.08	NS		0.13	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J₀	0.80	0.87	0.84	2.04	2.21	2.12	2.32	2.57	2.45
J₁	0.87	0.89	0.88	2.44	3.14	2.79	2.88	3.68	3.28
Mean	0.84	0.88		2.24	2.68		2.60	3.13	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.03	NS		0.07	0.20		0.10	0.30	
Interaction									
F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F₁	J₀	0.78	0.80		1.90	2.06		2.10	2.34
	J₁	0.83	0.83		2.29	2.90		2.60	3.29
F₂	J₀	0.84	0.89		2.09	2.21		2.38	2.52
	J₁	0.86	0.86		2.35	3.03		2.78	3.57
F₃	J₀	0.80	0.92		2.13	2.35		2.48	2.86
	J₁	0.91	0.94		2.67	3.51		3.27	4.19
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	0.05	NS		0.12	NS		0.18	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

was observed with FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent and it was lower with FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya application.

At harvest

Leaf area index differed significantly due to the application of FYM, jeevamrutha and panchagavya. Higher leaf area index was observed with FYM at 200 per cent N equivalent (2.77) and it was lower with FYM at 100 per cent N equivalent (2.42). There was significant difference in leaf area index was observed with application of jeevamrutha. Maximum leaf area index was observed with application of jeevamrutha at 1000 litre ha⁻¹ (2.95) whereas, minimum leaf area index was observed in without jeevamrutha (2.20). Panchagavya spray influenced significantly on leaf area index. Higher leaf area index 2.81 (3 % panchagavya spray) and lower leaf area index 2.34 was recorded in without panchagavya spray.

Interaction effect

Panchagavya at 3 per cent and jeevamrutha at 1000 litre ha⁻¹ interaction given significantly higher leaf area index (3.31) as compared to other treatments and lower leaf area index was observed in without panchagavya and without jeevamrutha application (2.10). Leaf area index did not differ significantly due to the interaction effect of FYM and jeevamrutha, FYM and panchagavya, and FYM, jeevamrutha and panchagavya. However, higher leaf area index was observed with FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent and it was lower with FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya application.

Experiment conducted during *kharif* 2015

20 days after sowing

Leaf area index did not vary significantly due to the application of FYM, jeevamrutha and panchagavya. However, higher leaf area index was observed with FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent and it was lower with FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya application.

40 days after sowing

Leaf area index differed significantly due to the application of FYM, jeevamrutha and panchagavya. Higher leaf area index was observed with FYM at 200 per cent N equivalent (2.88) and it was lower with FYM at 100 per cent N equivalent (2.63). There was significant difference in leaf area index was observed with application of jeevamrutha. Maximum leaf area index was observed with application of jeevamrutha at 1000 litre ha⁻¹ (3.06) whereas, minimum leaf area index was observed in without jeevamrutha (2.29). Panchagavya spray influenced significantly on leaf area index. Higher leaf area index 2.91 was noticed in 3 % panchagavya spray and lower leaf area index 2.44 was recorded in without panchagavya spray.

Interaction effect

Panchagavya and jeevamruta interaction resulted in significantly higher leaf area index. Panchagavya at 3 per cent and jeevamruta at 1000 litres ha⁻¹ interaction resulted in significantly higher leaf area index (3.43) as compared to other treatments and lower was with without panchagavya and jeevamruta application (2.19). Leaf area index did not differed significantly due to the interaction effect of FYM and jeevamrutha, FYM and Panchagavya, jeevamrutha and panchagavya, FYM, jeevamrutha and panchagavya. However, higher leaf area index was observed with FYM at 200 per cent N equivalent, jeevamrutha at 1000 litres ha⁻¹ and panchagavya at 3 per cent and it was lower with FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya application.

At harvest

Leaf area index varied significantly due to the application of FYM, jeevamruta and panchagavya. Higher leaf area index was observed with FYM at 200 per cent N equivalent (3.62) followed by FYM at 150 per cent N equivalent (3.10) and it was lower with FYM at 100 per cent N equivalent (2.75). Significantly maximum leaf area index was observed with application of jeevamrutha at 1000 litre ha⁻¹ (3.62) whereas, lower leaf area index was observed in without jeevamrutha (2.69) application. Panchagavya spray influenced significantly on leaf area index. Higher leaf area index 3.45 was recorded in 3 % panchagavya spray and lower leaf area index 2.86 was recorded in without panchagavya spray.

Interaction effect

Panchagavya at 3 per cent and jeevamruta at 1000 litre ha⁻¹ interaction given significantly higher leaf area index (4.06) followed by alone application jeevamruta (3.18) and lower leaf area was in without panchagavya and without jeevamruta application (2.55). In FYM and jeevamruta interaction application of jeevamrutha along with FYM resulted in significantly higher leaf area index whereas FYM levels without jeevamruta interaction recorded lower leaf area index per plant. Leaf area index did not differed significantly due to the interaction effect of FYM and Panchagavya and FYM, jeevamrutha and panchagavya. However, higher leaf area index was observed with FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent and it was lower with FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya application.

Pooled data

The data pertaining to the leaf area index per plant of frenchbean as influenced by various levels of FYM, jeevamrutha and panchagavya application was significant at 40 DAS and harvest except at 20 DAS presented in Table 17.

At 40 DAS FYM at 200 per cent N equivalent recorded significantly higher leaf area index (2.66) followed by FYM at 150 per cent N equivalent (2.42) as compared to FYM at 100 per cent N equivalent (2.29). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher leaf area index (2.79 and 2.68) as compared to without jeevamrutha and without panchagavya application (2.12 and 2.24).

Panchagavya and jeevamruta interaction given significantly higher leaf area index. Panchagavya at 3 per cent and jeevamruta at 1000 litre ha⁻¹ interaction given significantly higher leaf area index followed (3.14) by alone application jeevamruta (2.44) and panchagavya (2.21) as compared to without Panchagavya and jeevamruta application.

At harvest FYM at 200 per cent N equivalent recorded significantly higher leaf area index (3.20) as compared to FYM at 150 per cent N equivalent (2.81) and FYM at 100 per cent N equivalent (2.58). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher leaf area index (3.28 and 3.13) as compared to without jeevamrutha and without panchagavya application (2.45 and 2.60). Panchagavya at 3 per cent and jeevamruta at 1000 litre ha⁻¹ interaction given significantly higher leaf area index (3.68) followed by alone application jeevamruta (2.88) as compared to panchagavya and without panchagavya and without jeevamruta application.

4.1.6 Number of nodules, fresh weight and dry weight of nodules per plant

The data on number of nodules, fresh weight and dry weight of nodules per plant differed significantly due to the application of various levels of FYM, jeevamrutha and panchagavya at flowering stage of frenchbean (Table 18).

Experiment conducted during *kharif* 2014

Nodule formation by plants was not observed during *Kharif* 2014.

Experiment conducted during *kharif* 2015

Number of nodules, fresh weight and dry weight of nodules per plant differed significantly due to the application of FYM, jeevamruta and panchagavya. More number of nodules and their fresh and dry weight per plant were recorded in FYM at 200 per cent N equivalent (87.1, 0.53 g and 0.10 g) followed by FYM at 150 per cent N equivalent (78.4, 0.48 g and 0.09 g) and it was lower with FYM at 100 per cent N equivalent (69.9, 0.41 g and 0.08 g). There was significant difference in number of nodules, fresh weight and dry weight of nodules per plant were observed with application of jeevamrutha. Maximum number of number of nodules, fresh weight and dry weight of nodules per plant were observed with application of jeevamrutha at 1000 litre ha⁻¹ (89.6, 0.551 g and 0.11 g) whereas, minimum number of nodules, fresh weight and dry weight of nodules per plant were observed in without jeevamrutha (67.1, 0.40 and 0.07 g). Application of panchagavya at 3 % recorded more number of number of nodules, fresh weight and dry weight of nodules per plant (85.1, 0.53 and 0.11 g) and lower number of nodules, fresh weight and dry weight of nodules per plant were observed in without panchagavya spray (71.7, 0.42 and 0.08 g).

Interaction effect

Application of FYM and panchagavya interaction significantly influenced on number of nodules except fresh weight and dry weight of nodules, where more number of nodules per plant were observed in FYM at 200 per cent N equivalent with panchagavya at 3 per cent spray (96.8) as compared to other treatments and lower was with FYM at

Table 18: Effect of FYM and liquid manures application on number of nodules, fresh weight and dry weight of nodules at flowering stage of frenchbean during Kharif 2015

Treatments	At flowering stage								
	Number of nodules plant ⁻¹			Fresh weight of nodules plant ⁻¹ (g)			Dry weight of nodules plant ⁻¹ (g)		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	58.4	80.8	69.6	0.34	0.48	0.41	0.06	0.10	0.08
F ₂	68.5	88.3	78.4	0.41	0.56	0.48	0.07	0.11	0.09
F ₃	74.5	99.7	87.1	0.46	0.60	0.53	0.09	0.12	0.10
Mean	67.1	89.6		0.40	0.55		0.07	0.11	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	1.99	5.85		0.02	0.04		0.003	0.01	
J	1.63	4.77		0.01	0.04		0.002	0.01	
F × J	2.82	NS		0.02	NS		0.004	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	61.8	77.4	69.6	0.36	0.47	0.41	0.06	0.09	0.08
F ₂	75.8	81.0	78.4	0.42	0.55	0.48	0.08	0.10	0.09
F ₃	77.3	96.8	87.1	0.47	0.59	0.53	0.09	0.12	0.10
Mean	71.7	85.1		0.42	0.53		0.08	0.11	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	1.63	4.77		0.01	0.04		0.002	0.01	
F × P	2.87	8.27		0.02	NS		0.004	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	60.1	74.2	67.1	0.35	0.45	0.40	0.06	0.08	0.07
J ₁	83.2	96.0	89.6	0.48	0.61	0.55	0.09	0.13	0.11
Mean	71.7	85.1		0.42	0.53		0.08	0.11	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	2.30	NS		0.02	NS		0.003	0.01	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁ J ₀	48.0	68.8		0.25	0.43		0.05	0.07	
F ₁ J ₁	75.7	86.0		0.46	0.50		0.08	0.11	
F ₂ J ₀	65.0	72.0		0.37	0.45		0.07	0.08	
F ₂ J ₁	86.7	90.0		0.48	0.64		0.09	0.13	
F ₃ J ₀	67.3	81.7		0.44	0.48		0.08	0.09	
F ₃ J ₁	87.3	112.0		0.51	0.69		0.10	0.15	
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	3.99	NS		0.03	0.09		0.005	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

100 per cent N equivalent with no panchagavya application (61.8). Dry weight of nodules per plant differed significantly due to interaction of jeevamruta and panchagavya application where application of jeevamruta (1000 l ha⁻¹) and panchagavya (3 %) given higher dry weight of nodules per plant (0.11 g) and lower was in without jeevamruta and without panchagavya application (0.06 g). Fresh weight of nodules per plant differed significantly due to the interaction effect of FYM, jeevamrutha and panchagavya. Application of FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent given higher fresh weight of nodules per plant (0.69 g) and it was lower with FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya application (0.25 g).

4.1.7 Dry matter accumulation in different plant parts

Dry matter accumulation in shoot (g plant⁻¹)

Dry matter accumulation in shoot differed significantly due to the application of solid and liquid manures are presented in the Tables 19, 20 and 21.

Experiment conducted during *kharif* 2014

20 days after sowing

Dry matter accumulation in shoot did not differ significantly due to the application of FYM, jeevamrutha and panchagavya. However, higher dry matter in shoot was observed with FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent and it was lower with FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya application.

40 Days after sowing

Dry matter accumulation in shoot varied significantly due to the application of FYM, jeevamrutha and panchagavya. Higher dry matter accumulation in shoot per plant was recorded in FYM at 200 per cent N equivalent (5.15 g) as compared to FYM at 100 per cent N equivalent (4.61 g) and on par with FYM at 150 per cent N equivalent (4.90 g). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent each application recorded significantly higher dry matter accumulation in shoot (5.31 and 5.19 g) as compared to without jeevamrutha and without panchagavya application (4.47 and 4.59 g).

At harvest

Application of FYM, jeevamrutha and panchagavya had significant influence on dry matter accumulation in shoot. Significantly higher dry matter accumulation in shoot per plant was recorded in FYM at 200 per cent N equivalent (5.98 g) as compared to FYM at 100 per cent N equivalent (5.75 g) and on par with FYM at 150 per cent N equivalent (5.75 g). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent each application recorded significantly higher dry matter accumulation in shoot (6.24 and 6.04 g) as compared to without jeevamrutha and without panchagavya application (5.18 and 5.38 g).

Table 19: Shoot weight of frenchbean at different growth stages as influenced by FYM and liquid manures application during *Kharif* 2014

Treatments	Shoot weight (g plant ⁻¹)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	1.03	1.07	1.05	4.25	4.97	4.61	4.93	5.87	5.40
F ₂	1.06	1.08	1.07	4.44	5.37	4.90	5.23	6.26	5.75
F ₃	1.08	1.13	1.11	4.71	5.58	5.15	5.38	6.58	5.98
Mean	1.06	1.10		4.47	5.31		5.18	6.24	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.05	NS		0.09	0.27		0.12	0.34	
J	0.04	NS		0.07	0.22		0.09	0.28	
F × J	0.07	NS		0.13	NS		0.16	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	1.04	1.07	1.05	4.32	4.91	4.61	5.05	5.76	5.40
F ₂	1.06	1.08	1.07	4.61	5.20	4.90	5.44	6.05	5.75
F ₃	1.13	1.08	1.11	4.84	5.46	5.15	5.66	6.30	5.98
Mean	1.10	1.08		4.59	5.19		5.38	6.04	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.04	NS		0.07	0.22		0.09	0.28	
F × P	0.07	NS		0.13	NS		0.16	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	1.07	1.04	1.06	4.17	4.76	4.47	4.89	5.47	5.18
J ₁	1.08	1.11	1.10	5.00	5.61	5.31	5.87	6.60	6.24
Mean	1.08	1.08		4.59	5.19		5.38	6.04	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.05	0.16		0.10	NS		0.13	NS	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁	J ₀	1.03	1.03	3.87	4.63	4.49	5.37		
	J ₁	1.04	1.10	4.77	5.18	5.60	6.14		
F ₂	J ₀	1.04	1.07	4.21	4.67	4.99	5.47		
	J ₁	1.07	1.10	5.01	5.73	5.89	6.63		
F ₃	J ₀	1.13	1.03	4.44	4.98	5.19	5.57		
	J ₁	1.13	1.13	5.23	5.93	6.13	7.03		
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.	S.Em ±	C.D.		
	0.09	NS		0.18	NS	0.23	NS		

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 20: Shoot weight of frenchbean at different growth stages as influenced by FYM and liquid manures application during *Kharif* 2015

Treatments	Shoot weight (g plant ⁻¹)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	1.07	1.09	1.08	4.36	5.19	4.78	5.13	6.08	5.60
F ₂	1.07	1.10	1.08	4.63	5.59	5.11	5.41	6.47	5.94
F ₃	1.15	1.19	1.17	4.92	5.82	5.37	5.55	6.80	6.18
Mean	1.09	1.13		4.64	5.53		5.37	6.45	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.04	NS		0.10	0.30		0.11	0.33	
J	0.04	NS		0.08	0.25		0.09	0.27	
F × J	0.06	NS		0.15	NS		0.16	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	1.06	1.10	1.08	4.43	5.12	4.78	5.22	5.99	5.60
F ₂	1.07	1.10	1.08	4.81	5.41	5.11	5.63	6.26	5.94
F ₃	1.15	1.19	1.17	5.05	5.69	5.37	5.84	6.51	6.18
Mean	1.09	1.13		4.76	5.41		5.56	6.25	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.04	NS		0.08	0.25		0.09	0.27	
F × P	0.05	NS		0.15	NS		0.16	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	1.09	1.10	1.09	4.31	4.97	4.64	5.05	5.68	5.37
J ₁	1.10	1.15	1.13	5.22	5.85	5.53	6.08	6.83	6.45
Mean	1.09	1.13		4.76	5.41		5.56	6.25	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.05	NS		0.12	NS		0.13	NS	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁	J ₀	1.06	1.08	3.90	4.83	4.63	5.63		
	J ₁	1.07	1.11	4.97	5.41	5.81	6.35		
F ₂	J ₀	1.08	1.06	4.39	4.87	5.18	6.65		
	J ₁	1.07	1.13	5.23	5.94	6.09	6.86		
F ₃	J ₀	1.12	1.17	4.64	5.19	5.35	5.76		
	J ₁	1.17	1.22	5.46	6.19	6.34	7.27		
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.	S.Em ±	C.D.		
	0.09	NS		0.21	NS	0.22	NS		

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 21: Shoot weight of frenchbean at different growth stages as influenced by FYM and liquid manures application (Pooled 2014 and 2015)

Treatments	Shoot weight (g plant ⁻¹)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	1.05	1.08	1.07	4.31	5.08	4.69	5.03	5.97	5.50
F ₂	1.06	1.09	1.08	4.53	5.48	5.01	5.32	6.37	5.85
F ₃	1.11	1.16	1.14	4.81	5.70	5.26	5.47	6.69	6.08
Mean	1.08	1.11		4.55	5.42		5.27	6.34	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.03	NS		0.10	0.28		0.11	0.32	
J	0.03	NS		0.08	0.23		0.09	0.27	
F × J	0.05	NS		0.14	NS		0.16	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	1.05	1.08	1.07	4.38	5.01	4.69	5.13	5.87	5.50
F ₂	1.06	1.09	1.08	4.71	5.30	5.01	5.54	6.15	5.85
F ₃	1.14	1.14	1.14	4.94	5.57	5.26	5.75	6.41	6.08
Mean	1.08	1.10		4.68	5.30		5.47	6.14	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.03	NS		0.08	0.23		0.09	0.27	
F × P	0.05	NS		0.14	NS		0.16	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	1.08	1.07	1.08	4.24	4.86	4.55	4.97	5.57	5.27
J ₁	1.09	1.13	1.11	5.11	5.73	5.42	5.98	6.71	6.34
Mean	1.08	1.10		4.68	5.30		5.47	6.14	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.04	NS		0.11	NS		0.13	NS	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁	J ₀	1.04	1.06		3.88	4.73		4.56	5.50
	J ₁	1.06	1.10		4.87	5.29		5.70	6.25
F ₂	J ₀	1.06	1.06		4.30	4.77		5.09	5.56
	J ₁	1.07	1.12		5.12	5.84		5.99	6.75
F ₃	J ₀	1.13	1.10		4.54	5.09		5.27	5.67
	J ₁	1.15	1.18		5.35	6.06		6.24	7.15
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	0.07	NS		0.19	NS		0.22	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Experiment conducted during *kharif* 2015

20 days after sowing

Dry matter accumulation in shoot did not vary significantly due to the application of FYM, jeevamrutha and panchagavya. However, higher dry matter in shoot was observed with FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent and it was lower with FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya application.

40 Days after sowing

Significantly higher dry matter accumulation in shoot per plant was recorded in FYM at 200 per cent N equivalent (5.11 g) as compared to FYM at 100 per cent N equivalent (4.78 g) and on par with FYM at 150 per cent N equivalent (5.37 g). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent each application recorded significantly higher dry matter accumulation in shoot (5.53 and 5.41 g) as compared to without jeevamrutha and without panchagavya application (4.64 and 4.76 g).

At harvest

Significantly higher dry matter accumulation in shoot per plant was recorded in FYM at 200 per cent N equivalent (6.18 g) as compared to FYM at 100 per cent N equivalent (5.60 g) and on par with FYM at 150 per cent N equivalent (5.60 g). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent each application recorded significantly higher dry matter accumulation in stem (6.45 and 6.25 g) as compared to without jeevamrutha and without panchagavya application (5.37 and 5.56 g).

Interaction effect

Dry matter accumulation in shoot per plant did not differ significantly due to the interaction effect of FYM and jeevamrutha, FYM and Panchagavya, jeevamrutha and panchagavya, FYM, jeevamrutha and panchagavya applications at 20, 40 DAS and at harvest during both the years.

Pooled

Data on dry matter accumulation in stem showed significant difference among the treatments at all stages except at 20 DAS (Table 21).

At 40 DAS and at harvest, significantly higher dry matter accumulation in stem per plant was recorded in FYM at 200 per cent N equivalent (5.26 and 6.08 g) as compared to FYM at 100 per cent N equivalent (4.69 and 5.50 g) and on par with FYM at 150 per cent N equivalent (5.01 and 5.85 g). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent each application recorded significantly higher dry matter accumulation in stem (5.42, 6.34 and 5.30, 6.14 g, respectively) as compared to without jeevamrutha and without panchagavya application (4.55, 5.27 and 4.68, 5.47 g, respectively).

Dry matter accumulation in leaves (g plant⁻¹)

Dry matter accumulation in leaves differed significantly due to the application of solid and liquid manures are presented in the Tables 22, 23 and 24.

Experiment conducted during *kharif* 2014

20 days after sowing

Dry matter accumulation in leaves per plant did not differ significantly due to the application of FYM, jeevamruta and panchagavya. However, higher dry matter in leaves was observed with FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent and it was lower with FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya application.

40 Days after sowing

Significantly higher dry matter accumulation in leaves per plant was recorded in FYM at 200 per cent N equivalent (6.06 g) as compared to FYM at 100 per cent N equivalent (5.39 g) and on par with FYM at 150 per cent N equivalent (5.73 g). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent each application recorded significantly higher dry matter accumulation in leaves (6.31 and 6.11 g) as compared to without jeevamrutha and without panchagavya application (5.14 and 5.34 g).

Dry matter accumulation in leaves per plant did not differ significantly due to the interaction effect of FYM and jeevamrutha, FYM and Panchagavya, jeevamrutha and panchagavya, FYM, jeevamrutha and panchagavya applications.

At harvest

FYM at 200 per cent N equivalent recorded significantly higher dry matter accumulation in leaves per plant (6.51 g) as compared to FYM at 100 per cent N equivalent (5.84 g) and on par with FYM at 150 per cent N equivalent (6.23 g). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent each application recorded significantly higher dry matter accumulation in leaves (6.95 and 6.62 g) as compared to without jeevamrutha and without panchagavya application (5.45 and 5.78 g).

Interaction effect

Interaction of jeevamruta and panchagavya had influence on the dry matter accumulation in leaves per plant. Application of Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent interaction resulted in significantly higher dry matter accumulation in leaves per plant (7.53 g) and lower drymatter was in without jeevamrutha and panchagavya applicaton (5.19 g). Dry matter accumulation in leaves per plant did not differed significantly due to the interaction effect of FYM and jeevamrutha, FYM and Panchagavya, FYM, jeevamrutha and panchagavya applications.

Table 22: Leaf weight of frenchbean at different growth stages as influenced by FYM and liquid manures application during *Kharif* 2014

Treatments	Leaf weight (g plant ⁻¹)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	1.48	1.54	1.51	4.81	5.96	5.39	5.18	6.50	5.84
F ₂	1.61	1.58	1.59	5.09	6.37	5.73	5.45	7.02	6.23
F ₃	1.66	1.73	1.70	5.53	6.59	6.06	5.71	7.32	6.51
Mean	1.58	1.62		5.14	6.31		5.45	6.95	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.09	NS		0.11	0.33		0.12	0.36	
J	0.08	NS		0.09	0.27		0.10	0.30	
F × J	0.13	NS		0.16	NS		0.18	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	1.52	1.51	1.51	4.95	5.82	5.39	5.44	6.24	5.84
F ₂	1.52	1.67	1.59	5.48	5.98	5.73	5.73	6.73	6.23
F ₃	1.62	1.77	1.70	5.61	6.52	6.06	6.15	6.88	6.51
Mean	1.55	1.65		5.34	6.11		5.78	6.62	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.08	NS		0.09	0.27		0.10	0.30	
F × P	0.13	NS		0.16	NS		0.16	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	1.51	1.66	1.58	4.76	5.53	5.14	5.19	5.70	5.14
J ₁	1.60	1.64	1.62	5.93	6.68	6.31	6.36	7.53	6.31
Mean	1.55	1.65		5.34	6.11		5.78	6.62	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.11	0.31		0.13	NS		0.14	0.42	
Interaction	P₀	P₁		P₀	P₁		P₀	P₁	
F × J × P									
F ₁ J ₀	1.47	1.50		4.47	5.16		4.47	5.16	
F ₁ J ₁	1.57	1.51		5.43	6.49		5.43	6.49	
F ₂ J ₀	1.52	1.70		4.78	5.40		4.78	5.40	
F ₂ J ₁	1.53	1.63		6.18	6.57		6.18	6.57	
F ₃ J ₀	1.55	1.77		5.02	6.04		5.02	6.04	
F ₃ J ₁	1.70	1.77		6.19	7.00		6.19	7.00	
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	0.19	NS		0.23	NS		0.25	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS - Days After Sowing, RDF - 63:100:75 NPK kg ha⁻¹

Table 23: Leaf weight of frenchbean at different growth stages as influenced by FYM and liquid manures application during *Kharif* 2015

Treatments	Leaf weight (g plant ⁻¹)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	1.58	1.75	1.67	4.98	6.17	5.57	5.49	6.81	6.15
F ₂	1.64	1.86	1.75	5.27	6.61	5.94	5.90	7.17	6.53
F ₃	1.68	1.93	1.80	2.74	6.84	6.29	6.08	7.66	6.87
Mean	1.63	1.85		5.33	6.54		5.82	7.22	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.09	NS		0.12	0.35		0.12	0.36	
J	0.07	NS		0.10	0.29		0.10	0.29	
F × J	0.13	NS		0.17	NS		0.17	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	1.61	1.73	1.67	5.12	6.03	5.57	5.59	6.71	6.15
F ₂	1.67	1.82	1.75	5.68	6.20	5.94	6.16	6.91	6.53
F ₃	1.72	1.89	1.80	5.82	6.77	6.29	6.36	7.38	6.87
Mean	1.66	1.81		5.54	6.33		6.04	7.00	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.07	NS		0.10	0.29		0.10	0.29	
F × P	0.13	NS		0.17	NS		0.17	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	1.51	1.76	1.63	4.92	5.73	5.33	5.45	6.19	6.15
J ₁	1.82	1.87	1.85	6.15	6.93	6.54	6.62	7.81	6.53
Mean	1.66	1.81		5.54	6.33		6.04	7.00	6.87
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.10	NS		0.14	NS		0.14	NS	
Interaction	P₀	P₁		P₀	P₁		P₀	P₁	
F × J × P									
F ₁ J ₀	1.46	1.70		4.61	5.34		5.10	5.87	
F ₁ J ₁	1.75	1.76		5.63	6.72		6.08	7.54	
F ₂ J ₀	1.50	1.78		4.95	5.60		5.61	6.19	
F ₂ J ₁	1.85	1.86		6.40	6.81		6.71	7.63	
F ₃ J ₀	1.57	1.79		5.21	6.27		5.65	6.50	
F ₃ J ₁	1.86	1.99		6.42	7.27		7.06	8.27	
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	0.18	NS		0.24	NS		0.24	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 24: Leaf weight of frenchbean at different growth stages as influenced by FYM and liquid manures application (Pooled 2014 and 2015)

Treatments	Leaf weight (g plant ⁻¹)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	1.53	1.65	1.59	4.89	6.07	5.48	5.33	6.66	6.00
F ₂	1.62	1.72	1.67	5.18	6.49	5.83	5.67	7.09	6.38
F ₃	1.67	1.83	1.75	5.63	6.72	6.18	5.89	7.49	6.69
Mean	1.61	1.73		5.24	6.42		5.63	7.08	
	S.Em±	C.D.		S.Em±	C.D.		S.Em±	C.D.	
F	0.06	NS		0.12	0.34		0.10	0.29	
J	0.05	NS		0.09	0.28		0.08	0.23	
F × J	0.09	NS		0.16	NS		0.14	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	1.56	1.62	1.59	5.03	5.92	5.48	5.52	6.48	6.00
F ₂	1.60	1.74	1.67	5.58	6.09	5.83	5.95	6.82	6.38
F ₃	1.67	1.83	1.75	5.71	6.64	6.18	6.25	7.13	6.69
Mean	1.61	1.73		5.44	6.22		5.91	6.81	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.05	NS		0.09	0.28		0.08	0.23	
F × P	0.09	NS		0.16	NS		0.14	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	1.51	1.71	1.61	4.84	5.63	5.24	5.32	5.94	5.63
J ₁	1.71	1.75	1.73	6.04	6.81	6.42	6.49	7.67	7.08
Mean	1.61	1.73		5.44	6.22		5.91	6.81	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.07	NS		0.13	NS		0.11	0.33	
Interaction	P₀	P₁		P₀	P₁		P₀	P₁	
F × J × P									
F ₁ J ₀	1.46	1.60		4.54	5.25		5.00	5.66	
F ₁ J ₁	1.66	1.63		5.53	6.60		6.03	7.29	
F ₂ J ₀	1.51	1.74		4.86	5.50		5.47	5.88	
F ₂ J ₁	1.69	1.75		6.29	6.69		6.42	7.76	
F ₃ J ₀	1.56	1.78		5.12	6.15		5.50	6.29	
F ₃ J ₁	1.78	1.88		6.31	7.13		7.01	7.97	
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	0.12	NS		0.23	NS		0.20	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Experiment conducted during *kharif* 2015

20 days after sowing

Dry matter accumulation in leaves per plant did not differ significantly due to the application of FYM, jeevamrutha and panchagavya. However, higher dry matter accumulation in leaves per plant was observed with FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent and it was lower with FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya application.

40 Days after sowing

Significantly higher dry matter accumulation in leaves per plant was recorded in FYM at 200 per cent N equivalent (6.29 g) as compared to FYM at 100 per cent N equivalent (5.94 g) and on par with FYM at 150 per cent N equivalent (5.57 g). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent each application recorded significantly higher dry matter accumulation in leaves (6.54 and 6.33 g) as compared to without jeevamrutha and without panchagavya application (5.33 and 5.54 g).

At harvest

FYM at 200 per cent N equivalent recorded significantly higher dry matter accumulation in leaves per plant (6.87 g) as compared to FYM at 100 per cent N equivalent (6.15 g) and on par with FYM at 150 per cent N equivalent (6.53 g). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent each application recorded significantly higher dry matter accumulation in leaves (7.22 and 7.0 g) as compared to without jeevamrutha and without panchagavya application (5.82 and 6.04 g).

Interaction effect

Dry matter accumulation in leaves per plant did not vary significantly due to the interaction effect of FYM and jeevamrutha, FYM and panchagavya, jeevamrutha and panchagavya, FYM, jeevamrutha and panchagavya applications at 20, 40 DAS and at harvest.

Pooled

At 40 DAS and at harvest, significantly higher dry weight of leaves per plant was recorded in FYM at 200 per cent N equivalent (6.18 and 6.69 g) followed by FYM at 150 per cent N equivalent (5.83 and 6.38 g) as compared to FYM at 100 per cent N equivalent (5.48 and 6.00 g). At 40 DAS and harvest jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher dry weight of leaves (6.42, 7.08 and 6.22, 6.81 g, respectively) as compared to without jeevamrutha and without panchagavya application (5.24, 5.63 and 5.44, 5.91 g, respectively).

At harvest panchagavya at 3 per cent and jeevamrutha at 1000 litre ha⁻¹ interaction gave significantly higher dry weight of leaves (7.67 g) per plant followed by individual application of jeevamrutha (6.49 g) and panchagavya (5.94 g) as compared to without Panchagavya and without jeevamrutha application (5.32 g). Dry matter accumulation in

leaves per plant did not vary significantly due to the interaction effect of FYM and jeevamrutha, FYM and panchagavya, FYM, jeevamrutha and panchagavya applications

Dry matter accumulation in roots (g plant⁻¹)

Dry matter accumulation in roots differed significantly due to the application of solid and liquid manures are presented in the Tables 25, 26 and 27.

Experiment conducted during *kharif* 2014

20 days after sowing

Dry matter accumulation in roots per plant did not differ significantly due to the application of FYM, jeevamrutha and panchagavya. However, higher dry matter accumulation in roots per plant was observed with FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent and it was lower with FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya application.

40 Days after sowing

Significantly higher dry matter accumulation in roots per plant was recorded in FYM at 200 per cent N equivalent (1.30 g) as compared to FYM at 100 per cent N equivalent (1.21 g) and on par with FYM at 150 per cent N equivalent (1.26 g). FYM at 100 per cent N equivalent found to be on par with FYM at 150 per cent N equivalent. Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent each application recorded significantly higher dry matter accumulation in root (1.35 and 1.30 g) as compared to without jeevamrutha and without panchagavya application (1.17 and 1.22 g)

At harvest

Significantly higher dry matter accumulation in roots per plant was recorded in FYM at 200 per cent N equivalent (1.62 g) as compared to FYM at 100 per cent N equivalent (1.54 g) and on par with FYM at 150 per cent N equivalent (1.59 g). FYM at 100 per cent N equivalent found to be on par with FYM at 150 per cent N equivalent. Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent each application recorded significantly higher dry matter accumulation in root (1.69 and 1.65 g) as compared to without jeevamrutha and without panchagavya application (1.47 and 1.51 g).

Experiment conducted during *kharif* 2015

20 days after sowing

Dry matter accumulation in roots per plant did not vary significantly due to the application of FYM, jeevamrutha and panchagavya. However, higher dry matter accumulation in roots per plant was observed with FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent and it was lower with FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya application.

Table 25: Root weight of frenchbean at different growth stages as influenced by FYM and liquid manures application during *Kharif* 2014

Treatments	Root weight (g plant ⁻¹)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	0.30	0.32	0.31	1.10	1.32	1.21	1.44	1.63	1.54
F ₂	0.30	0.33	0.32	1.16	1.36	1.26	1.47	1.70	1.59
F ₃	0.32	0.33	0.32	1.24	1.36	1.30	1.49	1.75	1.62
Mean	0.31	0.33		1.17	1.35		1.47	1.69	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.02	NS		0.03	0.07		0.02	0.07	
J	0.02	NS		0.02	0.06		0.02	0.05	
F × J	0.03	NS		0.04	NS		0.03	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	0.31	0.31	0.31	1.16	1.25	1.21	1.48	1.59	1.54
F ₂	0.31	0.32	0.32	1.23	1.29	1.26	1.52	1.65	1.59
F ₃	0.32	0.33	0.32	1.25	1.35	1.30	1.53	1.69	1.62
Mean	0.32	0.32		1.22	1.30		1.51	1.65	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.02	NS		0.02	0.06		0.02	0.05	
F × P	0.03	NS		0.04	NS		0.03	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	0.30	0.31	0.31	1.14	1.20	1.17	1.38	1.55	1.47
J ₁	0.33	0.33	0.33	1.29	1.40	1.35	1.64	1.74	1.69
Mean	0.32	0.32		1.22	1.30		1.51	1.65	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.02	NS		0.03	NS		0.03	NS	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁	J ₀	0.30	0.30	1.05	1.15		1.37	1.51	
	J ₁	0.33	0.2						
F ₂	J ₀	0.30	0.30	1.16	1.17		1.41	1.54	
	J ₁	0.33	0.33						
F ₃	J ₀	0.31	0.32	1.21	1.27		1.37	1.60	
	J ₁	0.33	0.33						
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	0.04	NS		0.05	NS		0.04	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 26: Root weight of frenchbean at different growth stages as influenced by FYM and liquid manures application during *Kharif* 2015

Treatments	Root weight (g plant ⁻¹)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	0.29	0.33	0.31	1.11	1.33	1.22	1.45	1.71	1.58
F ₂	0.33	0.35	0.34	1.19	1.37	1.28	1.49	1.76	1.62
F ₃	0.34	0.35	0.35	1.26	1.40	1.33	1.60	1.77	1.68
Mean	0.32	0.34		1.19	1.37		1.51	1.74	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.02	NS		0.03	0.08		0.03	0.08	
J	0.01	NS		0.02	0.07		0.02	0.07	
F × J	0.02	NS		0.04	NS		0.04	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	0.30	0.32	0.31	1.17	1.27	1.22	1.52	1.64	1.58
F ₂	0.33	0.34	0.34	1.24	1.33	1.28	1.56	1.69	1.62
F ₃	0.34	0.35	0.35	1.28	1.38	1.33	1.63	1.74	1.68
Mean	0.32	0.34		1.23	1.33		1.57	1.69	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.01	NS		0.02	0.07		0.02	0.07	
F × P	0.02	NS		0.04	NS		0.04	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	0.32	0.32	0.32	1.15	1.22	1.19	1.45	1.58	1.51
J ₁	0.33	0.35	0.34	1.30	1.43	1.37	1.69	1.80	1.74
Mean	0.32	0.34		1.23	1.33		1.57	1.69	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.02	NS		0.03	NS		0.03	NS	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁	J ₀	0.28	0.30		1.06	1.17		1.39	1.51
	J ₁	0.31	0.35		1.29	1.38		1.65	1.76
F ₂	J ₀	0.32	0.33		1.17	1.22		1.44	1.55
	J ₁	0.34	0.35		1.31	1.43		1.68	1.83
F ₃	J ₀	0.34	0.34		1.24	1.28		1.53	1.67
	J ₁	0.34	0.36		1.32	1.49		1.72	1.81
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	0.03	NS		0.06	NS		0.05	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS - Days After Sowing, RDF - 63:100:75 NPK kg ha⁻¹

Table 27: Root weight of frenchbean at different growth stages as influenced by FYM and liquid manures application (Pooled 2014 and 2015)

Treatments	Root weight (g plant ⁻¹)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	0.29	0.33	0.31	1.11	1.33	1.22	1.45	1.67	1.56
F ₂	0.31	0.34	0.33	1.18	1.36	1.27	1.48	1.73	1.61
F ₃	0.33	0.34	0.34	1.25	1.38	1.32	1.54	1.76	1.65
Mean	0.31	0.34		1.18	1.36		1.49	1.72	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.01	NS		0.02	0.07		0.02	0.05	
J	0.01	NS		0.02	0.05		0.01	0.04	
F × J	0.02	NS		0.03	NS		0.02	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	0.31	0.32	0.31	1.17	1.26	1.22	1.50	1.62	1.56
F ₂	0.32	0.33	0.33	1.23	1.31	1.27	1.54	1.67	1.61
F ₃	0.33	0.34	0.34	1.27	1.37	1.32	1.58	1.72	1.65
Mean	0.32	0.33		1.22	1.31		1.54	1.67	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.01	NS		0.02	0.05		0.01	0.04	
F × P	0.05	NS		0.03	NS		0.02	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	0.31	0.32	0.31	1.15	1.21	1.18	1.42	1.56	1.49
J ₁	0.33	0.34	0.34	1.30	1.42	1.36	1.66	1.78	1.72
Mean	0.32	0.33		1.22	1.31		1.54	1.67	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.01	NS		0.03	NS		0.02	NS	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁	J ₀	0.29	0.30		1.05	1.16		1.38	1.51
	J ₁	0.32	0.33		1.28	1.37		1.62	1.72
F ₂	J ₀	0.31	0.31		1.16	1.19		1.42	1.54
	J ₁	0.34	0.34		1.31	1.42		1.66	1.80
F ₃	J ₀	0.33	0.33		1.23	1.27		1.456	1.63
	J ₁	0.34	0.35		1.31	1.46		1.71	1.81
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	0.03	NS		0.04	NS		0.03	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

40 Days after sowing

Significantly higher dry matter accumulation in roots per plant was recorded in FYM at 200 per cent N equivalent (1.33 g) as compared to FYM at 100 per cent N equivalent (1.22 g) and on par with FYM at 150 per cent N equivalent (1.28 g). FYM at 100 per cent N equivalent found to be on par with FYM at 150 per cent N equivalent. Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent each application recorded significantly higher dry matter accumulation in root (1.37 and 1.33 g) as compared to without jeevamrutha and without panchagavya application (1.19 and 1.23 g)

At harvest

Significantly higher dry matter accumulation in roots per plant was recorded in FYM at 200 per cent N equivalent (1.68 g) as compared to FYM at 100 per cent N equivalent (1.58 g) and on par with FYM at 150 per cent N equivalent (1.62 g). FYM at 100 per cent N equivalent found to be on par with FYM at 150 per cent N equivalent. Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent each application recorded significantly higher dry matter accumulation in root (1.74 and 1.69 g) as compared to without jeevamrutha and without panchagavya application (1.51 and 1.57 g).

Interaction effect

Dry matter accumulation in roots per plant did not differ significantly due to the interaction effect of FYM and jeevamrutha, FYM and panchagavya, panchagavya and jeevamrutha, FYM, jeevamrutha and panchagavya applications during both the years at all the stages.

Pooled

Data on dry matter accumulation in roots showed significant difference among the treatments at all stages except at 20 DAS (Table 27).

At 40 and 60 DAS, significantly higher dry matter accumulation in roots per plant was recorded in FYM at 200 per cent N equivalent (1.32 and 1.65 g) as compared to FYM at 100 per cent N equivalent (1.22 and 1.56 g) and on par with FYM at 150 per cent N equivalent (1.27 and 1.61 g). FYM at 100 per cent N equivalent found to be on par with FYM at 150 per cent N equivalent. Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent each application recorded significantly higher dry matter accumulation in root (1.36, 1.72 and 1.31, 1.67 g, respectively) as compared to without jeevamrutha and without panchagavya application (1.18, 1.49 and 1.22, 1.54 g, respectively).

Dry matter accumulation in pods (g plant⁻¹)

Dry matter accumulation in pods differed significantly due to the application of solid and liquid manures are presented in the Table 28.

Table 28: Effect of FYM and liquid manures application on pod dry weight of frenchbean

Treatments	Pod dry weight plant ⁻¹ (g)								
	2014			2015			Pooled		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	5.63	7.19	6.41	6.36	8.02	7.19	5.99	7.60	6.80
F ₂	6.33	7.55	6.94	7.08	8.49	7.79	6.71	8.02	7.36
F ₃	6.76	7.81	7.28	8.09	9.36	8.73	7.43	8.58	8.01
Mean	6.24	7.52		7.18	8.62		6.71	8.07	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.18	0.52		0.17	0.50		0.17	0.50	
J	0.14	0.42		0.14	0.40		0.14	0.41	
F × J	0.25	NS		0.24	NS		0.24	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	5.83	7.00	6.41	6.56	7.81	7.19	6.20	7.40	6.80
F ₂	6.70	7.18	6.94	7.50	8.08	7.79	7.10	7.63	7.36
F ₃	6.86	7.71	7.28	8.22	9.23	8.73	7.54	8.47	8.01
Mean	6.46	7.30		7.43	8.37		6.95	7.83	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.14	0.42		0.14	0.40		0.14	0.41	
F × P	0.25	NS		0.24	NS		0.24	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	5.75	6.74	6.24	6.63	7.72	7.18	6.19	7.23	6.71
J ₁	7.18	7.85	7.52	8.22	9.02	8.62	7.70	8.44	8.07
Mean	6.46	7.30		7.43	8.37		6.95	7.83	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.20	NS		0.20	NS		0.20	NS	
Interaction	P₀	P₁		P₀	P₁		P₀	P₁	
F × J × P									
F ₁ J ₀	4.86	6.41		5.56	7.15		5.21	6.78	
F ₁ J ₁	6.80	7.59		7.56	8.47		7.18	8.03	
F ₂ J ₀	6.15	6.52		6.88	7.29		6.51	6.90	
F ₂ J ₁	7.25	7.84		8.12	8.86		7.68	8.35	
F ₃ J ₀	6.23	7.28		7.46	8.73		6.84	8.01	
F ₃ J ₁	7.49	8.13		8.99	9.73		8.24	8.93	
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	0.35	NS		0.34	NS		0.34	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS - Days After Sowing, RDF - 63:100:75 NPK kg ha⁻¹

Experiment conducted during *kharif* 2014

Significantly higher dry matter accumulation in pods per plant was recorded in FYM at 200 per cent N equivalent (7.28 g) as compared to FYM at 100 per cent N equivalent (6.41 g) and on par with FYM at 150 per cent N equivalent (6.94 g). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent each application recorded significantly higher dry matter accumulation in pod (7.52 and 7.30 g) as compared to without jeevamrutha and without panchagavya application (6.24 and 6.46 g).

Experiment conducted during *kharif* 2015

FYM at 200 per cent N equivalent recorded significantly higher dry matter accumulation in pods per plant (8.73 g) as compared to FYM at 100 per cent N equivalent (7.19 g) and on par with FYM at 150 per cent N equivalent (7.79 g). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent each application recorded significantly higher dry matter accumulation in pod (8.62 and 8.37 g) as compared to without jeevamrutha and without panchagavya application (7.72 and 7.43 g).

Interaction effect

Dry matter accumulation in pods per plant did not vary significantly due to the interaction effect of FYM and jeevamrutha, FYM and Panchagavya, panchagavya and jeevamrutha, FYM, jeevamrutha and panchagavya applications during both the years.

Pooled

Significantly higher dry matter accumulation in pods per plant was recorded in FYM at 200 per cent N equivalent (8.01 g) as compared to FYM at 100 per cent N equivalent (6.80 g) and on par with FYM at 150 per cent N equivalent (7.36 g). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent each application recorded significantly higher dry matter accumulation in pod (8.07 and 7.83 g) as compared to without jeevamrutha and without panchagavya application (6.71 and 6.95 g).

Dry matter accumulation in pods per plant did not differ significantly due to the interaction effect of FYM and jeevamrutha, FYM and Panchagavya, FYM, jeevamrutha and panchagavya applications.

4.1.8 Total dry matter production (g plant⁻¹)

Total dry matter production differ significantly due to application of soil and liquid manures at all crop growth stages except at 20 DAS (Tables 29, 30 and 31).

Experiment conducted during *kharif* 2014

20 days after sowing

Total dry matter production per plant did not vary significantly due to the application of FYM, jeevamrutha and panchagavya. However, higher total dry matter accumulation per plant was observed with FYM at 200 per cent N equivalent,

Table 29: Total dry matter production of frenchbean at different growth stages as influenced by FYM and liquid manures application during Kharif 2014

Treatments	Total dry matter (g plant ⁻¹)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	2.81	2.93	2.87	10.16	12.25	11.21	17.19	21.20	19.19
F ₂	2.96	2.99	2.98	10.69	13.10	11.89	18.48	22.52	20.50
F ₃	3.06	3.20	3.13	11.48	13.54	12.51	19.34	23.46	21.40
Mean	2.94	3.04		10.78	12.96		18.34	22.39	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.11	NS		0.16	0.48		0.21	0.63	
J	0.09	NS		0.13	0.39		0.17	0.51	
F × J	0.16	NS		0.23	NS		0.30	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	2.87	2.88	2.87	10.43	11.98	11.21	17.79	20.59	19.19
F ₂	2.89	3.07	2.98	11.32	12.47	11.89	19.39	21.62	20.50
F ₃	3.08	3.18	3.13	11.70	13.33	12.51	20.21	22.60	21.40
Mean	2.94	3.04		11.15	12.59		19.13	21.60	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.09	NS		0.13	0.39		0.17	0.51	
F × P	0.16	NS		0.23	NS		0.30	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	2.88	3.01	2.94	10.07	11.49	10.78	17.21	19.46	18.34
J ₁	3.01	3.07	3.04	12.23	13.70	12.96	21.05	23.74	22.39
Mean	2.94	3.04		11.15	12.59		19.13	21.60	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.13	NS		0.19	NS		0.25	NS	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁	J ₀	2.80	2.83	9.38	10.94	15.63	18.74	19.96	22.44
	J ₁	2.94	2.93		11.48		13.02		
F ₂	J ₀	2.86	3.07	10.15	11.23	17.87	19.10	20.91	24.14
	J ₁	2.92	3.06		12.49		13.70		
F ₃	J ₀	2.99	3.12	10.68	12.29	18.14	20.54	22.27	24.65
	J ₁	3.16	3.23		12.72		14.37		
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	0.22	NS		0.33	NS		0.43	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 30: Total dry matter production of frenchbean at different growth stages as influenced by FYM and liquid manures application during *Kharif* 2015

Treatments	Total dry matter (g plant ⁻¹)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F₁	2.94	3.17	3.05	10.45	12.69	11.57	18.42	22.61	20.52
F₂	3.03	3.31	3.17	11.09	13.56	12.33	19.89	23.89	21.89
F₃	3.17	3.47	3.32	11.91	14.07	12.99	21.32	25.59	23.46
Mean	3.05	3.32		11.15	13.44		19.88	24.03	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.11	NS		0.18	0.53		0.18	0.53	
J	0.09	NS		0.15	0.43		0.15	0.44	
F × J	0.16	NS		0.25	NS		0.26	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F₁	2.96	3.15	3.05	10.73	12.42	11.57	18.89	22.15	20.52
F₂	3.08	3.26	3.17	11.72	12.93	12.33	20.85	22.93	21.89
F₃	3.20	3.44	3.32	12.14	13.84	12.99	22.05	24.86	23.46
Mean	3.08	3.28		11.53	13.07		20.60	23.31	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.09	NS		0.15	NS		0.15	0.44	
F × P	0.16	NS		0.25	NS		0.26	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J₀	2.91	3.18	3.05	10.39	11.92	11.15	18.59	21.16	19.88
J₁	3.26	3.38	3.32	12.67	14.21	13.44	22.60	25.46	24.03
Mean	3.08	3.28		11.53	13.07		20.60	23.31	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.13	NS		0.21	NS		0.21	NS	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F₁	J₀	2.80	3.08		9.57	11.34		16.68	20.17
	J₁	3.13	3.21		11.88	13.50		21.11	24.12
F₂	J₀	2.90	3.17		10.51	11.68		19.11	20.67
	J₁	3.26	3.35		12.94	14.19		22.59	25.19
F₃	J₀	3.03	3.30		11.08	12.74		19.99	22.65
	J₁	3.38	3.57		13.20	14.94		24.11	27.08
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	0.23	NS		0.36	NS		0.36	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 31: Total dry matter production of frenchbean at different growth stages as influenced by FYM and liquid manures application (Pooled 2014 and 2015)

Treatments	Total dry matter (g plant ⁻¹)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	2.88	3.05	2.96	10.31	12.47	11.39	17.81	21.91	19.86
F ₂	3.00	3.15	3.07	10.89	13.33	12.11	19.19	23.21	21.20
F ₃	3.11	3.34	3.22	11.70	13.81	12.75	20.33	24.53	22.43
Mean	3.00	3.18		10.97	13.20		19.11	23.21	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.08	NS		0.17	0.50		0.18	0.52	
J	0.07	NS		0.14	0.41		0.15	0.43	
F × J	0.12	NS		0.24	NS		0.25	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	2.92	3.01	2.96	10.58	12.20	11.39	18.34	21.37	19.86
F ₂	2.99	3.16	3.07	11.52	12.70	12.11	20.12	22.27	21.20
F ₃	3.14	3.31	3.22	11.92	13.58	12.75	21.13	23.73	22.43
Mean	3.01	3.16		11.34	12.83		19.86	22.46	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.07	NS		0.14	0.41		0.15	0.43	
F × P	0.12	NS		0.24	NS		0.25	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	2.90	3.09	3.00	10.23	11.70	10.97	17.90	20.31	19.11
J ₁	3.13	3.23	3.18	12.45	13.95	13.20	21.83	24.60	23.21
Mean	3.01	3.16		11.34	12.83		19.86	22.46	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.10	NS		0.24	NS		0.21	NS	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁	J ₀	2.80	2.95		9.48	11.14		16.16	19.45
	J ₁	3.03	3.07		11.68	13.26		20.53	23.28
F ₂	J ₀	2.88	3.12		10.33	11.46		18.49	19.88
	J ₁	3.09	3.21		12.71	13.94		21.75	24.66
F ₃	J ₀	3.01	3.21		10.88	12.51		19.06	21.60
	J ₁	3.27	3.40		12.96	14.65		23.19	25.86
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	0.17	NS		0.34	NS		0.36	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent and it was lower with FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya application.

40 Days after sowing

Total dry matter production per plant differed significantly due to the application of various levels of FYM, jeevamrutha and panchagavya. FYM at 200 per cent N equivalent recorded significantly higher total dry matter production (12.51 g) followed by FYM at 150 per cent N equivalent (11.89 g) and it was lower with FYM at 100 per cent N equivalent (11.21 g). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher total dry matter production (12.96 and 12.59 g) as compared to without jeevamrutha and without panchagavya application (10.78 and 11.15 g).

At harvest

FYM at 200 per cent N equivalent recorded significantly higher total dry matter production (21.4 g) followed by FYM at 150 per cent N equivalent (20.5 g) and it was lower with FYM at 100 per cent N equivalent (19.19 g). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher total dry matter production (22.39 and 21.60 g) as compared to without jeevamrutha and without panchagavya application (18.34 and 19.13 g).

Experiment conducted during *kharif* 2015

20 days after sowing

Total dry matter production per plant did not differ significantly due to the application of FYM, jeevamrutha and panchagavya. However, higher total dry matter accumulation per plant was observed with FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent and it was lower with FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya application.

40 Days after sowing

FYM at 200 per cent N equivalent recorded significantly higher total dry matter production (12.99 g) followed by FYM at 150 per cent N equivalent (12.33 g) and it was lower with FYM at 100 per cent N equivalent (11.57 g). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher total dry matter production (13.44 and 13.07 g) as compared to without jeevamrutha and without panchagavya application (11.15 and 11.53 g).

At harvest

Application of FYM at 200 per cent N equivalent recorded significantly higher total dry matter production (23.46 g) followed by FYM at 150 per cent N equivalent (21.89 g) and it was lower with FYM at 100 per cent N equivalent (20.52 g). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher total dry matter production (24.03 and 23.31 g) as compared to without jeevamrutha and without panchagavya application (19.88 and 20.60 g).

Interaction effect

Total dry matter production per plant did not differ significantly due to the interaction effect of FYM and jeevamrutha, FYM and Panchagavya, panchagavya and jeevamrutha, FYM, jeevamrutha and panchagavya applications at all the stages during both the years.

Pooled

At 40 DAS and harvest total dry matter production per plant differed significantly due to the application of various levels of FYM, jeevamrutha and panchagavya. FYM at 200 per cent N equivalent recorded significantly higher total dry matter production (12.75 and 22.43) followed by FYM at 150 per cent N equivalent (12.11 and 21.20) and it was lower with FYM at 100 per cent N equivalent (11.39 and 19.86). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher total dry matter production (13.20, 23.21 and 12.83, 22.46 g, respectively) as compared to without jeevamrutha and without panchagavya application (10.97, 19.11 and 11.34, 19.86 g, respectively).

Total Dry matter production in frenchbean did not vary significantly due to the interaction effect of FYM and jeevamrutha, FYM and Panchagavya, FYM, jeevamrutha and panchagavya applications.

Days to 50 per cent flowering

The data pertaining to 50 per cent flowering are presented in the Table 31a.

Experiment conducted during *kharif* 2014

Frenchbean treated with FYM at 200 per cent N equivalent (30.6 days) significantly attained early flowering (50 %), which was similar with FYM at 150 per cent N equivalent (30.6 days) than FYM at 100 per cent N equivalent (31.5 days). Application of jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent resulted in significantly early flowering (30.3 and 30.3 days respectively) as compared to without jeevamrutha and without panchagavya application (31.4 and 31.4 days respectively).

Experiment conducted during *kharif* 2015

Frenchbean treated with FYM at 150 per cent N equivalent (30.4 days) significantly attained early flowering (50 %), which was similar with FYM at 200 per cent N equivalent (30.5 days) than FYM at 100 per cent N equivalent (31.2 days). Application of jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent resulted in significantly early flowering (30.0 and 29.9 days respectively) as compared to without jeevamrutha and without panchagavya application (31.4 and 31.4 days respectively).

Interaction

Days taken for 50 per cent flowering did not differ significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application during both the years.

Table 31a: Fifty per cent flowering of frenchbean during 2014, 2015 and pooled data as influenced by FYM and liquid manures application

Treatments	2014			2015			Pooled		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	32.2	30.8	31.5	32.0	30.3	31.2	32.08	30.58	31.33
F ₂	31.0	30.2	30.6	30.8	30.0	30.4	30.92	30.08	30.50
F ₃	31.2	30.0	30.6	31.3	29.7	30.5	31.25	29.83	30.54
Mean	31.4	30.3		31.4	30.0		31.42	30.17	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.32	NS		0.30	NS		0.23	0.68	
J	0.26	0.77		0.25	0.72		0.19	0.56	
F × J	0.45	NS		0.42	NS		0.33	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	32.0	31.0	31.5	31.8	30.5	31.2	31.92	30.75	31.33
F ₂	31.0	30.2	30.6	31.0	29.8	30.4	31.00	30.00	30.50
F ₃	31.3	29.8	30.6	31.5	29.5	30.5	31.42	29.67	30.54
Mean	31.4	30.3		31.4	29.9		31.44	30.14	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.26	0.77		0.25	NS		0.19	0.56	
F × P	0.45	NS		0.42	NS		0.33	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	32.2	30.7	31.4	32.3	30.4	31.4	32.28	30.56	31.42
J ₁	30.7	30.0	30.3	30.6	29.4	30.0	30.61	29.72	30.17
Mean	31.4	30.3		31.44	29.9		31.44	30.14	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.37	NS		0.35	NS		0.27	NS	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁	J ₀	33.0	31.3	33.0	31.0	33.00	31.17		
	J ₁	31.0	30.7	30.7	30.0	30.83	30.33		
F ₂	J ₀	31.3	30.7	31.3	30.3	31.33	30.50		
	J ₁	30.7	29.7	30.7	29.3	30.67	29.50		
F ₃	J ₀	32.3	30.0	32.7	30.3	32.50	30.00		
	J ₁	30.3	29.7	30.3	29.0	30.33	29.33		
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	0.64	NS		0.60	NS		0.47	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Pooled

The data pertaining to 50 per cent flowering are presented in the table 31a.

Frenchbean treated with FYM at 200 per cent N equivalent (30.54 days) significantly attained early flowering (50 %), which was similar with FYM at 150 per cent N equivalent (30.50 days) than FYM at 100 per cent N equivalent (31.33 days). Application of jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent resulted in significantly early flowering (30.17 and 30.14 days respectively) as compared to without jeevamrutha and without panchagavya application (31.42 and 31.44 days respectively).

Days taken for 50 per cent flowering did not differ significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application.

Exp II: Effect of jeevamrutha and panchagavya on growth and yield of frenchbean (*Phaseolus vulgaris* L.)

4.2 Growth parameters

Growth parameters *viz.*, plant height, number of leaves, number of branches, leaf area, leaf area index, Number of nodules plant⁻¹, Day's taken for 50 per cent flowering and dry weight of frenchbean were significantly influenced by various levels of panchagavya and jeevamrutha application at 40 DAS and at harvest except 20 DAS.

4.2.1 Plant height (cm)

Plant height at different stages of crop growth as influenced by liquid manures is presented in the Table 32, 33 and 34.

Experiment conducted during *kharif* 2014

20 Days after sowing

Plant height did not differ significantly due application of jeevamrutha and panchagavya application. However, application of higher levels of jeevamrutha (2000 litres ha⁻¹) and panchagavya (6 %) recorded higher plant height.

40 Days after sowing

Significant plant height was observed due to the application of jeevamrutha. Jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher plant height (25.51 cm) followed by jeevamrutha at 1500 litre ha⁻¹ (24.33 cm), jeevamrutha at 1000 litre ha⁻¹ (24.14 cm) and significantly lower plant height was recorded with no-jeevamrutha application (22.95 cm). There was significant difference observed with application of panchagavya. Panchagavya at 6 per cent recorded significantly higher plant height (24.93 cm) which was on par with panchagavya at 3 per cent (24.41 cm) and it was lower with no-panchagavya application (23.35 cm).

Table 32: Plant height of frenchbean at different growth stages as influenced by application of liquid manures during *Kharif* 2014

Jeevamrutha Levels	Plant height (cm)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	10.37	11.12	11.59	11.03	21.06	23.62	24.16	22.95	22.31	24.85	25.94	24.37
J₁	10.62	11.69	11.97	11.43	23.81	24.16	24.45	24.14	24.63	25.66	26.41	25.57
J₂	11.22	11.72	11.89	11.61	23.66	24.45	24.89	24.33	25.41	26.01	26.54	25.99
J₃	11.78	11.53	11.72	11.68	24.89	25.40	26.23	25.51	26.79	26.92	28.07	27.26
Mean	11.00	11.52	11.79		23.35	24.41	24.93		24.78	25.86	26.74	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.28		NS		0.38		0.97		0.40		1.16	
Panchagavya	0.24		NS		0.33		1.12		0.34		1.01	
J × P	0.49		NS		0.66		NS		0.69		NS	

Note: J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, J₂ - Jeevamrutha 1500 litre/ha, J₃ - Jeevamrutha 2000 litre/ha
P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, P₃ - Panchagavya at 6 %, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 33: Plant height of frenchbean at different growth stages as influenced by application of liquid manures during *Kharif* 2015

Jeevamrutha Levels	Plant height (cm)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	11.03	11.83	12.33	11.73	22.17	24.87	25.43	24.16	23.73	26.43	27.60	25.92
J₁	11.30	12.43	12.73	12.16	25.07	25.43	25.73	25.41	26.20	27.30	28.10	27.20
J₂	11.93	12.47	12.63	12.34	24.90	25.73	26.20	25.61	27.03	27.67	28.23	27.64
J₃	12.53	12.27	12.47	12.42	26.40	26.70	27.43	26.84	28.50	28.63	29.87	29.00
Mean	11.70	12.25	12.54		24.63	25.68	26.20		26.37	27.51	28.45	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.33		NS		0.41		1.19		0.42		1.24	
Panchagavya	0.28		NS		0.35		1.03		0.36		1.07	
J × P	0.57		NS		0.70		NS		0.73		NS	

Note: **J₀** - Without Jeevamrutha, **J₁** - Jeevamrutha 1000 litre/ha, **J₂** - Jeevamrutha 1500 litre/ha, **J₃** - Jeevamrutha 2000 litre/ha
P₀ - Without panchagavya, **P₁** - Panchagavya at 3 %, **P₃** - Panchagavya at 6 %, **DAS** – Days After Sowing, **RDF** – 63:100:75 NPK kg ha⁻¹

Table 34: Plant height of frenchbean at different growth stages as influenced by application of liquid manures (Pooled 2014 and 2015)

Jeevamrutha Levels	Plant height (cm)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	10.70	11.48	11.96	11.38	21.4	24.2	24.8	23.5	23.0	25.6	26.8	25.1
J₁	10.96	12.06	12.35	11.79	24.4	24.8	25.1	24.8	25.4	26.5	27.3	26.4
J₂	11.58	12.09	12.26	11.98	24.3	25.1	25.5	25.0	26.2	26.8	27.4	26.8
J₃	12.16	11.90	12.09	12.05	25.6	26.0	26.8	26.2	27.6	27.8	29.0	28.1
Mean	11.35	11.88	12.17		24.0	25.0	25.6		25.6	26.7	27.6	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.29		NS		0.38		1.15		0.41		1.20	
Panchagavya	0.25		NS		0.33		1.00		0.35		1.04	
J × P	0.51		NS		0.66		NS		0.71		NS	

Note: J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, J₂ - Jeevamrutha 1500 litre/ha, J₃ - Jeevamrutha 2000 litre/ha
P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, P₃ - Panchagavya at 6 %, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

At harvest

Application of jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher plant height (27.26 cm) followed by jeevamrutha at 1500 litre ha⁻¹ (25.99 cm), jeevamrutha at 1000 litre ha⁻¹ (25.57 cm) and significantly lower plant height was recorded with no-jeevamrutha application (24.37 cm). Panchagavya at 6 per cent recorded significantly higher plant height (26.74 cm) which was on par with panchagavya at 3 per cent (25.86 cm) and it was lower with no-panchagavya application (24.78 cm).

Experiment conducted during *kharif* 2015

20 Days after sowing

Plant height did not differ significantly due application of jeevamrutha and panchagavya application. However, application of higher levels of jeevamrutha (2000 litres ha⁻¹) and panchagavya (6 %) recorded higher plant height.

40 Days after sowing

Significantly higher plant height was observed due to the application of jeevamrutha. Jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher plant height (26.84 cm) followed by jeevamrutha at 1500 litre ha⁻¹ (25.61 cm), jeevamrutha at 1000 litre ha⁻¹ (25.41 cm) and significantly lower plant height was recorded with no-jeevamrutha application (24.16 cm). There was significant difference observed with application of panchagavya. Panchagavya at 6 per cent recorded significantly higher plant height (26.2 cm) which was on par with panchagavya at 3 per cent (25.68 cm) and it was lower with no-panchagavya application (24.63 cm).

At harvest

Application of jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher plant height (29.0 cm) followed by jeevamrutha at 1500 litre ha⁻¹ (27.64 cm), jeevamrutha at 1000 litre ha⁻¹ (27.2 cm) and significantly lower plant height was recorded with no-jeevamrutha application (25.92 cm). Panchagavya at 6 per cent recorded significantly higher plant height (28.45 cm) which was on par with panchagavya at 3 per cent (27.51 cm) and it was lower with no-panchagavya application (26.37 cm).

Interaction effect

Plant height did not vary significantly due to the interaction between various levels of jeevamrutha and panchagavya application at all the stages during both the years.

Pooled

Plant height varied significantly due to the application of various levels of FYM and jeevamrutha. At 40 DAS and harvest jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher plant height (26.2 and 28.1 cm) followed by jeevamrutha at 1500 litre ha⁻¹ (25.0 and 26.8 cm), jeevamrutha at 1000 litre ha⁻¹ (24.8 and 26.4 cm) and significantly lower plant height was recorded with no-jeevamrutha application (23.5 and 25.1 cm). Panchagavya at 6 per cent recorded significantly higher plant height (25.6 and

27.6 cm) which was on par with panchagavya at 3 per cent (25.0 and 26.7 cm) and it was lower with no-panchagavya application (24.0 and 25.6 cm).

Plant height did not differ significantly due to the interaction between various levels of jeevamrutha and panchagavya application.

4.2.2 Number of branches per plant

Number of branches per plant at different stages of crop growth as influenced by liquid manures are presented in the Tables 35, 36 and 37.

Experiment conducted during *kharif* 2014

20 Days after sowing

Number of branches per plant did not differ significantly due application of jeevamrutha and panchagavya application. However, application of higher levels of jeevamrutha (2000 litres ha⁻¹) and panchagavya (6 %) recorded more number of branches per plant.

40 Days after sowing

Application of liquid manures had significant influence the number of branches. Jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher number of branches (4.33) followed by jeevamrutha at 1500 litre ha⁻¹ (4.04), jeevamrutha at 1000 litre ha⁻¹ (3.91), where application jeevamrutha at 1500 litre ha⁻¹ found on par with jeevamrutha at 1000 litre ha⁻¹ application and significantly lower number of branches were recorded with no-jeevamrutha application (3.56). There was significant difference observed with application of panchagavya. Panchagavya at 6 per cent recorded significantly higher number of branches (4.25) followed by panchagavya at 3 per cent (3.97) and it was lower with no-panchagavya application (3.67).

At harvest

Application of liquid manures significantly influenced the number of branches. Jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher number of branches (6.64) followed by jeevamrutha at 1500 litre ha⁻¹ (5.78), jeevamrutha at 1000 litre ha⁻¹ (5.40), where application jeevamrutha at 1500 litre ha⁻¹ found on par with jeevamrutha at 1000 litre ha⁻¹ application and significantly lower number of branches were recorded with no-jeevamrutha application (4.98). Panchagavya at 6 per cent recorded significantly higher number of branches (6.13) followed by panchagavya at 3 per cent (5.67) and it was lower with no-panchagavya application (5.30).

Experiment conducted during *kharif* 2015

20 Days after sowing

Number of branches per plant did not differ significantly due to application of jeevamrutha and panchagavya application. However, application of higher levels of

Table 35: Number of branches of frenchbean at different growth stages as influenced by application of liquid manures during Kharif 2014

Jeevamrutha Levels	Number of branches plant ⁻¹											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	0.93	1.07	0.93	0.98	3.13	3.60	3.93	3.56	4.67	4.93	5.33	4.98
J₁	0.93	1.00	1.00	0.98	3.67	3.80	4.27	3.91	4.80	5.40	6.00	5.40
J₂	0.93	1.00	1.07	1.00	3.73	4.07	4.33	4.04	5.33	5.80	6.20	5.78
J₃	1.07	1.07	1.07	1.07	4.13	4.40	4.47	4.33	6.40	6.53	7.00	6.64
Mean	0.97	1.03	1.02		3.67	3.97	4.25		5.30	5.67	6.13	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.04		NS		0.09		0.27		0.13		0.39	
Panchagavya	0.04		NS		0.08		0.23		0.11		0.34	
J × P	0.07		NS		0.16		NS		0.23		NS	

Note: **J₀** - Without Jeevamrutha, **J₁** - Jeevamrutha 1000 litre/ha, **J₂** - Jeevamrutha 1500 litre/ha, **J₃** - Jeevamrutha 2000 litre/ha

P₀ - Without panchagavya, **P₁** - Panchagavya at 3 %, **P₃** - Panchagavya at 6 %, **DAS** – Days After Sowing, **RDF** – 63:100:75 NPK kg ha⁻¹

Table 36: Number of branches of frenchbean at different growth stages as influenced by application of liquid manures during Kharif 2015

Jeevamrutha Levels	Number of branches plant ⁻¹											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	0.93	0.93	0.93	0.93	3.33	3.87	4.27	3.82	4.93	5.33	5.73	5.33
J₁	1.00	1.00	1.00	1.00	3.87	4.00	4.53	4.13	5.20	5.80	6.40	5.80
J₂	1.00	1.00	1.13	1.04	3.93	4.40	4.60	4.31	5.73	6.20	6.60	6.18
J₃	1.07	1.07	1.07	1.07	4.47	4.60	4.80	4.62	6.80	7.00	7.40	7.07
Mean	1.00	1.00	1.03		3.90	4.22	4.55		5.67	6.08	6.53	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.04		NS		0.10		0.29		0.14		0.41	
Panchagavya	0.04		NS		0.09		0.25		0.12		0.36	
J × P	0.08		NS		0.17		NS		0.24		NS	

Note: J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, J₂ - Jeevamrutha 1500 litre/ha, J₃ - Jeevamrutha 2000 litre/ha
P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, P₂ - Panchagavya at 6 %, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 37: Number of branches of frenchbean at different growth stages as influenced by application of liquid manures (Pooled 2014 and 2015)

Jeevamrutha Levels	Number of branches plant ⁻¹											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	0.93	1.00	0.93	0.96	3.23	3.73	4.10	3.69	4.80	5.13	5.53	5.16
J₁	0.97	1.00	1.00	0.99	3.77	3.90	4.40	4.02	5.00	5.60	6.20	5.60
J₂	0.97	1.00	1.10	1.02	3.83	4.23	4.47	4.18	5.53	6.00	6.40	5.98
J₃	1.07	1.07	1.07	1.07	4.30	4.50	4.63	4.48	6.60	6.77	7.20	6.86
Mean	0.98	1.02	1.03		3.78	4.09	4.40		5.48	5.88	6.33	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.04		NS		0.09		0.28		0.14		0.40	
Panchagavya	0.03		NS		0.08		0.24		0.12		0.35	
J × P	0.06		NS		0.16		NS		0.24		NS	

Note: **J₀** - Without Jeevamrutha, **J₁**- Jeevamrutha 1000 litre/ha, **J₂** - Jeevamrutha 1500 litre/ha, **J₃** - Jeevamrutha 2000 litre/ha
P₀ - Without panchagavya, **P₁** - Panchagavya at 3 %, **P₃** - Panchagavya at 6 %, **DAS** – Days After Sowing, **RDF** – 63:100:75 NPK kg ha⁻¹

jeevamruta (2000 litres ha⁻¹) and panchagavya (6 %) recorded more number of branches per plant.

40 Days after sowing

Jeevamrutha and panchagavya application significantly influenced on the number of branches per plant. Jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher number of branches (4.62) followed by jeevamrutha at 1500 litre ha⁻¹ (4.31), jeevamrutha at 1000 litre ha⁻¹ (4.13), where application jeevamrutha at 1500 litre ha⁻¹ found on par with jeevamrutha at 1000 litre ha⁻¹ application and significantly lower number of branches were recorded with no-jeevamrutha application (3.82). There was significant difference observed with application of panchagavya. Panchagavya at 6 per cent recorded significantly higher number of branches (4.55) followed by panchagavya at 3 per cent (4.22) and it was lower with no-panchagavya application (3.90).

At harvest

Jeevamrutha and panchagavya application had significant influence on the number of branches per plant. Jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher number of branches (7.07) followed by jeevamrutha at 1500 litre ha⁻¹ (6.18), jeevamrutha at 1000 litre ha⁻¹ (5.80), where application jeevamrutha at 1500 litre ha⁻¹ found on par with jeevamrutha at 1000 litre ha⁻¹ application and significantly lower number of branches were recorded with no-jeevamrutha application (5.33). Panchagavya at 6 per cent recorded significantly higher number of branches (6.53) followed by panchagavya at 3 per cent (6.08) and it was lower with no-panchagavya application (5.67).

Interaction effect

Number of branches per plant did not differ significantly due to the interaction between various levels of jeevamrutha and panchagavya application at all the stages during both the years.

Pooled

There was significant difference observed with application of liquid manures. At 40 DAS and at harvest jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher number of branches (4.48 and 6.86) followed by jeevamrutha at 1500 litre ha⁻¹ (4.18 and 5.98), jeevamrutha at 1000 litre ha⁻¹ (4.02 and 5.60), where application jeevamrutha at 1500 litre ha⁻¹ found on par with jeevamrutha at 1000 litre ha⁻¹ application and significantly lower number of branches were recorded with no-jeevamrutha application (3.69 and 5.16). Panchagavya at 6 per cent recorded significantly higher number of branches (4.40 and 6.33) followed by panchagavya at 3 per cent (4.09 and 5.88) and it was lower with no-panchagavya application (3.78 and 5.48).

Plant height did not differ significantly due to the interaction between various levels of jeevamrutha and panchagavya application.

4.2.3 Number of leaves per plant

Number of leaves per plant at different stages of growth as influenced by liquid manures are presented in the Tables 38, 39 and 40.

Experiment conducted during *kharif* 2014

20 Days after sowing

Number of leaves per plant did not differ significantly due application of jeevamrutha and panchagavya application. However, application of higher levels of jeevamrutha (2000 litres ha⁻¹) and panchagavya (6 %) recorded higher number of leaves per plant.

40 Days after sowing

Application of liquid manures significantly influenced the number of leaves. Jeevamrutha at 2000 litres ha⁻¹ recorded significantly higher number of leaves per plant (37.07) followed by Jeevamrutha at 1500 litre ha⁻¹ (33.80), jeevamrutha at 1000 litre ha⁻¹ (31.33) and it was lower with no- jeevamrutha application (29.03). Panchagavya at 6 per cent recorded significantly higher number of leaves (35.53) followed by panchagavya at 3 per cent (32.65) and it was lower with no-panchagavya application (30.24).

At harvest

Application of liquid manures significantly influenced the number of leaves. Jeevamrutha at 2000 litres ha⁻¹ recorded significantly higher number of leaves per plant (37.67) followed by Jeevamrutha at 1500 litre ha⁻¹ (33.78), jeevamrutha at 1000 litre ha⁻¹ (31.71) and it was lower with no- jeevamrutha application (29.33). Panchagavya at 6 per cent recorded significantly higher number of leaves (36.03) followed by panchagavya at 3 per cent (32.78) and it was lower with no-panchagavya application (30.55).

Experiment conducted during *kharif* 2015

20 Days after sowing

Number of leaves per plant did not differ significantly due to application of jeevamrutha and panchagavya. However, application of higher levels of jeevamrutha (2000 litres ha⁻¹) and panchagavya (6 %) recorded higher number of leaves per plant.

40 Days after sowing

Jeevamrutha and panchagavya application significantly influenced the number of leaves per plant. Jeevamrutha at 2000 litres ha⁻¹ recorded significantly higher number of leaves per plant (39.56) followed by Jeevamrutha at 1500 litre ha⁻¹ (36.44), jeevamrutha at 1000 litre ha⁻¹ (34.07) and it was lower with no- jeevamrutha application (31.89). There was significant difference observed with application of panchagavya. Panchagavya at 6 per cent recorded significantly higher number of leaves (38.13) followed by panchagavya at 3 per cent (35.3) and it was lower with no-panchagavya application (33.03).

Table 38: Number of leaves of frenchbean at different growth stages as influenced by application of liquid manures during Kharif 2014

Jeevamrutha Levels	Number of leaves plant ⁻¹											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	7.93	7.91	8.02	7.95	26.17	28.27	32.67	29.03	26.60	28.53	32.87	29.33
J₁	7.93	8.20	8.32	8.15	28.20	30.73	35.07	31.33	29.27	30.73	35.13	31.71
J₂	8.20	8.27	8.33	8.27	30.27	34.40	36.73	33.80	30.27	34.33	36.73	33.78
J₃	8.60	8.67	8.67	8.64	36.33	37.20	37.67	37.07	36.07	37.53	39.40	37.67
Mean	8.17	8.26	8.33		30.24	32.65	35.53		30.55	32.78	36.03	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.19		NS		0.74		2.17		0.80		2.36	
Panchagavya	0.17		NS		0.64		1.88		0.70		2.04	
J × P	0.34		NS		1.28		NS		1.39		NS	

Note: J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, J₂ - Jeevamrutha 1500 litre/ha, J₃ - Jeevamrutha 2000 litre/ha
P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, P₃ - Panchagavya at 6 %, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 39: Number of leaves of frenchbean at different growth stages as influenced by application of liquid manures during Kharif 2015

Jeevamrutha Levels	Number of leaves plant ⁻¹											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	8.00	8.13	8.40	8.18	29.13	31.13	35.40	31.89	29.80	32.07	35.47	32.44
J₁	8.13	8.20	8.20	8.18	31.07	33.47	37.67	34.07	31.73	33.80	38.00	34.51
J₂	7.80	8.20	8.73	8.24	33.07	36.93	39.33	36.44	33.40	37.27	39.53	36.73
J₃	9.13	9.27	9.40	9.27	38.87	39.67	40.13	39.56	39.20	40.13	42.13	40.49
Mean	8.27	8.45	8.68		33.03	35.30	38.13		33.53	35.82	38.78	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.33		NS		0.71		2.08		0.68		1.99	
Panchagavya	0.28		NS		0.61		1.80		0.59		1.72	
J × P	0.57		NS		1.23		NS		1.18		NS	

Note: J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, J₂ - Jeevamrutha 1500 litre/ha, J₃ - Jeevamrutha 2000 litre/ha
P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, P₃ - Panchagavya at 6 %, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 40: Number of leaves of frenchbean at different growth stages as influenced by application of liquid manures (Pooled 2014 and 2015)

Jeevamrutha Levels	Number of leaves plant ⁻¹											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	7.97	8.02	8.21	8.07	27.7	29.7	34.0	30.5	28.2	30.3	34.2	30.9
J₁	8.03	8.20	8.26	8.16	29.6	32.1	36.4	32.7	30.5	32.3	36.6	33.1
J₂	8.00	8.23	8.53	8.26	31.7	35.7	38.0	35.1	31.8	35.8	38.1	35.3
J₃	8.87	8.97	9.03	8.96	37.6	38.4	38.9	38.3	37.6	38.8	40.8	39.1
Mean	8.22	8.36	8.51		31.6	34.0	36.8		32.0	34.3	37.4	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.24		NS		0.72		2.13		0.74		2.16	
Panchagavya	0.21		NS		0.63		1.84		0.64		1.87	
J × P	0.41		NS		1.26		NS		1.27		NS	

Note: **J₀** - Without Jeevamrutha, **J₁** - Jeevamrutha 1000 litre/ha, **J₂** - Jeevamrutha 1500 litre/ha, **J₃** - Jeevamrutha 2000 litre/ha
P₀ - Without panchagavya, **P₁** - Panchagavya at 3 %, **P₂** - Panchagavya at 6 %, **DAS** – Days After Sowing, **RDF** – 63:100:75 NPK kg ha⁻¹

At harvest

Jeevamrutha and panchagavya application had significant influence on the number of leaves per plant. Jeevamrutha at 2000 litres ha⁻¹ recorded significantly higher number of leaves per plant (40.49) followed by Jeevamrutha at 1500 litre ha⁻¹ (36.73), jeevamrutha at 1000 litre ha⁻¹ (34.51) and it was lower with no- jeevamrutha application (32.44). Panchagavya at 6 per cent recorded significantly higher number of leaves (38.78) followed by panchagavya at 3 per cent (35.82) and it was lower with no-panchagavya application (33.53).

Interaction effect

Number of leaves per plant did not differ significantly due to the interaction between various levels of jeevamrutha and panchagavya application at all the stages during both the years.

Pooled

There was significant difference observed with application of jeevamrutha and panchagavya. At 40 DAS number of leaves per plant differed significantly due to the application of varied levels of jeevamrutha and panchagavya. Jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher number of leaves per plant (38.3) followed by Jeevamrutha at 1500 litre ha⁻¹ (35.1), jeevamrutha at 1000 litre ha⁻¹ (32.7) and it was lower with no- jeevamrutha application (30.5).

At harvest jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher number of leaves (39.1) followed by jeevamrutha at 1500 litre ha⁻¹ (35.3), jeevamrutha at 1000 litre ha⁻¹ (33.1), where application jeevamrutha at 1500 litre ha⁻¹ found on par with jeevamrutha at 1000 litre ha⁻¹ application and significantly lower number of leaves were recorded with no-jeevamrutha application (30.9).

At 40 DAS and harvest panchagavya at 6 per cent recorded significantly higher number of leaves (36.8 and 37.4) followed by panchagavya at 3 per cent application (34.0 and 34.3) and significantly lower number of leaves was observed with no- panchagavya application (31.6 and 32.0). Number of leaves per plant did not differ significantly due to the interaction between various levels of jeevamrutha and panchagavya application. However, higher number of leaves were observed with jeevamrutha at 2000 litre ha⁻¹ and panchagavya at 6 per cent (38.9 and 40.8) and it was lower with no - jeevamrutha and no-panchagavya application (27.7 and 28.2).

4.2.4 Leaf area (cm²)

Leaf area per plant at different stages of growth as influenced by liquid manures is presented in the Tables 41, 42 and 43.

Experiment conducted during *kharif* 2014

20 Days after sowing

Leaf area per plant did not differ significantly due to application of jeevamrutha and panchagavya. However, application of higher levels of jeevamrutha (2000 litres ha⁻¹) and panchagavya (6 %) recorded higher leaf area per plant.

40 Days after sowing

Leaf area per plant differed significantly due to the application of varied levels of jeevamrutha and panchagavya. Jeevamrutha at 2000 litres ha⁻¹ recorded significantly higher leaf area per plant (1171.74 cm²) followed by Jeevamrutha at 1500 litre ha⁻¹ (1044.6 cm²), jeevamrutha at 1000 litre ha⁻¹ (982.59 cm²) and it was lower with no-jeevamrutha application (896.74 cm²). There was significant difference observed with application of panchagavya. Panchagavya at 6 per cent recorded significantly higher Leaf area (1125.98 cm²) followed by panchagavya at 3 per cent (1036.77 cm²) and it was lower with no-panchagavya application (909.01 cm²).

Leaf area per plant differed significantly due to the interaction between various levels of jeevamrutha and panchagavya application. Significantly higher leaf area per plant was observed with jeevamrutha at 2000 litre ha⁻¹ and panchagavya at 6 per cent inter action (1219.57 cm²) and it was on par with jeevamrutha at 2000 litre ha⁻¹ + panchagavya at 3 per cent, jeevamrutha at 2000 litre ha⁻¹ + without panchagavya and jeevamrutha at 1500 litre ha⁻¹ + panchagavya at 6 per cent inter actions and it was lower with no - jeevamrutha and no-panchagavya application (757.03 cm²).

At harvest

Jeevamrutha at 2000 litres ha⁻¹ recorded significantly higher leaf area per plant (1181.26 cm²) followed by Jeevamrutha at 1500 litre ha⁻¹ (1056.36 cm²), jeevamrutha at 1000 litre ha⁻¹ (1013.25 cm²) and it was lower with no- jeevamrutha application (945.78 cm²). Panchagavya at 6 per cent recorded significantly higher Leaf area (1136.60 cm²) followed by panchagavya at 3 per cent (1065.57 cm²) and it was lower with no-panchagavya application (945.31 cm²).

Interaction effect

Leaf area per plant did not differ significantly due to the interaction between various levels of jeevamrutha and panchagavya application at 20 DAS and harvest.

Experiment conducted during *kharif* 2015

20 Days after sowing

Leaf area per plant did not differ significantly due to application of jeevamrutha and panchagavya and their inter actions. However, application of higher levels of jeevamrutha (2000 litres ha⁻¹) and panchagavya (6 %) recorded higher leaf area per plant.

Table 41: Leaf area of frenchbean at different growth stages as influenced by application of liquid manures during *Kharif* 2014

Jeevamrutha Levels	Leaf area (cm ²)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	422.80	398.33	427.40	416.18	757.03	864.08	1069.10	896.74	810.09	955.26	1072.00	945.78
J₁	410.63	426.00	402.56	413.06	823.88	1038.50	1085.40	982.59	895.36	1041.55	1102.83	1013.25
J₂	424.33	396.67	476.80	432.60	918.57	1085.40	1129.84	1044.60	934.77	1102.10	1132.20	1056.36
J₃	463.42	471.33	489.93	474.89	1136.54	1159.10	1219.57	1171.74	1141.03	1163.36	1239.38	1181.26
Mean	430.29	423.08	449.17		909.01	1036.77	1125.98		945.31	1065.57	1136.60	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	16.83		NS		20.62		60.49		19.93		58.45	
Panchagavya	14.58		NS		17.86		52.38		17.26		50.62	
J × P	29.16		NS		35.72		104.77		34.52		NS	

Note: J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, J₂ - Jeevamrutha 1500 litre/ha, J₃ - Jeevamrutha 2000 litre/ha

P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, P₂ - Panchagavya at 6 %, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 42: Leaf area of frenchbean at different growth stages as influenced by application of liquid manures during *Kharif* 2015

Jeevamrutha Levels	Leaf area plant ⁻¹ (cm ²)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	410.60	416.01	394.10	406.90	829.99	916.92	1129.16	958.69	966.96	1036.11	1275.95	1093.01
J₁	415.06	420.60	424.55	420.07	876.22	1100.79	1150.91	1042.64	990.13	1243.89	1300.53	1178.19
J₂	425.40	434.22	435.43	431.68	980.60	1155.46	1203.13	1113.06	1108.08	1305.67	1363.69	1259.15
J₃	437.43	440.40	449.33	442.39	1207.26	1233.26	1270.88	1237.14	1368.39	1397.78	1440.18	1402.12
Mean	422.12	427.81	425.85		973.52	1101.61	1188.52		1108.39	1245.87	1345.09	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	19.05		NS		20.21		59.27		22.32		65.46	
Panchagavya	16.50		NS		17.50		51.33		19.33		56.69	
J × P	32.99		NS		35.00		102.65		38.66		113.37	

Note: J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, J₂ - Jeevamrutha 1500 litre/ha, J₃ - Jeevamrutha 2000 litre/ha

P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, P₃ - Panchagavya at 6 %, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 43: Leaf area of frenchbean at different growth stages as influenced by application of liquid manures (Pooled 2014 and 2015)

Jeevamrutha Levels	Leaf area (cm ²)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	408.23	414.92	410.03	411.06	793.51	890.50	1099.13	927.71	888.52	995.69	1173.98	1019.40
J₁	412.23	417.47	413.56	414.42	850.05	1069.65	1118.16	1012.62	942.75	1142.72	1201.68	1095.72
J₂	418.78	417.39	439.40	425.19	949.59	1120.43	1166.49	1078.83	1021.43	1203.89	1247.94	1157.75
J₃	433.76	439.15	447.67	440.19	1171.90	1196.18	1245.22	1204.44	1254.71	1280.57	1339.78	1291.69
Mean	418.25	422.23	427.66		941.26	1069.19	1157.25		1026.85	1155.72	1240.84	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	14.83		NS		13.43		39.40		21.01		61.63	
Panchagavya	12.84		NS		11.63		34.12		18.20		53.37	
J × P	25.68		NS		23.27		68.24		36.40		NS	

Note: J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, J₂ - Jeevamrutha 1500 litre/ha, J₃ - Jeevamrutha 2000 litre/ha

P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, P₂ - Panchagavya at 6 %, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

40 Days after sowing

Jeevamrutha at 2000 litres ha⁻¹ recorded significantly higher leaf area per plant (1237.14 cm²) followed by Jeevamrutha at 1500 litre ha⁻¹ (1113.06 cm²), jeevamrutha at 1000 litre ha⁻¹ (1042.64 cm²) and it was lower with no- jeevamrutha application (958.69 cm²). Panchagavya at 6 per cent recorded significantly higher Leaf area (1188.52) followed by panchagavya at 3 per cent (1101.61 cm²) and it was lower with no-panchagavya application (973.52 cm²).

Leaf area per plant differed significantly due to the interaction between various levels of jeevamrutha and panchagavya application. Significantly higher leaf area per plant was observed with jeevamrutha at 2000 litre ha⁻¹ and panchagavya at 6 per cent inter action (1270.88 cm²) and it was on par with jeevamrutha at 2000 litre ha⁻¹ + panchagavya at 3 per cent, jeevamrutha at 2000 litre ha⁻¹ + without panchagavya and jeevamrutha at 1500 litre ha⁻¹ + panchagavya at 6 per cent inter actions and it was lower with no - jeevamrutha and no-panchagavya application (829.99 cm²).

At harvest

Leaf area per plant differed significantly due to the application of varied levels of jeevamrutha and panchagavya. Jeevamrutha at 2000 litres ha⁻¹ recorded significantly higher leaf area per plant (1402.12 cm²) followed by Jeevamrutha at 1500 litre ha⁻¹ (1259.15 cm²), jeevamrutha at 1000 litre ha⁻¹ (1178.19 cm²) and it was lower with no- jeevamrutha application (1093.01 cm²). Panchagavya at 6 per cent recorded significantly higher leaf area (1345.09 cm²) followed by panchagavya at 3 per cent (1245.87 cm²) and it was lower with no-panchagavya application (1108.39 cm²).

Leaf area per plant differed significantly due to the interaction between various levels of jeevamrutha and panchagavya application. Significantly higher leaf area per plant was observed with jeevamrutha at 2000 litre ha⁻¹ and panchagavya at 6 per cent inter action (1440.18 cm²) and it was on par with jeevamrutha at 2000 litre ha⁻¹ + panchagavya at 3 per cent, jeevamrutha at 2000 litre ha⁻¹ + without panchagavya and jeevamrutha at 1500 litre ha⁻¹ + panchagavya at 6 per cent inter actions and it was lower with no - jeevamrutha and no-panchagavya application (966.96 cm²).

Pooled

There was significant difference observed with application of jeevamrutha and panchagavya. At 40 DAS leaf area per plant differed significantly due to the application of varied levels of jeevamrutha and panchagavya. Jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher leaf area per plant (1204.44 cm²) followed by Jeevamrutha at 1500 litre ha⁻¹ (1078.83 cm²), jeevamrutha at 1000 litre ha⁻¹ (1012.62 cm²) and it was lower with no- jeevamrutha application (927.71 cm²). Leaf area per plant differed significantly due to the interaction between various levels of jeevamrutha and panchagavya application. Significantly higher leaf area per plant was observed with jeevamrutha at 2000 litre ha⁻¹ and panchagavya at 6 per cent inter action (1245.22 cm²) and it was on par with jeevamrutha at 2000 litre ha⁻¹ + panchagavya at 3 per cent, inter actions and it was lower with no - jeevamrutha and no-panchagavya application (793.51 cm²).

At harvest jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher leaf area per plant (1291.69 cm²) followed by jeevamrutha at 1500 litre ha⁻¹ (1157.75 cm²), jeevamrutha at 1000 litre ha⁻¹ (1095.72 cm²) and significantly lower leaf area per plant was recorded with no-jeevamrutha application (1019.4 cm²). Leaf area per plant did not differ significantly due to the interaction between various levels of jeevamrutha and panchagavya application.

At 40 DAS and harvest panchagavya at 6 per cent recorded significantly higher leaf area per plant (1157.25 and 1240.84 cm²) followed by panchagavya at 3 per cent application (1069.19 and 1155.72 cm²) and significantly lower leaf area per plant was observed with no- panchagavya application (941.26 and 1026.85 cm²).

4.2.5 Leaf Area Index (LAI)

Leaf area index per plant at different stages of growth as influenced by liquid manures are presented in the Tables 44, 45 and 46.

Experiment conducted during *kharif* 2014

20 Days after sowing

Leaves area index per plant did not vary significantly due to the application of jeevamrutha and panchagavya. However, application of higher levels of jeevamrutha (2000 litres ha⁻¹) and panchagavya (6 %) recorded higher leaf area index.

40 Days after sowing

Leaf area index per plant differed significantly due to the application of varied levels of jeevamrutha and panchagavya. Jeevamrutha at 2000 litres ha⁻¹ recorded significantly higher leaf area index (2.60) followed by Jeevamrutha at 1500 litre ha⁻¹ (2.32), jeevamrutha at 1000 litre ha⁻¹ (2.18) and it was lower with no- jeevamrutha application (1.99). Panchagavya at 6 per cent recorded significantly higher Leaf area index (2.50) followed by panchagavya at 3 per cent (2.30) and it was lower with no-panchagavya application (2.02).

Leaf area index per plant varied significantly due to the interaction between various levels of jeevamrutha and panchagavya application. Significantly higher leaf area per plant was observed with jeevamrutha at 2000 litre ha⁻¹ and panchagavya at 6 per cent inter action (2.71) and it was on par with jeevamrutha at 2000 litre ha⁻¹ + panchagavya at 3 per cent, jeevamrutha at 2000 litre ha⁻¹ + without panchagavya and jeevamrutha at 1500 litre ha⁻¹ + panchagavya at 6 per cent inter actions and it was lower with no - jeevamrutha and no-panchagavya application (1.68).

At harvest

Application of Jeevamrutha at 2000 litres ha⁻¹ recorded significantly higher leaf area index (2.63) followed by Jeevamrutha at 1500 litre ha⁻¹ (2.35), jeevamrutha at 1000 litre ha⁻¹ (2.25) and it was lower with no- jeevamrutha application (2.10). Panchagavya at 6 per cent recorded significantly higher Leaf area index (2.53) followed by panchagavya at 3 per cent (2.37) and it was lower with no-panchagavya application (2.10).

Table 44: Leaf area index of frenchbean at different growth stages as influenced by application of liquid manures during Kharif 2014

Jeevamrutha Levels	Leaf area index											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	0.90	0.92	0.95	0.92	1.68	1.92	2.38	1.99	1.80	2.12	2.38	2.10
J₁	0.91	0.92	0.89	0.91	1.83	2.31	2.41	2.18	1.99	2.31	2.45	2.25
J₂	0.92	0.89	0.99	0.93	2.04	2.41	2.51	2.32	2.08	2.45	2.52	2.35
J₃	0.96	0.97	0.99	0.97	2.53	2.58	2.71	2.60	2.54	2.59	2.75	2.63
Mean	0.92	0.93	0.95		2.02	2.30	2.50		2.10	2.37	2.53	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.04		NS		0.05		0.13		0.04		0.13	
Panchagavya	0.04		NS		0.04		0.12		0.04		0.11	
J × P	0.08		NS		0.08		0.23		0.08		NS	

Note: J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, J₂ - Jeevamrutha 1500 litre/ha, J₃ - Jeevamrutha 2000 litre/ha
P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, P₃ - Panchagavya at 6 %, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 45: Leaf area index of frenchbean at different growth stages as influenced by application of liquid manures during Kharif 2015

Jeevamrutha Levels	Leaf area index											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	0.91	0.92	0.88	0.90	1.84	2.04	2.51	2.13	2.15	2.30	2.84	2.43
J₁	0.92	0.93	0.94	0.93	1.95	2.45	2.56	2.32	2.20	2.76	2.89	2.62
J₂	0.95	0.96	0.97	0.96	2.18	2.57	2.67	2.47	2.46	2.90	3.03	2.80
J₃	0.97	0.98	1.00	0.98	2.68	2.74	2.82	2.75	3.04	3.11	3.20	3.12
Mean	0.94	0.95	0.95		2.16	2.45	2.64		2.46	2.77	2.99	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.04		NS		0.04		0.13		0.05		0.15	
Panchagavya	0.04		NS		0.04		0.11		0.04		0.13	
J × P	0.07		NS		0.08		0.23		0.09		0.25	

Note: J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, J₂ - Jeevamrutha 1500 litre/ha, J₃ - Jeevamrutha 2000 litre/ha
P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, P₃ - Panchagavya at 6 %, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 46: Leaf area index of frenchbean at different growth stages as influenced by application of liquid manures (Pooled 2014 and 2015)

Jeevamrutha Levels	Leaf area index											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	0.91	0.92	0.91	0.91	1.76	1.98	2.44	2.06	1.97	2.21	2.61	2.27
J₁	0.92	0.93	0.92	0.92	1.89	2.38	2.48	2.25	2.09	2.54	2.67	2.43
J₂	0.93	0.93	0.98	0.94	2.11	2.49	2.59	2.40	2.27	2.68	2.77	2.57
J₃	0.96	0.98	0.99	0.98	2.60	2.66	2.77	2.68	2.79	2.85	2.98	2.87
Mean	0.93	0.94	0.95		2.09	2.38	2.57		2.28	2.57	2.76	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.03		NS		0.03		0.09		0.05		0.14	
Panchagavya	0.03		NS		0.03		0.08		0.04		0.12	
J × P	0.06		NS		0.05		0.15		0.08		NS	

Note: **J₀** - Without Jeevamrutha, **J₁**- Jeevamrutha 1000 litre/ha, **J₂** - Jeevamrutha 1500 litre/ha, **J₃** - Jeevamrutha 2000 litre/ha
P₀ - Without panchagavya, **P₁** - Panchagavya at 3 %, **P₃** - Panchagavya at 6 %, **DAS** – Days After Sowing, **RDF** – 63:100:75 NPK kg ha⁻¹

Interaction effect

Leaf area index did not differ significantly due to the interaction between various levels of jeevamrutha and panchagavya application at 20 and at harvest.

Experiment conducted during *kharif* 2015

20 Days after sowing

Leaf area index per plant did not differ significantly due application of jeevamrutha and panchagavya. However, application of higher levels of jeevamrutha (2000 litres ha⁻¹) and panchagavya (6 %) recorded higher leaf area index. Leaf area index per plant did not differ significantly due to the interaction between various levels of jeevamrutha and panchagavya application.

40 Days after sowing

Jeevamrutha at 2000 litres ha⁻¹ recorded significantly higher leaf area index (2.75) followed by Jeevamrutha at 1500 litres ha⁻¹ (2.47), jeevamrutha at 1000 litres ha⁻¹ (2.32) and it was lower with no- jeevamrutha application (2.13). Panchagavya at 6 per cent recorded significantly higher Leaf area index (2.64) followed by panchagavya at 3 per cent (2.45) and it was lower with no-panchagavya application (2.16).

Leaf area index differed significantly due to the interaction between various levels of jeevamrutha and panchagavya application. Significantly higher leaf area index was observed with jeevamrutha at 2000 litres ha⁻¹ and panchagavya at 6 per cent inter action (2.82) and it was on par with jeevamrutha at 2000 litre ha⁻¹ + panchagavya at 3 per cent, jeevamrutha at 2000 litres ha⁻¹ + without panchagavya and jeevamrutha at 1500 litres ha⁻¹ + panchagavya at 6 per cent interactions and it was lower with no - jeevamrutha and no-panchagavya application (1.84).

At harvest

Leaf area index differed significantly due to the application of varied levels of jeevamrutha and panchagavya. Jeevamrutha at 2000 litres ha⁻¹ recorded significantly higher leaf area index (3.12) followed by Jeevamrutha at 1500 litres ha⁻¹ (2.80), jeevamrutha at 1000 litres ha⁻¹ (2.62) and it was lower with no- jeevamrutha application (2.43). Panchagavya at 6 per cent recorded significantly higher leaf area index (2.99) followed by panchagavya at 3 per cent (2.77) and it was lower with no-panchagavya application (2.46).

Leaf area index varied significantly due to the interaction between various levels of jeevamrutha and panchagavya application. Significantly higher leaf area index was observed with jeevamrutha at 2000 litres ha⁻¹ and panchagavya at 6 per cent interaction (3.20) and it was on par with jeevamrutha at 2000 litres ha⁻¹ + panchagavya at 3 per cent, jeevamrutha at 2000 litres ha⁻¹ + without panchagavya and jeevamrutha at 1500 litres ha⁻¹ + panchagavya at 6 per cent interactions and it was lower with no - jeevamrutha and no-panchagavya application (2.15).

Pooled

At 40 DAS leaf area index differed significantly due to the application of varied levels of jeevamrutha and panchagavya. Jeevamrutha at 2000 L ha⁻¹ recorded significantly higher leaf area index (2.68) followed by Jeevamrutha at 1500 litre ha⁻¹ (2.40), jeevamrutha at 1000 litre ha⁻¹ (2.25) and it was lower with no- jeevamrutha application (2.06). Leaf area index differed significantly due to the interaction between various levels of jeevamrutha and panchagavya application. Panchagavya at 6 per cent recorded significantly higher leaf area index (2.57) followed by panchagavya at 3 per cent application (2.38) and significantly lower leaf area index was observed with no-panchagavya application (2.9).

Significantly higher leaf area per plant was observed with combined application of jeevamrutha at 2000 litre ha⁻¹ and panchagavya at 6 per cent (2.77) and it was on par with jeevamrutha at 2000 litre ha⁻¹ + panchagavya at 3 per cent and it was lower with no -jeevamrutha and no-panchagavya application (1.76).

At harvest jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher leaf area index (2.87) followed by jeevamrutha at 1500 litre ha⁻¹ (2.57), jeevamrutha at 1000 litre ha⁻¹ (2.43) and significantly lower leaf area index was recorded with no-jeevamrutha application (2.27). Panchagavya at 6 per cent recorded significantly higher leaf area index (2.98) followed by panchagavya at 3 per cent application (2.57) and significantly lower leaf area index was observed with no- panchagavya application (2.28). Leaf area index did not differ significantly due to the interaction between various levels of jeevamrutha and panchagavya application.

4.2.6 Number of nodules, fresh weight and dry weight of nodules per plant

The data on number of nodules, fresh weight and dry weight of nodules per plant differed significantly due to the application of various levels of jeevamrutha and panchagavya at flowering stage of frenchbean (Table 47).

Experiment conducted during *kharif* 2014

Nodulation formation by plants was not observed during *Kharif* 2014.

Experiment conducted during *kharif* 2015

Application of jeevamrutha at 2000 litres ha⁻¹ recorded significantly higher number of nodules and their fresh and dry weight per plant (113.3, 0.67 g and 0.15 g) followed by jeevamrutha at 1500 litres ha⁻¹ (96.3, 0.52 g and 0.12 g, respectively), jeevamrutha at 1000 litres ha⁻¹ (90.2, 0.48 g and 0.11 g, respectively) as compared to without jeevamrutha application (66.0, 0.39 g and 0.09 g, respectively) whereas, jeevamrutha at 1500 litres ha⁻¹ was on par with jeevamrutha at 1000 litres ha⁻¹. Panchagavya at 6 per cent application recorded significantly higher nodules and their fresh and dry weight per plant (101.5, 0.59 g, 0.14 g, respectively) followed panchagavya at 3 per cent application (91.1, 0.51 g, 0.12 g, respectively) as compared to without panchagavya application (81.7, 0.45 g, 0.09 g, respectively).

Table 47: Effect of liquid manures application on Number of nodules, fresh weight and dry weight of nodules at flowering stage of frenchbean during *Kharif* 2015

Jeevamrutha Levels	40 DAS											
	Number of nodules plant ⁻¹				Fresh wt of nodules plant ⁻¹ (g)				Dry wt of nodules plant ⁻¹ (g)			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	48.3	67.1	82.6	66.0	0.26	0.44	0.47	0.39	0.07	0.08	0.11	0.09
J₁	81.9	89.0	99.7	90.2	0.44	0.45	0.56	0.48	0.09	0.12	0.12	0.11
J₂	87.6	96.7	104.6	96.3	0.48	0.52	0.57	0.52	0.08	0.12	0.15	0.12
J₃	108.9	111.6	119.3	113.3	0.63	0.65	0.74	0.67	0.13	0.14	0.18	0.15
Mean	81.7	91.1	101.5		0.45	0.51	0.59		0.09	0.12	0.14	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	3.25		9.52		0.02		0.05		0.004		0.013	
Panchagavya	2.81		8.24		0.01		0.04		0.004		0.011	
J × P	5.62		NS		0.03		NS		0.007		NS	

Note: **J₀** - Without Jeevamrutha, **J₁**- Jeevamrutha 1000 litre/ha, **J₂**- Jeevamrutha 1500 litre/ha, **J₃**- Jeevamrutha 2000 litre/ha
P₀ - Without panchagavya, **P₁**- Panchagavya at 3 %, **P₃**- Panchagavya at 6 %, **DAS** – Days After Sowing, **RDF** – 63:100:75 NPK kg ha⁻¹

Interaction effect

Number of nodules and their fresh and dry weight per plant did not differ significantly due to the interaction between various levels of jeevamrutha and panchagavya application at flowering stage of frenchbean.

4.2.7 Dry matter accumulation in different plant parts

Data on dry matter distribution to different plant parts at various growth stages as influenced by various levels of jeevamrutha panchagavya and their interaction.

Dry matter accumulation in shoot (g plant⁻¹)

The dry matter accumulation in shoot (g plant⁻¹) differed significantly due to different levels of liquid manures application at 40 DAS and at harvest except 20 DAS are furnished in Tables 48, 49 and 50.

Experiment conducted during *kharif* 2014

20 Days after sowing

Dry matter accumulation in shoot per plant did not vary significantly due to the application of jeevamrutha and panchagavya. However, application of higher levels of jeevamrutha (2000 litres ha⁻¹) and panchagavya (6 %) recorded higher dry matter accumulation in shoot.

40 Days after sowing

Application of jeevamrutha at 2000 litres ha⁻¹ recorded significantly higher dry matter accumulation in shoot (5.52 g) followed by jeevamrutha at 1500 litres ha⁻¹ (4.76 g), jeevamrutha at 1000 litres ha⁻¹ (4.58 g), whereas, application jeevamrutha at 1500 litres ha⁻¹ found on par with jeevamrutha at 1000 litres ha⁻¹ application and significantly lower dry matter accumulation in shoot was recorded with no-jeevamrutha application (4.04 g). There was significant difference observed with application of panchagavya. Panchagavya at 6 per cent recorded significantly higher dry matter in shoot (5.17 g) followed by panchagavya at 3 per cent (4.67 g) and it was lower with no-panchagavya application (4.34 g).

At harvest

Application of jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher dry matter accumulation in shoot (6.25g) followed by jeevamrutha at 1500 litre ha⁻¹ (5.50), jeevamrutha at 1000 litre ha⁻¹ (5.24 g), where application jeevamrutha at 1500 litre ha⁻¹ found on par with jeevamrutha at 1000 litre ha⁻¹ application and significantly lower dry matter accumulation in shoot was recorded with no-jeevamrutha application (4.78 g). There was significant difference observed with application of panchagavya. Panchagavya at 6 per cent recorded significantly higher dry matter in shoot (5.90 g) followed by panchagavya at 3 per cent (5.49 g) and it was lower with no-panchagavya application (4.94 g).

Table 48: Shoot weight of frenchbean at different growth stages as influenced by application of liquid manures during *Kharif* 2014

Jeevamrutha Levels	Shoot weight (g plant ⁻¹)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	0.99	1.00	1.06	1.02	3.55	4.24	4.32	4.04	4.25	4.99	5.11	4.78
J₁	1.01	1.07	1.14	1.07	4.22	4.29	5.22	4.58	4.73	5.10	5.88	5.24
J₂	1.00	1.14	1.15	1.10	4.27	4.54	5.47	4.76	4.87	5.59	6.03	5.50
J₃	1.11	1.14	1.10	1.12	5.30	5.60	5.67	5.52	5.92	6.27	6.57	6.25
Mean	1.03	1.09	1.12		4.34	4.67	5.17		4.94	5.49	5.90	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.04		0.011		0.12		0.34		0.16		0.47	
Panchagavya	0.03		0.09		0.10		0.30		0.14		0.41	
J × P	0.06		NS		0.20		NS		0.28		NS	

Note: **J₀** - Without Jeevamrutha, **J₁**- Jeevamrutha 1000 litre/ha, **J₂**- Jeevamrutha 1500 litre/ha, **J₃**- Jeevamrutha 2000 litre/ha
P₀ - Without panchagavya, **P₁** - Panchagavya at 3 %, **P₃**- Panchagavya at 6 %, **DAS** – Days After Sowing, **RDF** – 63:100:75 NPK kg ha⁻¹

Table 49: Shoot weight of frenchbean at different growth stages as influenced by application of liquid manures during *Kharif* 2015

Jeevamrutha Levels	Shoot weight (g plant ⁻¹)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	1.01	1.00	1.01	1.01	3.56	4.37	4.35	4.09	4.44	5.25	5.55	5.08
J₁	1.05	1.04	1.02	1.03	4.39	4.78	5.23	4.80	5.34	5.68	5.91	5.64
J₂	1.02	1.10	1.10	1.07	4.32	5.25	5.58	5.05	5.35	6.27	6.49	6.04
J₃	1.08	1.13	1.14	1.12	5.36	5.58	6.24	5.73	6.23	6.38	7.15	6.59
Mean	1.04	1.07	1.07		4.41	4.99	5.35		5.34	5.90	6.28	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.05		NS		0.15		0.43		0.19		0.54	
Panchagavya	0.04		NS		0.13		0.37		0.16		0.47	
J × P	0.08		NS		0.25		NS		0.32		NS	

Note: **J₀** - Without Jeevamrutha, **J₁**- Jeevamrutha 1000 litre/ha, **J₂**- Jeevamrutha 1500 litre/ha, **J₃**- Jeevamrutha 2000 litre/ha
P₀- Without panchagavya, **P₁**- Panchagavya at 3 %, **P₃**- Panchagavya at 6 %, **DAS** – Days After Sowing, **RDF** – 63:100:75 NPK kg ha⁻¹

Table 50: Shoot weight of frenchbean at different growth stages as influenced by application of liquid manures (Pooled 2014 and 2015)

Jeevamrutha Levels	Shoot weight (g plant ⁻¹)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	1.00	1.00	1.04	1.01	3.56	4.30	4.33	4.06	4.35	5.12	5.33	4.93
J₁	1.03	1.05	1.08	1.05	4.31	4.54	5.23	4.69	5.04	5.39	5.90	5.44
J₂	1.01	1.12	1.13	1.09	4.29	4.89	5.52	4.90	5.11	5.93	6.26	5.77
J₃	1.09	1.15	1.13	1.12	5.33	5.59	5.96	5.63	6.08	6.33	6.86	6.42
Mean	1.03	1.08	1.09		4.37	4.83	5.26		5.14	5.69	6.09	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.03		NS		0.07		0.20		0.11		0.33	
Panchagavya	0.03		NS		0.06		0.17		0.10		0.29	
J × P	0.05		NS		0.12		0.35		0.20		NS	

Note: **J₀** - Without Jeevamrutha, **J₁** - Jeevamrutha 1000 litre/ha, **J₂** - Jeevamrutha 1500 litre/ha, **J₃** - Jeevamrutha 2000 litre/ha
P₀ - Without panchagavya, **P₁** - Panchagavya at 3 %, **P₃** - Panchagavya at 6 %, **DAS** – Days After Sowing, **RDF** – 63:100:75 NPK kg ha⁻¹

Experiment conducted during *kharif* 2015

20 Days after sowing

Dry matter accumulation in shoot per plant did not differ significantly due to the application of jeevamrutha and panchagavya. However, application of higher levels of jeevamrutha (2000 litres ha⁻¹) and panchagavya (6 %) recorded higher dry matter accumulation in shoot.

40 Days after sowing

Application of jeevamrutha at 2000 litres ha⁻¹ recorded significantly higher dry matter accumulation in shoot (5.73 g) followed by jeevamrutha at 1500 litres ha⁻¹ (5.05 g), jeevamrutha at 1000 litres ha⁻¹ (4.80 g), where application jeevamrutha at 1500 litres ha⁻¹ found on par with jeevamrutha at 1000 litre ha⁻¹ application and significantly lower dry matter accumulation in shoot was recorded with no-jeevamrutha application (4.09 g). There was significant difference observed with application of panchagavya. Panchagavya at 6 per cent recorded significantly higher dry matter in shoot (5.35 g) followed by panchagavya at 3 per cent (4.99 g) and it was lower with no-panchagavya application (4.41 g).

At harvest

Application of jeevamrutha at 2000 litres ha⁻¹ recorded significantly higher dry matter accumulation in shoot (6.59 g) followed by jeevamrutha at 1500 litre ha⁻¹ (6.04 g), jeevamrutha at 1000 litre ha⁻¹ (5.64 g), whereas, application jeevamrutha at 1500 litre ha⁻¹ found on par with jeevamrutha at 1000 litre ha⁻¹ application and significantly lower dry matter accumulation in shoot was recorded with no-jeevamrutha application (5.08). There was significant difference observed with application of panchagavya. Panchagavya at 6 per cent recorded significantly higher dry matter in shoot (6.28 g) followed by panchagavya at 3 per cent (5.90 g) and it was lower with no-panchagavya application (5.34 g).

Interaction effect

Dry matter accumulation in shoot per plant did not differ significantly due to the interaction between various levels of jeevamrutha and panchagavya application at all the stages during both the years.

Pooled

Significant differences were observed in shoot dry matter per plant due to the application of jeevamrutha and panchagavya. At 40 DAS and harvest jeevamrutha at 2000 litres ha⁻¹ recorded significantly higher dry matter accumulation in stem (5.63 and 6.42 g) followed by jeevamrutha at 1500 litres ha⁻¹ (4.90 and 5.77 g), jeevamrutha at 1000 litres ha⁻¹ (4.69 and 5.44 g) and significantly lower dry matter in stem was recorded with no-jeevamrutha application (4.06 and 4.93 g). Panchagavya at 6 per cent recorded significantly higher dry matter in stem (5.26 and 6.09 g) followed by panchagavya at 3 per cent (4.83 and 5.69) and it was lower with no-panchagavya application (4.37 and 5.14 g).

Dry matter in shoot per plant differed significantly due to the interaction between various levels of jeevamrutha and panchagavya application at 40 DAS. Significantly higher dry matter accumulation in shoot was noticed in jeevamrutha at 2000 litres ha⁻¹ and panchagavya at 6 per cent (5.96 g) as compared to other treatments and it was lower with no - jeevamrutha and no-panchagavya application (3.56 g). At harvest dry matter accumulation in shoot per plant did not differ significantly due to the interaction between various levels of jeevamrutha and Panchagavya application.

Dry matter accumulation in leaves (g plant⁻¹)

Dry matter accumulation in leaves (g plant⁻¹) varied significantly due to different levels of liquid manures application at 40 and at harvest except 20 DAS are furnished in Tables 51, 52 and 53.

Experiment conducted during *kharif* 2014

20 Days after sowing

Dry matter accumulation in leaves per plant did not differ significantly due application of jeevamrutha and panchagavya. However, application of higher levels of jeevamrutha (2000 litres ha⁻¹) and panchagavya (6 %) recorded higher dry matter accumulation in leaves.

40 Days after sowing

The leaf dry matter per plant varied significantly due to the application of jeevamrutha. Higher leaf dry matter per plant was observed with jeevamrutha at 2000 litres ha⁻¹ (6.23 g) followed by jeevamrutha at 1500 litres ha⁻¹ (5.97 g), jeevamrutha at 1000 litres ha⁻¹ (5.83 g), where application jeevamrutha at 1500 litres ha⁻¹ found on par with jeevamrutha at 1000 litres ha⁻¹ application and significantly lower dry matter accumulation in leaves was recorded with no-jeevamrutha application (4.92 g). Panchagavya spray influenced significantly on leaf dry matter per plant. Higher leaf dry matter per plant of 6.04 g found in 6 % panchagavya spray which was on par with 3 % panchagavya and lower leaf dry matter of 5.24 g was observed in without panchagavya spray.

At harvest

The leaf dry matter per plant varied significantly due to the application of jeevamrutha. Higher leaf dry matter per plant was observed with jeevamrutha at 2000 litres ha⁻¹ (6.57 g) followed by jeevamrutha at 1500 litres ha⁻¹ (5.87 g), jeevamrutha at 1000 litres ha⁻¹ (5.69 g), where application jeevamrutha at 1500 litres ha⁻¹ found on par with jeevamrutha at 1000 litres ha⁻¹ application and significantly lower dry matter accumulation in leaves was recorded with no-jeevamrutha application (5.14 g). Panchagavya spray influenced significantly on leaf dry matter per plant. Higher leaf dry matter per plant found in 6 per cent panchagavya (6.23 g) spray followed by with 3 per cent panchagavya spray (5.83 g) and lower leaf dry matter was observed in without panchagavya spray (5.39 g).

Table 51: Leaf weight of frenchbean at different growth stages as influenced by application of liquid manures during *Kharif* 2014

Jeevamrutha Levels	Leaf weight (g plant ⁻¹)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	1.48	1.51	1.62	1.54	4.38	5.05	5.32	4.92	4.47	5.23	5.73	5.14
J₁	1.47	1.51	1.65	1.54	5.30	6.06	6.14	5.83	5.40	5.73	5.93	5.69
J₂	1.44	1.74	1.75	1.64	5.41	6.21	6.28	5.97	5.45	6.00	6.14	5.87
J₃	1.73	1.73	1.74	1.73	5.89	6.36	6.43	6.23	6.24	6.37	7.10	6.57
Mean	1.53	1.62	1.69		5.24	5.92	6.04		5.39	5.83	6.23	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.09		NS		0.13		0.37		0.14		0.40	
Panchagavya	0.08		NS		0.11		0.32		0.12		0.35	
J × P	0.16		NS		0.22		NS		0.24		NS	

Note: **J₀** - Without Jeevamrutha, **J₁**- Jeevamrutha 1000 litre/ha, **J₂**- Jeevamrutha 1500 litre/ha, **J₃**- Jeevamrutha 2000 litre/ha
P₀ - Without panchagavya, **P₁** - Panchagavya at 3 %, **P₃**- Panchagavya at 6 %, **DAS** – Days After Sowing, **RDF** – 63:100:75 NPK kg ha⁻¹

Table 52: Leaf weight of frenchbean at different growth stages as influenced by application of liquid manures during *Kharif* 2015

Jeevamrutha Levels	Leaf weight (g plant ⁻¹)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	1.47	1.48	1.55	1.50	4.50	5.10	5.38	4.99	4.58	5.33	5.87	5.26
J₁	1.47	1.59	1.69	1.58	5.33	6.22	6.24	5.93	5.28	5.75	6.00	5.68
J₂	1.66	1.74	1.76	1.72	5.11	6.25	6.32	5.89	5.39	6.12	6.52	6.01
J₃	1.73	1.77	1.77	1.75	5.94	6.38	6.73	6.35	6.30	6.64	7.41	6.78
Mean	1.58	1.64	1.69		5.22	5.99	6.17		5.39	5.96	6.45	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.10		NS		0.15		0.45		0.14		0.40	
Panchagavya	0.09		NS		0.13		0.39		0.12		0.35	
J × P	0.17		NS		0.27		NS		0.24		NS	

Note: **J₀** - Without Jeevamrutha, **J₁** - Jeevamrutha 1000 litre/ha, **J₂** - Jeevamrutha 1500 litre/ha, **J₃** - Jeevamrutha 2000 litre/ha
P₀ - Without panchagavya, **P₁** - Panchagavya at 3 %, **P₂** - Panchagavya at 6 %, **DAS** – Days After Sowing, **RDF** – 63:100:75 NPK kg ha⁻¹

Table 53: Leaf weight of frenchbean at different growth stages as influenced by application of liquid manures (Pooled 2014 and 2015)

Jeevamrutha Levels	Leaf weight (g plant ⁻¹)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	1.47	1.49	1.59	1.52	4.44	5.08	5.35	4.96	4.52	5.28	5.80	5.20
J₁	1.47	1.55	1.67	1.56	5.32	6.14	6.19	5.88	5.34	5.74	5.97	5.68
J₂	1.55	1.74	1.76	1.68	5.26	6.23	6.30	5.93	5.42	6.06	6.33	5.94
J₃	1.73	1.75	1.76	1.74	5.92	6.37	6.58	6.29	6.27	6.50	7.25	6.68
Mean	1.55	1.63	1.69		5.23	5.95	6.10		5.39	5.90	6.34	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.07		NS		0.11		0.33		0.11		0.31	
Panchagavya	0.06		NS		0.10		0.28		0.09		0.27	
J × P	0.12		NS		0.19		NS		0.18		NS	

Note: J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, J₂ - Jeevamrutha 1500 litre/ha, J₃ - Jeevamrutha 2000 litre/ha
P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, P₂ - Panchagavya at 6 %, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Experiment conducted during *kharif* 2015

20 Days after sowing

Dry matter accumulation in leaves per plant did not differ significantly due application of jeevamrutha and panchagavya. However, application of higher levels of jeevamrutha (2000 litres ha⁻¹) and panchagavya (6 %) recorded higher dry matter accumulation in leaves.

40 Days after sowing

Leaf dry matter per plant varied significantly due to the application of jeevamrutha. Higher leaf dry matter per plant was observed with jeevamrutha at 2000 litres ha⁻¹ (6.35 g) followed by jeevamrutha at 1500 litres ha⁻¹ (5.89 g), jeevamrutha at 1000 litres ha⁻¹ (5.93 g), where application jeevamrutha at 1500 litres ha⁻¹ found on par with jeevamrutha at 1000 litres ha⁻¹ application and significantly lower dry matter accumulation in leaves was recorded with no-jeevamrutha application (4.99 g). Panchagavya spray influenced significantly on leaf dry matter per plant. Higher leaf dry matter per plant found in 6 % panchagavya (6.17 g) spray followed by with 3 % panchagavya spray (5.99 g) and lower leaf dry matter was observed in without panchagavya spray (5.22 g).

At harvest

Leaf dry matter per plant varied significantly due to the application of jeevamrutha. Higher leaf dry matter per plant was observed with jeevamrutha at 2000 litre ha⁻¹ (6.78 g) followed by jeevamrutha at 1500 litres ha⁻¹ (6.01 g), jeevamrutha at 1000 litre ha⁻¹ (5.68 g), where application jeevamrutha at 1500 litres ha⁻¹ found on par with jeevamrutha at 1000 litres ha⁻¹ application and significantly lower dry matter accumulation in leaves was recorded with no-jeevamrutha application (5.26 g). Panchagavya spray influenced significantly on leaf dry matter per plant. Higher leaf dry matter per plant found in 6 % panchagavya (6.45 g) spray followed by with 3 % panchagavya spray (5.96 g) and lower leaf dry matter was observed in without panchagavya spray (5.39 g).

Interaction effect

Dry matter accumulation in leaves per plant did not differ significantly due to the interaction between various levels of jeevamrutha and panchagavya application at all the stages during both the years.

Pooled

The leaf dry matter per plant varied significantly due to the application of jeevamrutha. At 40 DAS and harvest jeevamrutha at 2000 litres ha⁻¹ recorded significantly higher dry matter accumulation in leaves (6.29 and 6.68) followed by jeevamrutha at 1500 litres ha⁻¹ (5.93 and 5.94), jeevamrutha at 1000 litres ha⁻¹ (5.88 and 5.68), where application jeevamrutha at 1500 litre ha⁻¹ found on par with jeevamrutha at 1000 litres ha⁻¹ application and significantly lower dry matter accumulation in leaves was recorded with no-jeevamrutha application (4.96 and 5.20).

At 40 DAS panchagavya at 6 per cent recorded significantly higher dry matter accumulation in leaves (6.10) which was on par with panchagavya at 3 per cent (5.95) and it was lower with no-panchagavya application (5.23).

At harvest panchagavya at 6 per cent recorded significantly higher dry matter accumulation in leaves (6.34) followed by panchagavya at 3 per cent (5.90) and it was lower with no-panchagavya application (5.39).

Dry matter accumulation in leaves per plant did not differ significantly due to the interaction between various levels of jeevamrutha and panchagavya application.

Dry matter accumulation in roots (g plant⁻¹)

Dry matter accumulation in roots varied significantly due to different treatments and their interaction at 40 DAS and harvest except 20 DAS are presented in Tables 54, 55 and 56.

Experiment conducted during *kharif* 2014

20 Days after sowing

Dry matter accumulation in roots per plant did not differ significantly due application of jeevamrutha and panchagavya. However, application of higher levels of jeevamrutha (2000 litres ha⁻¹) and panchagavya (6 %) recorded higher dry matter accumulation in root.

40 Days after sowing

Application of jeevamrutha at 2000 litres ha⁻¹ recorded significantly higher dry matter accumulation in roots (1.34 g) followed by jeevamrutha at 1500 litres ha⁻¹ (1.30 g), jeevamrutha at 1000 litres ha⁻¹ (1.28 g) where jeevamrutha at 1500 litres ha⁻¹ on par with jeevamrutha at 1000 litres ha⁻¹ and significantly lower dry matter in roots was recorded with no-jeevamrutha (1.13 g). Panchagavya spray influenced significantly on root dry matter per plant. Panchagavya at 6 per cent recorded significantly higher dry matter in roots (1.31 g) followed by panchagavya at 3 per cent (1.26 g) and it was lower with no-panchagavya application (1.21 g).

At harvest

Application of jeevamrutha at 2000 litres ha⁻¹ recorded significantly higher dry matter accumulation in roots (1.67 g) followed by jeevamrutha at 1500 litre ha⁻¹ (1.62 g), jeevamrutha at 1000 litre ha⁻¹ (1.60 g) where jeevamrutha at 1500 litre ha⁻¹ on par with jeevamrutha at 1000 litre ha⁻¹ and significantly lower dry matter in roots was recorded with no-jeevamrutha (1.43 g). Panchagavya spray influenced significantly on root dry matter per plant. Panchagavya at 6 per cent recorded significantly higher dry matter in roots (1.64 g) followed by panchagavya at 3 per cent (1.58 g) and it was lower with no-panchagavya application (1.52 g).

Table 54: Root weight of frenchbean at different growth stages as influenced by application of liquid manures during *Kharif* 2014

Jeevamrutha Levels	Root weight (g plant ⁻¹)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	0.29	0.30	0.30	0.30	1.01	1.14	1.23	1.13	1.32	1.44	1.54	1.43
J₁	0.31	0.30	0.30	0.30	1.26	1.29	1.30	1.28	1.57	1.61	1.62	1.60
J₂	0.28	0.29	0.32	0.30	1.28	1.31	1.33	1.30	1.58	1.62	1.65	1.62
J₃	0.30	0.31	0.33	0.32	1.29	1.32	1.39	1.34	1.61	1.64	1.77	1.67
Mean	0.29	0.30	0.31		1.21	1.26	1.31		1.52	1.58	1.64	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.02		NS		0.02		0.05		0.02		0.05	
Panchagavya	0.01		NS		0.01		0.04		0.02		0.05	
J × P	0.03		NS		0.03		0.08		0.03		NS	

Note: J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, J₂ - Jeevamrutha 1500 litre/ha, J₃ - Jeevamrutha 2000 litre/ha

P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, P₃ - Panchagavya at 6 %, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 55: Root weight of frenchbean at different growth stages as influenced by application of liquid manures during *Kharif* 2015

Jeevamrutha Levels	Root weight (g plant ⁻¹)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	0.29	0.30	0.30	0.29	1.03	1.18	1.25	1.16	1.37	1.52	1.54	1.48
J₁	0.32	0.31	0.32	0.32	1.26	1.31	1.32	1.30	1.53	1.60	1.63	1.59
J₂	0.31	0.31	0.32	0.32	1.29	1.32	1.35	1.32	1.56	1.68	1.75	1.67
J₃	0.31	0.33	0.35	0.33	1.28	1.34	1.42	1.35	1.75	1.80	1.86	1.80
Mean	0.31	0.31	0.32		1.22	1.29	1.33		1.55	1.65	1.70	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.02		NS		0.02		0.05		0.02		0.07	
Panchagavya	0.02		NS		0.02		0.05		0.02		0.06	
J × P	0.03		NS		0.03		NS		0.04		NS	

Note: **J₀** - Without Jeevamrutha, **J₁**- Jeevamrutha 1000 litre/ha, **J₂**- Jeevamrutha 1500 litre/ha, **J₃**- Jeevamrutha 2000 litre/ha
P₀- Without panchagavya, **P₁**- Panchagavya at 3 %, **P₃**- Panchagavya at 6 %, **DAS** – Days After Sowing, **RDF** – 63:100:75 NPK kg ha⁻¹

Table 56: Root weight of frenchbean at different growth stages as influenced by application of liquid manures (Pooled 2014 and 2015)

Jeevamrutha Levels	Root weight (g plant ⁻¹)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	0.29	0.30	0.30	0.30	1.02	1.16	1.24	1.14	1.34	1.48	1.54	1.46
J₁	0.31	0.31	0.31	0.31	1.26	1.30	1.31	1.29	1.55	1.60	1.62	1.59
J₂	0.29	0.30	0.32	0.31	1.28	1.32	1.34	1.31	1.57	1.65	1.70	1.64
J₃	0.31	0.32	0.34	0.32	1.29	1.33	1.41	1.34	1.68	1.72	1.82	1.74
Mean	0.30	0.31	0.32		1.21	1.28	1.32		1.54	1.62	1.67	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.01		NS		0.01		0.03		0.02		0.05	
Panchagavya	0.01		NS		0.01		0.02		0.01		0.04	
J × P	0.02		NS		0.02		0.05		0.03		NS	

Note: **J₀** - Without Jeevamrutha, **J₁**- Jeevamrutha 1000 litre/ha, **J₂** - Jeevamrutha 1500 litre/ha, **J₃** - Jeevamrutha 2000 litre/ha
P₀ - Without panchagavya, **P₁** - Panchagavya at 3 %, **P₃** - Panchagavya at 6 %, **DAS** – Days After Sowing, **RDF** – 63:100:75 NPK kg ha⁻¹

Experiment conducted during *kharif* 2015

20 Days after sowing

Dry matter accumulation in roots per plant did not differ significantly due to the application of jeevamrutha and panchagavya. However, application of higher levels of jeevamrutha (2000 litres ha⁻¹) and panchagavya (6 %) recorded higher dry matter accumulation in root.

40 Days after sowing

Application of jeevamrutha at 2000 litres ha⁻¹ recorded significantly higher dry matter accumulation in roots (1.35 g) followed by jeevamrutha at 1500 litres ha⁻¹ (1.32 g), jeevamrutha at 1000 litres ha⁻¹ (1.30 g) where jeevamrutha at 2000 litres ha⁻¹ on par with jeevamrutha at 1500 litres ha⁻¹ and significantly lower dry matter in roots was recorded with no-jeevamrutha (1.16 g). Panchagavya spray influenced significantly on root dry matter per plant. Panchagavya at 6 per cent recorded significantly higher dry matter in roots (1.33 g) followed by panchagavya at 3 per cent (1.29 g) and it was lower with no-panchagavya application (1.22 g).

At harvest

Application of jeevamrutha at 2000 litres ha⁻¹ recorded significantly higher dry matter accumulation in roots (1.80 g) followed by jeevamrutha at 1500 litres ha⁻¹ (1.67 g), jeevamrutha at 1000 litres ha⁻¹ (1.59 g) where jeevamrutha at 1500 litres ha⁻¹ on par with jeevamrutha at 1000 litres ha⁻¹ and significantly lower dry matter in roots was recorded with no-jeevamrutha (1.48 g). Panchagavya spray influenced significantly on root dry matter per plant. Panchagavya at 6 per cent recorded significantly higher dry matter in roots (1.70 g) followed by panchagavya at 3 per cent (1.65 g) and it was lower with no-panchagavya application (1.55 g).

Interaction effect

Dry matter accumulation in root per plant did not differ significantly due to the interaction between various levels of jeevamrutha and panchagavya application at all the stages of crop during both the years.

Pooled

The root dry matter per plant varied significantly due to the application of jeevamrutha and panchagavya. At 40 DAS and harvest application of jeevamrutha at 2000 litres ha⁻¹ recorded significantly higher dry matter accumulation in roots (1.34 and 1.74 g) followed by jeevamrutha at 1500 litres ha⁻¹ (1.31 and 1.64 g), jeevamrutha at 1000 litre ha⁻¹ (1.29 and 1.59 g) where jeevamrutha at 1500 litres ha⁻¹ on par with jeevamrutha at 1000 litre ha⁻¹ and significantly lower dry matter in roots was recorded with no-jeevamrutha (1.14 and 1.46 g). Panchagavya at 6 per cent recorded significantly higher dry matter in roots (1.32 and 1.67 g) followed by panchagavya at 3 per cent (1.28 and 1.62 g) and it was lower with no-panchagavya application (1.21 and 1.54 g).

At 40 DAS dry matter in roots per plant differs significantly due to the interaction between various levels of jeevamrutha and panchagavya application. Significantly higher dry matter accumulation in roots was noticed in jeevamrutha at 2000 litre ha⁻¹ and panchagavya at 6 per cent (1.41 g) as compared to other treatments and it was lower with no - jeevamrutha and no-panchagavya application (1.02 g). At harvest dry matter accumulation in roots per plant did not differ significantly due to the interaction between various levels of jeevamrutha and panchagavya application.

Dry matter accumulation in pods (g plant⁻¹)

Dry matter accumulation in pods differed significantly due to different levels of jeevamrutha and panchagavya applications at harvest are presented in Table 57.

Experiment conducted during *kharif* 2014

At harvest jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher dry matter accumulation in pods (7.48 g) followed by jeevamrutha at 1500 litre ha⁻¹ (6.66 g), jeevamrutha at 1000 litre ha⁻¹ (6.33 g) and significantly lower dry matter accumulation in pods was recorded with no-jeevamrutha application (5.48 g). Panchagavya at 6 per cent recorded significantly higher dry matter accumulation in pods (7.06 g) followed by panchagavya at 3 per cent (6.57 g) and it was lower with no-panchagavya application (5.84 g).

Dry matter accumulation in pods differed significantly due to the interaction between various levels of jeevamrutha and panchagavya application. Significantly higher dry matter accumulation in pods was observed with jeevamrutha at 2000 litre ha⁻¹ and panchagavya at 6 per cent (7.88 g) which was on par with jeevamrutha at 2000 litre ha⁻¹ and panchagavya at 3 per cent, jeevamrutha at 1500 litre ha⁻¹ and panchagavya at 6 per cent and it was lower with no - jeevamrutha and no-panchagavya application (5.03 g).

Experiment conducted during *kharif* 2015

At harvest jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher dry matter accumulation in pods (8.12 g) followed by jeevamrutha at 1500 litre ha⁻¹ (7.36 g), jeevamrutha at 1000 litre ha⁻¹ (6.91 g) and significantly lower dry matter accumulation in pods was recorded with no-jeevamrutha application (6.56 g). Panchagavya at 6 per cent recorded significantly higher dry matter accumulation in pods (7.98 g) followed by panchagavya at 3 per cent (7.30 g) and it was lower with no-panchagavya application (6.43 g).

Dry matter accumulation in pods did not differ significantly due to the interaction between jeevamrutha and Panchagavya application.

Pooled

At harvest jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher dry matter accumulation in pods (7.80 g) followed by jeevamrutha at 1500 litre ha⁻¹ (7.01 g), jeevamrutha at 1000 litre ha⁻¹ (6.62 g) and significantly lower dry matter accumulation in pods was recorded with no-jeevamrutha application (6.02 g). Panchagavya at 6 per cent

Table 57: Effect of liquid manures application on dry weight of pods per plant frenchbean during Kharif 2015

Jeevamrutha Levels	Dry weight of pods (g plant ⁻¹)											
	2014				2015				Pooled			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	5.03	5.66	5.75	5.48	5.93	6.74	7.00	6.56	5.48	6.20	6.38	6.02
J₁	5.41	6.50	7.08	6.33	5.73	7.08	7.94	6.91	5.57	6.79	7.51	6.62
J₂	5.79	6.69	7.51	6.66	6.41	7.31	8.36	7.36	6.10	7.00	7.93	7.01
J₃	7.12	7.44	7.88	7.48	7.65	8.09	8.61	8.12	7.38	7.77	8.25	7.80
Mean	5.84	6.57	7.06		6.43	7.30	7.98		6.13	6.94	7.52	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.10		0.30		0.13		0.38		0.11		0.32	
Panchagavya	0.09		0.26		0.11		0.33		0.10		0.28	
J × P	0.18		0.53		0.23		NS		0.19		0.56	

Note: **J₀** - Without Jeevamrutha, **J₁** - Jeevamrutha 1000 litre/ha, **J₂** - Jeevamrutha 1500 litre/ha, **J₃** - Jeevamrutha 2000 litre/ha
P₀ - Without panchagavya, **P₁** - Panchagavya at 3 %, **P₂** - Panchagavya at 6 %, **DAS** – Days After Sowing, **RDF** – 63:100:75 NPK kg ha⁻¹

recorded significantly higher dry matter accumulation in pods (7.52 g) followed by panchagavya at 3 per cent (6.94 g) and it was lower with no-panchagavya application (6.13 g).

Dry matter accumulation in pods differed significantly due to the interaction between various levels of jeevamrutha and panchagavya application. Significantly higher dry matter accumulation in pods was observed with jeevamrutha at 2000 litre ha⁻¹ and panchagavya at 6 per cent (8.25 g) which was on par with jeevamrutha at 2000 litre ha⁻¹ and panchagavya at 3 per cent, jeevamrutha at 1500 litre ha⁻¹ and panchagavya at 6 per cent and it was lower with no - jeevamrutha and no-panchagavya application (5.48 g).

4.2.8 Total dry matter production (g/plant)

Total dry matter production in plant varied significantly due to different treatment applications at 40 DAS and harvest except 20 DAS are presented in Tables 58, 59 and 60.

Experiment conducted during *kharif* 2014

20 Days after sowing

Total dry matter production per plant did not vary significantly due application of jeevamrutha and panchagavya. However, application of higher levels of jeevamrutha (2000 litres ha⁻¹) and panchagavya (6 %) recorded higher total dry matter production per plant.

40 Days after sowing

Total dry matter per plant varied significantly due to the application of jeevamrutha. Jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher total dry matter production (13.09 g) followed by jeevamrutha at 1500 litre ha⁻¹ (12.03 g), jeevamrutha at 1000 litre ha⁻¹ (11.69 g), where application jeevamrutha at 1500 litre ha⁻¹ found on par with jeevamrutha at 1000 litre ha⁻¹ application and significantly lower total dry matter production was recorded with no-jeevamrutha application (10.08 g). Total dry matter per plant varied significantly due to the application of jeevamrutha. Panchagavya at 6 per cent recorded significantly higher total dry matter production (12.52 g) followed by panchagavya at 3 per cent (11.85 g) application and it was lower with no-panchagavya application (10.79 g).

At harvest

Application of jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher total dry matter production (21.98 g) followed by jeevamrutha at 1500 litre ha⁻¹ (19.64 g), jeevamrutha at 1000 litre ha⁻¹ (18.85 g) and significantly lower total dry matter production was recorded with no-jeevamrutha application (16.84 g). Total dry matter per plant varied significantly due to the application of jeevamrutha. Panchagavya at 6 per cent recorded significantly higher total dry matter production (20.82 g) followed by panchagavya at 3 per cent (19.47 g) application and it was lower with no-panchagavya application (17.69 g).

Table 58: Total dry matter of frenchbean at different growth stages as influenced by application of liquid manures during Kharif 2014

Jeevamrutha Levels	Total dry matter (g plant ⁻¹)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	2.75	2.81	2.99	2.85	8.94	10.43	10.87	10.08	15.08	17.32	18.13	16.84
J₁	2.78	2.88	3.08	2.92	10.78	11.64	12.66	11.69	17.12	18.94	20.51	18.85
J₂	2.72	3.13	3.16	3.00	10.95	12.06	13.07	12.03	17.68	19.90	21.33	19.64
J₃	3.14	3.18	3.17	3.16	12.48	13.28	13.49	13.09	20.89	21.72	23.32	21.98
Mean	2.85	3.00	3.10		10.79	11.85	12.52		17.69	19.47	20.82	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.10		NS		0.18		0.52		0.22		0.65	
Panchagavya	0.09		NS		0.15		0.45		0.19		0.56	
J × P	0.18		NS		0.31		NS		0.38		NS	

Note: J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, J₂ - Jeevamrutha 1500 litre/ha, J₃ - Jeevamrutha 2000 litre/ha

P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, P₃ - Panchagavya at 6 %, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 59: Total dry matter of frenchbean at different growth stages as influenced by application of liquid manures during Kharif 2015

Jeevamrutha Levels	Total dry matter (g plant ⁻¹)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	2.76	2.78	2.86	2.80	9.10	10.65	10.98	10.24	16.32	18.84	19.95	18.37
J₁	2.83	2.94	3.03	2.93	10.99	12.30	12.79	12.03	17.88	20.11	21.47	19.82
J₂	2.99	3.16	3.18	3.11	10.71	12.81	13.25	12.26	18.71	21.39	23.12	21.07
J₃	3.11	3.23	3.27	3.20	12.59	13.30	14.39	13.42	21.92	22.91	25.03	23.29
Mean	2.92	3.03	3.08		10.85	12.27	12.85		18.71	20.81	22.39	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.09		NS		0.17		0.50		0.26		0.78	
Panchagavya	0.08		NS		0.15		0.43		0.23		0.67	
J × P	0.16		NS		0.29		NS		0.46		NS	

Note: J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, J₂ - Jeevamrutha 1500 litre/ha, J₃ - Jeevamrutha 2000 litre/ha

P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, P₂ - Panchagavya at 6 %, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 60: Total dry matter of frenchbean at different growth stages as influenced by application of liquid manures (Pooled 2014 and 2015)

Jeevamrutha Levels	Total dry matter (g plant ⁻¹)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	2.76	2.80	2.92	2.83	9.02	10.54	10.92	10.16	15.70	18.08	19.04	17.61
J₁	2.81	2.91	3.06	2.92	10.89	11.97	12.73	11.86	17.50	19.52	20.99	19.34
J₂	2.85	3.14	3.17	3.06	10.83	12.44	13.16	12.14	18.20	20.65	22.22	20.36
J₃	3.13	3.21	3.22	3.18	12.53	13.29	13.94	13.25	21.41	22.32	24.18	22.63
Mean	2.89	3.01	3.09		10.82	12.06	12.69		18.20	20.14	21.61	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.07		NS		0.11		0.32		0.18		0.53	
Panchagavya	0.06		NS		0.10		0.28		0.16		0.46	
J × P	0.13		NS		0.19		NS		0.31		NS	

Note: J₀ - Without Jeevamrutha, J₁- Jeevamrutha 1000 litre/ha, J₂- Jeevamrutha 1500 litre/ha, J₃- Jeevamrutha 2000 litre/ha

P₀- Without panchagavya, P₁- Panchagavya at 3 %, P₃- Panchagavya at 6 %, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Experiment conducted during *kharif* 2015

20 Days after sowing

Total dry matter production per plant did not differ significantly due application of jeevamrutha and panchagavya. However, application of higher levels of jeevamrutha (2000 litres ha⁻¹) and panchagavya (6 %) recorded higher total dry matter production per plant.

40 Days after sowing

Total dry matter per plant varied significantly due to the application of jeevamrutha. Jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher total dry matter production (13.42 g) followed by jeevamrutha at 1500 litre ha⁻¹ (12.26 g), jeevamrutha at 1000 litre ha⁻¹ (12.03 g), where application jeevamrutha at 1500 litre ha⁻¹ found on par with jeevamrutha at 1000 litre ha⁻¹ application and significantly lower total dry matter production was recorded with no-jeevamrutha application (10.24 g). Total dry matter per plant varied significantly due to the application of jeevamrutha. Panchagavya at 6 per cent recorded significantly higher total dry matter production (12.85 g) followed by panchagavya at 3 per cent (12.27 g) application and it was lower with no-panchagavya application (10.85 g).

At harvest

Application of jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher total dry matter production (23.29 g) followed by jeevamrutha at 1500 litre ha⁻¹ (21.07 g), jeevamrutha at 1000 litre ha⁻¹ (19.82 g) and significantly lower total dry matter production was recorded with no-jeevamrutha application (18.37 g). Total dry matter per plant varied significantly due to the application of jeevamrutha. Panchagavya at 6 per cent recorded significantly higher total dry matter production (22.39 g) followed by panchagavya at 3 per cent (20.81 g) application and it was lower with no-panchagavya application (18.71 g).

Interaction effect

Total dry matter production per plant did not differ significantly due to the interaction between various levels of jeevamrutha and panchagavya application at all the stages of crop during both the years.

Pooled

The total dry matter production differ DAS significantly, among treatments at all stages except at 20 DAS (Table 60). At 40 jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher total dry matter production (13.25 g) followed by jeevamrutha at 1500 litre ha⁻¹ (12.14 g), jeevamrutha at 1000 litre ha⁻¹ (11.86 g), where application jeevamrutha at 1500 litre ha⁻¹ found on par with jeevamrutha at 1000 litre ha⁻¹ application and significantly lower total dry matter production was recorded with no-jeevamrutha application (10.16 g).

At harvest jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher total dry matter production (22.63 g) followed by jeevamrutha at 1500 litre ha⁻¹ (20.36 g), jeevamrutha at 1000 litre ha⁻¹ (19.34 g) and significantly lower total dry matter production was recorded with no-jeevamrutha application (17.61 g).

At 40 DAS and at harvest panchagavya at 6 per cent recorded significantly higher total dry matter production (12.69 and 21.61 g) followed by panchagavya at 3 per cent (12.06 and 20.14 g) application and it was lower with no-panchagavya application (10.82 and 18.20 g).

Total dry matter accumulation per plant did not differ significantly due to the interaction between various levels of jeevamrutha and panchagavya application at 40 DAS and harvest.

Days to 50 per cent flowering

The data pertaining to 50 per cent flowering are presented in the Table 60a.

Experiment conducted during *kharif* 2014

Jeevamrutha at 2000 litre ha⁻¹ recorded significantly early flowering (30.1 days) followed by jeevamrutha at 1500 litre ha⁻¹ (31.1 days), jeevamrutha at 1000 litre ha⁻¹ (31.2 days), where jeevamrutha at 1500 litre ha⁻¹ was on par with jeevamrutha at 1000 litre ha⁻¹ and significantly delayed flowering was noticed in without jeevamrutha application (32.1 days). Panchagavya at 6 per cent application recorded significantly early flowering (30.4 days) followed by panchagavya at 3 per cent application (31.2 days) as compared to without panchagavya application (31.8 days).

Experiment conducted during *kharif* 2015

Jeevamrutha at 2000 litre ha⁻¹ recorded significantly early flowering (29.9 days) followed by jeevamrutha at 1500 litre ha⁻¹ (30.5 days), jeevamrutha at 1000 litre ha⁻¹ (31.3 days), where jeevamrutha at 1500 litre ha⁻¹ was on par with jeevamrutha at 1000 litre ha⁻¹ and significantly delayed flowering was noticed in without jeevamrutha application (32.3 days). Panchagavya at 6 per cent application recorded significantly early flowering (30.3 days) followed by panchagavya at 3 per cent application (31.0 days) as compared to without panchagavya application (31.8 days).

Interaction effect

Flowering (50 %) did not differ significantly due to the interaction between various levels of jeevamrutha and panchagavya application.

Pooled

Jeevamrutha at 2000 litre ha⁻¹ recorded significantly early flowering (30.0 days) followed by jeevamrutha at 1500 litre ha⁻¹ (30.83 days), jeevamrutha at 1000 litre ha⁻¹ (31.28 days), where jeevamrutha at 1500 litre ha⁻¹ was on par with jeevamrutha at 1000 litre ha⁻¹ and significantly delayed flowering was noticed in without jeevamrutha application (32.22 days) .

Table 60a: Fifty per cent flowering of frenchbean during 2014, 2015 and pooled data as influenced by jeevamrutha and panchagavya application

Jeevamrutha Levels	2014				2015				Pooled			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	33.33	31.67	31.33	32.11	33.33	32.00	31.67	32.33	33.33	31.83	31.50	32.22
J₁	31.67	31.33	30.67	31.22	31.67	31.33	31.00	31.33	31.67	31.33	30.83	31.28
J₂	31.67	31.33	30.33	31.11	31.33	30.67	29.67	30.56	31.50	31.00	30.00	30.83
J₃	30.67	30.33	29.33	30.11	30.67	30.00	29.00	29.89	30.67	30.17	29.17	30.00
Mean	31.83	31.17	30.42		31.75	31.00	30.33		31.79	31.08	30.38	
	S.Em ±		CD at 5%		S.Em ±	CD at 5%			S.Em ±		CD at 5%	
Jeevamrutha	0.24		0.71		0.28	0.82			0.20		0.58	
Panchagavya	0.21		0.62		0.24	0.71			0.17		0.50	
J × P	0.42		NS		0.49	NS			0.34		NS	

Note: **J₀** - Without Jeevamrutha, **J₁** - Jeevamrutha 1000 litre/ha, **J₂** - Jeevamrutha 1500 litre/ha, **J₃** - Jeevamrutha 2000 litre/ha
P₀ - Without panchagavya, **P₁** - Panchagavya at 3 %, **P₂** - Panchagavya at 6 %, **DAS** – Days After Sowing, **RDF** – 63:100:75 NPK kg ha⁻¹

Panchagavya at 6 per cent application recorded significantly early flowering (30.38 days) followed by panchagavya at 3 per cent application (31.08 days) as compared to without panchagavya application (31.79 days).

Fifty per cent flowering in frenchbean did not differ significantly due to the interaction between various levels of jeevamrutha and panchagavya application.

EXPERIMENT I: Effect of different levels of FYM, jeevamrutha and panchagavya on yield and yield components

4.3.1 Number of pods per plant

Number of pods per plant differed significantly due to solid and liquid manure application and their interaction at harvest are presented in Tables 61, 62 and 63.

Experiment conducted during *kharif* 2014

Number of pods per plant significantly influenced by the application of FYM, jeevamrutha and panchagavya. Higher number of pods per plant was observed with FYM at 200 per cent N equivalent (15.3) and it was on par with FYM at 150 percent N equivalent (14.7). Whereas lower number of pods plant⁻¹ was observed with FYM at 100 per cent N equivalent (13.6). Panchagavya and jeevamrutha application influenced significantly on number of pods per plant. More number of pods per plant were observed in jeevamrutha at 1000 L ha⁻¹ (15.9), panchagavya at 3 per cent (15.4) and lower number of pods per plant were observed in without jeevamrutha and without panchagavya application (13.2 and 13.7).

Experiment conducted during *kharif* 2015

Significantly higher number of pods per plant were observed with FYM at 200 per cent N equivalent (17.35) and it was on par with FYM at 150 percent N equivalent (16.50). Whereas lower number of pods plant⁻¹ were observed with FYM at 100 per cent N equivalent (14.95). Panchagavya and jeevamrutha application influenced significantly on number of pods per plant. More number of pods per plant were observed in jeevamrutha at 1000 litre ha⁻¹ (17.76), panchagavya at 3 per cent (17.23) and lower number of pods per plant were observed in without jeevamrutha and without panchagavya application (14.77 and 15.30).

Interaction effect

Number of pods per plant did not differ significantly due to the interaction effect of FYM and jeevamrutha, FYM and panchagavya, jeevamrutha and panchagavya, FYM, jeevamrutha and panchagavya during both the years.

Pooled

There were significant differences among varied levels of FYM, jeevamrutha and panchagavya with respect to number of pods per plant at harvest (Table 63). Significantly higher number of pods (16.34) were recorded with FYM at 200 per cent N equivalent and it was on par with FYM at 150 percent N equivalent (15.60) whereas lower number of

Table 61: Yield parameters of frenchbean as influenced by FYM and liquid manures application during Kharif 2014

Treatments	At Harvest								
	Number of pods plant ⁻¹			Green pod weight plant ⁻¹ (g)			Pod length (cm)		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	11.90	15.30	13.6	60.76	78.97	69.86	13.90	14.60	14.30
F ₂	13.40	16.00	14.7	68.73	81.59	75.16	14.70	15.40	15.00
F ₃	14.20	16.40	15.3	72.41	84.48	78.45	15.10	15.60	15.40
Mean	13.20	15.90		67.30	81.68		14.60	15.20	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.35	1.04		1.39	4.09		0.18	0.53	
J	0.29	0.85		1.14	3.34		0.15	0.43	
F × J	0.50	NS		1.97	5.78		0.25	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	12.40	14.70	13.6	63.49	76.24	69.86	14.00	14.50	14.30
F ₂	14.10	15.30	14.7	71.58	78.74	75.16	14.60	15.50	15.00
F ₃	14.50	16.20	15.3	73.61	83.29	78.45	15.10	15.60	15.40
Mean	13.70	15.40		69.56	79.42		14.60	15.20	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.29	0.85		1.14	3.34		0.15	0.43	
F × P	0.50	NS		1.97	NS		0.25	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	12.20	14.10	13.2	62.19	72.41	67.30	14.20	14.90	14.60
J ₁	15.10	16.70	15.9	76.92	86.44	81.68	14.90	15.40	15.20
Mean	13.70	15.40		69.56	79.42		14.60	15.20	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.41	NS		1.61	NS		0.21	NS	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁	J ₀	10.30	13.40	52.91	68.61	13.80	14.00		
	J ₁	14.50	16.10	74.07	83.87	14.20	15.00		
F ₂	J ₀	13.10	13.80	66.67	70.79	14.00	15.30		
	J ₁	15.20	16.70	76.49	86.69	15.20	15.60		
F ₃	J ₀	13.30	15.20	67.00	77.82	14.80	15.40		
	J ₁	15.70	17.20	80.21	88.75	15.40	15.70		
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.	S.Em ±	C.D.		
	0.71	NS		2.79	NS	0.36	NS		

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 62: Yield parameters of frenchbean as influenced by FYM and liquid manures application during Kharif 2015

Treatments	At Harvest								
	Number of pods plant ⁻¹			Green pod weight plant ⁻¹ (g)			Pod length (cm)		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	13.09	16.80	14.95	67.93	87.48	77.71	14.46	15.23	14.85
F ₂	15.12	17.87	16.50	76.90	92.05	84.47	15.85	16.63	16.24
F ₃	16.09	18.61	17.35	86.48	100.86	93.67	16.78	17.35	17.06
Mean	14.77	17.76		77.10	93.46		15.70	16.40	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.36	1.06		2.00	5.88		0.11	0.34	
J	0.30	0.87		1.64	4.80		0.09	0.27	
F × J	0.51	1.50		2.84	NS		0.16	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	13.65	16.24	14.95	70.76	84.66	77.71	14.62	15.07	14.85
F ₂	15.84	17.16	16.50	80.75	88.20	84.47	15.77	16.71	16.24
F ₃	16.42	18.29	17.35	88.01	99.33	93.67	16.77	17.35	17.06
Mean	15.30	17.23		79.84	90.73		15.72	16.38	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.30	0.87		1.64	4.80		0.09	0.27	
F × P	0.51	1.50		2.84	NS		0.16	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	13.72	15.82	14.77	71.49	82.72	77.10	15.31	16.08	15.70
J ₁	16.88	18.64	17.76	88.19	98.74	93.46	16.13	16.68	16.40
Mean	15.30	17.23		79.84	90.73		15.72	16.38	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.42	NS		2.31	NS		0.13	NS	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁	J ₀	11.41	14.77	59.80	76.06	14.39	14.53		
	J ₁	15.89	17.71	81.71	93.26	14.85	15.61		
F ₂	J ₀	14.69	15.55	74.52	79.28	15.14	16.56		
	J ₁	16.98	18.76	86.97	97.12	16.40	16.87		
F ₃	J ₀	15.05	17.14	80.14	92.82	16.40	17.15		
	J ₁	17.78	19.44	95.88	105.84	17.15	17.55		
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.	S.Em ±	C.D.		
	0.72	NS		4.01	NS	0.23	NS		

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS - Days After Sowing, RDF - 63:100:75 NPK kg ha⁻¹

Table 63: Yield parameters of frenchbean as influenced by FYM and liquid manures application (Pooled 2014 and 2015)

Treatments	At Harvest								
	Number of pods plant ⁻¹			Green pod weight plant ⁻¹ (g)			Pod length (cm)		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	12.48	16.03	14.26	64.34	83.23	73.78	14.19	14.91	14.55
F ₂	14.28	16.92	15.60	72.82	86.82	79.82	15.25	16.02	15.63
F ₃	15.16	17.52	16.34	79.45	92.67	86.06	15.95	16.46	16.21
Mean	13.97	16.82		72.20	87.57		15.13	15.80	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.36	1.04		1.68	4.92		0.12	0.35	
J	0.29	0.85		1.37	4.02		0.10	0.28	
F × J	0.50	NS		2.37	NS		0.17	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	13.03	15.49	14.26	67.12	80.45	73.78	14.33	14.78	14.55
F ₂	14.98	16.21	15.60	76.17	83.47	79.82	15.18	16.08	15.63
F ₃	15.44	17.24	16.34	80.81	91.31	86.06	15.95	16.47	16.21
Mean	14.48	16.31		74.70	85.08		15.15	15.78	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.29	0.85		1.37	4.02		0.10	0.28	
F × P	0.50	NS		2.37	NS		0.17	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	12.97	14.98	13.97	66.84	77.56	72.20	14.77	15.50	15.13
J ₁	16.00	17.65	16.82	82.56	92.59	87.57	15.54	16.06	15.80
Mean	14.48	16.31		74.70	85.08		15.15	15.78	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.41	NS		1.94	NS		0.14	NS	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁	J ₀	10.87	14.09		56.35	72.33		14.11	14.27
	J ₁	15.18	16.89		77.89	88.56		14.54	15.29
F ₂	J ₀	13.88	14.68		70.60	75.04		14.57	15.93
	J ₁	10.09	17.75		81.73	91.90		15.80	16.23
F ₃	J ₀	14.16	16.17		73.57	85.32		15.62	16.29
	J ₁	16.73	18.32		88.05	97.29		6.27	16.64
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	0.71	NS		3.36	NS		0.24	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Pods plant⁻¹ were observed with FYM at 100 per cent N equivalent (14.26). Significantly higher number of pods were recorded with jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent (16.82 and 16.31) as compared to without jeevamrutha and without panchagavya application (13.97 and 14.48). Pod number of pods did not differ significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application.

4.3.2 Green pod weight (g plant⁻¹)

Green pod weight per plant as influenced by application of solid and organic liquid manures is presented in Tables 61, 62 and 63.

Experiment conducted during *kharif* 2014

Significant difference in green pod weight per plant was noticed due to the application of FYM. Higher green pod weight per plant was observed with FYM at 200 per cent N equivalent (78.45 g) and it was on par with FYM at 150 per cent N equivalent (75.16 g) and lower was in FYM at 100 per cent N equivalent (69.86). There was significant difference with application of jeevamrutha and panchagavya on green pod weight per plant. Higher green pod weight per plant was observed with application of jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent (81.68 and 79.42 g) as compared to without jeevamrutha and without panchagavya application (67.30 and 69.56 g).

Experiment conducted during *kharif* 2015

Significantly higher green pod weight per plant was observed with FYM at 200 per cent N equivalent (93.67 g) and it was on par with FYM at 150 per cent N equivalent (84.47 g) and lower was in FYM at 100 per cent N equivalent (77.71 g). There was significant difference with application of jeevamrutha and panchagavya on green pod weight per plant. Higher green pod weight per plant was observed with application of jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent (93.46 and 90.73 g) as compared to without jeevamrutha and without panchagavya application (77.10 and 79.84 g).

Interaction effect

Green pod weight did not differ significantly due to the interaction effect of FYM and jeevamrutha, FYM and panchagavya, jeevamrutha and panchagavya, FYM, jeevamrutha and panchagavya during both the years.

Pooled

The data presented on green pod weight per plant differed significantly due to various levels of FYM, jeevamrutha and panchagavya application (Table 25). Significantly higher green pod weight per plant was recorded with FYM at 200 per cent N equivalent (86.06 g) and it was on par with FYM at 150 per cent N equivalent (79.82 g) as compared to FYM at 100 per cent N equivalent (73.78 g). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent recorded significantly higher green pod weight per

plant (87.57 and 85.08 g, respectively) as compared to without jeevamrutha and without panchagavya application (72.20 and 74.70 g, respectively). Green pod weight per plant did not differ significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application.

4.3.3 Pod length (cm)

Pod length as influenced by different FYM levels, organic liquid formulations and their interaction effects are presented in Tables 61, 62 and 63.

Experiment conducted during *kharif* 2014

There were significant differences among the treatments with respect to length of the pods at harvest. Application of FYM at 200 per cent N equivalent significantly recorded higher pod length (15.4 cm) than FYM at 100 per cent N equivalent (14.3 cm), which was on par with FYM at 150 per cent N equivalent (15.0 cm). Application of jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent resulted in significantly higher pod length (15.2 and 15.2 cm, respectively) as compared to without jeevamrutha and without panchagavya application (14.6 and 14.6 cm).

Experiment conducted during *kharif* 2015

There were significant differences among the treatments with respect to length of the pods at harvest. Application of FYM at 200 per cent N equivalent significantly recorded higher pod length (17.06 cm) than FYM at 100 per cent N equivalent (14.85 cm), which was on par with FYM at 150 per cent N equivalent (16.24 cm). Application of jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent resulted in significantly higher pod length (16.40 and 16.38 cm, respectively) as compared to without jeevamrutha and without panchagavya application (15.70 and 15.72 cm).

Interaction effect

Pod length did not differ significantly due to the interaction between various levels of FYM and jeevamrutha, FYM and panchagavya, jeevamrutha and panchagavya, FYM, jeevamrutha and panchagavya during both the years.

Pooled

There were significant differences among the treatments with respect to length of the pods at harvest (Table 63). Application of FYM at 200 per cent N equivalent significantly recorded higher pod length (16.21 cm) than FYM at 100 per cent N equivalent (14.55 cm), which was on par with FYM at 150 per cent N equivalent (15.63 cm). Application of jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent resulted in significantly higher pod length (15.80 and 15.78 cm) as compared to without jeevamrutha and without panchagavya application (15.13 and 15.15 cm). Pod length did not differ significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application.

4.4 Effect of different levels of FYM, jeevamrutha and panchagavya on pod yield, haulm yield of frenchbean

The data pertaining to the effect of solid and liquid manure on pod and haulm yield (q ha^{-1}) of frenchbean are presented in the Tables 64 and 65.

4.4.1 Green pod yield (q ha^{-1})

The pod yield varied significantly due to the application of FYM, jeevamrutha and panchagavya (Table 64).

Experiment conducted during *kharif* 2014

Green pod yield differed significantly due to the application of solid and liquid manures. Higher pod yield was observed with 200 per cent N equivalent through FYM (135.2 q ha^{-1}) as compared to 100 per cent N equivalent (120.3 q ha^{-1}) and it was found on par with 150 per cent N equivalent FYM application (132.5 q ha^{-1}). Soil application of jeevamrutha and foliar spray of panchagavya recorded significantly higher pod yield (141.7 and 138.7 q ha^{-1}) as compared to without application of jeevamrutha and panchagavya (117.0 and 120.0 q ha^{-1}).

Experiment conducted during *kharif* 2015

Green pod yield differed significantly due to the application of solid and liquid manures. Significantly higher pod yield was observed with 200 per cent N equivalent through FYM (168.5 q ha^{-1}) as compared to 100 per cent N equivalent (134.4 q ha^{-1}) and it was found on par with 150 per cent N equivalent FYM application (158.8 q ha^{-1}). Soil application of jeevamrutha and foliar spray of panchagavya recorded significantly higher pod yield (168.3 and 164.7 q ha^{-1}) as compared to without application of jeevamrutha and panchagavya (139.5 and 143.1 q ha^{-1}).

Interaction effect

Green pod yield of frenchbean did not differ significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application during both the years. However, application of FYM at 200 per cent N equivalent jeevamrutha at $1000 \text{ litre ha}^{-1}$ and panchagavya at 3 per cent recorded higher green pod yield (189.3 q ha^{-1}) of frenchbean as compared to other treatments and it was lower with FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya application (90.1 q ha^{-1}).

Pooled

Higher level of nitrogen *i.e.*, 200 per cent N equivalent through FYM recorded significantly higher frenchbean yield (151.9 q ha^{-1}) as compared to 100 % N equivalent (127.4 q ha^{-1}) and it was found on par with 150 % N equivalent FYM application (145.7 q ha^{-1}). Soil application of jeevamrutha and foliar spray of panchagavya recorded significantly higher pod yield (155.0 and 151.7 q ha^{-1}) as compared to without application of jeevamrutha and panchagavya (128.3 and 131.6 q ha^{-1}).

Table 64: Green pod yield of frenchbean during 2014, 2015 and pooled data as influenced by FYM and liquid manures application

Treatments	Green pod yield (q ha ⁻¹)								
	2014			2015			Pooled		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	102.5	138.2	120.3	114.8	154.0	134.4	108.7	146.1	127.4
F ₂	123.2	141.9	132.5	147.5	170.2	158.8	135.3	156.0	145.7
F ₃	125.3	145.0	135.2	156.2	180.9	168.5	140.8	162.9	151.9
Mean	117.0	141.7		139.5	168.3		128.3	155.0	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	2.57	7.52		3.41	10.0		2.36	6.92	
J	2.09	6.14		2.78	8.16		1.93	5.65	
F × J	3.63	NS		4.82	NS		3.33	9.78	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	105.7	135.0	120.3	118.4	150.4	134.4	112.1	142.7	127.4
F ₂	125.9	139.2	132.5	150.8	166.8	158.8	138.4	153.0	145.7
F ₃	128.5	141.8	135.2	160.2	176.9	168.5	144.3	159.4	151.9
Mean	120.0	138.7		143.1	164.7		131.6	151.7	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	2.09	6.14		2.78	8.16		1.93	5.65	
F × P	3.63	NS		4.82	NS		3.33	9.78	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	104.9	129.1	117.0	125.8	153.2	139.5	115.3	141.2	128.3
J ₁	135.2	148.2	141.7	160.5	176.2	168.3	147.8	162.2	155.0
Mean	120.0	138.7		143.1	164.7		131.6	151.7	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	2.96	NS		3.94	NS		2.72	7.99	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁ J ₀	79.7	125.3		90.1	139.5		84.9	132.4	
F ₁ J ₁	131.7	144.7		146.8	161.2		139.2	153.0	
F ₂ J ₀	116.3	130.0		139.3	155.7		127.8	142.8	
F ₂ J ₁	135.5	148.3		162.3	178.0		148.9	163.2	
F ₃ J ₀	118.7	132.0		147.9	164.5		133.3	148.3	
F ₃ J ₁	138.3	151.7		172.4	189.3		155.4	170.5	
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	5.13	NS		6.82	NS		4.72	13.83	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Interaction effect between jeevamrutha (1000 litres ha⁻¹) and panchagavya (3 %) recorded significantly higher green pod yield (162.2 q ha⁻¹) as compared to other treatments. Significantly lower yield was recorded without jeevamrutha and without panchagavya applications (115.3 q ha⁻¹).

Interaction effect between 200 per cent N equivalent through FYM and jeevamrutha 1000 litre ha⁻¹ recorded significantly higher green pod yield (162.9 q ha⁻¹) and found on par with 150 % N equivalent through FYM with jeevamrutha 1000 litre ha⁻¹ (156.0 q ha⁻¹). Significantly lower yield was recorded with 100 per cent N equivalent through FYM and without jeevamrutha applications (108.70 q ha⁻¹).

Interaction effect between FYM at 200 per cent N equivalent and panchagavya (3 %) recorded significantly higher green pod yield (159.4 q ha⁻¹) and, which was on par with application of FYM at 150 % N equivalent with panchagavya at 3 per cent combination (153.0 q ha⁻¹). Significantly lower green pod yield was recorded with the combination of 100 per cent N equivalent through FYM and without panchagavya application (112.1 q ha⁻¹).

Interaction effect between FYM at 200 per cent N equivalent, jeevamrutha (1000 litres ha⁻¹) and panchagavya (3 %) recorded significantly higher green pod yield (170.5 q ha⁻¹) and, which was on par with application of jeevamrutha at 1000 litres/ha and panchagavya at 3 % combination with 150 per cent N equivalent through FYM (163.2 q ha⁻¹). Significantly lower green pod yield was recorded with the combination of 100 % N equivalent through FYM and without jeevamrutha and panchagavya application (84.9 q ha⁻¹).

4.4.2 Haulm yield (q ha⁻¹)

The haulm yield varied significantly due to the application of FYM, jeevamrutha and panchagavya application are presented in table 65.

Experiment conducted during *kharif* 2014

Application of FYM at 200 per cent N equivalent recorded significantly higher straw yield of frenchbean (30.5 q ha⁻¹) as compared to 100 per cent N equivalent (27.5 q ha⁻¹) and it was found on par with 150 % N equivalent FYM application (29.3 q ha⁻¹). Soil application of jeevamrutha and foliar spray of panchagavya recorded significantly higher straw yield (32.2 and 30.9 q ha⁻¹) as compared to without application of jeevamrutha and panchagavya (26.0 and 27.3 q ha⁻¹).

Experiment conducted during *kharif* 2015

Application of FYM at 200 per cent N equivalent recorded significantly higher straw yield of frenchbean (31.9 q ha⁻¹) as compared to 100 per cent N equivalent (28.8 q ha⁻¹) and it was found on par with 150 per cent N equivalent FYM application (30.5 q ha⁻¹). Soil application of jeevamrutha and foliar spray of panchagavya recorded significantly higher straw yield (33.4 and 32.3 q ha⁻¹) as compared to without application of jeevamrutha and panchagavya (27.4 and 28.4 q ha⁻¹).

Table 65: Haulm yield of frenchbean during 2014, 2015 and pooled data as influenced by FYM and liquid manures application

Treatments	Haulm yield (q ha ⁻¹)								
	2014			2015			Pooled		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	24.8	30.3	27.5	25.9	31.6	28.8	25.4	30.9	28.1
F ₂	26.1	32.4	29.3	27.6	33.4	30.5	26.9	32.9	29.9
F ₃	27.1	33.9	30.5	28.5	35.2	31.9	27.8	34.6	31.2
Mean	26.0	32.2		27.4	33.4		26.7	32.8	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.37	1.09		0.36	1.05		0.32	0.94	
J	0.30	0.89		0.29	0.86		0.26	0.76	
F × J	0.53	NS		0.51	NS		0.45	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	25.7	29.3	27.5	26.5	31.0	28.8	26.1	30.2	28.1
F ₂	27.3	31.2	29.3	28.8	32.1	30.5	28.1	31.7	29.9
F ₃	28.8	32.2	30.5	29.9	33.9	31.9	29.3	33.0	31.2
Mean	27.3	30.9		28.4	32.3		27.8	31.6	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.30	0.89		0.29	0.86		0.26	0.45	
F × P	0.53	NS		0.51	NS		0.45	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	24.6	27.4	26.0	25.7	29.0	27.4	25.2	28.2	26.7
J ₁	30.0	34.4	32.2	31.1	35.7	33.4	30.5	35.1	32.8
Mean	27.3	30.9		28.4	32.3		27.8	31.6	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.43	NS		0.41	NS		0.37	NS	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁	J ₀	23.1	26.5		23.8	28.1		23.4	27.3
	J ₁	28.4	32.1		29.2	33.9		28.8	33.0
F ₂	J ₀	25.2	27.1		26.3	28.9		25.7	28.0
	J ₁	29.5	35.3		31.3	35.4		30.4	35.4
F ₃	J ₀	25.6	28.6		27.0	30.1		26.3	29.3
	J ₁	32.0	35.8		32.7	37.7		32.4	36.8
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	0.74	NS		0.72	NS		0.64	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Interaction effect

Haulm yield of frenchbean did not differ significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application during both the years.

Pooled

Higher level of nitrogen *i.e.*, 200 per cent N equivalent through FYM recorded significantly higher straw yield of frenchbean (31.18 q/ha) as compared to 100 per cent N equivalent (28.14 q ha⁻¹) and it was found on par with 150 per cent N equivalent FYM application (29.87 q ha⁻¹). Soil application of jeevamrutha and foliar spray of panchagavya recorded significantly higher straw yield (32.79 and 31.63 q ha⁻¹) as compared to without application of jeevamrutha and panchagavya (26.68 and 27.84 q ha⁻¹).

Straw yield of frenchbean did not differ significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application. However, application of FYM at 200 per cent N equivalent jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent recorded higher straw yield of frenchbean (36.75 q ha⁻¹) as compared to other treatments and it was lower with FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya application (25.37 q ha⁻¹).

EXPERIMENT II: Effect of different levels of jeevamrutha and panchagavya on yield and yield components

4.5.1 Number of pods per plant

Number of pods per plant differed significantly due to different treatment applications and their interaction at harvest are presented in Tables 66, 67 and 68.

Experiment conducted during *kharif* 2014

The number of pods per plant varied significantly due to the application of jeevamrutha. Higher number of pods per plant were observed with jeevamrutha at 2000 litre ha⁻¹ (15.36) followed by jeevamrutha at 1500 litre ha⁻¹ (14.01), jeevamrutha at 1000 litre ha⁻¹ (12.98) and it was lower with without jeevamrutha application (11.84). Panchagavya spray significantly influenced on number of pods per plant. Panchagavya at 6 per cent (14.69) recorded more number of pods per plant followed by panchagavya at 3 per cent (13.52) and it was lower with no- panchagavya application (12.43).

Interaction effect

Number of pods differed significantly due to the interaction between various levels of jeevamrutha and panchagavya application. Application of jeevamrutha at 2000 litre ha⁻¹ and panchagavya at 6 per cent recorded significantly higher number of pods (15.67) and it was on par with jeevamrutha at 2000 litre ha⁻¹ and panchagavya at 3 per cent (15.60), jeevamrutha at 1500 litre ha⁻¹ with panchagavya at 6 per cent (15.65) and jeevamrutha at 2000 litre ha⁻¹ and no-panchagavya application (14.80) whereas lower

Table 66: Yield parameters of frenchbean at different growth stages as influenced by application of liquid manures during Kharif 2014

Jeevamrutha Levels	Yield parameters											
	Number of pods plant ⁻¹				Green pod weight plant ⁻¹ (g)				Pod length (cm)			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	11.13	12.00	12.40	11.84	55.23	59.31	61.98	58.84	13.40	14.25	14.79	14.15
J₁	11.33	12.53	15.07	12.98	57.46	68.92	75.00	67.13	13.93	14.45	15.02	14.46
J₂	12.47	13.93	15.63	14.01	60.32	72.44	78.04	70.27	14.03	14.89	15.11	14.68
J₃	14.80	15.60	15.67	15.36	73.96	77.57	81.57	77.70	14.98	15.39	15.46	15.28
Mean	12.43	13.52	14.69		61.74	69.56	74.15		14.09	14.74	15.09	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.27		0.78		1.05		3.07		0.16		0.46	
Panchagavya	0.23		0.68		0.91		2.66		0.14		0.40	
J × P	0.46		1.36		1.81		5.31		0.27		0.80	

Note: **J₀** - Without Jeevamrutha, **J₁**- Jeevamrutha 1000 litre/ha, **J₂**- Jeevamrutha 1500 litre/ha, **J₃**- Jeevamrutha 2000 litre/ha
P₀ - Without panchagavya, **P₁** - Panchagavya at 3 %, **P₃** - Panchagavya at 6 %, **DAS** – Days After Sowing, **RDF** – 63:100:75 NPK kg ha⁻¹

Table 67: Yield parameters of frenchbean at different growth stages as influenced by application of liquid manures during Kharif 2015

Jeevamrutha Levels	Yield parameters											
	Number of pods plant ⁻¹				Green pod weight plant ⁻¹ (g)				Pod length (cm)			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	12.81	13.76	14.34	13.64	64.09	69.59	73.29	68.99	13.46	14.36	14.85	14.23
J₁	12.55	13.95	16.61	14.37	62.76	75.65	82.03	73.48	14.42	14.61	15.34	14.79
J₂	13.02	14.92	16.81	14.92	66.18	79.41	85.63	77.08	14.93	15.78	15.85	15.52
J₃	15.88	16.75	16.82	16.48	78.68	82.77	86.97	82.81	15.64	16.28	16.38	16.10
Mean	13.56	14.84	16.15		67.93	76.85	81.98		14.61	15.26	15.61	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.29		0.85		1.10		3.23		0.19		0.57	
Panchagavya	0.25		0.73		0.95		2.80		0.17		0.49	
J × P	0.50		1.46		1.91		5.59		0.33		NS	

Note: J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, J₂ - Jeevamrutha 1500 litre/ha, J₃ - Jeevamrutha 2000 litre/ha

P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, P₃ - Panchagavya at 6 %, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 68: Yield parameters of frenchbean at different growth stages as influenced by application of liquid manures (Pooled 2014 and 2015)

Jeevamrutha Levels	Yield parameters											
	Number of pods plant ⁻¹				Green pod weight plant ⁻¹ (g)				Pod length (cm)			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	11.97	12.88	13.37	12.74	59.66	64.45	67.63	63.91	13.43	14.31	14.82	14.19
J₁	11.94	13.24	15.84	13.67	60.11	72.28	78.52	70.30	14.17	14.53	15.18	14.63
J₂	12.74	14.42	16.22	14.46	63.25	75.93	81.83	73.67	14.48	15.34	15.48	15.10
J₃	15.34	16.18	16.24	15.92	76.32	80.17	84.27	80.25	15.31	15.84	15.92	15.69
Mean	13.00	14.18	15.42		64.84	73.21	78.06		14.35	15.00	15.35	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.27		0.80		1.01		2.96		0.13		0.38	
Panchagavya	0.24		0.70		0.88		2.57		0.11		0.33	
J × P	0.48		1.39		1.75		5.13		0.23		NS	

Note: **J₀** - Without Jeevamrutha, **J₁**- Jeevamrutha 1000 litre/ha, **J₂**- Jeevamrutha 1500 litre/ha, **J₃**- Jeevamrutha 2000 litre/ha
P₀- Without panchagavya, **P₁**- Panchagavya at 3 %, **P₃**- Panchagavya at 6 %, **DAS** – Days After Sowing, **RDF** – 63:100:75 NPK kg ha⁻¹

number of pods were observed in no - jeevamrutha and no - panchagavya application (11.13).

Experiment conducted during *kharif* 2015

The number of pods per plant differed significantly due to the application of jeevamrutha. Higher number of pods per plant were observed with jeevamrutha at 2000 litre ha⁻¹ (16.48) followed by jeevamrutha at 1500 litre ha⁻¹ (14.92), jeevamrutha at 1000 litre ha⁻¹ (14.37) and it was lower with without jeevamrutha application (13.64). Panchagavya spray significantly influenced the number of pods per plant. Panchagavya at 6 per cent (16.15) recorded more number of pods per plant followed by panchagavya at 3 per cent (14.84) and it was lower with no- panchagavya application (13.56).

Interaction effect

Number of pods differed significantly due to the interaction between various levels of jeevamrutha and panchagavya application. Application of jeevamrutha at 2000 litre ha⁻¹ and panchagavya at 6 per cent recorded significantly higher number of pods (16.82) and it was on par with jeevamrutha at 2000 litre ha⁻¹ and panchagavya at 3 per cent, jeevamrutha at 1500 litre ha⁻¹ with panchagavya at 6 per cent, jeevamrutha at 2000 litre ha⁻¹ with no-panchagavya application and jeevamrutha at 1000 litre ha⁻¹ with panchagavya at 6 per cent whereas lower number of pods were observed in no - jeevamrutha and no - panchagavya application (12.81).

Pooled

There was significant difference among varied levels of jeevamrutha and panchagavya with respect to number of pods per plant at harvest. Significantly higher number of pods were recorded with jeevamrutha at 2000 litre ha⁻¹ (15.92) followed by jeevamrutha at 1500 litre ha⁻¹ (14.46), jeevamrutha at 1000 litre ha⁻¹ (13.67) and it was lower with without jeevamrutha application (12.74). Significantly higher number of pods and green pod weight was recorded with panchagavya at 6 per cent (15.42) followed by panchagavya at 3 per cent (14.18) and it was lower with no- panchagavya application (13.0).

Number of pods differed significantly due to the interaction between various levels of jeevamrutha and panchagavya application. Application of jeevamrutha at 2000 litre ha⁻¹ and panchagavya at 6 per cent recorded significantly higher number of pods (16.24) and it was on par with jeevamrutha at 2000 litre ha⁻¹ and panchagavya at 3 per cent, jeevamrutha at 1500 litre ha⁻¹ with panchagavya at 6 per cent, jeevamrutha at 1000 litre ha⁻¹ with panchagavya at 6 per cent and jeevamrutha at 2000 litre ha⁻¹ and no-panchagavya application. Significantly lower number of pods were observed in no - jeevamrutha and no - panchagavya application (11.97).

4.5.2 Green pod weight (g plant⁻¹)

Green pod weight per plant as influenced by different organic liquids manures and their interaction (Tables 66, 67 and 68).

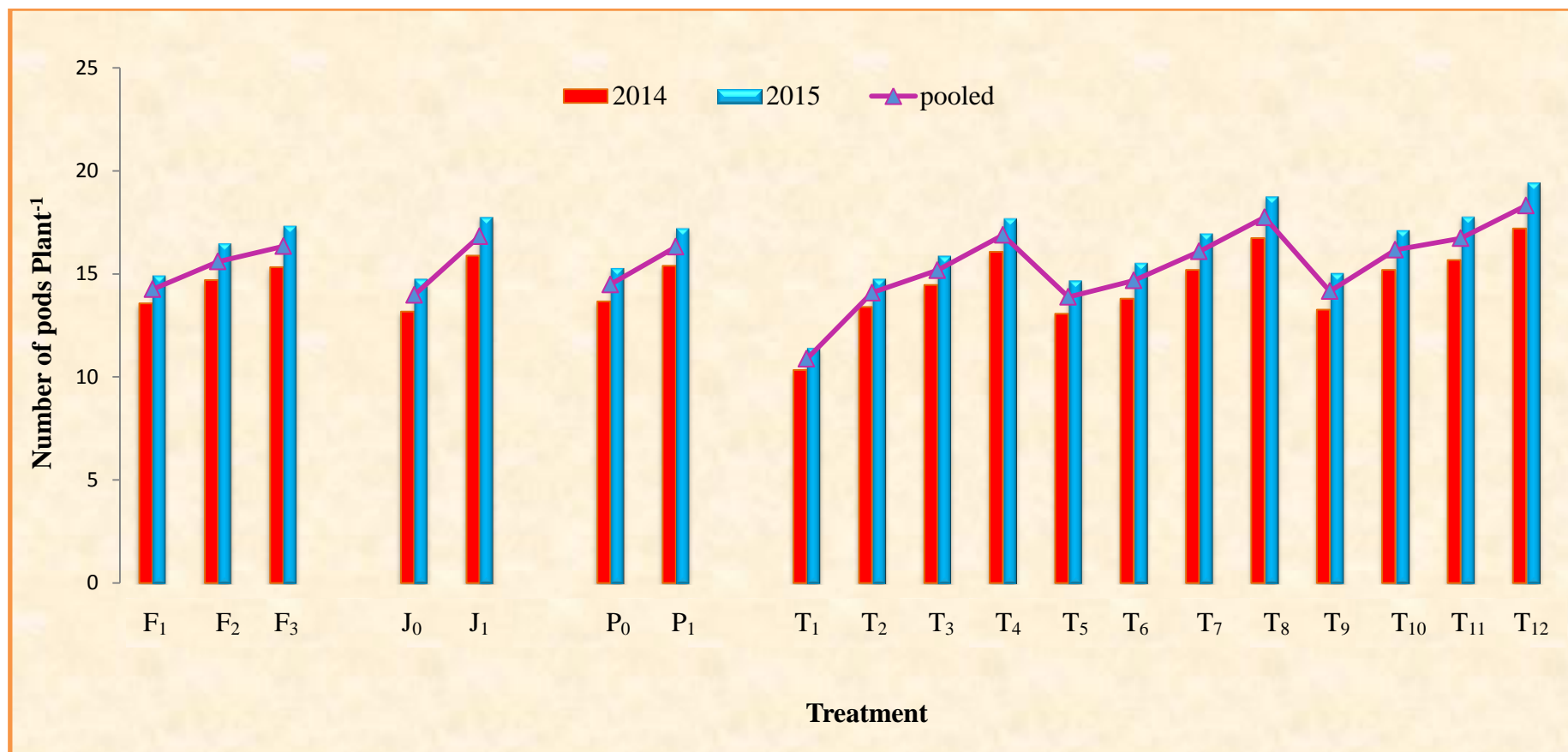


Fig. 3: Influence of FYM, jeevamruta and panchagavya application on number of pods per plant of frenchbean

F₁- 100 %, F₂- 150 % and F₃- 200 % equivalent N through FYM, J₀- Without Jeevamrutha, J₁- Jeevamrutha 1000 litre/ha, P₀- Without panchagavya, P₁- Panchagavya at 3 %, T₁= F₁J₀P₀, T₂= F₁J₀P₁, T₃= F₁J₁P₀, T₄= F₁J₁P₁, T₅= F₂J₀P₀, T₆= F₂J₀P₁, T₇= F₂J₁P₀, T₈= F₂J₁P₁, T₉= F₃J₀P₀, T₁₀= F₃J₀P₁, T₁₁= F₃J₁P₀, T₁₂= F₃J₁P₁

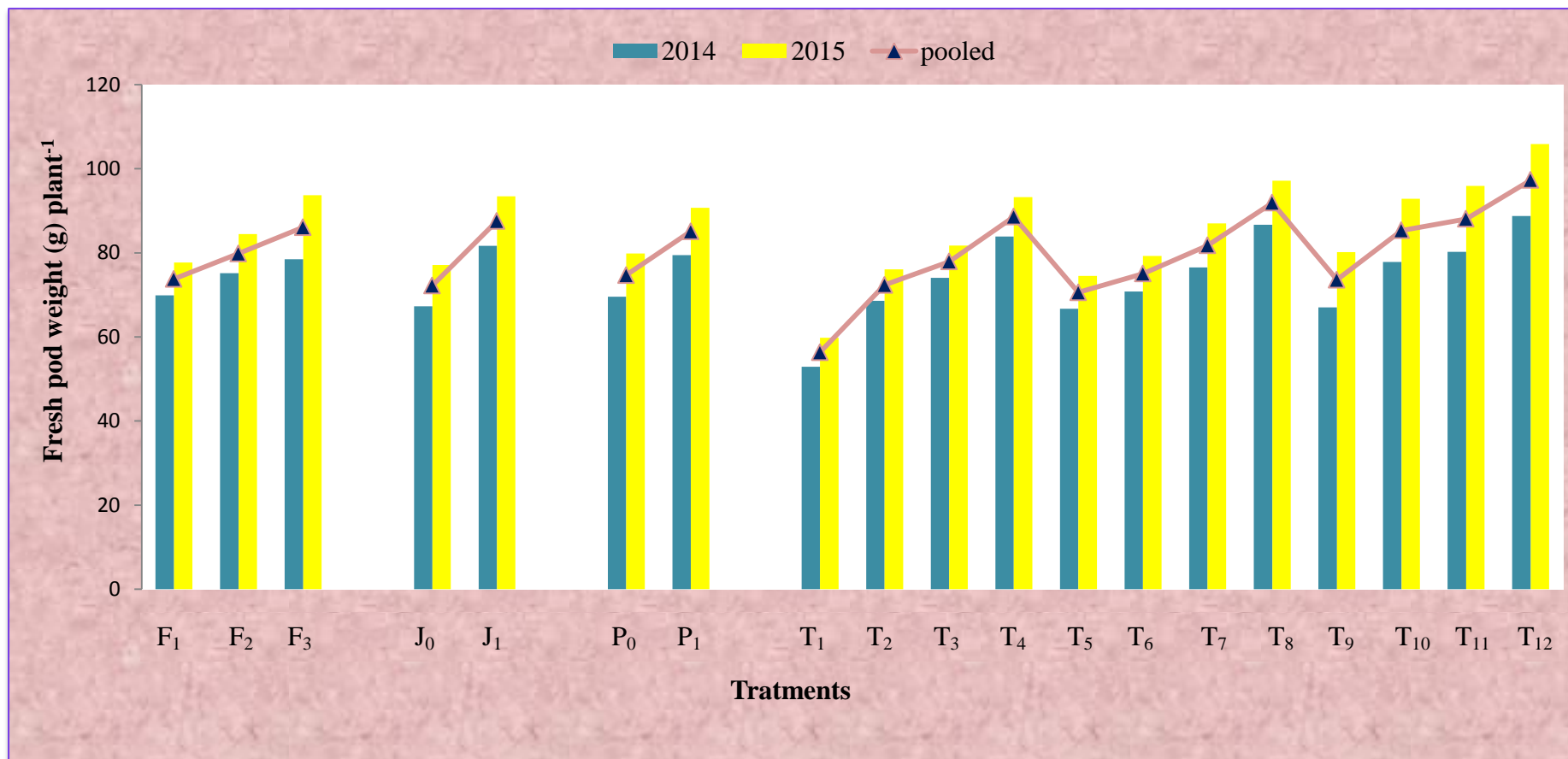


Fig. 4: Influence of FYM, jeevamruta and panchagavya application on fresh pod weight per plant of frenchbean

F₁- 100 %, F₂- 150 % and F₃- 200 % equivalent N through FYM, J₀- Without Jeevamruta, J₁- Jeevamruta 1000 litre/ha, P₀- Without panchagavya, P₁- Panchagavya at 3 %, T₁= F₁J₀P₀, T₂= F₁J₀P₁, T₃=F₁J₁P₀, T₄=F₁J₁P₁, T₅=F₂J₀P₀, T₆= F₂J₀P₁, T₇=F₂J₁P₀, T₈=F₂J₁P₁, T₉=F₃J₀P₀, T₁₀=F₃J₀P₁, T₁₁= F₃J₁P₀, T₁₂=F₃J₁P₁

Experiment conducted during *kharif* 2014

The green pod weight per plant differed significantly due to the application of jeevamrutha. Higher green pod weight per plant was observed with jeevamrutha at 2000 litre ha⁻¹ (77.7 g) followed by jeevamrutha at 1500 litre ha⁻¹ (70.27 g), jeevamrutha at 1000 litre ha⁻¹ (67.13 g) and it was lower with without jeevamrutha application (58.84 g). Panchagavya spray significantly influenced on green pod weight per plant. Panchagavya at 6 per cent recorded higher (74.15 g) green pod weight per plant followed by panchagavya at 3 per cent (69.56 g) and it was lower with no- panchagavya application (61.74 g).

Green pod weight per plant differed significantly due to the interaction between various levels of jeevamrutha and panchagavya application. Application of jeevamrutha at 2000 litre ha⁻¹ and panchagavya at 6 per cent recorded significantly higher green pod weight per plant (81.57 g) and it was on par with jeevamrutha at 2000 litre ha⁻¹ and panchagavya at 3 per cent and jeevamrutha at 1500 litre ha⁻¹ with panchagavya at 6 per cent whereas lower green pod weight per plant was observed in no - jeevamrutha and no - panchagavya application (55.23 g).

Experiment conducted during *kharif* 2015

The green pod weight per plant differed significantly due to the application of jeevamrutha. Higher green pod weight per plant was observed with jeevamrutha at 2000 litre ha⁻¹ (82.81 g) followed by jeevamrutha at 1500 litre ha⁻¹ (77.08 g), jeevamrutha at 1000 litre ha⁻¹ (73.48 g) and it was lower with without jeevamrutha application (68.99 g). Panchagavya spray significantly influenced on green pod weight per plant. Panchagavya at 6 per cent (81.98 g) recorded higher green pod weight per plant followed by panchagavya at 3 per cent (76.85 g) and it was lower with no- panchagavya application (67.93 g).

Green pod weight per plant differed significantly due to the interaction between various levels of jeevamrutha and panchagavya application. Application of jeevamrutha at 2000 litre ha⁻¹ and panchagavya at 6 per cent recorded significantly higher green pod weight per plant (86.97 g) and it was on par with jeevamrutha at 2000 litre ha⁻¹ and panchagavya at 3 per cent and jeevamrutha at 1500 litre ha⁻¹ with panchagavya at 6 per cent and jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 6 per cent whereas lower green pod weight per plant was observed in no - jeevamrutha and no - panchagavya application (64.09 g).

Pooled

Green pod weight per plant differed significantly due to the interaction between various levels of jeevamrutha and panchagavya application. Significantly higher green pod weight was recorded with jeevamrutha at 2000 litre ha⁻¹ (80.25 g) followed by jeevamrutha at 1500 litre ha⁻¹ (73.67 g), jeevamrutha at 1000 litre ha⁻¹ (70.30 g) and it was lower with without jeevamrutha application (63.91 g). Significantly higher green pod weight was recorded with panchagavya at 6 per cent (78.06 g) followed by panchagavya at 3 per cent (73.21 g) and it was lower with no- panchagavya application (64.84 g).

Interaction between various levels of jeevamrutha and panchagavya recorded significantly higher green pod weight per plant. Where application of jeevamrutha at 2000 litre ha⁻¹ and panchagavya at 6 per cent recorded significantly more green pod weight (84.27 g) and it was on par with jeevamrutha at 2000 litre ha⁻¹ and panchagavya at 3 per cent (80.17 g) and jeevamrutha at 1500 litre ha⁻¹ with panchagavya at 6 per cent (81.83 g) and significantly lower green pod weight was found in without jeevamrutha and without panchagavya application (59.66 g).

4.5.3 Pod length (cm)

Pod length as influenced by different organic liquids manures and their interaction effects are presented in (Tables 66, 67 and 68).

Experiment conducted during *kharif* 2014

There was significant difference among the treatments with respect to length of the pods at harvest. Application of jeevamrutha at 2000 litre ha⁻¹ significantly given higher pod length (15.28 cm) followed by jeevamrutha at 1500 litre ha⁻¹ (14.68 cm), jeevamrutha at 1000 litre ha⁻¹ (14.46 cm) where application of jeevamrutha at 1500 litre ha⁻¹ found on par with jeevamrutha at 1500 litre ha⁻¹ and significantly lower pod length was recorded with no-jeevamrutha application (14.15 cm). Panchagavya at 6 per cent application resulted in significantly higher pod length (15.09 cm) followed by panchagavya application at 3 per cent (14.74 cm) and significantly lower pod length was recorded in without panchagavya application (14.09 cm).

Experiment conducted during *kharif* 2015

There was significant differences among the treatments with respect to length of the pods at harvest. Application of jeevamrutha at 2000 litre ha⁻¹ significantly given higher pod length (16.10 cm) followed by jeevamrutha at 1500 litre ha⁻¹ (15.52 cm), jeevamrutha at 1000 litre ha⁻¹ (14.79 cm). Significantly lower pod length was recorded with no-jeevamrutha application (14.23 cm). Panchagavya at 6 per cent application resulted in significantly higher pod length (15.61 cm) followed by panchagavya application at 3 per cent (15.26 cm) and significantly lower pod length was recorded in without panchagavya application (14.61 cm).

Interaction effect

Pod length did not differ significantly due to the interaction between various levels of jeevamrutha and panchagavya application during both the years.

Pooled

Length of the pods significantly influenced by liquid manures application at harvest. Application of jeevamrutha at 2000 litre ha⁻¹ significantly recorded higher pod length (15.69 cm) followed by jeevamrutha at 1500 litre ha⁻¹ (15.10 cm), , jeevamrutha at 1000 litre ha⁻¹ (14.63 cm) and significantly lower pod length was recorded with no-jeevamrutha application (14.19 cm). Panchagavya at 6 per cent application resulted in significantly higher pod length (15.35 cm) followed by panchagavya application at 3 per

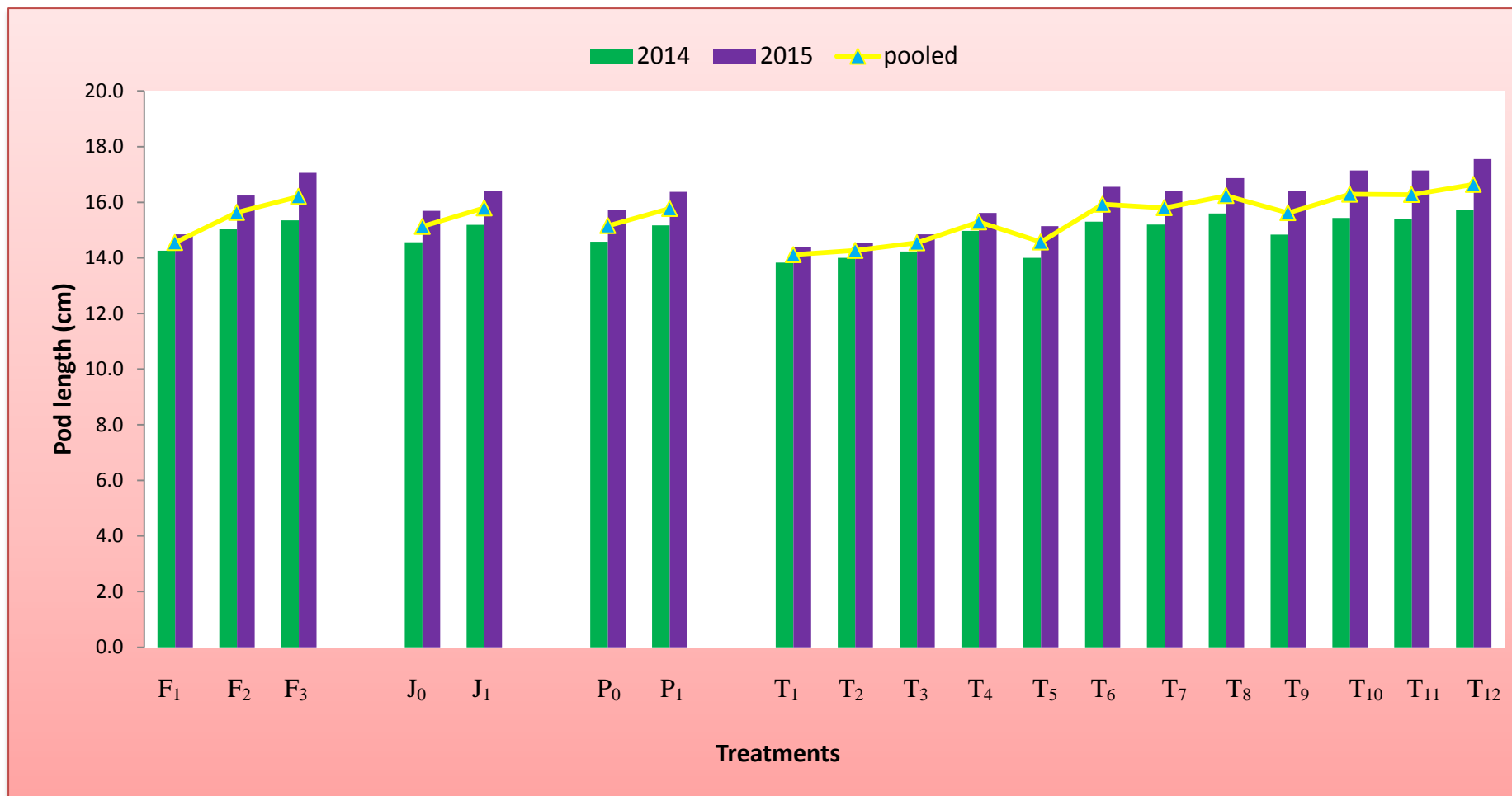


Fig. 5: Influence of FYM, jeevamruta and panchagavya application pod length of frenchbean

F₁- 100 %, F₂- 150 % and F₃- 200 % equivalent N through FYM, J₀- Without Jeevamruta, J₁- Jeevamruta 1000 litre/ha, P₀- Without panchagavya, P₁- Panchagavya at 3 %, T₁= F₁J₀P₀, T₂= F₁J₀P₁, T₃=F₁J₁P₀, T₄=F₁J₁P₁, T₅=F₂J₀P₀, T₆= F₂J₀P₁, T₇=F₂J₁P₀, T₈=F₂J₁P₁, T₉=F₃J₀P₀, T₁₀=F₃J₀P₁, T₁₁= F₃J₁P₀, T₁₂=F₃J₁P₁

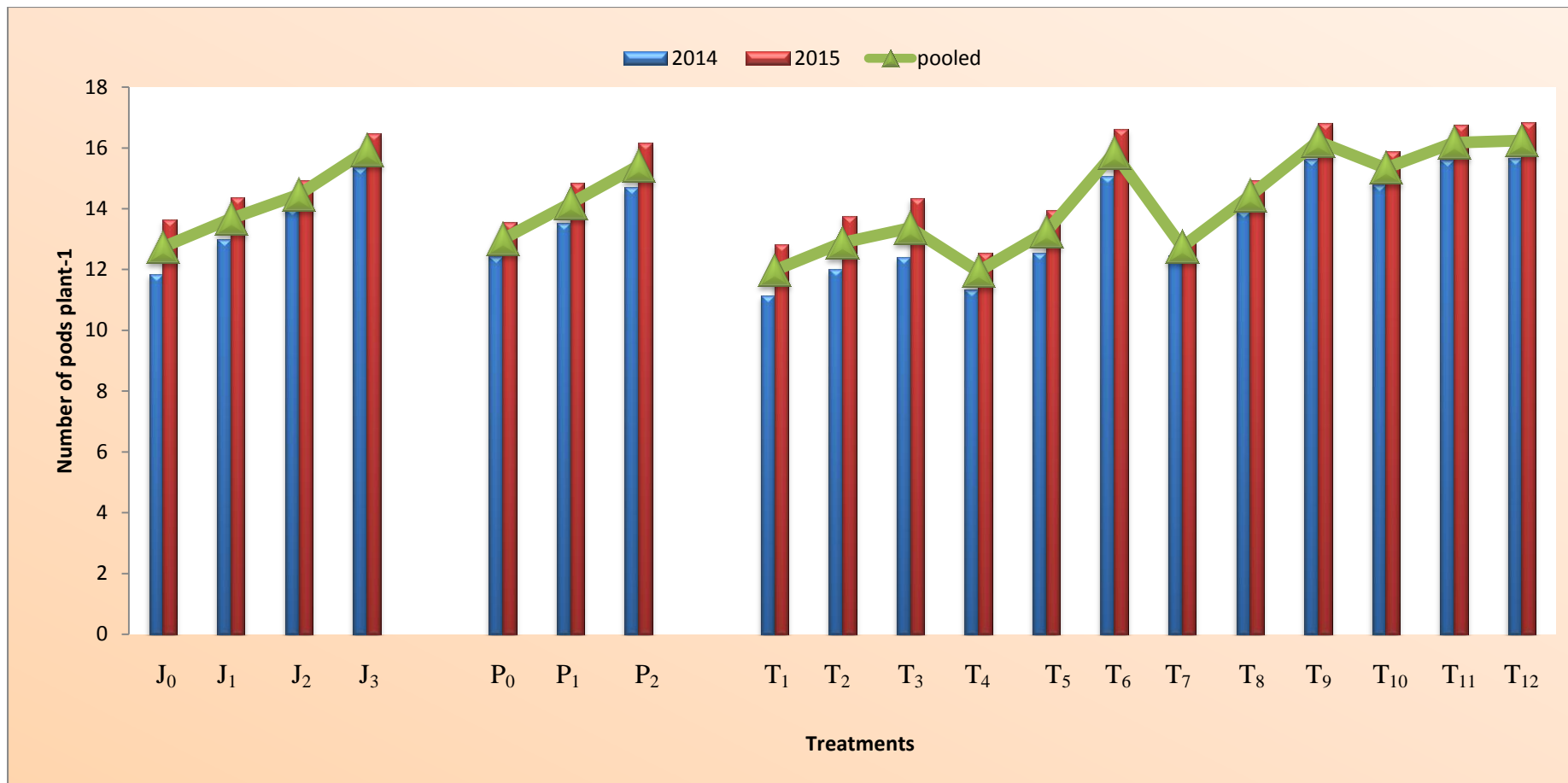


Fig. 6: Influence of jeevamrutha and panchagavya application on number of pods per plant of frenchbean

J₀- Without Jeevamrutha, **J₁**- Jeevamrutha 1000 litre/ha, **J₂**- Jeevamrutha 1500 litre/ha, **J₃**- Jeevamrutha 2000 litre/ha, **P₀**- Without panchagavya, **P₁**- Panchagavya at 3 %, **P₃**- Panchagavya at 6 %, **T₁**= J₀P₀, **T₂**=J₀P₁, **T₃**=J₀P₂, **T₄**=J₁P₀, **T₅**=J₁P₁, **T₆**=J₁P₂, **T₇**=J₂P₀, **T₈**=J₂P₁, **T₉**=J₂P₂, **T₁₀**=J₃P₀, **T₁₁**=J₃P₁, **T₁₂**=J₃P₂



Fig. 7: Influence of jeevamruta and panchagavya application on pod weight per plant of frenchbean

J₀- Without Jeevamrutha, **J₁**- Jeevamrutha 1000 litre/ha, **J₂**- Jeevamrutha 1500 litre/ha, **J₃**- Jeevamrutha 2000 litre/ha, **P₀**- Without panchagavya, **P₁**- Panchagavya at 3 %, **P₂**- Panchagavya at 6 %, **T₁**= J₀P₀, **T₂**=J₀P₁, **T₃**=J₀P₂, **T₄**=J₁P₀, **T₅**=J₁P₁, **T₆**=J₁P₂, **T₇**=J₂P₀, **T₈**=J₂P₁, **T₉**=J₂P₂, **T₁₀**=J₃P₀, **T₁₁**=J₃P₁, **T₁₂**=J₃P₂

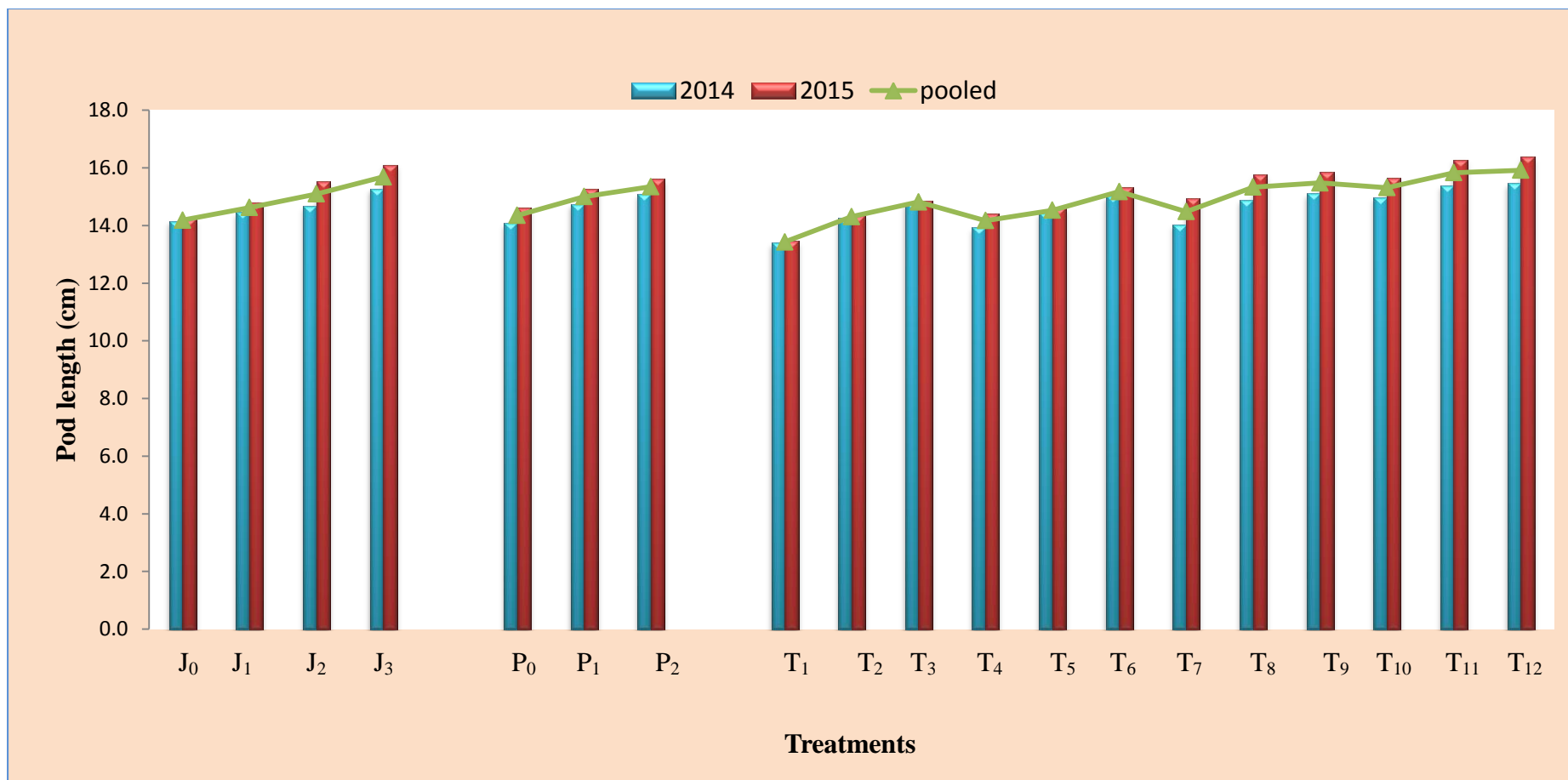


Fig. 8: Influence of jeevamruta and panchagavya application on pod length of frenchbean

J₀- Without Jeevamruta, J₁- Jeevamruta 1000 litre/ha, J₂- Jeevamruta 1500 litre/ha, J₃- Jeevamruta 2000 litre/ha, P₀- Without panchagavya, P₁- Panchagavya at 3 %, P₃- Panchagavya at 6 %, T₁= J₀P₀, T₂=J₀P₁, T₃=J₀P₂, T₄=J₁P₀, T₅=J₁P₁, T₆=J₁P₂, T₇=J₂P₀, T₈=J₂P₁, T₉=J₂P₂, T₁₀=J₃P₀, T₁₁=J₃P₁, T₁₂=J₃P₂

cent (15.00 cm) and significantly lower pod length was recorded in without panchagavya application (14.35 cm).

Pod length did not differ significantly due to the interaction between various levels of jeevamrutha and panchagavya application.

4.6 Effect of different levels of jeevamrutha and panchagavya on pod yield and haulm yield of frenchbean

The data pertaining to the effect of various levels of jeevamrutha and panchagavya on pod yield and haulm yield (q ha⁻¹) of frenchbean are presented in the Tables 69 and 70.

4.6.1 Green pod yield (q ha⁻¹)

The pod yield varied significantly due to the application of jeevamrutha and panchagavya.

Experiment conducted during *kharif* 2014

Jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher green pod yield (134.3 q ha⁻¹) followed by jeevamrutha at 1500 litre ha⁻¹ (115.0 q ha⁻¹), jeevamrutha at 1000 litre ha⁻¹ (106.7 q ha⁻¹), as compared to without jeevamrutha application (99.8 q ha⁻¹). Panchagavya at 6 per cent application recorded significantly higher green pod yield (124.4 q ha⁻¹) followed by panchagavya at 3 per cent application (116.1 q ha⁻¹) as compared to without panchagavya application (101.4 q ha⁻¹).

Experiment conducted during *kharif* 2015

Jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher green pod yield (156.9 q ha⁻¹) followed by jeevamrutha at 1500 litre ha⁻¹ (136.5 q ha⁻¹), jeevamrutha at 1000 litre ha⁻¹ (123.1 q ha⁻¹), as compared to without jeevamrutha application (112.8 q ha⁻¹). Panchagavya at 6 per cent application recorded significantly higher green pod yield (142.8 q ha⁻¹) followed by panchagavya at 3 per cent application (134.1 q ha⁻¹) as compared to without panchagavya application (120.1 q ha⁻¹).

Interaction effect

Green pod yield did not differ significantly due to the interaction between various levels of jeevamrutha and panchagavya application during both the years. However, higher green pod yield was observed with jeevamrutha at 2000 litre ha⁻¹ and panchagavya at 6 per cent (165.8 q ha⁻¹) and it was with with no - jeevamrutha and no-panchagavya application (93.9 q ha⁻¹).

Pooled

Jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher green pod yield (145.6 q ha⁻¹) followed by jeevamrutha at 1500 litre ha⁻¹ (125.8 q ha⁻¹), jeevamrutha at 1000 litre ha⁻¹ (114.9 q ha⁻¹), as compared to without jeevamrutha application (106.3 q ha⁻¹). Panchagavya at 6 per cent application recorded significantly higher green pod yield

Table 69: Effect of jeevamrutha and panchagavya application during 2014, 2015 and pooled data on green pod yield of frenchbean

Jeevamrutha Levels	Green pod yield (q ha ⁻¹)											
	2014				2015				Pooled			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	83.0	104.0	112.4	99.8	93.91	117.67	126.88	112.8	88.5	110.8	119.7	106.3
J₁	91.9	107.7	120.6	106.7	115.05	121.47	132.73	123.1	103.5	114.6	126.7	114.9
J₂	104.4	117.8	122.9	115.0	123.96	139.75	145.82	136.5	114.2	128.8	134.3	125.8
J₃	126.2	134.8	141.8	134.3	147.45	157.49	165.77	156.9	136.8	146.1	153.8	145.6
Mean	101.4	116.1	124.4		120.09	134.09	142.80		110.7	125.1	133.6	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	1.97		5.78		3.10		9.10		1.92		5.64	
Panchagavya	1.71		5.00		2.69		7.88		1.67		4.89	
J × P	3.41		NS		5.37		NS		3.33		NS	

Note: **J₀** - Without Jeevamrutha, **J₁**- Jeevamrutha 1000 litre/ha, **J₂**- Jeevamrutha 1500 litre/ha, **J₃**- Jeevamrutha 2000 litre/ha

P₀- Without panchagavya, **P₁**- Panchagavya at 3 %, **P₂**- Panchagavya at 6 %, **DAS** – Days After Sowing, **RDF** – 63:100:75 NPK kg ha⁻¹

(133.6 q ha⁻¹) followed by panchagavya at 3 per cent application (125.1 q ha⁻¹) as compared to without panchagavya application (110.7 q ha⁻¹).

Green pod yield did not vary significantly due to the interaction between various levels of jeevamrutha and panchagavya application. However, higher green pod yield was observed with jeevamrutha at 2000 litre ha⁻¹ and panchagavya at 6 per cent (153.8 q ha⁻¹) and it was with no - jeevamrutha and no-panchagavya application (88.5 q ha⁻¹).

4.6.2 Haulm yield (q ha⁻¹)

The haulm yield varied significantly due to the application of jeevamrutha and panchagavya (Table 70).

Experiment conducted during *kharif* 2014

Jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher haulm yield of frenchbean (31.35 q ha⁻¹) followed by jeevamrutha at 1500 litre ha⁻¹ (27.97 q ha⁻¹), jeevamrutha at 1000 litre ha⁻¹ (26.96 q ha⁻¹), as compared to without jeevamrutha application (24.38 q ha⁻¹). Panchagavya at 6 per cent application recorded significantly higher haulm yield of french bean (29.72 q ha⁻¹) followed by panchagavya at 3 per cent application (27.8 q ha⁻¹) as compared to without panchagavya application (25.47 q ha⁻¹).

Experiment conducted during *kharif* 2015

Jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher haulm yield of frenchbean (32.85 q ha⁻¹) followed by jeevamrutha at 1500 litre ha⁻¹ (27.81 q ha⁻¹), jeevamrutha at 1000 litre ha⁻¹ (27.81 q ha⁻¹), as compared to without jeevamrutha application (25.38 q ha⁻¹). Panchagavya at 6 per cent application recorded significantly higher haulm yield of french bean (31.17 q ha⁻¹) followed by panchagavya at 3 per cent application (29.15 q ha⁻¹) as compared to without panchagavya application (26.14 q ha⁻¹).

Interaction effect

Haulm yield did not differ significantly due to the interaction between various levels of jeevamrutha and panchagavya application during both the years.

Pooled

Jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher haulm yield of french bean (32.1 q ha⁻¹) followed by jeevamrutha at 1500 litre ha⁻¹ (28.78 q ha⁻¹), jeevamrutha at 1000 litre ha⁻¹ (27.39 q ha⁻¹), as compared to without jeevamrutha application (24.88 q ha⁻¹). Panchagavya at 6 per cent application recorded significantly higher haulm yield of french bean (30.45 q ha⁻¹) followed by panchagavya at 3 per cent application (28.47 q ha⁻¹) as compared to without panchagavya application (25.94 q ha⁻¹).

Haulm yield of frenchbean did not vary significantly due to the interaction between various levels of jeevamrutha and panchagavya application.

Table 70: Effect of jeevamruta and panchagavya application during 2014, 2015 and pooled data on haulm yield of frenchbean

Jeevamruta Levels	Haulm yield (q ha ⁻¹)											
	2014				2015				Pooled			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	21.44	25.04	26.64	24.38	22.21	26.02	27.92	25.38	21.83	25.53	27.28	24.88
J₁	25.14	26.78	28.97	26.96	26.13	28.09	29.21	27.81	25.64	27.44	29.09	27.39
J₂	25.57	28.49	29.85	27.97	26.46	30.41	31.93	29.60	26.02	29.45	30.89	28.78
J₃	29.74	30.86	33.44	31.35	30.85	32.07	35.62	32.85	30.30	31.47	34.53	32.10
Mean	25.47	27.80	29.72		26.41	29.15	31.17		25.94	28.47	30.45	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamruta	0.44		1.28		0.55		1.60		0.35		1.03	
Panchagavya	0.38		1.11		0.47		1.39		0.31		0.90	
J × P	0.75		NS		0.95		NS		0.61		NS	

Note: J₀ - Without Jeevamruta, J₁ - Jeevamruta 1000 litre/ha, J₂ - Jeevamruta 1500 litre/ha, J₃ - Jeevamruta 2000 litre/ha

P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, P₃ - Panchagavya at 6 %, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Discussion on the findings relating to the effect of solid and liquid manures on growth and yield of frenchbean

The economic yield of a plant is an outcome of a series of integrated interactions of various biological events involving biochemical, physiological and morphological changes which take place during its development in accordance with the supply of light, water, temperature and nutrients (Donald, 1962).

The variation in pod yield with different organic sources differed significantly (Table 64 and Fig. 11). The pod yield increased with increase in fertility levels higher fruit yield of 135.2 q ha⁻¹ was recorded with application of FYM at 200 per cent N equivalent and it was 11.0 and 1.9 per cent yield increase over the 100 and 150 per cent N equivalents FYM. 150 per cent N equivalents FYM recorded 9.2 per cent yield increase over the 100 per cent N equivalents FYM during *khari* 2014. During 2015 yield increase in FYM at 200 per cent N equivalent (168.5 q ha⁻¹) over 100 and 150 per cent N equivalents FYM was 20.2 and 5.8 per cent and 150 per cent N equivalents FYM recorded 15.4 per cent yield increase over the 100 per cent N equivalents FYM. This might be due to higher number of pods per plant, pod length and pod weight. Increased yield attributes due to the application of FYM (200 %) might be due to taller plants (27.99 cm) with more number of branches per plant (7.17), higher leaf area index (3.20) and higher dry matter accumulation (22.43 g) per plant. These improved yield and yield parameters observed with application of FYM might be due to fast mineralization of FYM this might have facilitated release of plant nutrients to labile nutrient pool thereby more availability to plants. Results of the present study were in conformity with the results of Lakshmanan *et al.* (1993), Shashidhara, (2000), Malawadi, (2003), Kattimani, (2004), Sanjutha *et al.* (2008), Kondapa Naidu *et al.* (2009) and Premsekhar and Rajashree, (2009). Increased yield due to increasing sink potential as indicated by higher number of pods. This could be attributed to better availability and uptake of moisture, nutrients which helped in production of more photosynthates and its translocation to the pods during their development (Srivastava, (1988) and Gopinath *et al.* (2009). This might be also due to higher root biomass observed with increased levels of FYM (1.65 g) reflected in higher lateral roots would provide more surface area for absorption of water and minerals by the plants. The higher root surface area and also increased FYM levels might have supported the multiplication and development of *Rhizobium* in the soil which is reflected in increased number of nodules per plant (87.1) and nodule dry weight (0.10 g) at higher FYM levels (Table 62).

The higher leaf number and broader leaves observed with higher N equivalent FYM application which resulted in greater surface area could be considered as an indication of enhanced area for photosynthesis and production of higher photosynthates (Sumbramanain, 2005) this might have resulted in higher total dry matter accumulation. Besides, they might have improved the maximum water holding capacity (43.11 %) and reduced the bulk density (1.29 g/cc) (Table 148). The higher soil organic carbon of soil might be due to higher soil organic carbon of soil added through FYM which increased water holding capacity and reduced the bulk density due to humic substances penetrated the inter lamella space of clay minerals and influenced the interaction of clay with other soil constituents and ultimately increased water holding capacity of the soil (Singh *et al.*,

2006) this is in accordance with Sangeetha and Balakrishnan (2010) who have also reported application of FYM + neem cake has reduced bulk density (1.14 and 1.12 Mg m⁻³), higher spore space (56.9 and 57.0 %) improved water holding capacity (42.0 and 43.5 %) was observed during *rabi* 2007 and 2008.

The increase in pod yield with increased FYM in present investigation was also in accordance with Umamaheswari and Haripriya, (2008) and Bhriguvanshi, (1988) who have also reported higher yield levels with increased levels of vermicompost and FYM in capsicum and wheat. Similarly Devakumar *et al.* (2008), Boraiah (2013), Siddappa (2015) and Devakumar *et al.* (2016) have also reported higher yield of capsicum, fieldbean and frenchbean with application of higher levels of FYM. Increased yield due to increasing sink potential as indicated by higher number of pods. This could be attributed to better availability and uptake of moisture, nutrients which helped in production of more photosynthates and its translocation to the pods during their development (Srivastava, 1988 and Gopinath *et al.*, 2009). Photosynthetic capacity of plant is a function of photo-synthetically active leaf area indicated by leaf area index (LAI). In the present investigation significantly higher LAI was observed (3.20) with higher levels of FYM (200 % N equivalent FYM) which might be due to production of higher leaf area (1439.68 cm²). This results in production of higher photosynthates accumulation. Similar results were also observed in green gram and groundnut by Ravi Kumar, 2009.

Higher pod yield of frenchbean resulted with increased levels of FYM with jeevamruta. During both the years 2014 and 2015 higher pod yield recorded in FYM at 200 per cent N equivalent with jeevamruta (145.0 and 180.9 q ha⁻¹) as compared to their individual application of FYM (135.2 and 168.5 q ha⁻¹) and jeevamruta (141.7 and 168.3 q ha⁻¹). During both the seasons combined application of FYM at 200 per cent N equivalent with jeevamruta resulted in 6.7 and 6.9 per cent increase in yield over individual application of FYM at 200 per cent N equivalent and 2.3 and 7.0 per cent yield increase over individual application of jeevamruta during 2014 and 2015 (Table 64). Pod yield of frenchbean varied significantly due to application of jeevamruta (1000 litre ha⁻¹). During both the years higher pod yield was observed with jeevamruta (141.7 and 168.3 q ha⁻¹) application in the FYM levels as compared to application of jeevamruta (106.7 and 123.1 q ha⁻¹) in panchagavya levels (Tables 64 and 69). There was increase of 14.7 and 24.7 per cent yield during 2014 and 19.2 and 26.9 per cent during 2015 with jeevamruta at 1000 litre ha⁻¹ and without jeevamruta in FYM levels over jeevamruta at 1000 litre ha⁻¹ and no jeevamruta in panchagavya levels, respectively. This might be due to most of the nutrients supplied through FYM with liquid manures are readily available for plant growth and development and also could have matched crop's demand for nutrients. Besides, they might have improved the soil physical properties, enhanced soil microbial activity and higher nutrient availability resulting in congenial soil condition. It was observed by Devakumar *et al.* (2008) that jeevamruta is a rich source of beneficial microorganisms *viz.*, bacteria, fungi, actinomycetes, N-fixers and p- solubilisers. Besides it is also a good source of decomposers which might have hastened the process of applied FYM to the plots. Further higher increase in frenchbean yield during 2015 might also be due to the enhanced mineralisation of FYM added during previous season plus added



Plate 4: Crop performance in 200 per cent N equivalent through FYM + jeevamrutha at 1000 litres ha⁻¹ + panchagavya 3 per cent



Plate 5: Crop performance in 100 per cent N equivalent through FYM + without jeevamrutha + without panchagavya



Plate 6: Crop performance in jeevamrutha at 2000 litres ha⁻¹ + panchagavya 6 per cent



Plate 7: Crop performance in without jeevamrutha + without panchagavya

FYM during current cropping season. Similar increment in growth parameters was also observed with increased level of FYM and bio-digester liquid manures by Reddy *et al.* (2011), Siddaram (2012) Sudheendra (2012) and Siddappa *et al.* (2015). Higher pod yield was recorded with application of FYM at 200 per cent N equivalent with jeevamrutha at 1000 litre ha⁻¹ which was reflected by yield attributing characters like number of pods per plant (17.52), pod weight per plant (92.67 g), pod length (16.46 cm) of frenchbean (Table 63). The increased yield attributes might be due to higher plant height (28.89 cm) with more number of branches (7.47) per plant and higher total dry matter production (24.53) per plant and also due to higher green foliage observed in FYM and jeevamrutha application. Higher growth parameters with application of FYM and liquid manures may be due to nutrient content of FYM and liquid manures and their faster mineralization of nitrogen. Similarly, Babu and Reddy (2000) opined that slow release of nutrients from the organic sources at later stages of crop growth might have resulted in increased dry matter and yield. Jeevamrutha contains macro and micro nutrients and also beneficial micro organism present in the liquid organic manures (Somasundaram, 2003, Devakumar *et al.*, 2008) which made crop perform better in the present investigation. This might be due to most of the nutrients supplied through FYM with liquid manures are readily available for plant growth and development and also could have matched crop's demand for nutrients. Besides, they might have improved the soil physical properties, enhanced soil microbial activity and higher nutrient availability resulting in congenial soil condition. This is also in line with Deshmukh *et al.* (2012) revealed that in organic farming application of 100 per cent RDN through vermicompost + jeevamruth resulted in higher grain and straw yields of soybean and wheat over 100 per cent RDN through compost and vermicompost application alone in the soybean-wheat cropping system. Similarly Significantly higher dry pod and haulm yield of groundnut were found in the treatment receiving integrated organic nutrient supply system involving FYM, pressmud cake, *Glyricidia*, *Azotobacter*, P-solubilizing bacteria, cowdung urine slurry over their individual application in cotton-groundnut cropping system (Badole and More, 2001). Similarly Ravi Kumar (2009), Boraiah (2013), Devakumar *et al.* (2008) and Siddappa (2015) have also reported higher yield of groundnut, capsicum and fieldbean with application of higher levels of FYM with jeevamrutha levels.

Pod yield of frenchbean resulted in higher yield with increased levels of FYM with panchagavya (Table 64). During both the years higher pod yield recorded in FYM at 200 per cent N equivalent with panchagavya at 3 per cent (141.8 and 176.9 q ha⁻¹) as compared to their individual application of FYM (135.2 and 168.5 q ha⁻¹) and Panchagavya (138.7 and 164.7 q ha⁻¹). During both the seasons combined application of FYM at 200 per cent N equivalent with panchagavya resulted in 4.7 and 4.8 per cent increase in yield over individual application of FYM at 200 per cent N equivalent. While it was 2.2 and 7.0 per cent yield increase over individual application of panchagavya during 2014 and 2015 (Table 64). Pod yield of frenchbean varied significantly due to application of panchagavya at 3 per cent. During both the years higher pod yield was observed in panchagavya at 3 per cent (138.7 and 164.7 q ha⁻¹) application with FYM levels as compared to application of panchagavya at 3 per cent (116.1 and 134.1 q ha⁻¹) in jeevamrutha levels (Table 64). There was an increase of 16.3 and 15.5 per cent yield during 2014 and 18.6 and 16.1 per cent during 2015 in panchagavya at 3 per cent and

without panchagavya in FYM levels over panchagavya at 3 per cent and no panchagavya in jeevamruata levels, respectively. This might be due to improvement in soil physical condition coupled with increased availability of plant nutrients. This is in accordance with Vasumathi *et al.* (2001). Rajanna *et al.* (2012) concluded that continuous application of liquid organic manures along with bulky manures helped in improving the soil fertility and found essential in order to achieve the sustainability in terms of ecosystem. This is in conformity with Sadanandan *et al.* (1998), Vasumathi *et al.* (2001) and Kanimozhi (2004). Foliar spray of panchagavya at 3 per cent enhanced the growth parameters since it contains macro and micro nutrients, growth hormones and biofertilizers in the liquid formulations and further it might have due to growth enzymes present in panchagavya which favour rapid cell division and multiplication and combined application of organics might have resulted in better availability of nutrients throughout the crop growth period as witnessed in increased soil microbial population. Further, these treatment combinations of various levels of FYM along with supplementation of panchagavya through foliar nutrition resulted in better growth and yield as compared to without panchagavya spray. This might be because of panchagavya contains nutrients, micro organisms and plant growth promoters (Xu and Xu, 2000). These results are also in conformity with the findings of Shwetha (2008), who found higher and on par seed yield of soybean with RDF + FYM when combined application of organic manures were made along with panchagavya. Several workers have also reported increase in crop yields with combined application of organic manures (Thomas Abraham and Lal, 2003; Gholve *et al.*, 2005; Patil *et al.*, 2012 Sharadha, 2013 and Siddappa *et al.* (2015). Similarly, in maize-chickpea sequential systems, it was concluded that the combined application of enriched compost + vermicompost + green leaf manure + panchagavya spray + biodynamic spray at flowering produced significantly higher maize yield (6195 kg ha^{-1}) and application of enriched compost + vermicompost + green leaf manure + panchagavya spray at flowering and 15 days intervals recorded significantly higher yield of chickpea (1779 kg ha^{-1}) over control (3906 and 1246 kg ha^{-1} , respectively) (Anon, 2011a).

Somasundaram *et al.* (2003b) observed that the biogas slurry with panchagavya combination is adjudged as the best organic nutritional practice for the sustainability of maize-sunflower-greengram system by its overall performance on growth, productivity, quality of crops, soil health and economics.

During *Kharif* 2014 and 2015 application of jeevamrutha at $1000 \text{ litre ha}^{-1}$ recorded significantly higher frenchbean yield (141.7 and 168.3 q ha^{-1}) as compared to without jeevamrutha application (117.0 and 139.5 q ha^{-1}) and an increase in yield was 26.6 q ha^{-1} with jeevamrutha and 22.5 q ha^{-1} without jeevamrutha over the seasons (2014 and 2015) in first experiment (Table 64). While in second experiment, application of jeevamrutha at $2000 \text{ litre ha}^{-1}$ recorded significantly higher frenchbean yield (134.3 and 156.9 q ha^{-1}) and an increase of 14.3 , 20.5 and 25.7 per cent during 2014 and 13.0 , 21.6 and 28.1 per cent during 2015 over 1500 , $1000 \text{ litre ha}^{-1}$ and without jeevamrutha application, respectively. Jeevamrutha application at 1500 and $1000 \text{ litre ha}^{-1}$ increased the yield of 13.23 and 6.49 per cent in 2014 and 17.4 and 8.3 per cent than without jeevamrutha application (Table 69). These results are in conformity with Siddappa (2015) in fieldbean where jeevamrutha at $1500 \text{ litres ha}^{-1}$ recorded significantly higher grain

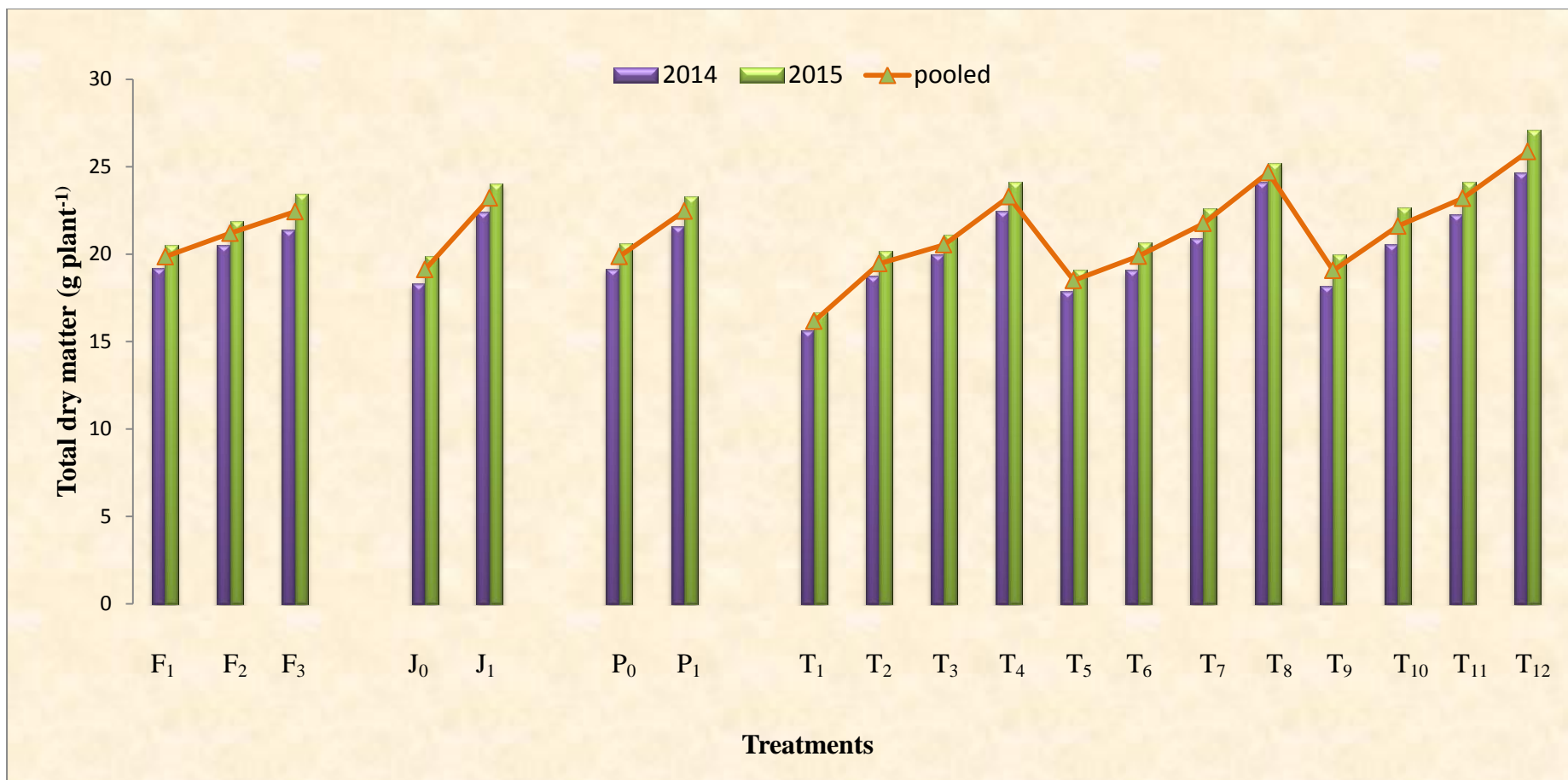


Fig. 9: Influence of FYM, jeevamruta and panchagavya application on total dry matter per plant of frenchbean

F₁- 100 %, F₂- 150 % and F₃- 200 % equivalent N through FYM, J₀- Without Jeevamrutha, J₁- Jeevamrutha 1000 litre/ha, P₀- Without panchagavya, P₁- Panchagavya at 3 %, T₁= F₁J₀P₀, T₂= F₁J₀P₁, T₃=F₁J₁P₀, T₄=F₁J₁P₁, T₅=F₂J₀P₀, T₆= F₂J₀P₁, T₇=F₂J₁P₀, T₈=F₂J₁P₁, T₉=F₃J₀P₀, T₁₀=F₃J₀P₁, T₁₁= F₃J₁P₀, T₁₂=F₃J₁P₁

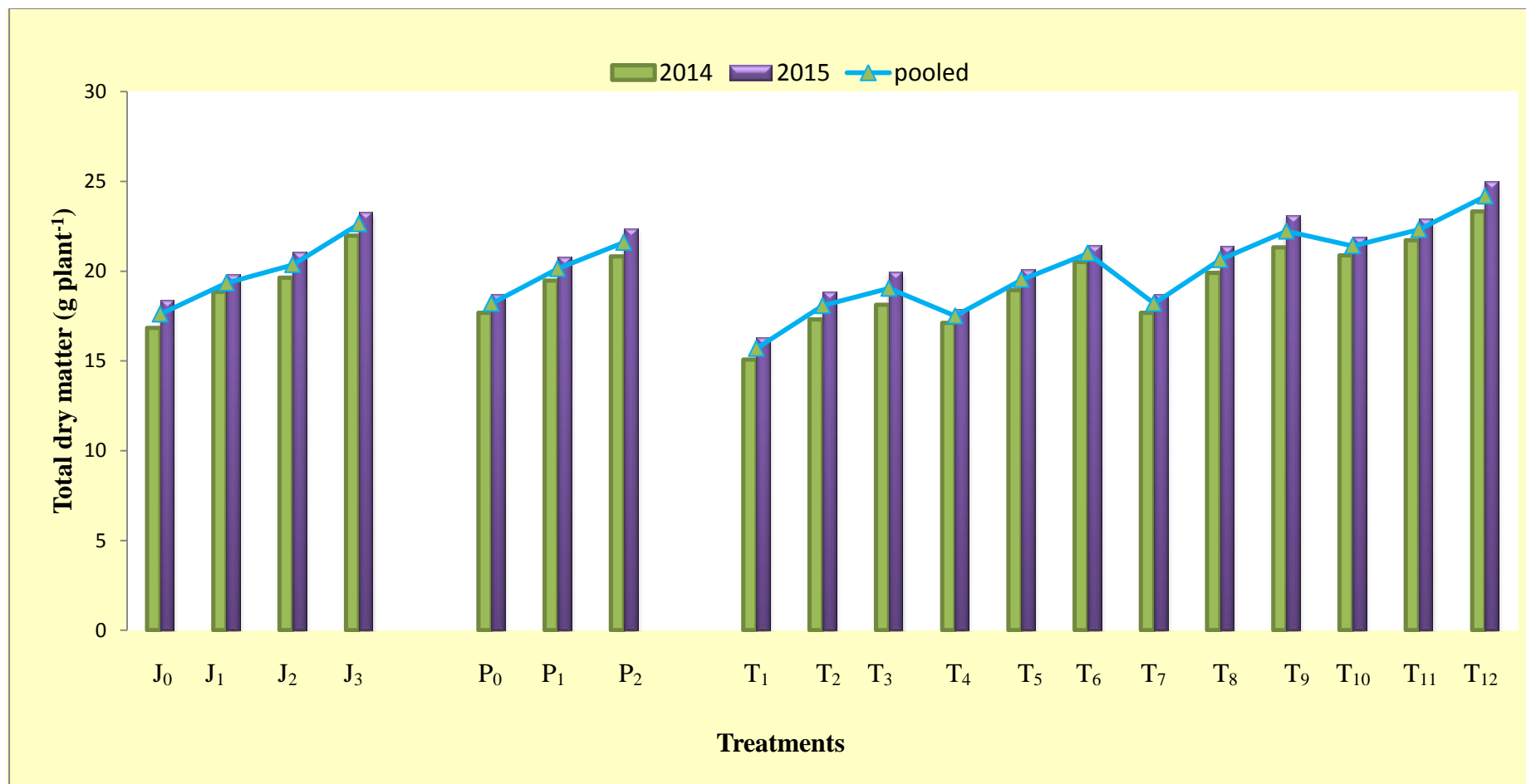


Fig. 10: Influence of jeevamrutha and panchagavya application on total dry matter accumulation per plant of frenchbean

J₀- Without Jeevamrutha, **J₁**- Jeevamrutha 1000 litre/ha, **J₂**- Jeevamrutha 1500 litre/ha, **J₃**- Jeevamrutha 2000 litre/ha, **P₀**- Without panchagavya, **P₁**- Panchagavya at 3 %, **P₂**- Panchagavya at 6 %, **T₁**= J₀P₀, **T₂**=J₀P₁, **T₃**=J₀P₂, **T₄**=J₁P₀, **T₅**=J₁P₁, **T₆**=J₁P₂, **T₇**=J₂P₀, **T₈**=J₂P₁, **T₉**=J₂P₂, **T₁₀**=J₃P₀, **T₁₁**=J₃P₁, **T₁₂**=J₃P₂

yield ($1245.8 \text{ kg ha}^{-1}$) an increase of 35.12 per cent over without jeevamrutha application (808.3 kg ha^{-1}). Similar results were also reported by Devakumar *et al.*, (2008) and Boraiah (2013) in field bean and capsicum. The increase in pod yield of frenchbean might be due to better availability of nutrients throughout the crop growth period. This was ensured by improved microbial activity in the soil. Increased yield due to increasing sink potential as indicated by higher number of pods. This could be attributed to better availability and uptake of moisture, nutrients which helped in production of more photosynthates and its translocation to the pods during their development (Srivastava, 1988 and Gopinath *et al.*, 2009). These findings are in accordance with Kasbe *et al.*, (2009) and they reported that higher nutrient status of jeevamrutha formulation ($2500 \text{ litres ha}^{-1}$) resulted in profuse growth which was reflected in higher dry matter accumulation and yield parameters.

Increase in yield with increased levels of jeevamrutha application might also be due to taller plants with more number of branches per plant, more pods per plant, higher pod weight per plant, higher leaf area and total dry matter production per plant (Fig. 9 and 10). This might be due to the fact that most of the nutrients supplied through liquid manures are readily available for plant growth and development and also could have matched crop's demand for nutrients. Higher growth parameters with jeevamrutha application also due to presence of growth promoting substances such as auxins, gibberlins, cytokinens and beneficial microorganisms apart from having lower concentration of both macro and micro nutrients. Similarly, increment in growth parameters were also observed with increased levels of jeevamrutha application in fieldbean (Devakumar *et al.*, 2008 and Siddappa, 2015). Significantly, higher dry matter production recorded with application of jeevamrutha was observed throughout the crop growth period might be due to the continuous supply of nutrients and plant growth promoting substances present in jeevamrutha this might have resulted in better growth and yield of frenchbean. This is in confirmity with Sreenivasa *et al.* (2009), Nileema and Sreenivasa (2011) and Boraiah (2013) who have noticed higher dry matter production and number of fruits per plant and fruit weight of capsicum with application of jeevamrutha. Devakumar *et al.* (2008 2011 and 2014) and Sreenivasa *et al.* (2009) have also reported the presence of higher beneficial microbial population and the beneficial effect of jeevamrutha in enhancing the growth and yield.

Application of higher levels of jeevamrutha at $2000 \text{ litre ha}^{-1}$ recorded higher yield during 2014 and 2015 (134.3 and 156.9 q ha^{-1}) with panchagavya levels which was comparable with FYM at 200 per cent N equivalent during 2014 (135.2 q ha^{-1}) and FYM at 150 per cent N equivalent (158.8 q ha^{-1}) during *Kharif* 2015. This is in line with Siddappa (2015) who have reported application of jeevamrutha at $1500 \text{ litre ha}^{-1}$ recorded higher grain yield ($1245.8 \text{ kg ha}^{-1}$) as compared to FYM at 200 per cent N equivalent ($1135.8 \text{ kg ha}^{-1}$) in fieldbean. Similarly, Aulakh *et al.* (2013) also reported that application of jeevamrutha (soil + foliar) resulted higher grain yield in Maze-wheat and Rice-wheat cropping system as compared to FYM at 200 per cent N equivalent. Growth and yield parameters with respect to jeevamrutha at $200 \text{ litre ha}^{-1}$ and FYM at 150 per cent N equivalent in present investigation were having comparable values throughout the crop growth period might be due to the continuous supply of nutrients and plant growth

promoting substances present in jeevamrutha this might have resulted in better growth and yield of frenchbean. This might also be due to the fact that jeevamrutha having more impact on crop growth as compared to FYM, most of the nutrients supplied through liquid manures are readily available for plant growth and development and also presence of growth promoting substances in jeevamrutha such as auxins, gibberlins, cytokinens and it is a fermented liquid product containing huge quantity of microbial load which enhances soil bio-mass upon its application to the soil even at very lesser rate as it act as a tonic to soil besides improving soil health (Vasanthkumar, 2006; Palekar, 2006 and Devakumar *et al.*, 2008 and 2014).

During *Kharif* 2014 and 2015 application of panchagavya at 3 per cent recorded significantly higher frenchbean yield (138.7 and 164.7 q ha⁻¹) as compared to without panchagavya application (120.0 and 143.1 q ha⁻¹) and an increase in yield was 26.0 q ha⁻¹ with panchagavya and 23.1 q ha⁻¹ without panchagavya over the season (2014 and 2015) in first experiment. While in second experiment application of panchagavya at 6 per cent recorded significantly higher frenchbean yield (124.4 and 142.8 q ha⁻¹) and an increase of 6.7 and 18.5 per cent during 2014 and 6.1 and 15.9 per cent during 2015 over 3 per cent and without panchagavya application, respectively. Panchagavya application at 3 per cent recorded 12.7 and 10.4 per cent yield increase over without panchagavya application during 2014 and 2015 (Table 69). Increase in yield with higher levels of panchagavya application might be due to increased plant height, Number of branches, total dry matter accumulation, Number of pods per plant and pod weight. This is in confirmity with Vasumathi *et al.* (2001), Geetha and Devaraj (2013) and Swain *et al.* (2015). Foliar spray of panchagavya enhanced the growth parameters since it contains macro and micro nutrients which are readily available for plant growth and development, growth hormones and biofertilizers in liquid formulations and further it might have also due to growth enzymes present in panchagavya which favour rapid cell division and multiplication and this is in accordance with Geetha and Devaraj (2013) and Vasumathi, *et al.* (2001). Further, higher yield levels with panchagavya spray might also be due to growth promoters like auxines, GA along with biofertilizers which helped in producing higher biomass (Sanjutha *et al.*, 2008; Palekar, 2006; Natarajan, 2007 and Patel *et al.*, 2014), this is also in conformity with Devakumar *et al.* (2008 and 2011), who have also reported presence of beneficial microorganisms such as N-fixers, P-solblizers, Actinomycetes, fungi and bacteria in panchagavya and multiplication of beneficial biocontrol agents in panchagavya.

This might also be due to the better availability of nutrients and effective conversion of Fe, Mg and zinc at the sight of photosynthesis into pigments. Azospirillum present in the panchagavya and coconut water is one of ingredient of panchagavya which contains kinetin along with other enzymes might have increased the chlorophyll content of leaves since they play a vital role in N fixation and pigment synthesis, this was also in conformity with Devakumar *et al.* (2008 and 2011) and Geetha and Devaraj (2013). According to Chandrakala *et al.*, (2007), foliar spray of panchagavya increased biological efficiency of crop plants by creating greater source (Plant sprayed with panchagavya invariably produce bigger leaves) in the plant that might have helped in absorption of nutrients and increased photosynthetic efficiency of plants (Boomathi *et al.*, 2005).

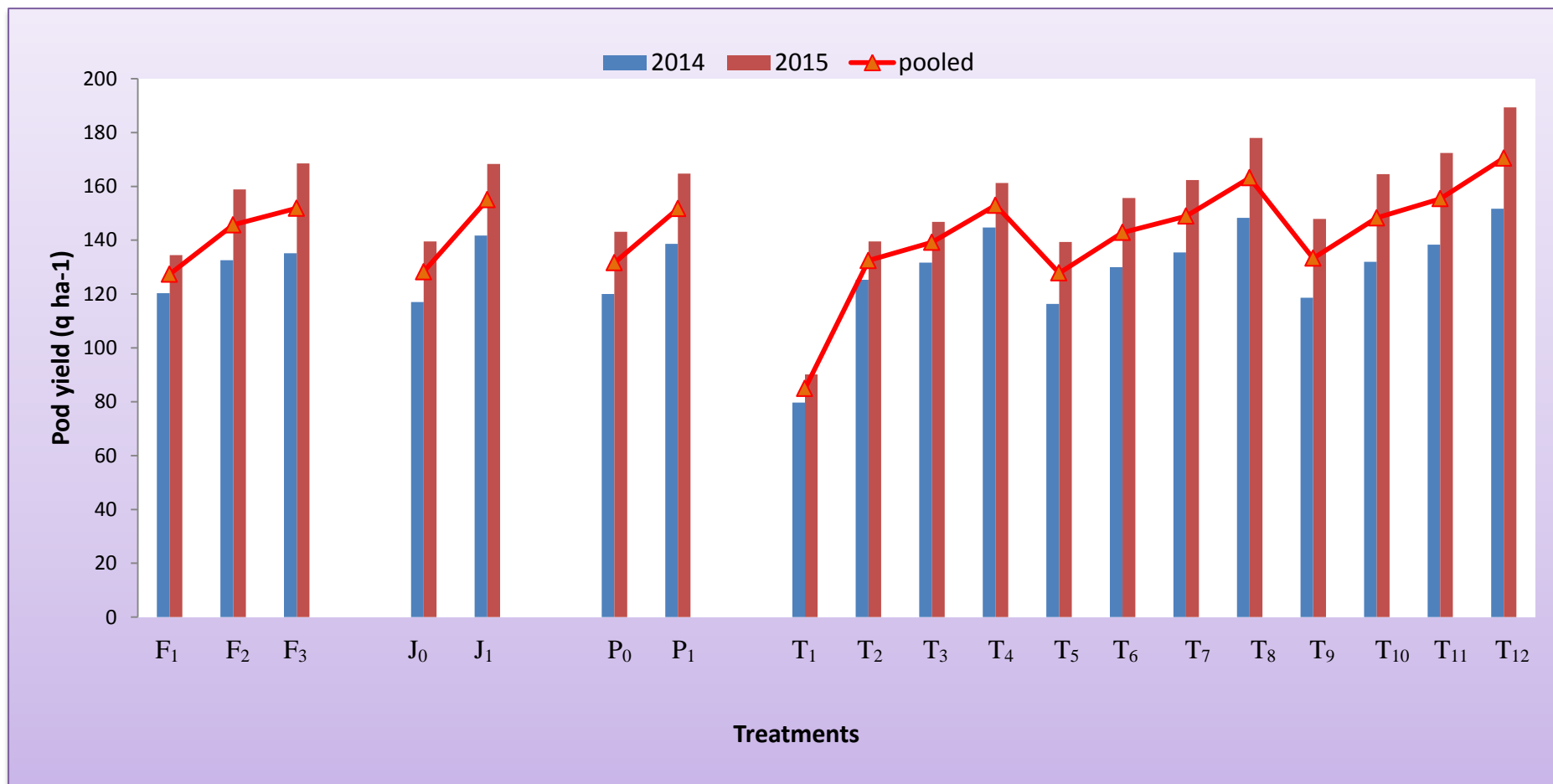


Fig. 11: Influence of FYM, jeevamruta and panchagavya application on pod yield of frenchbean

F₁- 100 %, F₂- 150 % and F₃- 200 % equivalent N through FYM, J₀- Without Jeevamruta, J₁- Jeevamruta 1000 litre/ha, P₀- Without panchagavya, P₁- Panchagavya at 3 %, T₁= F₁J₀P₀, T₂= F₁J₀P₁, T₃=F₁J₁P₀, T₄=F₁J₁P₁, T₅=F₂J₀P₀, T₆= F₂J₀P₁, T₇=F₂J₁P₀, T₈=F₂J₁P₁, T₉=F₃J₀P₀, T₁₀=F₃J₀P₁, T₁₁= F₃J₁P₀, T₁₂=F₃J₁P₁

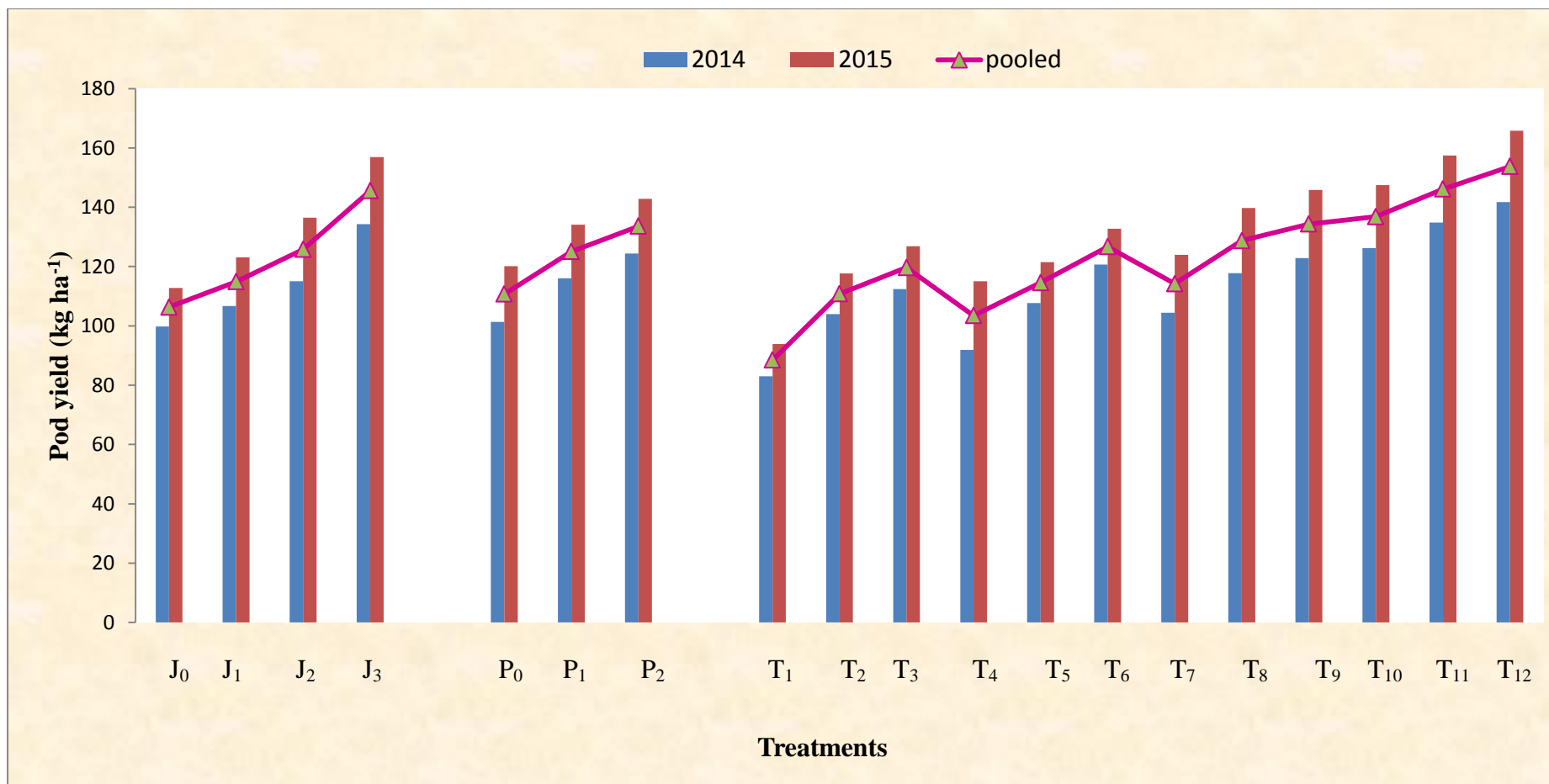


Fig. 12: Influence of jeevamruta and panchagavya application on pod yield of frenchbean

J₀- Without Jeevamrutha, **J₁**- Jeevamrutha 1000 litre/ha, **J₂**- Jeevamrutha 1500 litre/ha, **J₃**- Jeevamrutha 2000 litre/ha, **P₀**- Without panchagavya, **P₁**- Panchagavya at 3 %, **P₂**- Panchagavya at 6 %, **T₁**= J₀P₀, **T₂**=J₀P₁, **T₃**=J₀P₂, **T₄**=J₁P₀, **T₅**=J₁P₁, **T₆**=J₁P₂, **T₇**=J₂P₀, **T₈**=J₂P₁, **T₉**=J₂P₂, **T₁₀**=J₃P₀, **T₁₁**=J₃P₁, **T₁₂**=J₃P₂

Similarly increment in growth and yield parameters were also observed with application of panchagavya at 6 per cent in capsicum (Boraiah, 2013) and panchagavya at 5 per cent in mungbean (Sharvankumar, 2014). According to Muthuvel (2002) four sprays of panchagavya at 3 per cent and moringa leaf extract spray 25 ml liter⁻¹ resulted in higher growth parameters and yield.

Application of jeevamruta with panchagavya recorded higher growth and yield parameters in both the experiments. During 2014 and 2015 application of jeevamruta at 1000 litre ha⁻¹ with panchagavya 3 per cent in first experiment recorded higher pod yield (148.2 and 176.2 q ha⁻¹) as compared to their individual application of jeevamruta at 1000 litre ha⁻¹ (141.7 and 168.3 q ha⁻¹) and panchagavya 3 per cent (138.7 and 164.7 q ha⁻¹) i.e., combined application resulted in 4.61 and 4.65 per cent yield increase over jeevamruta individual application while it was 6.89 and 6.96 in panchagavya over panchagavya individual application during 2014 and 2015 respectively. While in second experiment jeevamruta at 2000 litre ha⁻¹ with panchagavya 6 per cent recorded higher pod yield (141.8 and 165.77 q ha⁻¹) as compared to their individual application of jeevamruta at 2000 litre ha⁻¹ (134.3 and 156.9 q ha⁻¹) and only panchagavya 6 per cent (124.4 and 142.8 q ha⁻¹) during 2014 and 2015. Combined application resulted in 5.59 and 5.65 per cent yield increase yield over jeevamruta individual application while it was 17.34 and 16.09 in panchagavya over individual application during 2014 and 2015 respectively. This might be due to the fact that jeevamrutha and panchagavya are rich source of beneficial microorganisms and contains growth promoting substances such as auxins, gibberlins, cytokinens apart from having lower concentration of both macro and micro nutrients. This is in conformity with Devakumar *et al.* (2008, 2011 and 2014) and Sreenivasa *et al.* (2009) have also reported the higher beneficial microbial population and the beneficial effect of liquid manures in enhancing the microbial load in the jeevamrutha. Further, application of beejamrutha + jeevamrutha + panchagavaya might have resulted in better availability of nutrients throughout crop growth due to higher microbial activities and soil enzymatic activity resulted in better crop establishment and yield. Shwetha (2008) reported that 25 to 35 per cent increase in seed yield of soybean with the application of beejamrutha, jeevamrutha and panchagavya along with different organic manures. This was also in conformity with Sanjutha *et al.* (2008), Shridhar *et al.* (2001), Sadanandam *et al.* (1998) and Swain *et al.* (2015) who have also reported application of panchagavya and organic manures significantly influence the plant height, number of branches, nutrient content, total dry matter of production and yield in different crops.

Jeevamrutha and panchagavya application resulted in early flowering as compared to without jeevamrutha and without panchagavya this may be due to presence growth promoting substances and better nutrition of plants. Similar results were also noticed by Siddappa (2015) in fieldbean and Sharvankumar (2014) in mungbean. Application of panchagavya has growth regulating effect along with insecticidal properties which must have triggered the formation of florigen resulting in early flowering (Swain *et al.*, 2015).

Combined application of FYM at 200 per cent N equivalent with jeevamruta 1000 litre ha⁻¹ and panchagavya at 3 per cent recorded higher yield of 151.7 and 189.3 q ha⁻¹ as compared to their individual application of FYM at 200 per cent N equivalent (135.2 and 168.5 q ha⁻¹), jeevamruta 1000 litre ha⁻¹ (141.7 and 168.3 q ha⁻¹) and panchagavya at 3 per cent (138.7 and 164.7 q ha⁻¹) during *Kharif* 2104 and 2015 (Table 64). Combined application of FYM at 200 per cent N equivalent with jeevamruta 1000 litre ha⁻¹ and panchagavya at 3 per cent recorded increase in the per cent yield of 10.9 and 10.5 over FYM at 200 per cent N equivalent, 6.6 and 11.1 over jeevamruta 1000 litre ha⁻¹ and 8.6 and 13.0 over panchagavya at 3 per cent individual application during *Kharif* 2104 and 2015. This might be due to most of the nutrients supplied through FYM with liquid manures are readily available for plant growth and development and also could have matched crop's demand for nutrients. Besides, they might have improved the soil physical properties, enhanced soil microbial activity and higher nutrient availability resulting in congenial soil condition. Besides, they might have improved the soil physical properties, enhanced soil microbial activity and higher nutrient availability resulting in congenial soil condition and also beneficial micro organism present in the liquid organic manures (Somasundaram, 2003, Devakumar *et al.*, 2008 and Lavanya *et al.*, 2016) which made crop perform better in the present investigation. Application of liquid manures enhanced the growth parameters since they contain macro and micro nutrients, growth hormones and biofertilizers in the liquid formulations and further it might be due to growth enzymes present in panchagavya which favour rapid cell division and multiplication and combined application of organics might have resulted in better availability of nutrients throughout the crop growth period as witnessed in increased soil microbial population. Devakumar *et al.* (2016) reported that application of N equivalent compost with beejamruta and jeevamruta resulted in increasing the yield of organic fieldbean compared to individual application of different N equivalent compost, beejamruta and jeevamruta. Similar results were also noticed by Reshma *et al.* (2016) reported that combined application of jeevamruta (1000 litre ha⁻¹) and panchagavya (7.5 %) with organic manures resulted in better growth, yield and yield attributing characters in cowpea besides conserving soil health.

Exp I: Effect of different levels of FYM, jeevamrutha and panchagavya on quality parameters of frenchbean

Quality parameters were significantly influenced by application of solid and liquid manures. The data pertaining to the quality parameters *viz.*, protein, shelf life and carbohydrate content of green pods are presented in Tables 71, 72 and 73.

4.7.1 Crude protein content (%)

Experiment conducted during *kharif* 2014

There was increase in crude protein content of green pods with increased levels of FYM, jeevamrutha and panchagavya application. Significantly higher protein content was recorded with FYM at 200 per cent (22.70 %) followed by FYM at 150 percent N equivalent (21.44 %) as compared to FYM at 100 per cent N equivalent (20.57 %). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent recorded significantly



200 per cent N equivalent through FYM + jeevamrutha at 1000 litres ha⁻¹ + panchagavya 3 per cent



100 per cent N equivalent through FYM + without jeevamrutha + without panchagavya

Plate 8: Effect of FYM, jeevamrutha and panchagavya on on root nodulation



Jeevamrutha at 2000 litres ha⁻¹ + panchagavya 6 per cent



Without jeevamrutha + without panchagavya

Plate 9: Effect of jeevamrutha and panchagavya on root nodulation

Table 71: Effect of FYM and liquid manures on quality parameters of french during Kharif 2014

Treatments	At Harvest								
	Crude Protein (%)			CHO (%)			Shelf life (Days)		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	20.40	20.73	20.57	4.17	4.60	4.39	8.17	8.83	8.50
F ₂	20.74	22.14	21.44	4.76	5.05	4.90	8.50	9.50	9.00
F ₃	22.31	23.09	22.70	5.04	5.21	5.13	9.17	9.83	9.50
Mean	21.15	21.99		4.66	4.95		8.61	9.39	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.17	0.51		0.07	0.21		0.21	0.60	
J	0.14	0.41		0.06	0.17		0.17	0.49	
F × J	0.24	NS		0.10	NS		0.29	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	20.50	20.63	20.57	4.29	4.49	4.69	8.17	8.83	8.50
F ₂	20.90	21.97	21.44	4.80	5.00	4.90	8.67	9.33	9.00
F ₃	22.34	23.06	22.70	5.06	5.20	5.13	9.17	9.83	9.50
Mean	21.25	21.89		4.71	4.90		8.67	9.33	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.14	0.41		0.06	0.17		0.17	0.49	
F × P	0.24	NS		0.10	NS		0.29	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	20.90	21.40	21.15	4.55	4.76	4.66	8.33	8.89	8.61
J ₁	21.60	22.37	21.99	4.88	5.03	4.95	9.00	9.78	9.39
Mean	21.25	21.89		4.71	4.90		8.67	9.33	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.20	NS		0.08	NS		0.24	NS	
Interaction	P₀	P₁		P₀	P₁		P₀	P₁	
F × J × P									
F ₁ J ₀	20.32	20.49		4.07	4.28		8.00	8.33	
F ₁ J ₁	20.68	20.78		4.50	4.70		8.33	9.33	
F ₂ J ₀	20.69	20.78		4.66	4.85		8.33	8.67	
F ₂ J ₁	21.12	23.16		4.94	5.15		9.00	10.00	
F ₃ J ₀	21.69	22.94		4.94	5.15		8.67	8.67	
F ₃ J ₁	22.99	23.19		5.19	5.24		9.67	10.00	
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	0.34	1.01		0.14	NS		0.41	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 72: Effect of FYM and liquid manures on quality parameters of frenchbean during Kharif 2015

Treatments	At Harvest								
	Crude Protein (%)			CHO (%)			Shelf life (Days)		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	20.77	21.14	20.96	4.25	4.69	4.47	8.67	9.33	9.00
F ₂	21.09	22.49	21.79	4.84	5.13	4.99	9.00	9.83	9.42
F ₃	22.73	23.51	23.12	5.13	5.31	5.22	9.67	10.17	9.92
Mean	21.53	22.38		4.74	5.04		9.11	9.78	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.17	0.50		0.05	0.14		0.18	0.52	
J	0.14	0.41		0.04	0.12		0.14	0.42	
F × J	0.24	NS		0.07	NS		0.25	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	20.87	21.05	20.96	4.37	4.57	4.47	8.67	9.33	9.00
F ₂	21.26	22.32	21.79	4.89	5.09	4.99	9.00	9.83	9.42
F ₃	22.79	23.46	23.12	5.16	5.28	5.22	9.67	10.17	9.92
Mean	21.64	22.27		4.80	4.98		9.11	9.78	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.14	0.41		0.04	0.12		0.14	0.42	
F × P	0.24	NS		0.07	NS		0.25	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	21.25	21.81	21.53	4.64	4.84	4.74	8.78	9.44	9.11
J ₁	22.03	22.73	22.38	4.97	5.12	5.04	9.44	10.11	9.78
Mean	21.64	22.27		4.80	4.98		9.11	9.78	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.20	NS		0.06	NS		0.20	NS	
Interaction	P₀	P₁		P₀	P₁		P₀	P₁	
F × J × P									
F ₁ J ₀	20.65	20.90		4.14	4.35		8.33	9.00	
F ₁ J ₁	21.09	21.19		4.59	4.79		9.00	9.67	
F ₂ J ₀	20.98	21.20		4.74	4.95		8.67	9.33	
F ₂ J ₁	21.54	23.44		5.04	5.23		9.33	10.33	
F ₃ J ₀	22.12	23.35		5.04	5.22		9.33	10.00	
F ₃ J ₁	23.45	23.56		5.28	5.34		10.00	10.33	
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	0.34	1.00		0.06	NS		0.35	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS - Days After Sowing, RDF - 63:100:75 NPK kg ha⁻¹

Table 73: Effect of FYM and liquid manures on quality parameters of frenchbean (Pooled 2014 and 2015)

Treatments	At Harvest								
	Crude Protein (%)			CHO (%)			Shelf life (Days)		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	20.59	20.93	20.76	4.21	4.65	4.43	8.42	9.08	8.75
F ₂	20.91	22.32	21.61	4.80	5.09	4.94	8.75	9.67	9.21
F ₃	22.52	23.30	22.91	5.09	5.26	5.17	9.42	10.00	9.71
Mean	21.34	22.18		4.70	5.00		8.86	9.58	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.17	0.50		0.05	0.15		0.16	0.47	
J	0.14	0.41		0.04	0.12		0.13	0.39	
F × J	0.24	NS		0.07	NS		0.23	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	20.68	20.84	20.76	4.33	4.53	4.43	8.42	9.08	8.75
F ₂	21.08	22.14	21.61	4.84	5.05	4.94	8.83	9.58	9.21
F ₃	22.56	23.26	22.91	5.11	5.24	5.17	9.42	10.00	9.71
Mean	21.44	22.08		4.76	4.94		8.89	9.56	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.14	0.41		0.04	0.12		0.13	0.39	
F × P	0.24	NS		0.07	NS		0.23	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	21.07	21.61	21.34	4.60	4.80	4.70	8.56	9.17	8.86
J ₁	21.81	22.55	22.18	4.92	5.08	5.00	9.22	9.94	9.58
Mean	21.44	22.08		4.76	4.94		8.89	9.56	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.20	NS		0.06	NS		0.19	NS	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁	J ₀	20.49	20.69		4.10	4.31		8.17	8.67
	J ₁	20.88	20.98		4.55	4.75		8.67	9.50
F ₂	J ₀	20.83	20.99		4.70	4.90		8.50	9.00
	J ₁	21.33	23.30		4.99	5.19		9.17	10.17
F ₃	J ₀	21.90	23.14		4.99	5.19		9.00	9.83
	J ₁	23.22	23.38		5.23	5.29		9.83	10.17
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	0.34	NS		0.1	NS		0.32	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

higher crude protein content of green pod (21.99 and 21.89 %) as compared to without jeevamrutha and without panchagavya application (21.15 and 21.25 %).

Crude protein content of green pods differs significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application. Application of FYM at 200 per cent N equivalent jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent recorded significantly higher crude protein content of green pods (23.19 %) as compared to FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya application (20.32 %). Application of both jeevamrutha and panchagavya along with FYM interaction given higher crude protein content of green pods as compared to no-jeevamrutha and no-panchagavya along with FYM interaction.

Crude protein content of green pods did not differ significantly due to the interaction between FYM and jeevamrutha, FYM and panchagavya, jeevamrutha application and panchagavya.

Experiment conducted during *kharif* 2015

There was increased crude protein content of green pods with increased levels of FYM, jeevamrutha and panchagavya application. Significantly higher protein content was recorded with FYM at 200 per cent (23.12 %) followed by FYM at 150 percent N equivalent (21.79 %) as compared to FYM at 100 per cent N equivalent (20.96 %). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent recorded significantly higher crude protein content of green pod (21.81 and 22.73 %) as compared to without jeevamrutha and without panchagavya application (21.25 and 22.03 %).

Significantly higher crude protein content of green pod was recorded with the interaction between FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent (23.56 %) as compared to FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya application (20.65 %). Application of both jeevamrutha and panchagavya along with FYM interaction given higher crude protein content of green pods as compared to no-jeevamrutha and no-panchagavya along with FYM interaction.

Crude protein content of green pods did not differ significantly due to the interaction between FYM and jeevamrutha, FYM and panchagavya, jeevamrutha and panchagavya application.

Pooled

There was increased crude protein content of green pods with increased levels of FYM, jeevamrutha and panchagavya application. Significantly higher protein content was recorded with FYM at 200 per cent (22.91 %) followed by FYM at 150 percent N equivalent (21.61 %) as compared to FYM at 100 per cent N equivalent (20.79 %). Jeevamrutha at 1000 L ha⁻¹ and panchagavya at 3 per cent recorded significantly higher crude protein content of green pod (22.18 and 22.08 %, respectively) as compared to without jeevamrutha and without panchagavya application (21.34 and 21.44 %, respectively).

Crude protein content of green pods differed significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application. Application of FYM at 200 per cent N equivalent jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent recorded significantly higher crude protein content of green pods (23.38 %) as compared to FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya application (20.49 %). Crude protein content of green pods did not differ significantly due to the interaction between FYM and jeevamrutha, FYM and panchagavya, jeevamrutha and panchagavya application.

4.7.2 Carbohydrate content (%)

Experiment conducted during *kharif* 2014

There was increased carbohydrate content of green pods with increased levels of FYM, jeevamrutha and panchagavya application. Application of FYM at 200 per cent N equivalent (5.13 %) recorded significantly higher carbohydrate content of green pods followed by FYM at 150 percent N equivalent (4.90 %) as compared to FYM at 100 per cent N equivalent (4.39 %). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent recorded significantly higher carbohydrate content of green pod (4.95 and 4.90 %) as compared to without jeevamrutha and without panchagavya application (4.66 and 4.71 %).

Experiment conducted during *kharif* 2015

Increased levels of FYM, jeevamrutha and panchagavya application resulted in increased carbohydrate content of green pods. Significantly higher carbohydrate content of green pod was recorded with the application of FYM at 200 per cent N equivalent (5.22 %) followed by FYM at 150 percent N equivalent (4.99 %) as compared to FYM at 100 per cent N equivalent (4.47 %). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent recorded significantly higher carbohydrate content of green pod (5.04 and 4.98 %) as compared to without jeevamrutha and without panchagavya application (4.74 and 4.80 %).

Interaction effect

Carbohydrate content of green pods did not differ significantly due to the interaction between FYM and jeevamrutha, FYM and panchagavya, jeevamrutha and panchagavya, FYM, jeevamrutha and panchagavya application during both the years.

Pooled

There was increased carbohydrate content of green pods with increased levels of FYM, jeevamrutha and panchagavya application. Application of FYM at 200 per cent N equivalent (5.17 %) recorded significantly higher carbohydrate content of green pods followed by FYM at 150 percent N equivalent (4.94 %) as compared to FYM at 100 per cent N equivalent (4.43 %). Jeevamrutha at 1000 L ha⁻¹ and panchagavya at 3 per cent recorded significantly higher Carbohydrate content of green pod (5.00 and 4.94 %, respectively) as compared to without jeevamrutha and without panchagavya application (4.70 and 4.76 %, respectively). Carbohydrate content of green pods did not differ

significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application.

4.7.3 Shelf life of frenchbean at room temperature (days)

Experiment conducted during *kharif* 2014

Shelf life of frenchbean increased with increased levels of FYM, jeevamrutha and panchagavya application. Keeping duration of green pods was significantly more in FYM at 200 per cent N equivalent (9.50) followed by FYM at 150 percent N equivalent (9.00) and FYM at 100 per cent N equivalent (8.50). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent recorded significantly higher shelf life of green pods (9.39 and 9.33) as compared to without jeevamrutha and without panchagavya application (8.61 and 8.67, respectively).

Experiment conducted during *kharif* 2015

Keeping duration of green pods was significantly more in FYM at 200 per cent N equivalent (9.92) followed by FYM at 150 percent N equivalent (9.42) and FYM at 100 per cent N equivalent (9.00). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent recorded significantly higher shelf life of green pods (9.78 and 9.78) as compared to without jeevamrutha and without panchagavya application (9.11 and 9.11, respectively).

Interaction effect

Shelf life of frenchbean did not differ significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application during both the years.

Pooled

Shelf life of frenchbean increased with increased levels of FYM, jeevamrutha and panchagavya application. Keeping duration of green pods was significantly more in FYM at 200 per cent N equivalent (9.71) followed by FYM at 150 percent N equivalent (9.21) and FYM at 100 per cent N equivalent (8.75). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent recorded significantly higher shelf life of green pods (9.58 and 9.56, respectively) as compared to without jeevamrutha and without panchagavya application (8.86 and 8.89, respectively). Keeping duration of frenchbean did not differ significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application.

Exp II. Effect of different levels of jeevamrutha and panchagavya on quality parameters of frenchbean

Quality parameters were significantly influenced by application of liquid manures. The data pertaining to the quality parameters *viz.*, protein, shelf life and carbohydrate content of green pods are presented in tables 74, 75 and 76.

4.8.1 Crude protein content (%)

Experiment conducted during *kharif* 2014

Jeevamrutha and panchagavya application increased crude protein content of green pods with increased levels. Significantly higher protein content was recorded with jeevamrutha at 2000 litre ha⁻¹ (21.53 %) followed by jeevamrutha at 1500 litre ha⁻¹ (21.12 %), jeevamrutha at 1000 litre ha⁻¹ (20.81 %) as compared no jeevamrutha application (20.33 %). Panchagavya at 6 per cent recorded significantly higher crude protein content of green pod (21.22 %) followed by panchagavya at 3 per cent (20.94 %) as compared to without panchagavya application (20.67 %).

Experiment conducted during *kharif* 2015

Jeevamrutha and panchagavya application increased crude protein content of green pods with increased levels. Significantly higher protein content was recorded with jeevamrutha at 2000 litre ha⁻¹ (22.07 %) followed by jeevamrutha at 1500 litre ha⁻¹ (21.64 %), jeevamrutha at 1000 litre ha⁻¹ (21.28 %) as compared no jeevamrutha application (20.76 %). Panchagavya at 6 per cent recorded significantly higher crude protein content of green pod (21.73 %) followed by panchagavya at 3 per cent (21.45 %) as compared to without panchagavya application (21.13 %).

Interaction effect

Crude protein content of green pods did not differ significantly due to the interaction between various levels of jeevamrutha and panchagavya application during both the years.

Pooled

Jeevamrutha and panchagavya application increased crude protein content of green pods with increased levels. Significantly higher protein content was recorded with jeevamrutha at 2000 litre ha⁻¹ (21.8 %) followed by jeevamrutha at 1500 litre ha⁻¹ (21.38 %), jeevamrutha at 1000 litre ha⁻¹ (21.04 %) as compared no jeevamrutha application (20.54 %). Panchagavya at 6 per cent recorded significantly higher crude protein content of green pod (21.48 %) followed by panchagavya at 3 per cent (21.20 %) as compared to without panchagavya application (20.90 %). Crude protein and carbohydrate content of green pods did not differ significantly due to the interaction between various levels of jeevamrutha and panchagavya application.

Table 74: Effect of liquid manures on quality parameters of frenchbean during *Kharif* 2014

Jeevamrutha Levels	Crude Protein (%)				CHO (%)				Shelf life (Days)			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	20.21	20.29	20.48	20.33	3.99	4.20	4.44	4.21	8.33	8.33	8.67	8.44
J₁	20.65	20.71	21.06	20.81	4.62	4.71	4.76	4.70	8.67	9.33	9.67	9.22
J₂	20.73	21.25	21.37	21.12	4.74	5.03	5.10	4.96	8.67	10.00	10.33	9.67
J₃	21.08	21.52	21.98	21.53	5.05	5.08	5.14	5.09	9.67	10.00	10.67	10.11
Mean	20.67	20.94	21.22		4.60	4.76	4.86		8.83	9.42	9.83	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.09		0.25		0.05		0.15		0.21		0.61	
Panchagavya	0.08		0.22		0.04		0.13		0.18		0.52	
J × P	0.15		NS		0.09		NS		0.36		NS	

Note: **J₀** - Without Jeevamrutha, **J₁**- Jeevamrutha 1000 litre/ha, **J₂** - Jeevamrutha 1500 litre/ha, **J₃** - Jeevamrutha 2000 litre/ha

P₀ - Without panchagavya, **P₁** - Panchagavya at 3 %, **P₂** - Panchagavya at 6 %, **DAS** – Days After Sowing, **RDF** – 63:100:75 NPK kg ha⁻¹

Table 75: Effect of liquid manures on quality parameters of frenchbean during *Kharif* 2015

Jeevamrutha Levels	Crude Protein (%)				CHO (%)				Shelf life (Days)			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	20.58	20.77	20.93	20.76	4.10	4.31	4.55	4.32	8.67	9.00	9.67	9.11
J₁	21.08	21.21	21.55	21.28	4.74	4.83	4.88	4.81	9.33	10.00	10.33	9.89
J₂	21.23	21.78	21.90	21.64	4.86	5.16	5.23	5.08	9.67	10.33	10.67	10.22
J₃	21.63	22.05	22.54	22.07	5.18	5.21	5.26	5.22	10.00	10.67	11.00	10.56
Mean	21.13	21.45	21.73		4.72	4.87	4.98		9.42	10.00	10.42	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.09		0.26		0.05		0.15		0.22		0.63	
Panchagavya	0.08		0.22		0.04		0.13		0.19		0.55	
J × P	0.15		NS		0.09		NS		0.37		NS	

Note: J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, J₂ - Jeevamrutha 1500 litre/ha, J₃ - Jeevamrutha 2000 litre/ha

P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, P₂ - Panchagavya at 6 %, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 76: Effect of liquid manures on quality parameters of frenchbean at harvest (Pooled 2014 and 2015)

Jeevamrutha Levels	Crude Protein (%)				CHO (%)				Shelf life (Days)			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	20.39	20.53	20.71	20.54	4.04	4.25	4.49	4.26	8.50	8.67	9.17	8.78
J₁	20.86	20.96	21.30	21.04	4.68	4.77	4.82	4.76	9.00	9.67	10.00	9.56
J₂	20.98	21.51	21.64	21.38	4.80	5.09	5.17	5.02	9.17	10.17	10.50	9.94
J₃	21.36	21.79	22.26	21.80	5.12	5.15	5.20	5.15	9.83	10.33	10.83	10.33
Mean	20.90	21.20	21.48		4.66	4.82	4.92		9.13	9.71	10.13	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.09		0.25		0.05		0.15		0.19		0.56	
Panchagavya	0.07		0.22		0.04		0.13		0.17		0.49	
J × P	0.15		NS		0.09		NS		0.33		NS	

Note: **J₀** - Without Jeevamrutha, **J₁**- Jeevamrutha 1000 litre/ha, **J₂** - Jeevamrutha 1500 litre/ha, **J₃** - Jeevamrutha 2000 litre/ha

P₀- Without panchagavya, **P₁**- Panchagavya at 3 %, **P₂**- Panchagavya at 6 %, **DAS** – Days After Sowing, **RDF** – 63:100:75 NPK kg ha⁻¹

4.8.2 Carbohydrate content (%)

Experiment conducted during *kharif* 2014

Jeevamrutha and panchagavya application increased carbohydrate content of green pods with increased levels. Significantly higher carbohydrate content was recorded with jeevamrutha at 2000 litre ha⁻¹ (5.09 %) followed by jeevamrutha at 1500 litre ha⁻¹ (4.96 %), jeevamrutha at 1000 litre ha⁻¹ (4.70 %) as compared no jeevamrutha application (4.21 %). Panchagavya at 6 per cent recorded significantly higher carbohydrate content of green pod (4.86 %) followed by panchagavya at 3 per cent (4.76 %) as compared to without panchagavya application (4.67 %).

Experiment conducted during *kharif* 2015

Jeevamrutha and panchagavya application increased carbohydrate content of green pods with increased levels. Significantly higher carbohydrate content was recorded with jeevamrutha at 2000 litre ha⁻¹ (5.22 %) followed by jeevamrutha at 1500 litre ha⁻¹ (5.08 %), jeevamrutha at 1000 litre ha⁻¹ (4.81 %) as compared no jeevamrutha application (4.32 %). Panchagavya at 6 per cent recorded significantly higher carbohydrate content of green pod (4.98 %) followed by panchagavya at 3 per cent (4.87 %) as compared to without panchagavya application (4.72 %).

Interaction effect

Carbohydrate content of green pods did not differ significantly due to the interaction between various levels of jeevamrutha and panchagavya application during both the years.

Pooled

Jeevamrutha and panchagavya application increased carbohydrate content of green pods with increased levels. Significantly higher carbohydrate content was recorded with jeevamrutha at 2000 L ha⁻¹ (5.15) followed by jeevamrutha at 1500 litre ha⁻¹ (5.02), jeevamrutha at 1000 litre ha⁻¹ (4.76) as compared no jeevamrutha application (4.26). Panchagavya at 6 per cent recorded significantly higher crude protein content and carbohydrate content of green pod (4.92) followed by panchagavya at 3 per cent (4.82) as compared to without panchagavya application (4.66).

Carbohydrate content of green pods did not differ significantly due to the interaction between various levels of jeevamrutha and panchagavya application.

4.8.3 Shelf life of frenchbean at room temperature (days)

Experiment conducted during *kharif* 2014

Shelf life of frenchbean increased with increased levels of jeevamrutha and panchagavya application (Table 40). Keeping duration of green pods was significantly more in jeevamrutha at 2000 litre ha⁻¹ (10.11) followed by jeevamrutha at 1500 litre ha⁻¹ (9.67), jeevamrutha at 1000 litre ha⁻¹ (9.22) as compared no jeevamrutha application (8.44). Panchagavya at 6 per cent recorded significantly more shelf life of green pod

(9.83) followed by panchagavya at 3 per cent (9.42) as compared to without panchagavya application (8.83).

Experiment conducted during *kharif* 2015

Shelf life of frenchbean increased with increased levels of jeevamrutha and panchagavya application (Table 40). Keeping duration of green pods was significantly more in jeevamrutha at 2000 litre ha⁻¹ (10.56) followed by jeevamrutha at 1500 litre ha⁻¹ (10.22), jeevamrutha at 1000 litre ha⁻¹ (9.89) as compared no jeevamrutha application (9.11). Panchagavya at 6 per cent recorded significantly more shelf life of green pod (10.42) followed by panchagavya at 3 per cent (10.0) as compared to without panchagavya application (9.42).

Interaction effect

Shelf life of green pods did not differ significantly due to the interaction between various levels of jeevamrutha and panchagavya application during both the years.

Pooled

Shelf life of frenchbean increased with increased levels of jeevamrutha and panchagavya application (Table 76). Keeping duration of green pods was significantly more in jeevamrutha at 2000 litre ha⁻¹ (10.33) followed by jeevamrutha at 1500 litre ha⁻¹ (9.94), jeevamrutha at 1000 litre ha⁻¹ (9.56) as compared no jeevamrutha application (8.78). Panchagavya at 6 per cent recorded significantly more keeping duration of green pod (10.13) followed by panchagavya at 3 per cent (9.71) as compared to without panchagavya application (9.13).

Shelf life of frenchbean did not differ significantly due to the interaction between various levels of jeevamrutha and panchagavya application.

Discussion on the findings relating to the performance of FYM and liquid manures on quality of frenchbean

The term quality implies the degree of excellence of a product or its suitability for a particular use. Quality of produce encompasses appearance, texture, nutritive values, chemical constituents, mechanical properties, functional properties and defects. Shelf life affects food quality, which in turn influences the consumer's buying decisions. Product quality is very important to growers because it determines marketable yield and can affect price.

In present investigation application of FYM, panchagavy and jeevamrutha in both experiments improved the quality parameters *viz.*, protein content, keeping quality and carbohydrate content of frenchbean as compared to lower levels of FYM, Jeevamrutha and panchagavya application. The shelf life of frenchbean was significantly higher with FYM, higher levels of panchagavya and jeevamrutha application. The shelf life ranged between 8.0 to 10.0 days during 2014 and 8.33 to 10.33 during 2015 in first experiment observed with different combinations of FYM, jeevamrutha and panchagavya (Fig 13). While, in second experiment it ranged from 8.33 to 10.67 days during 2014 and 8.67 to

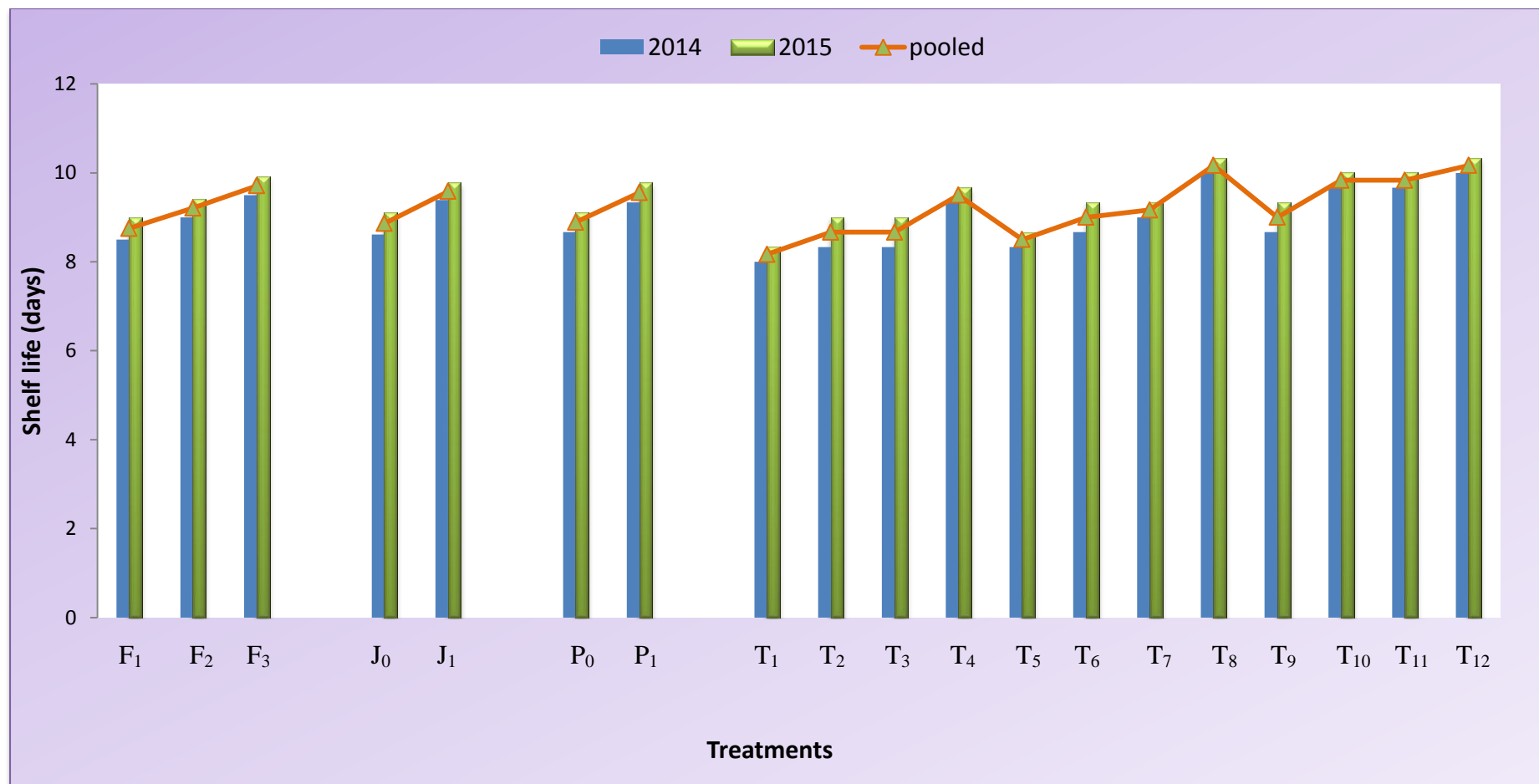


Fig. 13: Influence of FYM, jeevamruta and panchagavya application on shelf life (days) of frenchbean

F₁- 100 %, F₂- 150 % and F₃- 200 % equivalent N through FYM, J₀- Without Jeevamrutha, J₁- Jeevamrutha 1000 litre/ha, P₀- Without panchagavya, P₁- Panchagavya at 3 %, T₁= F₁J₀P₀, T₂= F₁J₀P₁, T₃=F₁J₁P₀, T₄=F₁J₁P₁, T₅=F₂J₀P₀, T₆= F₂J₀P₁, T₇=F₂J₁P₀, T₈=F₂J₁P₁, T₉=F₃J₀P₀, T₁₀=F₃J₀P₁, T₁₁= F₃J₁P₀, T₁₂=F₃J₁P₁

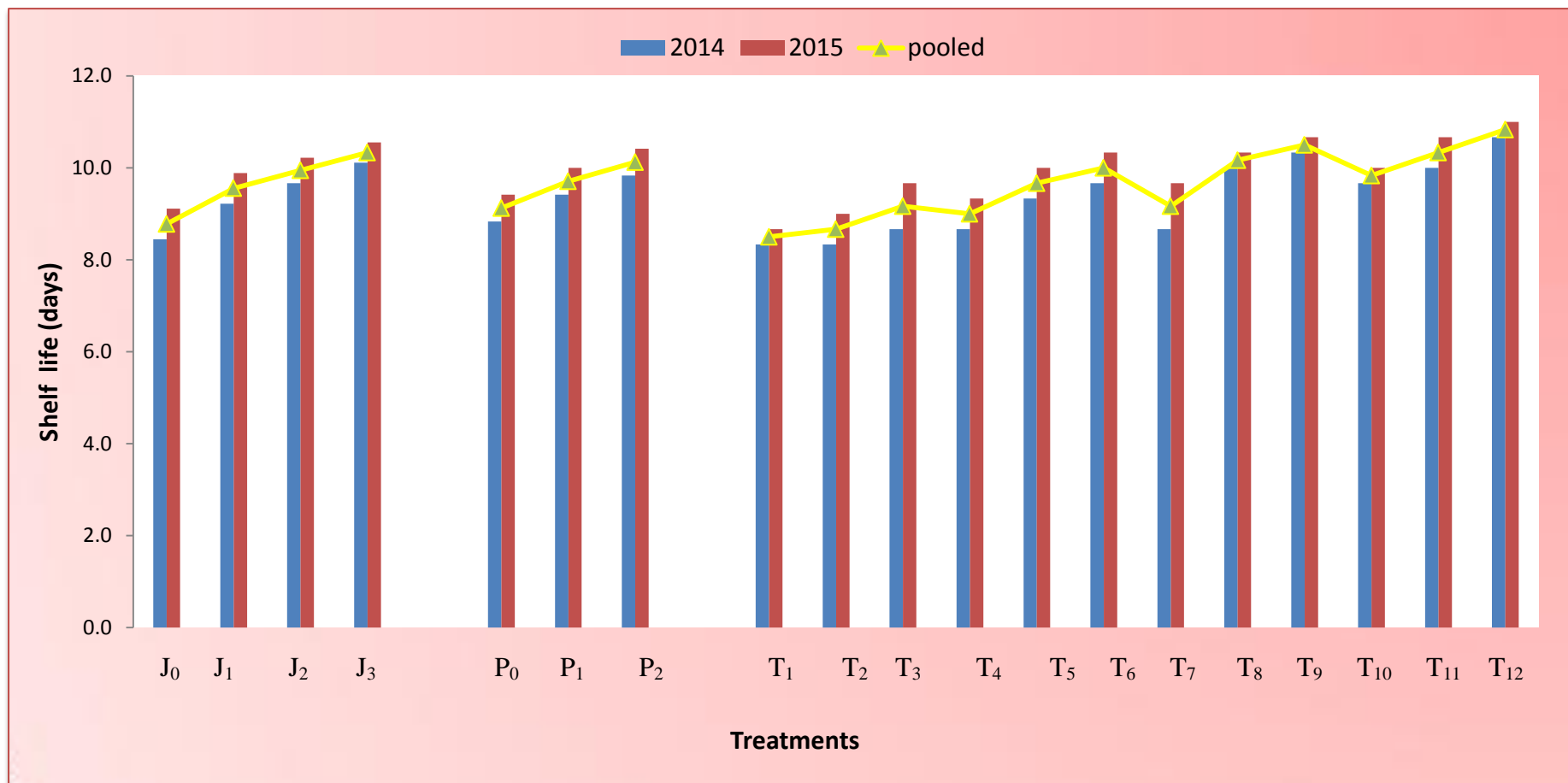


Fig. 14: Influence of jeevamruta and panchagavya application on shelf life (days) of frenchbean

J₀- Without Jeevamrutha, **J₁**- Jeevamrutha 1000 litre/ha, **J₂**- Jeevamrutha 1500 litre/ha, **J₃**- Jeevamrutha 2000 litre/ha, **P₀**- Without panchagavya, **P₁**- Panchagavya at 3 %, **P₃**- Panchagavya at 6 %, **T₁**= J₀P₀, **T₂**=J₀P₁, **T₃**=J₀P₂, **T₄**=J₁P₀, **T₅**=J₁P₁, **T₆**=J₁P₂, **T₇**=J₂P₀, **T₈**=J₂P₁, **T₉**=J₂P₂, **T₁₀**=J₃P₀, **T₁₁**=J₃P₁, **T₁₂**=J₃P₂

11 days during 2015 was observed with different combinations of jeevamruta and panchagavya (Fig 14). Crude protein content ranged from 20.32 to 23.19 during 2014 and 20.65 and 23.56 during 2015 in the first experiment (Tables 72 and 73) while, it was ranged from 20.21 to 21.98 per cent in 2014 and 20.58 to 22.54 per cent in 2015 in different combination of jeevamruta and panchagavya in the second experiment (Tables 74 and 75). The reason for higher protein may be due to more availability of nutrients particularly nitrogen which is an integral part of protein. Carbohydrate content ranged from 4.07 to 5.24 during 2014 and 4.14 and 5.34 during 2015 in the first experiment while, it was ranged from 3.99 to 5.14 per cent in 2014 and 4.10 to 5.26 per cent in 2015 with different combination of jeevamruta and panchagavya in the second experiment (Tables 74 and 75). Pradeep Gopakkali and Sharanappa (2014) reported that effect of EBDLM and panchagavya may be attributed to the increased activity of microbes which might have resulted in the release of more gibberellins, auxins and cytokinins. These growth hormones in turn accelerate the physiological process like synthesis of carbohydrates and other proximate substances. The improvement in quality attributes protein content, keeping quality and carbohydrate content of frenchbean with FYM, panchagavya and jeevamrutha might be ascribed to beneficial effects of FYM, jeevamruta and panchagavya on crop quality. Results are in accordance with Vennila and Jayanthi (2008) reported that presence of auxin in panchagavya controls the water regulation in developing fruits. Regular and uniform water supply to the developing fruits resulted in increased ascorbic acid content and crude protein content in okra. Uma maheshwari and Haripriya (2008) have also reported in pepper that the quality attributes were significantly higher with all the organic manures tested plots compared to inorganic fertilizers. Better quality produce by the application of organic manures is due to better supply of plant nutrients including secondary and micro nutrients and also the growth regulators. Similarly, Premsekhar and Rajashree (2009) were also of the opinion that organic manure gave better quality okra fruits with less fibre and moisture content with FYM application compared to control, this indicates more dry matter content in fruits with FYM application and results in extended shelf life. Similar findings were also observed by Jayaram Reddy and Reddy (2011); Siddaram (2012); Maheshbabu *et al.*, (2008); Kiran (2014) and Siddappa (2015). Organic nutrient sources have desirable effect on fruit growth, development and quality and delaying the ripening and senescence, thus resulting in good quality fruits (Sharma *et al.*, 1996) due to supply of secondary nutrients as well as micronutrients.

Exp I: Effect of different levels of FYM, jeevamrutha and panchagavya on N, P and K content of frenchbean at different growth stages

The data pertaining to the nitrogen, phosphorous and potassium (%) content in plant as influenced by solid and liquid manures are presented in the Tables 77-86.

Experiment conducted during *kharif* 2014

4.9.1 Nitrogen content

Nitrogen content in plant differed significantly due to solid and liquid manures application is presented in the Tables 77, 78 and 79.

20 Days after sowing

Nitrogen content in plant varied significantly due to the application of FYM. Higher nitrogen content in plant was observed with 200 per cent N equivalent through FYM (3.11 %) as compared to 100 % N equivalent (2.91 %) and it was found on par with 150 % N equivalent FYM application (3.11 %). Nitrogen content in plant did not differ significantly due to the application of jeevamruta and panchagvaya.

40 Days after sowing

Nitrogen content in plant differed significantly due to the application of FYM. Significantly higher nitrogen content was recorded with FYM at 200 per cent N equivalent (3.05 %) followed by FYM at 150 per cent N equivalent (2.97 %) as compared to FYM at 100 per cent N equivalent (2.74 %). There was significance in nitrogen content in plant due to the application of jeevamruta and panchagvya. Application of Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent recorded significantly higher nitrogen content (3.00 and 2.97 %) as compared to without jeevamrutha and without panchagavya application (2.84 and 2.87 %).

At harvest

Nitrogen content in plant varied significantly due to the application of FYM. significantly higher nitrogen content was recorded with FYM at 200 per cent N equivalent (2.38 %) followed by FYM at 150 per cent N equivalent (2.34 %) as compared to FYM at 100 per cent N equivalent (2.25 %). There was significance in nitrogen content in plant due to the application of jeevamruta and panchagvya. Application of Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent recorded significantly higher nitrogen content (2.36 and 2.35 %) as compared to without jeevamrutha and without panchagavya application (2.28 and 2.30 %).

Experiment conducted during *kharif* 2015

20 Days after sowing

Nitrogen content in plant differed significantly due to the application of FYM. Higher nitrogen content in plant was observed with 200 per cent N equivalent through FYM as compared to 100 per cent N equivalent and it was found on par with 150 per cent N equivalent FYM application. Nitrogen content in plant did not differ significantly due to the application of jeevamruta and panchagvaya.

40 Days after sowing

Nitrogen content in plant varied significantly due to the application of FYM. Significantly higher nitrogen content was recorded with FYM at 200 per cent N equivalent (3.10 %) followed by FYM at 150 per cent N equivalent (3.02 %) as compared to FYM at 100 per cent N equivalent (2.78 %). There was significance in nitrogen content in plant due to the application of jeevamruta and panchagvya. Application of Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent recorded significantly higher nitrogen content (3.04 and 3.02 %) as compared to without jeevamrutha and without panchagavya application (2.89 and 3.02 %).

Table 77: Plant N content as influenced by FYM and liquid manures application at different growth stage of frenchbean during *Kharif* 2014

Treatments	Plant N (%)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	2.96	2.86	2.91	2.68	2.80	2.74	2.24	2.27	2.25
F ₂	3.02	3.14	3.08	2.89	3.06	2.97	2.27	2.40	2.34
F ₃	3.04	3.19	3.11	2.95	3.15	3.05	2.34	2.43	2.38
Mean	3.01	3.06		2.84	3.00		2.28	2.36	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.04	0.13		0.02	0.07		0.02	0.05	
J	0.04	NS		0.02	0.06		0.01	0.04	
F × J	0.06	NS		0.03	NS		0.02	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	3.00	2.83	2.91	2.70	2.78	2.74	2.24	2.26	2.25
F ₂	3.06	3.10	3.08	2.90	3.04	2.97	2.31	2.36	2.34
F ₃	3.09	3.13	3.11	3.00	3.10	3.05	2.34	2.42	2.38
Mean	3.05	3.02		2.87	2.97		2.30	2.35	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.04	NS		0.02	0.06		0.01	0.04	
F × P	0.06	NS		0.03	NS		0.02	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	2.99	3.02	3.01	2.79	2.89	2.84	2.26	2.31	2.28
J ₁	3.11	3.02	3.06	2.94	3.06	3.00	2.34	2.39	2.36
Mean	3.05	3.02		2.87	3.07		2.30	2.35	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.05	NS		0.03	NS		0.02	NS	
Interaction	P₀	P₁		P₀	P₁		P₀	P₁	
F × J × P									
F ₁ J ₀	2.96	3.97		2.67	2.69		2.22	2.25	
F ₁ J ₁	3.04	3.69		2.74	2.86		2.26	2.27	
F ₂ J ₀	3.01	3.03		2.84	2.93		2.26	2.28	
F ₂ J ₁	3.11	3.16		2.96	3.15		2.35	2.44	
F ₃ J ₀	3.01	3.07		2.86	3.05		2.29	2.38	
F ₃ J ₁	3.17	3.20		3.13	3.17		2.40	2.46	
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	0.09	NS		0.05	NS		0.03	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 78: Plant N content as influenced by FYM and liquid manures application at different growth stage of frenchbean during *Kharif* 2015

Treatments	Plant N (%)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	3.02	2.92	2.97	2.74	2.83	2.78	2.28	2.31	2.30
F ₂	3.08	3.20	3.14	2.94	3.10	3.02	2.32	2.44	2.38
F ₃	3.09	3.26	3.18	3.01	3.20	3.10	2.38	2.47	2.43
Mean	3.06	3.13		2.89	3.04		2.33	2.41	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.04	0.13		0.02	0.07		0.02	0.04	
J	0.04	NS		0.02	0.06		0.01	0.04	
F × J	0.06	NS		0.03	NS		0.02	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	3.05	2.89	2.97	2.76	2.81	2.78	2.29	2.31	2.30
F ₂	3.12	3.16	3.14	2.94	3.10	3.02	2.35	2.40	2.38
F ₃	3.15	3.21	3.18	3.05	3.16	3.10	2.39	2.46	2.43
Mean	3.11	3.09		2.92	3.02		2.34	2.39	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.04	NS		0.02	0.06		0.01	0.04	
F × P	0.06	NS		0.03	NS		0.02	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	3.05	3.08	3.06	2.84	2.94	2.89	2.30	2.35	2.33
J ₁	3.17	3.09	3.13	2.99	3.10	3.04	2.38	2.43	2.41
Mean	3.11	3.09		2.92	3.02		2.34	2.39	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.05	NS		0.03	NS		0.02	NS	
Interaction	P₀	P₁		P₀	P₁		P₀	P₁	
F × J × P									
F ₁ J ₀	3.01	3.03		2.73	2.75		2.27	2.30	
F ₁ J ₁	3.09	2.75		2.79	2.87		2.31	2.32	
F ₂ J ₀	3.07	3.09		2.88	2.99		2.31	2.33	
F ₂ J ₁	3.17	3.23		3.00	3.21		2.40	2.48	
F ₃ J ₀	3.06	3.12		2.97	3.09		2.33	2.43	
F ₃ J ₁	3.23	3.30		3.18	3.22		2.45	2.49	
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	0.09	NS		0.05	NS		0.03	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 79: Plant N content as influenced by FYM and liquid manures application at different growth stage of frenchbean (Pooled 2014 and 2015)

Treatments	Plant N (%)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	2.99	2.89	2.94	2.71	2.81	2.76	2.26	2.29	2.27
F ₂	3.05	3.17	3.11	2.91	3.08	3.00	2.30	2.42	2.36
F ₃	3.06	3.23	3.14	2.98	3.18	3.08	2.36	2.45	2.40
Mean	3.03	3.10		2.87	3.02		2.30	2.39	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.04	0.13		0.02	0.07		0.02	0.05	
J	0.04	NS		0.02	0.06		0.01	0.04	
F × J	0.06	NS		0.03	NS		0.02	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	3.03	2.86	2.94	2.73	2.79	2.76	2.26	2.28	2.27
F ₂	3.09	3.13	3.11	2.92	3.07	3.00	2.33	2.38	2.36
F ₃	3.12	3.17	3.14	3.02	3.13	3.08	2.37	2.44	2.40
Mean	3.08	3.05		2.89	3.00		2.32	2.37	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.04	NS		0.02	0.06		0.01	0.04	
F × P	0.06	NS		0.03	NS		0.02	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	3.02	3.05	3.03	2.82	2.92	2.87	2.28	2.33	2.30
J ₁	3.14	3.06	3.10	2.97	3.08	3.02	2.36	2.41	2.39
Mean	3.08	3.05		2.89	3.00		2.32	2.37	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.05	NS		0.03	NS		0.02	NS	
Interaction	P₀	P₁		P₀	P₁		P₀	P₁	
F × J × P									
F ₁ J ₀	2.98	3.00		2.70	2.72		2.25	2.27	
F ₁ J ₁	3.07	2.72		2.76	2.86		2.28	2.29	
F ₂ J ₀	3.04	3.06		2.86	2.96		2.29	2.31	
F ₂ J ₁	3.14	3.20		2.98	3.18		2.38	2.46	
F ₃ J ₀	3.03	3.09		2.89	3.06		2.31	2.41	
F ₃ J ₁	3.20	3.25		3.16	3.19		2.42	2.47	
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	0.09	NS		0.05	NS		0.03	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

At harvest

Application of FYM at 200 per cent N equivalent recorded significantly higher nitrogen content in plant (2.43 %) followed by FYM at 150 per cent N equivalent (2.38 %) as compared to FYM at 100 per cent N equivalent (2.30 %). Application of jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent recorded significantly higher nitrogen content (2.41 and 2.39 %) as compared to without jeevamrutha and without panchagavya application (2.33 and 2.34 %).

Interaction effect

Nitrogen, phosphorous and potassium content in plant did not vary significantly due to the interactions between various levels of FYM, jeevamrutha and panchagavya application at all the crop growth stages during both the years.

Pooled

Nitrogen content in plant differed significantly due to the application of FYM. At 40 DAS significantly higher nitrogen content was recorded with FYM at 200 per cent N equivalent (3.08 %) followed by FYM at 150 per cent N equivalent (3.00 %) as compared to FYM at 100 per cent N equivalent (2.76 %). At harvest significantly higher nitrogen content was recorded with FYM at 200 per cent N equivalent (2.40 %) as compared to FYM at 100 per cent N equivalent (2.27 %) and was on par with FYM at 150 per cent N equivalent (2.36 %).

Application of Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent at 40 DAS and at harvest recorded significantly higher nitrogen content (3.02, 3.00 and 2.39, 2.37 %, respectively) as compared to without jeevamrutha and without panchagavya application (2.87, 2.89 and 2.30, 2.32 %, respectively).

Nitrogen content in plant did not vary significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application

4.9.2 Phosphorous content

Phosphorous content in plant differed significantly due to solid and liquid manures application are presented in the Tables 80, 81 and 82.

Experiment conducted during *kharif* 2014

20 Days after sowing

Phosphorous content in plant did not differ significantly due to the application of solid and liquid manures. However higher phosphorus content in plant was observed with 200 per cent N equivalent through FYM, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application.

Table 80: Plant phosphorus content as influenced by FYM and liquid manures application at different growth stage of frenchbean during *Kharif* 2014

Treatments	Plant Phosphorus (%)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	0.286	0.291	0.289	0.262	0.266	0.264	0.224	0.227	0.225
F ₂	0.291	0.302	0.297	0.268	0.283	0.276	0.229	0.241	0.235
F ₃	0.293	0.304	0.298	0.274	0.287	0.280	0.237	0.247	0.242
Mean	0.290	0.299		0.268	0.279		0.230	0.238	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.004	NS		0.002	0.01		0.003	0.008	
J	0.004	NS		0.002	0.01		0.002	0.006	
F × J	0.006	NS		0.003	NS		0.004	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	0.288	0.290	0.289	0.263	0.265	0.264	0.224	0.227	0.225
F ₂	0.294	0.300	0.297	0.271	0.280	0.276	0.230	0.239	0.235
F ₃	0.297	0.300	0.298	0.275	0.286	0.280	0.238	0.246	0.242
Mean	0.293	0.296		0.270	0.277		0.231	0.237	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.004	NS		0.002	0.01		0.002	0.006	
F × P	0.006	NS		0.003	NS		0.004	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	0.288	0.292	0.290	0.265	0.271	0.268	0.227	0.233	0.230
J ₁	0.298	0.301	0.299	0.274	0.283	0.279	0.234	0.242	0.238
Mean	0.293	0.296		0.270	0.277		0.237	0.237	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.005	NS		0.003	NS		0.003	NS	
Interaction	P₀	P₁		P₀	P₁		P₀	P₁	
F × J × P									
F ₁ J ₀	0.285	0.286		0.260	0.263		0.222	0.225	
F ₁ J ₁	0.290	0.293		0.266	0.267		0.226	0.228	
F ₂ J ₀	0.288	0.294		0.267	0.270		0.227	0.231	
F ₂ J ₁	0.299	0.306		0.275	0.290		0.233	0.248	
F ₃ J ₀	0.290	0.295		0.269	0.280		0.231	0.242	
F ₃ J ₁	0.304	0.305		0.282	0.292		0.244	0.250	
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	0.009	NS		0.005	NS		0.005	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 81: Plant phosphorus content as influenced by FYM and liquid manures application at different growth stage of frenchbean during *Kharif* 2015

Treatments	Plant Phosphorus (%)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	0.291	0.296	0.294	0.268	0.274	0.271	0.229	0.232	0.230
F ₂	0.296	0.308	0.302	0.275	0.290	0.283	0.233	0.246	0.239
F ₃	0.299	0.311	0.305	0.281	0.294	0.288	0.241	0.251	0.246
Mean	0.295	0.305		0.275	0.286		0.234	0.243	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.005	NS		0.002	0.005		0.003	0.008	
J	0.004	NS		0.001	0.004		0.002	0.007	
F × J	0.007	NS		0.003	NS		0.004	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	0.293	0.295	0.294	0.269	0.272	0.271	0.229	0.232	0.230
F ₂	0.299	0.305	0.302	0.278	0.288	0.283	0.234	0.244	0.239
F ₃	0.303	0.307	0.305	0.282	0.293	0.288	0.241	0.251	0.246
Mean	0.298	0.302		0.277	0.284		0.235	0.242	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.004	NS		0.001	0.004		0.002	0.007	
F × P	0.007	NS		0.003	NS		0.004	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	0.293	0.297	0.295	0.271	0.278	0.275	0.231	0.238	0.234
J ₁	0.303	0.307	0.305	0.282	0.290	0.286	0.239	0.247	0.243
Mean	0.298	0.302		0.277	0.284		0.235	0.242	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.006	NS		0.002	NS		0.003	NS	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁	J ₀	0.290	0.292	0.265	0.270	0.227	0.231		
	J ₁	0.295	0.298		0.273		0.274	0.231	0.232
F ₂	J ₀	0.293	0.299	0.274	0.277	0.231	0.235		
	J ₁	0.305	0.311	0.283	0.298	0.238	0.253		
F ₃	J ₀	0.296	0.301	0.275	0.287	0.234	0.247		
	J ₁	0.309	0.312	0.289	0.299	0.248	0.254		
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.	S.Em ±	C.D.		
	0.01	NS		0.004	NS	0.005	NS		

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 82: Plant phosphorus content as influenced by FYM and liquid manures application at different growth stage of frenchbean (Pooled 2014 and 2015)

Treatments	Plant Phosphorus (%)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	0.288	0.294	0.291	0.265	0.270	0.267	0.226	0.229	0.228
F ₂	0.294	0.305	0.299	0.272	0.287	0.279	0.231	0.243	0.237
F ₃	0.296	0.307	0.301	0.278	0.290	0.284	0.239	0.249	0.244
Mean	0.292	0.302		0.271	0.282		0.232	0.240	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.004	NS		0.002	0.01		0.003	0.008	
J	0.004	NS		0.002	0.004		0.002	0.006	
F × J	0.006	NS		0.003	0.01		0.004	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	0.290	0.292	0.291	0.266	0.268	0.267	0.226	0.229	0.228
F ₂	0.297	0.302	0.299	0.275	0.284	0.279	0.232	0.242	0.237
F ₃	0.300	0.303	0.301	0.279	0.290	0.284	0.239	0.248	0.244
Mean	0.295	0.299		0.273	0.281		0.233	0.240	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.004	NS		0.002	0.004		0.002	0.006	
F × P	0.006	NS		0.003	NS		0.004	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	0.291	0.294	0.292	0.268	0.275	0.271	0.229	0.235	0.232
J ₁	0.300	0.304	0.302	0.278	0.287	0.282	0.237	0.244	0.240
Mean	0.295	0.299		0.273	0.281		0.233	0.240	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.005	NS		0.002	NS		0.003	NS	
Interaction									
F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁ J ₀	0.288	0.289		0.263	0.267		0.225	0.228	
F ₁ J ₁	0.293	0.295		0.270	0.270		0.228	0.230	
F ₂ J ₀	0.291	0.296		0.270	0.274		0.229	0.233	
F ₂ J ₁	0.302	0.308		0.279	0.294		0.236	0.251	
F ₃ J ₀	0.293	0.298		0.272	0.284		0.233	0.245	
F ₃ J ₁	0.306	0.308		0.285	0.295		0.252	0.252	
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	0.009	NS		0.004	NS		0.005	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

40 Days after sowing

Phosphorous content of frenchbean varied significantly due to the application of various levels of FYM, jeevamrutha and panchagavya. Application of FYM at 200 per cent N equivalent recorded significantly higher phosphorous content of frenchbean (0.280 %) followed by FYM at 150 per cent N equivalent (0.276 %) and it was lower with FYM at 100 per cent N equivalent (0.264 %). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher phosphorous content of frenchbean (0.279 and 0.277 %) as compared to without jeevamrutha and without panchagavya application (0.268 and 0.270 %).

At harvest

Phosphorous content of frenchbean differed significantly due to the application of various levels of FYM, jeevamrutha and panchagavya. Application of FYM at 200 per cent N equivalent recorded significantly higher phosphorous content of frenchbean (0.242 %) followed by FYM at 150 per cent N equivalent (0.235 %) and it was lower with FYM at 100 per cent N equivalent (0.225 %). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher phosphorous content of frenchbean (0.238 and 0.237 %) as compared to without jeevamrutha and without panchagavya application (0.230 and 0.231 %).

Experiment conducted during *kharif* 2015

20 Days after sowing

Phosphorous content in plant did not differ significantly due to the application of solid and liquid manures. However higher phosphorus content in plant was observed with 200 per cent N equivalent through FYM, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application.

40 Days after sowing

Phosphorous content of frenchbean varied significantly due to the application of various levels of FYM, jeevamrutha and panchagavya. Application of FYM at 200 per cent N equivalent recorded significantly higher phosphorous content of frenchbean (0.288 %) followed by FYM at 150 per cent N equivalent (0.283 %) and it was lower with FYM at 100 per cent N equivalent (0.271 %). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher phosphorous content of frenchbean (0.286 and 0.284 %) as compared to without jeevamrutha and without panchagavya application (0.275 and 0.277 %).

At harvest

Phosphorous content of frenchbean varied significantly due to the application of various levels of FYM, jeevamrutha and panchagavya. Application of FYM at 200 per cent N equivalent recorded significantly higher phosphorous content of frenchbean (0.246 %) followed by FYM at 150 per cent N equivalent (0.239 %) and it was lower with FYM at 100 per cent N equivalent (0.230 %). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher phosphorous content

of frenchbean (0.243 and 0.242 %) as compared to without jeevamrutha and without panchagavya application (0.234 and 0.235 %).

Interaction effect

Phosphorous content in plant did not differ significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application at all the stages of crop growth during both the years.

Pooled

Phosphorous content of frenchbean varied significantly due to the application of various levels of FYM, jeevamrutha and panchagavya. At 40 DAS and harvest phosphorous content of frenchbean differed significantly due to the application of various levels of FYM, jeevamrutha and panchagavya. Application of FYM at 200 per cent N equivalent recorded significantly higher phosphorous content of frenchbean (0.284, and 0.244 %) followed by FYM at 150 per cent N equivalent (0.279 and 0.237 %) and it was lower with FYM at 100 per cent N equivalent (0.267 and 0.288 %). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher phosphorous content of frenchbean (0.282, 0.240 and 0.281, 0.240 %, respectively) as compared to without jeevamrutha and without panchagavya application (0.271, 0.232 and 0.273, 0.233 %, respectively).

4.9.3 Potassium content

Potassium content in plant varied significantly due to solid and liquid manures application are presented in the Tables 83, 84 and 85.

Experiment conducted during *kharif* 2014

20 Days after sowing

Potassium content in plant did not differ significantly due to the application of solid and liquid manures. However higher potassium content in plant was observed with 200 per cent N equivalent through FYM, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application.

40 Days after sowing

Potassium content of frenchbean varied significantly due to the application of various levels of FYM, jeevamrutha and panchagavya. Higher potassium content was recorded with FYM at 200 per cent N equivalent (2.17 %) as compared to FYM at 100 per cent N equivalent (2.05 %) and was on par with FYM at 150 per cent N equivalent (2.14 %). Application of Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent recorded higher potassium content (2.16 and 2.14 %) as compared to without jeevamrutha and without panchagavya application (2.07 and 2.10 %).

Table 83: Plant potassium content as influenced by FYM and liquid manures application at different growth stage of frenchbean during *Kharif* 2014

Treatments	Plant Potassium (%)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	2.86	2.84	2.85	2.02	2.08	2.05	1.69	1.73	1.71
F ₂	2.88	2.98	2.93	2.08	2.20	2.14	1.73	1.83	1.78
F ₃	2.90	3.06	2.98	2.13	2.21	2.17	1.81	1.86	1.83
Mean	2.88	2.96		2.07	2.16		1.74	1.81	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.04	NS		0.01	0.04		0.01	0.04	
J	0.03	NS		0.01	0.04		0.01	0.03	
F × J	0.06	NS		0.02	NS		0.02	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	2.84	2.86	2.85	2.03	2.06	2.05	1.70	1.72	1.71
F ₂	2.89	2.97	2.93	2.11	2.16	2.14	1.75	1.80	1.78
F ₃	2.99	2.98	2.98	2.15	2.19	2.17	1.82	1.85	1.83
Mean	2.91	2.94		2.10	2.14		1.76	1.79	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.03	NS		0.01	0.04		0.01	0.03	
F × P	0.06	NS		0.02	NS		0.02	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	2.87	2.89	2.88	2.05	2.10	2.07	1.73	1.76	1.74
J ₁	2.95	2.98	2.96	2.14	2.18	2.16	1.78	1.83	1.81
Mean	2.91	2.94		2.10	2.14		1.76	1.79	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.05	NS		0.02	NS		0.02	NS	
Interaction	P₀	P₁		P₀	P₁		P₀	P₁	
F × J × P									
F ₁ J ₀	2.85	2.86		2.01	2.03		1.69	1.70	
F ₁ J ₁	2.84	2.85		2.05	2.10		1.72	1.74	
F ₂ J ₀	2.85	2.91		2.05	2.10		1.72	1.74	
F ₂ J ₁	2.94	3.03		2.17	2.22		1.78	1.87	
F ₃ J ₀	2.90	2.91		2.10	2.16		1.78	1.83	
F ₃ J ₁	3.07	3.06		2.20	2.22		1.85	1.87	
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	0.08	NS		0.03	NS		0.03	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 84: Plant potassium content as influenced by FYM and liquid manures application at different growth stage of frenchbean during *Kharif* 2015

Treatments	Plant Potassium (%)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	2.91	2.90	2.90	2.07	2.14	2.10	1.73	1.77	1.75
F ₂	2.93	3.04	2.99	2.14	2.25	2.19	1.77	1.87	1.82
F ₃	2.96	3.12	3.04	2.19	2.27	2.23	1.83	1.91	1.87
Mean	2.93	3.02		2.13	2.22		1.77	1.85	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.04	NS		0.02	0.05		0.01	0.04	
J	0.03	NS		0.01	0.04		0.01	0.03	
F × J	0.06	NS		0.02	NS		0.02	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	2.89	2.91	2.90	2.08	2.12	2.10	1.74	1.76	1.75
F ₂	2.94	3.03	2.99	2.17	2.22	2.19	1.79	1.84	1.82
F ₃	3.04	3.04	3.04	2.21	2.25	2.23	1.85	1.89	1.87
Mean	2.96	2.99		2.15	2.20		1.79	1.83	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.03	NS		0.01	0.04		0.01	0.03	
F × P	0.06	NS		0.02	NS		0.02	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	2.92	2.95	2.93	2.11	2.15	2.13	1.76	1.79	1.77
J ₁	3.00	3.04	3.02	2.20	2.24	2.22	1.83	1.87	1.85
Mean	2.96	2.99		2.15	2.20		1.79	1.83	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.05	NS		0.02	NS		0.02	NS	
Interaction	P₀	P₁		P₀	P₁		P₀	P₁	
F × J × P									
F ₁ J ₀	2.90	2.92		2.06	2.08		1.72	1.74	
F ₁ J ₁	2.89	2.91		2.11	2.16		1.76	1.78	
F ₂ J ₀	2.90	2.96		2.11	2.16		1.76	1.77	
F ₂ J ₁	2.99	3.09		2.23	2.27		1.83	1.91	
F ₃ J ₀	2.95	2.97		2.16	2.22		1.80	1.86	
F ₃ J ₁	3.12	3.11		2.26	2.28		1.89	1.92	
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	0.08	NS		0.03	NS		0.03	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 85: Plant potassium content as influenced by FYM and liquid manures application at different growth stage of frenchbean (Pooled 2014 and 2015)

Treatments	Plant Potassium (%)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	2.88	2.87	2.88	2.04	2.11	2.07	1.71	1.75	1.73
F ₂	2.90	3.01	2.96	2.11	2.22	2.17	1.75	1.85	1.80
F ₃	2.93	3.09	3.01	2.16	2.24	2.20	1.82	1.88	1.85
Mean	2.91	2.99		2.10	2.19		1.76	1.83	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.04	NS		0.02	0.04		0.01	0.04	
J	0.03	NS		0.01	0.04		0.01	0.03	
F × J	0.06	NS		0.02	NS		0.02	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	2.87	2.88	2.88	2.06	2.09	2.07	1.72	1.74	1.73
F ₂	2.92	3.00	2.96	2.14	2.19	2.17	1.77	1.82	1.80
F ₃	3.01	3.01	3.01	2.18	2.22	2.20	1.83	1.87	1.85
Mean	2.93	2.96		2.13	2.17		1.78	1.81	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.03	NS		0.01	0.04		0.01	0.03	
F × P	0.06	NS		0.02	NS		0.02	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	2.89	2.92	2.91	2.08	2.12	2.10	1.75	1.77	1.76
J ₁	2.97	3.01	2.99	2.17	2.21	2.19	1.81	1.85	1.83
Mean	2.93	2.96		2.13	2.17		1.78	1.81	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.05	NS		0.02	NS		0.02	NS	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁	J ₀	2.87	2.89	2.03	2.05	1.70	1.72		
	J ₁	2.86	2.88	2.08	2.13	1.74	1.76		
F ₂	J ₀	2.87	2.94	2.08	2.13	1.74	1.76		
	J ₁	2.96	3.06	2.20	2.25	1.80	1.89		
F ₃	J ₀	2.93	2.94	2.13	2.19	1.79	1.84		
	J ₁	3.10	3.09	2.23	2.25	1.87	1.89		
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.	S.Em ±	C.D.		
	0.08	NS		0.03	NS	0.03	NS		

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

At harvest

Potassium content of frenchbean differed significantly due to the application of various levels of FYM, jeevamrutha and panchagavya. Higher potassium content was recorded with FYM at 200 per cent N equivalent (1.83 %) followed by FYM at 150 per cent N equivalent (1.78 %) and lower was in FYM at 100 per cent N equivalent (1.71 %). Application of Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent recorded higher potassium content (1.81 and 1.79 %) as compared to without jeevamrutha and without panchagavya application (1.74 and 1.76 %).

Experiment conducted during *kharif* 2015

20 Days after sowing

Potassium content in plant did not differ significantly due to the application of solid and liquid manures. However higher potassium content in plant was observed with 200 per cent N equivalent through FYM, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application.

40 Days after sowing

Potassium content of frenchbean varied significantly due to the application of various levels of FYM, jeevamrutha and panchagavya. Higher potassium content was recorded with FYM at 200 per cent N equivalent (2.23 %) as compared to FYM at 100 per cent N equivalent (2.10 %) and was on par with FYM at 150 per cent N equivalent (2.19 %). Application of Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent recorded higher potassium content (2.22 and 2.20 %) as compared to without jeevamrutha and without panchagavya application (2.13 and 2.15 %).

At harvest

Potassium content of frenchbean differed significantly due to the application of various levels of FYM, jeevamrutha and panchagavya. Higher potassium content was recorded with FYM at 200 per cent N equivalent (1.87 %) followed by FYM at 150 per cent N equivalent (1.82 %) and lower was in FYM at 100 per cent N equivalent (1.75 %). Application of Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent recorded higher potassium content (1.85 and 1.83 %) as compared to without jeevamrutha and without panchagavya application (1.77 and 1.79 %).

Inter action effect

Potassium content in plant did not differ significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application at all the crop growth stages during both the years.

Pooled

Phosphorous content of frenchbean differed significantly due to the application of various levels of FYM, jeevamrutha and panchagavya. At 40 DAS significantly higher potassium content was recorded with FYM at 200 per cent N equivalent (2.20 %) as

compared to FYM at 100 per cent N equivalent (2.07 %) and was on par with FYM at 150 per cent N equivalent (2.17 %).

At harvest significantly higher potassium content was recorded with FYM at 200 per cent N equivalent (1.85 %) followed by FYM at 150 per cent N equivalent (1.80 %) as compared to FYM at 100 per cent N equivalent (1.73 %).

Application of Jeevamrutha at 1000 L ha⁻¹ and panchagavya at 3 per cent at 40 DAS and harvest recorded significantly higher potassium content (2.19, 1.83 and 2.17, 1.81 %, respectively) as compared to without jeevamrutha and without panchagavya application (2.10, 1.76 and 2.13, 1.78 %, respectively).

Nitrogen, phosphorous and potassium content in frenchbean at 40 DAS and harvest did not differ significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application.

4.9.4 Pod N, P and K

The data pertaining to the nitrogen, phosphorous and potassium (%) content of pod as influenced by solid and liquid manures are presented in the Tables 86, 87 and 88.

Experiment conducted during *kharif* 2014

Nitrogen, phosphorous and potassium (%) content of green pods differed significantly due to the application of various levels of FYM, jeevamrutha and panchagavya. Higher nitrogen, phosphorus and potassium content in pods were recorded with FYM at 200 per cent N equivalent (3.63, 0.067 and 3.21 %, respectively) followed by FYM at 150 per cent N equivalent (3.43, 0.065 and 3.15 %, respectively) as compared to FYM at 100 per cent N equivalent (3.29, 0.062 and 3.00 %, respectively). Whereas application of FYM at 200 per cent N equivalent found on par with FYM at 150 per cent N equivalent in case of pod phosphorus and potassium content.

Application of Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent recorded significantly higher nitrogen (3.52 and 3.50 %), phosphorus (0.068 and 0.066 %) and potassium (3.18 and 3.15 %) content in pods as compared to without jeevamrutha (3.38, 0.061 and 3.06 %, respectively) and without panchagavya application (3.40, 0.063 and 3.09 %, respectively).

Interaction effect

Nitrogen content in pod was significantly influenced by interaction of FYM, jeevamrutha and panchagavya application except phosphorous and potassium content. Higher nitrogen content in pod was noticed in FYM at 200 per cent N equivalent with Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent (3.71 %) and on par with FYM at 200 per cent N equivalent with jeevamrutha at 1000 litre ha⁻¹ and without panchagavya, FYM at 200 per cent N equivalent with panchagavya at 3 per cent and without jeevamrutha application and FYM at 150 per cent N equivalent with Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent. Lower nitrogen content in pod was

Table 86: Nitrogen, phosphorus and potassium content of pod as influenced by FYM and liquid manures application during *Kharif* 2014

Treatments	Pod nutrients								
	Pod Nitrogen (%)			Pod Phosphorus (%)			Pod Potassium (%)		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	3.26	3.32	3.29	0.06	0.065	0.062	2.97	3.03	3.00
F ₂	3.32	3.54	3.43	0.061	0.069	0.065	3.06	3.24	3.15
F ₃	3.57	3.69	3.63	0.063	0.071	0.067	3.15	3.27	3.21
Mean	3.38	3.52		0.061	0.068		3.06	3.18	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.03	0.08		0.001	0.002		0.02	0.06	
J	0.02	0.07		0.0005	0.001		0.02	0.05	
F × J	0.04	NS		0.001	NS		0.03	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	3.28	3.30	3.29	0.062	0.063	0.062	2.99	3.01	3.00
F ₂	3.34	3.52	3.43	0.063	0.067	0.065	3.10	3.20	3.15
F ₃	3.57	3.69	3.63	0.065	0.069	0.067	3.18	3.24	3.21
Mean	3.40	3.50		0.063	0.066		3.09	3.15	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.02	0.07		0.0005	0.001		0.02	0.05	
F × P	0.04	NS		0.001	NS		0.03	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	3.34	3.42	3.38	0.060	0.063	0.061	3.02	3.09	3.06
J ₁	3.46	3.58	3.52	0.067	0.069	0.068	3.15	3.20	3.18
Mean	3.40	3.50		0.063	0.066		3.09	3.15	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.03	NS		0.001	NS		0.02	NS	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁	J ₀	3.25	3.28	0.059	0.061	2.95	2.98		
	J ₁	3.31	3.32		0.064		0.065	3.02	3.04
F ₂	J ₀	3.31	3.33	0.060	0.062	3.02	3.11		
	J ₁	3.38	3.70	0.066	0.071	3.19	3.28		
F ₃	J ₀	3.47	3.67	0.064	0.065	3.10	3.19		
	J ₁	3.68	3.71	0.069	0.072	3.25	3.29		
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.	S.Em ±	C.D.		
	0.06	0.16		0.001	NS	0.04	NS		

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 87: Nitrogen, phosphorus and potassium content of pod as influenced by FYM and liquid manures application during *Kharif* 2015

Treatments	Nutrient contents of Pod								
	Pod Nitrogen (%)			Pod Phosphorus (%)			Pod Potassium (%)		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F₁	3.32	3.38	3.35	0.064	0.069	0.067	3.04	3.11	3.07
F₂	3.37	3.60	3.49	0.066	0.074	0.070	3.14	3.32	3.23
F₃	3.64	3.76	3.70	0.068	0.075	0.071	3.22	3.35	3.29
Mean	3.45	3.58		0.066	0.073		3.13	3.26	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.03	0.08		0.001	0.002		0.02	0.06	
J	0.02	0.07		0.0005	0.001		0.02	0.05	
F × J	0.04	NS		0.001	NS		0.03	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F₁	3.34	3.37	3.35	0.066	0.068	0.067	3.06	3.09	3.07
F₂	3.40	3.57	3.49	0.068	0.071	0.070	3.18	3.28	3.23
F₃	3.65	3.75	3.70	0.070	0.073	0.071	3.25	3.32	3.29
Mean	3.46	3.56		0.068	0.071		3.17	3.23	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.02	0.07		0.0005	0.002		0.02	0.05	
F × P	0.04	NS		0.001	NS		0.03	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J₀	3.40	3.49	3.45	0.065	0.067	0.066	3.10	3.17	3.13
J₁	3.52	3.64	3.58	0.071	0.074	0.073	3.24	3.28	3.26
Mean	3.46	3.56		0.068	0.071		3.17	3.23	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.03	NS		0.001	NS		0.02	NS	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F₁	J₀	3.30	3.34		0.063	0.066		3.02	3.05
	J₁	3.37	3.39		0.069	0.070		3.10	3.12
F₂	J₀	3.36	3.39		0.065	0.067		3.09	3.19
	J₁	3.45	3.75		0.071	0.076		3.27	3.37
F₃	J₀	3.54	3.74		0.065	0.070		3.17	3.27
	J₁	3.75	3.77		0.074	0.076		3.33	3.37
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	0.05	0.16		0.001	NS		0.04	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 88: Nitrogen, phosphorus and potassium content of pod as influenced by FYM and liquid manures application (Pooled 2014 and 2015)

Treatments	Nutrient contents of Pod								
	Pod Nitrogen (%)			Pod Phosphorus (%)			Pod Potassium (%)		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	3.29	3.35	3.32	0.062	0.067	0.065	3.00	3.07	3.04
F ₂	3.35	3.57	3.46	0.064	0.071	0.067	3.10	3.28	3.19
F ₃	3.60	3.73	3.67	0.065	0.073	0.069	3.18	3.31	3.25
Mean	3.41	3.55		0.064	0.070		3.10	3.22	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.03	0.08		0.001	0.002		0.02	0.06	
J	0.02	0.07		0.0005	0.001		0.02	0.05	
F × J	0.04	NS		0.001	NS		0.03	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	3.31	3.33	3.32	0.064	0.065	0.065	3.03	3.05	3.04
F ₂	3.37	3.54	3.46	0.066	0.069	0.067	3.14	3.24	3.19
F ₃	3.61	3.72	3.67	0.067	0.071	0.069	3.22	3.28	3.25
Mean	3.43	3.53		0.066	0.068		3.13	3.19	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.02	0.07		0.0005	0.001		0.02	0.05	
F × P	0.04	NS		0.001	NS		0.03	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	3.37	3.46	3.41	0.062	0.065	0.064	3.06	3.13	3.10
J ₁	3.49	3.61	3.55	0.069	0.072	0.070	3.20	3.24	3.22
Mean	3.43	3.53		0.066	0.068		3.13	3.19	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.03	NS		0.001	NS		0.02	NS	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁ J ₀	3.28	3.31		0.061	0.063		2.99	3.01	
F ₁ J ₁	3.34	3.36		0.067	0.067		3.06	3.08	
F ₂ J ₀	3.33	3.36		0.063	0.065		3.05	3.15	
F ₂ J ₁	3.41	3.73		0.069	0.073		3.23	3.33	
F ₃ J ₀	3.50	3.70		0.063	0.067		3.14	3.23	
F ₃ J ₁	3.72	3.74		0.072	0.074		3.29	3.33	
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	0.05	0.16		0.001	NS		0.04	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

observed in FYM at 100 per cent N equivalent with without jeevamrutha and without panchagavya application (3.25 %).

Nitrogen, phosphorous and potassium content in green pods did not differ significantly due to the interaction between FYM and jeevamrutha, FYM and panchagavya, panchagavya and jeevamrutha application.

Experiment conducted during *kharif* 2015

Nitrogen, phosphorous and potassium (%) content of green pods differed significantly due to the application of various levels of FYM, jeevamrutha and panchagavya. Higher nitrogen, phosphorus and potassium content in pods was recorded with FYM at 200 per cent N equivalent (3.70, 0.071 and 3.29 %, respectively) followed by FYM at 150 per cent N equivalent (3.49, 0.070 and 3.23 %, respectively) as compared to FYM at 100 per cent N equivalent (3.35, 0.067 and 3.07 %, respectively). Whereas application of FYM at 200 per cent N equivalent found on par with FYM at 150 per cent N equivalent in case of pod phosphorus and potassium content.

Application of Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent recorded significantly higher nitrogen (3.58 and 3.56 %), phosphorus (0.073 and 0.071 %) and potassium (3.26 and 3.23 %) content in pods as compared to without jeevamrutha (3.45, 0.066 and 3.13 %, respectively) and without panchagavya application (3.46, 0.068 and 3.17 %, respectively).

Interaction effect

Nitrogen content in pod was significantly influenced by interaction of FYM, jeevamrutha and panchagavya application except phosphorous and potassium content. Higher nitrogen content in pod was noticed in FYM at 200 per cent N equivalent with Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent (3.77 %) and on par with FYM at 200 per cent N equivalent with Jeevamrutha at 1000 litre ha⁻¹ and without panchagavya, FYM at 200 per cent N equivalent with panchagavya at 3 per cent and without jeevamrutha application and FYM at 150 per cent N equivalent with jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent. Lower nitrogen content in pod was observed in FYM at 100 per cent N equivalent with without jeevamrutha at and without panchagavya application (3.30 %).

Nitrogen, phosphorous and potassium content in green pods did not differ significantly due to the interaction between FYM and jeevamrutha, FYM and panchagavya, panchagavya and jeevamrutha application.

Pooled

Nitrogen, phosphorous and potassium (%) content of green pods differed significantly due to the application of various levels of FYM, jeevamrutha and panchagavya. Higher nitrogen, phosphorus and potassium content in pods were recorded with FYM at 200 per cent N equivalent (3.67, 0.069 and 3.25 %, respectively) followed by FYM at 150 per cent N equivalent (3.46, 0.067 and 3.19 %, respectively) as compared

to FYM at 100 per cent N equivalent (3.32, 0.065 and 3.04 %, respectively). Whereas application of FYM at 200 per cent N equivalent found on par with FYM at 150 per cent N equivalent in case of pod phosphorus and potassium content.

Application of Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent recorded significantly higher nitrogen (3.55 and 3.53 %), phosphorus (0.07 and 0.068 %) and potassium (3.22 and 3.19 %) content in pods as compared to without jeevamrutha (3.41, 0.064 and 3.1 %, respectively) and without panchagavya application (3.43, 0.066 and 3.13 %, respectively).

Nitrogen content in pod was significantly influenced by interaction of FYM, jeevamrutha and panchagavya application except phosphorous and potassium content. Higher nitrogen content in pod was noticed in FYM at 200 per cent N equivalent with Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent (3.74 %) and on par with FYM at 200 per cent N equivalent with Jeevamrutha at 1000 litre ha⁻¹ and without panchagavya, FYM at 200 per cent N equivalent with panchagavya at 3 per cent and without jeevamrutha application and FYM at 150 per cent N equivalent with jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent. Lower nitrogen content in pod was observed in FYM at 100 per cent N equivalent with without jeevamrutha at and without panchagavya application (3.28 %).

Nitrogen, phosphorous and potassium content in green pods did not differ significantly due to the interaction between FYM and jeevamrutha, FYM and panchagavya, panchagavya and jeevamrutha application.

Exp II: Effect of different levels of jeevamrutha and panchagavya on N, P and K content of frenchbean at different crop growth stages

The data pertaining to the nitrogen, phosphorous and potassium (%) content of pod as influenced by liquid manures. There was significant difference in nitrogen, phosphorous and potassium content of frenchbean at 40 DAS and harvest except at 20 DAS.

4.10.1 Nitrogen content

Nitrogen content in plant differed significantly due to liquid manures application are presented in the Tables 89, 90 and 91. Nitrogen content in frenchbean increased with increased levels of jeevamrutha and panchagavya application.

Experiment conducted during *kharif* 2014

20 Days after sowing

Nitrogen content in frenchbean did not differ significantly due to application of liquid manures. However, higher nitrogen content in plant was noticed in higher levels of jeevamrutha and panchagavya application.

Table 89: Plant N content as influenced by liquid manures application at different growth stage of frenchbean during *Kharif* 2014

Jeevamrutha Levels	Plant N (%)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	2.97	2.98	2.98	2.98	2.64	2.68	2.70	2.67	2.18	2.22	2.22	2.21
J₁	2.99	3.08	3.08	3.05	2.73	2.82	2.84	2.80	2.24	2.26	2.29	2.26
J₂	3.09	3.10	3.10	3.09	2.82	2.85	2.87	2.84	2.28	2.31	2.34	2.31
J₃	3.10	3.11	3.11	3.10	2.86	2.91	2.97	2.91	2.30	2.32	2.37	2.33
Mean	3.04	3.07	3.07		2.76	2.81	2.84		2.25	2.28	2.31	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.04		NS		0.02		0.05		0.01		0.02	
Panchagavya	0.04		NS		0.01		0.04		0.01		0.02	
J × P	0.07		NS		0.03		NS		0.01		NS	

Note: J₀ - Without Jeevamrutha, J₁- Jeevamrutha 1000 litre/ha, J₂- Jeevamrutha 1500 litre/ha, J₃- Jeevamrutha 2000 litre/ha

P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, P₃- Panchagavya at 6 %, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 90: Plant N content as influenced by liquid manures application at different growth stage of frenchbean during *Kharif* 2015

Jeevamrutha Levels	Plant N (%)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	3.03	3.04	3.03	3.03	2.71	2.73	2.75	2.73	2.23	2.26	2.28	2.26
J₁	3.03	3.14	3.13	3.10	2.79	2.88	2.91	2.86	2.29	2.32	2.34	2.31
J₂	3.14	3.16	3.15	3.15	2.87	2.91	2.93	2.90	2.33	2.36	2.39	2.36
J₃	3.15	3.16	3.16	3.16	2.92	2.98	3.04	2.98	2.35	2.38	2.41	2.38
Mean	3.09	3.12	3.12		2.82	2.87	2.91		2.30	2.33	2.35	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.04		NS		0.02		0.05		0.01		0.02	
Panchagavya	0.04		NS		0.01		0.04		0.01		0.02	
J × P	0.07		NS		0.03		NS		0.01		NS	

Note: **J₀** - Without Jeevamrutha, **J₁**- Jeevamrutha 1000 litre/ha, **J₂**- Jeevamrutha 1500 litre/ha, **J₃**- Jeevamrutha 2000 litre/ha
P₀ - Without panchagavya, **P₁** - Panchagavya at 3 %, **P₃**- Panchagavya at 6 %, **DAS** – Days After Sowing, **RDF** – 63:100:75 NPK kg ha⁻¹

Table 91: Plant N content as influenced by liquid manures application at different growth stage of frenchbean (Pooled 2014 and 2015)

Jeevamrutha Levels	Plant N (%)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	3.00	3.01	3.00	3.01	2.67	2.70	2.72	2.70	2.21	2.24	2.25	2.23
J₁	3.01	3.11	3.10	3.07	2.76	2.85	2.87	2.83	2.26	2.29	2.31	2.29
J₂	3.11	3.13	3.12	3.12	2.85	2.88	2.90	2.87	2.31	2.34	2.37	2.34
J₃	3.12	3.14	3.13	3.13	2.89	2.95	3.00	2.95	2.32	2.35	2.39	2.35
Mean	3.06	3.10	3.09		2.79	2.84	2.87		2.28	2.30	2.33	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.04		NS		0.02		0.05		0.01		0.02	
Panchagavya	0.04		NS		0.01		0.04		0.01		0.02	
J × P	0.07		NS		0.03		NS		0.01		NS	

Note: **J₀** - Without Jeevamrutha, **J₁**- Jeevamrutha 1000 litre/ha, **J₂** - Jeevamrutha 1500 litre/ha, **J₃** - Jeevamrutha 2000 litre/ha
P₀ - Without panchagavya, **P₁** - Panchagavya at 3 %, **P₃** - Panchagavya at 6 %, **DAS** – Days After Sowing, **RDF** – 63:100:75 NPK kg ha⁻¹

40 Days after sowing

Nitrogen content in frenchbean was significantly high in jeevamrutha at 2000 litre ha⁻¹ (2.91 %) followed by jeevamrutha at 1500 litre ha⁻¹ (2.84 %), jeevamrutha at 1000 litre ha⁻¹ (2.80 %) as compared to no jeevamrutha application (2.67 %). Panchagavya at 6 per cent recorded higher nitrogen content in frenchbean (2.84 %) found on par with panchagavya at 3 per cent (2.81 %) and lower nitrogen content was noticed in without panchagavya application (2.76 %).

At harvest

Significantly higher content of nitrogen was recorded with application of jeevamrutha at 2000 litre ha⁻¹ (2.33 %) followed by jeevamrutha at 1500 litre ha⁻¹ (2.31 %) and jeevamrutha at 1000 litre ha⁻¹ (2.26 %) as compared to without jeevamrutha application (2.21 %). Panchagavya spray influenced significantly on nitrogen content of plant. Panchagavya at 6 per cent recorded higher nitrogen content in frenchbean (2.31 %) followed by panchagavya at 3 per cent (2.28 %) and lower nitrogen content was noticed in without panchagavya application (2.25 %).

Experiment conducted during *kharif* 2015

20 Days after sowing

Nitrogen content in frenchbean did not differ significantly due to application of liquid manures. However, higher nitrogen content in plant was noticed in higher levels of jeevamrutha and panchagavya application.

40 Days after sowing

Nitrogen content in frenchbean was significantly high in jeevamrutha at 2000 litre ha⁻¹ (2.98 %) followed by jeevamrutha at 1500 litre ha⁻¹ (2.90 %), jeevamrutha at 1000 litre ha⁻¹ (2.86 %) as compared to no jeevamrutha application (2.73 %). Panchagavya spray influenced significantly on nitrogen content of plant. Panchagavya at 6 per cent recorded higher nitrogen content in frenchbean (2.91 %) found on par with panchagavya at 3 per cent (2.87 %) and lower nitrogen content was noticed in without panchagavya application (2.82 %).

At harvest

Significantly higher content of nitrogen was recorded in application of jeevamrutha at 2000 litre ha⁻¹ (2.38 %) followed by jeevamrutha at 1500 litre ha⁻¹ (2.36 %) and jeevamrutha at 1000 litre ha⁻¹ (2.31 %) as compared to without jeevamrutha application (2.26 %). Panchagavya spray influenced significantly on nitrogen content of plant. Panchagavya at 6 per cent recorded higher nitrogen content in frenchbean (2.35 %) followed by panchagavya at 3 per cent (2.33 %) and lower nitrogen content was noticed in without panchagavya application (2.30 %).

Interaction effect

Nitrogen content in frenchbean did not differ significantly due to the interaction between jeevamrutha and panchagavya application at all the crop growth stages during both the yeas.

Pooled

Nitrogen content of frenchbean was significantly influenced by liquid manures application. At 40 DAS jeevamrutha at 2000 litre ha⁻¹ application recorded higher nitrogen content in plant (2.95 %) followed by jeevamrutha at 1500 litre ha⁻¹ (2.87 %), jeevamrutha at 1000 litre ha⁻¹ (2.83 %) as compared no jeevamrutha application (2.70 %). Panchagavya at 6 per cent recorded significantly higher nitrogen content of frenchbean (2.87) as compared to without panchagavya application (2.79) which was on par with panchagavya at 3 per cent (2.87).

At harvest nitrogen content of frenchbean was significantly more in jeevamrutha at 2000 litre ha⁻¹ (10.33) followed by jeevamrutha at 1500 litre ha⁻¹ (9.94), jeevamrutha at 1000 litre ha⁻¹ (9.56) as compared to no jeevamrutha application (8.78), where jeevamrutha at 1500 litre ha⁻¹ on par with jeevamrutha at 1000 litre ha⁻¹ application. Panchagavya at 6 per cent recorded significantly higher nitrogen content of frenchbean (2.33) followed by panchagavya at 3 per cent (2.3) as compared to without panchagavya application (2.28).

Nitrogen content in frenchbean did not differ significantly due to the interaction between jeevamrutha and panchagavya application,

4.10.2 Phosphorous content

Phosphorous content in plant differed significantly due to liquid manures applications are presented in the Tables 92, 93 and 94.

Experiment conducted during *kharif* 2014

20 Days after sowing

Phosphorous content in frenchbean did not differ significantly due to application of liquid manures. However, higher phosphorous content in plant was noticed in higher levels of jeevamrutha and panchagavya application.

40 Days after sowing

Phosphorous content in frenchbean was significantly higher in jeevamrutha at 2000 litre ha⁻¹ (0.279 %) followed by jeevamrutha at 1500 litre ha⁻¹ (0.271 %), jeevamrutha at 1000 litre ha⁻¹ (0.266 %) as compared to without jeevamrutha application (0.260 %). Panchagavya spray influenced significantly on phosphorous content of plant. Panchagavya at 6 per cent recorded higher phosphorous content in frenchbean (0.273 %) and was found on par with panchagavya at 3 per cent (0.270 %) and lower phosphorous content was noticed in without panchagavya application (0.265 %).

Table 92: Plant Phosphorus content as influenced by liquid manures application at different growth stage of frenchbean during *Kharif* 2014

Jeevamrutha Levels	Plant Phosphorus (%)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	0.282	0.283	0.283	0.283	0.259	0.260	0.262	0.260	0.220	0.223	0.224	0.222
J₁	0.285	0.285	0.282	0.284	0.263	0.266	0.269	0.266	0.226	0.231	0.232	0.230
J₂	0.288	0.285	0.287	0.287	0.265	0.273	0.275	0.271	0.229	0.234	0.241	0.235
J₃	0.290	0.291	0.297	0.293	0.272	0.280	0.285	0.279	0.230	0.238	0.244	0.237
Mean	0.286	0.286	0.287		0.265	0.270	0.273		0.226	0.231	0.235	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.005		NS		0.001		0.004		0.001		0.004	
Panchagavya	0.004		NS		0.001		0.003		0.001		0.003	
J × P	0.008		NS		0.002		NS		0.002		NS	

Note: **J₀** - Without Jeevamrutha, **J₁**- Jeevamrutha 1000 litre/ha, **J₂**- Jeevamrutha 1500 litre/ha, **J₃**- Jeevamrutha 2000 litre/ha
P₀- Without panchagavya, **P₁**- Panchagavya at 3 %, **P₃**- Panchagavya at 6 %, **DAS** – Days After Sowing, **RDF** – 63:100:75 NPK kg ha⁻¹

Table 93: Plant Phosphorus content as influenced by liquid manures application at different growth stage of frenchbean during *Kharif* 2015

Jeevamrutha Levels	Plant Phosphorus (%)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	0.287	0.289	0.290	0.289	0.264	0.267	0.268	0.267	0.225	0.227	0.228	0.227
J₁	0.291	0.290	0.293	0.291	0.271	0.272	0.275	0.273	0.231	0.235	0.236	0.234
J₂	0.294	0.291	0.292	0.292	0.273	0.279	0.282	0.278	0.234	0.239	0.246	0.240
J₃	0.296	0.298	0.303	0.299	0.278	0.285	0.290	0.284	0.234	0.244	0.249	0.242
Mean	0.292	0.292	0.295		0.271	0.276	0.279		0.231	0.236	0.240	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.005		NS		0.002		0.004		0.001		0.004	
Panchagavya	0.004		NS		0.001		0.004		0.001		0.003	
J × P	0.009		NS		0.003		NS		0.002		NS	

Note: J₀ - Without Jeevamrutha, J₁- Jeevamrutha 1000 litre/ha, J₂- Jeevamrutha 1500 litre/ha, J₃ - Jeevamrutha 2000 litre/ha

P₀- Without panchagavya, P₁ - Panchagavya at 3 %, P₃- Panchagavya at 6 %, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 94: Plant Phosphorus content as influenced by liquid manures application at different growth stage of french bean (Pooled 2014 and 2015)

Jeevamrutha Levels	Plant Phosphorus (%)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	0.285	0.286	0.287	0.286	0.262	0.264	0.265	0.264	0.223	0.225	0.226	0.224
J₁	0.288	0.288	0.287	0.288	0.267	0.269	0.272	0.269	0.229	0.233	0.234	0.232
J₂	0.291	0.288	0.290	0.290	0.269	0.276	0.279	0.274	0.232	0.236	0.243	0.237
J₃	0.293	0.295	0.300	0.296	0.275	0.282	0.287	0.282	0.232	0.241	0.247	0.240
Mean	0.289	0.289	0.291		0.268	0.273	0.276		0.229	0.234	0.238	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.004		NS		0.001		0.004		0.001		0.004	
Panchagavya	0.004		NS		0.001		0.004		0.001		0.003	
J × P	0.008		NS		0.002		NS		0.002		NS	

Note: **J₀**- Without Jeevamrutha, **J₁**- Jeevamrutha 1000 litre/ha, **J₂**- Jeevamrutha 1500 litre/ha, **J₃**- Jeevamrutha 2000 litre/ha
P₀- Without panchagavya, **P₁**- Panchagavya at 3 %, **P₃**- Panchagavya at 6 %, **DAS** – Days After Sowing, **RDF** – 63:100:75 NPK kg ha⁻¹

At harvest

Significantly higher content of phosphorous in frenchbean was recorded in application of jeevamrutha at 2000 litre ha⁻¹ (0.237 %) followed by jeevamrutha at 1500 litre ha⁻¹ (0.235 %) and jeevamrutha at 1000 litre ha⁻¹ (0.230 %) as compared to without jeevamrutha application (0.222 %). Panchagavya spray influenced significantly on phosphorous content of plant. Panchagavya at 6 per cent recorded higher phosphorous content in frenchbean (0.235 %) followed by panchagavya at 3 per cent (0.231 %) and lower phosphorous content was noticed in without panchagavya application (0.226 %).

Experiment conducted during *kharif* 2015

20 Days after sowing

Phosphorous content in frenchbean did not differ significantly due to application of liquid manures. However, higher phosphorous content in plant was noticed in higher levels of jeevamrutha and panchagavya application.

40 Days after sowing

Phosphorous content in frenchbean was significantly higher in jeevamrutha at 2000 litre ha⁻¹ (0.284 %) followed by jeevamrutha at 1500 litre ha⁻¹ (0.278 %), jeevamrutha at 1000 litre ha⁻¹ (0.273 %) as compared to without jeevamrutha application (0.267 %). Panchagavya spray influenced significantly on phosphorous content of plant. Panchagavya at 6 per cent recorded higher phosphorous content in frenchbean (0.279 %) and was found on par with panchagavya at 3 per cent (0.276 %) and lower phosphorous content was noticed in without panchagavya application (0.271 %).

At harvest

Significantly higher content of phosphorous in frenchbean was recorded in application of jeevamrutha at 2000 litre ha⁻¹ (0.242 %) followed by jeevamrutha at 1500 litre ha⁻¹ (0.240 %) and jeevamrutha at 1000 litre ha⁻¹ (0.234 %) as compared to without jeevamrutha application (0.227 %). Panchagavya spray influenced significantly on phosphorous content of plant. Panchagavya at 6 per cent recorded higher phosphorous content in frenchbean (0.240 %) followed by panchagavya at 3 per cent (0.236 %) and lower phosphorous content was noticed in without panchagavya application (0.231 %).

Phosphorous content in frenchbean did not differ significantly due to the interaction between jeevamrutha and panchagavya application during both the years.

Pooled

Phosphorous content of frenchbean increased with increased levels of jeevamrutha and panchagavya application. At 40 DAS phosphorous content of frenchbean was significantly high in jeevamrutha at 2000 litre ha⁻¹ (0.282) followed by jeevamrutha at 1500 litre ha⁻¹ (0.274), jeevamrutha at 1000 litre ha⁻¹ (0.269) as compared no jeevamrutha application (0.264). At harvest phosphorous content of frenchbean was significantly more in jeevamrutha at 2000 litre ha⁻¹ (0.240) followed by jeevamrutha at 1500 litre ha⁻¹ (0.237), jeevamrutha at 1000 litre ha⁻¹ (0.232) as compared no jeevamrutha

application (0.224), where jeevamrutha at 1500 litre ha⁻¹ was on par with jeevamrutha at 1000 litre ha⁻¹ application.

At 40 DAS and harvest Panchagavya at 6 per cent recorded significantly more phosphorous content of frenchbean (0.276 and 0.238) followed by panchagavya at 3 per cent (0.273 and 0.234) and lower was with panchagavya application (0.268 and 0.299).

Phosphorous content in frenchbean did not differ significantly due to the interaction between jeevamrutha and panchagavya application.

4.10.3 Potassium content

Potassium content in plant differed significantly due to solid and liquid manures applications are presented in the Tables 95, 96 and 97.

Experiment conducted during *kharif* 2014

20 Days after sowing

Potassium content in frenchbean did not differ significantly due to application of liquid manures. However, higher potassium content in plant was noticed in higher levels of jeevamrutha and panchagavya application.

40 Days after sowing

Potassium content in frenchbean was significantly higher in jeevamrutha at 2000 litre ha⁻¹ (2.18 %) followed by jeevamrutha at 1500 litre ha⁻¹ (2.13 %), jeevamrutha at 1000 litre ha⁻¹ (2.10 %) as compared to without jeevamrutha application (2.02 %). Panchagavya spray influenced significantly on potassium content of plant. Panchagavya at 6 per cent recorded higher potassium content in frenchbean (2.13 %) and was found on par with panchagavya at 3 per cent (2.11 %) and lower potassium content was noticed in without panchagavya application (2.08 %).

At harvest

Significantly higher content of potassium in frenchbean was recorded in application of jeevamrutha at 2000 litre ha⁻¹ (1.78 %) followed by jeevamrutha at 1500 litre ha⁻¹ (1.74 %) and jeevamrutha at 1000 litre ha⁻¹ (1.72 %) as compared to without jeevamrutha application (1.65 %). Panchagavya spray influenced significantly on potassium content of plant. Panchagavya at 6 per cent recorded higher potassium content in frenchbean (1.74 %) found on par with panchagavya at 3 per cent (1.73 %) and lower potassium content was noticed in without panchagavya application (1.70 %).

Experiment conducted during *kharif* 2015

20 Days after sowing

Potassium content in frenchbean did not differ significantly due to application of liquid manures. However, higher potassium content in plant was noticed in higher levels of jeevamrutha and panchagavya application.

Table 95: Plant Potassium content of as influenced by liquid manures application at different growth stage of frenchbean during *Kharif* 2014

Jeevamrutha Levels	Plant Potassium (%)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	2.84	2.85	2.86	2.85	1.98	2.03	2.04	2.02	1.64	1.66	1.67	1.65
J₁	2.86	2.87	2.86	2.86	2.08	2.11	2.13	2.10	1.69	1.73	1.74	1.72
J₂	2.86	2.87	2.88	2.87	2.11	2.14	2.15	2.13	1.72	1.74	1.75	1.74
J₃	2.87	2.92	2.98	2.92	2.16	2.18	2.19	2.18	1.74	1.78	1.80	1.78
Mean	2.86	2.88	2.90		2.08	2.11	2.13		1.70	1.73	1.74	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.02		NS		0.01		0.03		0.01		0.02	
Panchagavya	0.02		NS		0.01		0.02		0.01		0.02	
J × P	0.04		NS		0.02		NS		0.01		NS	

Note: J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, J₂ - Jeevamrutha 1500 litre/ha, J₃ - Jeevamrutha 2000 litre/ha

P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, P₂ - Panchagavya at 6 %, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 96: Plant Potassium content of as influenced by liquid manures application at different growth stage of frenchbean during *Kharif* 2015

Jeevamrutha Levels	Plant Potassium (%)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	2.91	2.92	2.93	2.92	2.04	2.08	2.10	2.07	1.68	1.71	1.72	1.70
J₁	2.93	2.94	2.93	2.93	2.13	2.17	2.19	2.16	1.74	1.78	1.79	1.77
J₂	2.93	2.94	2.95	2.94	2.17	2.20	2.20	2.19	1.77	1.79	1.80	1.79
J₃	2.94	2.98	3.05	2.99	2.21	2.23	2.25	2.23	1.79	1.83	1.86	1.83
Mean	2.93	2.94	2.97		2.14	2.17	2.19		1.75	1.78	1.79	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.02		NS		0.01		0.03		0.01		0.02	
Panchagavya	0.02		NS		0.01		0.02		0.01		0.02	
J × P	0.04		NS		0.02		NS		0.01		NS	

Note: **J₀** - Without Jeevamrutha, **J₁**- Jeevamrutha 1000 litre/ha, **J₂** - Jeevamrutha 1500 litre/ha, **J₃** - Jeevamrutha 2000 litre/ha
P₀ - Without panchagavya, **P₁** - Panchagavya at 3 %, **P₃**- Panchagavya at 6 %, **DAS** – Days After Sowing, **RDF** – 63:100:75 NPK kg ha⁻¹

Table 97: Plant Potassium content as influenced by liquid manures application at different growth stage of french bean (Pooled 2014 and 2015)

Jeevamrutha Levels	Plant Potassium (%)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	2.87	2.89	2.90	2.89	2.01	2.05	2.07	2.04	1.66	1.68	1.69	1.68
J₁	2.89	2.90	2.90	2.90	2.11	2.14	2.16	2.13	1.72	1.76	1.76	1.75
J₂	2.90	2.91	2.92	2.91	2.14	2.17	2.18	2.16	1.75	1.77	1.78	1.76
J₃	2.90	2.95	3.01	2.95	2.19	2.21	2.22	2.20	1.77	1.81	1.83	1.80
Mean	2.89	2.91	2.93		2.11	2.14	2.16		1.72	1.75	1.77	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.02		NS		0.01		0.03		0.01		0.02	
Panchagavya	0.02		NS		0.01		0.02		0.01		0.02	
J × P	0.04		NS		0.02		NS		0.01		NS	

Note: J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, J₂ - Jeevamrutha 1500 litre/ha, J₃ - Jeevamrutha 2000 litre/ha
P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, P₃ - Panchagavya at 6 %, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

40 Days after sowing

Potassium content in frenchbean was significantly higher in jeevamrutha at 2000 litre ha⁻¹ (2.33 %) followed by jeevamrutha at 1500 litre ha⁻¹ (2.19 %), jeevamrutha at 1000 litre ha⁻¹ (2.16 %) as compared to without jeevamrutha application (2.07 %). Panchagavya spray influenced significantly on potassium content of plant. Panchagavya at 6 per cent recorded higher potassium content in frenchbean (2.19 %) followed by panchagavya at 3 per cent (2.17 %) and lower potassium content was noticed in without panchagavya application (2.14 %).

At harvest

Significantly higher content of potassium in frenchbean was recorded in application of jeevamrutha at 2000 litre ha⁻¹ (1.83 %) followed by jeevamrutha at 1500 litre ha⁻¹ (1.79 %) and jeevamrutha at 1000 litre ha⁻¹ (1.77 %) as compared to without jeevamrutha application (1.70 %). Panchagavya spray influenced significantly on potassium content of plant. Panchagavya at 6 per cent recorded higher potassium content in frenchbean (1.79 %) and was found on par with panchagavya at 3 per cent (1.78 %) and lower potassium content was noticed in without panchagavya application (1.75 %).

Potassium content in frenchbean did not differ significantly due to the interaction between jeevamrutha and panchagavya application during both the yeas.

Pooled

Potassium content in frenchbean significantly influenced by application of liquid manures. At 40 DAS and harvest jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher potassium content (2.20 and 1.80) followed by jeevamrutha at 1500 litre ha⁻¹ (2.16 and 1.76), jeevamrutha at 1000 litre ha⁻¹ (2.13 and 1.75) and significantly lower potassium content was recorded with no-jeevamrutha application (2.04 and 1.68).

At 40 DAS panchagavya at 6 per cent recorded significantly higher potassium content (2.16) followed by panchagavya at 3 per cent (2.14) and it was lower with no-panchagavya application (2.11). At harvest panchagavya at 6 per cent recorded significantly higher potassium content (1.77) as compared to no-panchagavya application (1.72) and which was on par with panchagavya at 3 per cent (1.75).

Potassium content of frenchbean did not differs significantly due to the interaction between jeevamrutha and panchagavya application.

4.10.4 Pod N, P and K

The data pertaining to the nitrogen, phosphorous and potassium (%) content of pod as influenced by liquid manures are presented in the Tables 98, 99 and 100.

Experiment conducted during *kharif* 2014

Application of jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher nitrogen, phosphorus and potassium content in pods (3.44, 0.067 and 3.13) followed by

jeevamrutha at 1500 litre ha⁻¹ (3.38, 0.064 and 3.11), jeevamrutha at 1000 litre ha⁻¹ (3.33, 0.063 and 3.05) and significantly lower with no-jeevamrutha application (3.25, 0.059 and 2.92). Panchagavya spray influenced significantly on nitrogen, phosphorus and potassium content of plant. Panchagavya at 6 per cent recorded significantly higher nitrogen, phosphorus and potassium content in pods (3.40, 0.065 and 3.11) followed by panchagavya at 3 per cent (3.35, 0.063 and 3.07) and it was lower with no-panchagavya application (3.31, 0.062 and 2.97).

Experiment conducted during *kharif* 2015

Application of jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher nitrogen, phosphorus and potassium content in pods (3.53, 0.069 and 3.21) followed by jeevamrutha at 1500 litre ha⁻¹ (3.46, 0.066 and 3.18), jeevamrutha at 1000 litre ha⁻¹ (3.40, 0.065 and 3.14) and significantly lower with no-jeevamrutha application (3.32, 0.062 and 3.01). Panchagavya spray influenced significantly on nitrogen, phosphorus and potassium content of plant. Panchagavya at 6 per cent recorded significantly higher nitrogen, phosphorus and potassium content in pods (3.48, 0.067 and 3.19) followed by panchagavya at 3 per cent (3.43, 0.066 and 3.14) and it was lower with no-panchagavya application (3.38, 0.064 and 3.07).

Interaction effect

Nitrogen, phosphorus and potassium content in pods did not differ significantly due to the interaction between jeevamrutha and panchagavya application during both the years.

Pooled

Application of jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher nitrogen, phosphorus and potassium content in pods (3.49, 0.068 and 3.17) followed by jeevamrutha at 1500 litre ha⁻¹ (3.42, 0.065 and 3.14), jeevamrutha at 1000 litre ha⁻¹ (3.37, 0.064 and 3.09) and significantly lower with no-jeevamrutha (3.29, 0.06 and 2.96). Panchagavya at 6 per cent recorded significantly higher nitrogen, phosphorus and potassium content in pods (3.44, 0.066 and 3.15) followed by panchagavya at 3 per cent (3.39, 0.064 and 3.11) and it was lower with no-panchagavya application (3.34, 0.063 and 3.02).

Nitrogen, phosphorus and potassium content in pods did not differ significantly due to the interaction between various levels of jeevamrutha and panchagavya application.

Discussion on the findings relating to the performance of FYM and liquid manures on nutrient content of frenchbean

The nutrient content of frenchbean was significantly influenced by application of FYM during both the years. Among the FYM levels, higher N, P and K content of frenchbean was found to be maximum in FYM at 200 per cent N equivalent (3.1, 0.288 and 2.23 %) over FYM at 100 per cent N equivalent (2.78, 0.271 and 2.10 % NPK) (Table 139). This might be due to more supply of nitrogen, phosphorous and potassium through decomposition of FYM and also fast mineralization of FYM due to higher

Table 98: Nitrogen, Phosphorus and Potassium content of pod as influenced by liquid manures application during *Kharif* 2014

Jeevamrutha Levels	Nutrient contents of Pod											
	Pod Nitrogen (%)				Pod Phosphorus (%)				Pod Potassium (%)			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	3.23	3.25	3.28	3.25	0.057	0.058	0.060	0.059	2.90	2.91	2.93	2.92
J₁	3.30	3.31	3.37	3.33	0.061	0.063	0.064	0.063	2.93	3.08	3.15	3.05
J₂	3.32	3.40	3.42	3.38	0.063	0.064	0.066	0.064	2.99	3.14	3.18	3.11
J₃	3.37	3.44	3.52	3.44	0.065	0.068	0.068	0.067	3.06	3.16	3.19	3.13
Mean	3.31	3.35	3.40		0.062	0.063	0.065		2.97	3.07	3.11	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.01		0.04		0.0003		0.0010		0.01		0.04	
Panchagavya	0.01		0.04		0.0003		0.0009		0.01		0.03	
J × P	0.02		NS		0.0006		NS		0.02		0.06	

Note: **J₀** - Without Jeevamrutha, **J₁** - Jeevamrutha 1000 litre/ha, **J₂** - Jeevamrutha 1500 litre/ha, **J₃** - Jeevamrutha 2000 litre/ha

P₀ - Without panchagavya, **P₁** - Panchagavya at 3 %, **P₂** - Panchagavya at 6 %, **DAS** – Days After Sowing, **RDF** – 63:100:75 NPK kg ha⁻¹

Table 99: Nitrogen, Phosphorus and Potassium content of pod as influenced by liquid manures application during *Kharif* 2015

Jeevamrutha Levels	Nutrient content of Pod											
	Pod Nitrogen (%)				Pod Phosphorus (%)				Pod Potassium (%)			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	3.29	3.32	3.35	3.32	0.060	0.063	0.064	0.062	2.98	2.99	3.05	3.01
J₁	3.37	3.39	3.45	3.40	0.065	0.064	0.066	0.065	3.05	3.14	3.22	3.14
J₂	3.40	3.48	3.50	3.46	0.064	0.066	0.068	0.066	3.10	3.21	3.24	3.18
J₃	3.46	3.53	3.61	3.53	0.067	0.069	0.071	0.069	3.14	3.23	3.25	3.21
Mean	3.38	3.43	3.48		0.064	0.066	0.067		3.07	3.14	3.19	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.01		0.04		0.0006		0.0016		0.01		0.04	
Panchagavya	0.01		0.04		0.0005		0.0014		0.01		0.04	
J × P	0.02		NS		0.0010		NS		0.03		NS	

Note: **J₀** - Without Jeevamrutha, **J₁** - Jeevamrutha 1000 litre/ha, **J₂** - Jeevamrutha 1500 litre/ha, **J₃** - Jeevamrutha 2000 litre/ha

P₀ - Without panchagavya, **P₁** - Panchagavya at 3 %, **P₂** - Panchagavya at 6 %, **DAS** – Days After Sowing, **RDF** – 63:100:75 NPK kg ha⁻¹

Table 100: Nitrogen, Phosphorus and Potassium content of pod as influenced by liquid manures application (Pooled 2014 and 2015)

Jeevamrutha Levels	Nutrient contents of Pod											
	Pod Nitrogen (%)				Pod Phosphorus (%)				Pod Potassium (%)			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	3.26	3.28	3.31	3.29	0.058	0.061	0.062	0.060	2.94	2.95	2.99	2.96
J₁	3.34	3.35	3.41	3.37	0.063	0.063	0.065	0.064	2.99	3.11	3.18	3.09
J₂	3.36	3.44	3.46	3.42	0.064	0.065	0.067	0.065	3.05	3.17	3.21	3.14
J₃	3.42	3.49	3.56	3.49	0.066	0.069	0.070	0.068	3.10	3.19	3.22	3.17
Mean	3.34	3.39	3.44		0.063	0.064	0.066		3.02	3.11	3.15	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.01		0.04		0.0004		0.0012		0.01		0.03	
Panchagavya	0.01		0.04		0.0003		0.0010		0.01		0.03	
J × P	0.02		NS		0.0007		NS		0.02		0.05	

Note: **J₀** - Without Jeevamrutha, **J₁**- Jeevamrutha 1000 litre/ha, **J₂** - Jeevamrutha 1500 litre/ha, **J₃** - Jeevamrutha 2000 litre/ha
P₀ - Without panchagavya, **P₁** - Panchagavya at 3 %, **P₃** - Panchagavya at 6 %, **DAS** – Days After Sowing, **RDF** – 63:100:75 NPK kg ha⁻¹

microbial activity which serve as food for microbes this might have facilitated release of plant nutrients to labile nutrient pool thereby more availability to plants. This might also due to higher root biomass observed with increased levels of FYM reflected in higher lateral roots would provide more surface area for absorption of water and minerals by the plants. Incorporation of FYM found to produce more humic acid and humin substances, which form chelates with phosphorus. The chelated phosphorus has been reported to be more soluble in water, which might have favoured in more release of phosphorus and easily available to the crop (Hussain *et al.*, 2001). Increase in available phosphorus could be due to release of organic acids during the decomposition of organic matter, which helped in the solubility of native phosphates as a result of which the available phosphorus content in soil could have increased. Applied organic matter leads to the formation of a coating on sesquioxides, resulting in reduction of phosphate fixing capacity of soils (Sheshadri Reddy, 2005). Significantly lower nutrient content was recorded with 100 per cent N equivalent which might be due to lesser supply of N, P and K as compared to FYM at 200 per cent N equivalent. Similar findings have been reported from Bangalore, on finger millet where in the application of FYM 10 t ha⁻¹ increased available nitrogen (148.7 kg ha⁻¹), phosphorus (20.1 kg ha⁻¹) and potassium (136.4 kg ha⁻¹) as compared to control (94.3, 18.2 & 113.2, respectively) (Reddy *et al.*, 2011). Similar results were also noticed by Shete *et al.* (2011) and Siddappa (2015) in greengram and fieldbean.

Application of liquid manures *i.e.*, jeevamruta and panchagavya significantly influenced on nutrient concentration of frenchbean during both the years. The nutrient concentration increased with increased levels of jeevamruta and panchagavya application either alone or in combination. Among the jeevamrutha and panchagavya levels, application of jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent alone or in combination increased nutrient concentration of frenchbean in first experiment (Table 79, 82 and 85) and jeevamrutha at 2000 litre ha⁻¹ and panchagavya at 6 per cent in second experiment (Tables 91, 94 and 97) alone or in combination recorded significantly higher nutrient content of N, P and K per cent in plants at all the stages during both the years. This may be due to liquid manures contains macro and micro nutrients which are readily available for plant growth and development. Increased availability of nutrients due to build up of soil micro flora resulting in increased bacteria, fungi, actinomycetes, P-solubilizer and N fixer population in the soil. Similar results were found with Brijeshsingh (2008) he observed that application of jeevamruha, beejamrutha and panchagavya recorded significantly higher N, P and K content in the dry chilli fruit which might be due to supply of nutrients through liquid manures having beneficial microbes and enzymes. Siddaram (2012) observed that application of FYM at 10 t ha⁻¹ + bio-digester liquid manure equivalent to 35 kg N ha⁻¹ recorded significantly higher N, P and K uptake of field bean (92.3, 1535 and 83.8 kg ha⁻¹, respectively) over control and was on par with FYM at 10 t ha⁻¹ + bio-digester liquid manure equivalent to 30 kg N ha⁻¹ (91.0, 15.22 and 82.6 N, P and K, respectively kg ha⁻¹). These results are in agreement with the findings of Reddy *et al.*, (1992); Sharma and Mishra (1997); Siddappa (2015). Sreenivasa *et al.* (2009 and 2010) have reported that, presence of N fixers, P-solubilizers and other beneficial microorganisms in panchagavya, jeevamrutha, biodigester liquid manures support the improvement in soil fertility in turn increase in yield. However, the increase in uptake of nutrients with foliar spray of panchagavya was ascribed to increased

biological efficacy of crop plants and creating greater source and sink in the plant system (Boomathi *et al.*, 2005) that might have contributed for greater absorption of nutrients. In panchagavya, ammonia and nitrite oxidizers were found to colonize the leaves and increased the uptake and total N (Papen *et al.* 2002) and the presence of Indole Acetic Acid (IAA) stimulated the growth of adventitious roots (which arise from the base of the stem) and it also made root tips to work more actively. This might have helped in higher uptake of nutrients available in the soil (Sudhaker Rao, 1997). These results are in agreement with the findings of Beulah (2001) in *Moringa oleifera*. In case of Jeevamruta, addition of nutrients like nitrogen, phosphorus and potassium and micro organisms viz., nitrogen fixers, phosphorous solubilizing microorganisms made higher availability of these nutrients and resulted in higher uptake (Kasbe, 2008).

Soil physico-chemical and biological properties

Exp I: Effect of different levels of FYM, jeevamrutha and panchagavya on soil microbial Population

The data pertaining to populations of bacteria, fungi, actinomycetes, phosphorous solubilizer and nitrogen fixers in soil as influenced by solid and liquid manures are presented in the Tables 101-115. Microbial population differed significantly at 20, 40 DAS and at harvest due to the varied levels of FYM, jeevamrutha and panchagavya application.

4.11.1 Bacteria (10^6 cfu g⁻¹)

Bacterial population at different growth stages as influenced by solid and liquid manures and their interaction effects are presented in Tables 101-103.

Experiment conducted during *kharif* 2014

20 Days after sowing

Application of FYM at 200 per cent N equivalent recorded significantly higher populations of bacteria (31.4) followed by FYM at 150 per cent N equivalent (28.1). Whereas, significantly lower population was observed with FYM at 100 per cent N equivalent (24.2). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher bacterial population (32.4 and 30.4) as compared to without jeevamrutha and without panchagavya application (23.4 and 25.3).

Interaction effect

Bacterial population differed significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application. Application of FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent interaction recorded significantly higher bacteria (39.3) as compared to other interactions and lower bacterial population was recorded in FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya interaction (15.0). Bacterial population did not differ significantly due to the interaction effect of FYM and jeevamrutha, FYM and panchagavya, jeevamrutha and panchagavya.

Table 101: Bacterial population of rhizosphere soil as influenced by FYM and liquid manures application at different growth stages of frenchbean during *Kharif* 2014

Treatments	Bacteria (No. $\times 10^6$ cfu g ⁻¹)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	18.7	29.7	24.2	25.8	42.2	34.0	21.5	37.1	29.3
F ₂	24.0	32.2	28.1	34.0	45.8	39.9	29.8	40.4	35.1
F ₃	27.5	35.3	31.4	39.3	49.7	44.5	34.5	44.0	39.3
Mean	23.4	32.4		33.0	45.9		28.6	40.5	
	S.Em \pm	C.D.		S.Em \pm	C.D.		S.Em \pm	C.D.	
F	0.62	1.81		0.74	2.16		0.89	2.60	
J	0.50	1.48		0.60	1.76		0.72	2.12	
F \times J	0.87	NS		1.04	3.05		1.25	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	22.0	26.3	24.2	30.5	37.5	34.0	25.6	32.9	29.3
F ₂	25.8	30.3	28.1	36.5	43.3	39.9	32.1	38.2	35.1
F ₃	28.2	34.7	31.4	40.3	48.7	44.5	35.4	43.1	39.3
Mean	25.3	30.4		35.8	43.2		31.0	38.1	
	S.Em \pm	C.D.		S.Em \pm	C.D.		S.Em \pm	C.D.	
P	0.50	1.48		0.60	1.76		0.72	2.12	
F \times P	0.87	NS		1.04	NS		1.25	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	20.7	26.1	23.4	28.9	37.1	33.0	24.6	32.6	28.6
J ₁	30.0	34.8	32.4	42.6	49.2	45.9	37.5	43.5	40.5
Mean	25.3	30.4		35.8	43.2		31.0	38.1	
	S.Em \pm	C.D.		S.Em \pm	C.D.		S.Em \pm	C.D.	
J \times P	0.71	NS		0.85	NS		1.02	NS	
Interaction F \times J \times P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁	J ₀	15.0	22.3	20.1	31.4	15.3	27.7		
	J ₁	29.0	30.3	40.9	43.6	35.9	38.2		
F ₂	J ₀	22.0	26.0	31.0	37.0	27.2	32.4		
	J ₁	29.7	34.7	42.0	49.7	36.9	44.0		
F ₃	J ₀	25.0	30.0	35.7	43.0	31.2	37.8		
	J ₁	31.3	39.3	45.0	54.3	39.7	48.3		
F \times J \times P	S.Em \pm	C.D.		S.Em \pm	C.D.	S.Em \pm	C.D.		
	1.23	3.62		1.47	4.32	1.77	5.20		

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS - Days After Sowing, RDF - 63:100:75 NPK kg ha⁻¹

Table 102: Bacterial population of rhizosphere soil as influenced by FYM and liquid manures application at different growth stages of frenchbean during Kharif 2015

Treatments	Bacteria (No. $\times 10^6$ cfu g ⁻¹)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	22.2	34.1	28.1	27.9	45.3	36.6	22.8	38.7	30.7
F ₂	27.8	36.8	32.3	36.7	49.5	43.1	31.3	42.3	36.8
F ₃	31.7	40.3	36.0	42.2	52.3	47.3	36.2	46.8	41.5
Mean	37.2	37.1		35.6	49.0		30.1	42.6	
	S.Em \pm	C.D.		S.Em \pm	C.D.		S.Em \pm	C.D.	
F	0.74	2.16		0.77	2.25		0.91	2.68	
J	0.60	1.76		0.62	1.83		0.75	2.19	
F \times J	1.04	NS		1.08	3.18		1.29	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	25.8	30.4	28.1	32.8	40.3	36.6	27.0	34.5	30.7
F ₂	29.9	34.7	32.3	39.4	46.8	43.1	33.6	40.0	36.8
F ₃	32.6	39.4	36.0	43.2	51.3	47.3	37.1	45.8	41.5
Mean	29.4	34.9		38.5	46.2		32.6	40.1	
	S.Em \pm	C.D.		S.Em \pm	C.D.		S.Em \pm	C.D.	
P	0.60	1.76		0.62	1.83		0.75	2.19	
F \times P	1.04	NS		1.08	NS		1.29	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	24.3	30.2	27.2	31.2	40.0	35.6	26.0	34.2	30.1
J ₁	34.6	39.6	37.1	45.7	52.3	49.0	39.2	46.0	42.6
Mean	29.4	34.9		38.5	46.2		32.6	40.1	
	S.Em \pm	C.D.		S.Em \pm	C.D.		S.Em \pm	C.D.	
J \times P	0.85	NS		0.88	NS		1.06	NS	
Interaction	P₀	P₁		P₀	P₁		P₀	P₁	
F \times J \times P									
F ₁ J ₀	18.3	26.1		21.8	34.0		16.5	29.0	
F ₁ J ₁	33.3	34.8		43.9	46.7		37.5	39.9	
F ₂ J ₀	25.7	30.0		33.6	39.9		28.6	34.0	
F ₂ J ₁	34.1	39.4		45.2	53.7		38.6	45.9	
F ₃ J ₀	29.0	34.4		38.3	46.0		32.8	39.5	
F ₃ J ₁	36.2	44.4		48.0	56.7		41.5	52.2	
F \times J \times P	S.Em \pm	C.D.		S.Em \pm	C.D.		S.Em \pm	C.D.	
	1.47	NS		1.53	4.49		1.83	5.36	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS - Days After Sowing, RDF - 63:100:75 NPK kg ha⁻¹

Table 103: Bacterial population of rhizosphere soil as influenced by FYM and liquid manures application at different growth stages of frenchbean (Pooled 2014 and 2015)

Treatments	Bacteria (No. $\times 10^6$ cfu g ⁻¹)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	20.44	31.86	26.15	26.83	43.76	35.29	22.13	37.89	30.01
F ₂	25.92	34.47	30.19	35.37	47.64	41.50	30.58	41.36	35.97
F ₃	29.59	37.84	33.72	40.75	51.00	45.88	35.33	45.41	40.37
Mean	25.32	34.72		34.32	47.47		29.34	41.55	
	S.Em \pm	C.D.		S.Em \pm	C.D.		S.Em \pm	C.D.	
F	0.58	1.71		0.72	2.11		0.89	2.61	
J	0.47	1.39		0.59	1.72		0.73	2.13	
F \times J	0.82	NS		1.02	2.98		1.26	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	23.92	28.39	26.15	31.67	38.92	35.29	26.30	33.71	30.01
F ₂	27.86	32.53	30.19	37.95	45.06	41.50	32.83	39.10	35.97
F ₃	30.39	37.04	33.72	41.75	50.00	45.88	36.29	44.45	40.37
Mean	27.39	32.65		37.12	44.66		31.81	39.09	
	S.Em \pm	C.D.		S.Em \pm	C.D.		S.Em \pm	C.D.	
P	0.47	1.39		0.59	1.72		0.73	2.13	
F \times P	0.82	NS		1.02	NS		1.26	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	22.50	28.13	25.32	30.07	38.56	34.32	25.28	33.41	29.34
J ₁	32.28	37.16	34.72	44.17	50.76	47.47	38.34	44.77	41.55
Mean	27.39	32.65		37.12	44.66		31.81	39.09	
	S.Em \pm	C.D.		S.Em \pm	C.D.		S.Em \pm	C.D.	
J \times P	0.67	NS		0.83	NS		1.03	NS	
Interaction F \times J \times P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁ J ₀	16.67	24.22		20.9	32.72		15.91	28.35	
F ₁ J ₁	31.17	32.55		42.39	45.12		36.69	39.08	
F ₂ J ₀	23.83	28.00		32.28	38.45		27.91	33.24	
F ₂ J ₁	31.88	37.05		43.62	51.67		37.74	44.97	
F ₃ J ₀	27.00	32.18		37.00	44.50		32.01	38.64	
F ₃ J ₁	33.79	41.89		46.50	55.50		40.57	50.26	
F \times J \times P	S.Em \pm	C.D.		S.Em \pm	C.D.		S.Em \pm	C.D.	
	1.16	3.41		1.44	4.21		1.78	5.22	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS - Days After Sowing, RDF - 63:100:75 NPK kg ha⁻¹

40 Days after sowing

Application of FYM at 200 per cent N equivalent recorded significantly higher populations of bacteria (44.5) followed by FYM at 150 per cent N equivalent (39.9) whereas, significantly lower population was observed with FYM at 100 per cent N equivalent (34.0). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher bacterial population (45.9 and 43.2) as compared to without jeevamrutha and without panchagavya application (33.0 and 35.8).

Interaction effect

Microbial population differed significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application. Interaction of FYM and jeevamrutha levels given significantly higher microbial population. Application of FYM at 200 per cent N equivalent and jeevamrutha at 1000 litre ha⁻¹ recorded significantly higher bacterial population (49.7) whereas significantly lower was with FYM at 100 per cent N equivalent and without jeevamrutha (25.8). Application of FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent interaction recorded significantly higher bacteria (54.3) as compared to other interactions and lower bacterial population was recorded in FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya interaction (20.1). Bacterial population did not differ significantly due to the interaction effect of FYM and panchagavya, jeevamrutha and panchagavya application.

At harvest

Application of FYM at 200 per cent N equivalent recorded significantly higher populations of bacteria (39.3) followed by FYM at 150 per cent N equivalent (35.1). Whereas, significantly lower population was observed with FYM at 100 per cent N equivalent (29.3). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher bacterial population (40.5 and 38.1) as compared to without jeevamrutha and without panchagavya application (28.6 and 31.0).

Interaction effect

Bacteria population differed significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application. Application of FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent interaction recorded significantly higher bacterial population (48.3) and on par with FYM at 150 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent whereas, significantly lower bacterial population was recorded in FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya interaction (15.3). Bacterial population did not differ significantly due to the interaction effect of FYM and jeevamrutha, FYM and panchagavya, jeevamrutha and panchagavya.

Experiment conducted during *kharif* 2015

20 Days after sowing

Application of FYM at 200 per cent N equivalent recorded significantly higher populations of bacteria (36.0) followed by FYM at 150 per cent N equivalent (32.3). Whereas, significantly lower population was observed with FYM at 100 per cent N equivalent (28.1). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher bacterial population (37.1 and 34.9) as compared to without jeevamrutha and without panchagavya application (27.2 and 29.4).

Interaction effect

Bacterial population differed significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application. Application of FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent interaction recorded significantly higher bacteria (44.4) as compared to other interactions and lower bacterial population was recorded in FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya interaction (18.3). Bacteria population did not differ significantly due to the interaction effect of FYM and jeevamrutha, FYM and panchagavya, jeevamrutha and panchagavya.

40 Days after sowing

Application of FYM at 200 per cent N equivalent recorded significantly higher populations of bacteria (47.3) followed by FYM at 150 per cent N equivalent (43.1) whereas, significantly lower population was observed with FYM at 100 per cent N equivalent (36.6). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher bacterial population (49.0 and 46.2) as compared to without jeevamrutha and without panchagavya application (35.6 and 38.5).

Interaction effect

Interaction of FYM and jeevamrutha levels given significantly higher bacterial population. Application of FYM at 200 per cent N equivalent and jeevamrutha at 1000 litre ha⁻¹ recorded significantly higher bacterial population (52.3) and on par with FYM at 200 per cent N equivalent and jeevamrutha at 1000 litre ha⁻¹ (49.5) whereas significantly lower was with FYM at 100 per cent N equivalent and without jeevamrutha (27.9). Bacterial population differed significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application. Application of FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent interaction recorded significantly higher bacteria (56.7) and on par with FYM at 150 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application (53.7) while lower bacterial population was recorded in FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya interaction (21.8). Bacterial population did not differ significantly due to the interaction effect of FYM and panchagavya, jeevamrutha and panchagavya application.

At harvest

Application of FYM at 200 per cent N equivalent recorded significantly higher populations of bacteria (41.5) followed by FYM at 150 per cent N equivalent (36.8). Whereas, significantly lower population was observed with FYM at 100 per cent N equivalent (30.7). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher bacterial population (42.6 and 40.1) as compared to without jeevamrutha and without panchagavya application (30.1 and 32.6).

Interaction effect

Bacterial population differed significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application. Application of FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent interaction recorded significantly higher bacterial population (52.2) as compared to other treatments while significantly lower bacterial population was recorded in FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya interaction (16.5). bacterial population did not differ significantly due to the interaction effect of FYM and jeevamrutha, FYM and panchagavya, jeevamrutha and panchagavya.

4.11.2 Fungi (10⁴ cfu g⁻¹)

Fungal population at different growth stages as influenced by solid and liquid manures and their interaction effects are presented in Tables 104, 105 and 106.

Experiment conducted during *kharif* 2014

20 Days after sowing

Application of FYM at 200 per cent N equivalent recorded significantly higher populations of fungi (22.1) followed by FYM at 150 per cent N equivalent (19.6). Whereas, significantly lower population was observed with FYM at 100 per cent N equivalent (17.0). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher fungal population (22.7 and 21.3) as compared to without jeevamrutha and without panchagavya application (16.4 and 17.8)

Interaction effect

Fungal population differed significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application. Application of FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent interaction recorded significantly higher fungi (27.7) as compared to other interactions and lower fungal population was recorded in FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya interaction (11.0). Fungal population did not differ significantly due to the interaction effect of FYM and jeevamrutha, FYM and panchagavya, jeevamrutha and panchagavya.

Table 104: Fungal population of rhizosphere soil as influenced by FYM and liquid manures application at different growth stages of frenchbean during Kharif 2014

Treatments	Fungi (No. $\times 10^4$ cfu g ⁻¹)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	13.3	20.7	17.0	15.2	24.4	19.8	13.9	21.7	17.8
F ₂	16.7	22.5	19.6	19.7	26.6	23.1	17.6	24.0	20.8
F ₃	19.3	24.8	22.1	22.7	29.5	26.1	20.2	27.2	23.7
Mean	16.4	22.7		19.2	26.9		17.2	24.3	
	S.Em \pm	C.D.		S.Em \pm	C.D.		S.Em \pm	C.D.	
F	0.42	1.22		0.41	1.21		0.40	1.17	
J	0.34	1.00		0.34	0.99		0.33	0.95	
F \times J	0.59	NS		0.58	NS		0.56	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	15.7	18.3	17.0	18.0	21.7	19.8	16.3	19.3	17.8
F ₂	18.0	21.2	19.6	21.1	25.2	23.1	18.8	22.7	20.8
F ₃	19.8	24.3	22.1	23.2	28.9	26.1	20.9	26.5	23.7
Mean	17.8	21.3		20.8	25.3		18.7	22.9	
	S.Em \pm	C.D.		S.Em \pm	C.D.		S.Em \pm	C.D.	
P	0.34	NS		0.34	0.99		0.33	0.95	
F \times P	0.59	NS		0.58	NS		0.56	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	14.7	18.2	16.4	16.9	21.5	19.2	15.3	19.1	17.2
J ₁	21.0	24.3	22.7	24.7	29.0	26.9	22.0	24.3	24.3
Mean	17.8	21.3		20.8	25.3		18.7	22.9	
	S.Em \pm	C.D.		S.Em \pm	C.D.		S.Em \pm	C.D.	
J \times P	0.48	NS		0.47	NS		0.46	NS	
Interaction F \times J \times P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁	J ₀	11.0	15.7		12.3	18.1		11.7	16.2
	J ₁	20.3	21.0		23.7	25.2		21.0	22.4
F ₂	J ₀	15.3	18.0		17.9	21.4		16.0	19.1
	J ₁	20.7	24.3		24.3	28.9		21.7	26.3
F ₃	J ₀	17.7	21.0		20.4	24.9		18.3	22.1
	J ₁	22.0	27.7		26.0	33.0		23.4	30.9
F \times J \times P	S.Em \pm	C.D.		S.Em \pm	C.D.		S.Em \pm	C.D.	
	0.83	2.44		0.82	2.41		0.80	2.34	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS - Days After Sowing, RDF - 63:100:75 NPK kg ha⁻¹

Table 105: Fungal population of rhizosphere soil as influenced by FYM and liquid manures application at different growth stages of frenchbean during Kharif 2015

Treatments	Fungi (No. × 10 ⁴ cfu g ⁻¹)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	15.1	23.3	19.2	15.8	26.6	21.2	15.0	23.5	19.3
F ₂	19.0	25.3	22.1	21.8	29.0	25.2	19.0	25.8	22.4
F ₃	21.9	27.8	24.9	24.8	32.2	28.5	21.7	28.7	25.2
Mean	18.7	25.5		20.7	29.3		18.6	26.0	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.52	1.54		0.52	1.51		0.48	1.41	
J	0.43	1.25		0.42	1.24		0.39	1.15	
F × J	0.74	NS		0.73	2.14		0.68	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	17.6	20.8	19.2	18.9	23.6	21.2	17.3	21.2	19.3
F ₂	20.4	23.9	22.1	23.0	27.5	25.2	20.3	24.5	22.4
F ₃	22.4	27.3	24.9	25.4	31.6	28.5	22.5	27.8	25.2
Mean	20.1	24.0		22.4	27.5		20.1	24.5	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.43	1.25		0.42	1.24		0.39	1.15	
F × P	0.74	NS		0.73	2.14		0.68	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	16.7	20.7	18.7	18.0	23.4	20.7	16.3	20.8	18.6
J ₁	23.6	27.3	25.5	26.9	31.7	29.3	23.8	28.2	26.0
Mean	20.1	24.0		22.4	27.5		20.1	24.5	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.60	NS		0.60	NS		0.55	NS	
Interaction	P₀	P₁		P₀	P₁		P₀	P₁	
F × J × P									
F ₁ J ₀	12.3	17.9		12.0	19.7		12.0	18.0	
F ₁ J ₁	22.9	23.7		25.8	27.5		22.7	24.3	
F ₂ J ₀	17.5	20.4		19.4	23.4		17.3	20.7	
F ₂ J ₁	23.2	27.3		26.5	31.5		23.3	28.3	
F ₃ J ₀	20.1	23.7		22.4	27.1		19.7	23.7	
F ₃ J ₁	24.8	30.9		28.3	36.0		25.3	32.0	
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	1.05	3.07		1.03	3.03		0.96	2.82	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 106: Fungal population of rhizosphere soil as influenced by FYM and liquid manures application at different growth stages of frenchbean (Pooled 2014 and 2015)

Treatments	Fungi (No. $\times 10^4$ cfu g ⁻¹)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	14.22	21.97	18.10	15.52	25.55	20.54	14.47	22.61	18.54
F ₂	17.83	23.89	20.86	20.54	27.83	24.18	18.28	24.92	21.60
F ₃	20.61	26.34	23.47	23.72	30.83	27.28	20.94	27.92	24.43
Mean	17.55	24.07		19.93	28.07		17.90	25.15	
	S.Em \pm	C.D.		S.Em \pm	C.D.		S.Em \pm	C.D.	
F	0.45	1.33		0.43	1.25		0.43	1.26	
J	0.37	1.08		0.35	1.02		0.35	1.03	
F \times J	0.64	NS		0.60	1.77		0.61	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	16.64	19.55	18.10	18.44	22.63	20.54	16.83	20.25	18.54
F ₂	19.19	22.52	20.86	22.04	26.33	24.18	19.58	23.61	21.60
F ₃	21.14	25.81	23.47	24.31	30.25	27.28	21.69	27.17	24.43
Mean	18.99	22.63		21.60	26.40		19.37	23.68	
	S.Em \pm	C.D.		S.Em \pm	C.D.		S.Em \pm	C.D.	
P	0.37	NS		0.35	1.02		0.35	1.03	
F \times P	0.64	NS		0.60	NS		0.61	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	15.66	19.44	17.55	17.42	22.44	19.93	15.83	19.96	17.90
J ₁	22.32	25.81	24.07	25.77	30.37	28.07	22.91	27.39	25.15
Mean	18.99	22.63		21.60	26.40		19.37	23.68	
	S.Em \pm	C.D.		S.Em \pm	C.D.		S.Em \pm	C.D.	
J \times P	0.52	NS		0.49	NS		0.49	NS	
Interaction F \times J \times P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁ J ₀	11.67	16.77		12.17	18.88		11.83	17.11	
F ₁ J ₁	21.62	22.33		24.72	26.37		21.83	23.39	
F ₂ J ₀	16.43	19.22		18.65	22.43		16.67	19.89	
F ₂ J ₁	21.95	25.83		25.43	30.22		22.50	27.33	
F ₃ J ₀	18.88	22.33		21.45	26.00		19.00	22.89	
F ₃ J ₁	23.40	29.28		27.17	34.50		24.39	32.45	
F \times J \times P	S.Em \pm	C.D.		S.Em \pm	C.D.		S.Em \pm	C.D.	
	0.90	2.65		0.85	2.50		0.86	2.51	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS - Days After Sowing, RDF - 63:100:75 NPK kg ha⁻¹

40 Days after sowing

Application of FYM at 200 per cent N equivalent recorded significantly higher populations of fungi (26.1) followed by FYM at 150 per cent N equivalent (23.1) whereas, significantly lower population was observed with FYM at 100 per cent N equivalent (19.8). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher fungal population (26.9 and 25.3) as compared to without jeevamrutha and without panchagavya application (19.2 and 20.8)

Interaction effect

Fungal population differed significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application. Application of FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent interaction recorded significantly higher fungal population (33.0) as compared to other treatments and lower fungal population was recorded in FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya interaction (12.3). Fungal population did not differ significantly due to the interaction effect of FYM and jeevamrutha, FYM and panchagavya, jeevamrutha and panchagavya application.

At harvest

Application of FYM at 200 per cent N equivalent recorded significantly higher populations of fungi (23.7) followed by FYM at 150 per cent N equivalent (20.8). Whereas, significantly lower population was observed with FYM at 100 per cent N equivalent (17.8). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher fungal population (24.3 and 22.9) as compared to without jeevamrutha and without panchagavya application (17.2 and 18.7)

Interaction effect

Fungal population varied significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application. Application of FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent interaction recorded significantly higher fungal population (30.9) as compared to other treatments while significantly lower fungal population was recorded in FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya interaction (11.7). Fungal population did not differ significantly due to the interaction effect of FYM and jeevamrutha, FYM and panchagavya, jeevamrutha and panchagavya.

Experiment conducted during *kharif* 2015

20 Days after sowing

Application of FYM at 200 per cent N equivalent recorded significantly higher populations of fungi (24.9) followed by FYM at 150 per cent N equivalent (22.1) whereas, significantly lower population was observed with FYM at 100 per cent N equivalent (19.2). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher fungal population (25.5 and 24.0) as compared to without jeevamrutha and without panchagavya application (18.7 and 20.1)

Interaction effect

Fungal population differed significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application. Application of FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent interaction recorded significantly higher fungi (30.9) as compared to other interactions and lower fungal population was recorded in FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya interaction (12.3). Fungal population did not differ significantly due to the interaction effect of FYM and jeevamrutha, FYM and panchagavya, jeevamrutha and panchagavya.

40 Days after sowing

Application of FYM at 200 per cent N equivalent recorded significantly higher populations of fungi (28.5) followed by FYM at 150 per cent N equivalent (25.2) whereas, significantly lower population was observed with FYM at 100 per cent N equivalent (21.2). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher fungal population (29.3 and 27.5) as compared to without jeevamrutha and without panchagavya application (20.7 and 22.4)

Interaction effect

Interaction of FYM and jeevamrutha levels given significantly higher fungal population. Application of FYM at 200 per cent N equivalent and jeevamrutha at 1000 litre ha⁻¹ recorded significantly higher fungal population (32.2) and significantly lower was with FYM at 100 per cent N equivalent and without jeevamrutha (15.8). Fungal population varied significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application. Application of FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent interaction recorded significantly higher fungal population (36.0) as compared to other treatments and lower fungal population was recorded in FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya interaction (12.0). Fungal population did not differ significantly due to the interaction effect of FYM and jeevamrutha, FYM and panchagavya, jeevamrutha and panchagavya application.

Harvest

Application of FYM at 200 per cent N equivalent recorded significantly higher populations of fungi (25.2) followed by FYM at 150 per cent N equivalent (22.4) and significantly lower population was observed with FYM at 100 per cent N equivalent (19.3). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher fungal population (26.0 and 24.5) as compared to without jeevamrutha and without panchagavya application (18.6 and 20.1)

Interaction effect

Fungal population differed significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application. Application of FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent inter

action recorded significantly higher fungal population (32.0) as compared to other treatments while significantly lower fungal population was recorded in FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya interaction (12.0). Fungal population did not differ significantly due to the interaction effect of FYM and jeevamrutha, FYM and panchagavya, jeevamrutha and panchagavya.

4.11.3 Actinomycetes (10^3 cfu g⁻¹)

Population of actinomycetes at different growth stages as influenced by solid and liquid manures and their interaction effects are presented in Tables 107, 108 and 109.

Experiment conducted during *kharif* 2014

20 Days after sowing

Application of FYM at 200 per cent N equivalent recorded significantly higher populations of actinomycetes (26.1) followed by FYM at 150 per cent N equivalent (23.4) and significantly lower population was observed with FYM at 100 per cent N equivalent (19.9). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher population of actinomycetes (27.2 and 25.2) as compared to without jeevamrutha and without panchagavya application (19.1 and 21.1)

Interaction effect

Interaction of FYM and jeevamrutha levels given significantly higher population of actinomycetes. Application of FYM at 200 per cent N equivalent and jeevamrutha at 1000 litre ha⁻¹ recorded significantly higher population of actinomycetes (29.2) found on par with FYM at 150 per cent N equivalent and jeevamrutha at 1000 litre ha⁻¹, FYM at 100 per cent N equivalent and jeevamrutha at 1000 litre ha⁻¹ and significantly lower was with FYM at 100 per cent N equivalent and without jeevamrutha (14.8). Population of actinomycetes differed significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application. Application of FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent interaction recorded significantly higher actinomycetes (31.7) found on par with FYM at 150 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent and lower population of actinomycetes was recorded in FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya interaction (11.7). Population of actinomycetes did not differ significantly due to the interaction effect of FYM and panchagavya, jeevamrutha and panchagavya.

40 Days after sowing

Application of FYM at 200 per cent N equivalent recorded significantly higher populations of actinomycetes (30.5) followed by FYM at 150 per cent N equivalent (27.9) whereas, significantly lower population was observed with FYM at 100 per cent N equivalent (23.7). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher population of actinomycetes (31.8 and 29.8) as compared to without jeevamrutha and without panchagavya application (22.9 and 24.9)

Table 107: Actinomycetes population of rhizosphere soil as influenced by FYM and liquid manures application at different growth stages of frenchbean during Kharif 2014

Treatments	Actinomycetes (No. × 10 ³ cfu g ⁻¹)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	14.8	25.0	19.9	17.7	29.7	23.7	14.0	24.5	19.2
F ₂	19.3	27.5	23.4	23.7	32.2	27.9	19.3	26.8	23.1
F ₃	23.0	29.2	26.1	27.3	33.7	30.5	22.9	29.7	26.3
Mean	19.1	27.2		22.9	31.8		18.7	27.0	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.51	1.50		0.58	1.69		0.46	1.36	
J	0.42	1.23		0.47	1.38		0.38	1.11	
F × J	0.72	2.12		0.82	2.39		0.65	1.92	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	18.2	21.7	19.9	21.2	26.2	23.7	16.7	21.7	19.2
F ₂	21.3	25.5	23.4	25.5	30.3	27.9	20.8	25.3	32.1
F ₃	23.7	28.5	26.1	28.0	33.0	30.5	23.4	29.1	26.3
Mean	21.1	25.2		24.9	29.8		20.3	25.4	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.42	1.23		0.47	1.38		0.38	1.11	
F × P	0.72	NS		0.82	NS		0.65	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	16.7	21.4	19.1	19.8	26.0	22.9	15.9	21.5	18.7
J ₁	25.4	29.0	27.2	30.0	33.7	31.8	24.7	29.3	27.0
Mean	21.1	25.2		24.9	29.8		20.3	25.4	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.59	NS		0.67	NS		0.53	NS	
Interaction									
F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁	J ₀	11.7	18.0		13.7	21.7		10.0	17.9
	J ₁	24.7	25.3		28.7	30.7		23.4	25.5
F ₂	J ₀	17.7	21.0		21.3	26.0		17.2	21.4
	J ₁	25.0	30.0		29.7	34.7		24.3	29.3
F ₃	J ₀	20.7	25.3		24.3	30.3		20.5	25.2
	J ₁	26.7	31.7		31.7	35.7		26.4	33.0
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	1.02	3.00		1.15	NS		0.92	2.71	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 108: Actinomycetes population of rhizosphere soil as influenced by FYM and liquid manures application at different growth stages of frenchbean during Kharif 2015

Treatments	Actinomycetes (No. × 10 ³ cfu g ⁻¹)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	15.7	26.7	21.2	18.8	31.8	25.3	15.1	26.2	20.6
F ₂	20.7	29.3	25.0	25.7	35.0	30.3	20.6	28.7	24.6
F ₃	24.7	31.5	28.1	29.8	36.5	33.2	24.4	31.9	28.2
Mean	20.4	29.1		24.8	34.4		20.0	28.9	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.56	1.63		0.62	1.81		0.55	1.62	
J	0.45	1.33		0.50	1.48		0.45	1.32	
F × J	0.79	2.31		0.87	NS		0.78	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	19.2	23.2	21.2	22.3	28.3	25.3	18.0	23.2	20.6
F ₂	22.8	27.2	25.0	27.7	33.0	30.3	22.2	27.1	24.6
F ₃	25.5	30.7	28.1	30.7	35.7	33.2	25.2	31.2	28.2
Mean	22.5	27.0		26.9	32.3		21.8	27.1	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.45	1.33		0.50	1.48		0.45	1.32	
F × P	0.79	NS		0.87	NS		0.78	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	17.8	22.9	20.4	21.4	28.1	24.8	17.1	23.0	20.0
J ₁	27.1	31.1	29.1	32.3	36.6	34.4	26.5	31.3	28.9
Mean	22.5	27.0		26.9	32.3		21.8	27.1	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.64	NS		0.71	NS		0.64	NS	
Interaction	P₀	P₁		P₀	P₁		P₀	P₁	
F × J × P									
F ₁ J ₀	12.1	19.3		14.0	23.7		11.1	19.1	
F ₁ J ₁	26.3	27.1		30.7	33.0		25.0	27.3	
F ₂ J ₀	19.0	22.3		23.3	28.0		18.4	22.8	
F ₂ J ₁	26.6	32.0		32.0	38.0		26.0	31.3	
F ₃ J ₀	22.3	27.1		27.0	32.7		21.9	27.0	
F ₃ J ₁	28.6	34.3		34.3	38.7		28.4	35.3	
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	1.11	3.26		1.23	NS		1.10	3.23	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 109: Actinomycetes population of rhizosphere soil as influenced by FYM and liquid manures application at different growth stages of frenchbean (Pooled 2014 and 2015)

Treatments	Actinomycetes (No. × 10 ³ cfu g ⁻¹)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	15.29	25.85	20.57	18.25	30.75	24.50	14.52	25.31	19.92
F ₂	20.00	28.39	24.20	24.67	33.58	29.13	19.96	27.74	23.85
F ₃	23.85	30.31	27.08	28.58	35.08	31.83	23.64	30.80	27.22
Mean	19.71	28.18		23.83	33.14		19.37	27.95	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.50	1.47		0.56	1.64		0.46	1.34	
J	0.41	1.20		0.46	1.34		0.37	1.09	
F × J	0.71	2.07		0.79	2.32		0.64	1.89	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	18.70	22.44	20.57	21.75	27.25	24.50	17.38	22.45	19.92
F ₂	22.06	26.33	24.20	26.58	31.67	29.13	21.49	26.20	23.85
F ₃	24.56	29.61	27.08	29.33	34.33	31.83	24.30	30.14	27.22
Mean	21.77	26.12		25.89	31.08		21.06	26.27	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.41	1.20		0.46	1.34		0.37	1.09	
F × P	0.71	NS		0.79	NS		0.64	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	17.25	22.18	19.71	20.61	27.06	23.83	16.51	22.23	19.37
J ₁	26.30	30.07	28.18	31.17	35.11	33.14	25.60	30.30	27.95
Mean	21.77	26.12		25.89	31.08		21.06	26.27	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.58	NS		0.65	NS		0.53	NS	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁ J ₀	11.91	19.67		13.83	22.67		10.53	18.50	
F ₁ J ₁	25.49	26.20		29.67	31.83		24.22	26.41	
F ₂ J ₀	18.34	21.67		22.33	27.00		17.83	22.08	
F ₂ J ₁	25.78	31.00		30.83	36.33		25.15	30.33	
F ₃ J ₀	21.50	26.20		25.67	31.50		21.17	23.12	
F ₃ J ₁	27.62	33.01		33.00	37.17		27.43	34.17	
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	1.00	2.93		1.12	NS		0.91	2.67	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Interaction effect

Interaction of FYM and jeevamrutha levels given significantly higher population of actinomycetes. Application of FYM at 200 per cent N equivalent and jeevamrutha at 1000 litre ha⁻¹ recorded significantly higher population of actinomycetes (33.7) found on par with FYM at 150 per cent N equivalent and jeevamrutha at 1000 litre ha⁻¹ and significantly lower was with FYM at 100 per cent N equivalent and without jeevamrutha (17.7). Population of actinomycetes did not differ significantly due to the interaction effect of FYM and panchagavya, jeevamrutha and panchagavya, FYM, jeevamrutha and panchagavya application.

At harvest

Application of FYM at 200 per cent N equivalent recorded significantly higher populations of actinomycetes (26.3) followed by FYM at 150 per cent N equivalent (23.1) while significantly lower population was observed with FYM at 100 per cent N equivalent (19.2). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher population of actinomycetes (27.0 and 25.4) as compared to without jeevamrutha and without panchagavya application (18.7 and 20.3)

Interaction effect

Interaction of FYM and jeevamrutha levels given significantly higher population of actinomycetes. Application of FYM at 200 per cent N equivalent and jeevamrutha at 1000 litre ha⁻¹ recorded significantly higher population of actinomycetes (29.7) and significantly lower was with FYM at 100 per cent N equivalent and without jeevamrutha (14.0). Population of actinomycetes differed significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application. Application of FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent interaction recorded significantly higher population of actinomycetes (33.0) as compared to other treatments while significantly lower population of actinomycetes was recorded in FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya interaction (10.0). Population of actinomycetes did not differ significantly due to the interaction effect of FYM and panchagavya, jeevamrutha and panchagavya application.

Experiment conducted during *kharif* 2015

20 Days after sowing

Application of FYM at 200 per cent N equivalent recorded significantly higher populations of actinomycetes (28.1) followed by FYM at 150 per cent N equivalent (25.0) and significantly lower population was observed with FYM at 100 per cent N equivalent (21.2). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher population of actinomycetes (29.1 and 27.0) as compared to without jeevamrutha and without panchagavya application (20.4 and 22.5)

Interaction effect

Interaction of FYM and jeevamrutha levels given significantly higher population of actinomycetes. Application of FYM at 200 per cent N equivalent and jeevamrutha at

1000 litres ha⁻¹ recorded significantly higher population of actinomycetes (31.5) found on par with FYM at 150 per cent N equivalent and jeevamrutha at 1000 litre ha⁻¹ and significantly lower was with FYM at 100 per cent N equivalent and without jeevamrutha (15.7). Population of actinomycetes differed significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application. Application of FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent inter action recorded significantly higher actinomycetes (34.3) found on par with FYM at 150 per cent N equivalent, jeevamrutha at 1000 litres ha⁻¹ and panchagavya at 3 per cent and lower population of actinomycetes was recorded in FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya interaction (12.1). Population of actinomycetes did not differ significantly due to the interaction effect of FYM and panchagavya, jeevamrutha and panchagavya.

40 Days after sowing

Application of FYM at 200 per cent N equivalent recorded significantly higher populations of actinomycetes (33.2) followed by FYM at 150 per cent N equivalent (30.3) whereas, significantly lower population was observed with FYM at 100 per cent N equivalent (25.3). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher population of actinomycetes (34.4 and 32.3) as compared to without jeevamrutha and without panchagavya application (24.8 and 26.9)

Interaction effect

Interaction of FYM and jeevamrutha levels given significantly higher population of actinomycetes. Application of FYM at 200 per cent N equivalent and jeevamrutha at 1000 litre ha⁻¹ recorded significantly higher population of actinomycetes (36.5) found on par with FYM at 150 per cent N equivalent and jeevamrutha at 1000 litre ha⁻¹ and significantly lower was with FYM at 100 per cent N equivalent and without jeevamrutha (18.8). Population of actinomycetes did not differ significantly due to the interaction effect of FYM and panchagavya, jeevamrutha and panchagavya, FYM, jeevamrutha and panchagavya application.

At harvest

Application of FYM at 200 per cent N equivalent recorded significantly higher populations of actinomycetes (28.2) followed by FYM at 150 per cent N equivalent (24.6) while significantly lower population was observed with FYM at 100 per cent N equivalent (20.6). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher population of actinomycetes (28.9 and 27.1) as compared to without jeevamrutha and without panchagavya application (20.0 and 21.8)

Interaction effect

Population of actinomycetes differed significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application. Application of FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent inter action recorded significantly higher population of actinomycetes (35.3) as compared to other treatments while significantly lower population of actinomycetes was recorded in

FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya interaction (11.1). Population of actinomycetes did not differ significantly due to the interaction effect of FYM and jeevamrutha, FYM and panchagavya, jeevamrutha and panchagavya application.

4.11.4 N- fixers (10^5 cfu g⁻¹)

Population of N- fixers at different growth stages as influenced by solid and liquid manures and their interaction effects are presented in Tables 110, 111 and 112.

Experiment conducted during *kharif* 2014

20 Days after sowing

Application of FYM at 200 per cent N equivalent recorded significantly higher populations of N- fixers (25.5) followed by FYM at 150 per cent N equivalent (21.3) and significantly lower population was observed with FYM at 100 per cent N equivalent (17.3). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher population of N- fixers (26.9 and 24.1) as compared to without jeevamrutha and without panchagavya application (15.8 and 18.7)

Interaction effect

Population of N- fixers differed significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application. Application of FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent interaction recorded significantly higher N- fixers (34.0) while lower population of N- fixers were recorded in FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya interaction (8.3). Population of N- fixers did not differ significantly due to the interaction effect of FYM and jeevamrutha, FYM and panchagavya and jeevamrutha and panchagavya.

40 Days after sowing

Application of FYM at 200 per cent N equivalent recorded significantly higher populations of N- fixers (27.7) followed by FYM at 150 per cent N equivalent (23.1) whereas, significantly lower population was observed with FYM at 100 per cent N equivalent (19.0). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher population of N- fixers (29.2 and 26.0) as compared to without jeevamrutha and without panchagavya application (17.3 and 20.5)

Interaction effect

Interaction of FYM and panchagavya levels given significantly higher population of N- fixers. Application of FYM at 200 per cent N equivalent and panchagavya at 3 per cent recorded significantly higher population of N- fixers (31.7) while significantly lower was with FYM at 100 per cent N equivalent and without panchagavya (17.3). Population of N- fixers did not differ significantly due to the interaction effect of FYM and jeevamrutha, jeevamrutha and panchagavya, FYM, jeevamrutha and panchagavya application.

Table 110: N-fixers population of rhizosphere soil as influenced by FYM and liquid manures application at different growth stages of frenchbean during Kharif 2014

Treatments	N-fixers (No. × 10 ⁵ cfu g ⁻¹)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	11.0	23.5	17.3	12.5	25.5	19.0	11.2	21.8	16.5
F ₂	15.7	27.0	21.3	17.0	29.2	23.1	14.3	25.5	19.9
F ₃	20.8	30.2	25.5	22.5	32.8	27.7	19.0	28.7	23.8
Mean	15.8	26.9		17.3	29.2		14.8	25.3	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.48	1.40		0.54	1.59		0.42	1.23	
J	0.39	1.15		0.44	1.30		0.34	1.01	
F × J	0.68	NS		0.77	NS		0.59	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	15.7	18.8	17.3	17.3	20.7	19.0	14.7	18.3	16.5
F ₂	18.3	24.3	21.3	20.5	25.7	23.1	17.7	22.2	19.9
F ₃	22.0	29.0	29.0	23.7	31.7	27.7	20.3	27.3	23.8
Mean	18.7	24.1		20.5	26.0		17.6	22.6	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.39	1.15		0.44	1.30		0.34	1.01	
F × P	0.68	1.98		0.77	2.25		0.59	1.74	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	13.1	18.6	15.8	14.4	20.2	17.3	12.0	17.7	14.8
J ₁	24.2	26.9	26.9	26.6	31.8	29.2	23.1	27.6	25.3
Mean	18.7	24.1		20.5	26.0		17.6	22.6	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.55	NS		0.63	NS		0.49	NS	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁	J ₀	8.3	13.7	9.7	15.3	8.0	14.3		
	J ₁	23.0	24.0	25.0	26.0	21.3	22.3		
F ₂	J ₀	13.3	18.0	14.7	19.3	12.3	16.3		
	J ₁	23.3	30.7	26.3	32.0	23.0	28.0		
F ₃	J ₀	17.7	24.0	19.0	26.0	15.7	22.3		
	J ₁	26.3	34.0	28.3	37.3	25.0	32.3		
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.	S.Em ±	C.D.		
	0.96	2.81		1.08	NS	0.84	2.47		

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 111: N-fixers population of rhizosphere soil as influenced by FYM and liquid manures application at different growth stages of frenchbean during Kharif 2015

Treatments	N-fixers (No. $\times 10^5$ cfu g ⁻¹)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	11.8	25.5	18.7	13.3	27.8	20.6	12.0	24.7	18.3
F ₂	16.8	28.9	22.9	18.5	30.8	24.6	15.8	27.5	21.7
F ₃	22.7	32.5	27.6	24.6	36.7	30.5	21.2	30.5	25.8
Mean	17.1	29.0		18.7	31.7		16.3	27.6	
	S.Em \pm	C.D.		S.Em \pm	C.D.		S.Em \pm	C.D.	
F	0.49	1.43		0.59	1.74		0.47	1.37	
J	0.40	1.17		0.48	1.42		0.38	1.2	
F \times J	0.69	2.02		0.84	NS		0.66	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	17.0	20.3	18.7	18.8	22.3	20.6	15.8	20.8	18.3
F ₂	19.8	25.9	22.9	21.1	28.2	24.6	19.5	23.8	21.7
F ₃	23.8	31.3	27.6	26.3	34.6	30.5	22.8	28.8	25.8
Mean	20.2	25.9		22.1	28.4		19.4	24.5	
	S.Em \pm	C.D.		S.Em \pm	C.D.		S.Em \pm	C.D.	
P	0.40	1.17		0.48	1.42		0.38	1.12	
F \times P	0.69	2.02		0.84	1.42		0.66	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	14.2	20.0	17.1	15.6	21.9		13.8	18.9	16.3
J ₁	26.2	31.7	29.0	28.6	34.9		25.0	30.1	27.6
Mean	20.2	25.9		22.1	28.4		19.4	24.5	
	S.Em \pm	C.D.		S.Em \pm	C.D.		S.Em \pm	C.D.	
J \times P	0.56	NS		0.68	NS		0.54	NS	
Interaction	P₀	P₁		P₀	P₁		P₀	P₁	
F \times J \times P									
F ₁ J ₀	9.0	14.7		10.3	16.3		8.7	15.3	
F ₁ J ₁	25.0	26.0		27.2	28.3		23.0	26.3	
F ₂ J ₀	14.3	19.3		16.0	21.0		14.0	17.7	
F ₂ J ₁	25.3	32.5		26.2	35.3		25.0	30.0	
F ₃ J ₀	19.3	26.0		20.3	28.2		18.7	23.7	
F ₃ J ₁	28.3	36.7		32.3	41.0		27.0	34.0	
F \times J \times P	S.Em \pm	C.D.		S.Em \pm	C.D.		S.Em \pm	C.D.	
	0.97	2.86		1.18	3.47		0.93	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 112: N-fixers population of rhizosphere soil as influenced by FYM and liquid manures application at different growth stages of frenchbean (Pooled 2014 and 2015)

Treatments	N-fixers (No. × 10 ⁵ cfu g ⁻¹)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	11.42	24.50	17.96	12.92	26.63	19.78	11.58	23.25	17.42
F ₂	16.25	27.97	22.11	17.75	29.97	23.86	15.08	26.50	20.79
F ₃	21.75	31.33	26.54	23.39	34.75	29.07	20.08	29.58	24.83
Mean	16.47	27.93		18.02	30.45		15.58	26.44	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.47	1.37		0.47	1.38		0.40	1.17	
J	0.38	1.12		0.38	1.12		0.32	0.95	
F × J	0.66	1.94		0.66	NS		0.56	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	16.33	19.58	17.96	18.05	21.50	19.78	15.25	19.58	17.42
F ₂	19.08	25.14	22.11	20.80	26.92	23.86	18.58	23.00	20.79
F ₃	22.92	30.17	26.54	25.00	33.14	29.07	21.58	28.08	24.83
Mean	19.44	24.96		21.28	27.19		18.47	23.56	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.38	1.12		0.38	1.12		0.32	0.95	
F × P	0.66	1.94		0.66	1.95		0.56	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	13.67	19.28	16.47	15.00	21.04	18.02	12.89	18.28	15.58
J ₁	25.22	30.64	27.93	27.57	33.33	30.45	24.06	28.83	26.44
Mean	19.44	24.96		21.28	27.19		18.47	23.56	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.54	NS		0.54	NS		0.46	NS	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁ J ₀	8.67	14.16		10.00	15.83		8.33	14.83	
F ₁ J ₁	24.00	24.99		26.10	27.17		22.17	24.33	
F ₂ J ₀	13.83	18.67		15.33	20.17		13.17	17.00	
F ₂ J ₁	24.33	31.60		26.27	33.67		24.00	29.00	
F ₃ J ₀	18.50	25.00		19.67	27.12		17.17	23.00	
F ₃ J ₁	27.33	35.33		30.33	39.17		26.00	33.17	
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	0.93	2.74		0.94	2.75		0.80	2.33	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

At harvest

Application of FYM at 200 per cent N equivalent recorded significantly higher populations of N- fixers (23.8) followed by FYM at 150 per cent N equivalent (19.9) while significantly lower population was observed with FYM at 100 per cent N equivalent (16.5). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher population of N- fixers (25.3 and 22.6) as compared to without jeevamrutha and without panchagavya application (14.8 and 17.6)

Interaction effect

Interaction of FYM and panchagavya levels given significantly higher population of N- fixers. Application of FYM at 200 per cent N equivalent and panchagavya at 3 per cent recorded significantly higher population of N- fixers (27.3) while significantly lower was with FYM at 100 per cent N equivalent and without panchagavya (14.7). Population of N- fixers differed significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application. Application of FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent interaction recorded significantly higher population of actinomycetes (32.3) as compared to other treatments while significantly lower population of N- fixers was recorded in FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya interaction (8.0). Population of N- fixers did not differ significantly due to the interaction effect of FYM and jeevamrutha, jeevamrutha and panchagavya application.

Experiment conducted during *kharif* 2015

20 Days after sowing

Application of FYM at 200 per cent N equivalent recorded significantly higher populations of N- fixers (27.6) followed by FYM at 150 per cent N equivalent (22.9) and significantly lower population was observed with FYM at 100 per cent N equivalent (18.7). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher population of N- fixers (29.0 and 25.9) as compared to without jeevamrutha and without panchagavya application (17.1 and 20.2)

Interaction effect

Interaction of FYM and jeevamrutha levels given significantly higher population of N- fixers. Application of FYM at 200 per cent N equivalent and jeevamrutha 1000 litres ha⁻¹ recorded significantly higher population of N- fixers (32.5) while significantly lower was with FYM at 100 per cent N equivalent and without jeevamrutha (11.8). Interaction of FYM and panchagavya levels given significantly higher population of N- fixers. Application of FYM at 200 per cent N equivalent and panchagavya at 3 per cent recorded significantly higher population of N- fixers (31.3) while significantly lower was with FYM at 100 per cent N equivalent and without panchagavya (17.0). Population of N- fixers differed significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application. Application of FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent interaction recorded significantly higher N- fixers (36.7) while lower population of N- fixers were

recorded in FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya interaction (9.0). Population of N- fixers did not differ significantly due to the interaction effect of jeevamrutha and panchagavya.

40 Days after sowing

Application of FYM at 200 per cent N equivalent recorded significantly higher populations of N- fixers (30.5) followed by FYM at 150 per cent N equivalent (24.6) whereas, significantly lower population was observed with FYM at 100 per cent N equivalent (20.6). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher population of N- fixers (31.7 and 28.4) as compared to without jeevamrutha and without panchagavya application (18.7 and 22.1)

Interaction effect

Interaction of FYM and panchagavya levels given significantly higher population of N- fixers. Application of FYM at 200 per cent N equivalent and panchagavya at 3 per cent recorded significantly higher population of N- fixers (34.6) while significantly lower was with FYM at 100 per cent N equivalent and without panchagavya (18.8). Population of N- fixers differed significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application. Application of FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent interaction recorded significantly higher N- fixers (41.0) while lower population of N- fixers were recorded in FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya interaction (10.3). Population of N- fixers did not differ significantly due to the interaction effect of FYM and jeevamrutha, jeevamrutha and panchagavya, application.

At harvest

Application of FYM at 200 per cent N equivalent recorded significantly higher populations of N- fixers (25.8) followed by FYM at 150 per cent N equivalent (21.7) while significantly lower population was observed with FYM at 100 per cent N equivalent (18.3). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher population of N- fixers (27.6 and 24.5) as compared to without jeevamrutha and without panchagavya application (16.3 and 19.4).

Interaction effect

Population of N- fixers did not differ significantly due to the interaction effect of FYM and jeevamrutha, FYM and panchagavya, jeevamrutha and panchagavya and FYM, jeevamrutha and panchagavya application.

4.11.5 P-solubalisers (10⁵ cfu g⁻¹)

Population of P-solubalisers at different growth stages as influenced by solid and liquid manures and their interaction effects are presented in Tables 113, 114 and 115.

Experiment conducted during *kharif* 2014

20 Days after sowing

Application of FYM at 200 per cent N equivalent recorded significantly higher populations of P-solubalisers (26.8) followed by FYM at 150 per cent N equivalent (24.0) and significantly lower population was observed with FYM at 100 per cent N equivalent (20.6). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher population of P-solubalisers (27.7 and 26.0) as compared to without jeevamrutha and without panchagavya application (19.9 and 21.6).

Interaction effect

Population of P-solubalisers differed significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application. Application of FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent inter action recorded significantly higher P-solubalisers (33.3) and lower population of P-solubalisers was recorded in FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya interaction (12.7). Population of P-solubalisers did not differ significantly due to the interaction effect of FYM and jeevamrutha, FYM and panchagavya, jeevamrutha and panchagavya.

40 Days after sowing

Application of FYM at 200 per cent N equivalent recorded significantly higher populations of P-solubalisers (37.7) followed by FYM at 150 per cent N equivalent (33.8) whereas, significantly lower population was observed with FYM at 100 per cent N equivalent (28.8). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher population of P-solubalisers (38.8 and 36.4) as compared to without jeevamrutha and without panchagavya application (28.1 and 30.4)

Interaction effect

Interaction of FYM and jeevamrutha levels given significantly higher population of P-solubalisers. Application of FYM at 200 per cent N equivalent and jeevamrutha at 1000 litre ha⁻¹ recorded significantly higher population of P-solubalisers (41.8) and significantly lower was with FYM at 100 per cent N equivalent and without jeevamrutha (21.8). Population of P-solubalisers differed significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application. Application of FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent inter action recorded significantly higher P-solubalisers (45.0) found on par with FYM at 150 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent and lower population of P-solubalisers was recorded in FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya interaction (17.0). Population of P-solubalisers did not differ significantly due to the interaction effect of FYM and panchagavya, jeevamrutha and panchagavya application.

Table 113: P-Solubaliser population of rhizosphere soil as influenced by FYM and liquid manures application at different growth stages of frenchbean during *Kharif* 2014

Treatments	P-Solubiliser (No. × 10 ⁵ cfu g ⁻¹)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	15.8	25.3	20.6	21.8	35.8	28.8	17.5	30.4	24.0
F ₂	20.5	27.5	24.0	28.8	38.7	33.8	24.4	33.2	28.8
F ₃	23.5	30.2	26.8	33.5	41.8	37.7	28.4	36.1	32.3
Mean	19.9	27.7		28.1	38.8		23.5	33.3	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.48	1.42		0.61	1.79		0.68	2.01	
J	0.40	1.16		0.50	1.47		0.59	1.64	
F × J	0.69	NS		0.87	2.54		0.97	2.84	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	18.7	22.5	20.6	25.8	31.8	28.8	20.9	27.0	24.0
F ₂	22.0	26.0	24.0	31.0	36.5	33.8	26.3	31.4	28.8
F ₃	24.2	29.5	26.8	34.5	40.8	37.7	29.3	35.2	32.3
Mean	21.6	26.0		30.4	36.4		25.5	31.2	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.40	1.16		0.50	1.47		0.56	1.64	
F × P	0.69	NS		0.87	NS		0.97	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	17.6	22.3	19.9	24.6	31.6	28.1	20.2	26.7	23.5
J ₁	25.7	29.7	27.7	36.3	41.2	38.8	30.9	35.7	33.3
Mean	21.6	26.0		30.4	36.4		25.5	31.2	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.56	NS		0.71	NS		0.79	NS	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁	J ₀	12.7	19.0	17.0	26.7	12.4	22.6		
	J ₁	24.7	26.0	34.7	37.0	29.4	31.4		
F ₂	J ₀	18.7	22.3	26.3	31.3	22.3	26.6		
	J ₁	25.3	29.7	35.7	41.7	30.2	36.2		
F ₃	J ₀	21.3	25.7	30.3	36.7	25.8	31.1		
	J ₁	27.0	33.3	38.7	45.0	32.9	39.3		
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.	S.Em ±	C.D.		
	0.97	2.84		1.22	3.59	1.37	4.01		

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 114: P-Solubaliser population of rhizosphere soil as influenced by FYM and liquid manures application at different growth stages of frenchbean during Kharif 2015

Treatments	P-Solubiliser (No. $\times 10^5$ cfu g ⁻¹)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	17.7	27.5	22.6	23.4	38.7	31.1	19.7	33.3	26.5
F ₂	22.8	30.0	26.4	31.1	41.2	36.2	26.3	36.2	31.3
F ₃	25.7	33.0	29.3	36.2	44.8	40.5	31.0	39.7	35.3
Mean	22.1	30.2		30.2	41.6		25.7	36.4	
	S.Em \pm	C.D.		S.Em \pm	C.D.		S.Em \pm	C.D.	
F	0.62	1.82		0.61	1.79		0.56	1.63	
J	0.51	1.48		0.50	1.46		0.45	1.33	
F \times J	0.88	NS		0.86	2.53		0.79	2.31	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	20.3	24.8	22.6	27.7	34.4	31.1	23.2	29.8	26.5
F ₂	24.3	28.5	26.4	33.3	39.1	36.2	28.5	34.0	31.3
F ₃	26.5	32.2	29.3	37.5	43.5	40.5	32.2	38.5	35.3
Mean	23.7	28.5		32.9	39.0		27.9	34.1	
	S.Em \pm	C.D.		S.Em \pm	C.D.		S.Em \pm	C.D.	
P	0.51	1.48		0.50	1.46		0.45	1.33	
F \times P	0.88	NS		0.86	NS		0.79	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	19.6	24.6	22.1	26.4	34.0	30.2	22.4	28.9	25.7
J ₁	27.9	32.4	30.2	39.3	43.9	41.6	33.4	39.3	36.4
Mean	23.7	28.5		32.9	39.0		27.9	34.1	
	S.Em \pm	C.D.		S.Em \pm	C.D.		S.Em \pm	C.D.	
J \times P	0.72	NS		0.70	2.07		0.64	NS	
Interaction	P₀	P₁		P₀	P₁		P₀	P₁	
F \times J \times P									
F ₁ J ₀	14.0	21.3		18.0	28.8		15.0	24.3	
F ₁ J ₁	26.7	28.3		37.4	40.0		31.3	35.3	
F ₂ J ₀	21.3	24.3		28.4	33.8		24.0	28.7	
F ₂ J ₁	27.3	32.7		38.1	44.3		33.0	39.3	
F ₃ J ₀	23.3	28.0		32.7	39.6		28.3	33.7	
F ₃ J ₁	29.7	36.3		42.3	47.3		36.0	43.3	
F \times J \times P	S.Em \pm	C.D.		S.Em \pm	C.D.		S.Em \pm	C.D.	
	1.24	NS		1.22	3.58		1.11	3.26	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 115: P-Solubaliser population of rhizosphere soil as influenced by FYM and liquid manures application at different growth stages of frenchbean (Pooled 2014 and 2015)

Treatments	P-Solubiliser (No. × 10 ⁵ cfu g ⁻¹)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	16.75	26.42	21.58	22.61	37.28	29.94	18.58	31.89	25.24
F ₂	21.67	28.75	25.21	29.98	39.95	34.97	25.39	34.69	30.04
F ₃	24.58	31.58	28.08	34.83	43.33	39.08	29.72	37.89	33.81
Mean	21.00	28.92		29.14	40.19		24.56	34.82	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.52	1.53		0.56	1.65		0.56	1.64	
J	0.43	1.25		0.46	1.35		0.46	1.34	
F × J	0.74	NS		0.80	2.33		0.79	2.32	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	19.50	23.67	21.58	26.78	33.11	29.94	22.06	28.42	25.24
F ₂	23.17	27.25	25.21	32.15	37.78	34.97	27.39	32.69	30.04
F ₃	25.33	30.83	28.08	36.02	42.14	39.08	30.75	36.86	33.81
Mean	22.67	27.25		31.65	37.68		26.73	32.66	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.43	1.25		0.46	1.35		0.46	1.34	
F × P	0.74	NS		0.80	NS		0.79	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	18.56	23.44	21.00	25.48	32.80	29.14	21.31	27.81	24.56
J ₁	26.78	31.06	28.92	37.82	42.55	40.19	32.15	37.50	34.82
Mean	22.67	27.25		31.65	37.68		26.73	32.66	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.60	NS		0.65	NS		0.64	NS	
Interaction	P₀	P₁		P₀	P₁		P₀	P₁	
F × J × P									
F ₁ J ₀	13.33	20.17		17.50	27.72		13.72	23.44	
F ₁ J ₁	25.67	27.17		36.06	38.49		30.39	33.39	
F ₂ J ₀	20.00	23.33		27.39	32.57		23.16	27.61	
F ₂ J ₁	26.33	31.70		36.91	43.00		31.61	37.78	
F ₃ J ₀	22.33	26.83		31.54	38.12		27.06	32.39	
F ₃ J ₁	28.33	34.83		46.17	46.17		34.44	41.33	
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	1.05	3.07		1.13	3.30		1.12	3.28	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

At harvest

Application of FYM at 200 per cent N equivalent recorded significantly higher populations of P-solubalisers (32.3) followed by FYM at 150 per cent N equivalent (28.8) while significantly lower population was observed with FYM at 100 per cent N equivalent (24.0). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher population of P-solubalisers (33.3 and 31.2) as compared to without jeevamrutha and without panchagavya application (23.5 and 25.5)

Interaction effect

Interaction of FYM and jeevamrutha levels given significantly higher population of P-solubalisers. Application of FYM at 200 per cent N equivalent and jeevamrutha at 1000 litre ha⁻¹ recorded significantly higher population of P-solubalisers (36.1) and jeevamrutha at 1000 litre ha⁻¹ and significantly lower was with FYM at 100 per cent N equivalent and without jeevamrutha (17.5). Population of P-solubalisers differed significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application. Application of FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent interaction recorded significantly higher population of P-solubalisers (39.3) found on par with FYM at 150 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application while significantly lower population of actinomycetes was recorded in FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya interaction (12.4). Population of P-solubalisers did not differ significantly due to the interaction effect of FYM and panchagavya, jeevamrutha and panchagavya application.

Experiment conducted during *kharif* 2015

20 Days after sowing

Application of FYM at 200 per cent N equivalent recorded significantly higher populations of P-solubalisers (29.3) followed by FYM at 150 per cent N equivalent (26.4) and significantly lower population was observed with FYM at 100 per cent N equivalent (22.6). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher population of P-solubalisers (30.2 and 28.5) as compared to without jeevamrutha and without panchagavya application (22.1 and 23.7).

Interaction effect

Population of P-solubalisers did not differ significantly due to the interaction effect of FYM and jeevamrutha, FYM and panchagavya, jeevamrutha and panchagavya, FYM, jeevamrutha and panchagavya application.

40 Days after sowing

Application of FYM at 200 per cent N equivalent recorded significantly higher populations of P-solubalisers (40.5) followed by FYM at 150 per cent N equivalent (36.2) whereas, significantly lower population was observed with FYM at 100 per cent N equivalent (31.1). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent

application recorded significantly higher population of P-solubalisers (41.6 and 39.0) as compared to without jeevamrutha and without panchagavya application (30.2 and 32.9)

Interaction effect

Interaction of FYM and jeevamrutha levels given significantly higher population of P-solubalisers. Application of FYM at 200 per cent N equivalent and jeevamrutha at 1000 litre ha⁻¹ recorded significantly higher population of P-solubalisers (44.8) and significantly lower was with FYM at 100 per cent N equivalent and without jeevamrutha (23.4). Interaction of panchagavya and jeevamrutha levels given significantly higher population of P-solubalisers. Application of jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent recorded significantly higher population of P-solubalisers (43.9) and significantly lower was with without panchagavya and without jeevamrutha (26.4) application. Population of P-solubalisers differed significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application. Application of FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent inter action recorded significantly higher P-solubalisers (47.3) found on par with FYM at 150 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent and lower population of P-solubalisers was recorded in FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya interaction (18.0). Population of P-solubalisers did not differ significantly due to the interaction effect of FYM and panchagavya.

At harvest

Application of FYM at 200 per cent N equivalent recorded significantly higher populations of P-solubalisers (35.3) followed by FYM at 150 per cent N equivalent (31.3) while significantly lower population was observed with FYM at 100 per cent N equivalent (26.5). Jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent application recorded significantly higher population of P-solubalisers (36.4 and 34.1) as compared to without jeevamrutha and without panchagavya application (25.7 and 27.9)

Interaction effect

Interaction of FYM and jeevamrutha levels given significantly higher population of P-solubalisers. Application of FYM at 200 per cent N equivalent and jeevamrutha at 1000 litre ha⁻¹ recorded significantly higher population of P-solubalisers (39.7) and jeevamrutha at 1000 litre ha⁻¹ and significantly lower was with FYM at 100 per cent N equivalent and without jeevamrutha (19.7). Population of P-solubalisers differed significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application. Application of FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent inter action recorded significantly higher population of P-solubalisers (43.3) while significantly lower population of actinomycetes was recorded in FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya interaction (15.0). Population of P-solubalisers did not differ significantly due to the interaction effect of FYM and panchagavya, jeevamrutha and panchagavya application.

Pooled

The data pertaining to the population of bacteria, fungi, actinomycetes, phosphorous solubilizer and nitrogen fixer is furnished in Tables 103, 106, 109, 112 and 115.

Bacteria, fungi, actinomycetes, phosphorous solubilizer and nitrogen fixer population differed significantly at 20, 40 DAS and harvest due to the varied levels of FYM, jeevamrutha and panchagavya application.

At 20, 40 DAS and harvest application of FYM at 200 per cent N equivalent recorded significantly higher populations of bacteria ($33.72, 45.88$ and 40.37×10^6 cfu g^{-1} , respectively), fungi ($23.47, 27.28$ and 24.43×10^4 cfu g^{-1} , respectively), actinomycetes ($27.08, 31.83$ and 27.22×10^3 cfu g^{-1} , respectively), N-fixers ($26.54, 29.07$ and 24.83×10^5 cfu g^{-1} , respectively) and P-solubaiser ($28.08, 39.08$ and 33.81×10^6 cfu g^{-1} , respectively) followed by FYM at 150 per cent N equivalent (bacterial- $30.19, 41.50$ and 35.97×10^6 cfu g^{-1} , fungi- $20.86, 24.18$ and 21.60×10^4 cfu g^{-1} , actinomycetes- $24.20, 29.13$ and 23.85×10^3 cfu g^{-1} , N-fixers $22.11, 23.86$ and 20.79×10^5 cfu g^{-1} , and P-solubaiser- $25.21, 34.97$ and 30.04×10^6 cfu g^{-1} , respectively). Whereas, significantly lower microbial population was observed with FYM at 100 per cent N equivalent (bacterial- $26.15, 35.29$ and 30.01×10^6 cfu g^{-1} , fungi- $18.10, 20.54$ and 18.54×10^4 cfu g^{-1} , actinomycetes- $20.57, 24.50$ and 19.92×10^3 cfu g^{-1} , N-fixers $17.96, 19.78$ and 17.42×10^5 cfu g^{-1} , and P-solubaiser- $21.58, 29.94$ and 25.24×10^6 cfu g^{-1} , respectively).

At 20, 40 DAS and harvest application of Jeevamrutha at 1000 litre ha^{-1} application recorded significantly higher bacteria ($34.72, 47.47$ and 41.55×10^6 cfu g^{-1} , respectively), fungi ($24.07, 28.07$ and 25.15×10^4 cfu g^{-1} , respectively), actinomycetes ($28.18, 33.14$ and 27.95×10^3 cfu g^{-1} , respectively), N-fixers ($27.93, 30.45$ and 26.44×10^5 cfu g^{-1} , respectively) and P-solubaiser ($28.92, 40.19$ and 34.82×10^6 cfu g^{-1} , respectively) as compared to without jeevamrutha application (bacterial- $25.32, 34.32$ and 29.34×10^6 cfu g^{-1} , fungi- $17.55, 19.93$ and 17.90×10^4 cfu g^{-1} , actinomycetes- $19.71, 23.83$ and 19.37×10^3 cfu g^{-1} , N-fixers $16.47, 18.02$ and 15.58×10^5 cfu g^{-1} , and P-solubaiser- $21.00, 29.14$ and 24.56×10^6 cfu g^{-1} , respectively).

At 20, 40 DAS and harvest application of Panchagavya at 3 per cent recorded significantly higher bacteria ($32.65, 44.66$ and 39.09×10^6 cfu g^{-1} , respectively), fungi ($22.63, 26.40$ and 23.68×10^4 cfu g^{-1} , respectively), actinomycetes ($26.12, 31.08$ and 26.27×10^3 cfu g^{-1} , respectively), N-fixers ($24.96, 27.19$ and 23.56×10^5 cfu g^{-1} , respectively) and P-solubaiser ($27.25, 37.68$ and 32.66×10^6 cfu g^{-1} , respectively) as compared to without panchagavya application (bacterial- $27.39, 37.12$ and 31.81×10^6 cfu g^{-1} , fungi- $18.99, 21.60$ and 19.37×10^4 cfu g^{-1} , actinomycetes- $21.77, 25.89$ and 21.06×10^3 cfu g^{-1} , N-fixers $19.44, 21.28$ and 18.47×10^5 cfu g^{-1} , and P-solubaiser- $22.67, 31.65$ and 26.73×10^6 cfu g^{-1} , respectively).

At 20, 40 DAS and harvest application of microbial population differed significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application. Application of FYM at 200 per cent N equivalent, jeevamrutha

at 1000 litre ha⁻¹ and panchagavya at 3 per cent inter action recorded significantly higher bacteria (41.89, 55.50 and 50.26 × 10⁶ cfu g⁻¹, respectively), fungi (29.28, 34.50 and 32.45 × 10⁴ cfu g⁻¹, respectively), actinomycetes (33.01, 37.17 and 34.17 × 10³ cfu g⁻¹, respectively), N-fixers (35.33, 39.17 and 33.17 × 10⁵ cfu g⁻¹, respectively) and P-solubaiser (34.83, 46.17 and 41.33 × 10⁶ cfu g⁻¹, respectively) as compared to FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya interaction (bacterial- 16.67, 20.90 and 15.91 × 10⁶ cfu g⁻¹, fungi- 11.67, 12.17 and 11.83 × 10⁴ cfu g⁻¹, actinomycetes- 11.91, 13.83 and 10.53 × 10³ cfu g⁻¹, N-fixers 8.67, 10.00 and 8.33 × 10⁵ cfu g⁻¹, and P-solubaiser- 13.33, 17.50 and 13.72 × 10⁶ cfu g⁻¹, respectively). Either Jeevamruta and panchagavya application along with FYM interaction given higher microbial population as compared to no-jeevamruta and no-panchagavya along with FYM interactions.

Interaction of FYM and jeevamrutha levels given significantly higher microbial population. Application of FYM at 200 per cent N equivalent and jeevamrutha at 1000 litre ha⁻¹ resulted in significantly higher N-fixers (31.33 × 10⁵ cfu g⁻¹) and actinomycetes (30.31 × 10³ cfu g⁻¹) at 20 DAS and bacteria (51.00 × 10⁶ cfu g⁻¹), fungi (30.83 × 10⁴ cfu g⁻¹), actinomycetes (35.08 × 10³ cfu g⁻¹) and P-solubaiser (43.33 × 10⁶ cfu g⁻¹) at 40 DAS and P-solubaiser (43.33 × 10⁶ cfu g⁻¹) and actinomycetes (30.80 × 10³ cfu g⁻¹) population at harvest as compared to FYM at 100 per cent N equivalent and without jeevamrutha.

Interaction of FYM and panchagavya levels given significantly higher N-fixer at 20 and 40 DAS. Where application of FYM at 200 per cent N equivalent and panchagavya at 3 per cent resulted in significantly higher N-fixers (30.17 and 33.14 × 10⁵ cfu g⁻¹) as compared to other treatment inter action.

Exp II: Effect of different levels of jeevamrutha and panchagavya on soil microbial Population

4.12.1 Bacteria (10⁶ cfu g⁻¹)

Bacterial population at different growth stages as influenced by liquid manures and their interaction effects are presented in Tables 116, 117 and 118.

Experiment conducted during *kharif* 2014

20 Days after sowing

Application of jeevamrutha at 2000 litre ha⁻¹ application recorded significantly higher populations of bacteria (35.78) followed by jeevamrutha at 1500 litre ha⁻¹ application (32.33), jeevamrutha at 1000 litre ha⁻¹ application application (26.89). Whereas, significantly lower bacterial population was observed in without jeevamruta (19.22). Panchagavya at 6 per cent recorded significantly higher populations of bacteria (30.75) followed by panchagavya at 3 per cent (28.83) and it was lower with no-panchagavya application (26.08).

Table 116: Bacterial population of rhizosphere soil as influenced by liquid manures application at different growth stages of frenchbean during Kharif 2014

Jeevamrutha Levels	Bacteria (No. $\times 10^6$ cfu g ⁻¹)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	14.67	21.00	22.00	19.22	18.10	27.33	29.00	24.81	15.50	23.27	24.77	21.18
J₁	25.00	26.33	29.33	26.89	33.00	35.00	39.33	35.78	28.00	29.33	29.67	29.00
J₂	29.00	33.33	34.67	32.33	38.67	43.00	45.00	42.22	32.77	37.67	38.00	36.14
J₃	35.67	34.67	37.00	35.78	45.67	47.33	49.33	47.44	39.33	39.67	42.33	40.44
Mean	26.08	28.83	30.75		33.86	38.17	40.67		28.90	32.48	33.69	
	S.Em \pm		CD at 5%		S.Em \pm		CD at 5%		S.Em \pm		CD at 5%	
Jeevamrutha	0.74		2.17		1.23		3.61		0.95		2.79	
Panchagavya	0.64		1.88		1.07		3.13		0.82		2.42	
J \times P	1.28		NS		2.13		NS		1.65		4.83	

Note: J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, J₂ - Jeevamrutha 1500 litre/ha, J₃ - Jeevamrutha 2000 litre/ha

P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, P₃ - Panchagavya at 6 %, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 117: Bacterial population of rhizosphere soil as influenced by liquid manures application at different growth stages of frenchbean during *Kharif* 2015

Jeevamrutha Levels	Bacteria (No. $\times 10^6$ cfu g ⁻¹)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	16.67	23.00	24.67	21.44	20.00	29.33	30.67	26.67	16.27	24.33	26.00	22.20
J₁	27.00	29.00	31.67	29.22	35.00	36.67	41.33	37.67	29.67	31.00	31.21	30.63
J₂	30.67	35.67	37.33	34.56	40.67	44.67	46.33	43.89	34.33	39.33	39.60	37.76
J₃	37.67	38.33	40.33	38.78	46.67	48.33	51.00	48.67	40.95	41.33	44.00	42.09
Mean	28.00	31.50	33.50		35.58	39.75	42.33		30.30	34.00	35.20	
	S.Em \pm		CD at 5%		S.Em \pm		CD at 5%		S.Em \pm		CD at 5%	
Jeevamrutha	0.77		2.26		0.98		2.88		0.79		2.32	
Panchagavya	0.67		1.96		0.85		2.50		0.68		2.01	
J \times P	1.33		NS		1.70		NS		1.37		NS	

Note: J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, J₂ - Jeevamrutha 1500 litre/ha, J₃ - Jeevamrutha 2000 litre/ha

P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, P₃ - Panchagavya at 6 %, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 118: Bacterial population of rhizosphere soil as influenced by liquid manures application at different growth stages of frenchbean (Pooled 2014 and 2015)

Jeevamrutha Levels	Bacteria (No. × 10 ⁶ cfu g ⁻¹)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	15.67	22.00	23.33	20.33	19.05	28.33	29.83	25.74	15.89	23.80	25.38	21.69
J₁	26.00	27.67	30.50	28.06	34.00	35.83	40.33	36.72	28.83	30.17	30.44	29.81
J₂	29.83	34.50	36.00	33.44	39.67	43.83	45.67	43.06	33.55	38.50	38.80	36.95
J₃	36.67	36.50	38.67	37.28	46.17	47.83	50.17	48.06	40.14	40.50	43.17	41.27
Mean	27.04	30.17	32.13		34.72	38.96	41.50		29.60	33.24	34.45	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.73		2.15		1.08		3.16		0.86		2.53	
Panchagavya	0.64		1.86		0.93		2.74		0.75		2.19	
J × P	1.27		NS		1.87		NS		1.50		NS	

Note: **J₀** - Without Jeevamrutha, **J₁**- Jeevamrutha 1000 litre/ha, **J₂** - Jeevamrutha 1500 litre/ha, **J₃** - Jeevamrutha 2000 litre/ha
P₀ - Without panchagavya, **P₁** - Panchagavya at 3 %, **P₃** - Panchagavya at 6 %, **DAS** – Days After Sowing, **RDF** – 63:100:75 NPK kg ha⁻¹

40 Days after sowing

Application of jeevamrutha at 2000 litre ha⁻¹ application recorded significantly higher populations of bacteria (47.44) followed by jeevamrutha at 1500 litre ha⁻¹ application (42.22), jeevamrutha at 1000 litre ha⁻¹ application application (35.78). Whereas, significantly lower bacterial population was observed in without jeevamrutha (24.81). Panchagavya at 6 per cent recorded significantly higher populations of bacteria (40.67) followed by panchagavya at 3 per cent (28.83) and it was lower with no-panchagavya application (33.86).

At harvest

Application of jeevamrutha at 2000 litre ha⁻¹ application recorded significantly higher populations of bacteria (40.44) followed by jeevamrutha at 1500 litre ha⁻¹ application (36.14), jeevamrutha at 1000 litre ha⁻¹ application application (29.0). Whereas, significantly lower bacterial population was observed in without jeevamrutha (21.18). Panchagavya at 6 per cent recorded significantly higher populations of bacteria (33.69) followed by panchagavya at 3 per cent (32.48) and it was lower with no-panchagavya application (28.90).

Experiment conducted during *kharif* 2015

20 Days after sowing

Application of jeevamrutha at 2000 litre ha⁻¹ application recorded significantly higher populations of bacteria (38.78) followed by jeevamrutha at 1500 litre ha⁻¹ application (34.56), jeevamrutha at 1000 litre ha⁻¹ application application (29.22). Whereas, significantly lower bacterial population was observed in without jeevamrutha (21.44). Panchagavya at 6 per cent recorded significantly higher populations of bacteria (33.50) followed by panchagavya at 3 per cent (31.5) and it was lower with no-panchagavya application (28.0).

40 Days after sowing

Application of jeevamrutha at 2000 litre ha⁻¹ application recorded significantly higher populations of bacteria (48.67) followed by jeevamrutha at 1500 litre ha⁻¹ application (43.89), jeevamrutha at 1000 litre ha⁻¹ application application (37.67). Whereas, significantly lower bacterial population was observed in without jeevamrutha (26.67). Panchagavya at 6 per cent recorded significantly higher populations of bacteria (42.33) followed by panchagavya at 3 per cent (39.75) and it was lower with no-panchagavya application (35.58).

At harvest

Application of jeevamrutha at 2000 litre ha⁻¹ application recorded significantly higher populations of bacteria (42.09) followed by jeevamrutha at 1500 litre ha⁻¹ application (37.76), jeevamrutha at 1000 litre ha⁻¹ application application (30.63). Whereas, significantly lower bacterial population was observed in without jeevamrutha (22.20). Panchagavya at 6 per cent recorded significantly higher populations of bacteria

(35.20) followed by panchagavya at 3 per cent (34.0) and it was lower with no-panchagavya application (30.3).

Interaction effect

Bacterial population did not differ significantly due to the interaction of jeevamrutha and panchagavya application at 20, 40 and at harvest during both the years.

4.12.2 Fungi (10^4 cfu g^{-1})

Fungal population at different growth stages as influenced by liquid manures and their interaction effects are presented in Tables 119, 120 and 121.

Experiment conducted during *kharif* 2014

20 Days after sowing

Application of jeevamrutha at 2000 litre ha^{-1} application recorded significantly higher populations of fungi (22.33) followed by jeevamrutha at 1500 litre ha^{-1} application (19.89), jeevamrutha at 1000 litre ha^{-1} application application (16.78). Whereas, significantly lower fungal population was observed in without jeevamrutha (11.67). Panchagavya at 6 per cent recorded significantly higher populations of fungi (19.5) followed by panchagavya at 3 per cent (17.67) and it was lower with no-panchagavya application (15.83).

40 Days after sowing

Application of jeevamrutha at 2000 litre ha^{-1} application recorded significantly higher populations of fungi (31.22) followed by jeevamrutha at 1500 litre ha^{-1} application (26.33), jeevamrutha at 1000 litre ha^{-1} application application (21.33). Whereas, significantly lower fungal population was observed in without jeevamrutha (15.11). Panchagavya at 6 per cent recorded significantly higher populations of fungi (25.58) followed by panchagavya at 3 per cent (28.83) and it was lower with no-panchagavya application (21.08).

At harvest

Application of jeevamrutha at 2000 litre ha^{-1} application recorded significantly higher populations of fungi (25.03) followed by jeevamrutha at 1500 litre ha^{-1} application (21.32), jeevamrutha at 1000 litre ha^{-1} application application (17.36). Whereas, significantly lower fungal population was observed in without jeevamrutha (20.94). Panchagavya at 6 per cent recorded significantly higher populations of fungi (19.13) followed by panchagavya at 3 per cent (32.48) and it was lower with no-panchagavya application (16.89).

Experiment conducted during *kharif* 2015

20 Days after sowing

Application of jeevamrutha at 2000 litre ha^{-1} application recorded significantly higher populations of fungi (26.67) followed by jeevamrutha at 1500 litre ha^{-1} application

Table 119: Fungal population of rhizosphere soil as influenced by liquid manures application at different growth stages of frenchbean during *Kharif* 2014

Jeevamrutha Levels	Fungi (No. $\times 10^4$ cfu g ⁻¹)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	9.33	12.00	13.67	11.67	13.00	15.33	17.00	15.11	10.90	12.27	13.53	12.23
J₁	15.00	16.67	18.67	16.78	19.00	21.00	24.00	21.33	15.13	16.70	20.23	17.36
J₂	18.00	20.33	21.33	19.89	22.67	27.33	29.00	26.33	18.10	22.87	23.00	21.32
J₃	21.00	21.67	24.33	22.33	29.67	31.67	32.33	31.22	23.43	24.67	27.00	25.03
Mean	15.83	17.67	19.50		21.08	23.83	25.58		16.89	19.13	20.94	
	S.Em \pm		CD at 5%		S.Em \pm		CD at 5%		S.Em \pm		CD at 5%	
Jeevamrutha	0.63		1.85		1.10		3.24		0.85		2.48	
Panchagavya	0.55		1.60		0.96		2.81		0.73		2.15	
J \times P	1.09		NS		1.91		NS		1.46		NS	

Note: J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, J₂ - Jeevamrutha 1500 litre/ha, J₃ - Jeevamrutha 2000 litre/ha

P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, P₂ - Panchagavya at 6 %, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 120: Fungal population of rhizosphere soil as influenced by liquid manures application at different growth stages of frenchbean during *Kharif* 2015

Jeevamrutha Levels	Fungi (No. $\times 10^4$ cfu g ⁻¹)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	11.33	14.33	16.33	14.00	14.0	16.7	18.7	16.4	12.0	14.3	15.7	14.00
J₁	18.00	19.67	22.33	20.00	21.0	23.0	26.3	23.4	17.3	19.3	23.3	20.00
J₂	21.67	24.33	25.67	23.89	25.0	29.0	31.3	28.4	21.0	26.0	26.7	24.56
J₃	25.33	26.00	28.67	26.67	32.3	34.3	35.3	34.0	27.3	28.7	31.0	29.00
Mean	19.08	21.08	23.25		23.08	25.75	27.92		19.42	22.08	24.17	
	S.Em \pm		CD at 5%		S.Em \pm		CD at 5%		S.Em \pm		CD at 5%	
Jeevamrutha	0.77		2.26		0.71		2.07		0.75		2.20	
Panchagavya	0.67		1.95		0.61		1.79		0.65		1.91	
J \times P	1.33		NS		1.22		NS		1.30		NS	

Note: **J₀** - Without Jeevamrutha, **J₁**- Jeevamrutha 1000 litre/ha, **J₂**- Jeevamrutha 1500 litre/ha, **J₃**- Jeevamrutha 2000 litre/ha

P₀ - Without panchagavya, **P₁** - Panchagavya at 3 %, **P₃** - Panchagavya at 6 %, **DAS** – Days After Sowing, **RDF** – 63:100:75 NPK kg ha⁻¹

Table 121: Fungal population of rhizosphere soil as influenced by liquid manures application at different growth stages of frenchbean (Pooled 2014 and 2015)

Jeevamrutha Levels	Fungi (No. $\times 10^4$ cfu g ⁻¹)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	10.33	13.17	15.00	12.83	13.50	16.00	17.83	15.78	11.45	13.30	14.60	13.12
J₁	16.50	18.17	20.50	18.39	20.00	22.00	25.17	22.39	16.23	18.02	21.78	18.68
J₂	19.83	22.33	23.50	21.89	23.83	28.17	30.17	27.39	19.55	24.43	24.83	22.94
J₃	23.17	23.83	26.50	24.50	31.00	33.00	33.83	32.61	25.38	26.67	29.00	27.02
Mean	17.46	19.38	21.38		22.08	24.79	26.75		18.15	20.60	22.55	
	S.Em \pm		CD at 5%		S.Em \pm		CD at 5%		S.Em \pm		CD at 5%	
Jeevamrutha	0.70		2.05		0.83		2.45		0.79		2.32	
Panchagavya	0.60		1.77		0.72		2.12		0.69		2.01	
J \times P	1.21		NS		1.45		NS		1.37		NS	

Note: **J₀** - Without Jeevamrutha, **J₁** - Jeevamrutha 1000 litre/ha, **J₂** - Jeevamrutha 1500 litre/ha, **J₃** - Jeevamrutha 2000 litre/ha
P₀ - Without panchagavya, **P₁** - Panchagavya at 3 %, **P₂** - Panchagavya at 6 %, **DAS** – Days After Sowing, **RDF** – 63:100:75 NPK kg ha⁻¹

(23.89), jeevamrutha at 1000 litre ha⁻¹ application (20.0). Whereas, significantly lower fungal population was observed in without jeevamrutha (14.0). Panchagavya at 6 per cent recorded significantly higher populations of fungi (23.25) followed by panchagavya at 3 per cent (21.08) and it was lower with no-panchagavya application (19.08).

40 Days after sowing

Application of jeevamrutha at 2000 litre ha⁻¹ application recorded significantly higher populations of fungi (34.0) followed by jeevamrutha at 1500 litre ha⁻¹ application (28.4), jeevamrutha at 1000 litre ha⁻¹ application (23.4). Whereas, significantly lower fungal population was observed in without jeevamrutha (16.40). Panchagavya at 6 per cent recorded significantly higher populations of fungi (25.75) followed by panchagavya at 3 per cent (21.08) and it was lower with no-panchagavya application (23.08).

At harvest

Application of jeevamrutha at 2000 litre ha⁻¹ application recorded significantly higher populations of fungi (29.0) followed by jeevamrutha at 1500 litre ha⁻¹ application (24.56), jeevamrutha at 1000 litre ha⁻¹ application (20.0). Whereas, significantly lower fungal population was observed in without jeevamrutha (14.0). Panchagavya at 6 per cent recorded significantly higher populations of fungi (24.17) followed by panchagavya at 3 per cent (22.08) and it was lower with no-panchagavya application (19.42).

Interaction effect

Fungal population did not differ significantly due to the interaction effect of jeevamrutha and panchagavya application at 20, 40 and at harvest during both the years.

4.12.3 Actinomycetes (10⁴ cfu g⁻¹)

Population of actinomycetes at different growth stages as influenced by liquid manures and their interaction effects are presented in Tables 122, 123 and 124.

Experiment conducted during *kharif* 2014

20 Days after sowing

Application of jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher populations of actinomycetes (28.0) followed by jeevamrutha at 1500 litre ha⁻¹ application (25.78), jeevamrutha at 1000 litre ha⁻¹ application (24.33). Whereas, significantly lower actinomycetes population was observed in without jeevamrutha (18.0). Panchagavya at 6 per cent recorded significantly higher populations of actinomycetes (25.83) followed by panchagavya at 3 per cent (24.33) and it was lower with no-panchagavya application (21.92).

Table 122: Actinomycetes population of rhizosphere soil as influenced by liquid manures application at different growth stages of frenchbean during *Kharif* 2014

Jeevamrutha Levels	Actinomycetes (No. $\times 10^3$ cfu g ⁻¹)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	13.33	19.33	21.33	18.00	15.00	23.00	25.33	21.11	10.67	17.33	19.33	15.78
J₁	22.33	24.67	26.00	24.33	27.00	29.00	29.33	28.44	20.67	22.67	23.67	22.33
J₂	24.67	25.67	27.00	25.78	28.33	30.00	31.33	29.89	21.67	23.00	24.67	23.11
J₃	27.33	27.67	29.00	28.00	29.67	31.00	33.67	31.44	22.67	25.00	27.67	25.11
Mean	21.92	24.33	25.83		25.00	28.25	29.92		18.92	22.00	23.83	
	S.Em \pm		CD at 5%		S.Em \pm		CD at 5%		S.Em \pm		CD at 5%	
Jeevamrutha	0.63		1.84		0.85		2.48		0.65		1.91	
Panchagavya	0.54		1.59		0.73		2.15		0.56		1.65	
J \times P	1.09		NS		1.47		NS		1.13		NS	

Note: J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, J₂ - Jeevamrutha 1500 litre/ha, J₃ - Jeevamrutha 2000 litre/ha

P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, P₃ - Panchagavya at 6 %, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 123: Actinomycetes population of rhizosphere soil as influenced by liquid manures application at different growth stages of frenchbean during *Kharif* 2015

Jeevamrutha Levels	Actinomycetes (No. × 10 ³ cfu g ⁻¹)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	14.67	20.67	23.33	19.56	15.33	25.00	27.33	22.56	12.33	19.67	22.00	18.00
J₁	24.67	26.67	27.67	26.33	29.00	31.67	32.33	31.00	23.67	25.67	26.67	25.33
J₂	27.00	28.33	29.33	28.22	31.33	32.67	34.00	32.67	24.33	26.00	27.33	25.89
J₃	29.33	30.33	31.67	30.44	32.33	33.67	36.00	34.00	26.00	28.00	31.00	28.33
Mean	23.92	26.50	28.00		27.00	30.75	32.42		21.58	24.83	26.75	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.74		2.17		0.96		2.82		0.71		2.09	
Panchagavya	0.64		1.88		0.83		2.44		0.62		1.81	
J × P	1.28		NS		1.66		NS		1.24		NS	

Note: **J₀** - Without Jeevamrutha, **J₁**- Jeevamrutha 1000 litre/ha, **J₂** - Jeevamrutha 1500 litre/ha, **J₃** - Jeevamrutha 2000 litre/ha
P₀ - Without panchagavya, **P₁** - Panchagavya at 3 %, **P₃** - Panchagavya at 6 %, **DAS** – Days After Sowing, **RDF** – 63:100:75 NPK kg ha⁻¹

Table 124: Actinomycetes population of rhizosphere soil as influenced by liquid manures application at different growth stages of frenchbean (Pooled 2014 and 2015)

Jeevamrutha Levels	Actinomycetes (No. $\times 10^3$ cfu g ⁻¹)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	14.00	20.00	22.33	18.78	15.17	24.00	26.33	21.83	11.50	18.50	20.67	16.89
J₁	23.50	25.67	26.83	25.33	28.00	30.33	30.83	29.72	22.17	24.17	25.17	23.83
J₂	25.83	27.00	28.17	27.00	29.83	31.33	32.67	31.28	23.00	24.50	26.00	24.50
J₃	28.33	29.00	30.33	29.22	31.00	32.33	34.83	32.72	24.33	26.50	29.33	26.72
Mean	22.92	25.42	26.92		26.00	29.50	31.17		20.25	23.42	25.29	
	S.Em \pm		CD at 5%		S.Em \pm		CD at 5%		S.Em \pm		CD at 5%	
Jeevamrutha	0.66		1.94		0.87		2.55		0.64		1.88	
Panchagavya	0.57		1.68		0.75		2.21		0.56		1.63	
J \times P	1.15		NS		1.50		NS		1.11		NS	

Note: J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, J₂ - Jeevamrutha 1500 litre/ha, J₃ - Jeevamrutha 2000 litre/ha
P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, P₃ - Panchagavya at 6 %, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

40 Days after sowing

Application of jeevamrutha at 2000 litre ha⁻¹ application recorded significantly higher populations of actinomycetes (31.44) followed by jeevamrutha at 1500 litre ha⁻¹ application (29.89), jeevamrutha at 1000 litre ha⁻¹ application (28.44). Whereas, significantly lower actinomycetes population was observed in without jeevamrutha (21.11). Panchagavya at 6 per cent recorded significantly higher populations of actinomycetes (29.92) followed by panchagavya at 3 per cent (28.52) and it was lower with no-panchagavya application (25.0).

At harvest

Application of jeevamrutha at 2000 litre ha⁻¹ application recorded significantly higher populations of actinomycetes (25.11) followed by jeevamrutha at 1500 litre ha⁻¹ application (23.11), jeevamrutha at 1000 litre ha⁻¹ application (22.33). Whereas, significantly lower actinomycetes population was observed in without jeevamrutha (15.78). Panchagavya at 6 per cent recorded significantly higher populations of actinomycetes (23.83) followed by panchagavya at 3 per cent (22.0) and it was lower with no-panchagavya application (18.92).

Experiment conducted during *kharif* 2015

20 Days after sowing

Application of jeevamrutha at 2000 litre ha⁻¹ application recorded significantly higher populations of actinomycetes (30.44) followed by jeevamrutha at 1500 litre ha⁻¹ application (28.22), Jeevamrutha at 1000 litre ha⁻¹ application (26.33). Whereas, significantly lower actinomycetes population was observed in without jeevamrutha (19.56). Panchagavya at 6 per cent recorded significantly higher populations of actinomycetes (28.0) followed by panchagavya at 3 per cent (26.5) and it was lower with no-panchagavya application (23.92).

40 Days after sowing

Application of jeevamrutha at 2000 litre ha⁻¹ application recorded significantly higher populations of actinomycetes (34.0) followed by jeevamrutha at 1500 litre ha⁻¹ application (32.67), Jeevamrutha at 1000 litre ha⁻¹ application (31.0). Whereas, significantly lower actinomycetes population was observed in without jeevamrutha (25.56). Panchagavya at 6 per cent recorded significantly higher populations of actinomycetes (32.42) followed by panchagavya at 3 per cent (30.75) and it was lower with no-panchagavya application (27.0).

At harvest

Application of jeevamrutha at 2000 litre ha⁻¹ application recorded significantly higher populations of actinomycetes (28.33) followed by jeevamrutha at 1500 litre ha⁻¹ application (25.89), Jeevamrutha at 1000 litre ha⁻¹ application (25.33). Whereas, significantly lower actinomycetes population was observed in without jeevamrutha (18.0). Panchagavya at 6 per cent recorded significantly higher population of actinomycetes

(26.75) followed by panchagavya at 3 per cent (24.83) and it was lower with no-panchagavya application (21.58).

Interaction effect

Actinomycetes population did not differ significantly due to the interaction effect of jeevamrutha and panchagavya application at 20, 40 and at harvest during both the years.

4.12.4 N-fixers (10^5 cfu g⁻¹)

Population of N-fixers at different growth stages as influenced by liquid manures and their interaction effects are presented in Tables 125, 126 and 127.

Experiment conducted during *kharif* 2014

20 Days after sowing

Application of jeevamrutha at 2000 litre ha⁻¹ application recorded significantly higher populations of N-fixers (28.0) followed by jeevamrutha at 1500 litre ha⁻¹ application (24.56), Jeevamrutha at 1000 litre ha⁻¹ application (22.0). Whereas, significantly lower N-fixers population was observed in without jeevamrutha (13.4). Panchagavya at 6 per cent recorded significantly higher populations of N-fixers (25.0) followed by panchagavya at 3 per cent (22.0) and it was lower with no-panchagavya application (19.0).

40 Days after sowing

Application of jeevamrutha at 2000 litre ha⁻¹ application recorded significantly higher populations of N-fixers (33.0) and on par with jeevamrutha at 1500 litre ha⁻¹ application (29.0), Jeevamrutha at 1000 litre ha⁻¹ application (27.56). Whereas, significantly lower N-fixers population was observed in without jeevamrutha (17.11). Panchagavya at 6 per cent recorded significantly higher populations of N-fixers (29.83) followed by panchagavya at 3 per cent (27.75) and it was lower with no-panchagavya application (22.42).

At harvest

Application of jeevamrutha at 2000 litre ha⁻¹ application recorded significantly higher populations of N-fixers (25.89) and on par with jeevamrutha at 1500 litre ha⁻¹ application (22.44), jeevamrutha at 1000 litre ha⁻¹ application (20.56). Whereas, significantly lower N-fixers population was observed in without jeevamrutha (12.67). Panchagavya at 6 per cent recorded significantly higher populations of N-fixers (22.83) and on par with panchagavya at 3 per cent (20.75) and it was lower with no-panchagavya application (15.78).

Table 125: N-fixers population of rhizosphere soil as influenced by liquid manures application at different growth stages of frenchbean during Kharif 2014

Jeevamrutha Levels	N-fixers (No. × 10 ⁵ cfu g ⁻¹)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	8.33	14.33	17.67	13.44	11.00	18.67	21.67	17.11	9.67	13.33	15.00	12.67
J₁	20.33	21.33	24.33	22.00	24.33	28.00	30.33	27.56	18.00	21.00	22.67	20.56
J₂	21.67	25.33	26.67	24.56	26.00	30.00	31.00	29.00	20.00	22.67	24.67	22.44
J₃	25.67	27.00	31.33	28.00	28.33	34.33	36.33	33.00	22.67	26.00	29.00	25.89
Mean	19.00	22.00	25.00		22.42	27.75	29.83		17.58	20.75	22.83	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.75		2.20		0.71		2.08		0.65		1.90	
Panchagavya	0.65		1.91		0.61		1.80		0.56		1.64	
J × P	1.30		NS		1.23		NS		1.12		3.29	

Note: J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, J₂ - Jeevamrutha 1500 litre/ha, J₃ - Jeevamrutha 2000 litre/ha
P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, P₃ - Panchagavya at 6 %, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 126: N-fixers population of rhizosphere soil as influenced by liquid manures application at different growth stages of frenchbean during *Kharif* 2015

Jeevamrutha Levels	N-fixers (No. $\times 10^5$ cfu g ⁻¹)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	9.33	16.00	20.00	15.11	12.33	20.33	23.67	18.78	10.67	14.67	16.67	14.00
J₁	23.00	24.33	27.67	25.00	26.33	30.00	32.67	29.67	20.00	23.33	24.67	22.67
J₂	24.33	28.00	29.67	27.33	28.00	32.33	33.33	31.22	22.00	24.67	27.00	24.56
J₃	29.00	30.33	35.00	31.44	30.33	37.00	39.33	35.56	24.67	28.67	31.67	28.33
Mean	21.42	24.67	28.08		24.25	29.92	32.25		19.33	22.83	25.00	
	S.Em \pm		CD at 5%		S.Em \pm		CD at 5%		S.Em \pm		CD at 5%	
Jeevamrutha	0.79		2.31		0.76		2.23		0.71		2.08	
Panchagavya	0.68		2.00		0.66		1.93		0.61		1.80	
J \times P	1.36		NS		1.32		NS		1.23		NS	

Note: J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, J₂ - Jeevamrutha 1500 litre/ha, J₃ - Jeevamrutha 2000 litre/ha

P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, P₃ - Panchagavya at 6 %, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 127: N-fixers population of rhizosphere soil as influenced by liquid manures application at different growth stages of frenchbean (Pooled 2014 and 2015)

Jeevamrutha Levels	N-fixers (No. × 10 ⁵ cfu g ⁻¹)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	8.83	15.17	18.83	14.28	11.67	19.50	22.67	17.94	10.17	14.00	15.83	13.33
J₁	21.67	22.83	26.00	23.50	25.33	29.00	31.50	28.61	19.00	22.17	23.67	21.61
J₂	23.00	26.67	28.17	25.94	27.00	31.17	32.17	30.11	21.00	23.67	25.83	23.50
J₃	27.33	28.67	33.17	29.72	29.33	35.67	37.83	34.28	23.67	27.33	30.33	27.11
Mean	20.21	23.33	26.54		23.33	28.83	31.04		18.46	21.79	23.92	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.76		2.24		0.73		2.14		0.68		1.98	
Panchagavya	0.66		1.94		0.63		1.86		0.59		1.72	
J × P	1.32		NS		1.27		NS		1.17		NS	

Note: **J₀** - Without Jeevamrutha, **J₁**- Jeevamrutha 1000 litre/ha, **J₂** - Jeevamrutha 1500 litre/ha, **J₃** - Jeevamrutha 2000 litre/ha
P₀ - Without panchagavya, **P₁** - Panchagavya at 3 %, **P₃** - Panchagavya at 6 %, **DAS** – Days After Sowing, **RDF** – 63:100:75 NPK kg ha⁻¹

Experiment conducted during *kharif* 2015

20 Days after sowing

Application of jeevamrutha at 2000 litre ha⁻¹ application recorded significantly higher populations of N-fixers (31.44) followed by jeevamrutha at 1500 litre ha⁻¹ application (27.33), Jeevamrutha at 1000 litre ha⁻¹ application (25.0). Whereas, significantly lower N-fixers population was observed in without jeevamrutha (15.11). Panchagavya at 6 per cent recorded significantly higher populations of N-fixers (28.08) followed by panchagavya at 3 per cent (24.67) and it was lower with no-panchagavya application (21.42).

40 Days after sowing

Application of jeevamrutha at 2000 litre ha⁻¹ application recorded significantly higher populations of N-fixers (35.56) and on par with jeevamrutha at 1500 litre ha⁻¹ application (31.22), Jeevamrutha at 1000 litre ha⁻¹ application (29.67). Whereas, significantly lower N-fixers population was observed in without jeevamrutha (18.78). Panchagavya at 6 per cent recorded significantly higher populations of N-fixers (32.25) followed by panchagavya at 3 per cent (29.92) and it was lower with no-panchagavya application (24.25).

At harvest

Application of jeevamrutha at 2000 litre ha⁻¹ application recorded significantly higher populations of N-fixers (28.33) followed by jeevamrutha at 1500 litre ha⁻¹ application (24.56), Jeevamrutha at 1000 litre ha⁻¹ application (22.67). Whereas, significantly lower N-fixers population was observed in without jeevamrutha (14.0). Panchagavya at 6 per cent recorded significantly higher populations of N-fixers (25.0) and on par with panchagavya at 3 per cent (22.83) and it was lower with no-panchagavya application (19.33).

Interaction effect

N-fixers population did not differ significantly due to the interaction effect of jeevamrutha and panchagavya application at 20, 40 and at harvest during both the years.

4.12.5 P-solubalisers (10⁵ cfu g⁻¹)

Population of P-solubalisers at different growth stages as influenced by liquid manures and their interaction effects are presented in Tables 128, 129 and 130.

Experiment conducted during *kharif* 2014

20 Days after sowing

Application of jeevamrutha at 2000 litre ha⁻¹ application recorded significantly higher populations of P-solubalisers (29.67) and on par with jeevamrutha at 1500 litre ha⁻¹ application (27.22), Jeevamrutha at 1000 litre ha⁻¹ application (25.67). Whereas, significantly lower P-solubalisers population was observed in without jeevamrutha (17.56). Panchagavya at 6 per cent recorded significantly higher populations of

Table 128: P-Solubiliser population of rhizosphere soil as influenced by liquid manures application at different growth stages of frenchbean during Kharif 2014

Jeevamrutha Levels	P-Solubiliser (No. $\times 10^5$ cfu g ⁻¹)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	11.00	19.33	22.33	17.56	14.67	20.67	21.33	18.89	11.67	16.33	17.00	15.00
J₁	23.67	25.33	28.00	25.67	25.33	27.00	29.00	27.11	20.00	21.33	23.33	21.56
J₂	24.33	27.00	30.33	27.22	26.33	28.67	31.67	28.89	21.00	22.67	25.33	23.00
J₃	27.67	29.67	31.67	29.67	31.33	34.33	37.00	34.22	25.00	27.33	29.43	27.26
Mean	21.67	25.33	28.08		24.42	27.67	29.75		19.42	21.92	23.78	
	S.Em \pm		CD at 5%		S.Em \pm		CD at 5%		S.Em \pm		CD at 5%	
Jeevamrutha	0.72		2.10		0.74		2.16		0.67		1.97	
Panchagavya	0.62		1.82		0.64		1.87		0.58		1.70	
J \times P	1.24		NS		1.28		NS		1.16		NS	

Note: J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, J₂ - Jeevamrutha 1500 litre/ha, J₃ - Jeevamrutha 2000 litre/ha

P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, P₃ - Panchagavya at 6 %, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 129: P-Solubiliser population of rhizosphere soil as influenced by liquid manures application at different growth stages of frenchbean during *Kharif* 2015

Jeevamrutha Levels	P-Solubiliser (No. $\times 10^5$ cfu g ⁻¹)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	12.33	21.00	24.33	19.22	16.33	22.67	23.33	20.78	12.67	17.33	18.33	16.11
J₁	26.00	27.33	30.33	27.89	27.67	29.67	32.00	29.78	21.67	23.33	25.33	23.44
J₂	27.33	29.33	32.67	29.78	29.00	31.67	34.67	31.78	23.00	24.67	27.33	25.00
J₃	29.67	32.00	34.33	32.00	34.33	37.67	41.00	37.67	27.00	29.33	32.00	29.44
Mean	23.83	27.42	30.42		26.83	30.42	32.75		21.08	23.67	25.75	
	S.Em \pm		CD at 5%		S.Em \pm		CD at 5%		S.Em \pm		CD at 5%	
Jeevamrutha	0.71		2.08		0.78		2.30		0.70		2.06	
Panchagavya	0.62		1.80		0.68		1.99		0.61		1.78	
J \times P	1.23		3.61		1.36		NS		1.21		NS	

Note: J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, J₂ - Jeevamrutha 1500 litre/ha, J₃ - Jeevamrutha 2000 litre/ha

P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, P₃ - Panchagavya at 6 %, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 130: P-Solubiliser population of rhizosphere soil as influenced by liquid manures application at different growth stages of frenchbean (Pooled 2014 and 2015)

Jeevamrutha Levels	P-Solubiliser (No. $\times 10^5$ cfu g ⁻¹)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	11.67	20.17	23.33	18.39	15.50	21.67	22.33	19.83	12.17	16.83	17.67	15.56
J₁	24.83	26.33	29.17	26.78	26.50	28.33	30.50	28.44	20.83	22.33	24.33	22.50
J₂	25.83	28.17	31.50	28.50	27.67	30.17	33.17	30.33	22.00	23.67	26.33	24.00
J₃	28.67	30.83	33.00	30.83	32.83	36.00	39.00	35.94	26.00	28.33	30.72	28.35
Mean	22.75	26.38	29.25		25.63	29.04	31.25		20.25	22.79	24.76	
	S.Em \pm		CD at 5%		S.Em \pm		CD at 5%		S.Em \pm		CD at 5%	
Jeevamrutha	0.65		1.91		0.76		2.22		0.68		2.01	
Panchagavya	0.56		1.65		0.66		1.93		0.59		1.74	
J \times P	1.13		3.31		1.31		NS		1.19		NS	

Note: **J₀** - Without Jeevamrutha, **J₁**- Jeevamrutha 1000 litre/ha, **J₂** - Jeevamrutha 1500 litre/ha, **J₃** - Jeevamrutha 2000 litre/ha
P₀ - Without panchagavya, **P₁** - Panchagavya at 3 %, **P₃** - Panchagavya at 6 %, **DAS** – Days After Sowing, **RDF** – 63:100:75 NPK kg ha⁻¹

P-solubalisers (28.08) followed by panchagavya at 3 per cent (25.33) and it was lower with no-panchagavya application (21.67).

40 Days after sowing

Application of jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher populations of P-solubalisers (34.22) followed by jeevamrutha at 1500 litre ha⁻¹ application (28.89), Jeevamrutha at 1000 litre ha⁻¹ application (27.11). Whereas, significantly lower P-solubalisers population was observed in without jeevamrutha (18.89). Panchagavya at 6 per cent recorded significantly higher populations of P-solubalisers (29.75) followed by panchagavya at 3 per cent (27.67) and it was lower with no-panchagavya application (24.42).

At harvest

Application of jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher populations of P-solubalisers (27.26) followed by jeevamrutha at 1500 litre ha⁻¹ application (23.0), Jeevamrutha at 1000 litre ha⁻¹ application (21.56). Whereas, significantly lower P-solubalisers population was observed in without jeevamrutha (15.0). Panchagavya at 6 per cent recorded significantly higher populations of P-solubalisers (23.78) followed by panchagavya at 3 per cent (21.92) and it was lower with no-panchagavya application (19.42).

Experiment conducted during *kharif* 2015

20 Days after sowing

Jeevamrutha at 2000 litre ha⁻¹ application recorded significantly higher populations of P-solubalisers (32.0) followed by jeevamrutha at 1500 litre ha⁻¹ application (29.78), Jeevamrutha at 1000 litre ha⁻¹ application (27.89). Whereas, significantly lower P-solubalisers population was observed in without jeevamrutha (19.22). Panchagavya at 6 per cent recorded significantly higher populations of P-solubalisers (30.42) followed by panchagavya at 3 per cent (27.42) and it was lower with no-panchagavya application (23.83).

40 Days after sowing

Application of jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher populations of P-solubalisers (37.67) followed by jeevamrutha at 1500 litre ha⁻¹ application (31.78), Jeevamrutha at 1000 litre ha⁻¹ application (29.78). Whereas, significantly lower P-solubalisers population was observed in without jeevamrutha (20.78). Spray of panchagavya at 6 per cent recorded significantly higher populations of P-solubalisers (32.75) followed by panchagavya at 3 per cent (30.42) and it was lower with no-panchagavya application (26.83).

At harvest

Significantly higher population of P-solubalisers (29.44) were observed with application of jeevamrutha at 2000 litre ha⁻¹ followed by jeevamrutha at 1500 litre ha⁻¹ application (25.0), Jeevamrutha at 1000 litre ha⁻¹ application (23.44). Whereas,

significantly lower P-solubalisers population was observed in without jeevamrutha (16.11). Panchagavya at 6 per cent recorded significantly higher populations of P-solubalisers (27.75) followed by panchagavya at 3 per cent (23.67) and it was lower with no-panchagavya application (21.08).

Interaction effect

P-solubalisers population did not differ significantly due to the interaction effect of jeevamrutha and panchagavya application at 20, 40 and at harvest during both the years.

Pooled

The data pertaining to the population of bacteria, fungi, actinomycetes, phosphorous solubilizer and nitrogen fixer is furnished in Tables 118, 121, 124, 127 and 130.

Bacteria, fungi, actinomycetes, phosphorous solubiliser and nitrogen fixer population differed significantly at at 20, 40 DAS and harvest due to the varied levels of FYM, jeevamrutha and panchagavya application.

At at 20, 40 DAS and harvest application of jeevamrutha at 2000 litre ha⁻¹ application recorded significantly higher populations of bacteria (37.28, 48.06 and 41.27 × 10⁶ cfu g⁻¹, respectively) and fungi (24.5, 32.61 and 27.02 × 10⁴ cfu g⁻¹, respectively) followed by jeevamrutha at 1500 litre ha⁻¹ application (bacterial- 33.44, 43.06 and 36.95 × 10⁶ cfu g⁻¹, fungi- 21.89, 27.39 and 22.94 × 10⁴ cfu g⁻¹, respectively), Jeevamrutha at 1000 litre ha⁻¹ application application (bacterial- 28.06, 36.72 and 29.81 × 10⁶ cfu g⁻¹, fungi- 18.39, 22.39 and 18.68 × 10⁴ cfu g⁻¹, respectively). Whereas, significantly lower bacterial and fungal population was observed in without jeevamrutha (bacterial- 20.33, 25.74 and 21.69 × 10⁶ cfu g⁻¹, fungi- 12.83, 15.78 and 13.21 × 10⁴ cfu g⁻¹, respectively). Panchagavya at 6 per cent recorded significantly higher populations of bacteria (32.13, 41.5 and 34.45 × 10⁶ cfu g⁻¹) and fungi (21.38, 26.75 and 22.55 × 10⁴ cfu g⁻¹, respectively) followed by panchagavya at 3 per cent (bacterial- 30.17, 38.96 and 33.24 × 10⁶ cfu g⁻¹, fungi- 19.38, 24.79 and 20.60 × 10⁴ cfu g⁻¹, respectively) and it was lower with no-panchagavya application (bacterial-27.04, 34.72 and 29.60 × 10⁶ cfu g⁻¹, fungi-17.46, 22.08 and 18.15 × 10⁴ cfu g⁻¹, respectively). Whereas, in fungi at at 20, 40 DAS and harvest and in bacteria at 40 DAS and harvest application of panchagavya at 6 per cent found on par with panchagavya at 3 per cent applications.

Application of Jeevamrutha at 2000 litre ha⁻¹ at at 20, 40 DAS and harvest recorded significantly higher populations of actinomycetes (29.22, 32.72 and 26.72 × 10³ cfu g⁻¹, respectively) and P-solubalisers (30.83, 35.94 and 28.35 × 10⁵ cfu g⁻¹, respectively) followed by jeevamrutha at 1500 litre ha⁻¹ application (actinomycetes – 27.00, 31.28 and 24.50 × 10³ cfu g⁻¹, P-solubalisers– 28.50, 30.33 and 24.00 × 10⁵ cfu g⁻¹, respectively), Jeevamrutha at 1000 litre ha⁻¹ application application (actinomycetes – 25.33, 29.72 and 23.83 × 10³ cfu g⁻¹, P-solubalisers – 26.78, 28.44 and 22.50 × 10⁵ cfu g⁻¹, respectively). Where jeevamrutha at 1500 litre ha⁻¹ application on par with jeevamrutha at 1000 litre ha⁻¹ application and significantly lower actinomycetes and P-solubalisers

were observed in without jeevamruta (actinomycetes – 18.78, 21.83 and 16.89×10^3 cfu g^{-1} , P-solubalisers – 18.39, 19.83 and 15.56×10^5 cfu g^{-1} , respectively). Panchagavya at 6 per cent recorded significantly higher populations of actinomycetes (26.92, 31.17 and 25.29×10^3 cfu g^{-1}) and P-solubalisers (29.25, 31.25 and 24.76×10^5 cfu g^{-1} , respectively) followed by panchagavya at 3 per cent (actinomycetes – 25.42, 29.50 and 23.42×10^3 cfu g^{-1} , P-solubalisers – 26.38, 29.04 and 22.79×10^5 cfu g^{-1} , respectively) and it was lower with no-panchagavya application (actinomycetes -22.92, 26.0 and 20.25×10^3 cfu g^{-1} , P-solubalisers – 22.75, 25.63 and 20.25×10^5 cfu g^{-1} , respectively). Whereas, in actinomycetes at 20 and 40 DAS application of panchagavya at 6 per cent found on par with panchagavya at 3 per cent.

At at 20, 40 DAS and harvest application of Jeevamrutha at 2000 litre ha^{-1} recorded significantly higher population of N-fixers (29.72, 34.28 and 27.11×10^5 cfu g^{-1} , respectively) followed by jeevamrutha at 1500 litre ha^{-1} application (25.94, 30.11 and 23.50×10^5 cfu g^{-1} , respectively), Jeevamrutha at 1000 litre ha^{-1} application (23.5, 28.61 and 21.61×10^6 cfu g^{-1} , respectively) and lower in without jeevamruta application (14.28, 17.94 and 13.33×10^5 cfu g^{-1} , respectively). Whereas, at 40 DAS and harvest application of jeevamrutha at 1500 litre ha^{-1} on par with jeevamrutha at 1000 litre ha^{-1} . Panchagavya at 6 per cent recorded significantly higher N-fixers (26.54, 31.04 and 23.92×10^5 cfu g^{-1} , respectively) followed by panchagavya at 3 per cent (23.33, 28.83 and 21.79×10^5 cfu g^{-1} , respectively) and it was lower with no-panchagavya application (20.21, 23.33 and 18.46×10^5 cfu g^{-1} , respectively).

Discussion on the findings relating to the performance of solid and liquid manures on soil microbial count

The increase in microbial population which is an indicator of soil fertility and soil health. Microbial communities are important for the functioning of the ecosystem, both in relation to direct interactions with plants and with regard to nutrient and organic matter cycling. They are involved in the fundamental activities that ensure the stability and productivity of both agricultural systems and natural ecosystems. Increase in population results in increased soil microbial biomass, a temporary reservoir of labile nutrients. Further, increase in various other biological activities such as enzyme activities, mineralization capabilities, rate of nitrification, microbial diversity *etc.*, will have influence on soil fertility. These biological parameters can also be used as effective indicators for assessing long-term soil and crop management effects on soil quality. Thus, the microflora could influence plant growth in many ways as all plant nutrients pass through this chain (Giri, 2005).

Application of FYM, panchagavya and jeevamrutha significantly influenced the bacteria, fungi, actinomycetes, P- solubilizer and N-fixer population in the soil at all the stages of crop growth.

In the present investigation, application of FYM at 200 per cent N equivalent recorded significantly higher bacteria, fungi, actinomycetes, P- solubilizer and N-fixer population followed by FYM at 150 per cent N equivalent and lower population was with FYM at 100 per cent N equivalent (Tables 45 and 46). This might be due to the beneficial

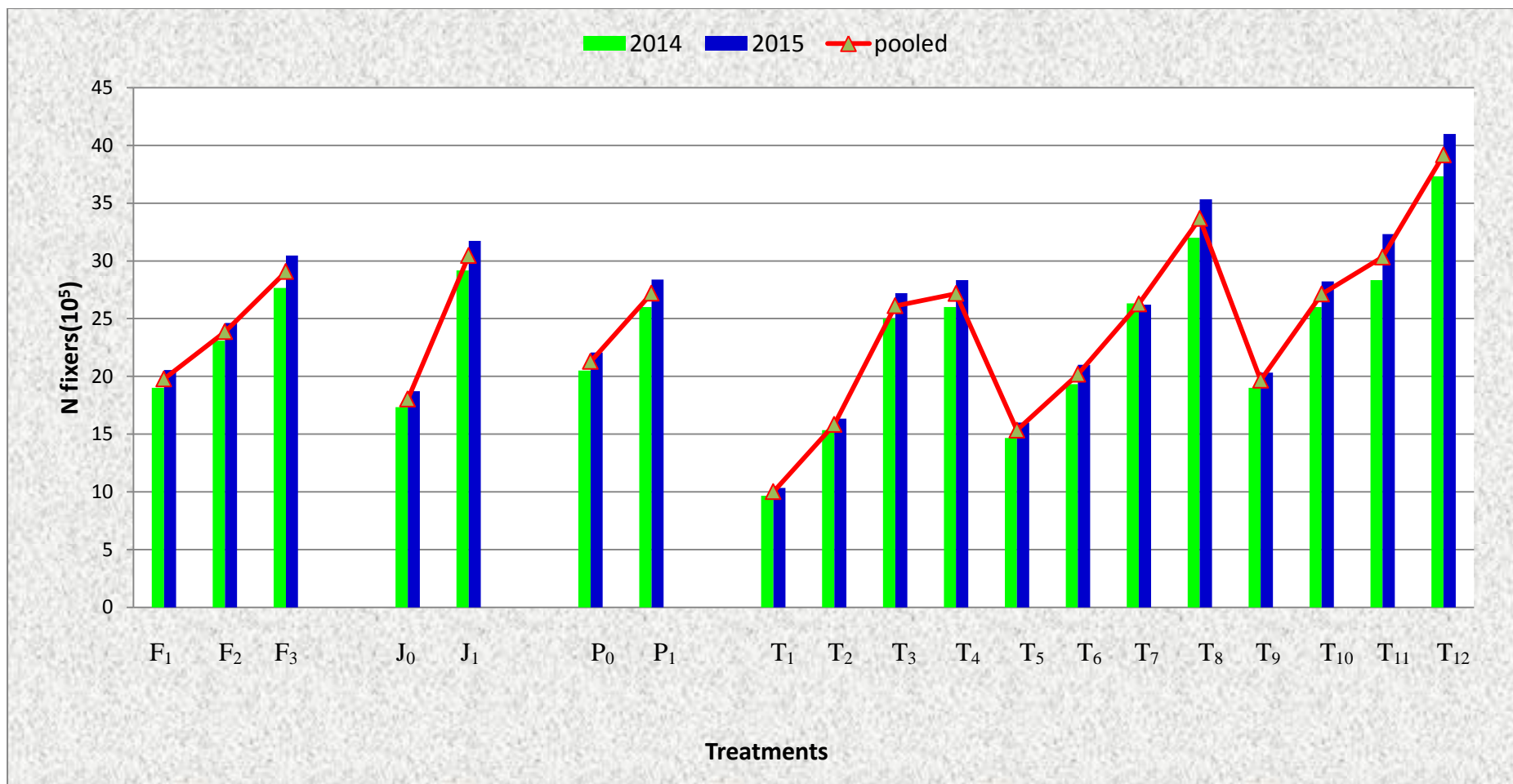


Fig. 15: Influence of FYM, jeevamruta and panchagavya application on soil N fixers at 40 DAS of frenchbean

F₁- 100 %, F₂- 150 % and F₃- 200 % equivalent N through FYM, J₀- Without Jeevamruta, J₁- Jeevamruta 1000 litre/ha, P₀- Without panchagavya, P₁- Panchagavya at 3 %, T₁= F₁J₀P₀, T₂= F₁J₀P₁, T₃=F₁J₁P₀, T₄=F₁J₁P₁, T₅=F₂J₀P₀, T₆= F₂J₀P₁, T₇=F₂J₁P₀, T₈=F₂J₁P₁, T₉=F₃J₀P₀, T₁₀=F₃J₀P₁, T₁₁= F₃J₁P₀, T₁₂=F₃J₁P₁

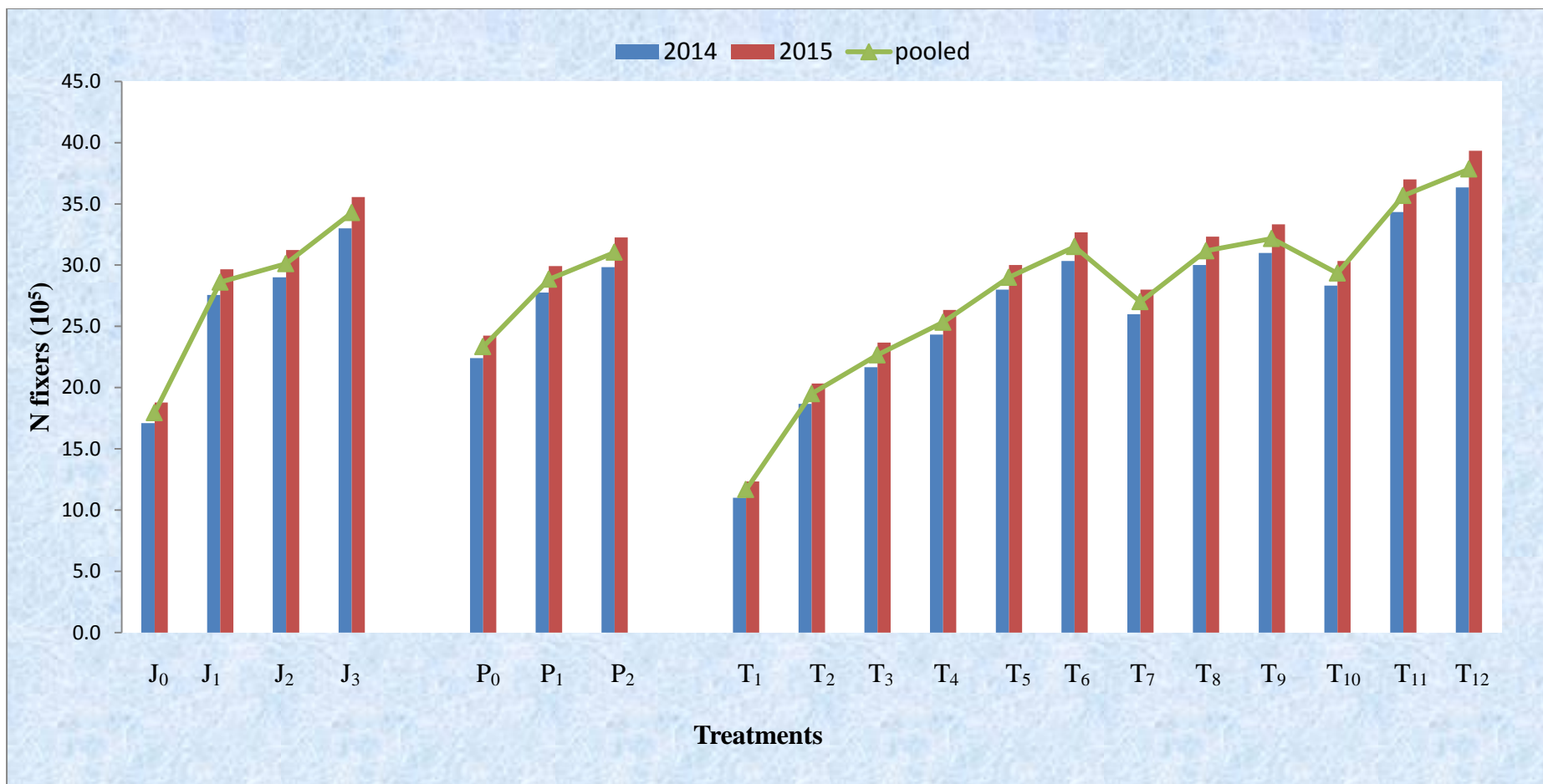


Fig. 16: Influence of jeevamruta and panchagavya application on N fixers at 40 DAS of frenchbean

J₀- Without Jeevamrutha, **J₁**- Jeevamrutha 1000 litre/ha, **J₂**- Jeevamrutha 1500 litre/ha, **J₃**- Jeevamrutha 2000 litre/ha, **P₀**- Without panchagavya, **P₁**- Panchagavya at 3 %, **P₃**- Panchagavya at 6 %, **T₁**= J₀P₀, **T₂**=J₀P₁, **T₃**=J₀P₂, **T₄**=J₁P₀, **T₅**=J₁P₁, **T₆**=J₁P₂, **T₇**=J₂P₀, **T₈**=J₂P₁, **T₉**=J₂P₂, **T₁₀**=J₃P₀, **T₁₁**=J₃P₁, **T₁₂**=J₃P₂

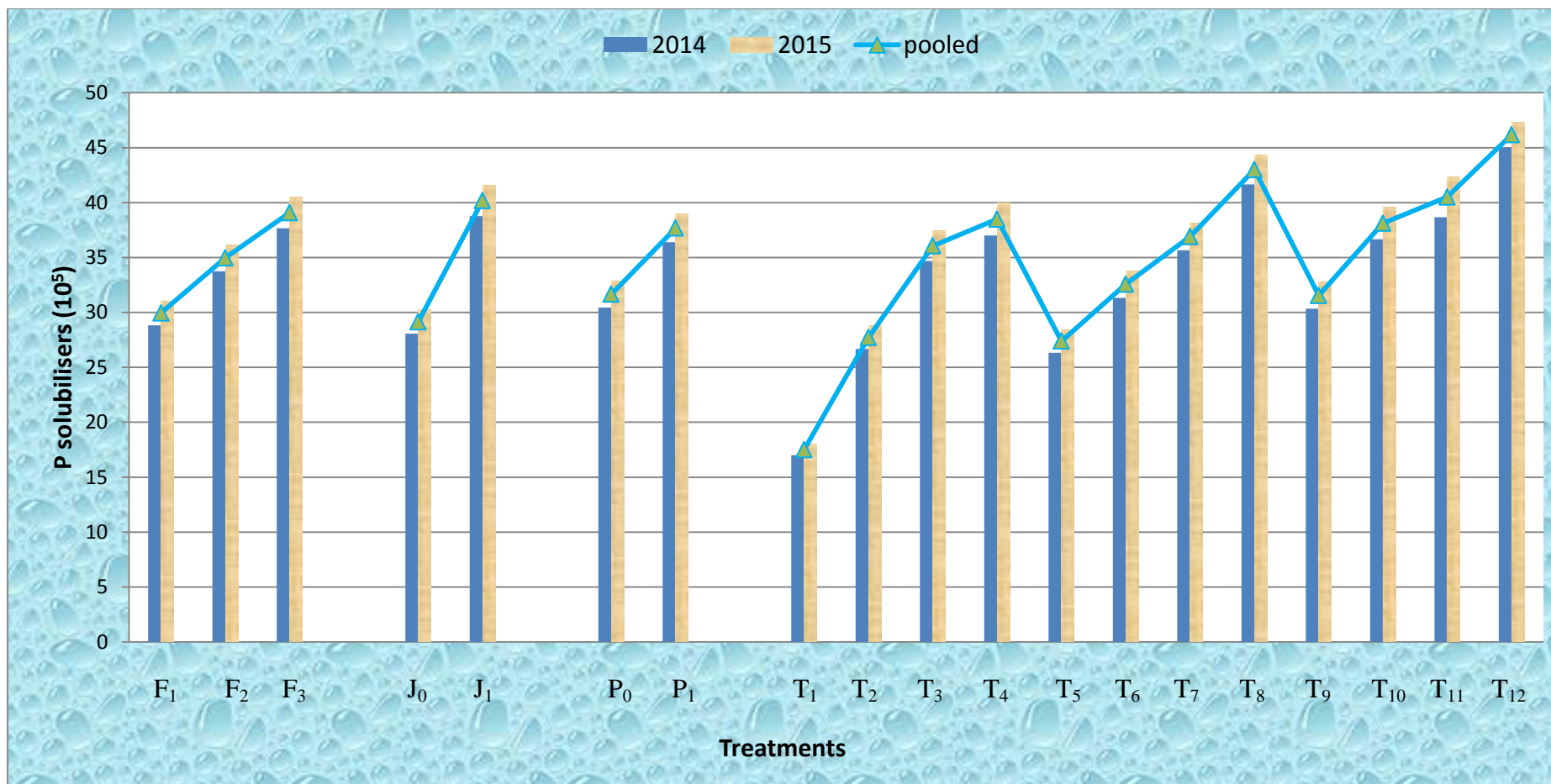


Fig. 17: Influence of FYM, jeevamruta and panchagavya application on soil P- Solubilizes at 40 DAS of frenchbean

F₁- 100 %, F₂- 150 % and F₃- 200 % equivalent N through FYM, J₀- Without Jeevamrutha, J₁- Jeevamrutha 1000 litre/ha, P₀- Without panchagavya, P₁- Panchagavya at 3 %, T₁= F₁J₀P₀, T₂= F₁J₀P₁, T₃=F₁J₁P₀, T₄=F₁J₁P₁, T₅=F₂J₀P₀, T₆= F₂J₀P₁, T₇=F₂J₁P₀, T₈=F₂J₁P₁, T₉=F₃J₀P₀, T₁₀=F₃J₀P₁, T₁₁= F₃J₁P₀, T₁₂=F₃J₁P₁

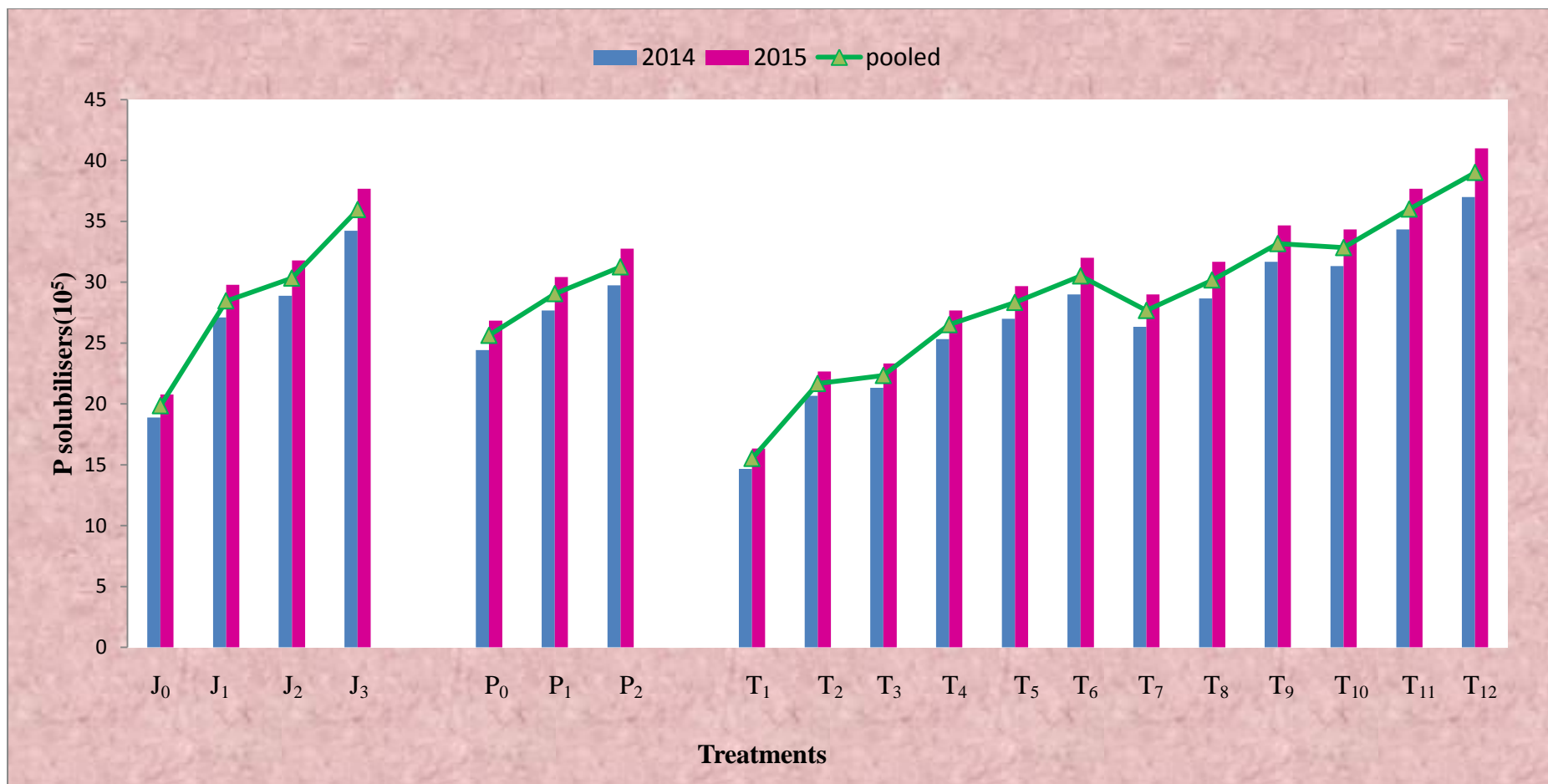


Fig. 18: Influence of jeevamruta and panchagavya application on P- solubilisers at 40 DAS of frenchbean

J₀- Without Jeevamruta, J₁- Jeevamruta 1000 litre/ha, J₂- Jeevamruta 1500 litre/ha, J₃- Jeevamruta 2000 litre/ha, P₀- Without panchagavya, P₁- Panchagavya at 3 %, P₃- Panchagavya at 6 %, T₁= J₀P₀, T₂=J₀P₁, T₃=J₀P₂, T₄=J₁P₀, T₅=J₁P₁, T₆=J₁P₂, T₇=J₂P₀, T₈=J₂P₁, T₉=J₂P₂, T₁₀=J₃P₀, T₁₁=J₃P₁, T₁₂=J₃P₂

effect of FYM which serves as a source of carbon and energy for soil microorganisms (Kulvinder Kaur *et al.*, 2005, Boraiah, 2013 and Siddappa, 2015). Combined application of FYM and Jeevamruta, FYM and panchagavya, FYM, jeevamruta and panchagavya recorded higher microbial population as compared to their individual application. This might be due to the beneficial effect of FYM which serves as a source of carbon and energy for soil microorganisms in addition to that liquid manures contains enormous amount of microbial load which multiplies in the soil and acts as a tonic to enhance the microbial activity in the soil. (Kulvinder Kaur *et al.*, 2005 and Boraiah, 2013). Similar results were also noticed by Siddappa *et al.*, (2016) and Latha *et al.*, (2016).

In present investigation among jeevamrutha levels, application of jeevamrutha at 2000 litres ha⁻¹ and jeevamrutha 1000 litres ha⁻¹ in second experiment recorded significantly higher bacteria (41.27 and 41.55 × 10⁶), fungi (27.02 and 25.15 × 10⁴), actinomycetes (26.72 and 27.95 × 10³), P- solubilizers (28.35 and 34.82 × 10⁵) and N-fixers (27.11 and 26.44 × 10⁵) population over without jeevamrutha application. Application of panchagavya recorded significantly higher microbial population as compared to without panchagavya application in first experiment. Whereas in second experiment application of panchagavya at 6 per cent followed by panchagavya at 3 per cent resulted in higher microbial population as compared to without panchagavya application at all stages during both the years. This might be due to jeevamrutha and panchagavya contains enormous amount of microbial load which multiplies in the soil and acts as a tonic to enhance the microbial activity in the soil. Palekar, (2006); Vasanthakumar, (2006); Shreenivas *et al.*, (2011); Patel *et al.*, 2014 and Geetha and Devaraj (2013) also reported that liquid manures contains micronutrients in addition to different microflora especially nitrogen fixers and phosphate solubilizers. Similar observations were made by Swaminthan (2005) who reported that presence of naturally occurring beneficial microorganisms predominantly bacteria, yeast, actinomycetes, photosynthetic bacteria and certain fungi were detected in organic liquid manures. Devakumar *et al.* (2014) reported that the use of handful of soil for jeevamrutha preparation serves as source of initial inoculums of bacteria, fungi, actinomycetes, N-fixers and P- solubilizers. Hence, more number of beneficial microorganisms were found in organic liquid manure formulations. These observations are in conformity with Papan *et al.*, (2002). Combined application of jeevamrutha and panchagavya recorded higher microbial populations as compared to their individual applications (43.2 × 10⁶, 29.0 × 10⁴, 29.3 × 10³, 30.3 × 10⁵ and 30.7 × 10⁵ bacteria, fungi, actinomycetes, N-fixers and P-solubilisers, respectively. This might be due to enhanced effect of both liquid manure on soil micro flora as compared to individual applications and also jeevamrutha and panchagavya had supported the multiplication of different beneficial microbes (Lavanya *et al.*, 2016 and Reshma *et al.*, 2016). Similarly, jeevamrutha and panchagavya contains enormous amount of microbial load which multiplies in the soil and acts as a tonic to enhance the microbial activity in the soil (Devakumar *et al.*, 2008 and Patel *et al.*, 2014).

4.13 Exp I: Effect of different levels of FYM, jeevamrutha and panchagavya on soil dehydrogenase activity

The data pertaining to dehydrogenase activity in soil as influenced by solid and liquid manures are presented in the Tables 131, 132 and 133.

Experiment conducted during *kharif* 2014

20 Days after sowing

Dehydrogenase activity of soil differed significantly due to the application of various levels of FYM, jeevamrutha and panchagavya. Application of FYM at 200 per cent N equivalent recorded significantly higher dehydrogenase activity (321.7) followed by FYM at 150 per cent N equivalent (304.6) and it was lower with FYM at 100 per cent N equivalent (268.7). Significantly higher dehydrogenase activity was recorded in Jeevamrutha at 1000 litre ha⁻¹ (307.2) and panchagavya at 3 per cent application (302.6) as compared to without jeevamrutha (289.6) and without panchagavya (294.1) application.

40 Days after sowing

Dehydrogenase activity of soil differed significantly due to the application of various levels of FYM, jeevamrutha and panchagavya. Application of FYM at 200 per cent N equivalent recorded significantly higher dehydrogenase activity (309.9) followed by FYM at 150 per cent N equivalent (293.0) and it was lower with FYM at 100 per cent N equivalent (258.5). Significantly higher dehydrogenase activity was recorded in Jeevamrutha at 1000 litre ha⁻¹ (295.7) and panchagavya at 3 per cent application (291.3) as compared to without jeevamrutha (278.5) and without panchagavya (283.0) application.

At harvest

Dehydrogenase activity of soil differed significantly due to the application of various levels of FYM, jeevamrutha and panchagavya. Application of FYM at 200 per cent N equivalent recorded significantly higher dehydrogenase activity (278.0) followed by FYM at 150 per cent N equivalent (263.5) and it was lower with FYM at 100 per cent N equivalent (233.5). Significantly higher dehydrogenase activity was recorded in Jeevamrutha at 1000 litre ha⁻¹ (265.9) and panchagavya at 3 per cent application (261.8) as compared to without jeevamrutha (250.8) and without panchagavya (254.9) application.

Experiment conducted during *kharif* 2015

20 Days after sowing

Dehydrogenase activity of soil differed significantly due to the application of various levels of FYM, jeevamrutha and panchagavya. Application of FYM at 200 per cent N equivalent recorded significantly higher dehydrogenase activity (370.1) followed by FYM at 150 per cent N equivalent (350.8) and it was lower with FYM at 100 per cent N equivalent (310.9). Significantly higher dehydrogenase activity was recorded in

Table 131: Dehydrogenase activity of soil as influenced by FYM and liquid manures application at different growth stages of frenchbean during *Kharif* 2014

Treatments	Dehydrogenase activity ($\mu\text{g TPF g}^{-1} \text{ soil day}^{-1}$)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	255.8	281.6	268.7	246.1	270.9	258.5	222.3	244.8	233.5
F ₂	295.5	313.8	304.6	284.2	301.8	293.0	256.0	271.1	263.5
F ₃	317.4	326.1	321.7	305.3	314.5	309.9	274.2	281.8	278.0
Mean	289.6	307.2		278.5	295.4		250.8	265.9	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	2.60	7.63		2.47	7.24		2.31	6.78	
J	2.12	6.23		2.02	5.91		1.89	5.54	
F × J	3.68	NS		3.49	NS		3.27	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	265.5	272.0	268.7	255.5	261.5	258.5	230.8	236.3	233.5
F ₂	297.9	311.3	304.6	286.6	299.3	293.0	258.2	268.8	263.5
F ₃	318.9	324.6	321.7	306.8	312.9	309.9	275.6	280.4	278.0
Mean	294.1	302.6		283.0	291.3		254.9	261.8	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	2.12	6.23		2.02	5.91		1.89	5.54	
F × P	3.68	NS		3.49	NS		3.27	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	285.0	294.1	289.6	274.2	282.8	278.5	247.3	254.4	250.8
J ₁	303.2	311.1	307.2	291.7	299.7	295.7	265.5	269.3	265.9
Mean	294.1	302.6		283.0	291.3		254.9	261.8	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	3.00	NS		2.85	NS		2.67	NS	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁	J ₀	251.7	260.0	242.2	250.0	218.8	225.9		
	J ₁	279.2	284.0		268.7		273.1	242.7	246.8
F ₂	J ₀	288.0	302.9	277.0	291.3	250.4	261.6		
	J ₁	307.9	319.7		296.2		307.4	266.1	276.1
F ₃	J ₀	315.4	319.4	303.4	307.1	272.5	275.8		
	J ₁	322.4	329.7		310.1		318.8	278.8	284.9
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	5.20	NS		4.94	NS		4.62	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 132: Dehydrogenase activity of soil as influenced by FYM and liquid manures application at different growth stages of frenchbean during *Kharif* 2015

Treatments	Dehydrogenase activity ($\mu\text{g TPF g}^{-1} \text{ soil day}^{-1}$)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F₁	295.9	325.8	310.9	286.4	315.3	300.9	253.5	279.0	266.2
F₂	340.8	360.9	350.8	329.8	349.2	339.5	291.8	309.0	300.4
F₃	365.0	375.2	370.1	353.2	363.1	358.1	312.6	321.3	316.9
Mean	333.9	353.9		323.1	342.5		286.0	303.1	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	3.10	9.08		2.98	8.74		2.64	7.73	
J	2.53	7.41		2.43	7.13		2.15	6.31	
F × J	4.38	12.84		4.21	NS		3.73	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F₁	307.1	314.6	310.9	297.3	304.4	300.9	263.1	296.4	266.2
F₂	343.8	357.6	357.9	332.6	346.3	339.5	294.4	306.5	300.4
F₃	367.0	373.2	370.1	355.1	361.2	358.1	314.2	319.6	316.9
Mean	339.3	348.6		323.8	337.3		290.6	298.5	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	2.53	7.41		2.43	7.13		2.15	6.31	
F × P	4.38	NS		4.21	NS		3.73	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J₀	329.1	338.7	333.9	318.5	327.7	323.1	281.9	290.0	286.0
J₁	349.4	358.5	353.9	338.2	346.9	342.5	299.3	307.0	303.1
Mean	339.3	348.6		328.3	337.3		290.6	298.5	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	3.57	NS		3.44	NS		3.04	NS	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F₁	J₀	291.3	300.6		281.9	291.0		249.5	257.5
	J₁	323.0	328.6		312.7	317.9		276.7	281.4
F₂	J₀	333.3	348.2		322.5	337.0		285.4	298.2
	J₁	354.2	367.6		342.7	355.7		303.3	314.8
F₃	J₀	362.8	367.2		351.1	355.3		310.7	314.4
	J₁	371.1	379.3		359.1	367.0		317.8	324.8
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	6.19	NS		5.96	NS		5.27	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 133: Dehydrogenase activity of soil as influenced by FYM and liquid manures application at different growth stages of frenchbean (Pooled 2014 and 2015)

Treatments	Dehydrogenase activity ($\mu\text{g TPF g}^{-1} \text{ soil day}^{-1}$)								
	20 DAS			40 DAS			At harvest		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	275.89	303.71	289.80	266.26	293.09	279.67	237.91	261.89	249.90
F ₂	318.11	337.33	327.72	306.96	325.52	316.24	273.90	290.07	281.98
F ₃	341.19	350.63	345.91	329.23	338.76	333.99	293.37	301.56	297.47
Mean	311.73	330.55		300.82	319.12		268.39	284.51	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	2.83	8.31		2.71	7.94		2.47	7.26	
J	2.31	6.78		2.21	6.48		2.02	5.92	
F × J	4.00	NS		3.83	NS		3.50	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	286.31	293.29	289.80	276.36	282.98	279.67	246.92	252.87	249.90
F ₂	320.83	334.60	327.72	309.64	322.84	316.24	276.30	287.67	281.98
F ₃	342.92	348.90	345.91	330.93	337.06	333.99	294.94	299.99	297.47
Mean	316.69	325.60		305.64	314.29		272.72	280.18	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	2.31	6.78		2.21	6.48		2.02	5.92	
F × P	4.00	NS		3.83	NS		3.50	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	307.08	316.39	311.73	296.36	305.27	300.82	264.56	272.23	268.39
J ₁	326.30	334.81	330.55	314.93	323.32	319.12	280.88	288.13	284.51
Mean	316.69	325.60		305.64	314.29		272.72	280.18	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	3.27	NS		3.13	NS		2.86	NS	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁	J ₀	271.48	280.30		262.05	270.46		234.14	241.67
	J ₁	301.13	306.28		290.67	295.50		259.70	264.08
F ₂	J ₀	310.65	325.57		299.79	314.13		267.91	279.88
	J ₁	331.02	343.64		319.49	331.55		284.69	295.45
F ₃	J ₀	339.10	343.29		327.24	331.22		291.62	295.13
	J ₁	346.75	354.50		334.62	342.90		298.26	304.86
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	5.66	NS		5.42	NS		4.95	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Jeevamrutha at 1000 litres ha⁻¹ (353.9) and panchagavya at 3 per cent application (348.6) as compared to without jeevamrutha (333.9) and without panchagavya (339.3) application.

40 Days after sowing

Dehydrogenase activity of soil differed significantly due to the application of various levels of FYM, jeevamrutha and panchagavya. Application of FYM at 200 per cent N equivalent recorded significantly higher dehydrogenase activity (358.1) followed by FYM at 150 per cent N equivalent (339.5) and it was lower with FYM at 100 per cent N equivalent (300.9). Significantly higher dehydrogenase activity was recorded in Jeevamrutha at 1000 litre ha⁻¹ (342.5) and panchagavya at 3 per cent application (337.3) as compared to without jeevamrutha (323.1) and without panchagavya (328.3) application.

At harvest

Dehydrogenase activity of soil differed significantly due to the application of various levels of FYM, jeevamrutha and panchagavya. Application of FYM at 200 per cent N equivalent recorded significantly higher dehydrogenase activity (316.9) followed by FYM at 150 per cent N equivalent (300.4) and it was lower with FYM at 100 per cent N equivalent (266.2). Significantly higher dehydrogenase activity was recorded in Jeevamrutha at 1000 litre ha⁻¹ (303.1) and panchagavya at 3 per cent application (298.5) as compared to without jeevamrutha (286.0) and without panchagavya (290.6) application.

Interaction effect

Dehydrogenase activity in soil did not differ significantly due to the interaction effect of FYM and jeevamrutha, FYM and panchagavya, jeevamrutha and panchagavya, FYM, jeevamrutha and panchagavya application at 20, 40 and at harvest during both the years.

Pooled

The data pertaining to dehydrogenase activity in soil at different stages are presented in Table 136.

At 20, 40 DAS and harvest dehydrogenase activity of soil differed significantly due to the application of various levels of FYM, jeevamrutha and panchagavya. Application of FYM at 200 per cent N equivalent recorded significantly higher dehydrogenase activity (345.91, 333.99 and 297.47, respectively) followed by FYM at 150 per cent N equivalent (327.72, 316.24 and 281.98, respectively) and it was lower with FYM at 100 per cent N equivalent (289.80, 279.67 and 249.90, respectively). Significantly higher dehydrogenase activity was recorded in Jeevamrutha at 1000 litre ha⁻¹ (330.55, 319.12 and 284.51, respectively) and panchagavya at 3 per cent application (325.60, 314.29 and 280.18, respectively) as compared to without jeevamrutha (311.73, 300.82 and 268.39) and without panchagavya (316.69, 305.64 and 272.72) application.

Dehydrogenase activity of soil at 20, 40 DAS and harvest did not differ significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application. However, application of FYM at 200 per cent N equivalent jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent recorded higher dehydrogenase activity as compared to other treatments and lower dehydrogenase activity recorded with FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya application.

4.14 Exp II: Effect of different levels of jeevamrutha and panchagavya on soil dehydrogenase activity

Application of liquid manures significantly influenced on dehydrogenase activity in soil at different growth stages are presented in Tables 134, 135 and 136.

Experiment conducted during *kharif* 2014

20 Days after sowing

Dehydrogenase activity of soil differed significantly due to the application of various levels of jeevamrutha and panchagavya. Application of jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher dehydrogenase activity (303.0) followed by jeevamrutha at 1500 litre ha⁻¹ (292.4), Jeevamrutha at 1000 litre ha⁻¹ (279.8) and it was lower in without jeevamrutha application (258.6). Application of panchagavya at 6 per cent recorded significantly higher dehydrogenase activity (289.4) as compared to without panchagavya (276.7) application and it was on par with panchagavya at 3 per cent application (284.2).

40 Days after sowing

Application of various levels of jeevamrutha and panchagavya resulted in significantly higher dehydrogenase activity in soil. Application of jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher dehydrogenase activity (306.3) followed by jeevamrutha at 1500 litre ha⁻¹ (293.1), jeevamrutha at 1000 litre ha⁻¹ (270.8) and it was lower in without jeevamrutha application (247.7). Panchagavya at 6 per cent application recorded significantly higher dehydrogenase activity (285.3) as compared to without panchagavya (272.5) application and it was on par with panchagavya at 3 per cent application (280.6)

At harvest

Significantly higher dehydrogenase activity was recorded with the application of jeevamrutha at 2000 litre ha⁻¹ (277.0) followed by jeevamrutha at 1500 litre ha⁻¹ (266.2), Jeevamrutha at 1000 litre ha⁻¹ (249.9) and it was lower in without jeevamrutha application (232.9). Application of panchagavya at 6 per cent recorded significantly higher dehydrogenase activity (262.1) as compared to without panchagavya (249.4) application and it was found on par with panchagavya at 3 per cent application (262.1)

Table 134: Dehydrogenase activity of soil as influenced by liquid manures application at different growth stages of frenchbean during *Kharif* 2014

Jeevamrutha Levels	Dehydrogenase activity ($\mu\text{g TPF g}^{-1} \text{ soil day}^{-1}$)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	249.6	258.7	267.5	258.6	240.2	249.1	253.6	247.7	220.6	238.3	239.9	232.9
J₁	272.7	281.7	285.1	279.8	264.5	272.6	275.2	270.8	242.7	249.8	257.3	249.9
J₂	287.3	292.7	297.1	292.4	284.6	293.5	301.3	293.1	260.9	266.9	270.8	266.2
J₃	297.5	303.6	308.0	303.0	300.8	307.0	311.1	306.3	273.5	277.1	280.5	277.0
Mean	276.8	284.2	289.4		272.5	280.6	285.3		249.4	258.0	262.1	
	S.Em \pm		CD at 5%		S.Em \pm		CD at 5%		S.Em \pm		CD at 5%	
Jeevamrutha	2.87		8.42		3.05		8.94		3.36		9.87	
Panchagavya	2.49		7.29		2.64		7.74		2.91		8.55	
J \times P	4.97		NS		5.28		NS		5.83		NS	

Note: J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, J₂ - Jeevamrutha 1500 litre/ha, J₃ - Jeevamrutha 2000 litre/ha

P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, P₂ - Panchagavya at 6 %, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 135: Dehydrogenase activity of soil as influenced by liquid manures application at different growth stages of frenchbean during *Kharif* 2015

Jeevamrutha Levels	Dehydrogenase activity ($\mu\text{g TPF g}^{-1} \text{ soil day}^{-1}$)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	290.7	307.2	312.4	303.4	277.7	288.1	297.1	287.6	243.1	260.0	265.7	256.3
J₁	319.9	327.4	332.3	326.5	305.1	319.6	322.6	315.8	273.7	277.0	285.7	278.8
J₂	335.8	340.9	346.7	341.1	336.0	341.6	346.7	341.4	289.9	303.2	308.8	300.6
J₃	348.1	354.9	359.8	354.3	349.3	354.7	357.5	353.8	305.6	310.0	316.1	310.5
Mean	323.6	332.6	337.8		317.0	326.0	331.0		278.1	287.6	294.1	
	S.Em \pm		CD at 5%		S.Em \pm		CD at 5%		S.Em \pm		CD at 5%	
Jeevamrutha	3.50		10.26		3.43		10.06		3.69		10.83	
Panchagavya	3.03		8.88		2.97		8.71		3.20		9.38	
J \times P	6.06		NS		5.94		NS		6.40		NS	

Note: **J₀** - Without Jeevamrutha, **J₁**- Jeevamrutha 1000 litre/ha, **J₂**- Jeevamrutha 1500 litre/ha, **J₃**- Jeevamrutha 2000 litre/ha
P₀- Without panchagavya, **P₁**- Panchagavya at 3 %, **P₃**- Panchagavya at 6 %, **DAS** – Days After Sowing, **RDF** – 63:100:75 NPK kg ha⁻¹

Table 136: Dehydrogenase activity of soil as influenced by liquid manures application at different growth stages of frenchbean (Pooled 2014 and 2015)

Jeevamrutha Levels	Dehydrogenase activity ($\mu\text{g TPF g}^{-1} \text{ soil day}^{-1}$)											
	20 DAS				40 DAS				At harvest			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	270.12	282.98	289.95	281.02	258.97	268.60	275.35	267.64	231.83	249.15	252.79	244.59
J₁	296.28	304.52	308.68	303.16	284.78	296.13	298.87	293.26	258.23	263.40	271.51	264.38
J₂	311.55	316.80	321.93	316.76	310.31	317.57	323.96	317.28	275.40	285.03	289.82	283.42
J₃	322.80	329.25	333.92	328.66	325.03	330.86	334.32	330.07	289.51	293.57	298.30	293.79
Mean	300.19	308.39	313.62		294.77	303.29	308.12		263.75	272.79	278.11	
	S.Em \pm		CD at 5%		S.Em \pm		CD at 5%		S.Em \pm		CD at 5%	
Jeevamrutha	2.63		7.71		2.99		8.78		3.24		9.50	
Panchagavya	2.28		6.68		2.59		7.60		2.81		8.23	
J \times P	4.56		NS		5.18		NS		5.61		NS	

Note: **J₀** - Without Jeevamrutha, **J₁** - Jeevamrutha 1000 litre/ha, **J₂** - Jeevamrutha 1500 litre/ha, **J₃** - Jeevamrutha 2000 litre/ha
P₀ - Without panchagavya, **P₁** - Panchagavya at 3 %, **P₂** - Panchagavya at 6 %, **DAS** – Days After Sowing, **RDF** – 63:100:75 NPK kg ha⁻¹

Experiment conducted during *kharif* 2015

20 Days after sowing

Application of various levels of jeevamrutha and panchagavya resulted in significantly higher dehydrogenase activity in soil. Jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher dehydrogenase activity (354.3) followed by jeevamrutha at 1500 litre ha⁻¹ (341.1), jeevamrutha at 1000 litre ha⁻¹ (326.5) application and it was lower in without jeevamrutha application (303.4). Application of panchagavya at 6 per cent recorded significantly higher dehydrogenase activity (337.8) as compared to without panchagavya (332.6) application and it was on par with panchagavya at 3 per cent application (323.6).

40 Days after sowing

Application of jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher dehydrogenase activity (353.8) followed by Jeevamrutha at 1500 litre ha⁻¹ (341.4), Jeevamrutha at 1000 litre ha⁻¹ (315.8) and it was lower in without jeevamrutha application (287.6). Application of panchagavya at 6 per cent recorded significantly higher dehydrogenase activity (331.0) as compared to without panchagavya (317.0) application and it was on par with panchagavya at 3 per cent application (326.0)

At harvest

Various levels of jeevamrutha and panchagavya application showed significant difference in dehydrogenase activity of soil. Jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher dehydrogenase activity (310.5) followed by jeevamrutha at 1500 litre ha⁻¹ (300.6), jeevamrutha at 1000 litre ha⁻¹ (278.8) application and it was lower in without jeevamrutha application (256.3). Application of panchagavya at 6 per cent recorded significantly higher dehydrogenase activity (294.1) as compared to without panchagavya (278.1) application and it was on par with panchagavya at 3 per cent application (287.6)

Interaction effect

Dehydrogenase activity in soil did not differ significantly due to the interaction effect of jeevamrutha and panchagavya application at 20, 40 and at harvest during both the years.

Pooled

At at 20, 40 DAS and harvest dehydrogenase activity of soil differed significantly due to the application of various levels of jeevamrutha and panchagavya. Application of Jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher dehydrogenase activity (328.66, 330.07 and 293.79, respectively) followed by Jeevamrutha at 1500 litre ha⁻¹ (316.76, 317.28 and 283.42, respectively), Jeevamrutha at 1000 litre ha⁻¹ (303.16, 293.26 and 264.38, respectively) and it was lower in without jeevamrutha application (281.02, 267.64 and 244.59, respectively). Application of panchagavya at 6 per cent recorded significantly higher dehydrogenase activity (313.62, 308.12 and 278.11, respectively) as compared to without panchagavya (300.19, 294.77 and 263.75, respectively) application

and it was on par with panchagavya at 3 per cent application (308.39, 303.29 and 272.79, respectively)

Dehydrogenase activity of soil at 20, 40 DAS and harvest did not differ significantly due to the interaction between various levels of jeevamrutha and panchagavya application. However, application of Jeevamrutha at 2000 litre ha⁻¹ and panchagavya at 6 per cent recorded higher dehydrogenase activity and lower dehydrogenase activity was noticed with FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya application.

Discussion on the findings relating to the performance of solid and liquid manures on soil dehydrogenase activity

Measurement of dehydrogenase represents immediate metabolic activities of soil microorganism at the time of the test. Soil dehydrogenase activity is an oxidative degradation process *i.e.*, dehydrogenation of organic matter by transferring hydrogen and electrons from substrate to acceptors. Dehydrogenase enzymes play a significant role in the biological oxidation of soil organic matter. Dehydrogenase activity thus serves as an indicator of the microbiological redox systems and may be considered a good measure of microbial oxidative activities in soils.

In the present investigation application of higher levels of FYM (278.0 and 316.9), Jeevamrutha (284.5 and 293.8) and panchagavya (280.2 and 278.1) application in both experiments recorded significantly higher dehydrogenase activity as compared to lower levels of FYM and Jeevamrutha and panchagavya application at all the stages during both the years (Tables 133 and 136). This might be due to FYM, jeevamrutha and panchagavya contains enormous amount of microbial load which multiplies in the soil and acts as a tonic to enhance the microbial activity in the soil and FYM acts as source of substrate (Palekar, 2006; Vasanthakumar, 2006; Sreenivas and Nagaraj, 2011). Similarly Chandrakala *et al.* (2007) reported that combined application of FYM and beejamrutha + jeevamrutha + panchagavya recorded significantly higher *dehydrogenase* activity (30.00 and 25.67 mg TP g⁻¹ soil day at 120 and 160 DAT, respectively) in capsicum. This might be due to favourable effects of both FYM and liquid manures that help in proliferating microbial population by providing greater amount of nutrients particularly carbon as energy source. The dehydrogenase activity is useful for the assessment of soil microbial responses to manuring because they are believed to be linked primarily with microbial activities that are associated with the initial break down of organic materials (Bolton *et al.*, 1985). Marinari *et al.* (2000) reported that a higher level of dehydrogenase activity was observed in soil treated with the compost and FYM as compared to soil treated with mineral fertilizers. Marinari *et al.* (2007) found higher dehydrogenase activities under organic agriculture 1.6–3.9 times higher compared to the conventional agriculture, while Moeskops *et al.* (2010) reported dehydrogenase activities 3.8–6.4 times higher on organic farms and suggested that higher soil organic carbon contents may potentially explain increased enzyme activities. Gopinath *et al.*, (2009) have also reported higher dehydrogenase activity with different organic amendments which is in line with the results of the present study.

Exp I: Effect of different levels of FYM, jeevamrutha and panchagavya on nutrient status of soil after the harvest of frenchbean

There was significant difference in available nitrogen, phosphorous (P_2O_5) and potassium (K_2O) in soil due to the application of varied levels of FYM and jeevamrutha. Whereas, panchagavya application did not influence on the soil available phosphorous (P_2O_5) and potassium except on available nitrogen. The data pertaining to the available nitrogen, phosphorous and potassium in the soil after the harvest of frenchbean are presented in Tables 137, 138 and 139.

4.15.1 Nitrogen ($kg\ ha^{-1}$)

Experiment conducted during *kharif* 2014

Significantly higher available nitrogen in soil was recorded with FYM at 200 per cent N equivalent ($391.5\ kg\ ha^{-1}$) followed by FYM at 150 per cent N equivalent ($373.2\ kg\ ha^{-1}$) and it was lower with FYM at 100 per cent N equivalent ($335.3\ kg\ ha^{-1}$). Significantly higher available nitrogen was recorded with jeevamrutha at $1000\ litre\ ha^{-1}$ ($377.8\ kg\ ha^{-1}$) as compared to without jeevamrutha ($355.5\ kg\ ha^{-1}$) application.

Experiment conducted during *kharif* 2015

FYM at 200 per cent N equivalent recorded significantly higher available nitrogen ($439.1\ kg\ ha^{-1}$) followed by FYM at 150 per cent N equivalent ($419.1\ kg\ ha^{-1}$) and it was lower with FYM at 100 per cent N equivalent ($375.5\ kg\ ha^{-1}$). Significantly higher available nitrogen was recorded with jeevamrutha at $1000\ litre\ ha^{-1}$ ($424.3\ kg\ ha^{-1}$) as compared to without jeevamrutha ($398.1\ kg\ ha^{-1}$).

4.15.2 Phosphorous ($kg\ ha^{-1}$)

Experiment conducted during *kharif* 2014

Application of FYM at 200 per cent N equivalent resulted in significantly higher available phosphorous ($53.8\ kg\ ha^{-1}$) as compared to FYM at 100 per cent N equivalent ($45.86\ kg\ ha^{-1}$) and on par with FYM at 150 per cent N equivalent ($51.23\ kg\ ha^{-1}$). Significantly higher available phosphorous was recorded with jeevamrutha at $1000\ litre\ ha^{-1}$ ($51.93\ kg\ ha^{-1}$) as compared to without jeevamrutha ($48.67\ kg\ ha^{-1}$) application.

Experiment conducted during *kharif* 2015

Farm yard manure at 200 per cent N equivalent recorded significantly higher available phosphorous ($60.0\ kg\ ha^{-1}$) as compared to FYM at 100 per cent N equivalent ($47.4\ kg\ ha^{-1}$) and on par with FYM at 150 per cent N equivalent ($51.4\ kg\ ha^{-1}$). Jeevamrutha at $1000\ litre\ ha^{-1}$ ($58.0\ kg\ ha^{-1}$) recorded significantly higher available phosphorous as compared to without jeevamrutha ($54.5\ kg\ ha^{-1}$) application.

Table 137: Available N, P₂O₅ and K₂O of soil as influenced by FYM and liquid manures application at harvest stage of frenchbean during *Kharif* 2014

Treatments	At Harvest								
	Soil N (kg ha ⁻¹)			Soil P ₂ O ₅ (kg ha ⁻¹)			Soil K ₂ O (kg ha ⁻¹)		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F₁	318.6	352.0	335.3	43.61	48.11	45.86	237.85	262.85	250.35
F₂	363.4	383.1	373.2	49.76	52.69	51.23	271.29	287.31	279.30
F₃	384.7	398.3	391.5	52.64	55.00	53.82	287.15	297.37	292.26
Mean	355.5	377.8		48.67	51.93		265.43	282.51	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	6.61	19.40		1.02	2.99		5.63	16.51	
J	5.40	15.84		0.83	2.45		4.60	13.48	
F × J	9.35	NS		1.44	NS		7.96	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F₁	327.6	343.0	335.3	44.80	46.92	45.86	244.57	256.12	250.35
F₂	364.9	381.6	373.2	50.21	52.24	51.23	273.67	284.93	279.26
F₃	386.7	396.2	391.5	53.00	54.63	53.82	288.70	295.81	292.26
Mean	359.7	373.6		49.34	51.27		268.98	278.96	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	5.40	NS		0.83	NS		4.60	NS	
F × P	9.35	NS		1.44	NS		7.96	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J₀	347.9	363.1	355.5	47.62	49.71	48.67	259.75	271.11	265.43
J₁	371.5	384.1	377.8	51.05	52.82	51.93	278.21	286.80	282.51
Mean	359.7	373.6		49.34	51.27		268.98	278.96	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	7.64	NS		1.18	NS		6.50	NS	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F₁	J₀	310.6	326.5		42.50	44.72		231.91	243.78
	J₁	344.5	359.6		47.09	49.12		257.23	268.46
F₂	J₀	355.4	371.3		48.70	50.82		265.37	277.22
	J₁	374.3	391.9		51.71	53.67		281.98	292.63
F₃	J₀	377.8	391.5		51.67	53.60		281.98	281.98
	J₁	395.7	400.9		54.33	55.67		295.43	299.31
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	13.23	NS		2.04	NS		11.26	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 138: Available N, P₂O₅ and K₂O of soil as influenced by FYM and liquid manures application at harvest stage of frenchbean during *Kharif* 2015

Treatments	At Harvest								
	Soil N (kg ha ⁻¹)			Soil P ₂ O ₅ (kg ha ⁻¹)			Soil K ₂ O (kg ha ⁻¹)		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	356.8	394.3	375.5	48.84	53.88	51.36	264.02	291.76	277.89
F ₂	407.0	431.3	419.1	55.73	59.03	57.38	301.13	318.93	310.03
F ₃	430.7	447.4	439.1	58.94	61.09	60.02	318.73	330.08	324.41
Mean	398.1	424.3		54.50	58.00		294.63	313.59	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	8.79	25.80		1.23	3.60		6.43	18.87	
J	7.18	21.06		1.00	2.94		5.25	15.41	
F × J	12.44	NS		1.74	NS		9.10	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	366.9	384.2	375.5	50.17	52.55	51.36	271.48	284.30	277.89
F ₂	410.5	427.7	419.1	56.23	58.53	57.38	303.78	316.28	310.03
F ₃	433.5	444.6	439.1	59.28	60.75	60.02	320.47	328.35	324.41
Mean	403.6	418.8		55.23	57.28		298.58	309.64	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	7.18	NS		1.00	NS		5.25	NS	
F × P	12.44	NS		1.74	NS		9.10	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	389.6	406.7	398.1	53.33	55.68	54.50	288.33	300.92	294.63
J ₁	417.7	431.0	424.3	57.12	58.88	58.00	308.82	318.36	313.59
Mean	403.6	418.8		55.23	57.28		298.58	309.64	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	10.16	NS		1.42	NS		7.43	NS	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁	J ₀	347.9	365.7		47.60	50.07		257.43	270.60
	J ₁	385.8	402.7		52.74	55.02		285.53	298.00
F ₂	J ₀	398.1	415.8		54.54	56.92		294.56	307.72
	J ₁	423.0	439.6		57.92	60.15		313.00	324.83
F ₃	J ₀	423.0	438.5		57.85	60.03		313.0	324.48
	J ₁	444.1	450.6		60.71	61.47		327.92	332.23
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	17.59	NS		2.45	NS		12.87	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 139: Available N, P₂O₅ and K₂O of soil as influenced by FYM and liquid manures application at harvest stage of frenchbean (Pooled 2014 and 2015)

Treatments	At Harvest								
	Soil N (kg ha ⁻¹)			Soil P ₂ O ₅ (kg ha ⁻¹)			Soil K ₂ O (kg ha ⁻¹)		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	337.66	373.15	355.41	46.22	50.99	48.61	250.93	277.30	264.12
F ₂	385.16	407.21	396.18	52.74	55.86	54.30	286.21	303.12	294.66
F ₃	407.68	422.82	415.25	55.79	58.04	56.92	302.94	313.73	308.33
Mean	376.83	401.06		51.59	54.97		280.03	298.05	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	5.01	14.68		0.94	2.77		5.03	14.74	
J	4.09	11.90		0.77	2.26		4.10	12.03	
F × J	7.08	NS		1.34	NS		7.11	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	347.21	363.61	355.41	47.48	49.73	48.61	258.03	270.21	264.12
F ₂	387.70	404.67	396.18	53.22	55.39	54.30	288.73	300.60	294.66
F ₃	410.14	420.37	415.25	56.14	57.69	56.92	304.59	312.08	308.33
Mean	381.68	396.22		52.28	54.27		283.78	294.30	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	4.09	11.99		0.77	NS		4.10	NS	
F × P	7.08	NS		1.34	NS		7.11	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	368.79	384.88	376.83	50.48	52.69	51.59	274.04	286.02	280.03
J ₁	394.58	407.55	401.06	54.08	55.85	54.97	293.52	302.58	298.05
Mean	381.68	396.22		52.28	54.27		283.78	294.30	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	5.78	NS		1.09	NS		5.80	NS	
Interaction F × J × P	P₀	P₁		P₀	P₁		P₀	P₁	
F ₁	J ₀	329.24	346.09		45.05	47.39		244.67	377.30
	J ₁	365.18	381.13		49.92	52.07		271.38	270.21
F ₂	J ₀	376.75	393.56		51.62	53.87		279.96	303.12
	J ₁	398.65	415.78		54.82	56.91		297.49	300.60
F ₃	J ₀	400.38	414.99		54.76	56.82		297.49	313.73
	J ₁	419.40	425.75		57.52	58.57		311.68	312.08
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	10.01	NS		1.89	NS		10.05	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS - Days After Sowing, RDF - 63:100:75 NPK kg ha⁻¹

4.15.3 Potassium (kg ha⁻¹)

Experiment conducted during *kharif* 2014

Application of FYM at 200 per cent N equivalent resulted in significantly higher available potassium (292.3 kg ha⁻¹) as compared to FYM at 100 per cent N equivalent (250.4 kg ha⁻¹) and on par with FYM at 150 per cent N equivalent (279.3 kg ha⁻¹). Significantly higher available potassium was recorded with jeevamrutha at 1000 litre ha⁻¹ (282.5 kg ha⁻¹) as compared to without jeevamrutha (265.4 kg ha⁻¹) application.

Experiment conducted during *kharif* 2015

Significantly higher available potassium was recorded with the application FYM at 200 per cent N equivalent (324.4 kg ha⁻¹) as compared to FYM at 100 per cent N equivalent (310.0 kg ha⁻¹) and found on par with FYM at 150 per cent N equivalent (277.9 kg ha⁻¹). Jeevamrutha at 1000 litre ha⁻¹ application recorded significantly higher available potassium (313.6 kg ha⁻¹) as compared to without jeevamrutha (294.6 kg ha⁻¹) application.

Interaction effect

Available nitrogen, phosphorous and potassium in soil did not differ significantly due to the interaction between various levels of FYM and jeevamrutha, FYM and panchagavya, jeevamrutha and panchagavya, FYM, jeevamrutha and panchagavya application during both the years.

Pooled

There was significant difference in available nitrogen, phosphorous (P₂O₅) and potassium (K₂O) in soil due to the application of varied levels of FYM and jeevamrutha. Whereas, panchagavya application did not influence on the soil available phosphorous (P₂O₅) and potassium except on available nitrogen. The data pertaining to the available nitrogen, phosphorous and potassium in the soil after the harvest of frenchbean are presented in Table 47

Significantly higher available nitrogen was recorded with FYM at 200 per cent N equivalent (415.25 kg ha⁻¹) followed by FYM at 150 per cent N equivalent (396.18 kg ha⁻¹) and it was lower with FYM at 100 per cent N equivalent (355.41 kg ha⁻¹). Significantly higher available nitrogen was recorded with jeevamrutha at 1000 litre ha⁻¹ (401.06 kg ha⁻¹) and panchagavya at 3 per cent (396.22 kg ha⁻¹) as compared to without jeevamrutha (376.83 kg ha⁻¹) and without panchagavya (381.68 kg ha⁻¹) application.

Application of FYM at 200 per cent N equivalent given significantly higher available phosphorous and potassium (56.92 and 308.33 kg ha⁻¹) as compared to FYM at 100 per cent N equivalent (48.61 and 264.12 kg ha⁻¹) and on par with FYM at 150 per cent N equivalent (54.30 and 294.66 kg ha⁻¹). Significantly higher available phosphorous and potassium was recorded with jeevamrutha at 1000 litre ha⁻¹ (54.97 and 298.05 kg ha⁻¹) as compared to without jeevamrutha (51.59 and 280.03 kg ha⁻¹) application.

Available nitrogen, phosphorous and potassium in soil did not differ significantly due to the interaction between various levels of FYM, jeevamrutha and panchagavya application. However, application of FYM at 200 per cent N equivalent jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent recorded higher available nitrogen (424.91 kg ha⁻¹), phosphorous (58.57 kg ha⁻¹) and potassium (312.08 kg ha⁻¹) in soil as compared to other treatments and lower available nitrogen, phosphorous and potassium in soil was noticed with FYM at 100 per cent N equivalent, no - jeevamrutha and no - panchagavya application.

Exp II: Effect of different levels of jeevamrutha and panchagavya on nutrient status of soil after the harvest of frenchbean

There was significant difference in available nitrogen, phosphorous (P₂O₅) and potassium (K₂O) in soil due to the application of varied levels of jeevamrutha whereas application of panchagavya did not have significant difference on soil available nitrogen, phosphorous (P₂O₅) and potassium. The data pertaining to the available nitrogen, phosphorous and potassium in the soil after the harvest of frenchbean are presented in Tables 140, 141 and 142.

4.16.1 Nitrogen

Experiment conducted during *kharif* 2014

Significantly higher available nitrogen was recorded with jeevamrutha at 2000 litre ha⁻¹ (381.8 kg ha⁻¹) followed by jeevamrutha at 1500 litre ha⁻¹ (371.0 kg ha⁻¹), jeevamrutha at 1000 litre ha⁻¹ (354.4 kg ha⁻¹) and it was lower with no jeevamrutha application (321.1 kg ha⁻¹). Whereas the application of jeevamrutha at 2000 litre ha⁻¹ found on par with jeevamrutha at 1500 litre ha⁻¹ application and jeevamrutha at 1500 litre ha⁻¹ was on par with jeevamrutha at 1000 litre ha⁻¹.

Experiment conducted during *kharif* 2015

Jeevamrutha at 2000 litre ha⁻¹ application recorded significantly higher available nitrogen (427.6) followed by jeevamrutha at 1500 litre ha⁻¹ (415.5 kg ha⁻¹), jeevamrutha at 1000 litre ha⁻¹ (396.9) and it was lower with no jeevamrutha application (359.6). While, application of jeevamrutha at 2000 litre ha⁻¹ found on par with jeevamrutha at 1500 litre ha⁻¹ application and jeevamrutha at 1500 litre ha⁻¹ was on par with jeevamrutha at 1000 litre ha⁻¹.

4.16.2 Phosphorous

Experiment conducted during *kharif* 2014

Application of jeevamrutha at 2000 litre ha⁻¹ given significantly higher available phosphorous in soil (51.9 kg ha⁻¹) followed by jeevamrutha at 1500 litre ha⁻¹ (50.3 kg ha⁻¹) and jeevamrutha at 1000 litre ha⁻¹ (47.9 kg ha⁻¹) as compared to without jeevamrutha (42.7 kg ha⁻¹) application. Whereas the application of jeevamrutha at 2000 litre ha⁻¹ found on par with jeevamrutha at 1500 litre ha⁻¹ application and jeevamrutha at 1500 litre ha⁻¹ was on par with jeevamrutha at 1000 litre ha⁻¹.

Table 140: Available N, P₂O₅ and K₂O of soil as influenced by liquid manures application at harvest stage of french bean during *Kharif* 2014

Jeevamrutha Levels	At Harvest											
	Soil N (kg ha ⁻¹)				Soil P ₂ O ₅ (kg ha ⁻¹)				Soil K ₂ O (kg ha ⁻¹)			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	302.2	322.9	338.1	321.1	40.2	42.7	45.2	42.7	228.2	239.0	251.1	239.4
J₁	353.1	353.3	356.7	354.4	47.1	48.0	48.5	47.9	262.6	263.8	266.4	264.3
J₂	355.3	377.3	380.3	371.0	48.3	51.3	51.4	50.3	265.2	281.7	280.7	275.9
J₃	379.0	381.2	385.1	381.8	51.5	51.8	52.4	51.9	281.8	284.6	287.6	284.7
Mean	347.4	358.7	365.1		46.8	48.5	49.4		259.5	267.3	271.4	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	5.78		16.94		0.84		2.46		3.97		11.64	
Panchagavya	5.00		NS		0.73		NS		3.44		NS	
J × P	10.00		NS		1.45		NS		6.87		NS	

Note: **J₀** - Without Jeevamrutha, **J₁**- Jeevamrutha 1000 litre/ha, **J₂** - Jeevamrutha 1500 litre/ha, **J₃** - Jeevamrutha 2000 litre/ha

P₀ - Without panchagavya, **P₁** - Panchagavya at 3 %, **P₃** - Panchagavya at 6 %, **DAS** – Days After Sowing, **RDF** – 63:100:75 NPK kg ha⁻¹

Table 141: Available N, P₂O₅ and K₂O of soil as influenced by liquid manures application at harvest stage of french bean during *Kharif* 2015

Jeevamrutha Levels	At Harvest											
	Soil N (kg ha ⁻¹)				Soil P ₂ O ₅ (kg ha ⁻¹)				Soil K ₂ O (kg ha ⁻¹)			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	338.5	361.6	378.7	359.6	45.1	47.8	50.7	47.9	255.5	267.6	281.2	268.1
J₁	395.5	395.7	399.6	396.9	52.8	53.8	54.3	53.6	294.1	295.4	298.3	296.0
J₂	397.9	422.6	425.9	415.5	54.1	57.5	57.6	56.4	297.1	315.5	314.3	309.0
J₃	424.5	427.0	431.4	427.6	57.7	58.1	58.7	58.1	315.6	318.8	322.1	318.8
Mean	389.1	401.7	408.9		52.4	54.3	55.3		290.6	299.4	304.0	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	6.47		18.97		0.94		2.75		4.45		13.04	
Panchagavya	5.60		NS		0.81		NS		3.85		NS	
J × P	11.21		NS		1.63		NS		7.70		NS	

Note: **J₀** - Without Jeevamrutha, **J₁** - Jeevamrutha 1000 litre/ha, **J₂** - Jeevamrutha 1500 litre/ha, **J₃** - Jeevamrutha 2000 litre/ha
P₀ - Without panchagavya, **P₁** - Panchagavya at 3 %, **P₃** - Panchagavya at 6 %, **DAS** – Days After Sowing, **RDF** – 63:100:75 NPK kg ha⁻¹

Table 142: Available N, P₂O₅ and K₂O of soil as influenced by liquid manures application at harvest stage of frenchbean (Pooled 2014 and 2015)

Jeevamrutha Levels	At Harvest											
	Soil N (kg ha ⁻¹)				Soil P ₂ O ₅ (kg ha ⁻¹)				Soil K ₂ O (kg ha ⁻¹)			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	320.37	342.25	358.42	340.35	42.66	45.27	47.96	45.30	241.86	253.30	266.13	253.76
J₁	374.31	374.48	378.15	375.65	49.93	50.89	51.40	50.74	278.38	279.60	282.34	280.11
J₂	376.58	399.96	403.08	393.21	51.17	54.41	54.52	53.37	281.16	298.64	297.51	292.44
J₃	401.78	404.09	408.25	404.70	54.62	54.94	55.56	55.04	298.67	301.72	304.83	301.74
Mean	368.26	380.20	386.97		49.59	51.38	52.36		275.02	283.32	287.70	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	6.12		17.96		0.90		2.65		4.21		12.34	
Panchagavya	5.30		NS		0.78		NS		3.64		NS	
J × P	10.61		NS		1.56		NS		7.29		NS	

Note: J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, J₂ - Jeevamrutha 1500 litre/ha, J₃ - Jeevamrutha 2000 litre/ha

P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, P₃ - Panchagavya at 6 %, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Experiment conducted during *kharif* 2015

Application of jeevamrutha at 2000 litre ha⁻¹ given significantly higher available phosphorous in soil (58.1) followed by jeevamrutha at 1500 litre ha⁻¹ (56.4) and jeevamrutha at 1000 litre ha⁻¹ (53.6) as compared to without jeevamrutha (47.9) application. Whereas the application of jeevamrutha at 2000 litre ha⁻¹ found on par with jeevamrutha at 1500 litre ha⁻¹ application.

4.16.3 Potassium (kg ha⁻¹)

Experiment conducted during *kharif* 2014

Application of jeevamrutha at 2000 litre ha⁻¹ given significantly higher available phosphorous and potassium in soil (284.7) followed by jeevamrutha at 1500 litre ha⁻¹ (275.9) and jeevamrutha at 1000 litre ha⁻¹ (264.3) as compared to without jeevamrutha (239.4) application. While, the application of jeevamrutha at 2000 litre ha⁻¹ found on par with jeevamrutha at 1500 litre ha⁻¹ application and jeevamrutha at 1500 litre ha⁻¹ was on par with jeevamrutha at 1000 litre ha⁻¹.

Experiment conducted during *kharif* 2015

Significantly higher available potassium in soil was recorded with the application of jeevamrutha at 2000 litre ha⁻¹ (318.8) followed by jeevamrutha at 1500 litre ha⁻¹ (309.0) and jeevamrutha at 1000 litre ha⁻¹ (296.0) as compared to without jeevamrutha (268.1) application. Whereas the application of jeevamrutha at 2000 litre ha⁻¹ found on par with jeevamrutha at 1500 litre ha⁻¹ application and jeevamrutha at 1500 litre ha⁻¹ was on par with jeevamrutha at 1000 litre ha⁻¹.

Interaction effect

Available nitrogen, phosphorous and potassium in soil did not differ significantly due to the interaction between jeevamrutha and panchagavya application during both the years.

Pooled

The data pertaining to the available nitrogen, phosphorous and potassium in the soil after the harvest of frenchbean as influenced by liquid manures are presented in Table 142.

There was significant difference in available nitrogen, phosphorous (P₂O₅) and potassium (K₂O) in soil due to the application of varied levels of jeevamrutha. There was no significant difference in soil available nitrogen, phosphorous (P₂O₅) and potassium due to the application of panchagavya.

Significantly higher available nitrogen was recorded with jeevamrutha at 2000 litre ha⁻¹ (404.7 kg ha⁻¹) followed by jeevamrutha at 1500 L ha⁻¹ (393.21 kg ha⁻¹), jeevamrutha at 1000 litre ha⁻¹ (375.65 kg ha⁻¹) and it was lower with no jeevamrutha application (340.35 kg ha⁻¹). Whereas the application of jeevamrutha at 2000 litre ha⁻¹ found on par with jeevamrutha at 1500 litre ha⁻¹ application and jeevamrutha at 1500 litre ha⁻¹ was on par with jeevamrutha at 1000 litre ha⁻¹.

Application of jeevamrutha at 2000 litre ha⁻¹ given significantly higher available phosphorous and potassium in soil (55.04 and 301.74 kg ha⁻¹) followed by jeevamrutha at 1500 litre ha⁻¹ (53.37 and 292.44 kg ha⁻¹) and jeevamrutha at 1000 litre ha⁻¹ (50.74 and 280.11) as compared to without jeevamrutha (45.30 and 253.76 kg ha⁻¹) application. Whereas application of jeevamrutha at 2000 litres ha⁻¹ was on par with jeevamrutha at 1500 litre ha⁻¹.

Available nitrogen, phosphorous and potassium in soil did not differ significantly due to the interaction between various levels of jeevamrutha and panchagavya application. However, application of jeevamrutha at 2000 litre ha⁻¹ and panchagavya at 6 per cent recorded higher available nitrogen (408.25 kg ha⁻¹), phosphorous (55.56 kg ha⁻¹) and potassium (304.83 kg ha⁻¹) in soil and lower no - jeevamrutha and no - panchagavya application (320.37, 42.66 and 241.86, respectively).

Discussion on the findings relating to the performance of solid and liquid manures on available nutrient status of the soil

Application of farm yard manure significantly influenced on available nitrogen, phosphorous and potassium status in the soil after harvest of frenchbean during 2014 and 2015. Among the FYM levels, application at 200 per cent N equivalent recorded significantly higher available nutrient *viz.*, NPK (438.4, 60.02 and 324.41 kg ha⁻¹) in the soil followed by FYM at 150 per cent N equivalent (419.1, 57.38 and 324.41 kg NPK ha⁻¹) and lower with FYM at 100 per cent N equivalent (375.5, 51.36 and 277.89 kg NPK ha⁻¹) (Table 139). The FYM is considered a store house of almost all essential nutrients required for plant growth and also improves the soil environment improving the physico-chemical properties of soil. Thus, on addition of FYM the available nutrient status of soil increases considerably due to mineralization of native soil as well as its own nutrient contents (Yadav and Chipa, 2005). These results are in agreement with Ramesh *et al.*, (2008) who reported that, application of organic manures increased soil available N, P and K compared to chemical farming. This increase in available P might be due to the organic acids, which were released during microbial decomposition of organic matter which might have helped in solubility of native phosphates (Bhardwaj and Omanwar 1994). Incorporation of FYM found to produce more humic acid and humin substances, which form chelates with phosphorus. The chelated phosphorus has been reported to be more soluble in water, which might have favoured in more release of phosphorus and easily available to the crop (Hussain *et al.*, 2001). Higher availability of K might be due to beneficial effects of manures and reduction of potassium fixation. The added organic matter might have interacted with K clay complex to release K from non- exchangeable fraction to the labile pool. Tiwari *et al.*, (2002) reported that in long term experiment with soybean- wheat cropping system, inclusion of organic manures, like farm yard manure improved the organic carbon status and available N, P, K and S in soil thereby, sustained soil health.

Application of jeevamrutha significantly influenced on available nutrient status of soil after harvest of the frenchbean in both the experiments during both the years. Application of jeevamrutha 1000 litre ha⁻¹ in the first experiment recorded higher available N, P and K (423.9, 58.0 and 313.59 kg ha⁻¹) as compared to without jeevamrutha

application (398.1, 54.5 and 294.63 kg ha⁻¹) in the first experiment. Whereas, in second experiment higher levels of jeevamruta application recorded significantly higher soil N, P and K as compared to without jeevamruta application during both the years. While, Jeevamrutha at 2000 litre ha⁻¹ recorded significantly higher soil N, P and K content (427.6 and 58.1 and 318.8 kg ha⁻¹) (Table 142). This may be due to jeevamrutha contains enormous amount of microbial load which multiplies in the soil and acts as a tonic to enhance the microbial activity in the soil. Palekar, (2006); Vasanthakumar, (2006); Devakumar *et al.*, (2008) and Sreenivas and Nagaraj (2011) also reported that liquid manures contains micronutrients in addition to different microflora especially nitrogen fixers and phosphate solubilizers. Increase in available N in soil was due to mineralization of organic manures which was justified by the increased activity of soil micro organisms. The increase in potassium might be due to release of potassium from mineral bound K or native K (Pradeep and Sharanappa, 2014; Latha and Sharanappa, 2014).

Exp I: Effect of different levels of FYM and jeevamrutha on chemical properties of soil after the harvest of frenchbean

The data pertaining to the pH, Electrical Conductivity (EC) and Organic Carbon (OC) in soil as influenced by application of solid and liquid manures at harvest of frenchbean are presented in Tables 143, 144 and 145.

4.17.1 Soil pH

Experiment conducted during *kharif* 2014

There was significant difference in soil pH due to the application of varied levels of FYM. Significantly lower pH was recorded with FYM at 200 per cent N equivalent (6.44) followed by FYM at 150 per cent N equivalent (6.53) and significantly higher lower pH was recorded with FYM at 100 per cent N equivalent (6.36).

Experiment conducted during *kharif* 2015

Application of varied levels of FYM resulted in significant difference in the soil pH. Farm yard manure at 200 per cent N equivalent recorded significantly lower soil pH (6.28) followed by FYM at 150 per cent N equivalent (6.38) and significantly higher soil pH was recorded with FYM at 100 per cent N equivalent (6.54).

4.17.2 Soil EC

Experiment conducted during *kharif* 2014

Application of varied levels of FYM recorded significant difference in EC value of soil. Significantly lower EC value was recorded with FYM at 100 per cent N equivalent (0.207 dS m⁻¹) which was on par with FYM at 150 per cent N equivalent (0.214 dS m⁻¹). Significantly higher EC value was recorded with FYM at 200 per cent N equivalent (0.219 dS m⁻¹).

Table 143: pH, EC and OC of soil as influenced by FYM and liquid manures application at harvest stage of frenchbean during *Kharif* 2014

Treatments	At Harvest								
	pH			EC (ds m ⁻¹)			OC (%)		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	6.65	6.61	6.63	0.205	0.210	0.207	0.55	0.56	0.55
F ₂	6.55	6.51	6.53	0.209	0.218	0.214	0.57	0.58	0.57
F ₃	6.46	6.41	6.44	0.219	0.219	0.219	0.59	0.60	0.60
Mean	6.55	6.51		0.211	0.216		0.57	0.58	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.03	0.08		0.003	0.01		0.01	0.03	
J	0.02	NS		0.003	NS		0.01	NS	
F × J	0.04	NS		0.005	NS		0.02	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	6.63	6.62	6.63	0.208	0.207	0.207	0.55	0.56	0.55
F ₂	6.53	6.53	6.53	0.212	0.215	0.214	0.57	0.58	0.57
F ₃	6.44	6.43	6.44	0.220	0.219	0.219	0.60	0.60	0.60
Mean	6.54	6.53		0.213	0.214		0.57	0.58	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.02	NS		0.003	NS		0.01	NS	
F × P	0.04	NS		0.005	NS		0.02	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	6.56	6.55	6.55	0.211	0.211	0.211	0.57	0.57	0.57
J ₁	6.51	6.50	6.51	0.215	0.216	0.216	0.58	0.58	0.58
Mean	6.54	6.53		0.213	0.214		0.57	0.58	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.03	NS		0.004	NS		0.01	NS	
Interaction	P₀	P₁		P₀	P₁		P₀	P₁	
F × J × P									
F ₁ J ₀	6.65	6.64		0.207	0.203		0.55	0.55	
F ₁ J ₁	6.62	6.59		0.209	0.211		0.55	0.56	
F ₂ J ₀	6.55	6.55		0.207	0.212		0.57	0.57	
F ₂ J ₁	6.51	6.51		0.217	0.218		0.58	0.58	
F ₃ J ₀	6.47	6.46		0.219	0.219		0.59	0.59	
F ₃ J ₁	6.42	6.40		0.220	0.218		0.60	0.60	
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	0.05	NS		0.006	NS		0.02	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 144: pH, EC and OC of soil as influenced by FYM and liquid manures application at harvest stage of frenchbean during *Kharif* 2015

Treatments	pH			EC(ds m ⁻¹)			OC (%)		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	6.58	6.49	6.54	0.208	0.213	0.210	0.56	0.57	0.57
F ₂	6.40	6.37	6.38	0.214	0.222	0.218	0.59	0.60	0.60
F ₃	6.30	6.26	6.28	0.223	0.223	0.223	0.61	0.63	0.62
Mean	6.43	6.37		0.215	0.219		0.59	0.60	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.03	0.08		0.003	0.010		0.01	0.02	
J	0.02	NS		0.003	NS		0.01	NS	
F × J	0.04	NS		0.005	NS		0.01	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	6.56	6.51	6.54	0.210	0.211	0.210	0.57	0.57	0.57
F ₂	6.39	6.38	6.38	0.216	0.220	0.218	0.59	0.60	0.60
F ₃	6.29	6.27	6.28	0.224	0.223	0.223	0.62	0.62	0.62
Mean	6.41	6.39		0.216	0.218		0.59	0.60	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.02	NS		0.003	NS		0.01	NS	
F × P	0.04	NS		0.005	NS		0.01	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	6.44	6.42	6.43	0.214	0.215	0.215	0.59	0.59	0.59
J ₁	6.39	6.35	6.37	0.218	0.220	0.219	0.60	0.60	0.60
Mean	6.41	6.39		0.216	0.218		0.59	0.60	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.03	NS		0.004	NS		0.01	NS	
Interaction	P₀	P₁		P₀	P₁		P₀	P₁	
F × J × P									
F ₁ J ₀	6.60	6.56		0.209	0.207		0.56	0.56	
F ₁ J ₁	6.51	6.46		0.211	0.215		0.57	0.57	
F ₂ J ₀	6.41	6.40		0.211	0.216		0.58	0.59	
F ₂ J ₁	6.38	6.35		0.220	0.223		0.60	0.61	
F ₃ J ₀	6.31	6.29		0.224	0.223		0.61	0.61	
F ₃ J ₁	6.27	6.25		0.224	0.223		0.63	0.63	
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	0.06	NS		0.007	NS		0.02	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 145: pH, EC and OC of soil as influenced by FYM and liquid manures application at harvest stage of frenchbean (Pooled 2014 and 2015)

Treatments	pH			EC(ds m ⁻¹)			OC (%)		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)									
F ₁	6.62	6.55	6.58	0.206	0.211	0.209	0.55	0.57	0.56
F ₂	6.48	6.44	6.46	0.211	0.220	0.216	0.58	0.59	0.58
F ₃	6.38	6.33	6.36	0.221	0.221	0.221	0.60	0.62	0.61
Mean	6.49	6.44		0.213	0.217		0.58	0.59	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
F	0.03	0.07		0.003	0.01		0.01	0.02	
J	0.02	NS		0.003	NS		0.01	NS	
F × J	0.04	NS		0.005	NS		0.01	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	6.60	6.57	6.58	0.209	0.209	0.209	0.56	0.56	0.56
F ₂	6.46	6.45	6.46	0.214	0.217	0.216	0.58	0.59	0.58
F ₃	6.37	6.35	6.36	0.222	0.221	0.221	0.61	0.61	0.61
Mean	6.47	6.46		0.215	0.216		0.58	0.59	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
P	0.02	NS		0.003	NS		0.01	NS	
F × P	0.04	NS		0.005	NS		0.01	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	6.50	6.48	6.49	0.213	0.213	0.213	0.58	0.58	0.58
J ₁	6.45	6.43	6.44	0.217	0.218	0.219	0.59	0.59	0.59
Mean	6.47	6.46		0.215	0.216		0.58	0.59	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.03	NS		0.004	NS		0.01	NS	
Interaction	P₀	P₁		P₀	P₁		P₀	P₁	
F × J × P									
F ₁ J ₀	6.63	6.60		0.208	0.205		0.55	0.55	
F ₁ J ₁	6.56	6.53		0.210	0.213		0.56	0.57	
F ₂ J ₀	6.48	6.48		0.209	0.214		0.58	0.58	
F ₂ J ₁	6.44	6.43		0.219	0.221		0.59	0.59	
F ₃ J ₀	6.39	6.37		0.222	0.221		0.60	0.60	
F ₃ J ₁	6.34	6.33		0.222	0.221		0.62	0.62	
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	0.05	NS		0.007	NS		0.01	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Experiment conducted during *kharif* 2015

Varied levels of FYM application resulted significant difference in EC value of soil. Significantly lower EC value was recorded with FYM at 100 per cent N equivalent (0.210 dS m^{-1}) which was on par with FYM at 150 per cent N equivalent (0.218 dS m^{-1}). Significantly higher EC value was recorded with FYM at 200 per cent N equivalent (0.223 dS m^{-1}).

4.17.3 Soil organic carbon

Experiment conducted during *kharif* 2014

Significantly higher organic carbon was recorded with FYM at 200 per cent N equivalent (0.60 %) which was on par with FYM at 150 per cent N equivalent (0.57 %) and lower organic carbon was recorded with FYM at 100 per cent N equivalent (0.55 %).

Experiment conducted during *kharif* 2015

Significantly higher organic carbon was recorded with FYM at 200 per cent N equivalent (0.62 %) which was on par with FYM at 150 per cent N equivalent (0.60 %) and lower organic carbon was recorded with FYM at 100 per cent N equivalent (0.62 %).

Interaction effect

Soil pH, EC and organic carbon content of soil did not differ significantly due to the interaction between different levels of FYM and jeevamrutha, FYM and panchagavya, jeevamrutha and panchagavya, FYM, jeevamrutha and panchagavya application during both the years.

Pooled

The data pertaining to the pH, Electrical Conductivity (EC) and Organic Carbon (OC) in soil at harvest of frenchbean are presented in Table 145.

There was significant difference in soil pH due to the application of varied levels of FYM. Significantly higher pH was recorded with FYM at 100 per cent N equivalent (6.58) followed by FYM at 150 percent N equivalent (6.46) and significantly lower pH was recorded with FYM at 200 per cent N equivalent (6.36).

Application of varied levels of FYM resulted significant difference in EC value of soil. Significantly lower EC value was recorded with FYM at 100 per cent N equivalent (0.208 dS m^{-1}) which was on par with FYM at 150 per cent N equivalent (0.216 dS m^{-1}). Significantly higher EC value was recorded with FYM at 200 per cent N equivalent (0.225 dS m^{-1}). Significantly higher organic carbon recorded with FYM at 200 per cent N equivalent (0.61 %) which was on par with FYM at 150 per cent N equivalent (0.58 %) and lower organic carbon was recorded with FYM at 100 per cent N equivalent (0.56 %).

Soil pH, EC and organic carbon content of soil did not differ significantly due to the interaction between different levels of FYM, jeevamrutha and panchagavya application. However, lower soil pH, higher organic carbon and soil EC was observed

with FYM at 200 per cent N equivalent, jeevamrutha at 1000 litre ha⁻¹ and panchagavya at 3 per cent and it was lower with FYM at 100 per cent N equivalent no- jeevamrutha and no panchagavya.

4.17.4 Bulk density (BD) and Water holding capacity (MWHC)

The data pertaining to BD and maximum water holding capacity are presented in Tables 146, 147 and 148.

Experiment conducted during *kharif* 2014

Bulk density was significantly influenced by deferent levels of FYM application. Significantly lower BD was recorded with FYM at 200 per cent N equivalent (1.30 g/cc) followed by FYM at 150 per cent N equivalent (1.32 g/cc) and significantly higher was recorded with FYM at 100 per cent N equivalent (1.33 g/cc) where application of FYM at 200 per cent N equivalent found on par with FYM at 150 per cent N equivalent and 150 per cent N equivalent with FYM at 200 per cent N equivalent. Application of panchagavya did not have significant influence on BD of soil.

Experiment conducted during *kharif* 2015

Bulk density was significantly influenced by deferent levels of FYM application. Significantly lower BD was recorded with FYM at 200 per cent N equivalent (1.27 g/cc) followed by FYM at 150 per cent N equivalent (1.30 g/cc) and significantly higher was recorded with FYM at 100 per cent N equivalent (1.32 g/cc) where application of FYM at 200 per cent N equivalent found on par with FYM at 150 percent N equivalent and 150 percent N equivalent with FYM at 200 per cent N equivalent. Jeevamruta application significantly influenced on BD of soil, where application of jeevamruta at 1000 litre ha⁻¹ resulted in lower BD (1.29 g/cc) of soil as compared to without application of jeevamruta (1.31 g/cc). Application of panchagavya did not have significant influence on BD of soil.

Maximum Water holding capacity (MWHC)

Experiment conducted during *kharif* 2014

Maximum water holding capacity was significantly influenced by deferent levels of FYM application. Significantly higher MWHC was recorded with FYM at 200 per cent N equivalent (42.52 %) followed by FYM at 150 per cent N equivalent (39.24 %) and significantly lower was recorded with FYM at 100 per cent N equivalent (38.28 %) where application of FYM at 150 percent N equivalent found on par with FYM at 100 percent N equivalent. Application of jeevamruta and panchagavya did not have significant influence on MWHC of soil.

Experiment conducted during *kharif* 2015

Maximum water holding capacity was significantly influenced by deferent levels of FYM application. Significantly higher MWHC was recorded with FYM at 200 per cent N equivalent (43.70 %) followed by FYM at 150 per cent N equivalent (40.58

Table 146: Maximum water holding capacity and Bulk density of soil as influenced by FYM and liquid manures application during *Kharif* 2014

Treatments	At Harvest					
	MWH (%)			BD (g/cc)		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)						
F ₁	38.15	38.42	38.3	1.34	1.33	1.33
F ₂	38.58	39.90	39.2	1.33	1.32	1.32
F ₃	41.57	43.47	42.5	1.31	1.29	1.30
Mean	39.43	40.59		1.33	1.31	
	S.Em ±	C.D.		S.Em ±	C.D.	
F	0.64	1.89		0.01	0.02	
J	0.53	NS		0.004	NS	
F × J	0.91	NS		0.01	NS	
	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	37.98	38.58	38.28	1.33	1.33	1.33
F ₂	39.40	39.08	39.24	1.32	1.32	1.32
F ₃	42.32	42.72	42.50	1.30	1.30	1.30
Mean	39.90	40.13		1.32	1.32	
	S.Em ±	C.D.		S.Em ±	C.D.	
P	0.53	NS		0.004	NS	
F × P	0.91	NS		0.01	NS	
	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	38.92	39.92	39.4	1.33	1.32	1.33
J ₁	40.88	40.31	40.6	1.31	1.31	1.31
Mean	39.90	40.13		1.32	1.32	
	S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.74	NS		0.01	NS	
Interaction F × J × P	P₀	P₁		P₀	P₁	
F ₁	J ₀	37.30	39.00	1.34	1.34	
	J ₁	38.67	38.17	1.33	1.33	
F ₂	J ₀	38.33	38.83	1.33	1.33	
	J ₁	40.47	39.33	1.32	1.31	
F ₃	J ₀	41.13	42.00	1.31	1.31	
	J ₁	43.50	43.43	1.29	1.29	
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.	
	1.29	NS		0.01	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 147: Maximum water holding capacity and Bulk density of soil as influenced by FYM and liquid manures application during *Kharif* 2015

Treatments	At Harvest					
	MWH (%)			BD (g/cc)		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)						
F ₁	39.0	39.3	39.1	1.33	1.31	1.32
F ₂	40.0	41.2	40.6	1.30	1.29	1.30
F ₃	42.8	44.6	43.7	1.29	1.26	1.27
Mean	40.6	41.7		1.31	1.29	
	S.Em ±	C.D.		S.Em ±	C.D.	
F	0.63	1.84		0.01	0.02	
J	0.51	NS		0.01	0.02	
F × J	0.89	NS		0.01	NS	
	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	38.7	39.6	39.1	1.32	1.31	1.32
F ₂	40.6	40.6	40.6	1.31	1.29	1.30
F ₃	43.4	44.0	43.7	1.28	1.27	1.27
Mean	40.9	41.4		1.30	1.29	
	S.Em ±	C.D.		S.Em ±	C.D.	
P	0.51	NS		0.01	NS	
F × P	0.89	NS		0.01	NS	
	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	39.9	41.3	40.6	1.31	1.30	1.31
J ₁	41.8	41.5	41.7	1.29	1.28	1.29
Mean	40.9	41.4		1.30	1.29	
	S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.72	NS		0.01	NS	
Interaction F × J × P	P₀	P₁		P₀	P₁	
F ₁	J ₀	38.0	40.0	1.33	1.32	
	J ₁	39.3	39.2	1.32	1.31	
F ₂	J ₀	39.7	40.3	1.31	1.30	
	J ₁	41.5	40.8	1.30	1.28	
F ₃	J ₀	42.1	43.5	1.29	1.28	
	J ₁	44.7	44.5	1.26	1.25	
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.	
	1.25	NS		0.02	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 148: Maximum water holding capacity and Bulk density of soil as influenced by FYM and liquid manures application (Pooled 2014 and 2015)

Treatments	At Harvest					
	MWH (%)			BD (g/cc)		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Fertility levels (F)						
F ₁	38.57	38.83	38.70	1.33	1.32	1.33
F ₂	39.29	40.53	39.91	1.32	1.30	1.31
F ₃	42.19	44.03	43.11	1.30	1.28	1.29
Mean	S.Em ±	41.13		1.32	1.30	
	S.Em±	C.D.		S.Em ±	C.D.	
F	0.63	1.85		0.005	0.015	
J	0.52	NS		0.004	0.012	
F × J	0.89	NS		0.007	NS	
	P₀	P₁	Mean	P₀	P₁	Mean
F ₁	38.32	39.08	38.70	1.33	1.32	1.33
F ₂	39.98	39.83	39.91	1.31	1.31	1.31
F ₃	42.86	43.36	43.11	1.29	1.28	1.29
Mean	40.39	40.76		1.31	1.30	
	S.Em ±	C.D.		S.Em ±	C.D.	
P	0.52	NS		0.004	NS	
F × P	0.89	NS		0.007	NS	
	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	39.42	40.61	40.02	1.32	1.31	1.32
J ₁	41.35	40.91	41.13	1.30	1.30	1.30
Mean	40.39	40.76		1.31	1.30	
	S.Em ±	C.D.		S.Em ±	C.D.	
J × P	0.73	NS		0.006	NS	
Interaction	P₀	P₁		P₀	P₁	
F × J × P						
F ₁ J ₀	37.63	39.50		1.34	1.33	
F ₁ J ₁	39.00	38.67		1.32	1.32	
F ₂ J ₀	39.00	39.58		1.32	1.31	
F ₂ J ₁	40.97	40.08		1.31	1.30	
F ₃ J ₀	41.63	42.75		1.30	1.30	
F ₃ J ₁	44.09	43.97		1.28	1.27	
F × J × P	S.Em ±	C.D.		S.Em ±	C.D.	
	1.26	NS		0.01	NS	

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

%) and significantly lower was recorded with FYM at 100 per cent N equivalent (39.12 %) where application of FYM at 150 per cent N equivalent found on par with FYM at 100 per cent N equivalent. Application of jeevamruta and panchagavya did not have significant influence on MWHC of soil.

Interaction effect

BD and MWHC of soil did not differ significantly due to the interaction between different levels of FYM and jeevamrutha, FYM and panchagavya, jeevamrutha and panchagavya, FYM, jeevamrutha and panchagavya application during both the years.

Pooled

Maximum water holding capacity and bulk density is significantly influenced by different levels of FYM application. Significantly higher MWHC and BD was recorded with FYM at 200 per cent N equivalent (43.11 % and 1.29 g/cc) followed by FYM at 150 percent N equivalent (39.91 % and 1.31 g/cc) and significantly lower was recorded with FYM at 100 per cent N equivalent (38.7 % and 1.33 g/cc). where application of FYM at 150 percent N equivalent found on par with FYM at 100 percent N equivalent in case of MWHC. Jeevamruta application significantly influenced on BD of soil, where application of jeevamruta at 1000 litre ha⁻¹ resulted in lower BD (1.30 g/cc) of soil as compared to without application of jeevamruta (1.32 g/cc). Application of panchagavya do not have significant influence on MWHC and BD of soil. BD and MWHC of soil did not differ significantly due to the interaction between different levels of FYM jeevamrutha and panchagavya application.

Exp II: Effect of different levels of jeevamrutha and panchagavya on chemical and physical properties of soil after the harvest of frenchbean

The data pertaining to the pH, Electrical Conductivity (EC) and Organic Carbon (OC) in soil as influenced by application of liquid manures at harvest of frenchbean are presented in Tables 149, 150 and 151.

4.18.1 Soil pH, EC and Organic carbon

Experiment conducted during *kharif* 2014

There was no significant difference in soil pH, Electrical Conductivity and Organic Carbon due to the application of panchagavya and jeevamruta. However, lower soil pH, higher organic carbon and soil EC was observed with higher levels of jeevamruta and panchagavya application.

Experiment conducted during *kharif* 2015

Significantly higher organic carbon recorded with jeevamrutha at 2000 litres ha⁻¹ (0.59 %) which was on par with jeevamrutha at 1500 litres ha⁻¹ (0.57 %) and lower organic carbon was recorded in without jeevamruta application (0.55 %) which was on par with jeevamrutha at 1500 litres ha⁻¹ (0.55 %) and jeevamrutha at 1500 litres ha⁻¹

Table 149: pH, EC and OC of soil as influenced by liquid manures application at harvest stage of frenchbean during *Kharif* 2014

Jeevamrutha Levels	At Harvest											
	pH				EC (dsm ⁻¹)				OC (%)			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	6.64	6.64	6.64	6.64	0.205	0.206	0.205	0.205	0.54	0.54	0.55	0.55
J₁	6.63	6.63	6.63	6.63	0.209	0.205	0.211	0.208	0.55	0.55	0.54	0.55
J₂	6.62	6.59	6.61	6.61	0.216	0.219	0.218	0.218	0.56	0.57	0.56	0.56
J₃	6.58	6.56	6.57	6.57	0.217	0.221	0.221	0.219	0.56	0.57	0.58	0.57
Mean	6.62	6.61	6.61		0.212	0.213	0.214		0.55	0.56	0.56	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.05		NS		0.004		NS		0.01		NS	
Panchagavya	0.05		NS		0.004		NS		0.01		NS	
J × P	0.09		NS		0.007		NS		0.01		NS	

Note: J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, J₂ - Jeevamrutha 1500 litre/ha, J₃ - Jeevamrutha 2000 litre/ha

P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, P₃ - Panchagavya at 6 %, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 150: pH, EC and OC of soil as influenced by liquid manures application at harvest stage of frenchbean during *Kharif* 2015

Jeevamrutha Levels	At Harvest											
	pH				EC (dsm ⁻¹)				OC (%)			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	6.60	6.55	6.55	6.57	0.209	0.207	0.211	0.209	0.55	0.55	0.56	0.55
J₁	6.52	6.50	6.51	6.51	0.213	0.210	0.213	0.212	0.56	0.56	0.56	0.56
J₂	6.51	6.51	6.50	6.51	0.220	0.222	0.221	0.221	0.57	0.58	0.58	0.57
J₃	6.51	6.50	6.49	6.50	0.223	0.224	0.223	0.223	0.57	0.59	0.60	0.59
Mean	6.53	6.52	6.51		0.216	0.216	0.217		0.56	0.57	0.57	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.05		NS		0.004		NS		0.006		0.02	
Panchagavya	0.05		NS		0.003		NS		0.005		NS	
J × P	0.09		NS		0.007		NS		0.010		NS	

Note: **J₀** - Without Jeevamrutha, **J₁** - Jeevamrutha 1000 litre/ha, **J₂** - Jeevamrutha 1500 litre/ha, **J₃** - Jeevamrutha 2000 litre/ha
P₀ - Without panchagavya, **P₁** - Panchagavya at 3 %, **P₃** - Panchagavya at 6 %, **DAS** – Days After Sowing, **RDF** – 63:100:75 NPK kg ha⁻¹

Table 151: pH, EC and OC of soil as influenced by liquid manures application at harvest stage of frenchbean (Pooled 2014 and 2015)

Jeevamrutha Levels	At Harvest											
	pH				EC (dsm ⁻¹)				OC (%)			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	6.62	6.60	6.60	6.60	0.207	0.207	0.208	0.207	0.55	0.55	0.55	0.55
J₁	6.58	6.57	6.57	6.57	0.211	0.208	0.212	0.210	0.56	0.56	0.55	0.55
J₂	6.57	6.55	6.56	6.56	0.218	0.221	0.219	0.219	0.56	0.57	0.57	0.57
J₃	6.54	6.53	6.53	6.53	0.220	0.222	0.222	0.221	0.56	0.58	0.59	0.58
Mean	6.58	6.56	6.56		0.214	0.214	0.215		0.56	0.56	0.57	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.05		NS		0.004		0.01		0.01		0.02	
Panchagavya	0.05		NS		0.003		NS		0.01		NS	
J × P	0.09		NS		0.007		NS		0.01		NS	

Note: J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, J₂ - Jeevamrutha 1500 litre/ha, J₃ - Jeevamrutha 2000 litre/ha

P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, P₃ - Panchagavya at 6 %, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

(0.57 %). There was no significant difference in soil pH, Electrical Conductivity due to the application of jeevamruta and panchagavya.

Interaction effect

Soil pH, EC and Organic carbon of soil did not differ significantly due to the interaction between jeevamrutha and panchagavya application during both the years.

Pooled

The data pertaining to the pH, Electrical Conductivity (EC) and Organic Carbon (OC) in soil as influenced by liquid manures at harvest of frenchbean are presented in Table 151.

Application of varied levels of jeevamrutha resulted in significant difference in EC value of soil. Significantly lower EC value was recorded with no jeevamrutha application (0.223 dS m^{-1}) which was on par with jeevamrutha at $1000 \text{ litres ha}^{-1}$ (0.219 dS m^{-1}). Significantly higher EC value was recorded with jeevamrutha at 2000 l ha^{-1} (0.223 dSm^{-1}).

Significantly higher organic carbon recorded with jeevamrutha at $2000 \text{ litres ha}^{-1}$ (0.58 %) which was on par with jeevamrutha at $1500 \text{ litres ha}^{-1}$ (0.57 %) and lower organic carbon was recorded with jeevamrutha at $1000 \text{ litres ha}^{-1}$ (0.55 %) and without jeevamrutha application (0.55 %).

There was no significant difference in soil pH, Electrical Conductivity and Organic Carbon due to the application of panchagavya. However, lower soil pH, higher organic carbon and soil EC was observed with higher levels of panchagavya application.

Soil pH, EC and organic carbon content of soil did not differ significantly due to the interaction between different levels of jeevamrutha and panchagavya application. However, lower soil pH, higher organic carbon and soil EC was observed jeevamrutha at $2000 \text{ litres ha}^{-1}$ and panchagavya at 6 per cent and it was lower with no- jeevamrutha and no panchagavya application.

4.18.2 Bulk density (BD)

Experiment conducted during *kharif* 2014

Application of jeevamrutha and panchagavya did not show significant influence on BD of soil. However, application of higher levels jeevamrutha and panchagavya recorded less BD values as compared to without jeevamrutha and without panchagavya application (Tables 152, 153 and 154).

Experiment conducted during *kharif* 2015

Application of jeevamrutha showed significant influence on BD of soil. Jeevamrutha at $2000 \text{ litres ha}^{-1}$ (1.30 g/cc) was on par with jeevamrutha at $1500 \text{ litres ha}^{-1}$ (1.31 g/cc) and lower organic carbon was recorded in without jeevamrutha application (1.33

Table 152: Maximum water holding capacity, Bulk density and 50 % flowering of frenchbean as influenced by liquid manures application during *Kharif* 2014

Jeevamrutha Levels	At Harvest							
	MWH (%)				BD (g/cc)			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	37.00	37.00	37.33	37.11	1.34	1.34	1.33	1.34
J₁	37.33	37.67	37.67	37.56	1.34	1.33	1.33	1.33
J₂	37.67	38.00	39.00	38.22	1.33	1.33	1.32	1.33
J₃	38.33	38.33	38.67	38.44	1.33	1.32	1.32	1.32
Mean	37.58	37.75	38.17		1.34	1.33	1.33	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.45		NS		0.01		NS	
Panchagavya	0.39		NS		0.005		NS	
J × P	0.79		NS		0.01		NS	

Note: J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, J₂ - Jeevamrutha 1500 litre/ha, J₃ - Jeevamrutha 2000 litre/ha

P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, P₂ - Panchagavya at 6 %, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 153: Maximum water holding capacity, Bulk density and 50 % flowering of frenchbean as influenced by liquid manures application during *Kharif* 2015

Jeevamrutha Levels	At Harvest							
	MWH (%)				BD (g/cc)			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	37.67	38.33	38.33	38.11	1.33	1.33	1.32	1.33
J₁	38.33	38.67	38.67	38.56	1.33	1.32	1.32	1.32
J₂	38.33	38.33	39.00	38.56	1.32	1.31	1.31	1.31
J₃	38.67	39.00	40.67	39.44	1.31	1.30	1.30	1.30
Mean	38.25	38.58	39.17		1.32	1.31	1.31	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.44		NS		0.005		0.02	
Panchagavya	0.38		NS		0.005		NS	
J × P	0.75		NS		0.009		NS	

Note: J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, J₂ - Jeevamrutha 1500 litre/ha, J₃ - Jeevamrutha 2000 litre/ha

P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, P₃ - Panchagavya at 6 %, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 154: Maximum water holding capacity, Bulk density and 50 % flowering of frenchbean as influenced by liquid manures application (Pooled 2014 and 2015)

Jeevamrutha Levels	At Harvest							
	MWH (%)				BD (g/cc)			
	P ₀	P ₁	P ₂	Mean	P ₀	P ₁	P ₂	Mean
J₀	37.33	37.67	37.83	37.61	1.34	1.34	1.32	1.33
J₁	37.83	38.17	38.17	38.06	1.33	1.32	1.32	1.33
J₂	38.00	38.17	39.00	38.39	1.32	1.32	1.31	1.32
J₃	38.50	38.67	39.67	38.94	1.32	1.31	1.31	1.31
Mean	37.92	38.17	38.67		1.33	1.32	1.32	
	S.Em ±		CD at 5%		S.Em ±		CD at 5%	
Jeevamrutha	0.40		NS		0.005		NS	
Panchagavya	0.35		NS		0.005		NS	
J × P	0.70		NS		0.009		NS	

Note: J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre/ha, J₂ - Jeevamrutha 1500 litre/ha, J₃ - Jeevamrutha 2000 litre/ha

P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, P₃ - Panchagavya at 6 %, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

g/cc) which was on par with jeevamrutha at 1500 litres ha⁻¹ and jeevamrutha at 1500 litres ha⁻¹. There was no significant difference in soil BD due to the application of panchagavya (Table 154).

4.18.3 Water holding capacity (MWHC)

During both the years application of jeevamrutha and panchagavya did not show significant influence on MWHC of soil. However, application of higher levels jeevamrutha and panchagavya alone or in combination resulted in more MWHC values as compared to without jeevamrutha and without panchagavya application (Tables 152, 153 and 154).

Interaction effect

Soil BD and MWHC of soil did not differ significantly due to the interaction between jeevamrutha and panchagavya application during both the years.

Pooled

Application of jeevamrutha and panchagavya did not show significant influence on MWHC and BD of soil. However, application of higher levels jeevamrutha and panchagavya alone or in combination resulted in more MWHC (38.94, 38.67 and 39.67 %, respectively) and less BD (1.31, 1.32 and 1.31 g/cc, respectively) values as compared to without jeevamrutha and without panchagavya application (Table 154).

Discussion on the findings relating to the performance of solid and liquid manures on soil physical and chemical properties

Soil microorganisms breakdown a variety of organic materials and use a portion of these breakdown products to generate or synthesize a series of compounds that make up humus, a dark coloured amorphous substance composed of residual organic matter not readily decomposed by microorganisms. The three major fractions of humus are humic substances, poly-saccharides and other non-humic substances, and humin (Hussain *et al.*, 2001). These materials impact on the physical, chemical and bio-chemical properties of soil in many ways (Singh *et al.*, 2006). Humus improves the texture and structure of the soil, contributes to its buffering capacity, increase the water holding capacity of the soil and reduce the bulk density.

Soil physical and chemical properties such as BD, MWHC, organic carbon, pH and EC were significantly influenced by application of FYM during both the years. Among the FYM levels, FYM at 200 per cent N equivalent recorded significantly higher organic carbon content (0.62 %), lower pH (6.28) and higher EC (0.227 dsm⁻¹) followed by FYM 150 (0.60, 6.38 and 0.219) compared to FYM at 100 per cent N equivalent (0.57, 6.54 and 0.210) (Table 153). This significant changes might be due to direct incorporation of FYM which was under gone decomposition and adds organic matter to the soil, ultimately changed the physico-chemical properties of soil. The higher soil organic carbon of soil might be due to higher soil organic carbon of soil added through FYM which increased water holding capacity and reduced the bulk density due to humic substances penetrated the inter lamella space of clay minerals and influenced the interaction of clay with other soil constituents and ultimately increased water holding

capacity of the soil (Singh *et al.*, 2006). Patil *et al.* (2003) reported that application of FYM (15 to 30 t ha⁻¹) decreased the soil pH from 7.93 to 7.71 and increased the electrical conductivity and organic carbon content in soil. They also noticed that there was decrease in the calcium carbonate content with increase in the levels of farmyard manure. On the contrary, FYM prepared out of animal wastes (dung, urine) from animals fed with concentrated feeds rich in proteins, salts *etc.* decreased the pH and increased the soil EC, besides N, P, K and other nutrients. An organic farming system trial conducted for 30 years at Rodale Institute, USA, involving organic compost equivalent to 190 kg N ha⁻¹ for maize & 120 kg for oats was applied and then rotated with legumes like soybean and alfalfa. Results clearly revealed that soil aggregation, water holding capacity, soil aeration were improved. Further, ground water recharge was increased and run off was reduced (Anon., 2011a). This is in accordance with Sangeetha and Balakrishnan (2010) who have also reported application of FYM + neem cake has reduced bulk density (1.14 and 1.12 Mg m⁻³), higher spore space (56.9 and 57.0 %) improved water holding capacity (42.0 and 43.5 %) was observed during *rabi* 2007 and 2008. Reddy *et al.* (2011) reported from Mandya and Naganahalli, that soil organic carbon and nutrients status were improved by the application of FYM and bio-digester liquid manure. These results are in agreement with the findings of Birajadar *et al.* (2001) and Laxminarayana (2006).

In both the experiment EC, pH and maximum water holding capacity (MWHC) did not vary significantly due to panchagavya and jeevamrutha application during both the years. However, application of jeevamrutha and panchagavya lowered pH and recorded higher MWHC as compared to without jeevamrutha and panchagavya application. Similar results were also found with Mandal and Mandal, (1994), and Maheshwarappa *et al.* (1997). In the first experiment jeevamrutha influenced the Bulk density as compared to without jeevamrutha application with FYM levels. Whereas in second experiment jeevamrutha influence was not observed on bulk density.

4.19 Economics

The data pertaining to the cost of cultivation, gross returns, net returns and B:C ratio of frenchbean as influenced by FYM, jeevamrutha and panchagavya are presented in Tables 155 and 156.

4.19.1 Cost of cultivation

Higher cost of cultivation was recorded with FYM at 200 per cent N equivalent + jeevamrutha at 1000 litre ha⁻¹ + panchagavya at 3 per cent (₹ 1,36841 and 139841 ha⁻¹) followed by FYM at 200 per cent N equivalent + jeevamrutha at 1000 litre ha⁻¹ + without panchagavya (₹ 1,34635 and 1,37635 ha⁻¹). Whereas lower cost of cultivation was observed with FYM at 100 per cent N equivalent + no-jeevamrutha + no-panchagavya application (₹ 81585 and 87285 ha⁻¹) during 2014 and 2015.

In the second experiment higher cost of cultivation was recorded with jeevamrutha at 2000 litre ha⁻¹ + panchagavya at 6 per cent application (₹ 99417 and 102417ha⁻¹) followed by jeevamrutha at 1500 litre ha⁻¹ + panchagavya at 6 per cent application (₹ 94111 and 97111 ha⁻¹). Whereas lower cost of cultivation was observed

Table 155: Cost of cultivation, gross returns, net returns and B:C ratio of frenchbean as influenced by FYM and liquid manures

Treatments	Cost of cultivation (₹ ha ⁻¹)			Gross returns (₹ ha ⁻¹)			Net returns (₹ ha ⁻¹)			B:C ratio		
	2014	2015	Mean	2014	2015	Mean	2014	2015	Mean	2014	2015	Mean
T1: F₁J₀P₀	81585	87285	84435	241314	360414	300864	159729	273129	216429	2.96	4.13	3.54
T2: F₁J₀P₁	87791	90791	89291	376637	558119	467378	288846	467328	378087	4.29	6.15	5.22
T3: F₁J₁P₀	90535	93535	92035	395950	587095	491522	305415	493560	399487	4.37	6.28	5.33
T4: F₁J₁P₁	92741	95741	94241	434950	644983	539967	342209	549242	445726	4.69	6.74	5.71
T5: F₂J₀P₀	109385	112385	110885	349855	557200	453528	240470	444815	342643	3.20	4.96	4.08
T6: F₂J₀P₁	113191	116191	114691	391000	622787	506893	277809	506596	392202	3.45	5.36	4.41
T7: F₂J₁P₀	115535	118935	117235	407600	649343	528472	292065	530408	411237	3.53	5.46	4.49
T8: F₂J₁P₁	118141	121141	119641	446550	711933	579242	328409	590792	459601	3.78	5.88	4.83
T9: F₃J₀P₀	128085	131085	129585	357050	591581	474316	228965	460496	344731	2.79	4.51	3.65
T10:F₃J₀P₁	131891	134891	133391	397178	658085	527632	265287	523194	394241	3.01	4.88	3.95
T11:F₃J₁P₀	134635	137635	136135	416272	689783	553028	281637	552148	416893	3.09	5.01	4.05
T12:F₃J₁P₁	136841	139841	138341	456650	757112	606881	319809	617271	468540	3.34	5.41	4.38

Note: CD at 5 %, J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre ha⁻¹, P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, F₁ - 100 %, F₂ - 150 % and F₃ - 200 % equivalent N through FYM, DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

Table 156: Cost of cultivation, gross returns, net returns and B:C ratio of frenchbean as influenced by jeevamrutha and panchagavya application

Treatments	Cost of cultivation (₹ ha ⁻¹)			Gross returns (₹ ha ⁻¹)			Net returns (₹ ha ⁻¹)			B:C ratio		
	2014	2015	Mean	2014	2015	Mean	2014	2015	Mean	2014	2015	Mean
T1: J₀P₀	83605	86605	85105	249375	375624	312500	165770	289019	227395	2.98	4.34	3.66
T2: J₀P₁	74731	77731	76231	312425	470677	391551	237694	392946	315320	4.18	6.06	5.12
T3: J₀P₂	86417	89417	87917	337375	507525	422450	250958	418108	334533	3.90	5.68	4.79
T4: J₁P₀	90955	93155	92055	295125	460217	377671	204170	367062	285616	3.24	4.94	4.09
T5: J₁P₁	92361	95361	93861	327650	485893	406772	235289	390532	312911	3.55	5.10	4.32
T6: J₁P₂	93767	96767	95267	362500	530908	446704	268733	434141	351437	3.87	5.49	4.68
T7: J₂P₀	92030	95030	93530	314050	495829	404940	222020	400799	311410	3.41	5.22	4.32
T8: J₂P₁	92236	95236	93736	354100	558987	456543	261864	463751	362807	3.84	5.87	4.85
T9: J₂P₂	95642	98642	97142	369475	583281	476378	273833	484639	379236	3.86	5.91	4.89
T10: J₃P₀	93905	96905	95405	379650	589782	484716	285745	492877	389311	4.04	6.09	5.06
T11: J₃P₁	94111	97111	95611	405550	629956	517753	311439	532845	422142	4.31	6.49	5.40
T12: J₃P₂	99417	102417	100917	426650	663077	544864	327233	560660	443947	4.29	6.47	5.38

Note: J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre ha⁻¹, J₂ - Jeevamrutha 1500 litre ha⁻¹, J₃ - Jeevamrutha 2000 litre ha⁻¹

P₀ - Without panchagavya, P₁ - Panchagavya at 3 %, P₂ - Panchagavya at 6 %

DAS – Days After Sowing, RDF – 63:100:75 NPK kg ha⁻¹

with without jeevamrutha + without panchagavya application (₹ 83605.0 and 86605.0 ha⁻¹) during 2014 and 2015.

4.19.2 Gross returns

In the first experiment higher gross returns was recorded with FYM at 200 per cent N equivalent + jeevamrutha at 1000 litres ha⁻¹ + panchagavya spray at 3 per cent application (₹ 4,56650 and 7,57112 ha⁻¹) during 2014 and 2015 (Table 67), which was closely followed by FYM at 150 per cent N equivalent + jeevamrutha at 1000 litres ha⁻¹ + panchagavya spray at 3 per cent application (₹ 4,46550 and 7,11933 ha⁻¹) and lower was with FYM at 100 per cent N equivalent + without Jeevamrutha + without panchagavya spray application (₹ 2,41314 and 3,60414 ha⁻¹).

In second experiment higher gross return was recorded with jeevamrutha at 2000 litres ha⁻¹ + panchagavya 6 per cent (₹ 4,26650 and 6,63077 ha⁻¹) followed by jeevamrutha at 2000 litres ha⁻¹ + panchagavya 3 per cent (₹ 405550 and 629956 ha⁻¹). Whereas lower gross return was observed with without jeevamrutha + without panchagavya application (₹ 249375 and 375624) during 2014 and 2015.

4.19.3 Net returns

Application of 150 per cent N equivalent through FYM + jeevamrutha at 1000 litres ha⁻¹ + panchagavya 3 per cent recorded higher net returns (₹ 3,42209) followed by 150 per cent N equivalent through FYM + jeevamrutha at 1000 litres ha⁻¹ + panchagavya 3 per cent (₹ 3,28409) during 2014. While during 2015 it was recorded in 200 per cent N equivalent through FYM + jeevamrutha at 1000 litres ha⁻¹ + panchagavya 3 per cent (₹ 6,17271) followed by 150 per cent N equivalent through FYM + jeevamrutha at 1000 litres ha⁻¹ + panchagavya 3 per cent (₹ 5,90792). Whereas lower net returns was observed with 100 per cent N Equivalent through FYM + jeevamrutha at 0 litres ha⁻¹ + no-panchagavya application (₹1,59729 and 2,73129 ha⁻¹) during both the years.

In second experiment higher net returns was recorded with jeevamrutha at 2000 litres ha⁻¹ + panchagavya 6 per cent (₹ 3,27233 and 5,60660 ha⁻¹) followed by jeevamrutha at 2000 litres ha⁻¹ + panchagavya 3 per cent (₹ 3,114439 and 5,32845 ha⁻¹). Whereas lower net returns was observed with without jeevamrutha + without panchagavya application (₹ 1,65770 and 2,89019 ha⁻¹) during *Kharif* 2014 and 2015.

4.19.4 B:C ratio

During both the years higher benefit cost ratio (4.69 and 6.74) was recorded in 100 per cent N equivalent through FYM + jeevamrutha at 1000 litres ha⁻¹ + panchagavya at 3 per cent followed by 100 per cent N equivalent through FYM + jeevamrutha at 1000 litres ha⁻¹ + without panchagavya (4.37 and 6.28). Whereas lower B:C ratio was recorded with FYM at 100 per cent N equivalent + no-jeevamrutha + no-panchagavya application (2.96 and 4.13) during both the years.

In second experiment higher B:C ratio was recorded with jeevamrutha at 2000 litres ha⁻¹ + panchagavya 6 per cent (4.29 and 6.47) followed by jeevamrutha at 2000

litres ha⁻¹ + panchagavya 3 per cent (4.31 and 6.49). Whereas lower B:C ratio was observed with without jeevamrutha + without panchagavya application (2.98 and 4.34) during *Kharif* 2014 and 2015.

Application of 150 per cent N equivalent through FYM + jeevamrutha at 1000 litres ha⁻¹ + panchagavya 3 per cent recorded higher net returns (₹ 3,42,209) followed by 100 per cent N equivalent through FYM + jeevamrutha at 1000 litres ha⁻¹ + panchagavya 3 per cent (₹ 3,42,209) during 2014. While during 2015 it was recorded in 200 per cent N equivalent through FYM + jeevamrutha at 1000 litres ha⁻¹ + panchagavya 3 per cent (₹ 6,17,271) followed by 150 per cent N equivalent through FYM + jeevamrutha at 1000 litres ha⁻¹ + panchagavya 3 per cent (₹ 5,90,792). During both the years higher benefit cost ratio (4.69 and 6.74) was recorded in 100 per cent N equivalent through FYM + jeevamrutha at 1000 litres ha⁻¹ + panchagavya at 3 per cent followed by 100 per cent N equivalent through FYM + jeevamrutha at 1000 litres ha⁻¹ + without panchagavya (4.37 and 6.28) (Table 156). In second experiment jeevamrutha at 2000 litres ha⁻¹ + panchagavya 6 per cent recorded higher gross return (₹ 4,26650 and 6,63077 ha⁻¹) followed by jeevamrutha at 2000 litres ha⁻¹ + panchagavya 3 per cent (₹ 4,05550 and 6,29956 ha⁻¹), because of higher yield of field bean followed by higher gross returns (Table 155). The lower gross returns was recorded with no-jeevamrutha and no-panchagavya application (₹ 2,49375 and 3,75624 ha⁻¹) which was mainly due to lower green pod yield of frenchbean during both the years. Higher net returns (₹ 3,27233 and 5,60660 ha⁻¹) and benefit cost ratio (4.29 and 6.47) were recorded with jeevamrutha at 2000 litres ha⁻¹ + panchagavya 6 per cent during both the years (Table 155). These results are in conformity with the findings of Manjunatha *et al.*, (2009) reported that application of FYM at 7.5 t ha⁻¹ + 100 per cent RDF resulted in higher gross returns (₹ 35,551 ha⁻¹) in sunflower and was on par with the treatment, FYM at 7.5 t ha⁻¹ + jeevamrutha (₹ 34,729 ha⁻¹). The higher net returns and B:C ratio in both the experiment might be due to higher gross returns and lower cost of cultivation. These results are in line with the findings of Kiran (2104) who reported that application of beejamrutha + jeevamrutha + FYM + vermicompost + cow urine recorded on par net returns and B: C (30,076 ha⁻¹ and 2.70) as compared with RDF (34,978 ha⁻¹ and 2.82) because of lower production cost apart from higher grain yield. Similar results were also noticed by Deshmukh *et al.* (2012) and Yadav and Lourduraj (2006a). Similarly, In Maize-chickpea cropping system, net returns of ₹ 90,648 ha⁻¹ and higher B: C ratio (7.21) in the treatment receiving enriched compost + vermicompost + Green leaf manure + panchagavya spray + biodynamic spray and this was followed by application of enriched compost + vermicompost + Green leaf manure + panchagavya spray (₹ 84,090 ha⁻¹ and 6.35) when compared to control (₹ 54,518 ha⁻¹) (Anon, 2011a).

It was observed that application of jeevamrutha and panchagavya were found cheap and efficient organic substitutes along with other organic manures like FYM in integrated approach for high crop yield and profitability, besides improving the nutrient status of the soil (Kasbe, 2009; Boraiah, 2013; Kiran, 2014 and Siddappa, 2015).

Results of practical significance

Any genuine innovation is rendered useless, if it has no practical utility. The adoption of technology by farmers being the main objective, a technology can be more easily adopted, if the farming community is convinced about its benefits. The results obtained in the present investigation revealed the following practical utilities in promoting the use of different organic manures as a source of nutrients on improving the yield of frenchbean.

- Liquid organic manures panchagavya and jeevamruta being prepared from the locally available farm materials can be promoted as useful and profitable alternative for costly inorganic manures.
- Application of 100 per cent N equivalent through FYM + jeevamruta 1000 litre ha⁻¹ + panchagavya at 3 per cent can be used for profitable frenchbean production.
- We can use jeevamruta at 2000 litre ha⁻¹ alternative for N equivalent FYM application at 150 per cent which performed similar yield during both the seasons.
- Use of FYM, jeevamruta and panchagavya either alone or in combination helps to get higher green pod yield besides increase in soil physical, chemical and biological properties.
- Application of organic manures (FYM, jeevamruta and panchagavya) improve the quality and shelf life of the green pods.

Future line of work

- ❖ Long term effect of organic manures on soil physical, chemical and biological properties needs further investigation.
- ❖ There is a need to study the nutrient release pattern of different organic manures.
- ❖ Residual effect of FYM, jeevamrutha and panchagavya on succeeding crops need to be studied.

V SUMMARY

A field experiment was conducted at organic farming Research and Development Block of RIOF, University of Agricultural Sciences (UAS), Gandhi Krishi Vignana Kendra (GKVK), Bengaluru, during *Kharif* season of 2014 and 2015 in order to study “**Standardization of organic liquid manures for organic frenchbean production (*Phaseolus vulgaris* L.)**”. The experiment was laid out in a Factorial Randomized Complete Block Design (FRCBD) with three replications.

Experiment I: Influence of solid and liquid manures on growth and yield of french bean (*Phaseolus vulgaris* L.)

There were 12 treatment combinations which include three farmyard manure levels (100 % N, 150 % N and 200 % N equivalents through FYM), two jeevamrutha levels (0 litre ha⁻¹ and 1000 litres ha⁻¹) and two panchagavya levels (0 and 3 %). The significant observations of experiment are as follows

Growth parameters like plant height, number of branches, number of leaves and leaf area were higher with FYM at 200 per cent N equivalent as compared to FYM at 150 per cent N equivalent and FYM at 100 per cent N equivalent. Similarly, application of jeevamrutha and panchagavya also enhanced the growth parameters significantly at all the growth stages of crop except at 20 DAS.

Higher total dry matter per plant (21.40 and 23.46 g) was recorded in FYM 200 per cent N equivalent in FYM levels during both the seasons. Jeevamruta (22.39 and 24.03g) and panchagavya (21.60 and 23.31 g) recorded maximum total dry matter as compared to without jeevamrutha and panchagavya application during *Kharif* 2014 and 2015. Combined application of FYM 200 per cent, jeevamrutha 1000 litres ha⁻¹ and panchagavya at 3 per cent recorded maximum total dry matter of 24.65 and 27.08 g during both the seasons

Among N equivalent FYM levels, FYM at 200 per cent recorded higher number of nodules (87.1), fresh weight of nodules (0.53 g) and dry weight (0.10 g) per plant of during 2015. Application of jeevamrutha recorded maximum number of nodules (89.6), fresh weight of nodules (0.55 g) and dry weight (0.11 g) as compared to without jeevamrutha and panchagavya recorded maximum number of nodules (85.1), fresh weight of nodules (0.53 g) and dry weight (0.11 g) as compared to panchagavya application during *kharif* 2015. Combined application of FYM 200 per cent, jeevamrutha 1000 litre ha⁻¹ and panchagavya at 3 per cent recorded number of nodules (112.0), fresh weight of nodules (0.69 g) and dry matter per plant (0.15 g).

Among N equivalent FYM levels, FYM at 200 per cent recorded maximum number of pods (15.3 and 17.35), fresh weight of pods per plant (78.45 and 93.67 g) and pod length (15.4 and 17.06 cm) during 2014 and 2015. Application of jeevamrutha recorded maximum number of pods (15.9 and 17.76), fresh weight of pods per plant (81.68 and 93.46 g) and pod length (15.20 and 16.40 cm) and panchagavya recorded maximum number of pods (15.4 and 17.23), fresh weight of pods per plant (79.42 and

90.73 g) and pod length (15.2 and 16.38 cm) as compared to without jeevamruata and panchagavya application during *kharif* 2014 and 2015. Combined application of FYM 200 per cent, jeevamruta 1000 litre ha⁻¹ and panchagavya at 3 per cent recorded number of pods (17.2 and 19.44), fresh weight of pods per plant (88.75 and 105.84) and pod length (15.7 and 17.55 cm) during both the years.

During both the years among N equivalent FYM levels, FYM at 200 per cent recorded higher pod yield of 135.2 and 168.5 q ha⁻¹. Application of jeevamruta recorded higher pod yield of 141.7 and 168.3 q ha⁻¹ as compared to without jeevamruata while, panchagavya recorded higher pod yield of 138.7 and 164.7 q ha⁻¹ as compared to without panchagavya application during *kharif* 2014 and 2015. Combined application of FYM 200 per cent, jeevamruta 1000 litres ha⁻¹ and panchagavya at 3 per cent recorded higher pod yield of 151.7 and 189.3 q ha⁻¹ during both the seasons.

Among N equivalent FYM levels, FYM at 200 per cent recorded higher crude protein (22.7 and 23.12 %), carbohydrate (5.13 and 5.22 %) and shelf life (9.5 and 9.92 days) during 2014 and 2015. Application of jeevamruta recorded higher crude protein (21.99 and 22.38 %), carbohydrate (4.95 and 5.04 %) and shelf life (9.39 and 9.78 days) as compared to without jeevamruata while, panchagavya recorded higher crude protein (21.89 and 22.27), carbohydrate (4.90 and 4.98) and shelf life (9.33 and 9.78) as compared to without panchagavya application during *kharif* 2014 and 2015. Combined application of FYM 200 per cent, jeevamruta 1000 litres ha⁻¹ and panchagavya at 3 per cent recorded higher crude protein (23.19 and 23.56), carbohydrate (5.24 and 5.34) and shelf life (10.0 and 10.33) during both the years.

During both the years among N equivalent FYM levels, FYM at 200 per cent recorded maximum plant nitrogen content (3.05 and 3.10 %), phosphorus content (0.280 and 0.288 %) and potassium content (2.17 and 2.23 %) at 40 DAS during 2014 and 2015. Application of jeevamruta recorded higher nitrogen content (3.00 and 3.04 %), phosphorus content (0.279 and 0.286 %) and potassium content (2.16 and 2.22 %) as compared to without jeevamruata. Panchagavya application recorded higher plant nitrogen content (2.97 and 3.02 %), phosphorus content (0.277 and 0.284 %) and potassium content (2.14 and 2.20 %) as compared to without panchagavya application during *kharif* 2014 and 2015. Combined application of FYM 200 per cent, jeevamruta 1000 litre ha⁻¹ and panchagavya at 3 per cent recorded maximum plant nitrogen content (3.17 and 3.22 %), phosphorus content (0.292 and 0.299) and potassium content (2.22 and 2.28 %) during both the seasons.

Among N equivalent FYM levels, FYM at 200 per cent recorded higher pod nitrogen (3.63 and 3.70 %), phosphorus (0.0667 and 0.071 %) and potassium (3.21 and 3.29 %) content during 2014 and 2015. Application of jeevamruta recorded higher pod nitrogen (3.52 and 3.58 %), phosphorus (0.068 and 0.073 %) and potassium content (3.18 and 3.26 %) as compared to without jeevamruata and panchagavya recorded higher pod nitrogen (3.50 and 3.56 %), phosphorus (0.066 and 0.071 %) and potassium content (3.15 and 3.23 %) as compared to without panchagavya application during *kharif* 2014 and 2015. Combined application of FYM 200 per cent, jeevamruta 1000 litre ha⁻¹ and

panchagavya at 3 per cent recorded pod nitrogen (3.71 and 3.77 %), phosphorus (0.072 and 0.076 %) and potassium content (3.29 and 3.37 %) during both the years.

At all the crop growth stages dehydrogenase and microbial activity (bacteria, fungi, actinomycetes, P solubilizer and N-fixer) were significantly higher with FYM at 200 per cent N equivalent followed by FYM at 150 per cent N equivalent and significantly lower microbial population was with FYM at 100 per cent N equivalent. Application of jeevamrutha (1000 litres ha⁻¹) and panchagavya (3 %) recorded significantly higher dehydrogenase and microbial activity over without jeevamrutha and without panchagavya application.

Among N equivalent FYM levels, FYM at 200 per cent recorded higher soil available nitrogen (391.5 and 439.1 kg ha⁻¹), phosphorus (53.82 and 60.02 kg ha⁻¹) and potassium (292.3 and 324.4 kg ha⁻¹) during 2014 and 2015. Application of jeevamrutha recorded higher soil available nitrogen (377.8 and 424.3 kg ha⁻¹), phosphorus (51.93 and 58.0 kg ha⁻¹) and potassium (282.5 and 313.6 kg ha⁻¹) as compared to without jeevamrutha while, panchagavya recorded higher soil available nitrogen (373.6 and 418.8 kg ha⁻¹), phosphorus (51.3 and 57.3 kg ha⁻¹) and potassium content (279.0 and 309.6 kg ha⁻¹) as compared to without panchagavya application during *kharif* 2014 and 2015. Combined application of FYM 200 per cent, jeevamrutha 1000 litres ha⁻¹ and panchagavya at 3 per cent recorded significantly higher soil available nitrogen (400.9 and 450.6 kg ha⁻¹), phosphorus (55.67 and 61.47 kg ha⁻¹) and potassium content (299.3 and 332.2 kg ha⁻¹) during both the years.

Among N equivalent FYM levels, FYM at 200 per cent recorded higher soil lower pH (6.44 and 6.28), higher EC (0.219 and 0.223 ds m⁻¹) and organic carbon (0.60 and 0.62 %) during 2014 and 2015. Application of jeevamrutha recorded higher soil lower pH (6.51 and 6.37), higher EC (0.216 and 0.219) and organic carbon (0.58 and 0.60) as compared to without jeevamrutha while, panchagavya application recorded lower pH (6.53 and 6.39), higher EC (0.214 and 0.218 ds m⁻¹) and organic carbon (0.58 and 0.60 %) as compared to without panchagavya application during *kharif* 2014 and 2015. Combined application of FYM 200 per cent, jeevamrutha 1000 litres ha⁻¹ and panchagavya at 3 per cent recorded lower pH (6.40 and 6.25), and organic carbon (0.60 and 0.63 %) during both the years.

Application of 150 per cent N equivalent through FYM + jeevamrutha at 1000 litres ha⁻¹ + panchagavya 3 per cent recorded higher net returns (Rs. 3,42209) followed by 150 per cent N equivalent through FYM + jeevamrutha at 1000 litres ha⁻¹ + panchagavya 3 per cent (Rs. 3,28409) during 2014. While during 2015 it was recorded in 200 per cent N equivalent through FYM + jeevamrutha at 1000 litres ha⁻¹ + panchagavya 3 per cent (Rs. 6,17271) followed by 150 per cent N equivalent through FYM + jeevamrutha at 1000 litres ha⁻¹ + panchagavya 3 per cent (Rs. 5,90792). During both the years higher benefit cost ratio (4.69 and 6.74) was recorded in 100 per cent N equivalent through FYM + jeevamrutha at 1000 litres ha⁻¹ + panchagavya at 3 per cent followed by 100 per cent N equivalent through FYM + jeevamrutha at 1000 litres ha⁻¹ without panchagavya (4.37 and 6.28). Whereas lower B:C ratio was recorded with FYM at 100 per cent N

equivalent + no-jeevamrutha + no-panchagavya application (2.96 and 4.13) during both the years.

Exp II: Effect of jeevamrutha and panchagavya on growth and yield of frenchbean (*Phaseolus vulgaris* L.)

There were 12 treatment combination which includes four jeevamrutha levels (0, 1000, 1500 and 2000 litres ha⁻¹) and three panchagavya levels (0, 3 and 6 %). The significant observations of experiment are as follows.

During both the seasons among jeevamrutha levels, application of jeevamrutha at 2000 litre ha⁻¹ recorded higher plant height (27.26 and 29.00 cm) at harvest. Among panchagavya levels, application of panchagavya at 6 per cent recorded higher plant height (26.74 and 27.45 cm) during 2014 and 2015. Combined application of jeevamrutha at 2000 litre ha⁻¹ and panchagavya at 6 per cent recorded higher plant height (28.07 and 29.87 cm) during *kharif* 2014 and 2015.

More number of branches (6.64 and 7.07) and leaves (37.67 and 40.49) was recorded in jeevamrutha at 2000 litres ha⁻¹ among jeevamrutha levels at harvest during both the seasons. Among panchagavya levels, application of panchagavya at 6 per cent recorded higher number of branches (6.13 and 6.53) and leaves (36.03 and 38.78) at harvest during both the seasons. Combined application of jeevamrutha at 2000 litres ha⁻¹ and panchagavya at 6 per cent recorded higher number of branches (7.0 and 7.4) and leaves (39.40 and 42.13) during *kharif* 2014 and 2015.

During both the years among jeevamrutha levels, application of jeevamrutha at 2000 litre ha⁻¹ recorded higher leaf area per plant (1181.26 and 1402.12 cm²) and leaf area index (2.63 and 3.12) at harvest. Among panchagavya levels, application of panchagavya at 6 per cent recorded higher leaf area (1136.60 and 1345.09 cm²) and leaf area index (2.53 and 2.99). Combined application of jeevamrutha at 2000 litres ha⁻¹ and panchagavya at 6 per cent recorded higher leaf area (1239.38 and 1440.18 cm²) and leaf area index (2.75 and 3.20) during *kharif* 2014 and 2015.

Application of jeevamrutha at 2000 litres ha⁻¹ recorded higher total dry matter per plant (21.98 and 23.29) at harvest among the jeevamrutha levels during both the seasons. Application of panchagavya at 6 per cent recorded higher total dry matter (20.82 and 22.39) among panchagavya levels during both the seasons. Combined application of jeevamrutha at 2000 litres ha⁻¹ and panchagavya at 6 per cent recorded higher total dry matter (23.32 and 25.03) during *kharif* 2014 and 2015.

Among jeevamrutha levels, application of jeevamrutha at 2000 litres ha⁻¹ recorded higher number of nodules (113.3), fresh weight of nodules (0.67 g) and dry weight (0.15 g) per plant of during 2015. Among panchagavya levels, application of panchagavya at 6 per cent recorded higher number of nodules (101.5), fresh weight of nodules (0.59 g) and dry weight (0.14 g) per plant. Combined application of jeevamrutha at 2000 litres ha⁻¹ and panchagavya at 6 per cent recorded higher number of nodules (119.3), fresh weight of nodules (0.74 g) and dry weight (0.18 g) per plant of during 2015.

Among jeevamrutha levels, application of jeevamrutha at 2000 litres ha⁻¹ recorded maximum number of pods (15.36 and 16.48), fresh weight of pods per plant (77.70 and 82.81 g) and pod length (15.28 and 16.10 cm) during 2014 and 2015. Application of panchagavya at 6 per cent recorded maximum number of pods (14.69 and 16.15), fresh weight of pods per plant (74.15 and 81.98 g) and pod length (15.1 and 15.61 cm) among panchagavya levels during both the seasons. Combined application of jeevamrutha at 2000 litres ha⁻¹ and panchagavya at 6 per cent recorded maximum number of pods (15.67 and 16.82), fresh weight of pods per plant (81.57 and 86.97 g) and pod length (15.46 and 16.38 cm) during *kharif* 2014 and 2015.

During both the seasons among jeevamrutha levels, application of jeevamrutha at 2000 litres ha⁻¹ recorded higher pod yield (134.3 and 156.9 q ha⁻¹). Among panchagavya levels, application of panchagavya at 6 per cent recorded higher green pod yield (124.4 and 142.8 q ha⁻¹). Combined application of jeevamrutha at 2000 litres ha⁻¹ and panchagavya at 6 per cent recorded higher pod yield (141.8 and 165.77 q ha⁻¹) during both the seasons.

Among jeevamrutha levels, application of jeevamrutha at 2000 litres ha⁻¹ recorded higher crude protein (21.53 and 22.07 %), carbohydrate (5.09 and 5.22 %) and shelf life (10.11 and 10.56 days) during 2014 and 2015. Application of panchagavya at 6 per cent recorded higher crude protein (21.22 and 21.73 %), carbohydrate (4.86 and 4.98 %) and shelf life (9.83 and 10.42 days) during both the seasons. Combined application of jeevamrutha at 2000 litres ha⁻¹ and panchagavya at 6 per cent recorded higher crude protein (21.98 and 22.54 %), carbohydrate (5.14 and 5.26 %) and shelf life (10.62 and 11.0 days).

During both the seasons among jeevamrutha levels, application of jeevamrutha at 2000 litres ha⁻¹ recorded higher plant nitrogen content (2.91 and 2.98 %), phosphorus content (0.279 and 0.284 %) and potassium content (2.18 and 2.23 %) at 40 DAS. Among panchagavya levels, application of panchagavya at 6 per cent recorded higher plant nitrogen content (2.84 and 2.91 %), phosphorus (0.273 and 0.279 %) and potassium content (2.13 and 2.19 %). Combined application of jeevamrutha at 2000 litres ha⁻¹ and panchagavya at 6 per cent recorded higher plant nitrogen content (2.97 and 3.04 %), phosphorus (0.285 and 0.290 %) and potassium content (2.19 and 2.25 %) during both the seasons at 40 DAS.

Application of jeevamrutha at 2000 litres ha⁻¹ recorded higher pod nitrogen (3.44 and 3.53 %), phosphorus (0.067 and 0.069 %) and potassium (3.13 and 3.21 %) content among the jeevamrutha levels during both the seasons. Application of panchagavya at 6 per cent recorded higher pod nitrogen (3.40 and 3.48 %), phosphorus (0.0665 and 0.067 %) and potassium (3.11 and 3.19 %) content among the panchagavya levels during 2014 and 2015. Application of jeevamrutha at 2000 litres ha⁻¹ with panchagavya at 6 per cent recorded higher pod nitrogen (3.52 and 3.61 %), phosphorus (0.0668 and 0.071 %) and potassium (3.19 and 3.25 %) content during *kharif* 2014 and 2015

Dehydrogenase and microbial activity (bacteria, fungi, actinomycetes, P solubilizer and N-fixer) were significantly higher with jeevamrutha at 2000 litres ha⁻¹ followed by jeevamrutha at 150 per cent N equivalent, jeevamrutha 1000 litres ha⁻¹ and significantly lower with without jeevamrutha application at all the crop growth stages during both the years. Application of panchagavya at 6 and 3 % recorded significantly higher dehydrogenase and microbial activity over without panchagavya application during both the years.

Among jeevamrutha levels, application of jeevamrutha at 2000 litres ha⁻¹ recorded higher soil available nitrogen (381.8 and 427.6 kg ha⁻¹), phosphorus (51.9 and 58.1 kg ha⁻¹) and potassium (284.7 and 318.8 kg ha⁻¹) during 2014 and 2015. Application of panchagavya at 6 per cent recorded higher soil available nitrogen (365.1 and 408.9 kg ha⁻¹), phosphorus (49.4 and 55.3 kg ha⁻¹) and potassium (271.4 and 304.0 kg ha⁻¹) during during both the seasons. Combined application of jeevamrutha at 2000 litres ha⁻¹ and panchagavya at 6 per cent recorded higher soil available nitrogen (385.1 and 431.4 kg ha⁻¹), phosphorus (52.4 and 58.7 kg ha⁻¹) and potassium (287.6 and 322.1 kg ha⁻¹).

During both the seasons among jeevamrutha levels, application of jeevamrutha at 2000 litre ha⁻¹ recorded soil lower pH (6.57 and 6.50), higher EC (0.219 and 0.223 ds m⁻¹) and organic carbon (0.57 and 0.59 %) at harvest. Among panchagavya levels, application of panchagavya at 6 per cent recorded soil lower pH (6.61 and 6.51), higher EC (0.214 and 0.217 ds m⁻¹) and organic carbon (0.56 and 0.57 %). Combined application of jeevamrutha at 2000 litre ha⁻¹ and panchagavya at 6 per cent recorded higher soil lower pH (6.57 and 6.49), higher EC (0.221 and 0.223 ds m⁻¹) and organic carbon (0.58 and 0.60 %) during both the seasons.

During both the seasons application jeevamrutha at 2000 litres ha⁻¹ with panchagavya at 6 per cent recorded higher gross returns (₹ 4,26650.0 and 6,63077.0 ha⁻¹), net returns (₹ 3,27233.0 and 5,60660.0 ha⁻¹) and benefit cost ratio (4.29 and 6.47) followed by jeevamrutha at 2000 litres ha⁻¹ + panchagavya 3 per cent application during 2014 and 2015.

VI REFERENCES

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APPENDIX – I

Price of inputs and outputs used for calculating cost of cultivation

Sl. No.	Particulars	Price (₹)	
		2014	2015
A. Inputs			
1	Seed material		
	a. Frenchbean (Arka suvidha)	250 kg ⁻¹	300 kg ⁻¹
2	Organic manures		
	a. FYM	1000 t ⁻¹	1000 t ⁻¹
	b. Jeevamrutha	1.25 litre ⁻¹	1.25 litre ⁻¹
	c. Panchagavya	20.83 litre ⁻¹	20.83 litre ⁻¹
3	Plant protection measures		
	a. Neem soap	200 kg ⁻¹	200 kg ⁻¹
	b. Neem oil	350 litre ⁻¹	350 litre ⁻¹
	c. Biopower (<i>Beauveria bassiana</i>)	375 litre ⁻¹	375 litre ⁻¹
	d. <i>Trichoderma viridae</i>	150 kg ⁻¹	150 kg ⁻¹
5	Labour (Per day)		
	a. Male	200	200
	b. Female	190	190
6	a. Bullock Pair with men (per hour)	450	450
	b. Tractor (per hour)	300	300
B. Outputs			
	a. Green pod yield of frenchbean	30 kg ⁻¹	40 kg ⁻¹

APPENDIX – II

Nutrient composition of Farmyard manure, jeevamrutha and panchagavya

Sl. No.	Nutrient composition	FYM (%)	Jeevamrutha (%)	Panchagavya (%)
1	Total N	0.50	1.05	1.20
2	Total P	0.25	0.122	0.18
3	Total K	0.54	0.081	0.25
Quantity of FYM added				
Year	% N	Recommended N through FYM (63 kg ha ⁻¹)	Quantity of FYM added (t ha ⁻¹)	
2014	0.45	100 %	14.0	
		150 %	21.0	
		200 %	28.0	
2015	0.50	100 %	12.6	
		150 %	18.9	
		200 %	25.2	

Influence of Farm Yard Manure, Jeevamrutha and Panchagavya on Growth and Yield of French Bean (*Phaseolus vulgaris* L.)

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ABSTRACT

A field experiment was conducted at organic Farming Block of Research Institute on Organic Farming, University of Agricultural Sciences, GKVK, Bengaluru during 2014 to study the combined effect of FYM and liquid manures (jeevamrutha and panchagavya) on growth and yield of french bean. There were twelve treatment combinations comprising of two levels of each jeevamrutha (0 and 1000 l ha⁻¹) and panchagavya (0 and 3 %) with three levels of FYM. The experiment was laid out in Factorial Randomised Complete Block Design with three replications. Application of FYM in terms of 200 per cent N equivalent recorded significantly higher plant height (26.5 cm), number of branches (7.17), leaf area (1249 cm²) at 60 DAS, number of pods per plant (15.33), pod weight per plant (78.45 g) and green pod yield (135.2 q/ha) as compared to FYM in terms of 100 per cent N equivalent (24.9 cm, 6.23, 1091 cm², 13.57, 69.86 g and 120.3 qha⁻¹, respectively). Soil application of jeevamrutha (1000 l ha⁻¹) and foliar spray of panchagavya (3 %) recorded significantly higher plant height (26.7 and 26.6 cm), number of branches (6.93 and 6.89), leaf area (1325 and 1263 cm²), number of pods plant⁻¹ (15.89 and 15.40), pod weight plant⁻¹ (81.58 and 79.42 g) and green pod yield (141.7 and 138.7 qha⁻¹) as compared to without jeevamrutha (25.0 cm, 6.28, 991.0 cm², 13.18, 67.30 g and 117.0 qha⁻¹, respectively) and without panchagavya application (25.1 cm, 6.32, 1054.0 cm², 13.67, 69.56 g and 120.0 qha⁻¹, respectively).

FRENCH bean belongs to family leguminosae and it is considered to be a native of South and Central America. French bean is an excellent vegetable crop for pods as well as for seed and its worldwide significance for direct human consumption and a dietary supplement rich in proteins, vitamins and minerals such as calcium, phosphorus, iron and zinc (Broughton *et al.*, 2003). Organic agriculture is a holistic food production management system, which promotes and ensures biodiversity, biological cycles and biological activity by giving preference to the use of on farm inputs, which are highly adapted to the production system. Panchagavya and Jeevamrutha are eco-friendly organic preparations made from cow products. The products from cow have the ability to bring the flow of cosmic energy which in turn can revitalize the growth process (Sundararaman *et al.*, 2001 and Natarajan, 2002).

Use of organic liquid products such as Beejamrutha, Jeevamrutha and Panchagavya results in higher growth, yield and quality of crops and improve the soil physico-chemical and biological properties. They contain macro nutrients, essential micro nutrients, many vitamins, essential amino acids, growth

promoting factors like IAA, GA and beneficial microorganisms (Devakumar *et al.*, 2008 and Tharmaraj *et al.*, 2011). Use of farm yard manure and organic liquid formulations like Panchagavya, cow urine and jeevamrutha are potential sources of organic nutrients. Hence, the present experiment was conducted to study the combined effect of FYM, Panchagavya and Jeevamrutha on growth and yield of french bean.

A field experiment was conducted at Organic Farming Block of Research Institute on Organic Farming, Ghandhi Krishi Vignana Kendra, University of Agricultural Sciences, Bengaluru under protective irrigation during *kharif* 2014 to study the combined effect of Farm Yard Manure (FYM), jeevamrutha and panchagavya on growth and yield of french bean. The experiment was laid out in Factorial Randomised Complete Block Design with three replications. Recommended dose of nutrients for french bean was through FYM 63:100:75NPK kg / ha and nutrients were supplied on the basis of nitrogen equivalent to the crop. Treatment combinations included three FYM levels (100%, 150% and 200% N equivalent) and incorporated three weeks prior to sowing in the soil,

two jeevamrutha levels (0 and 1000 litres / ha) and two pancha gavya levels (0 and 3 %). Soil of the experimental site was red sandy loam with acidic pH (6.6), EC 0.24 dSm⁻¹, low in organic carbon (0.46 %) and medium in available nitrogen (331 kg ha⁻¹), P₂O₅ (38 kg ha⁻¹) and K₂O (231 kg ha⁻¹).

Jeevamrutha was prepared by mixing 10 kg of cow dung, 10 litre of cow urine, 2 kg of jaggery, 2 kg of pigeon pea flour and hand full of soil collected from farm. All these were put in 200 litre plastic drum and mixed thoroughly and volume was made up to 200 litre by adding water. The mixture was stirred well in clock wise direction thrice a day and plastic drum was kept in shade covered with wet jute bag. Jeevamrutha fermented for 10 days was applied to base of the plants manually at 15, 30 and 45 days after sowing (DAS) as per treatments.

Panchagavya was prepared by mixing 7 kg fresh cow dung and 1 kg ghee and incubated in a container for 2 days and it was mixed daily once. On third day, 10 litres cow urine and 10 litres water were added, mixed thoroughly and incubated for fermentation for 13 days. Then, 3 litres milk, 2 litres curd, 3 litres tender coconut water, 3 kg jaggery and 12 well ripened Cavendish banana were added and contents were incubated for 6 days. The mixture was stirred thoroughly thrice a day at morning, afternoon and evening. Plastic drum was kept in shade and it was covered with wet jute bag. After 21 days of fermentation mixture was filtered through a cotton cloth and used for spraying. Panchagavya spray was given at 15, 30 and 45 DAS as per treatments.

Application of varied levels of FYM influenced the growth and yield parameters of french bean. Growth parameters like plant height (26.5 cm), number of primary branches (7.17) and leaf area (1249.0 cm²) were found significantly higher with the application of 200 % N equivalent through FYM as compared to those with 100 per cent N equivalent (25.1 cm, 6.23 and 1091.0 cm², respectively) and were on par with the application of 150 per cent N equivalent through FYM (26.1, 6.68 and 1136.0 cm², respectively). Similarly, higher level of FYM *i.e.* 200 per cent N equivalent recorded significantly higher number of pods plant⁻¹ (15.33), pod weight plant⁻¹ (78.45 g) and pod

yield (134.6 q ha⁻¹) as compared to 100 % N equivalent (13.57, 69.86 and 120.3 q ha⁻¹, respectively) and it was found on par with 150 % N equivalent through FYM application (14.70, 75.16 and 132.5, respectively) (Table 1 & 2). The increase in growth and yield of these treatments may be due to the fact that FYM besides supplying N, P and K also improved the soil condition, which enhanced the source to sink relationship and also make unavailable sources of elemental nitrogen, bound phosphates, micronutrients, and decomposed plant residues into an available form to facilitate the plants to absorb the nutrients (Ravikumar, 2009 and Yadav *et al.*, 2013). These results are in agreement with findings of the Guriqbal Singh *et al.* (2012) in chickpea and Siddappa (2015) in field bean.

Application of jeevamrutha and panchagavya significantly influenced the growth and yield of french bean. Soil application of jeevamrutha and foliar spray of panchagavya had given significantly higher plant height (26.65 & 26.56 cm), number of branches (6.93 & 6.89), leaf area (1325 & 1263 cm²), number of pods plant⁻¹ (15.89 & 15.40), pod weight per plant (81.58 & 79.42 g) and pod yield (141.7 & 138.7 q / ha) as compared to without jeevamrutha (25.12 cm, 6.28, 991.0 cm², 13.18, 67.30 g and 117.0 q / ha, respectively) and without panchagavya application (25.21 cm, 6.32, 1054.0 cm², 13.67, 69.56 g and 120.0 q/ha, respectively) (Table I & II). The cow dung in panchagavya and jeevamrutha act as a media for the growth of beneficial microbes and cow urine provides nitrogen which is essential for crop growth upon fermentation with other ingredients in panchagavya and jeevamrutha. Tender coconut water is being used for preparation of panchagavya and it contains kinetin which has role in enhancing chlorophyll content and leaf size in plant, thus in turn enhanced photosynthetic activity, growth and yield. Fermented liquid organic manures also contain plant growth promoting substances like IAA, GA (Palekar, 2006, Devakumar *et al.*, 2008 and Nileema and Sreenivasa, 2011). These might have stimulated the necessary growth and development in plants, leading to better growth and yield of French bean. Similar results were also found by Sharma and Thomas (2010) and Siddappa (2015) in black gram and field bean.

TABLE I
Growth parameters of french bean as influenced by FYM, Jeevamrutha and Panchagavya application at 60 DAS

Treatments	60 DAS								
	Plant ht (cm)			No. of branches plant ⁻¹			Leaf area plant ⁻¹ (cm ²)		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
FYM levels (F)									
F ₁	23.82	26.01	24.92	5.90	6.57	6.23	945.0	1236.0	1091.0
F ₂	25.56	26.66	26.11	6.37	7.00	6.68	989.0	1283.0	1136.0
F ₃	25.64	27.29	26.46	6.57	7.22	7.17	1040.0	1457.0	1249.0
Mean	25.01	26.65		6.28	6.93		991.0	1325.0	
	S.E.m±	C.D.		S.E.m±	C.D.		S.E.m±	C.D.	
F	0.38	1.13		0.13	0.38		38.79	113.77	
J	0.31	0.92		0.11	0.31		31.67	92.90	
F x J	0.54	NS		0.18	NS		54.86	NS	
	P ₀	P ₁	Mean	P ₀	P ₁	Mean	P ₀	P ₁	Mean
F ₁	23.99	25.85	24.92	5.83	6.63	6.23	1000.0	1182.0	1091.0
F ₂	25.64	26.58	26.11	6.50	6.87	6.68	1042.0	1230.0	1136.0
F ₃	25.67	27.25	26.46	6.62	7.17	7.17	1120.0	1377.0	1249.0
Mean	25.10	26.56		6.32	6.89		1054.0	1263.0	
	S.E.m±	C.D.		S.E.m±	C.D.		S.E.m±	C.D.	
P	0.31	0.92		0.11	0.31		31.67	92.90	
F x P	0.54	NS		0.18	NS		54.86	NS	
	P ₀	P ₁	Mean	P ₀	P ₁	Mean	P ₀	P ₁	Mean
J ₀	24.28	25.74	25.01	5.96	6.60	6.28	946.0	1037.0	991.0
J ₁	25.93	27.38	26.65	6.68	7.18	6.93	1162.0	1489.0	1325.0
Mean	25.10	26.56		6.32	6.89		1054.0	1263.0	
	S.E.m±	C.D.		S.E.m±	C.D.		S.E.m±	C.D.	
J x P	0.44	NS		0.15	NS		44.79	131.37	
F x J x P	0.77	NS		0.26	NS		77.58	NS	

Note: CD at 5 per cent J₀- Without Jeevamrutha, J₁-Jeevamrutha 1000 litre ha⁻¹, P₀- Without Panchagavya, P₁- Panchagavyaat 3 %, F₁- 100 per cent, F₂- 150 per cent and F₃- 200 per cent equivalent N through FYM

TABLE II

Yield components of french bean as influenced by FYM, Jeevamrutha and Panchagavya application

Treatments	Podsplant ⁻¹			Pod wtplant ⁻¹ (g)			Green Pod yield (q ha ⁻¹)		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
FYM levels (F)									
F ₁	11.87	15.27	13.57	60.76	78.97	69.86	102.5	138.2	120.3
F ₂	13.43	15.97	14.70	68.73	81.59	75.16	123.2	141.9	132.5
F ₃	14.23	16.43	15.33	72.41	84.48	78.45	125.3	145.0	135.2
Mean	13.18	15.89		67.30	81.58		117.0	141.7	
	S.Em±	C.D.		S.Em±	C.D.		S.Em±	C.D.	
F	0.23	0.66		1.46	4.29		2.57	7.52	
J	0.18	0.54		1.20	3.51		2.09	6.14	
F x J	0.32	NS		2.07	NS		3.63	NS	
	P ₀	P ₁	Mean	P ₀	P ₁	Mean	P ₀	P ₁	Mean
F ₁	12.40	14.73	13.57	63.49	76.24	69.86	105.7	135.0	120.3
F ₂	14.13	15.27	14.70	71.58	78.74	75.16	125.9	139.2	132.5
F ₃	14.47	16.20	15.33	73.61	83.29	78.45	128.5	141.8	135.2
Mean	13.67	15.40		69.56	79.42		120.0	138.7	
	S.Em±	C.D.		S.Em±	C.D.		S.Em±	C.D.	
P	0.18	0.54		1.20	3.51		2.09	6.14	
F x P	0.32	NS		2.07	NS		3.63	NS	
	P ₀	P ₁	Mean	P ₀	P ₁		P ₀	P ₁	Mean
J ₀	12.22	14.13	13.18	62.19	72.41		104.9	129.1	117.0
J ₁	15.11	16.67	15.89	76.92	86.44		135.2	148.2	141.7
Mean	13.67	15.40		69.56	79.42		120.0	138.7	
	S.Em±	C.D.		S.Em±	C.D.		S.Em±	C.D.	
J x P	0.26	NS		1.69	NS		2.96	NS	
F x J x P	0.45	NS		2.93	NS		5.13	NS	

Note: CD at 5 per cent J₀ - Without Jeevamrutha, J₁ - Jeevamrutha 1000 litre ha⁻¹, P₀ - Without Panchagavya, P₁ - Panchagavya at 3%, F₁ - 100 per cent, F₂ - 150 per cent and F₃ - 200 per cent equivalent N through FYM

In conclusion this study found that application of liquid manures (Jeevamrutha and panchagavya) and FYM are beneficial in improving growth and yield of french bean due to better availability of nutrients, beneficial microbes and growth promoting substances.

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Effect of Jeevamrutha and Panchagavya on Growth, Yield and Microbial Population of French bean (*Phaseolus vulgaris* L.)

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ABSTRACT

Treatment combinations includes four jeevamrutha levels (0, 1000, 1500 and 2000 l ha⁻¹) and three panchagavya levels (0, 3 and 6 %). Application of higher levels of jeevamrutha (2000 l ha⁻¹) and panchagavya (6 %) recorded significantly higher plant height (27.26 and 26.74 cm), No of branches (6.64 and 6.13), leaf area (1181.26 and 1136.6 cm²), pods per plant (15.36 and 14.69 g) and green pod yield (134.3 and 124.4 q ha⁻¹) followed by jeevamrutha at 1500 litres per ha and 1000 l ha⁻¹ application (115.0 and 106.7 q ha⁻¹) and panchagavya at 3 per cent (116.0 q ha⁻¹). Significantly lower growth and green pod yield were found in without panchagavya (101.4 q ha⁻¹) and without jeevamrutha application. The lower growth and french bean yield was recorded in without jeevamrutha and panchagavya application (83.0 q ha⁻¹). Application of jeevamrutha and panchagavya resulted in significantly higher microbial population as compared to without jeevamrutha and without panchagavya application.

Keyword Organic French bean, Jeevamrutha, Panchagavya and soil microbes

French bean (*Phaseolus vulgaris* L.) is also known as snap bean, kidney bean, garden bean or string bean and in India locally known as rajmash, belongs to the family Leguminosae. French bean is considered to be a native of South and Central America. It is an important pulse-cum-vegetable crop of India, cultivated for its tender and mature pods, seeds and fodder. It is a nutritious vegetable and can be grown in all types of soils ranging from light sandy loam to clay soils and can be cultivated round the year in the country (Rana, *et al.*, 2009). French bean growing leading states in India are Maharashtra, Andhra Pradesh and Punjab. Organic farming has gained popularity in recent years not only in India, but also in Australia, Argentina, USA, UK, Germany, South Africa, China, Japan and other Asian countries like Sri Lanka and Pakistan. The

general acceptance of organic farming is not only due to greater demand for pollution free food, but also due to natural advantage in supporting the sustainability in agriculture. Panchagavya and Jeevamrutha are eco-friendly organic preparations made from cow products. The products from cow have the ability to bring the flow of cosmic energy which in turn can revitalize the growth process (Sundararaman *et al.*, 2001 and Natarajan, 2002). Use of organic liquid products such as Beejamrutha, Jeevamrutha and Panchagavya results in higher growth, yield and quality of crops and improve the soil physico-chemical and biological properties. They contain macro nutrients, essential micro nutrients, many vitamins, essential amino acids, growth promoting factors like IAA, GA and beneficial microorganisms (Devakumar *et al.*, 2008 and Tharmaraj *et al.*, 2011). The present investigation on response of french bean to jeevamrutha and panchagavya application growth, yield and on soil microbial population was carried out.

MATERIAL AND METHODS

A field experiment was conducted at Research Institute on Organic Farming Block, GKVK, University of agricultural sciences, Bengaluru under protective irrigation during kharif 2014 to study the effect of jeevamrutha and panchagavya on growth and yield of french bean. The experiment was laid out on Factorial Randomised Complete Block Design with three replications. Treatment combinations includes four jeevamrutha levels (0, 1000, 1500 and 2000 l ha⁻¹) and three panchagavya levels (0, 3 and 6 %). Treatment combinations includes T₁: J₁P₁, T₂: J₁P₂, T₃: J₁P₃, T₄: J₂P₁, T₅: J₂P₂, T₆: J₂P₃, T₇: J₃P₁, T₈: J₃P₂, T₉: J₃P₃, T₁₀: J₄P₁, T₁₁: J₄P₂ and T₁₂: J₄P₃. Soil of the experimental site was red sandy loam with acidic pH (6.6), medium in organic carbon (0.46 %) and medium in available nitrogen (331 kg ha⁻¹), phosphorus (38 kg ha⁻¹) and potassium (231 kg ha⁻¹).

Table 1. Yield of French bean as influenced by Jeevamrutha and Panchagavya application

Treatments	Yield q/ha			Mean
	Panchagavya 0 %	Panchagavya 3 %	Panchagavya 6 %	
Without jeevamrutha	83.0	104.0	112.4	99.8
Jeevamrutha1000 L/ha	91.9	107.7	120.6	106.7
Jeevamrutha1500 L/ha	104.4	117.8	122.9	115.0
Jeevamrutha 2000 L/ha	126.2	134.8	141.8	134.3
Mean	101.4	116.1	124.4	
	S.Em±	C.D at 5 %		
Jeevamrutha	1.97	5.78		
Panchagavya	1.71	5.00		
Jeevamrutha X Panchagavya	3.41	NS		

Jeevamrutha was prepared by mixing 10 kg of cow dung, 10 litre of cow urine, 2 kg of jaggery, 2 kg of pigeon pea flour and hand full of soil collected from farm. All these were put in 200 litre plastic drum and mixed thoroughly and volume was made up to 200 litre by adding water. The mixture was stirred well in clock wise direction thrice a day plastic drum was kept shade covered with wet jute bag. Jeevamrutha was fermented for 10 days applied to base of the plants manually at of 15, 30 and 45 days after sowing (DAS) as per treatments.

Panchagavya was prepared by mixing 7 kg

fresh cow dung and 1 kg ghee were mixed well and incubated in a container for 2 days and on third day, 10 litres cow urine and 10 litres water were added, mixed thoroughly and incubated for fermentation for 13 days. Then, 3 litres milk, 2 litres curd, 3 litres tender coconut water, 3 kg jaggery and 12 well ripened Cavendish banana were added and contents were incubated for 6 days. The mixture was stirred thoroughly thrice a day at morning, afternoon and evening. Plastic drum was kept in shade and it was covered with wet jute bag. After 21 days of fermentation mixture was

Table 2. Growth parameters as influenced by Jeevamrutha and Panchagavya application at 60 DAS

Treatments	Plant height (cm)	No. of branches /plant	Leaf area (cm ²)	Pods/plant
Jeevamrutha levels				
0 L/ha	24.37	4.98	945.78	11.84
1000 L/ha	25.57	5.40	1013.25	12.98
1500 L/ha	25.99	5.78	1056.36	14.01
2000 L/ha	27.26	6.64	1181.26	15.36
S.Em±	0.40	0.13	19.93	0.27
C.D at 5 %	1.16	0.39	58.45	0.78
Panchagavya levels				
0 %	24.78	5.30	945.31	12.43
3 %	25.86	5.67	1065.57	13.52
6 %	26.74	6.13	1136.60	14.69
S.Em±	0.34	0.11	17.26	0.23
C.D at 5 %	1.01	0.34	50.62	0.68
P X J				
S.Em±	0.69	0.23	34.52	0.46
C.D at 5 %	NS	NS	NS	NS

Table 3. Soil microbial population as influenced by Panchagavya and Jeevamrutha application in french bean at 40 DAS

Treatments	Bacteria (No. X 10 ⁶ CFU g ⁻¹)	Fungi (No. X 10 ⁴ CFU g ⁻¹)	Actinomycetes (No. X 10 ³ CFU g ⁻¹)	P- solubaliser (No. X 10 ⁵ CFU g ⁻¹)	N- fixers (No. X 10 ⁵ CFU g ⁻¹)
Jeevamrutha levels					
0 L/ha	24.81	15.11	21.11	18.89	17.11
1000 L/ha	35.78	21.33	28.44	27.11	27.56
1500 L/ha	42.22	26.33	29.89	28.89	29.00
2000 L/ha	47.44	31.22	31.44	34.22	33.00
S.Em±	1.23	1.10	0.85	0.74	0.71
C.D at 5 %	3.61	3.24	2.48	2.16	2.08
Panchagavya levels					
0 %	33.86	21.08	25.00	24.42	22.42
3 %	38.17	23.83	28.25	27.67	27.75
6 %	40.67	25.58	29.92	29.75	29.83
S.Em±	1.07	0.96	0.73	0.64	0.61
C.D at 5 %	3.13	2.81	2.75	1.87	1.80
P X J					
S.Em±	2.13	1.91	1.47	1.28	1.23
C.D at 5 %	NS	NS	NS	NS	NS

NS- Non Significant, DAS- Days After Sowing

filtered through a cotton cloth and used for spray. Panchagavya spray was given at of 15, 30 and 45 days after sowing (DAS) as per treatments.

RESULTS AND DISCUSSION

Application of jeevamrutha and panchagavya significantly influenced the growth, yield and microbial population of french bean as compared to without use of Jeevamrutha and panchagavya .

Application of jeevamrutha at 2000 l ha⁻¹ recorded significantly higher french bean yield of 134.3 q ha⁻¹ than other treatments and an increase of 14.3, 20.5 and 25.7 per cent over jeevamrutha application at 1500, 1000 l ha⁻¹ and without jeevamrutha application, respectively (Table1). Similarly, Application of panchagavya at 6 per cent significantly increased the yield (124.4 q ha⁻¹) over the panchagavya application at 3 per cent and without panchagavya application with an increase in 6.7 and 18.5 per cent green pod yield. The increase in pod yield may be due to the presence of macro nutrients, essential micronutrients, many vitamins, essential amino acids, growth promoting substances like IAA, GA and beneficial microorganisms in the liquid organic manures

(panchagavya and jeevamrutha) which might have resulted in better source-sink relationship *i.e.* better vegetative growth, more number of flowers, and more number of fruits. These are in confirmative with Palekar (2006), Natarajan (2007), and Mathuvelu (2002) have also reported that increase in yield of ladies finger, field bean and finger millet. Further, similar results were also observed by Devakumar *et al.* (2008) in field bean, Shwetha (2007) in soybean and Swain *et al.* (2015) in chilli revealed that application of liquid manures (panchagavya, jeevamrutha and beejamrutha) promotes biological activity in soil and enhance nutrient availability to crops there by improve the growth and yield.

Application of higher levels jeevamrutha at 2000 l ha⁻¹ recorded significantly higher growth parameters (plant height 27.26, number of branches 6.64, leaf area 1181.2 and Pods/plant 15.36) followed by jeevamrutha at 1500 (25.99, 5.78, 1056.36 and 14.01, respectively) and jeevamrutha at 1000 (25.57, 5.40, 1013.25 and 12.98, respectively).

The growth parameters with the application of jeevamrutha at 1000 and 1500 l ha⁻¹ recorded

were on par with each other. Application of panchagavya at 6 per cent recorded significantly higher growth parameters (plant height 26.74, number of branches 6.13, leaf area 1136.6 and Pods plant⁻¹ 14.69) followed by panchagavya at 3 per cent (25.86, 5.67, 1065.57 and 13.52, respectively) (Table 2). Significantly lower growth parameters were observed in without jeevamrutha and without panchagavya application. This may be due to presence of cow dung in panchagavya and jeevamrutha act as a medium for the growth of beneficial microbes and cow urine provides nitrogen which is essential for crop growth and yield (De Britto and girija, 2006) and also the positive influence of growth promoting hormones which accelerated the mobility of photosynthates. In case of Panchagavya spray, the easy transfer of nutrients to plant through foliar spray and the quantities of IAA and GA present in Panchagavya (Somasundaram, 2003), could have created the stimuli in the plant system and which in turn increased the production of growth regulators in cell system. Hence, stimulated the necessary growth and development in plants, leading to better yield. These results are in agreement with the Somasundaram (2003) in green gram, Selvaraj (2003) in french bean and Yadav and Chistopher Lourduraj (2006) in rice.

Among the jeevamrutha and panchagavya levels, application of jeevamrutha at 2000 l ha⁻¹ and panchagavya 6 % recorded significantly higher bacterial population (47.44×10^6 and 40.67×10^6), fungi (31.22×10^4 and 25.58×10^4), actinomycetes (31.44×10^3 and 29.92×10^3), P solubilizer (34.22×10^5 and 29.75×10^5) and N-fixer (33.00×10^5 and 29.83×10^5) CFU g⁻¹ of soil, followed by lower levels of Jeevamrutha application at 1500 l ha⁻¹ (42.22×10^6 , 26.33×10^4 , 29.89×10^3 , 28.89×10^5 and 29.00×10^5 CFU g⁻¹ of soil, respectively), Jeevamrutha application at 1000 l ha⁻¹ (35.78×10^6 , 21.33×10^4 , 28.44×10^3 , 27.11×10^5 and 27.56×10^5 CFU g⁻¹ of soil, respectively) and panchagavya application at 3 % (38.17×10^6 , 23.83×10^4 , 28.25×10^3 , 27.67×10^5 and 27.75×10^5 CFU g⁻¹ of soil, respectively) as compared to without jeevamrutha (24.81×10^6 , 15.11×10^4 , 21.11×10^3 , 18.89×10^5 and 17.11×10^5 CFU g⁻¹ of soil) and without panchagavya (33.86×10^6 , 21.08×10^4 , 25.00×10^3 , 24.42×10^5 and 22.42×10^5 CFU g⁻¹ of soil) application (Table 3). Higher microbial population might be due to jeevamrutha contains enormous

amount of microbial load which multiplies in the soil and acts as a tonic to enhance the microbial activity in the soil, as also reported by Palekar (2006), Vasanthakumar (2006) and Shreenivas *et al.*, (2011) also noticed that liquid manures contains micronutrients in addition to different microflora. Similar results were also reported by Devakumar *et al.*, (2008, 2014). Panchagavya also contains beneficial microorganisms which helps in increasing the microbial load in the soil after application. The results are in conformity with the findings of Swaminathan *et al.* (2007), Majumdar *et al.* (2006) and Shubha *et al.* (2014).

Higher levels of panchagavya and jeevamrutha interaction resulted in increased growth and yield of french bean as compared to lower levels interaction due to combination of treatments were found to be non significant.

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