

**“EFFECT OF VERMICOMPOST AND WEED
MANAGEMENT PRACTICES ON GROWTH AND YIELD OF
FENUGREEK (*Trigonella foenum-graecum* L.) UNDER
MIDDLE GUJARAT CONDITIONS”**

**A
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SUBMITTED TO THE
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FOR THE AWARD OF THE DEGREE**

**OF
Master of Science
(AGRICULTURE)**

**IN
AGRONOMY**

**BY
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B. Sc. (Agri.)**

**DEPARTMENT OF AGRONOMY
B. A. COLLEGE OF AGRICULTURE
ANAND AGRICULTURAL UNIVERSITY
ANAND – 388110 (GUJARAT)**

2014

(Reg. No. 04-1899-2012)

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(*Trigonella foenum-graecum* L.) UNDER MIDDLE GUJARAT
CONDITIONS"**

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ABSTRACT

A field experiment was conducted during *rabi* season of the year 2012 at College Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand (Gujarat) to study "Effect of vermicompost and weed management practices on growth and yield of fenugreek (*trigonella foenum-graecum* L.) under middle Gujarat conditions". The soil of the experimental field was loamy sand in texture, lower in available nitrogen (230.60 kg ha⁻¹), medium in available phosphorus (55.30 kg ha⁻¹) and higher in potassium (296.12 kg ha⁻¹) with slightly alkaline (pH 7.7) in reaction.

The experiment was laid out in factorial randomized block design with three replications. The two vermicompost levels and eight weed control treatments combination were *viz.*, Vermicompost 0 t ha⁻¹ + Weedy check (V₀W₁), Vermicompost 0 t ha⁻¹ + Hand weeding at 20 and 40 DAS (V₀W₂), Vermicompost 0 t ha⁻¹ + Pendimethalin @ 500 g ha⁻¹ as pre-emergence (V₀W₃), Vermicompost 0 t ha⁻¹ +

.....*Abstract*

Pendimethalin @ 500 g ha⁻¹ as PE *fb* HW at 30 DAS (V₀W₄), vermicompost 0 t ha⁻¹ + Oxyflourfen @ 80 g ha⁻¹ as PE (V₀W₅), vermicompost 0 t ha⁻¹ + Oxyflourfen @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS (V₀W₆), vermicompost 0 t ha⁻¹ + Oxadiargyl @ 75 g ha⁻¹ as PE (V₀W₇), vermicompost 0 t ha⁻¹ + Oxadiargyl @ 75 g ha⁻¹ as PE *fb* HW at 30 DAS (V₀W₈), Vermicompost 2 t ha⁻¹ + Weedy check (V₁W₁), Vermicompost 2 t ha⁻¹ + Hand weeding at 20 and 40 DAS (V₁W₂), Vermicompost 2 t ha⁻¹ + Pendimethalin @ 500 g ha⁻¹ as pre-emergence (V₁W₃), Vermicompost 2 t ha⁻¹ + Pendimethalin @ 500 g ha⁻¹ as PE *fb* HW at 30 DAS (V₁W₄), Vermicompost 2 t ha⁻¹ + Oxyflourfen @ 80 g ha⁻¹ as PE (V₁W₅), Vermicompost 2 t ha⁻¹ + Oxyflourfen @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS (V₁W₆), Vermicompost 2 t ha⁻¹ + Oxadiargyl @ 75 g ha⁻¹ as PE (V₁W₇), Vermicompost 2 t ha⁻¹ + Oxadiargyl @ 75 g ha⁻¹ as PE *fb* HW at 30 DAS (V₁W₈).

Result revealed that weed count, weed dry weight at 20 and 40 DAS and total weed dry weight at harvest were not influenced significantly due to different vermicompost treatments.

The various weed management practices showed significant results on weed count, weed dry weight at 20 and 40 DAS and total weed dry weight at harvest. At 20 DAS, significantly lower weed population and dry weight of monocot weeds were recorded under hand weeding carried out at 20 & 40 DAS which were remained at par with the treatments of oxadiargyl @ 75 g ha⁻¹ PE *fb* + HW at 30 DAS (W₈) and oxyflourfen @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS (W₆). Population and dry weight of dicot weeds recorded at 20 DAS were significantly lower in the treatment of hand weeding carried out at 20

and 40 DAS which were remained at par with the treatments of oxadiargyl @ 75 g ha⁻¹ PE *fb* + HW at 30 DAS (W₈) and oxyflourfen @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS (W₆).

At 40 DAS, hand weeding carried out at 20 and 40 DAS recorded significantly lower monocot weed counts. Significantly lower weed dry weight of monocot weeds were recorded under same treatment which was remained at par with the treatments of oxadiargyl @ 75 g ha⁻¹ PE *fb* + HW at 30 DAS (W₈) and oxyflourfen @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS (W₆). Significantly lower weed count and dry weight of dicot weeds were recorded under the treatment of hand weeding carried out 20 and 40 DAS which was remained at par with the treatments of oxadiargyl @ 75 g ha⁻¹ PE *fb* + HW at 30 DAS (W₈) and oxyflourfen @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS (W₆). Dry weight of total weeds recorded at harvest was significantly lower in same treatment. Maximum weed control efficiency was recorded in treatment of hand weeding carried out at 20 and 40 DAS and at harvest.

Application of vermicompost 2 t ha⁻¹ recorded significantly the highest plant height at 15 and 30 DAS and at harvest. The treatment of vermicompost 2 t ha⁻¹ recorded significantly the highest dry weight of root nodule, number of branches plant⁻¹, number of pods plant⁻¹ number of seeds pod⁻¹, test weight, seed and straw yield than the vermicompost 0 t ha⁻¹.

Hand weeding carried out at 20 and 40 DAS recorded significantly maximum plant height at 15 and 30 DAS and at harvest. The treatment of hand weeding carried out at 20 and 40 DAS also recorded significantly higher dry weight of root nodule, number of

branches plant⁻¹, number of pods plant⁻¹ number of seeds pod⁻¹, test weight, seed and straw yield which was remained at par with the treatments of oxadiargyl @ 75 g ha⁻¹ PE *fb* + HW at 30 DAS (W₈) and oxyflourfen @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS (W₆).

The cost benefit ratio was the highest under the treatment of vermicompost 0 t ha⁻¹ than the treatment application of vermicompost 2 t ha⁻¹.

The cost benefit ratio was higher under the treatment of HW carried out at 20 and 40 DAS and it was followed by pre-emergence application of oxyflourfen @ 80 g ha⁻¹ as *fb* HW at 30 DAS (W₆) and oxadiargyl @ 75 g ha⁻¹ *fb* + HW at 30 DAS (W₈) as compared to weedy check.

Thus from the yield and economics point of view, it is concluded that for securing higher yield and net returns the fenugreek crop should be manured with vermicompost 2 t ha⁻¹, coupled with weed management either through hand weeding at 20 and 40 DAS or pre-emergence application of oxadiargyl @ 75 g ha⁻¹ *fb* HW at 30 DAS or oxyflourfen @ 80 g ha⁻¹ *fb* HW at 30 DAS may suggest for loamy sand soil under middle Gujarat conditions.

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CERTIFICATE

This is certify that the thesis “**Effect of vermicompost and weed management practices on growth and yield of fenugreek (*Trigonella foenum-graecum* L.) under middle Gujarat conditions**” submitted by **Patel Chiragbhai Naginbhai**, Reg. No. **04-1899-2012** in partial fulfillment of the requirements for the award of the degree of **MASTER OF SCIENCE (AGRICULTURE)** in **AGRONOMY** of the Anand Agricultural University is a record of bonafide research work carried out by him under my personal guidance and supervision. The thesis has not previously formed the basis for award of any degree, diploma or other similar title.

Place : Anand
Date : /08/2014

(S. N. Shah)
Major Guide

DECLARATION

This is to declare that the whole of research work reported here in the thesis for partial fulfillment of the requirement for the degree of **Master of Science (Agri.) in Agronomy** by the undersigned is a result of investigation done by me under direct guidance and supervision of Dr. S. N. Shah, Associate Research Scientist, (Agronomy) Directorate of Research, A.A.U., Anand - 388110, Gujarat and no part of work has been submitted for any other degree so far.

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Towards the end of this endeavour it's my honour to extol my insight etiquette to all those who have directly or indirectly me to complete this task,

*Everything has its own beauty, but not everyone can see without critical observation and great vision. Today I stand on door of this vision only due to my Major Advisor **Dr. S. N. Shah**, Associate Research Scientist of Agronomy, Directorate of Research, Anand Agricultural University, Anand, Gujarat. This unprecedented occasion provides me an opportunity to express my deepest sense of reverence, gratitude, indebtedness and heartfelt respect to him for his clairvoyance in selecting my research topic, invaluable and inspiring guidance. His immense zeal of hard work, unfailing courtesy, never withering patience and perfection has always been a source of constant inspiration and encouragement for me during the course of present investigation.*

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Thanking you to all.....

Place: Anand

Date: /06/2013.

(Chirag N. Patel)

CONTENTS

CHAPTER NO.	TITLE	PAGE NO.
I	INTRODUCTION	1-4
II	REVIEW OF LITERATURE	5-25
III	MATERIALS AND METHODS	26-46
IV	EXPERIMENTAL RESULTS	47-91
V	DISCUSSION	92-108
VI	SUMMARY AND CONCLUSION	109-117
	BIBLIOGRAPHY	i-viii
	APPENDICES	i-ix

LIST OF TABLES

Table No.	Title	Page No.
3.1	Meteorological data recorded during crop season for the year 2012-13 (Weekly mean)	28
3.2	Physico-chemical properties of soil of the experimental plot	29
3.3	Cropping history of the experimental field	30
3.4	Details of treatment combinations	31
3.5	Details regarding herbicide used in experiment	33
	(a) Pendimethalin	
	(b) Oxyflourfen	
	(c) oxadiargyl	
3.6	Characteristics of fenugreek variety GF - 2	36
3.7	Calendar of cultural operations followed during the course of investigation	37
3.8	Information of herbicide formulation and their rate	39
3.9	Hand weeding operation carried out in experiment	40
3.10	Vermicompost application carried out in experiment	40
3.11	Chemical composition of vermicompost	41
3.12	Parameters studied during the course of investigation	45
4.1.1	Weed flora found in the experimental plot	48
4.1.2	Weed count at 20 DAS (no. m ⁻²) as influenced by varying levels of vermicompost and weed management practices	51
4.1.3	Weed count at 40 DAS (no. m ⁻²) as influenced by varying levels of vermicompost and weed management practices	54
4.1.4	Weed dry weight (g m ⁻²) at 20 DAS as influenced by varying levels of vermicompost and weed management practices	57
4.1.5	Weed dry weight (g m ⁻²) at 40 DAS as influenced by varying levels of vermicompost and weed management practices	60

4.1.6	Weed dry weight (kg ha ⁻¹) at harvest as influenced by varying levels of vermicompost and weed management practices	62
4.1.7	Weed control efficiency and weed index as influenced by different weed management practices	64
4.2.1	Plant population at 15 DAS and at harvest as influenced by varying levels of vermicompost and weed management practices	66
4.2.2	Plant height (cm) at 30 and 60 DAS and at harvest as influenced by varying levels of vermicompost and weed management practices	69
4.2.3	Dry weight of root nodule and no of branches as influenced by varying levels of vermicompost and weed management practices	72
4.2.4	Number of branches plant ⁻¹ as influenced by interaction of vermicompost and weed management practices	73
4.2.5	Visual symptoms on phytotoxicity in various doses of herbicides (Score- 0-10) on fenugreek crop	74
4.3.1	Number of pods plant ⁻¹ and number of seeds pod ⁻¹ as influenced by varying levels of vermicompost and weed management practices	77
4.3.2	Number of pods plant ⁻¹ as influenced by interaction of vermicompost and weed management practices	78
4.3.3	Days to 50% flowering and test weight as influenced by varying levels of vermicompost and weed management practices	81
4.3.4	Seed yield, straw yield (kg ha ⁻¹) and harvest index (%) as influenced by varying levels of vermicompost and weed management practices	86
4.3.5	Seed yield (kg ha ⁻¹) as influenced by interaction of vermicompost and weed management practices	87
4.3.6	Straw yield (kg ha ⁻¹) as influenced by interaction of vermicompost and weed management practices	87
4.3.7	Harvest index (%) as influenced by interaction of vermicompost and weed management practices	88
4.4.1	Gross realization, net realization and benefit cost ratio (CBR) for vermicompost and weed management treatments	89
4.4.2	Gross realization, net realization and benefit cost ratio (CBR) for treatment combinations	91

LIST OF FIGURES

Figure No.	Title	After page No.
3.1	Meteorological data recorded during crop season for the year 2011-12 (Weekly mean)	28
3.2	Lay out of experimental site	32
4.1.1	Weed count at 20 DAS (no. m ⁻²) as influenced by varying levels of vermicompost and weed management practices	51
4.1.2	Weed count at 40 DAS (no. m ⁻²) as influenced by varying levels of vermicompost and weed management practices	54
4.1.3	Weed dry weight (g m ⁻²) at 20 DAS as influenced by varying levels of vermicompost and weed management practices	57
4.1.4	Weed dry weight (g m ⁻²) at 40 DAS as influenced by varying levels of vermicompost and weed management practices	60
4.1.5	Weed dry weight (kg ha ¹) at harvest as influenced by varying levels of vermicompost and weed management practices	62
4.1.6	Weed control efficiency and weed index as influenced by different weed management practices	64
4.2.1	Plant height (cm) at 30 DAS, 60 DAS and at harvest as influenced by varying levels of vermicompost and weed management practices	69
4.2.2	Dry weight of root nodule and no of branches as influenced by varying levels of vermicompost and weed management practices	72
4.3.1	Number of pods plant ⁻¹ and number of seeds pod ⁻¹ as influenced by varying levels of vermicompost and weed management practices	77
4.3.2	Days to 50% flowering and test weight as influenced by varying levels of vermicompost and weed management practices	81
4.3.3	Seed yield and straw yield (kg ha ⁻¹) as influenced by varying levels of vermicompost and weed management practices	86
4.3.4	Harvest index (%) as influenced by varying levels of vermicompost and weed management practices	86

LIST OF PLATES

Plate No.	Title	After page No.
1	General view of experimental plot of fenugreek	32
2	Crop growth under the treatment of Vermicompost 2 t ha ⁻¹ + Weedy check (V ₁ W ₁)	99
3	Crop growth under the treatment of Vermicompost 2 t ha ⁻¹ + Hand weeding at 20 and 40 DAS (V ₁ W ₂)	99
4	Crop growth under the treatment of Vermicompost 2 t ha ⁻¹ + Oxadiargyl @ 75 g ha ⁻¹ as PE <i>fb</i> HW at 30 DAS	99
5	Crop growth under the treatment of Vermicompost 2 t ha ⁻¹ + Oxyflourfen @ 80 g ha ⁻¹ as PE <i>fb</i> HW at 30 DAS	99

LIST OF APPENDICES

Sr. No.	Title	Page No.
I	Cost of cultivation of fenugreek and other details of cost incurred	i-vi
II	Analysis of variance of studied parameters	vi-ix

LIST OF ABBREVIATIONS

Anon.	Anonymous
<i>a.i</i>	Active ingredient
Av.	Average
@	At the rate
⁰ C	Degree Celsius
C. D.	Critical difference
CBR.	Cost benefit ratio
C.V.	Co-efficient of variation
cm	Centimeter
cv.	Cultivars
DAS	Days after sowing
dsm ⁻¹	Deci siemens per meter
Dist.	District
<i>e.g.</i>	Example
EC	Electrical conductivity
EC	Emulsifiable concentration
<i>et al.</i>	Et alii: and others
<i>etc</i>	Etcetera, and rest, so on
Fig.	Figure
fb	Followed by
G	Gram
ha ⁻¹	Per hectare
Hour ⁻¹	Per hour
H.P.	Himachal pradesh
HW	Hand Weeding
i.e.	That is
IC	Interculturing

K ₂ O	Potassium oxide
Kg	Kilogram
Kg ha ⁻¹	Kilogram per hectare
m	Meter
Max.	Maximum
Min.	Minimum
ml	Milliliter
MT	Metric tone
N	Nitrogen
No.	Number
NS	Non significant
Pa	Pascal
pH	Potential of hydrogen ion
PE	Pre Emergence
PoE	Post Emergence
P ₂ O ₅	Phosphorus pentoxide
%	Per cent
R.H.	Relative humidity
RDF	Recommended dose of fertilizer
₹	Rupees
₹ ha ⁻¹	Rupees per hectare
S.Em. ±	Standard error of mean
Sig.	Significant
Std.	Standard
S.L	Soluble liquid
Var.	Variety
viz.	Namely
WCE	Weed control efficiency
WI	Weed index
Y	Yield

I. INTRODUCTION

Spices are used for flavour, colour, aroma and preservation of food or beverages. Spices may be derived from many parts of the plant *viz.* bark, buds, flowers, fruits, leaves, rhizomes, roots, seeds, stigmas and styles or the entire plant tops. The term 'herb' is used as a subset of spice and refers to plants with aromatic leaves. In terms of world trade value, the most important spice crops from the tropical regions are pepper, capsicums, nutmeg/mace, cardamom, allspice/pimento, vanilla, cloves, ginger, cinnamon and cassia, and turmeric. Coriander, cumin, mustard, and fenugreek seeds and the herbs sage, oregano, thyme, bay and the mints are the most important spice crops from non-tropical environments.

Fenugreek (*Trigonella foenum-graecum L.*) locally known as '*methi*' belonging to the family- Leguminosae and Sub family-Papilionacea is widely used as spice and condiment to add flavor in various foods.

Fenugreek seeds is used as a spice and fenugreek leaves are eaten as vegetable in India, China and the Middle East for centuries. The practitioners of Ayurvedic and Traditional Chinese Medicine have used and documented *methi* seeds for its many medicinal uses. The spice is exported in its whole and powdered forms as well as in the form of extracted oil which is extensively used as herbal supplements, therapeutic applications, culinary, tea, perfumery and dye. The major importers of Indian fenugreek are Saudi Arabia, Japan, Malaysia, USA, the UK, Singapore and Sri Lanka.

Fenugreek plant is a quick growing annual leguminous herb about 2 feet in height. Leaves are light green in color. Plant stems are long and slender. Fenugreek leaves are tripartite, toothed, grey-green obovate leaves, 20-25 mm long. Fenugreek seed pods contain ten to twenty small, flat, yellow-brown, pungent, aromatic seeds. Fenugreek seeds are small and stony; about 1/8 inch long, oblong, rhomboidal, with a deep furrow dividing them into two unequal lobes. Fenugreek seeds have a strong aroma and bitter in taste. Plants mature in about four months. The whole plant is uprooted and allowed to dry. The seeds are threshed out and further dried.

Fenugreek occupies an area of 94,760 ha with the production of 127.85 lakh tones and average productivity of 1349.19 kg ha⁻¹ in India and it occupied an area of 5244 ha with the production of 13.96 lakh tones and average productivity of 2652 kg ha⁻¹ in Gujarat state during the year 2012-2013 (Anon., 2013). Major producing states are Rajasthan, Madhya Pradesh, Gujarat, Uttar Pradesh, and Tamil Nadu. Of these, Rajasthan stands out as the single largest producer, contributing 87% of the total production of Indian fenugreek. It is used as a condiment for flavouring of foods. It has got medicinal value, hence used as medicine. Another species of fenugreek known as “Kasuri” or “Champa Methi” (*Trigonella corniculata*) belonging to same family is also cultivated in some states of India.

Fenugreek is cultivated as leafy vegetable, condiment and medicine. Fenugreek is cultivated worldwide under semi-arid agro-climatic condition having potential to fix atmospheric nitrogen and tolerant to mild salinity.

India is one of the major producer and exporter of fenugreek. Its seeds are used as condiment and vegetable for human consumption and concentrate for cattle feed. Its fresh and tender leaves are rich in iron, calcium, protein, vitamins and essential amino acids. Besides, it has medicinal value, as it prevents constipation, removes indigestion, stimulates digestive process and metabolism. Seeds are used for the treatment of diabetes, dysentery, diarrhea and rickets. Diosgenin which is extracted from the seeds is used in synthesis of sex hormones. Its roots are endowed with mini factory to synthesize nitrogen for plant. Thus, its cultivation enriches the soil in nitrogen. Fenugreek seed contain dietary fibre 45.4% (insoluble 32.1% and soluble 13.3%), protein 36%, oil 6%, ash 3.2%, starch 1.6%, sugar 0.4% (Anon., 2011).

Nutrient supply through organic manures can hardly fulfill the need of crop. Application of organic manure like farm yard manure or vermicompost when integrated with recommended dose of inorganic fertilizer result in improved soil fertility, growth and yield of fenugreek (Subbian and Palaniappan, 1992). Vermicompost enhances germination, plant growth, and crop yield, improves root growth and structure and enriches soil with micro-organisms (Anon., 2011).

Weed is important factor responsible for causing tremendous loss in fenugreek owing to initial slow growth which leads to severe crop-weed-competition and reduce growth and yield by as high as 91.4% (Mali and Suwalka, 1987). Weeds offer maximum competition to fenugreek for essentials of growth at its early stage of 25 days. Weeds reduce the seed yield to the tune

.....*Introduction*
of 14.2 to 69.0% depending upon their density and duration of competition (Kumar *et al.*, 2005). Lack of adequate and timely availability of labour inputs for weed management causes innumerable yield losses. Therefore, herbicidal weed management seems to be an appropriate proposition. Because of adsorbing effect of vermicompost to the herbicides, long lasting control of weed can be obtained. Looking to this, present experiment “Effect of vermicompost and weed management on growth and yield of fenugreek (*Trigonella foenum-graecum* L.) under middle Gujarat conditions is planned out with following objectives.

OBJECTIVES:

- (1) To study the effect of vermicompost on growth and seed yield of fenugreek.
- (2) To evaluate the efficacy and phytotoxicity of different herbicides for management of weeds in fenugreek.
- (3) To study the effect of different weed management practices on growth and seed yield of fenugreek.
- (4) To study the interaction effect of vermicompost and weed management practices on growth and seed yield of fenugreek as well as on weeds.

II. REVIEW OF LITERATURE

The work done on weed management in fenugreek is limited hence similar work on other related crops have also been presented wherever felt necessary. A brief summary of research work carried out by various research workers in India on weed flora, losses caused by weeds, effect on weeds and effect on growth and yield of fenugreek has been highlighted and reviewed under following heads:

2.1 Weed flora in fenugreek

2.2 Losses caused by weeds in fenugreek

2.3 Effect of weed management practices on weed parameters

2.4 Effect of vermicompost on growth and seed yield of fenugreek

2.5 Effect of weed management practices on growth and yield of fenugreek

2.6 Interaction effect of vermicompost and weed management practices on growth and yield of fenugreek

2.7 Economics of weed management

2.1 Weed flora in fenugreek

Weed flora is an integral part of each and every crop as well as cropping system. Their interference with crop plant is natural. Because of high competitive ability of weed and allelopathic influence, weed causes maximum damage to the crops. Knowledge on the composition of weed flora in a particular crop and their correct identity are necessary to formulate effective measures for their control.

Patel and Mehta (1989) conducted a field trial at Anand, (Gujarat) on integrated weed management in cumin in *rabi* season during the year 1985-86 and observed *Chenopodium album*, *Eragrostis tenella* and *Digitaria adscendens* as predominant weeds.

Chaudhary and Gupta (1991) at Jobner, (Rajasthan) studied the response of cumin to nitrogen application, weed control and sowing methods. The dominant weed flora recorded in the experiment were *Chenopodium murale* L., *C. album* L., *Melilotus indica* L., *Heliotropium ellipticum* Ladebour, *Plantago punmila* Wild. and *Sinesis arvensis* L.

Chaudhary (1999) at Jobner, (Rajasthan) had taken field trial on weed management in fenugreek. Pre dominant weed flora in the experimental plot were *Chenopodium murale* L., *Heliotropium ellipticum*, *Chenopodium album* L. and *Melilotus indica* L.

Zalavadia *et al.* (1999) conducted an experiment at Junagadh, (Gujarat) to study the integrated weed management in fenugreek and reported weed flora at experimental site included monocots viz., *Cynodon dactylon*, *Brachiaria* spp., *Echinochloa crusgalli* and *Dactyloctenijum aegyptium*, sedges viz., *Cyperus rotundus* L. and dicots viz., *Indigofera glandulosa*, *Digera arvensis*, *Portulaca oleracea*, *Tridex procumbenes*, *Chenopodium album*, *Amranthus viridis* L., *Celosia argentia* and *Euphorbia hirta*.

Senthivel (2001) studied the efficacy of four herbicides for controlling weeds in coriander during the year 1994-95 in Tamil Nadu. The predominant weeds viz., *Panicum repens*, *Cynodon dactylon*, *Cyperus*

rotundus, *Celosia argentea*, *Vicoa indica*, *Trianthema portulacastrum* and *Tridax procumbens* were observed at experimental site.

Shukla *et al.* (2003) carried out an experiment during *rabi* season of the year 2001-02 in Uttaranchal, India. The main weeds species *Oxalis corniculata*, *Argemone mexicana* and *Phalaris minor* were present in coriander experiment.

Yadav and Dahama (2003) conducted an experiment at Mandor, (Rajasthan) to determine the effect of planting date, irrigation and weed control method on yield and water use efficiency of cumin. The dominant weed flora recorded in the experiment were *Chenopodium murale* L., *C. album* L., *Rumex dentatus* L., *Asphodelus tenuifoliosus* L., *Cynodon dactylon* L. and *Melilotus indica* L.

Patel *et al.* (2004) at Anand, Gujarat observed major weed flora viz. *Chenopodium murale* L., *C. album* L., *Cyperus rotundus* L., *Dactyloctenium aegyptium* L. and *Phyllanthus niruri* L. in their experiment on influence of nitrogen and weed management practices on weeds and coriander.

The major weed flora observed by Kumar *et al.* (2005) at Pantnagar, (Uttaranchal) on sandy loam textured soil in fenugreek field were *Gnaphalium indicum*, *Chenopodium album*, *Fumaria parviflora*, *Anagallis arvensis*, *Phalaris minor*, *Oxalis corniculata*, *Cyperus rotundus* L., *Solanum nigrum* and *Cynodon dactylon*.

Patel *et al.* (2005) conducted an experiment on influence of irrigation schedule and weed management practices on growth and yield of

fenugreek (*Trigonella foenum-graecum* L.) at Anand, (Gujarat) during winter seasons of the year 2002-03 and 2003-04. They recorded *Chenopodium album*, *Chenopodium murale*, *Melilotus indica*, *Cyperus rotundus* L., *Asphodelus tenuifolius* as major weeds while *Erargostis major*, *Dactyloctenium aegyptium*, *Eleusine indica*, *Phyllanthus niruri* and *Portulaca oleracea* as minor weeds in fenugreek field.

Sagarka *et al.* (2005) conducted a field experiment during the winter seasons of the year 2000-01 to 2003-04, at Junagadh, (Gujarat) to evaluate the efficacy of an integrated approach for controlling the weeds of coriander. The major weeds in the experimental field were *Cyperus rotundus* (33 per cent), *Digera arvensis* (32 per cent), *Aeluropus villosus* (19 per cent) and *Dactyloctenium aegyptium* (4 per cent).

Tewari *et al.* (2005) carried out an experiment during the year 1998-99 and 1999-2000 at Kanpur, (Uttar Pradesh) to evaluate the efficacy of herbicides against weeds in coriander. The major weeds in the experimental field were *Coronopus didymus* (64.6 per cent), *Chenopodium album* (18.4 per cent), *Anagallis arvensis* (11.9 per cent), *Melilotus alba* (2.4 per cent) and *Phalaris minor* (2.6 per cent).

Mehriya *et al.* (2008) conducted a field trial at Jodhpur, (Rajasthan) to determine the effect of different weed management practices on the yield of cumin. *Chenopodium murale*, *C. album* and *Rumex dentatus* were the predominant weeds in the experimental field.

Nagar *et al.* (2009) conducted a field experiment during the winter seasons of the year 2003-04 and 2004-05 at Udaipur, (Rajasthan) to study the effect of integrated weed and nutrient management on weed density and productivity of coriander. The most pre-dominant weeds viz., *Chenopodium murale*, *Spergula arvensis* and *Melilotus indica* were observed during experimentation.

2.2 Losses caused by weeds in fenugreek

Weeds cause enormous losses, farmers are suffering to a great extent by way of reduction of crop yields, quality, wastage of human energy, resources and also increased the expenditure.

Out of the total annual loss of agricultural produce from various pests in India, weed account for 45 per cent, insects 30 per cent, diseases 20 per cent and other pests 5 per cent (Rao, 1983).

Mali and Suwalka (1987) carried out an experiment on studies on weed control in fenugreek at Jobner (Rajasthan) in *rabi* season of the year 1982-83. They found that weed reduces yield up to 91.4 per cent in fenugreek.

Raghvani *et al.* (1987) conducted an experiment during *rabi* seasons of the year 1981-84 at GAU, Junagadh (Gujarat) and reported that appreciable yield loss in cumin at the extent of 30 to 80 per cent was caused by weeds.

Parihar and Singh (1994) at Mandor, Jodhpur (Rajasthan) studied the effect of cultural and herbicidal weed management on the yield of cumin. They observed that uncontrolled weed growth reduced the yield up to 80-90 per cent in cumin.

Dungarwal *et al.* (2002) carried out an experiment on herbicidal weed management in fenugreek during winter seasons of the year 1998-99 and 1999-2000 at Udaipur, (Rajasthan). They observed that uncontrolled weed growth reduced seed yield by 26.4 per cent.

Shukla *et al.* (2003) conducted an experiment during *rabi* season of the year 2001-02 at (Uttaranchal), India. Results revealed that uncontrolled weed growth caused 73.9 per cent reduction in coriander seed yield as compared to weed-free conditions.

A field experiment was conducted on efficacy of herbicides on weed and seed yield of fenugreek (*Trigonella foenum-graecum* L.) at G. B. Pant University and Technology, Pantnagar (U.K) by Kumar *et al.* (2005). They observed that uncontrolled growth of weeds resulted in 93.7 per cent reduction in seed yield of fenugreek as compared to the weed free check.

Tewari *et al.* (2005) conducted an experiment during 1998-99 and 1999-2000 at Kanpur, (Uttar Pradesh), to evaluate the efficacy of herbicides against weeds in coriander. Allowing weed growth throughout the crop period resulted in 45.8 per cent reduction in seed yield as compared to manual weeding twice at 20 and 40 DAS.

Tripathi and Singh (2008) studied efficacy of herbicides on weed infestation and seed yield of fenugreek at Pantnagar, (U. K). They stated that uncontrolled growth of weeds reduced the seed yield of fenugreek by 86.3 per cent.

2.3 Effect of weed management practices on weed parameters

Zalavadia *et al.* (1999) conducted an experiment on integrated weed management in fenugreek at Junagadh, (Gujarat) during winter season of 1994-95. They observed that the application of fluchloralin @ 0.90 kg ha⁻¹ fb hand weeding at 30 DAS was 98.87 % efficient in reducing the dry weight of weeds which was at par with application of pendimethalin @ 0.60 kg ha⁻¹ fb hand weeding at 30 DAS and 2 hand weeding at 20 and 40 DAS were 98.55 and 96.94% efficient in this regard, respectively.

Senthivel (2001) at Gandhigram, (Tamilnadu) conducted an experiment during winter season of 1994-95 to study the chemical weed control in rainfed coriander. Minimum dry weight of weeds was recorded in pendimethalin treated plot *i.e* 14.8 and 1.9 kg ha⁻¹ at 40 DAS and at harvest, respectively.

A field experiment was conducted by Dungarwal *et al.*, (2002) during *rabi* season of the year 1998-99 and 1999-2000 at Department of Agronomy, MPUAT, Udaipur (Rajasthan) to evaluate weed control efficacy of pendimethalin, metolachlor, fluchloralin and trifluralin in fenugreek (*Trigonella foenum-graecum* L.). They observed that maximum weed control efficiency was recorded with the weed free check at all the stages followed by pendimethalin at 1.0 kg ha⁻¹ which was 61.7, 72.7, 71.8 and 81.6% at 25, 45, 65 days after sowing and at harvest, respectively.

Patel *et al.* (2004) conducted an experiment on influence of nitrogen and weed management on weeds and coriander at Anand, (Gujarat). They

found that pre-emergence application of oxadiazon @ 0.5 kg ha⁻¹ caused maximum reduction in weed density and dry weight of weeds followed by pendimethalin @ 0.75 kg ha⁻¹ and thus resulted in higher weed control efficiency of 95.0 and 93.1 per cent, respectively.

Sagarka *et al.* (2005) conducted an experiment during 2000-01 to 2003-04, at Junagadh, (Gujarat) on integrated approach in controlling the weeds of coriander. Integration of herbicide (Fluchloralin, pendimethalin, oxyflourfen) with HW at 30 DAS was effective in reducing total weed density (3.72, 3.46 and 4.64 No. m⁻²) and dry weight of weeds (7.3, 5.5 and 10.7 g m⁻²), respectively.

Tewari *et al.* (2005) conducted an experiment during 1998-99 and 1999-2000, at Kanpur, (Uttar Pradesh), to evaluate the efficacy of herbicides against weeds in coriander. Hand weeding at 20 and 40 DAS and pre-emergence application of pendimethalin @ 1.0 kg ha⁻¹ were effective in controlling the weeds in coriander.

Patel *et al.* (2006) at Anand Agricultural University, Anand (Gujarat) conducted a field experiment during the *rabi* seasons of 2003- 04 and 2004-05 to study the effect of FYM, molybdenum and weed management practices on weeds, yield attributes and yield of chickpea. They revealed that IC+HW carried out at 20 and 40 DAS and oxadiargyl @ 0.075 kg ha⁻¹ recorded minimum density and dry weight of weeds with the weed control efficiency of 77 and 72%.

Mehriya *et al.*, (2008) conducted a field experiment during the winter seasons of the year 2003-04 and 2004-05 at Agricultural Research

Station, Jodhpur (Rajasthan). They observed that application of oxiflurofen @ 50 and 75 g ha⁻¹ at 20 DAS with one hand weeding resulted in significantly lower weed population (2.2 m⁻²) with improved weed control efficiency (96.2%) in cumin.

Meena and Mehta (2009)^a conducted an experiment at National Research Centre on Seed Spices, Ajmer (Rajasthan) during the *rabi* season of 2005-07 to study the integrated weed management in coriander. Among the weed management practices, weed-free treatment was most effective in reducing the dry weight of weeds and recorded maximum weed control efficiency (85.94 per cent), followed by pre-emergence application of oxadiargyl @ 75 g ha⁻¹ + hand weeding at 45 days after sowing (78.31 per cent).

Meena and Mehta (2009)^b conducted an experiment at National Research Centre on Seed Spices, Ajmer (Rajasthan), during the *rabi* season of 2007-09 to find out most suitable and economical method of weed control in fennel. Besides weed free treatment, minimum dry weight of weeds (3.97 q ha⁻¹) and weed index (3.54 per cent) as well as highest WCE (95.48 per cent) were recorded with oxadiargyl @ 75 g ha⁻¹ + HW at 45 DAS and remained at par with pendimethalin @ 1.0 kg ha⁻¹ + HW at 45 DAS.

Nagar *et al.* (2009) conducted an experiment at Udaipur, (Rajasthan) on effect of weed and nutrient management on growth, yield and quality of coriander (*Coriandrum sativum* L.). Results revealed that hand weeding twice (HW) at 30 and 45 days after sowing (DAS) and pre-emergence application of pendimethalin @ 1.0 kg ha⁻¹ + hand weeding at 45 DAS were being

significantly reduced the density and dry weight of weeds as compare to other treatments.

Sharma (2009) conducted a field experiment at Agricultural Research Station, RAU, Bikaner (Rajasthan) during the *rabi* season of the year 2003-04 and 2006-07 in fenugreek and found maximum weed control efficiency (63%) with two hand weeding at 20 and 40. Among the herbicides, pre plant incorporation of fluchloralin 1.0 kg ha⁻¹ had the highest WCE (56.3%) followed by oxyflourfen 0.30 kg ha⁻¹ + one hand weeding at 30 DAS (53.0%).

Roy *et al.* (2010) at Samastipur, (Bihar) carried out a field experiment on weed management in coriander during *rabi* seasons of 2007-09. Results revealed that the lowest weed count, dry weight of weeds and the highest WCE were recorded under the treatment of pendimethalin @ 1.0 kg ha⁻¹ (PE) in bed planting system which was followed by the same treatment pendimethalin @ 1.0 kg ha⁻¹ (PE) in zero tillage.

A field experiment was conducted by Yadav *et al.* (2010) during the *rabi* season of the year 2008-09 at S.D.A.U. (Gujarat) to evaluate the suitable method for weed management in cumin. They found that application of oxadiargyl @ 50 g ha⁻¹ applied at 20 DAS *fb* 1 HW was found more effective in reducing weed population and resulted in highest weed control efficiency (82%) and lowest weed index (1.82%).

Yadav *et al.* (2010) carried out field experiment to evaluate the effect of weed management on weed and yield of coriander during *rabi* seasons of 2007-09 at Gwalior (M.P). They found that pendimethalin @ 1.0 kg ha⁻¹ and

isoproturon @ 0.75 kg ha⁻¹ each as PE *fb* HW at 30 DAS significantly reduced weed density and weed biomass.

2.4 Effect of vermicompost on growth and seed yield of fenugreek

Rajkhowa *et al.* (2000) conducted an experiment at Jorhat, (Assam) to study the effect of vermicompost on greengram nutrition. They observed that significantly higher dry matter (14.7 g plot⁻¹) and seed yield (8.3 g plot⁻¹) were obtained with the application of 75 % N as urea along with 5 t ha⁻¹ vermicompost and it was at par with application of N as vermicompost.

Kumari and Kumari (2002) conducted an experiment on effect of vermicompost enriched with rock phosphate on growth and yield of cowpea at Thiruvananthapuram, (Kerala). They found that the maximum value of yield contributing characters (pods plant⁻¹, number of seeds pod⁻¹, and test weight) and grain yield (1072 kg ha⁻¹) were recorded by enriched vermicompost.

Khiriya and Singh (2003) conducted a field experiment during *rabi* season of 1996-97 and 1997-98 at CCS Haryana Agricultural University, Hissar and they recorded that each successive dose of FYM up to 15 t ha⁻¹ significantly increased the growth parameters and yield attributing characters, seed yield and quality parameters of fenugreek.

Effect of organic manures (castor cake, mustard cake and FYM) alone or in combination with inorganic fertilizers was studied during 1997-2000 on yield, quality and economics of winter fennel at Main Spice Research Station, Jagudan, Gujarat by Patel *et al.* (2003). They recorded that the maximum net

profit (Rs 90, 393 ha⁻¹) and BCR (1 : 5.14) were obtained when recommended dose of fertilizer (N : P : K 90 : 45 : 0 kg ha⁻¹) applied through FYM alone.

Jat and Ahlawat (2004) conducted a field experiment on effect of vermicompost, biofertilizer and phosphorus on growth, yield and nutrient uptake by gram and their residual effect on fodder maize during winter and summer season of 1999-2000 and 2000-2001 at IARI, (New Delhi). They revealed that the application of vermicompost at 3 t ha⁻¹ resulted in higher dry matter (19.78 g plant⁻¹), pods plant⁻¹ (27.38), seed (2.35 t ha⁻¹) and straw yield (3.18 t ha⁻¹) of chickpea.

Patel *et al.* (2006) at Anand Agricultural University, Anand, (Gujarat) during the *rabi* seasons of 2003- 04 and 2004-05 conducted a field experiment to study the effect of FYM, molybdenum and weed management practices on weeds, yield attributes and yield of chickpea. They revealed that Seed and straw yields were recorded significantly higher under 5 t ha⁻¹ FYM + 1.5 kg ha⁻¹ Mo.

Deora *et al.* (2009) conducted a field experiment at Bikaner, (Rajasthan) during *rabi* 2005-06 to study on nutrient management and seed rate on growth and herbage yield of fenugreek. They revealed that the vermicompost @ 4 t ha⁻¹ significantly improved growth and yield attributes of fenugreek.

Sutaria *et al.* (2010) conducted a field experiment to study the response of legume crops (greengram, blackgram, cowpea) to enriched vermicompost under rainfed conditions for successive six years (2001-2006) at

Dry farming Research Station, Targhadia (Gujarat). They found that maximum grain yield (668 kg ha^{-1}) of greengram was recorded with 50 % RDF + 1 t ha^{-1} vermicompost, while that of blackgram (1029 kg ha^{-1}) and cowpea (825 kg ha^{-1}) with application of 100 % RDF.

Singh and Sharma (2011) carried out a field experiment at K V K, R.V.S Krishi Vishwa Vidyalaya, Morena, (Madhya Pradesh) during *rabi* season of 2004-05 and 2005-06 to study the effect of phosphorus and microbial inoculation on productivity, nutrient availability in soil and uptake of nutrients by chickpea (*Cicer arietinum*) grown on sandy loam soil. They found that maximum grain yield (2639 kg ha^{-1}) and stover yield (2978 kg ha^{-1}) of chickpea was recorded with addition of recommendation dose of P through P-enriched vermicompost along with *Rhizobium* and PSM inoculation, followed by 2575 kg ha^{-1} grain yield and 2916 kg ha^{-1} stover yield with application of recommended dose of P through P-enriched vermicompost and *Rhizobium* inoculation.

Yadav and Kumavat (2011) carried out a field experiment on effect of zinc and vermicompost on fenugreek (*Trigonella foenum-graecum* L.) under irrigation with different RSC water during *rabi* season at SKN college of Agriculture, Jobner (Rajasthan). They found that application of vermicompost 1.25 t ha^{-1} significantly increased the plant height (36.50 cm), seed index (1.05%) and seed yield (15.55).

Dhayal *et al.* (2012) conducted a field experiment to study the effect of integrated nitrogen management on soil properties and performance of

fenugreek at Agronomy farm S.K.N. College of Agriculture, Jobner, (Rajasthan) during *rabi* 2008-09. They observed that the application of 100 % RDN through FYM significantly increased the yield attributes, dry weight of root nodules, seed and straw yield, net return and B:C ratio followed by application of 75 % RDN through vermicompost + 25 N through DAP over control.

A field experiment was conducted at Pantnagar (Uttra Khand) in *rabi* season of the year 2007-08 to evaluate the response of integrated nutrient management on nutrient uptake, protein content and seed yield of fenugreek (*Trigonella foenum-graecum* L.) by Dubey *et al.*, (2012) and observed that application of vermicompost 5 t along with Rhizobium + 40 kg N/ha recorded significantly the highest seed yield (449.57 kg ha) and protein content (21.75%). The yield increment was in the tune of 70.69 % over control.

Pandey *et al.* (2012) conducted an experiment during rainy-cum-winter season of 2009-11 to study the effect of organic and inorganic source of nutrients on growth and yield of turmeric. They recorded that application of FYM @ 10 t ha⁻¹ resulted in maximum growth, fresh yield of rhizome (103 q ha⁻¹) and net income (3.06 lac ha⁻¹).

An experiment was conducted at Department of Plant Breeding and Genetics, PAU, Ludhiana, (Panjab) in *rabi* season of 2001-02 by Singh *et al.*, (2012). They found that chickpea grain yield (1567 kg ha⁻¹), plant height (62.2 cm) and 100-seed weight (14.3 g) were successive increase with application of vermicompost from 0 to 3 t/ha seemed to be optimum dose.

A field experiment was conducted at Central Institute of Medicinal and Aromatic Plant, Lucknow, (Uttar Pradesh) during 2009-10 by Upadhyay *et al.* (2012) to study the response of FYM, vermicompost (VC), inorganic input and integrated weed management on yield of mint. The results revealed that application of 40 : 20 : 20 kg NPK ha⁻¹ + FYM @ 5 t ha⁻¹ + VC @ 2 t ha⁻¹ in conjunction with hand weeding at 30, 60 and 90 + pendimethalin @ 11 a.i ha⁻¹ as pre-emergence recorded highest fresh herb yield of mint (240.5 q ha⁻¹).

A field experiment was conducted at Akola, Maharashtra during *kharif* season to study the effect of organic source on fertility, nutrient uptake and yield of soybean by Laharia *et al.* (2013). They found that the significantly higher yield of grain (16.70 q ha⁻¹) and straw yield (30.27 q ha⁻¹) was recorded by application of 100 % RDN through vermicompost + jeevamrut which was at par with 100 % RDN through vermicompost and 100 % RDN through FYM + jeevamrut.

2.5 Effect of weed management practices on growth and yield of fenugreek

Rathore *et al.* (1990) conducted an experiment in the *rabi* season during 1986-87 on effect of weed control measure on growth and yield of cumin. Result revealed that all treatments enhanced yields of cumin in comparison to the unweeded control. Best crop yield of 1.76 q ha⁻¹ was achieved with pendimethalin @ 1.0 kg ha⁻¹ as compared to rest of the treatments.

Chaudhary (1999) studied the effect of weed management on fenugreek (*Trigonella foenum-graecum* L.) at Jobner (Rajasthan) during the

year 1991-94. He found that maximum mean seed yield of 16.15 q ha⁻¹ was obtained with fluchloralin @ 0.75 kg ha⁻¹ supplemented with hand weeding once, closely followed by hand weeding twice, weed free and oxyflourfen @ 0.15 kg ha⁻¹ supplemented with hand weeding once.

Zalavadia *et al.* (1999) conducted an experiment on integrated weed management in fenugreek at Junagadh, (Gujarat) during winter season of 1994-95. They observed that the application of fluchloralin @ 0.90 kg ha⁻¹ *fb* hand weeding at 30 DAS was recorded higher seed (16.15 q ha⁻¹) and straw yield (26.78 q ha⁻¹) which was at par with application of pendimethalin @ 0.60 kg ha⁻¹ *fb* hand weeding at 30 DAS and 2 hand weeding at 20 and 40 DAS were recorded 15.95 q/ha and 16.50 q/ha seed yield, respectively.

Senthivel (2001) at Gandhigram, (Tamilnadu) conducted an experiment during *rabi* season of 1994-95 to study chemical weed control in rainfed coriander. They concluded that seed yield of coriander was higher in weed-free (1015 kg ha⁻¹) followed by hand weeding twice (815 kg ha⁻¹).

An experiment was conducted by Dungarwal *et al.*, (2002) at Department of Agronomy, MPUAT, Udaipur (Rajasthan) during *rabi* season of the year 1998-99 and 1999-2000 on herbicide weed management in fenugreek (*Trigonella foenum-graecum* L.). Pre- emergence application of pendimethalin at 1.0 kg ha⁻¹ was found most effective in controlling weeds which enhanced growth and yield components and resulted in production of higher seed yield (1118 kg ha⁻¹).

Singh *et al.* (2002) conducted an experiment at Hisar, (Haryana) during 1999-2000. Result revealed that weed-free treatment recorded higher

seed yield (14.62 q ha⁻¹) followed by pendimethalin @ 1.5 kg ha⁻¹ (13.86 q ha⁻¹) in coriander.

Tewari *et al.* (2005) conducted an experiment during 1998-99 and 1999-2000, at Kanpur, (Uttar Pradesh), to evaluate the efficacy of herbicides against weeds in coriander. Pre-emergence application of pendimethalin @ 1.0 kg ha⁻¹ and pretilachlor @ 1.5 kg ha⁻¹ recorded 54.6 and 50.7 per cent higher seed yield, respectively over weedy check.

Patel *et al.* (2006) at Anand Agricultural University, Anand during the *rabi* seasons of 2003- 04 and 2004-05 conducted a field experiment to study the effect of FYM, molybdenum and weed management practices on weeds, yield attributes and yield of chickpea. They revealed that IC+HW at 20 and 40 DAS recorded significantly higher seed (1409 kg ha⁻¹) and straw yields (1685 kg ha⁻¹) as compared to rest of the treatments except oxadiargyl at 0.075 kg ha⁻¹ and pendimethalin at 0.75 kg ha which were at par.

Kamboj *et al.* (2007) conducted a field experiment to find out economics of weed control treatments in fenugreek during *rabi* season of 1999-2000 at Hissar, (Haryana). The data revealed that pendimethalin @ 0.50 kg ha⁻¹ with one hand weeding at 40 DAS recorded maximum seed yield (17.53 q ha⁻¹) followed by oxyflourfen @ 0.10 kg ha⁻¹ with one hand weeding at 40 DAS (17.20 q ha⁻¹).

Patel *et al.* (2008) conducted a field experiment at Anand, (Gujarat) to study on chemical weed control in cumin during 2002-04. They found that application of pendimethalin @ 1.0 kg ha⁻¹ significantly increased plant height,

branches plant⁻¹ and ultimately seed yield (440 kg ha⁻¹) of cumin over rest of the treatments.

Nagar *et al.* (2009) conducted an experiment during the *rabi* seasons of 2003-04 and 2004-05 at Udaipur, (Rajasthan). Hand weeding twice (HW) at 30 and 45 days after sowing (DAS) and pre-emergence application of pendimethalin @ 1.0 kg ha⁻¹ + one hand weeding at 45 DAS significantly increased yield attributes (umbels, umbellate, test weight) of coriander resulting in higher seed yield of 1.58 and 1.57 t ha⁻¹, respectively.

Sharma (2009) carried out a field experiment on integrated weed management in fenugreek (*Trigonella foenum-graecum* L.) during the *rabi* season of the year 2003-04 and 2006-07 at Bikaner (Rajasthan). Results revealed that pre emergence application of pendimethalin 0.75 kg ha⁻¹ *fb* one hand weeding at 30 DAS had positive impact on plant height (45.8), branches plant⁻¹ (5.9) and seed yield (1660 kg ha⁻¹) which was at par with oxyflourfen @ 0.30 kg ha⁻¹ as PE + HW at 30 DAS.

Mehta *et al.* (2010) conducted a field experiment on fenugreek during *rabi* seasons of 2006-07 and 2007-08 at Sardarkrushinagar, (Gujarat). They observed that application of pendimethalin @ 0.75 kg ha⁻¹ + IC at 40 DAS and HW at 20 and 40 DAS were found as effective as weed free treatment in respect of yield attributes, seed and biological yield.

Meena *et al.* (2013) conducted an experiment to study on influence of weed control methods on yield, quality and economics in dill seed during *rabi* season of 2011-12 at S. K. Nagar, (Gujarat). They found that the higher grain (1294 kg ha⁻¹) and straw yield (2255 kg ha⁻¹) were recorded under weed

free treatment which was at par with pendimethalin 0.5 kg ha⁻¹ PE + oxadiargyl @ 75 g ha⁻¹ PoE at 20 DAS, pendimethalin 0.5 kg ha⁻¹ PE with one hand weeding at 30 DAS and pendimethalin 0.5 kg ha⁻¹ PE + oxadiargyl @ 50 g ha⁻¹ PoE at 20 DAS.

2.6 Interaction effect of vermicompost and weed management practices on growth and yield of fenugreek

Singh and Singh (2005) conducted an experiment on effect of organic manures and herbicides on yield and yield attributing characters of wheat during *rabi* season of 1999-2000 and 2000-2001 at Hisar, (Haryana). The results revealed that the higher yield in interaction effect was observed under vermicompost 15 t ha⁻¹ conjunction with weed free condition (49.17 q ha⁻¹) which was at par with vermicompost 15 t ha⁻¹ conjunction with metsulfuron @ 4 g ha⁻¹ (47.53 q ha⁻¹).

A field experiment was conducted at Central Institute of Medicinal and Aromatic Plant, Lucknow during 2009-10 to study the effect of FYM, vermicompost, chemical fertilizer and integrated weed management on yield, yield contributing characters and quality of mint (*Mentha arvensis* L.) by Upadhyay *et al.* (2012). They found that application of 40 : 20 : 20 kg NPK ha⁻¹ + FYM @ 5 t ha⁻¹ + vermicompost @ 2 t ha⁻¹ in conjunction with hand weeding at 30, 60 and 90 DAS + pendimethalin @ 1 kg a. i ha⁻¹ as pre-emergence (T₅W₄) recorded the highest number of branches (36.5) and fresh herb yield of mint (240.5 q ha⁻¹).

2.7 Economics of weed management

Patel and Mehta (1989) conducted a field trial at Anand, Gujarat on integrated weed management in cumin in *rabi* season during 1985-86 and stated that pendimethalin @ 0.5 kg ha⁻¹ proved the most economic treatment in cumin.

Patel *et al.* (2004) at Anand, Gujarat conducted an experiment on influence of nitrogen and weed management practices on weeds and coriander. they were concluded that pre-emergence application of oxadiazon @ 0.5 kg ha⁻¹ gave higher net monetary return of Rs. 42,354 ha⁻¹ and remained at par with application of pendimethalin @ 0.75 kg ha⁻¹ in coriander.

Patel *et al.* (2005) conducted an experiment at Anand, Gujarat during winter seasons of 2002-03 and 2003-04. They concluded that maximum net return was obtained with oxadiazon at 0.5 kg ha⁻¹ (Rs. 23,763 ha⁻¹) followed by pendimethalin @ 0.75 kg ha⁻¹ (Rs. 21,378 ha⁻¹) in fenugreek.

Tewari *et al.* (2005) conducted an experiment during 1998-99 and 1999-2000 in Kanpur, Uttar Pradesh, to evaluate the efficacy of herbicides against weeds in coriander. They observed that pre-emergence application of pendimethalin @ 1.0 kg ha⁻¹ and pretilachlor @ 1.5 kg ha⁻¹ gave higher net returns of ` 17,999 and 17,051 ha⁻¹, respectively.

Kamboj *et al.* (2007) conducted a field experiment to find out economics of weed control treatments in fenugreek during *rabi* season of 1999-2000 at Hissar, Haryana. The data revealed that pendimethalin @ 0.50 kg ha⁻¹ with one hand weeding at 40 DAS gave maximum income (Rs. 35376.00 ha⁻¹) followed by oxyflourfen @ 0.10 kg ha⁻¹ with one hand weeding at 40 DAS (Rs. 32152.00 ha⁻¹).

Nagar *et al.* (2009) conducted an experiment during the *rabi* seasons of 2003-04 and 2004-05 at Udaipur, Rajasthan. They reported that hand weeding twice (HW) at 30 and 45 days after sowing (DAS) and pre-emergence application of pendimethalin @ 1.0 kg ha⁻¹ + hand weeding at 45 DAS were remained at par and gave higher net return of Rs. 23,930 and 24,072 ha⁻¹, respectively.

Sharma (2009) conducted an experiment on integrated weed management in fenugreek during *rabi* seasons of 2003-07 at Bikaner, Rajasthan. He recorded that pre planting incorporation of fluchloralin @ 0.75 kg ha⁻¹ + one hand weeding at 30 DAS fetched higher net monetary returns (Rs. 16,904 ha⁻¹) closely followed by pre-emergence application of pendimethalin @ 0.75 kg ha⁻¹ + one hand weeding at 30 DAS (Rs. 16,684 ha⁻¹).

Mehta *et al.* (2010) conducted a field experiment on fenugreek during *rabi* seasons of 2006-07 and 2007-08 at Sardarkrushinagar, Gujarat and stated that application of pendimethalin @ 0.75 kg ha⁻¹ + IC at 40 DAS gave highest net return of ` 31,850 ha⁻¹ in fenugreek crop.

A field experiment was conducted at Akola, Maharashtra during kharif season to study the effect of organic source on fertility, nutrient uptake and yield of soybean by Laharia *et al.* (2013). They found that the highest net returns (Rs. 19884 ha⁻¹) was recorded by application of 100 % RDN through vermicompost + jeevamrut while highest B : C ratio (1.14) was recorded with application of 100 % RDN through FYM.

Meena *et al.* (2013) conducted an experiment to study on influence of weed control methods on yield, quality and economics in dill seed during *rabi* season of 2011-12 at S. K. Nagar, Gujarat. They found that the highest net returns of Rs. 19309 ha⁻¹ and B : C ratio of 2.60 were recorded under treatment pendimethalin 0.5 kg ha⁻¹ PE + oxadiargyl @ 75 g ha⁻¹ PoE at 20 DAS.

III. MATERIALS AND METHODS

This chapter deals with the details of materials used during the course of investigation and methods adopted in conducting the present investigation entitled **“Effect of vermicompost and weed management practices on growth and yield of fenugreek (*Trigonella foenum-graecum* L.) under middle Gujarat conditions”**

3.1 Experimental Site

The present investigation was conducted in *rabi* season of the year 2012-13 at plot no. A-32, College Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand (Gujarat).

3.1.1 Climate and weather condition

Geographically, Anand is situated at 22° 35' North latitude, 72° 55' East longitude with an elevation of 45.1 meters above mean sea level. The climate of Anand region is semi-arid and sub-tropical with hot summer and cool winter. In this region, generally monsoon commences in the month of June and retreats by the end of September. Most of the rainfall is received from South-West monsoon currents. July and August are the months of heavy showers. The average annual rainfall of this region is about 850 mm. Winter sets in the month of November and continues, till the middle of February. December and January are the coldest month of the year. The average temperature during the winter varies from 11 to 28 °C. The summer season usually commences during the second fortnight of February and ends by the month of June. April and May are the hottest months with the temperature

.....*Materials and methods*
rising as high as 43 °C and occasionally touching 45 °C. Monthly average wind velocity varies from 1.9 to 7.5 km hr⁻¹ with an average annual wind speed of 4.3 km hr⁻¹. The observation recorded on Meteorological parameters during the experimental period at the Meteorological observatory of the Anand Agricultural University, Anand are presented in Table 3.1 and graphically depicted in fig. 3.1. The weekly mean minimum temperature ranged between 8.9°C and 16.0°C and mean maximum temperature ranged between 25.9°C and 33.9°C during the crop season of 2012-13. The other weather parameters *viz.*, average relative humidity and sunshine hours was observed normal during the crop season. The unseasonal rain was not received during the study period. In general, the weather conditions were found favorable for normal crop growth.

Table 3.1: Mean weekly weather parameters recorded at the Meteorological Observatory, Anand Agricultural University, Anand for the crop season *rabi* 2012-13.

Standard Meteorological Weeks	Temperature °C		Bright Sunshine (Hours day ⁻¹)	Rainfall (mm)	Wind velocity (km hrs ⁻¹)	Mean Humidity (%)
	Max.	Min.				
November 2012						
45	32.6	13.9	9.6	0.0	2.0	57.9
46	33.2	15.5	9.5	0.0	1.5	61.7
47	31.4	12.4	9.5	0.0	1.7	59.5
48	31.1	13.3	9.8	0.0	2.0	65.5
December 2012						
49	30.5	16.0	8.8	0.0	2.1	63.3
50	31.0	13.8	8.9	0.0	1.6	69.1
51	29.7	14.2	8.6	0.0	2.7	67.3
52	28.6	10.3	9.3	0.0	2.3	62.0
January 2013						
1	25.9	8.9	8.3	0.0	2.6	67.6
2	27.9	9.9	9.5	0.0	2.5	62.3
3	26.9	11.2	8.5	0.0	3.2	68.1
4	26.3	11.1	9.3	0.0	4.4	55.7
5	30.5	14.2	10.2	0.0	1.9	69.4
February 2013						
6	28.2	12.7	9.1	0.0	4.2	64.4
7	31.1	14.9	8.9	0.0	3.2	65.9
8	31.8	14.0	10.1	0.0	3.5	59.8
9	32.7	12.8	10.7	0.0	3.5	50.9
March 2013						
10	32.0	12.9	8.9	0.0	3.2	49.4
11	33.9	14.4	9.4	0.0	3.5	39.5

3.1.2 Soil characteristics

The soil of the region is loamy sand and locally known as “*Goradu*” soil. The soil is alluvial by their nature of origin, very deep, well drained and fairly moisture retentive. Soils respond well to manures and irrigation. Soil is suitable to variety of crops of tropical and sub-tropical

regions. A composite soil samples were collected from an experimental plot from the depth of 0-15 cm and 0-30 cm before sowing. It was analyzed for determining the physico-chemical properties of soil and presented in Table 3.2.

Table 3.2: Physico-chemical properties of experimental field

Sr. No.	Properties	Soil depth		Method of analysis
		0 – 15 cm	0 – 30 cm	
A	Mechanical composition			
1	Course sand (%)	0.49	0.47	International pipette method (Piper, 1966)
2	Fine sand (%)	82.15	82.10	
3	Silt (%)	12.36	12.51	
4	Clay (%)	5.00	4.92	
5	Texture class	Loamy sand		
B	Chemical properties			
1	EC (1:2.5) (dS m ⁻¹)	0.22	0.23	Conductivity method (Jackson,1973)
2	Soil pH (1:2.5)	7.7	7.65	Potentiometric method (Jackson,1973)
3	Organic carbon (%)	0.39	0.34	Walkley and Black method (Jackson, 1973)
4	Available N (kg ha ⁻¹)	230.60	228.50	Alkaline KMnO ₄ method (Subbiah and Asija, 1954)
5	Available P ₂ O ₅ (kg ha ⁻¹)	55.30	55.10	Olsen’s method (Olsen <i>et al.</i> , 1954)
6	Available K ₂ O (kg ha ⁻¹)	296.12	294.50	Flame photometric method (Jackson, 1973)

The soil of the experimental field was loamy sand in texture, lower in available nitrogen (230.60 kg ha⁻¹), medium in available phosphorus (55.30 kg ha⁻¹) and higher in potassium (296.12 kg ha⁻¹) with slightly alkaline (pH 7.7) in reaction.

3.1.3 Cropping history of experimental plot

The details of the cropping history of the experimental plot for the preceding three years are presented in Table 3.3.

Table 3.3: Cropping history of the experimental field

Year	Season	Crop	Fertilizer (kg ha ⁻¹) applied		
			N	P ₂ O ₅	K ₂ O
2010-2011	<i>Kharif</i>	Pearlmillet	80	40	0
	<i>Rabi</i>	Wheat	120	60	0
2011-2012	Summer	Fodder Maize	100	50	0
	<i>Kharif</i>	Jute	-	-	-
	<i>Rabi</i>	Wheat	120	60	-
2012-2013	Summer	fallow	-	-	-
	<i>Kharif</i>	Pearlmillet	80	40	0
	<i>Rabi</i>	Present experiment	20	40	0

3.2 TREATMENT DETAILS

The details of the treatments studied in the present investigation are as follows:

3.2.1: Details of the Treatment :

Vermicompost (V):

$$V_0 = 0 \text{ t ha}^{-1}$$

$$V_1 = 2.0 \text{ t ha}^{-1}$$

Weed management (W):

W₁ = Weedy check

W₂ = Hand weeding at 20 and 40 DAS

W₃= Pendimethalin @ 500 g a.i. ha⁻¹ as PE

W₄= Pendimethalin @ 500 g a.i. ha⁻¹ as PE *fb* HW at 30 DAS

W₅= Oxyflourfen @ 80 g a.i. ha⁻¹ as PE

W₆= Oxyflourfen @ 80 g a.i. ha⁻¹ as PE *fb* HW at 30 DAS

W₇= Oxadiargyl @ 75 g a.i. ha⁻¹ as PE

W₈= Oxadiargyl @ 75 g a.i. ha⁻¹ as PE *fb* HW at 30 DAS

Table 3.4: Details of treatment combinations

Sr. No.	Treatment	Treatment Details
1	V ₀ W ₁	Vermicompost @ 0 t ha ⁻¹ + Weedy check
2	V ₀ W ₂	Vermicompost @ 0 t ha ⁻¹ + Hand weeding at 20 and 40 DAS
3	V ₀ W ₃	Vermicompost @ 0 t ha ⁻¹ + Pendimethalin @ 500 a.i. g ha ⁻¹ as pre-emergence
4	V ₀ W ₄	Vermicompost @ 0 t ha ⁻¹ + Pendimethalin @ 500 g a.i. ha ⁻¹ as PE <i>fb</i> HW at 30 DAS
5	V ₀ W ₅	Vermicompost @ 0 t ha ⁻¹ + Oxyflourfen @ 80 g a.i. ha ⁻¹ as PE
6	V ₀ W ₆	Vermicompost @ 0 t ha ⁻¹ + Oxyflourfen @ 80 g a.i. ha ⁻¹ as PE <i>fb</i> HW at 30 DAS
7	V ₀ W ₇	Vermicompost @ 0 t ha ⁻¹ + Oxadiargyl @ 75 g a.i. ha ⁻¹ as PE
8	V ₀ W ₈	Vermicompost @ 0 t ha ⁻¹ + Oxadiargyl @ 75 g a.i. ha ⁻¹ as PE <i>fb</i> HW at 30 DAS
9	V ₁ W ₁	Vermicompost @ 2 t ha ⁻¹ + Weedy check
10	V ₁ W ₂	Vermicompost @ 2 t ha ⁻¹ + Hand weeding at 20 and 40 DAS
11	V ₁ W ₃	Vermicompost @ 2 t ha ⁻¹ + Pendimethalin @ 500 g a.i. ha ⁻¹ as pre-emergence
12	V ₁ W ₄	Vermicompost @ 2 t ha ⁻¹ + Pendimethalin @ 500 g a.i. ha ⁻¹ as PE <i>fb</i> HW at 30 DAS
13	V ₁ W ₅	Vermicompost @ 2 t ha ⁻¹ + Oxyflourfen @ 80 g a.i. ha ⁻¹ as PE
14	V ₁ W ₆	Vermicompost @ 2 t ha ⁻¹ + Oxyflourfen @ 80 g a.i. ha ⁻¹ as PE <i>fb</i> HW at 30 DAS
15	V ₁ W ₇	Vermicompost @ 2 t ha ⁻¹ + Oxadiargyl @ 75 g a.i. ha ⁻¹ as PE
16	V ₁ W ₈	Vermicompost @ 2 t ha ⁻¹ + Oxadiargyl @ 75 g a.i. ha ⁻¹ as PE <i>fb</i> HW at 30 DAS

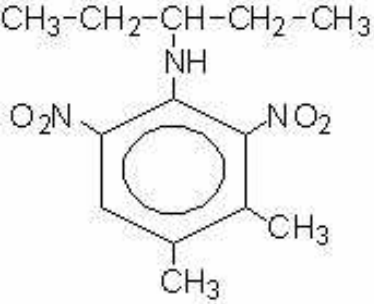
Note : PE - Pre emergence (at 2 to 3 DAS)

3.2.2 Experimental design and layout

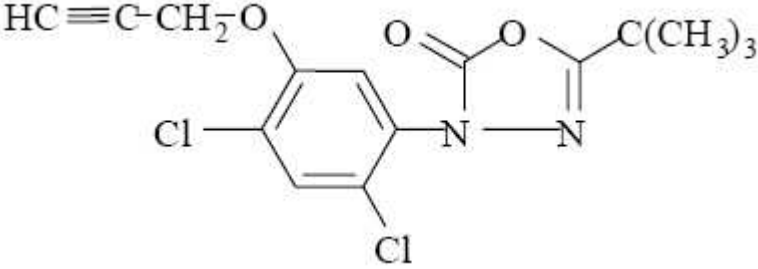
The experiment was laid out in Randomized Block Design (Factorial) as per plan shown in fig. 3.2. Other relevant details are as under:

1. Design of experiment : RBD (Factorial)
2. Number of treatments : 16
3. Number of replications : 3
4. Total Number of plots : 48
5. Crop and Variety : Fenugreek;
Gujarat Fenugreek - 2
6. Method of sowing : Drilling
7. Seed rate : 20 kg ha⁻¹
8. Spacing : 30 cm between rows
9. Plot size : a. Gross plot: 4.0 m x 2.4 m
b. Net plot : 3.0 m x 1.8 m
10. Irrigation : Seven
11. Fertilizer NPK (kg ha⁻¹) : N : P₂O₅ : K₂O
20 : 40 : 00

Table 3.5: Details regarding herbicide used in experiment

Sr. No.	Particulars	(a) Pendimethalin
1	Manufacturer	BASF India Ltd.
2	Chemical name	N-(1-ethylpropyl)-3,4-dimethyl-2,6-Dinitrobenzenamine
3	Trade name	Stomp (30 % EC)
4	Chemical structure	 <p style="text-align: center;"> $\text{CH}_3\text{-CH}_2\text{-CH(NH-)-CH}_2\text{-CH}_3$ O_2N NO_2 CH_3 CH_3 </p>
5	Group	Dinitroanilines
6	Solubility in water	0.3 mg l ⁻¹ (20 °C)
7	Melting point	56 - 57 °C
8	Vapour pressure	4.0 m Pa at 25 °C

Sr. No.	Particulars	Oxyfluorfen
1.	Manufacturer	Rallis Tata Enterprise
2.	Chemical name	2-chloro-1-(3-ethoxy-4-nitrophenoxy)-4-(trifluoromethyl)benzene
3.	IUPAC name	2-chloro- , , -trifluoro-p-tolyl 3-ethoxy-4-nitrophenyl ether
4.	Trade name	HONCHO (23.5 % EC)
5.	Molecular mass (g mol ⁻¹)	361.7
6.	Molecular Formula	C ₁₅ H ₁₁ ClF ₃ NO ₄
7.	Chemical structure	
8.	Group	Diphenyl ethers (Nitrophenyl ethers)
9.	Solubility in water	Nearly insoluble, 0.1ppm
10.	Melting point	181-183 ⁰ F (83-84 ⁰ C)
11.	Vapour pressure	Negligible 25 ⁰ C 2x10 ⁻⁶ mm hg at 25 ⁰ C
12.	Uses	This herbicide is used to control certain annual broad-leaf and grassy weeds in vegetables, fruit crops, cotton, ornamentals and on non-crop areas.

Sr. No.	Particulars	(c) Oxadiargyl
1	Manufacturer	Bayer CropScience Ltd
2	Chemical name	<i>5-tert-butyl-3-(2,4-dichloro-5-propargyloxyphenyl)-1,3,4-oxadiazol-2-(3H)-one</i>
3	Trade name	Raft (6 EC)
4	Chemical structure	
5	Group	protoporphyrinogen IX oxidase inhibitor
6	Solubility in water	0.37 ppm at 20±1 °C
7	Melting point	131 °C
8	Vapour pressure	2.5×10^{-6} Pa at 25 °C

3.3 CROP AND VARIETY

Two improved varieties of fenugreek have been released for general cultivation in Gujarat state. Between them Gujarat fenugreek-2 was evolved at Agricultural Research Station, Jagudan (Mehsana-Gujarat) and is most suitable under the agro-climatic condition of Gujarat state, hence this variety was selected for the present experiment.

Table 3.6: Characteristics of fenugreek variety GF-2

Characteristics	Gujarat fenugreek-2
Height of plant (cm)	65.9
No. of branches plant ⁻¹	5.8
Length of pod (cm)	11.3
No. of seeds pod ⁻¹	17
Seed colour	Dark yellow
Days to maturity	116
Yield (kg ha ⁻¹)	1950-2250
Test weight (g)	14.49

Source : Seed Spice Research Station, S. K. Nagar, Dantiwada, Gujarat

3.4 CULTURAL OPERATIONS

3.4.1 Land preparation

The land was cultivated by tractor drawn cultivator during the month of November. The big clods were crushed and then field was leveled with the help of planking. Thereafter, layout of the experiment was prepared. The sequence of field operations carried out during investigation is presented in Table 3.7.

3.4.2 Fertilizer application

The recommended dose of fertilizer i.e. 20 kg N ha⁻¹ and 40 kg P₂O₅ ha⁻¹ in the form of Di ammonium phosphate and Urea were applied in furrows just before sowing as basal dose.

Table 3.7: Calendar of cultural operations followed during the course of investigation

Sr. No.	Field Operation	Frequency	Date of operation
Land preparation			
1	(a) Ploughing	1	05-11-12
	(b) Harrowing and Planking	1	05-11-12
2	Layout of the field and opening of furrows	1	06-11-12
3	Sowing	1	06-11-12
4	Fertilizer application		
	(a) Basal dose (20-40-0)	1	06-11-12
5	Vermicompost application	1	06-11-12
5	Irrigation	7	06-11-12
			18-11-12
			06-12-12
			24-12-12
			04-01-13
			23-01-13
13-02-13			
6	Thinning	1	07-12-12
After care			
7	(a) Hand weeding at 20 and 40 DAS (W ₂)	1	26-11-12
	(d) Hand weeding at 30 DAS (W ₄ , W ₆ , W ₈)	1	17-12-12
Herbicide application			
8	(a) As Pre-emergence (PE) at 2 DAS (W ₃ , W ₄ , W ₅ , W ₆ , W ₇ , W ₈)	1	07-11-12
Plant protection			
9	Spraying of monocrotophos 36 % EC @ 0.07 % Chloropyriphos 20 % EC @ 2 lit ha ⁻¹	2	29-11-12
10	Harvesting	1	02-03-12
11	Threshing & cleaning	1	11-03-12

3.4.3 Sowing

The graded and healthy seeds of fenugreek, Gujarat fenugreek-2. The Seeds were sown manually in previously opened furrows at the depth of 3 to 5 cm and at 30 cm inter-row and 10 cm intra-row spacing.

3.4.4 Thinning

After sowing it should be within 15 to 20 DAS, thinning operation was carried out to facilitate optimum plant population in each plot.

3.4.5 Irrigation

Seven (Table 3.7) Irrigation was given. First was gave immediately after sowing to insure good and even germination by the providing adequate moisture in the soil.

3.4.6 Plant protection measure

At flowering stage, the crop was attacked by aphid, for which necessary control measures were taken by spraying monocrotophos 36 % EC @ 0.07 % and Chloropyriphos 20 % EC, @ 2 lit ha⁻¹ was applied with irrigation for control of termite.

3.4.7 Harvesting and Threshing

The crop was harvested when the crop had shown the sign of maturity. The border lines were harvested first and were removed out of experimental area. Five previously selected (tagged) plants were harvested separately for recording post harvest observations and their seed yield was added to final net plot yield. Then the net area was harvested simultaneously and the produce was sun dried in respective plots for a week. After satisfactory drying, the plot wise threshing and cleaning operations were done manually.

3.5 Application of weed management treatments

3.5.1 Herbicide application

Pre-emergence application of herbicides was sprayed on 2nd day after sowing. The required quantity of trade formulation of each herbicide for gross plots of 9.6 m² was calculated using the following formula.

$$Rh = \frac{Ai \times At}{Ci} \times 100$$

Where,

Rh = Required quantity of trade formulation of herbicide (ha⁻¹)

Ai = Quantity of active ingredient to be applied (kg)

At = Area to be treated (ha)

Ci = Concentration of active ingredient in the trade formulation

Accordingly the required quantity of herbicide formulation was determined by the formula for different herbicidal treatments as given below.

Table 3.8: Information of herbicide formulation and their rate

Treatment	Technical name of herbicides	Trade name of herbicides	Application rate (g or ml a.i. ha ⁻¹)	Product g or ml ha ⁻¹	Quantity of herbicide required g or ml (for 12 gross plot)
T ₃	Pendimethalin	Stomp (30 EC)	500	3300	20
T ₄	Pendimethalin	Stomp (30 EC)	500	3300	20
T ₅	Oxyflourfen	Honcho (23.5 EC)	80	680	4.1
T ₆	Oxyflourfen	Honcho (23.5 EC)	80	680	4.1
T ₇	Oxydiargyl	Raft (6 EC)	75	2500	15
T ₈	Oxydiargyl	Raft (6 EC)	75	2500	15

Enough quantity of water required for each plot had taken and measured herbicides were thoroughly mixed. The spraying was done by using Knapsack sprayer fitted with flat-fan nozzle using 500 L of water per hectare. The particulars of chemicals in this study are given in Table 3.7.

3.5.2 Hand weeding operations

Hand weeding was carried out with the help of *khurpi* according to the treatments. The particular of hand weeding done is given in Table 3.9.

Table 3.9: Hand weeding operation carried out in experiment

Treatments	Days after sowing (DAS)
W ₄ , W ₆ , W ₈	30 DAS
W ₂	20 & 40 DAS

3.6 Vermicompost application

Vermicompost was applied within line at sowing time of seed. The particular treatment of vermicompost is given in Table 3.10

Table 3.10: Vermicompost application carried out in experiment

Treatments	Dose of vermicompost
V ₀	0 t vermicompost ha ⁻¹
V ₁	2 t vermicompost ha ⁻¹

3.6.1: Nutrient content of vermicompost

The vermicompost sample used in the field experiment was analysed for chemical parameters which are presented in Table 3.11.

Table 3.11: Chemical composition of vermicompost

Parameters	Value	Methods adopted
Total nitrogen content (%)	1.66	Kjeldahl’s digestion method (Jackson,1973)
Total phosphorus content (%)	1.39	Vanadomolybdo phosphoric acid yellow colour (Jackson,1973)
Total potassium content (%)	0.60	Flame photometry (Jackson,1973)
Organic matter (%)	48.81	Walkley & black method (Jackson,1973)

3.7 EXPERIMENTAL OBSERVATIONS

The experimental observations on weeds and fenugreek crop are presented under the following heads.

3.7.1 Weed parameters

3.7.1.1 Phytotoxicity on crop, if any at 7 and 14 days after application.

The phytotoxicity of herbicides was measured at 7 to 14 days after application of herbicides. Phytotoxicity observations were recorded on vein clearing, necrosis, wilting, epinasty and hyponasty, *etc.* on 0-10 scale (as below) at 7 and 14 days after treatment.

Score	Phytotoxicity (%)
0	No Phytotoxicity
1	1-10
2	11-20
3	21-30
4	31-40
5	41-50
6	51-60
7	61-70
8	71-80
9	81-90
10	91-100

3.7.1.2 Weeds count (No. m⁻²)

Weeds count (group wise) was taken at 20 and 40 DAS using quadrates of 1 m². The number of weeds falling within the quadrates was counted separately and recorded according to nature of cotyledons.

3.7.1.3 Weed dry weight (g m⁻²) (monocot and dicot)

The weed samples were collected at 20, 40 DAS and at harvest by using quadrates of 1 m² area and expressed as g m⁻². Collected weed samples were sundried and then finally oven dried at 60 °C for 24 hrs. The dry weight was recorded when sample attained a constant weight.

3.7.1.5 Weed Index (%)

The yield reduction (%) owing to the presence of weeds was estimated by using the formula suggested by (Sharma 2009) and expressed as Weed Index (WI).

$$WI (\%) = \frac{X - Y}{X} \times 100$$

Where,

- WI = Weed Index (%)
- X = Maximum yield from the treatment
- Y = Yield from the treatment for which weed index is to be estimated

3.7.1.6 Weed Control Efficiency

The weed control efficiency was calculated by using the following formula (Sharma 2009).

$$WCE (\%) = \frac{DWC - DWT}{DWC} \times 100$$

Where,

WCE = Weed control efficiency in percent

DWC = Weed dry weight in control plot

DWT = Weed dry weight in treated plot

3.7.2 Study on growth parameters

3.7.2.1 Plant population (m^{-1} row length)

Plant population had taken at 15 DAS and at harvest per meter row length in each plot randomly from five spots.

3.7.2.2 Plant height (cm)

The plant height of the fenugreek plant was measured in centimeters from ground level to the top of the main shoot of five randomly selected and tagged plants in each plot of all replications at an interval of 30 and 60 DAS and at harvest. The average figure of plant height was used for statistical analysis.

3.7.2.3 Number of branches plant^{-1}

All the branches arising from the main shoot were counted from the selected five plants in each plot at each stage. Average value for each plot was computed and recorded separately.

3.7.2.4 Dry weight (mg) of root nodules plant^{-1}

For recording the dry weight (mg) of root nodules plant^{-1} five plants randomly selected from each plot. Plants were uprooted carefully; the soil mass embodying the root of the plants was washed off with water and dry weight (mg) of nodules plant^{-1} was recorded at 45 DAS.

3.7.3. Study on yield parameters

3.7.3.1 Days to 50% flowering

Number of days required for the crop to attain 50 % flowering was recorded by randomly selecting twenty five plants from each net plot. The mean value for each experimental plot was worked out and recorded

3.7.3.2 Number of pods plant⁻¹

The total numbers of pods picked from five tagged plants were counted and average value per plant was worked out and recorded from each treatment at harvest.

3.7.3.3 Number of seeds pod⁻¹

For counting number of seeds per net plot, the pods collected from tagged plants were used. The average number of seeds per pods was worked out and recorded separately at harvest.

3.7.3.4 Test weight (g)

A representative seed sample was drawn randomly from the bulk produce of each net plot, 1000 seeds were counted from the sample and their weight in gram was recorded as test weight of each treatment.

3.7.3.5 Seed yield (kg ha⁻¹)

Seed yield from each net plot was recorded in kilogram per net plot. Data of seed yield were then converted on hectare basis in kilogram.

3.7.3.6 Straw yield (kg ha⁻¹)

Straw yield was obtained by subtracting the seed yield of each net plot from their respective total dry matter (biological yield). Data of haulm yield were then converted on hectare basis in kilogram.

3.7.3.7 Harvest index (%)

Harvest index (%) was calculated for each treatment on the basis of formula suggested by Donald and Hamblin (1976).

$$HI (\%) = \frac{\text{Economical yield (kg ha}^{-1}\text{)}}{\text{Biological yield (kg ha}^{-1}\text{)}} \times 100$$

Table 3.12: Parameters studied during the course of investigation

Sr. No.	Characters	Sample size	Time of recording
A :Weed study			
1	Phytotoxicity on crop	-	At 7 and 14 days after application
2	Weed count (Group wise)	1 m ²	At 20 and 40 DAS
3	Dry weight of weeds (Group wise)	1 m ²	At 20 and 40 DAS
4	Total dry weight of weeds	1 m ²	At harvest
B: Growth Parameter study			
1	Plant Population	Per meter row length five spots	At 15 DAS and at harvest
2	Plant height (cm)	Five plants from net plot	At 30,60 DAS and at harvest
3	Number of branches per plant	Five plants from net plot	At harvest
4	Dry weight of root nodules	Five plants from net plot	At 45 DAS
C: Yield and yield attribute study			
1	Number of pods per plant	Five plants from net plot	At harvest
2	Number of seeds per pod	Five plants from net plot	At harvest
3	Seed yield (kg ha ⁻¹)	From net plot	After threshing
4	Straw yield (kg ha ⁻¹)	From net plot	After threshing
5	Test weight	Random sample of 1000 seeds at harvest from net plot	After threshing

3.8 STATISTICAL ANALYSIS

The statistical analysis of the various growth, yield, quality characters and other parameters studied in the investigation was carried out by using statistical methods appropriate to Randomized Block Design (factorial) at the computer center, Department of Agricultural Statistics, BACA, AAU, Anand, Gujarat as per the procedure described by Steel and Torrie (1982).

Standard error of mean (S. Em._±), critical difference (CD P= 0.05) and co-efficient of variation (C. V. %) were worked out and the same are presented in respective Tables. Square root transformation ($x + 0.5$) was employed for weed parameters. Duncan’s New Multiple Range Test (DNMRT) was employed for comparison of treatments mean.

3.9 ECONOMICS

Cost of cultivation of the crop of individual treatment was worked out taking in to consideration the cost of all the cultural operations starting from preparatory tillage to harvesting of the crop including the cost of all the inputs. The gross realization in term of Rs ha⁻¹ was worked out for each treatment taking the present market value of fenugreek seed and straw. The net profit was worked out by deducting the total expenditure from gross realization from each of the treatments and recorded accordingly. The cost benefit ratio (CBR) was worked out from the seed and straw yields of fenugreek obtained under different vermicompost and weed management treatments, considering the market prices. The cost: benefit ratio was calculated on the basis of formula given below.

$$CBR = \frac{\text{Total income (Rs ha}^{-1}\text{)}}{\text{Total expenditure (Rs ha}^{-1}\text{)}}$$

IV. EXPERIMENTAL RESULTS

The results of the field experiment entitled “**Effect of vermicompost and weed management practices on growth and yield of fenugreek (*Trigonellafoenum-graecum*L.) under Middle Gujarat condition**” on different parameters are presented in this chapter along with statistical inferences under the following heads.

- 4.1 Effect of treatments on weeds**
- 4.2 Effect of treatments on growth parameters**
- 4.3 Effect of treatments on yield and yield attributes**
- 4.4 Economics of different treatments**

4.1 EFFECT OF TREATMENTS ON WEEDS

- 4.1.1 Weeds flora
- 4.1.2 Weed count at 20 DAS (no. m⁻²)
- 4.1.3 Weed count at 40 DAS (no. m⁻²)
- 4.1.4 Dry weight of weeds at 20 DAS (g m⁻²)
- 4.1.5 Dry weight of weeds at 40 DAS (g m⁻²)
- 4.1.6 Dry weight of weeds at harvest (kg ha⁻¹)
- 4.1.7 Weed index (%)
- 4.1.8 Weed control efficiency (%)

4.1.1 Weeds flora

The details of weed flora observed in the experimental plots are given in Table 4.1.1 according to their Botanical name, English name, Family and Cotyledons.

Table-4.1.1: Weed flora found in the experimental plot

Sr. no.	Botanical name	English name	Family
Monocot weeds			
1	<i>Cynodon dactylon</i> L.	Bermuda grass	Poeceae
2	<i>Digitaria sanguinalis</i> L.	Crab grass	Poeceae
3	<i>Eragrotis major</i> L.	Indian love grass	Poeceae
4	<i>Dactyloctenium aegyptium</i> L.	Crow foot grass	Poeceae
5	<i>Eleusineindica</i> L.	Goose grass	Poeceae
Dicot weeds			
6	<i>Digera arvensis</i> forsk	Pig weed	Amaranthaceae
7	<i>Chinopodium album</i> L.	Lamb's quarters	Chenopodiaceae
8	<i>Chenopodium murale</i> L.	Nettle leaf goosefoot	Chenopodiaceae
9	<i>Phyllanthus niruri</i> L	Niruri	Euphorbiaceae
10	<i>Asphodeluste nuifolius</i> L. cav	Wild onion	Liliaceae
Sedges weeds			
11	<i>Cyprus rotundus</i> L.	Purple nut sedge	Cyperaceae

4.1.2 Weed count at 20 DAS (no. m⁻²)

The mean data on weed population per square meter area counted at 20 DAS as affected by vermicompost and weed management practices are presented in Table 4.1.2 and graphically represented in Fig. 4.1.1

4.1.2.1 Effect of vermicompost

It was observed from data given in Table 4.1.2 that the differences due to vermicompost levels was seemed to be non-significant with respect to monocot, dicot and total weed count (no. m⁻²) at 20 DAS.

4.1.2.2 Effect of weed management practices

The results pertaining to the influence of varying weed management practices on monocot weed count at 20 DAS showed that all the weed management treatments differed significantly from one another. Significantly the highest number of monocot weeds (9.31 no. m⁻²) was observed with weedy check (W₁) and lower (2.29no. m⁻²) under hand weeding at 20 and 40 DAS (W₂) which was remained at par with oxadiargyl @ 75 g ha⁻¹ as PE *fb* HW at 30 DAS (W₈) (2.73 no. m⁻²) and oxyflourfen @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS (W₆) (2.89 no. m⁻²).

The appraisal of data for dicot weed count at 20 DAS indicated that all weed management treatments had a significant influenced on the mean dicot weed count. Treatment hand weeding at 20 and 40 DAS (W₂) showed significantly lower dicot weeds (2.48 no. m⁻²) which was at remained par with oxadiargyl @ 75 g ha⁻¹ as PE *fb* HW at 30 DAS (W₈) (3.25 no. m⁻²) and oxyflourfen @ 80 g ha⁻¹ as

PE *fb* HW at 30 DAS (W₆) (3.30 no. m⁻²). The highest number of dicot weeds (10.52) was observed under weedy check (W₁).

It is evident from Table 4.1.2 that each weed management treatments influenced the total number of weeds significantly. Treatment W₁ (weedy check) was responsible for the highest number of total weeds (14.06 no. m⁻²) followed by pendimethalin @ 500 g ha⁻¹ as PE (W₃) (8.57 no. m⁻²), oxyflourfen @ 80 g ha⁻¹ as PE (W₅) (7.53 no. m⁻²), pendimethalin @ 500 g ha⁻¹ as PE *fb* HW at 30 DAS (W₄) (5.38 no. m⁻²) and oxadiargyl @ 75 g ha⁻¹ as PE (W₇) (5.29 no. m⁻²) in decreasing order of mean magnitude. Treatment hand weeding at 20 and 40 DAS (W₂) resulted in significantly the lowest (3.32 no. m⁻²) number of total weeds.

4.1.2.3 Effect of interaction

No V × W interaction was found to be existent in respect of monocot, dicot and total weed count at 20 DAS.

Table 4.1.2: Weed count at 20 DAS (no. m⁻²) as influenced by varying levels of vermicompost and weed management practices

Treatment	Weed count (no. m ⁻²) at 20 DAS		
	Monocot	Dicot	Total
Vermicompost (V)			
V₀ : Vermicompost 0 t ha⁻¹	4.62 (25.13)	5.37 (36.04)	7.08 (61.17)
V₁ : Vermicompost 2 t ha⁻¹	4.45 (24.50)	5.18 (32.04)	6.83 (56.54)
SEm±	0.11	0.18	0.13
CD (P=0.05)	NS	NS	NS
Weed Management (W)			
W₁ : Weedy check	9.31 ^a (86.67)	10.52 ^a (111.50)	14.06 ^a (198.17)
W₂ : Hand weeding at 20 and 40 DAS	2.29 ^d (4.83)	2.48 ^c (6.33)	3.32 ^f (11.17)
W₃ : Pendimethalin @ 500 g ha⁻¹ as PE	5.87 ^b (34.17)	5.96 ^b (36.33)	8.37 ^b (70.50)
W₄ : Pendimethalin @ 500 g ha⁻¹ as PE <i>fb</i> HW at 30 DAS	4.70 ^c (21.83)	5.38 ^b (29.67)	7.14 ^{c d} (51.50)
W₅ : Oxyflourfen @ 80 g ha⁻¹ as PE	4.43 ^c (19.50)	6.01 ^b (37.50)	7.53 ^c (57.00)
W₆ : Oxyflourfen @ 80 g ha⁻¹ as PE <i>fb</i> HW at 30 DAS	2.80 ^d (7.50)	3.30 ^c (11.00)	4.30 ^e (18.50)
W₇ : Oxadiargyl @ 75 g ha⁻¹ as PE	4.15 ^c (17.00)	5.29 ^b (29.33)	6.74 ^d (46.33)
W₈ : Oxadiargyl @ 75 g ha⁻¹ as PE <i>fb</i> HW at 30 DAS	2.73 ^d (7.00)	3.25 ^c (10.67)	4.19 ^e (17.67)
SEm±	0.22	0.35	0.27
CD (P=0.05)	Sign.	Sign.	Sign.
V × W Interaction	NS	NS	NS
C.V.%	11.78	16.48	9.50

Note : *Figures in the parenthesis are original values. All figures are subjected to transformed values to square root. Figures indicating common letters in the column do not differ significantly from each other at 5% level of significance according to Duncan New Multiple Range Test (DNMRT).

4.1.3 Weed count at 40 DAS (no. m⁻²)

The mean data on weed population per square meter area counted at 40 DAS as affected by vermicompost and weed management practices are presented in Table 4.1.3 and graphically represented in Fig. 4.1.3.

4.1.3.1 Effect of vermicompost

It was observed from the data given in Table 4.1.3 that the differences due to vermicompost levels were seemed to be non-significant with respect to monocot, dicot and total weed count (no. m⁻²) at 40 DAS.

4.1.3.2 Effect of weed management practices

Table 4.1.3 also gives a detailed account of the effect of various weed management practices on weed count at 40 DAS. At 40 DAS, significantly superior effect was observed under hand weeding treatment at 20 and 40 DAS (W₂) and recorded 1.81 no. m⁻² weeds which was at par with application of oxadiargyl @ 75 g ha⁻¹ as PE *fb* HW at 30 DAS (W₈) (2.27 no. m⁻²) in respect to monocot weed control followed by oxyflourfen @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS (W₆) (2.32 no. m⁻²) in increasing order of mean magnitude. The significantly maximum number of monocot weeds (4.48 no. m⁻²) was recorded under treatment weedy check (W₁).

Lower number of dicot weeds (1.90 no. m⁻²) was recorded under hand weeding at 20 and 40 DAS (W₂) which was remained at par with treatments oxadiargyl @ 75 g ha⁻¹ as PE *fb* HW at 30 DAS (W₈) (2.36 no. m⁻²) and

oxyflourfen @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS (W₆) (2.55 no. m⁻²). The highest number of dicot weeds (4.89 no. m⁻²) was recorded under treatment weedy check (W₁) at 40 DAS.

Treatment hand weeding at 20 and 40 DAS (W₂) contributed significantly minimum number of total weeds (2.54 no. m⁻²) followed by oxadiargyl @ 75 g ha⁻¹ as PE *fb* HW at 30 DAS (W₈) (3.15 no. m⁻²) and oxyflourfen @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS (W₆) (3.32 no. m⁻²). Treatment weedy check (W₁) showed significantly the highest total weed count (6.57 no. m⁻²) than the rest of weed control treatments at 40 DAS.

4.1.3.3 Effect of interaction

No V × W interaction was found to be existent in respect of monocot, dicot and total weed count at 40 DAS.

Table 4.1.3: Weed count at 40 DAS (no. m⁻²) as influenced by varying levels of vermicompost and weed management practices

Treatment	Weed count (no. m ⁻²) at 40 DAS		
	Monocot	Dicot	Total
Vermicompost (V)			
V₀ : Vermicompost 0 t ha⁻¹	3.13 (10.33)	3.53 (13.29)	4.62 (23.63)
V₁ : Vermicompost 2 t ha⁻¹	3.15 (10.21)	3.25 (11.17)	4.44 (21.38)
SEm±	0.09	0.11	0.98
CD (P=0.05)	NS	NS	NS
Weed Management (W)			
W₁ : Weedy check	4.48 ^a (19.83)	4.89 ^a (23.67)	6.57 ^a (43.50)
W₂ : Hand weeding at 20 and 40 DAS	1.81 ^c (3.17)	1.90 ^c (3.50)	2.54 ^d (6.67)
W₃ : Pendimethalin @ 500 g ha⁻¹ as PE	3.45 ^b (11.50)	3.53 ^b (12.17)	4.85 ^b (23.67)
W₄ : Pendimethalin @ 500 g ha⁻¹ as PE <i>fb</i> HW at 30 DAS	3.30 ^b (10.50)	3.75 ^b (13.83)	4.90 ^b (24.33)
W₅ : Oxyflourfen @ 80 g ha⁻¹ as PE	3.82 ^b (14.17)	4.75 ^a (22.33)	6.02 ^a (36.50)
W₆ : Oxyflourfen @ 80 g ha⁻¹ as PE <i>fb</i> HW at 30 DAS	2.32 ^c (5.00)	2.55 ^c (6.17)	3.32 ^c (11.17)
W₇ : Oxadiargyl @ 75 g ha⁻¹ as PE	3.67 ^b (13.17)	3.38 ^b (11.00)	4.90 ^b (24.17)
W₈ : Oxadiargyl @ 75 g ha⁻¹ as PE <i>fb</i> HW at 30 DAS	2.27 ^c (4.83)	2.36 ^c (5.17)	3.15 ^c (10.00)
SEm±	0.18	0.22	0.19
CD (P=0.05)	Sign.	Sign.	Sign.
V × W Interaction	NS	NS	NS
CV%	14.19	16.22	10.77

Note : *Figures in the parenthesis are original values. All figures are subjected to transformed values to square root. Figures indicating common letters in the column do not differ significantly from each other at 5% level of significance according to Duncan New Multiple Range Test (DNMRT).

4.1.4 Weed dry weight at 20 DAS (g m⁻²)

The mean data on weed dry weight (g m⁻²) at 20 DAS as affected by vermicompost and weed management practices are presented in Table 4.1.4 and graphically represented in Fig. 4.1.3.

4.1.4.1 Effect of vermicompost

It was observed from data given in Table 4.1.4 that the differences due to vermicompost levels were seemed to be non-significant with respect to monocot, dicot and total weed dry weight at 20 DAS.

4.1.4.2 Effect of weed management practices

The results pertaining to the influence of varying weed management practices on monocot weed dry weight at 20 DAS showed that all the weed management treatments differed significantly from one another. The lower monocot weed dry weight of 1.83 g m⁻² was observed under treatment hand weeding at 20 and 40 DAS (W₂) which was at par with application of oxadiargyl @ 75 g ha⁻¹ as PE *fb* HW at 30 DAS (W₈) (2.10 g m⁻²) and oxyflourfen @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS (W₆) (2.11 g m⁻²). Significantly the highest monocot weed dry weight (4.01 g m⁻²) was observed with weedy check (W₁).

The appraisal of data for dicot weed dry weight at 20 DAS indicated that all weed management treatments had a significant influence on the mean weed dry weight. Treatment weedy check (W₁) showed significantly highest dicot weed dry weight (3.74 g m⁻²) which was followed by treatments W₅ (2.98 g m⁻²), W₃ (2.96 g m⁻²), W₄ (2.67 g m⁻²) and W₇ (2.57 g m⁻²) in decreasing order of mean

magnitude. The lower dicot weed dry weight (2.05 g m^{-2}) was observed under treatment W_2 which was at par with treatments W_8 (2.13 g m^{-2}) and W_6 (2.23 g m^{-2}).

As it is evident from Table 4.1.4 that each weed management treatment influenced the total weed dry weight significantly. Treatment W_1 (weedy check) was responsible for highest total weed dry weight (5.40 g m^{-2}) followed by treatments W_3 (3.82 g m^{-2}), W_5 (3.79 g m^{-2}), W_4 (3.45 g m^{-2}) and W_7 (3.32 g m^{-2}) in decreasing order of mean magnitude. Treatment W_2 (2.57 g m^{-2}) resulted in minimum total weed dry weight which was at par with treatment W_8 (2.82 g m^{-2}).

4.1.4.3 Effect of nteraction

No $V \times W$ interaction was found to be existent in respect of monocot, dicot and total weed dry weight at 20 DAS.

Table 4.1.4 : Weed dry weight (g m⁻²) at 20 DAS as influenced by varying levels of vermicompost and weed management practices

Treatment	Weed dry weight (g m ⁻²) at 20 DAS		
	Monocot	Dicot	Total
Vermicompost (V)			
V₀ : Vermicompost 0 t ha⁻¹	2.54 (6.34)	2.70 (7.13)	3.57 (13.47)
V₁ : Vermicompost 2 t ha⁻¹	2.44 (5.92)	2.63 (6.73)	3.45 (12.65)
SEm±	0.04	0.05	0.04
CD (P=0.05)	NS	NS	NS
Weed Management (W)			
W₁ : Weedy check	4.01 ^a (15.59)	3.74 ^a (13.53)	5.40 ^a (29.21)
W₂ : Hand weeding at 20 and 40 DAS	1.83 ^d (2.95)	2.05 ^d (3.71)	2.57 ^c (6.66)
W₃ : Pendimethalin @ 500 g ha⁻¹ as PE	2.60 ^b (6.26)	2.96 ^b (8.35)	3.82 ^b (14.61)
W₄ : Pendimethalin @ 500 g ha⁻¹ as PE fb HW at 30 DAS	2.40 ^b (5.29)	2.67 ^c (6.67)	3.45 ^b (11.96)
W₅ : Oxyflourfen @ 80 g ha⁻¹ as PE	2.54 ^b (6.01)	2.98 ^b (8.43)	3.79 ^a (14.43)
W₆ : Oxyflourfen @ 80 g ha⁻¹ as PE fb HW at 30 DAS	2.11 ^c (4.00)	2.23 ^d (4.56)	2.91 ^c (8.56)
W₇ : Oxadiargyl @ 75 g ha⁻¹ as PE	2.32 ^{bc} (4.91)	2.57 ^c (6.17)	3.32 ^b (11.07)
W₈ : Oxadiargyl @ 75 g ha⁻¹ as PE fb HW at 30 DAS	2.10 ^c (3.92)	2.13 ^d (4.04)	2.82 ^c (7.97)
SEm±	0.08	0.09	0.09
CD (P=0.05)	Sign.	Sign.	Sign.
V × W Interaction	NS	NS	NS
CV %	8.25	8.95	6.30

Note : *Figures in the parenthesis are original values. All figures are subjected to transformed values to square root. Figures indicating common letters in the column do not differ significantly from each other at 5% level of significance according to Duncan New Multiple Range Test (DNMRT).

4.1.5 Weed dry weight at 40 DAS (g m^{-2})

The mean data on weed dry weight at 40 DAS (g m^{-2}) as affected by vermicompost and weed management practices are presented in Table 4.1.5 and graphically represented in Fig. 4.1.4.

4.1.5.1 Effect of vermicompost

It was observed from data given in Table 4.1.5 that the differences due to vermicompost levels were seemed to be non-significant with respect to monocot, dicot and total weed dry weight at 40 DAS.

4.1.5.2 Effect of weed management practices

The results pertaining to the influence of varying weed management practices on monocot weed dry weight at 40 DAS showed that all the weed management treatments differed significantly from one another. Significantly lower monocot weed dry weight (1.60 g m^{-2}) was observed under treatment hand weeding at 20 and 40 DAS (W_2) which was at par with application of oxadiargyl @ 75 g ha^{-1} as PE *fb* HW at 30 DAS (W_8) (1.77 g m^{-2}) and oxyflourfen @ 80 g ha^{-1} as PE *fb* HW at 30 DAS (W_6) (2.10 g m^{-2}) while highest monocot weed dry weight of 4.36 g m^{-2} was observed with weedy check (W_1).

The appraisal of data for dicot weed dry weight at 40 DAS indicated that all weed management treatments had a significant influence on the mean weed dry weight. The lower dicot weed dry weight (1.73 g m^{-2}) was observed under treatment of hand weeding at 20 and 40 DAS (W_2), which was at par with application of oxadiargyl @ 75 g ha^{-1} as PE *fb* HW at 30 DAS (W_8) (1.85 g m^{-2})

and oxyflourfen @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS (W₆) (1.90 g m⁻²). Treatment weedy check (W₁) showed significantly the highest dicot weed dry weight (2.61 g m⁻²).

It is evident from Table 4.1.5, that each weed management treatment influenced the total weed dry weight significantly. Treatment hand weeding at 20 and 40 DAS (W₂) (2.17 g m⁻²) resulted in minimum total weed dry weight which was at par with application of oxadiargyl @ 75 g ha⁻¹ as PE *fb* HW at 30 DAS (W₈) (2.42 g m⁻²) and oxyflourfen @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS (W₆) (2.65 g m⁻²). Treatment weedy check (W₁) was responsible for highest total weed dry weight (4.99 g m⁻²) followed by treatments oxyflourfen @ 80 g ha⁻¹ as PE (W₅) (4.28 g m⁻²), pendimethalin @ 500 g ha⁻¹ as PE (W₃) (3.97 g m⁻²), pendimethalin @ 500 g ha⁻¹ as PE *fb* HW at 30 DAS (W₄) (3.69 g m⁻²) and oxadiargyl @ 75 g ha⁻¹ as PE (W₇) (3.68 g m⁻²) in decreasing order of mean magnitude.

4.1.5.3 Effect of interaction

No V × W interaction was found to be existent in respect of monocot, dicot and total weed dry weight at 40 DAS.

Table 4.1.5 : Weed dry weight (gm⁻²) at 40 DAS as influenced by varying levels of vermicompost and weed management practices

Treatment	Weed dry weight (g m ⁻²) at 40 DAS		
	Monocot	Dicot	Total
Vermicompost (V)			
V₀ : Vermicompost 0 t ha⁻¹	2.92 (9.11)	2.21 (4.49)	3.54 (13.60)
V₁ : Vermicompost 2 t ha⁻¹	2.83 (8.39)	2.14 (4.21)	3.42 (12.60)
SEm±	0.09	0.04	0.07
CD (P=0.05)	NS	NS	NS
Weed Management (W)			
W₁ : Weedy check	4.36 ^a (18.83)	2.61 ^a (6.31)	4.99 ^a (25.13)
W₂ : Hand weeding at 20 and 40 DAS	1.60 ^d (2.24)	1.73 ^c (2.53)	2.17 ^f (4.77)
W₃ : Pendimethalin @ 500 g ha⁻¹ as PE	3.36 ^{bc} (10.92)	2.32 ^b (4.94)	3.97 ^{cd} (15.86)
W₄ : Pendimethalin @ 500 g ha⁻¹ as PE fb HW at 30 DAS	3.03 ^c (8.76)	2.32 ^b (4.91)	3.69 ^d (13.67)
W₅ : Oxyflourfen @ 80 g ha⁻¹ as PE	3.67 ^b (13.15)	2.40 ^{ab} (5.27)	4.28 ^{bc} (18.42)
W₆ : Oxyflourfen @ 80 g ha⁻¹ as PE fb HW at 30 DAS	2.10 ^d (3.98)	1.90 ^c (3.14)	2.65 ^e (7.28)
W₇ : Oxadiargyl @ 75 g ha⁻¹ as PE	3.04 ^c (8.99)	2.28 ^b (4.74)	3.68 ^d (13.73)
W₈ : Oxadiargyl @ 75 g ha⁻¹ as PE fb HW at 30 DAS	1.77 ^d (2.96)	1.85 ^c (2.97)	2.42 ^{ef} (5.93)
SEm±	0.19	0.08	0.15
CD (P=0.05)	Sign.	Sign.	Sign.
V × W Interaction	NS	NS	NS
CV %	16.13	8.83	10.34

Note : *Figures in the parenthesis are original values. All figures are subjected to transformed values to square root. Figures indicating common letters in the column do not differ significantly from each other at 5% level of significance according to Duncan New Multiple Range Test (DNMRT).

4.1.6 Total weed dry weight at harvest (kg ha⁻¹)

The mean data on weed dry weight recorded at harvest as affected by vermicompost and weed management treatments have been cited in Table 4.1.6 and graphically presented in Fig. 4.1.5.

4.1.6.1 Effect of vermicompost

It was observed from data given in Table 4.1.6 that the differences due to vermicompost levels were seemed to be non-significant with respect to monocot, dicot and total weed dry weight at harvest.

4.1.6.2 Effect of weed management practices

A perusal of data presented in Table 4.1.6 indicated that different weed management treatments significantly affected the mean dry weight of weeds.

The dry weight of weeds recorded at harvest was influenced significantly influenced by different weed management practices. The lower dry weight of weeds was observed under treatment hand weeding at 20 and 40 DAS (W₂) (5.78 kg ha⁻¹) which was at par with the application of oxadiargyl @ 75 g ha⁻¹ as PE *fb* HW at 30 DAS (W₈) (6.17 kg ha⁻¹) and oxyflourfen @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS (W₆) (6.52 kg ha⁻¹). The highest dry weight of weeds was observed in treatment weedy check (W₁) (15.84 kg ha⁻¹).

4.1.6.3 Effect of interaction

No V × W interaction was found to be existent in respect of monocot, dicot and total weed dry weight at 40 DAS.

Table 4.1.6: Weed dry weight (kg ha⁻¹) at harvest as influenced by varying levels of vermicompost and weed management practices

Treatment	Total weed dry weight (kg ha ⁻¹) at harvest
Vermicompost (V)	
V₀ : Vermicompost 0 t ha⁻¹	9.61 (105.54)
V₁ : Vermicompost 2 t ha⁻¹	9.06 (92.46)
SEm±	0.21
CD (P=0.05)	NS
Weed Management (W)	
W₁ : Weedy check	15.84 ^a (254.33)
W₂ : Hand weeding at 20 and 40 DAS	5.78 ^d (33.83)
W₃ : Pendimethalin @ 500 g ha⁻¹ as PE	11.73 ^b (137.83)
W₄ : Pendimethalin @ 500 g ha⁻¹ as PE <i>fb</i> HW at 30 DAS	8.81 ^c (78.83)
W₅ : Oxyflourfen @ 80 g ha⁻¹ as PE	10.91 ^b (119.33)
W₆ : Oxyflourfen @ 80 g ha⁻¹ as PE <i>fb</i> HW at 30 DAS	6.52 ^d (43.00)
W₇ : Oxadiargyl @ 75 g ha⁻¹ as PE	9.29 ^c (86.67)
W₈ : Oxadiargyl @ 75 g ha⁻¹ as PE <i>fb</i> HW at 30 DAS	6.17 ^d (38.17)
SEm±	0.43
CD (P=0.05)	Sign.
V × W Interaction	NS
CV %	11.15

Note : *Figures in the parenthesis are original values. All figures are subjected to transformed values to square root. Figures indicating common letters in the column do not differ significantly from each other at 5% level of significance according to Duncan New Multiple Range Test (DNMRT).

4.1.7 Weed index (WI)

Data presented in Table 4.1.7 showed the effect of different levels of vermicompost and weed management practices on weed index and also graphically presented in Fig. 4.1.6. The treatment oxadiargyl @ 75 g ha⁻¹ as PE *fb* HW at 30 DAS (W₈) showed least weed index (4.55 %) followed by oxyflourfen @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS (W₆) (5.04 %) . The treatment weedy check (W₁) recorded maximum weed index of 58.81 per cent.

4.1.8 Weed control efficiency (WCE)

Data pertaining to WCE for different treatments are presented in Table 4.1.7 and graphically presented in Fig. 4.1.6.

At harvest, higher WCE of 63.53 per cent was recorded under treatment hand weeding at 20 and 40 DAS (W₂) followed by oxadiargyl @ 75 g ha⁻¹ as PE *fb* HW at 30 DAS (W₈) (61.75 %) and oxyflourfen @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS (W₆) (60.54 %). The lowest WCE of 25.97 % was observed under treatment pendimethalin @ 500 g ha⁻¹ as PE (W₃).

Table 4.1.7 :Weed control efficiency (%) and weed index (%)as influenced by differentweed management practices

Treatments	Weed control efficiency (%) At harvest	WEED INDEX (%)
Weed management (W)		
W₁ : Weedy check	-	58.81
W₂ : Hand weeding at 20 and 40 DAS	63.53	-
W₃ : Pendimethalin @ 500 g ha⁻¹ as PE	25.97	38.20
W₄ : Pendimethalin @ 500 g ha⁻¹ as PE <i>fb</i> HW at 30 DAS	44.35	19.28
W₅ : Oxyflourfen @ 80 g ha⁻¹ as PE	31.16	26.17
W₆ : Oxyflourfen @ 80 g ha⁻¹ as PE <i>fb</i> HW at 30 DAS	58.82	5.04
W₇ : Oxadiargyl @ 75 g ha⁻¹ as PE	41.37	23.95
W₈ : Oxadiargyl @ 75 g ha⁻¹ as PE <i>fb</i> HW at 30 DAS	61.05	4.55

4.2 Effect of treatments on growth parameters

4.2.1 Plant population (number m⁻¹ row length)

4.2.2 Plant height (cm)

4.2.3 Dry weight of root nodules (mg plant⁻¹)

4.2.4 Number of branches plant⁻¹

4.2.5 Herbicide phytotoxicity

4.2.1 Plant population at 15 DAS and at harvest (No. m⁻¹ row length)

Data pertaining to the plant population at 15 DAS and at harvest as influenced by different levels of vermicompost and weed management practices are presented in Table 4.2.1.

4.2.1.1 Effect of vermicompost

It appears from the results (Table 4.2.1) that the differences in plant population due to vermicompost were found to be non-significant at 15 DAS and at harvest.

4.2.1.2 Effect of weed management practices

A perusal of data given in Table 4.2.1 indicated that effect of different weed management practices was also found to be non-significant at 15 DAS and at harvest.

4.2.1.3 Interaction effect

Plant population was found to be not-significant due to interaction effect between different levels of vermicompost and weed management practices (Table 4.2.1) at 15 DAS and harvest.

Table 4.2.1: Plant population at 15 DAS and at harvest as influenced by varying levels of vermicompost and weed management practices

Treatment	Plant population (No. of plants m ⁻¹ row length)	
	15 DAS	At harvest
Vermicompost (V)		
V₀ : Vermicompost 0 t ha⁻¹	33.96	32.88
V₁ : Vermicompost 2 t ha⁻¹	35.13	33.88
SEm±	0.59	0.44
CD (P=0.05)	NS	NS
Weed Management (W)		
W₁ : Weedy check	34.33	33.33
W₂ : Hand weeding at 20 and 40 DAS	36.67	34.67
W₃ : Pendimethalin @ 500 g ha⁻¹ as PE	33.00	31.67
W₄ : Pendimethalin @ 500 g ha⁻¹ as PE fb HW at 30 DAS	33.00	32.00
W₅ : Oxyflourfen @ 80 g ha⁻¹ as PE	33.83	33.00
W₆ : Oxyflourfen @ 80 g ha⁻¹ as PE fb HW at 30 DAS	34.83	33.50
W₇ : Oxadiargyl @ 75 g ha⁻¹ as PE	34.50	33.67
W₈ : Oxadiargyl @ 75 g ha⁻¹ as PE fb HW at 30 DAS	36.17	35.17
SEm±	1.19	0.88
CD (P=0.05)	NS	NS
V × W Interaction	NS	NS
CV %	8.44	6.48

4.2.2 Plant height (cm)

Data on plant height at 30 and 60 DAS and at harvest as influenced by different levels of vermicompost and weed management practices are presented in Table 4.2.2 and also graphically depicted in Fig. 4.2.1.

4.2.2.1 Effect of vermicompost

A perusal of data (Table 4.2.2) indicated that plant height at 30, 60 DAS and at harvest significantly differed due to variation in vermicompost level. At 30 DAS, the tallest plant (21.89 cm) was observed under the application of vermicompost 2 t ha⁻¹ (V₁) where as vermicompost 0 t ha⁻¹ (V₀) produced the smallest plant (20.31 cm).

Plant height recorded at 60 DAS and at harvest showed the differential response due to vermicompost levels and significantly the highest plant height was recorded under application of vermicompost 2 t ha⁻¹ (V₁), the values being 39.13 cm and 67.92 cm, respectively. The values of plant height under vermicompost 0 t ha⁻¹ (V₀) were 37.02 cm and 64.98 cm, at 60 DAS and at harvest, respectively.

4.2.2.2 Effect of weed management practices

Data presented in the Table 4.2.2 indicated that the plant height of fenugreek was significantly influenced by different weed management practices during the growth stages *viz.* at 30 and 60 DAS and at harvest.

Significantly higher plant height of 22.76 cm was recorded at 30DAS under treatment hand weeding at 20 and 40 DAS (W₂) which was remained at par with the treatment oxadiargyl @ 75 g ha⁻¹ as PE *fb* HW at 30 DAS (W₈) (22.58 cm) and oxyflourfen @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS (W₆) (21.74 cm). The lowest plant height of 19.96 cm was observed under treatment weedy check (W₁).

At 60 DAS, significantly higher plant height of 40.75 cm was recorded under treatment hand weeding at 20 and 40 DAS (W_2), which was remained at par with treatments of oxadiargyl @ 75 g ha⁻¹ as PE *fb* HW at 30 DAS (W_8) (40.50 cm) and oxyflourfen @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS (W_6) (39.91 cm). Whereas at harvest, significantly higher plant height of 69.17 cm was observed under hand weeding at 20 and 40 DAS (W_2) which was found to be at par with oxadiargyl @ 75 g ha⁻¹ as PE *fb* HW at 30 DAS (W_8) (68.47 cm) and oxyflourfen @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS (W_6) (67.83 cm).

4.2.2.3 Interaction effect

Interaction effect between vermicompost levels and weed management practices was found to be non-significant with respect to plant height measured periodically at 30, 60 DAS and at harvest of fenugreek (Table 4.2.2).

Table 4.2.2 : Plant height (cm) at 30 and 60 DAS and at harvest as influenced by varying levels of vermicompost and weed management practices

Treatment	Plant height (cm)		
	30 DAS	60 DAS	At Harvest
Vermicompost (V)			
V₀ : Vermicompost 0 t ha⁻¹	20.31 ^b	37.02 ^b	64.98 ^b
V₁ : Vermicompost 2 t ha⁻¹	21.77 ^a	39.13 ^a	67.92 ^a
SEm±	0.30	0.36	0.47
CD (P=0.05)	Sign.	Sign.	Sign.
Weed Management (W)			
W₁ : Weedy check	19.96 ^c	35.85 ^d	64.05 ^d
W₂ : Hand weeding at 20 and 40 DAS	22.76 ^a	40.75 ^a	69.17 ^a
W₃ : Pendimethalin @ 500 g ha⁻¹ as PE	20.03 ^{bc}	35.44 ^d	65.07 ^d
W₄ : Pendimethalin @ 500 g ha⁻¹ as PE <i>fb</i> HW at 30 DAS	20.06 ^{bc}	36.67 ^{cd}	65.32 ^{cd}
W₅ : Oxyflourfen @ 80 g ha⁻¹ as PE	20.49 ^{bc}	37.00 ^{cd}	65.50 ^{cd}
W₆ : Oxyflourfen @ 80 g ha⁻¹ as PE <i>fb</i> HW at 30 DAS	21.74 ^{ab}	39.91 ^{ab}	67.83 ^{abc}
W₇ : Oxadiargyl @ 75 g ha⁻¹ as PE	20.70 ^{bc}	38.47 ^{bc}	66.20 ^{bcd}
W₈ : Oxadiargyl @ 75 g ha⁻¹ as PE <i>fb</i> HW at 30 DAS	22.58 ^a	40.50 ^{ab}	68.47 ^{ab}
SEm±	0.59	0.71	0.95
CD (P=0.05)	Sign.	Sign.	Sign.
V × W Interaction	NS	NS	NS
CV %	6.89	4.57	3.50

4.2.3 Dry weight of root nodules (mg plant⁻¹)

Data on dry weight of root nodules as influenced by different levels of vermicompost and weed management practices are presented in Table 4.2.3 and also graphically depicted in Fig. 4.2.2.

4.2.3.1 Effect of vermicompost

A perusal of data (Table 4.2.3) indicated that dry weight of root nodules differed significantly due to variation vermicompost level. Significantly the highest dry weight of 1.55 mg plant⁻¹ was observed under application of vermicompost 2 t ha⁻¹ (V₁), while the lowest 1.47 mg plant⁻¹ was observed under application of vermicompost 0 t ha⁻¹ (V₀).

4.2.3.2 Effect of weed management practices

Data presented in the Table 4.2.3 indicated that the dry weight of root nodules was significantly influenced by different weed management practices.

Significantly higher dry weight of root nodules was recorded under treatment hand weeding at 20 and 40 DAS (W₂) (1.82 mg plant⁻¹), which was remained at par with the treatment oxadiargyl @ 75 g ha⁻¹ as PE *fb* HW at 30 DAS (W₈) (1.79 mg plant⁻¹) and oxyflourfen @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS (W₆) (1.68 mg plant⁻¹). The lowest dry weight of root nodules of 1.04 mg plant⁻¹ was observed under treatment weedy check (W₁).

4.2.3.3 Interaction effect

Interaction effect between vermicompost levels and weed management practices was found to be non-significant with respect to dry weight of root nodules (Table 4.2.3).

4.2.4 Number of branches plant⁻¹

Data on number of branches plant⁻¹ as influenced by different vermicompost levels and weed management practices are presented in Table 4.2.3 and also graphically depicted in Fig. 4.2.2.

4.2.4.1 Effect of vermicompost

Data given in Table 4.2.3 indicated that the differences in number of branches plant⁻¹ due to varying levels of vermicompost were the significant. The treatment vermicompost 2 t ha⁻¹ (V₁) produced significantly highest number of branches plant⁻¹ (5.65) than vermicompost 0 t ha⁻¹ (V₀) (5.00).

4.2.4.2 Effect of weed management practices

A perusal of data given in Table 4.2.3 indicated that effect of different weed management practices was also found significant. The treatment hand weeding at 20 and 40 DAS (W₂) produced significantly higher number of branches plant⁻¹ (6.20), which was remained at par with application of oxadiargyl @ 75 g ha⁻¹ as PE *fb* HW at 30 DAS (W₈) (5.93) and oxyflourfen @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS (W₆) (5.87). The lowest number of branches plant⁻¹ (4.33) was recorded under treatment weedy check (W₁).

4.2.4.3 Interaction effect

Data presented in Table 4.2.4 indicated that number of branches was found to be significant due to interaction effect between vermicompost levels and weed management practices (V x W). Interaction data given in Table 4.2.4 indicated that treatment combination of vermicompost 2 t ha⁻¹ and hand weeding at 20 and 40 DAS (V₁W₂) recorded significantly higher number of branches per plant (6.33) as compared to the rest of the treatment combinations, however, it was remained at par with the treatment combinations vermicompost 2 t ha⁻¹ + oxadiargyl @ 75 g ha⁻¹ as PE *fb* HW at 30 DAS (V₁W₈) (6.07), vermicompost 0 t ha⁻¹ + hand weeding at 20 and 40 DAS (V₀W₂) (6.07), vermicompost 0 t ha⁻¹ + oxyflourfen @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS (V₀W₆) (6.00), vermicompost 2 t ha⁻¹ + oxadiargyl @ 75 g ha⁻¹ as

PE (V₁W₇) (5.80) and vermicompost 0 t ha⁻¹ + oxadiargyl @ 75 g ha⁻¹ as PE *fb* HW at 30 DAS (V₀W₈) (5.80).

Table 4.2.3: Dry weight of root nodule and no of branches as influenced by varying levels of vermicompost and weed management practices

Treatment	Dry weight of nodule (mg plant ⁻¹)	No of branches per plant (no plant ⁻¹)
Vermicompost (V)		
V ₀ : Vermicompost 0 t ha ⁻¹	1.47 ^b	5.00 ^b
V ₁ : Vermicompost 2 t ha ⁻¹	1.55 ^a	5.65 ^a
SEm±	0.03	0.07
CD (P=0.05)	Sign.	Sign.
Weed Management (W)		
W ₁ : Weedy check	1.04 ^c	4.33 ^d
W ₂ : Hand weeding at 20 and 40 DAS	1.82 ^a	6.20 ^a
W ₃ : Pendimethalin @ 500 g ha ⁻¹ as PE	1.39 ^b	5.07 ^{bc}
W ₄ : Pendimethalin @ 500 g ha ⁻¹ as PE <i>fb</i> HW at 30 DAS	1.45 ^b	5.33 ^b
W ₅ : Oxyflourfen @ 80 g ha ⁻¹ as PE	1.44 ^b	4.83 ^c
W ₆ : Oxyflourfen @ 80 g ha ⁻¹ as PE <i>fb</i> HW at 30 DAS	1.68 ^a	5.87 ^a
W ₇ : Oxadiargyl @ 75 g ha ⁻¹ as PE	1.49 ^b	5.03 ^{bc}
W ₈ : Oxadiargyl @ 75 g ha ⁻¹ as PE <i>fb</i> HW at 30 DAS	1.79 ^a	5.93 ^a
SEm±	0.05	0.14
CD (P=0.05)	Sign.	Sign.
V × W Interaction	NS	Sign.
CV %	8.36	6.53

Table 4.2.4: Number of branches plant⁻¹ as influenced by interaction of vermicompost and weed management practices

Weed management (W)	Vermicompost (V)	
	V ₀ : 0 t ha ⁻¹	V ₁ : 2 t ha ⁻¹
W₁ : Weedy check	4.20 ^e	4.47 ^e
W₂ : Hand weeding at 20 and 40 DAS	6.07 ^{ab}	6.33 ^a
W₃ : Pendimethalin @ 500 g ha⁻¹ as PE	4.67 ^e	5.47 ^{cd}
W₄ : Pendimethalin @ 500 g ha⁻¹ as PE <i>fb</i> HW at 30 DAS	5.07 ^{de}	5.60 ^{bcd}
W₅ : Oxyflourfen @ 80 g ha⁻¹ as PE	4.20 ^e	5.47 ^{cd}
W₆ : Oxyflourfen @ 80 g ha⁻¹ as PE <i>fb</i> HW at 30 DAS	5.80 ^{abc}	6.00 ^{abc}
W₇ : Oxadiargyl @ 75 g ha⁻¹ as PE	4.27 ^e	5.80 ^{abc}
W₈ : Oxadiargyl @ 75 g ha⁻¹ as PE <i>fb</i> HW at 30 DAS	5.80 ^{abc}	6.07 ^{ab}
SEm±	0.20	
CD (P=0.05)	Sign.	
CV%	6.53	

4.2.5 Herbicides phytotoxicity

Data presented in Table 4.2.5 showed phytotoxicity of herbicides measured at 7 and 14 days after application in terms of visual phytotoxicity on crop indicated that the phytotoxicity of herbicide score was recorded zero in all the herbicidal treatments at 7 and 14 days after spraying on the fenugreek.

Table 4.2.5 : Visual symptoms on phytotoxicity in various doses of herbicides (Score- 0-10) on fenugreek crop

Treatments	Vein Clearing (DAHA)		Necrosis (DAHA)		Wilting (DAHA)		Epinasty and Hyponasty (DAHA)	
	7	14	7	14	7	14	7	14
W ₃ :Pendimethalin @ 500 g ha ⁻¹ as PE	0	0	0	0	0	0	0	0
W ₄ :Pendimethalin @ 500 g ha ⁻¹ as PE <i>fb</i> HW at 30 DAS	0	0	0	0	0	0	0	0
W ₅ :Oxyflourfen @ 80 g ha ⁻¹ as PE	0	0	0	0	0	0	0	0
W ₆ :Oxyflourfen @ 80 g ha ⁻¹ as PE <i>fb</i> HW at 30 DAS	0	0	0	0	0	0	0	0
W ₇ :Oxadiargyl @ 75 g ha ⁻¹ as PE	0	0	0	0	0	0	0	0
W ₈ :Oxadiargyl @ 75 g ha ⁻¹ as PE <i>fb</i> HW at 30 DAS	0	0	0	0	0	0	0	0

DAHA -Days After Herbicide Application, PE - Pre Emergence,

4.3 Effect of treatments on yield and yield attributes

4.3.1 Number of pods plant⁻¹

4.3.2 Number of seeds pod⁻¹

4.3.3 Test weight (g)

4.3.4 Days to 50 % flowering

4.3.5 Seed yield (kg ha⁻¹)

4.3.6 Straw yield (kg ha⁻¹)

4.3.7 Harvest index

4.3.1 Number of pods per plant

Data pertaining to the number of pods per plant as influenced by different vermicompost levels and weed management practices are presented in Table 4.3.1 and also furnished graphically in Fig. 4.3.1.

4.3.1.1 Effect of vermicompost

The number of pods per plant was significantly influenced by different levels of vermicompost (Table 4.3.1). From the result, it was observed that significantly higher number of pods plant⁻¹ (19.33) was recorded with the application of vermicompost 2 t ha⁻¹ (V₁) and the lowest number of pods per plant (17.54) was recorded under treatment vermicompost 0 t ha⁻¹ (V₀).

4.3.1.2 Effect of weed management practices

Perusal of data presented in Table 4.3.1 indicated that differences in number of pods per plant due to different weed management practices were significant. Significantly higher number of pods (24.97) was recorded under treatment hand weeding at 20 and 40 DAS (W₂) which was remained at par with oxadiargyl @ 75 g ha⁻¹ as PE *fb* HW at 30 DAS (W₈) (23.70) and oxyflourfen @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS (W₆) (23.47). The lowest number of pods per plant was observed under treatment weedy check (W₁) (11.57).

4.3.1.3 Interaction effect

Data presented in Table 4.3.1 indicated that number of pods per plant was significant due to interaction effect between vermicompost levels and weed management practices (V x W). Interaction data given in Table 4.3.1 indicated that treatment combination vermicompost 2 t ha⁻¹ + hand weeding at 20 and 40 DAS (V₁W₂) recorded significantly higher number of pods per plant (26.07) as compared to the rest of the treatment combinations, however, it was remained at par with the treatment combinations application of vermicompost 2 t ha⁻¹ + oxadiargyl @ 75 g ha⁻¹ as PE *fb* HW at 30 DAS (V₁W₈) (25.93) and vermicompost 2 t ha⁻¹ + oxyflourfen @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS (V₁W₆) (24.87).

4.3.2 Number of seeds pod⁻¹

Data on number of seeds pod⁻¹ as influenced by different levels of vermicompost and weed management practices are presented in the Table 4.3.1 and also graphically illustrated in Fig. 4.3.2.

4.3.2.1 Effect of vermicompost

Number of seeds pod⁻¹ as influenced due to different vermicompost treatments showed significant variation (Table 4.3.1). The treatment Vermicompost 2 t ha⁻¹ (V₁) gave 16.18 seeds pod⁻¹ and found significantly superior than treatment vermicompost 0 t ha⁻¹ (V₀) (15.22).

4.3.2.2 Effect of weed management practices

Data pertaining (Table 4.3.1) to seeds pod⁻¹ due to different weed management practices were significant, wherein, treatment hand weeding at 20 and 40 DAS (W₂) recorded significantly higher number of seeds pod⁻¹ (17.30) which was found to be at par with oxadiargyl @ 75 g ha⁻¹ as PE *fb* HW at 30 DAS (W₈) (17.17) and oxyflourfen @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS (W₆) (16.10). The treatment weedy check (W₁) recorded the lowest seeds pod⁻¹ (12.97).

4.3.2.3 Interaction effect

Interaction effect of different levels of vermicompost and weed management practices did not show any appreciable effect on number of seeds pod⁻¹ in fenugreek (Table 4.3.1).

Table 4.3.1 : Number of pods plant⁻¹ and number of seeds pod⁻¹ as influenced by varying levels of vermicompost and weed management practices

Treatment	No. of pods plant ⁻¹	No of seeds pod ⁻¹
Vermicompost (V)		
V₀ : Vermicompost 0 t ha⁻¹	17.54 ^b	15.22 ^b
V₁ : Vermicompost 2 t ha⁻¹	19.33 ^a	16.18 ^a
SEm±	0.33	0.26
CD (P=0.05)	0.94	0.75
Weed Management (W)		
W₁ : Weedy check	11.57 ^d	12.97 ^d
W₂ : Hand weeding at 20 and 40 DAS	24.97 ^a	17.30 ^a
W₃ : Pendimethalin @ 500 g ha⁻¹ as PE	15.53 ^c	15.47 ^c
W₄ : Pendimethalin @ 500 g ha⁻¹ as PE <i>fb</i> HW at 30 DAS	18.73 ^b	15.40 ^c
W₅ : Oxyflourfen @ 80 g ha⁻¹ as PE	13.10 ^d	15.70 ^b
W₆ : Oxyflourfen @ 80 g ha⁻¹ as PE <i>fb</i> HW at 30 DAS	23.47 ^a	16.10 ^{abc}
W₇ : Oxadiargyl @ 75 g ha⁻¹ as PE	16.40 ^c	15.50 ^c
W₈ : Oxadiargyl @ 75 g ha⁻¹ as PE <i>fb</i> HW at 30 DAS	23.70 ^a	17.17 ^{ab}
SEm±	0.64	0.52
CD (P=0.05)	1.86	1.49
V × W Interaction	Sign.	NS
CV %	8.56	8.07

Table 4.3.2: Number of pods plant⁻¹ as influenced by interaction of vermicompost and weed management practices

Treatments	Vermicompost (V)	
	V ₀ : 0 t ha ⁻¹	V ₁ : 2 t ha ⁻¹
W ₁ : Weedy check	9.93 ^h	13.20 ^g
W ₂ : Hand weeding at 20 and 40 DAS	23.87 ^{ab}	26.07 ^a
W ₃ : Pendimethalin @ 500 g ha ⁻¹ as PE	16.87 ^f	14.20 ^g
W ₄ : Pendimethalin @ 500 g ha ⁻¹ as PE <i>fb</i> HW at 30 DAS	19.53 ^{cde}	17.93 ^{ef}
W ₅ : Oxyflourfen @ 80 g ha ⁻¹ as PE	12.80 ^g	13.40 ^g
W ₆ : Oxyflourfen @ 80 g ha ⁻¹ as PE <i>fb</i> HW at 30 DAS	22.07 ^{bc}	24.87 ^a
W ₇ : Oxadiargyl @ 75 g ha ⁻¹ as PE	13.80 ^g	19.00 ^{def}
W ₈ : Oxadiargyl @ 75 g ha ⁻¹ as PE <i>fb</i> HW at 30 DAS	21.47 ^{bcd}	25.93 ^a
SEm±	0.91	
CD (P=0.05)	Sign.	
CV %	8.56	

4.3.3 Days to 50% flowering

Data pertaining to the days to 50% flowering as influenced by different levels of vermicompost and weed management treatments are presented in Table 4.3.3 and also graphically furnished in Fig. 4.3.2.

4.3.3.1 Effect of vermicompost

Days to 50% flowering was significantly influenced by different levels of vermicompost. From the result, it was observed that significantly the lower days to 50% flowering (41.78) was recorded under treatment vermicompost

2 t ha⁻¹ (V₁). Significantly higher number of days to 50% flowering (43.61) was recorded under treatment vermicompost 0 t ha⁻¹ (V₀).

4.3.3.2 Effect of Weed management treatments

The days to 50% flowering was significantly influenced by different weed management practices. Significantly lower days to 50% flowering (41.21) was recorded under treatment oxadiargyl @ 75 g ha⁻¹ as PE *fb* HW at 30 DAS (W₈) which was remained at par with treatment oxyflourfen @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS (W₆) (41.60) and hand weeding at 20 and 40 DAS (W₂) (42.51). Significantly higher number of days to 50% flowering (43.84) was observed under treatment weedy check (W₁).

4.3.3.3 Interaction effect

Interaction effect of different levels of vermicompost and weed management practices was found non-significant in respect to days to 50% flowering of fenugreek.

4.3.4 Test weight (g)

Data pertaining to the test weight as influenced by different levels of vermicompost and weed management practices are presented in Table 4.3.3 and graphically depicted in Fig. 4.3.2.

4.3.4.1 Effect of vermicompost

An appraisal of data presented in Table 4.3.3 indicated that the differences in the weight of 1000 seeds were found to be significant due to

vermicompost levels. Significantly higher test weight (12.02 g) was recorded under treatment vermicompost 2 t ha⁻¹ (V₁). Significantly the lowest test weight (11.27 g) was recorded under treatment vermicompost 0 t ha⁻¹ (V₀).

4.3.4.2 Effect of weed management practices

Application of different weed management practices had shown their significant effect on test weight (Table 4.3.3). Significantly higher test weight (13.23 g) was recorded under treatment hand weeding at 20 and 40 DAS (W₂) which was remained at par with treatment oxadiargyl @ 75 g ha⁻¹ as PE *fb* HW at 30 DAS (W₈) (12.40 g) and oxyflourfen @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS (W₆) (12.28 g) and significantly the lowest test weight (10.37g) was recorded under treatment weedy check (W₁).

4.3.4.3 Interaction effect

Interaction effect of vermicompost levels and weed management practices was found to be non-significant in respect to test weight (g) of fenugreek (Table 4.3.3).

Table 4.3.3 : Days to 50% flowering and test weight as influenced by varying levels of vermicompost and weed management practices

Treatments	Days to 50% flowering	Test weight (g)
Vermicompost (V)		
V₀ : Vermicompost 0 t ha⁻¹	43.61 ^a	11.27 ^b
V₁ : Vermicompost 2 t ha⁻¹	41.78 ^b	12.02 ^a
SEm±	0.26	0.18
CD (P=0.05)	Sign.	Sign.
Weed Management (W)		
W₁ : Weedy check	43.84 ^a	10.37 ^d
W₂ : Hand weeding at 20 and 40 DAS	42.51 ^{abc}	13.23 ^a
W₃ : Pendimethalin @ 500 g ha⁻¹ as PE	43.27 ^a	10.77 ^{cd}
W₄ : Pendimethalin @ 500 g ha⁻¹ as PE <i>fb</i> HW at 30 DAS	43.30 ^a	11.42 ^{bc}
W₅ : Oxyflourfen @ 80 g ha⁻¹ as PE	42.85 ^{ab}	11.22 ^{cd}
W₆ : Oxyflourfen @ 80 g ha⁻¹ as PE <i>fb</i> HW at 30 DAS	41.60 ^b	12.28 ^{ab}
W₇ : Oxadiargyl @ 75 g ha⁻¹ as PE	42.97 ^{ab}	11.48 ^{bc}
W₈ : Oxadiargyl @ 75 g ha⁻¹ as PE <i>fb</i> HW at 30 DAS	41.21 ^c	12.40 ^{ab}
SEm±	0.52	0.35
CD (P=0.05)	Sign.	Sign.
V × W Interaction	NS	NS
CV %	2.95	7.33

4.3.5 Seed yield (Kg ha⁻¹)

Seed yield as influenced by different levels of vermicompost and weed management practices are presented in Table 4.3.4 and also graphically depicted in Fig. 4.3.3.

4.3.5.1 Effect of vermicompost

Results presented in Table 4.3.4 showed that vermicompost treatments had a pronounced effect on seed yield of fenugreek. Application of vermicompost 2 t ha⁻¹ (V₁) resulted insignificantly higher seed yield and recorded 2261.56 kg ha⁻¹ while, the lowest seed yield, 1842.76 kg ha⁻¹ was recorded under the application of vermicompost 0 t ha⁻¹ (V₀).

4.3.5.2 Effect of weed management practices

Data present in Table 4.3.4 with respect to seed yield of fenugreek as influenced by weed management practices indicated that there were significant differences in seed yield of fenugreek. The treatment hand weeding at 20 and 40 DAS (W₂) recorded significantly higher value of seed yield (2623.10 kg ha⁻¹) which was remained at par with oxadiargyl @ 75 g ha⁻¹ as PE *fb* HW at 30 DAS (W₈) (2503.66 kg ha⁻¹) and oxyflourfen @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS (W₆) (2490.86 kg ha⁻¹). The weedy check W₁ lagged behind all in recording the lowest value of seed yield (1080.25 kg ha⁻¹).

4.3.5.3 Interaction effect

Data presented in Table 4.3.5 indicated that seed yield of fenugreek was found to be significant due to interaction effect between levels of vermicompost and weed management practices (V x W). Interaction data given in Table 4.3.5

indicated that treatment combination vermicompost 2 t ha⁻¹ + hand weeding at 20 and 40 DAS (V₁W₂) recorded significantly higher seed yield (2817.28 kg ha⁻¹) as compared to the rest of the treatment combinations, however, it was remained at par with the treatment combinations vermicompost 2 t ha⁻¹ + oxadiargyl @ 75 g ha⁻¹ as PE *fb* HW at 30 DAS (V₁W₈) (2708.56 kg ha⁻¹) and vermicompost 2 t ha⁻¹ + oxyflourfen @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS (V₁W₆) (2677.78 kg ha⁻¹). The lowest seed yield of 975.31 kg ha⁻¹ was recorded under the treatment combination of vermicompost 0 t ha⁻¹ + weedy check (V₀W₁).

4.3.6 Straw yield (kg ha⁻¹)

Data pertaining to straw yield as influenced by different levels of vermicompost and weed management practices are presented in Table 4.3.4 and graphically illustrated in Fig. 4.3.3.

4.3.6.1 Effect of levels of vermicompost

Data presented in Table 4.3.4 manifested that vermicompost levels brought out significant influenced on straw yield of fenugreek, where in, treatment vermicompost 2 t ha⁻¹ (V₁) produced maximum straw yield (4138.32 kg ha⁻¹). The lowest straw yield of 3638.89 kg ha⁻¹ was recorded under the treatment vermicompost 0 t ha⁻¹ (V₀).

4.3.6.2 Effect of weed management practices

Data presented in Table 4.3.4 indicated that straw yield was influenced significantly by weed management practices. The maximum value of

straw yield of 4599.30 kg ha⁻¹ was recorded under treatment oxadiargyl @ 75 g ha⁻¹ as PE *fb* HW at 30 DAS (W₈) which was found to be at par with treatment hand weeding at 20 and 40 DAS (W₂) and oxyflourfen @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS (W₆) and recorded 4419.44 kg ha⁻¹, 4475.00 kg ha⁻¹ straw yield, respectively. Treatment weedy check (W₁) registered the minimum value (2248.61 kg ha⁻¹) of straw yield.

4.3.6.3 Interaction effect

Data presented in Table 4.3.6 indicated that straw yield of fenugreek was found to be significant due to interaction effect between different levels of vermicompost and weed management practices (V x W). Interaction data given in Table 4.3.6 indicated that treatment combination of vermicompost 2 t ha⁻¹ + oxyflourfen @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS (V₁W₆) recorded significantly higher straw yield (4944.44 kg ha⁻¹) as compared to the rest of the treatment combinations, however, it was found to be at par with the treatment combinations vermicompost 2 t ha⁻¹ + oxadiargyl @ 75 g ha⁻¹ as PE *fb* HW at 30 DAS (V₁W₈) and vermicompost 2 t ha⁻¹ + hand weeding at 20 and 40 DAS (V₁W₂) and recorded 4865.27 kg ha⁻¹ and 4616.66 kg ha⁻¹ straw yield, respectively. The lowest straw yield of 1902.78 kg ha⁻¹ was recorded under the treatment combination of Vermicompost 0 t ha⁻¹ + weedy check (V₁W₂).

4.3.7 Harvest index (%)

Harvest index as influenced by different levels of vermicompost levels are presented in Table 4.3.4 and graphically presented in fig 4.3.4.

4.3.7.1 Effect of levels of vermicompost

The results presented in Table 4.3.4 revealed that harvest index was found to be significant due to various levels of vermicompost. The maximum value of harvest index of 35.00 % was recorded under treatment vermicompost 2 t ha⁻¹ (V₁), while the minimum was 33.47 % recorded under vermicompost 0 t ha⁻¹ (V₀).

4.3.7.2 Effect of weed management practices

The results presented in Table 4.3.4 revealed that different weed management practices brought out significant variation in respect of harvest index, wherein, the highest value of harvest index (37.23 %) was noticed under treatment hand weeding at 20 and 40 DAS (W₂). The lowest harvest index of 32.66 % was found in treatment weedy check (W₁).

4.3.7.3 Interaction effect

Data presented in Table 4.3.7 indicated that harvest index of fenugreek was found to be significant due to interaction effect between different levels of vermicompost and weed management practices (V x W). Interaction data given in Table 4.3.7 indicated that treatment combination vermicompost 2 t ha⁻¹ + hand weeding at 20 and 40 DAS (V₁W₂) recorded significantly higher harvest index 37.90 % as compared to the rest of the treatment combinations, however, it was found to be at par with the treatment combinations Vermicompost 2 t ha⁻¹ + pendimethalin @ 500 g ha⁻¹ as PE *fb* HW at 30 DAS (V₁W₄) (37.62 %), vermicompost 2 t ha⁻¹ + oxadiargyl @ 75 g ha⁻¹ as PE (V₁W₇) (37.03 %), vermicompost 0 t ha⁻¹ + oxyflourfen @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS (V₀W₆) (36.52 %), vermicompost 2 t ha⁻¹ + oxadiargyl @ 75 g ha⁻¹ as PE *fb* HW at 30 DAS (V₁W₈) (35.88 %) and vermicompost 0 t ha⁻¹ + hand weeding at 20 and 40 DAS

(V₀W₂) (36.57 %). The lowest harvest index (29.55 %) was recorded under the treatment combination vermicompost 0 t ha⁻¹ + oxadiargyl @ 75 g ha⁻¹ as PE (V₀W₇).

Table 4.3.4: Seed yield, straw yield (kg ha⁻¹) and harvest index (%) as influenced by varying levels of vermicompost and weed management practices

Treatments	Seed yield (kg ha ⁻¹)	Straw yield (kg ha ⁻¹)	Harvest index (%)
Vermicompost (V)			
V ₀ : Vermicompost 0 t ha ⁻¹	1842.76 ^b	3638.89 ^b	33.42 ^b
V ₁ : Vermicompost 2 t ha ⁻¹	2261.56 ^a	4138.32 ^a	35.00 ^a
SEm±	33.16	56.35	0.37
CD (P=0.05)	Sign.	Sign.	Sign.
Weed Management (W)			
W ₁ : Weedy check	1080.25 ^d	2248.61 ^e	32.66 ^{de}
W ₂ : Hand weeding at 20 and 40 DAS	2623.10 ^a	4419.44 ^a	37.23 ^a
W ₃ : Pendimethalin @ 500 g ha ⁻¹ as PE	1620.99 ^c	3529.16 ^d	31.58 ^e
W ₄ : Pendimethalin @ 500 g ha ⁻¹ as PE <i>fb</i> HW at 30 DAS	2117.28 ^b	4064.58 ^{bc}	34.10 ^{bcd}
W ₅ : Oxyflourfen @ 80 g ha ⁻¹ as PE	1936.42 ^b	3796.44 ^{cd}	33.73 ^{bcd}
W ₆ : Oxyflourfen @ 80 g ha ⁻¹ as PE <i>fb</i> HW at 30 DAS	2490.86 ^a	4475.00 ^a	35.84 ^{ab}
W ₇ : Oxadiargyl @ 75 g ha ⁻¹ as PE	1994.75 ^b	3926.30 ^c	33.29 ^{cde}
W ₈ : Oxadiargyl @ 75 g ha ⁻¹ as PE <i>fb</i> HW at 30 DAS	2503.66 ^a	4599.30 ^a	35.25 ^{abc}
SEm±	66.31	116.45	0.74
CD (P=0.05)	197.38	336.35	2.13
V × W Interaction	Sign.	Sign.	Sign.
CV %	8.18	7.35	5.28

Table 4.3.5: Seed yield (kg ha⁻¹) as influenced by interaction of vermicompost and weed management practices

Treatments Weed management (W)	Vermicompost (V)	
	V ₀ : 0 t ha ⁻¹	V ₁ : 2 t ha ⁻¹
W ₁ : Weedy check	975.31 ^e	1185.19 ^e
W ₂ : Hand weeding at 20 and 40 DAS	2428.91 ^{bc}	2817.28 ^a
W ₃ : Pendimethalin @ 500 g ha ⁻¹ as PE	1560.49 ^d	1681.48 ^d
W ₄ : Pendimethalin @ 500 g ha ⁻¹ as PE <i>fb</i> HW at 30 DAS	1827.16 ^d	2407.41 ^b
W ₅ : Oxyflourfen @ 80 g ha ⁻¹ as PE	1651.85 ^d	2220.99 ^c
W ₆ : Oxyflourfen @ 80 g ha ⁻¹ as PE <i>fb</i> HW at 30 DAS	2303.95 ^c	2677.78 ^{ab}
W ₇ : Oxadiargyl @ 75 g ha ⁻¹ as PE	1595.68 ^d	2393.83 ^c
W ₈ : Oxadiargyl @ 75 g ha ⁻¹ as PE <i>fb</i> HW at 30 DAS	2298.77 ^c	2708.56 ^a
SEm±	96.65	
CD (P=0.05)	Sign.	
CV%	8.18	

Table 4.3.6: Straw yield (kg ha⁻¹) as influenced by interaction of vermicompost and weed management practices

Treatments Weed management (W)	Vermicompost (V)	
	V ₀ : 0 t ha ⁻¹	V ₁ : 2 t ha ⁻¹
W ₁ : Weedy check	1902.78 ⁱ	2594.44 ^h
W ₂ : Hand weeding at 20 and 40 DAS	4222.22 ^{bcd}	4616.66 ^{ab}
W ₃ : Pendimethalin @ 500 g ha ⁻¹ as PE	3277.77 ^g	3780.55 ^{ef}
W ₄ : Pendimethalin @ 500 g ha ⁻¹ as PE <i>fb</i> HW at 30 DAS	4143.05 ^{bcd}	3986.11 ^{cde}
W ₅ : Oxyflourfen @ 80 g ha ⁻¹ as PE	3338.89 ^{fg}	4253.99 ^{bcd}
W ₆ : Oxyflourfen @ 80 g ha ⁻¹ as PE <i>fb</i> HW at 30 DAS	4005.55 ^{cde}	4944.44 ^a
W ₇ : Oxadiargyl @ 75 g ha ⁻¹ as PE	3787.50 ^{def}	4065.11 ^{cde}
W ₈ : Oxadiargyl @ 75 g ha ⁻¹ as PE <i>fb</i> HW at 30 DAS	4333.33 ^{bc}	4865.27 ^a
SEm±	164.69	
CD (P=0.05)	Sign.	
C.V.%	7.35	

Table 4.3.7: Harvest index (%) as influenced by interaction of vermicompost and weed management practices

Treatment Weed management (w)	Vermicompost (V)	
	V ₀ : 0 t ha ⁻¹	V ₁ : 2 t ha ⁻¹
W ₁ : Weedy check	33.93 ^{defg}	31.38 ^{ghi}
W ₂ : Hand weeding at 20 and 40 DAS	36.57 ^{abcd}	37.90 ^a
W ₃ : Pendimethalin @ 500 g ha ⁻¹ as PE	32.38 ^{fghi}	30.79 ^{hi}
W ₄ : Pendimethalin @ 500 g ha ⁻¹ as PE <i>fb</i> HW at 30 DAS	30.57 ^{hi}	37.62 ^{ab}
W ₅ : Oxyflourfen @ 80 g ha ⁻¹ as PE	33.22 ^{efgh}	34.23 ^{cdefg}
W ₆ : Oxyflourfen @ 80 g ha ⁻¹ as PE <i>fb</i> HW at 30 DAS	36.52 ^{abcd}	35.15 ^{abcde}
W ₇ : Oxadiargyl @ 75 g ha ⁻¹ as PE	29.55 ⁱ	37.03 ^{abcd}
W ₈ : Oxadiargyl @ 75 g ha ⁻¹ as PE <i>fb</i> HW at 30 DAS	34.62 ^{bcdef}	35.88 ^{abcde}
SEm±	1.04	
CD (P=0.05)	Sign.	
C.V.%	5.28	

4.4 Economics of different treatments

The cost of cultivation, net returns and cost benefit ratio of different vermicompost and weed management treatments are detailed in Table 4.4.1.

4.4.1 Effect of levels of vermicompost

The treatment of vermicompost 2 t ha⁻¹ (V₁) recorded maximum seed yield (2262 kg ha⁻¹), straw yield (4138 kg ha⁻¹) and net returns (51350 Rs ha⁻¹) but the cost benefit ratio was maximum under treatment Vermicompost 0 t ha⁻¹ (V₀).

4.4.1 Effect of weed management practices

Among the weed management treatments, treatment of hand weeding at 20 and 40 DAS recorded maximum net return (71399 Rs ha⁻¹) and cost benefit ratio (1:4.16) followed by application of oxyflourfen @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS (66936 Rs ha⁻¹ and 1:3.98) and oxadiargyl @ 75 g ha⁻¹ as PE *fb* HW at 30 DAS (66547 Rs ha⁻¹ and 1:3.85), respectively.

Table 4.4.1: Gross realization, net realization and benefit cost ratio (CBR) for vermicompost and weed management treatments

Treatments	Seed yield (kg ha ⁻¹)	straw yield (kg ha ⁻¹)	Gross return (Rs ha ⁻¹)	Total cost of cultivation (Rs ha ⁻¹)	Net return (Rs ha ⁻¹)	CBR
Vermicompost (V)						
V ₀ : Vermicompost 0 t ha ⁻¹	1842	3638	66289	18753	47536	1:3.53
V ₁ : Vermicompost 2 t ha ⁻¹	2262	4138	81224	29874	51350	1:2.72
Weed management (W)						
W ₁ : Weedy check	1080	2249	38933	18753	20180	1:2.08
W ₂ : Hand weeding at 20 and 40 DAS	2623	4419	94018	22619	71399	1:4.16
W ₃ : Pendimethalin @ 500 g ha ⁻¹ as PE	1621	3529	58499	20960	37539	1:2.79
W ₄ : Pendimethalin @ 500 g ha ⁻¹ as PE <i>fb</i> HW at 30 DAS	2117	4065	76137	22248	53889	1:3.42
W ₅ : Oxyflourfen @ 80 g ha ⁻¹ as PE	1936	3796	69673	21193	48480	1:3.29
W ₆ : Oxyflourfen @ 80 g ha ⁻¹ as PE <i>fb</i> HW at 30 DAS	2491	4475	89418	22481	66936	1:3.98
W ₇ : Oxadiargyl @ 75 g ha ⁻¹ as PE	1995	3926	71780	22093	49687	1:3.25
W ₈ : Oxadiargyl @ 75 g ha ⁻¹ as PE <i>fb</i> HW at 30 DAS	2504	4599	89928	23381	66547	1:3.85

Price of seed : 35 Rs kg⁻¹

Price of straw : 0.5 Rs kg⁻¹

4.4.3 Interaction effect

The treatment combination of vermicompost 2 t ha⁻¹ + hand weeding at 20 & 40 DAS (V₁W₂) recorded maximum net returns (67114.34 Rs ha⁻¹) followed by vermicompost 0 t ha⁻¹ + hand weeding at 20 & 40 DAS (V₀W₂), vermicompost 2 t ha⁻¹ + oxadiargyl @ 75 g ha⁻¹ as PE *fb*HW at 30 DAS (V₁W₈) and vermicompost 2 t ha⁻¹ + oxyflourfen @ 80 g ha⁻¹ as PE *fb*hw at 30 DAS (V₁W₆). The respective values were 64504.21 Rsha⁻¹, 62671.11 Rs ha⁻¹ and 62671.11 Rsha⁻¹, respectively

The benefit cost ratio was maximum (3.85) under the treatment combination of vermicompost 0 t ha⁻¹ + hand weeding at 20 & 40 DAS (V₀W₂) followed by treatment combination of vermicompost 0 t ha⁻¹ + oxadiargyl @ 75 g ha⁻¹ as PE *fb*hw at 30 DAS (V₀W₈), vermicompost 0 t ha⁻¹ + oxyflourfen @ 80 g ha⁻¹ as PE *fb*hw at 30 DAS (V₀W₆) and vermicompost 2 t ha⁻¹ + hand weeding at 20 & 40 DAS (V₁W₂). The respective values were 3.35, 3.48 and 2.99, respectively.

Table 4.4.2: Gross realization, net realization and benefit cost ratio (CBR) for treatment combinations

Treatment	Seed yield (kg ha⁻¹)	Straw yield (kg ha⁻¹)	Gross income (Rs ha⁻¹)	Total cost (Rs ha⁻¹)	Net income (Rs ha⁻¹)	CBR
V ₀ W ₁	975.31	1902.78	35087.19	18754.84	16332.35	1:1.87
V ₀ W ₂	2428.91	4222.22	87122.93	22618.72	64504.21	1:3.85
V ₀ W ₃	1560.49	3277.77	56256.17	20960.48	35295.69	1:2.68
V ₀ W ₄	1827.16	4143.05	66022.14	23536.4	42485.75	1:2.81
V ₀ W ₅	1651.85	3338.89	59484.26	21193.38	38290.88	1:2.81
V ₀ W ₆	2303.95	4005.55	82641.05	23769.3	58871.74	1:3.48
V ₀ W ₇	1595.68	3787.50	57742.51	22092.81	35649.71	1:2.61
V ₀ W ₈	2298.77	4333.33	82623.46	24668.73	57954.73	1:3.35
V ₁ W ₁	1185.19	2594.44	42778.7	29935.05	12843.66	1:1.43
V ₁ W ₂	2817.28	4616.66	100913.3	33798.93	67114.34	1:2.99
V ₁ W ₃	1681.48	3780.55	60742.13	32140.68	28601.45	1:1.89
V ₁ W ₄	2407.41	3986.11	86252.31	34716.6	51535.72	1:2.48
V ₁ W ₅	2220.99	4253.99	79861.56	32373.58	47487.98	1:2.47
V ₁ W ₆	2677.78	4944.44	96194.44	34949.5	61244.94	1:2.75
V ₁ W ₇	2393.83	4065.11	85816.51	33273.01	52543.5	1:2.58
V ₁ W ₈	2708.56	4865.27	97232.08	35848.93	61383.15	1:2.71

V. DISCUSSION

A brief discussion on results obtained from the present investigation entitled “Effect of vermicompost and weed management practices on growth and yield of fenugreek (*Trigonella foenum-graecum* L.) under Middle Gujarat conditions” has been presented in this chapter. The results of field experiment presented in the preceding chapter have been critically discussed in this chapter. It has been attempted to establish “effect and cause” relationship in light of variable evidence and literature.

Vermicompost and Weed management plays a vital role in increasing yield of fenugreek. Therefore, a close understanding of soil conditions, physiological factors affecting the growth and yield attributes of fenugreek need to be studied. The prime objective of the present investigation was to find out the vermicompost and efficacy of different weed management practices in relation to crop production per unit area. The factors which affected weed population, growth and development of crop and yield of fenugreek have been discussed in this chapter under the following sub-heads.

- 5.1 Effect of weather parameters on crop and weeds
- 5.2 Effect of treatments on weeds
- 5.3 Effect of treatments on growth parameters
- 5.4 Effect of treatments on yield and yield attributes
- 5.5 Interaction effect on growth, yield attributes and yield
- 5.6 Economics

5.1 EFFECT OF WEATHER PARAMETERS ON CROP AND WEEDS

Among the various factors responsible for affecting the yield and performance of crop as well as associated weeds, the weather parameters play a key role. The growth, development and finally the seed yield of fenugreek is the expression of prevalent weather condition, particularly temperature, bright sunshine hours, humidity and soil moisture availability during the crop seasons. The various weather parameters for the year 2012 (during crop season) recorded at the Meteorological Laboratory of the Anand Agricultural University, Anand located very nearer to the site of the present experiment are presented in Table 3.1 and graphically illustrated in Fig. 3.1. The fenugreek crop received sufficient temperature as seen from the data recorded during the experimental period. As a result, the crop growth was normal and hence, whatever variations observed in the study was attributed to different treatments exercised in the experiment.

5.2 EFFECT OF VERMICOMPOST AND WEED MANAGEMENT PRACTICES ON WEEDS

5.2.1 Weed flora

Weed flora recorded in weedy check showed that dicot weeds had 74.03 per cent share in total weed population. *Chenopodium album* L. was observed as most dominant dicot weed with 34.87 per cent infestation. *Chenopodium murale* L., *Digera arvensis* forsk, *Phyllanthus niruri* L. and *Asphodelustenuifolius* L. cav were another dominant weed and contributed 12.79, 12.20, 6.97 and 5.04 per cent, respectively. Similar results were also reported by Patel and Mehta (1989), Patel *et al.* (2005), Mehriya *et al.* (2008) and Nagar *et al.* (2009) in fenugreek, cumin and coriander crop.

The total monocot weeds contributes about 25.97 per cent share in total weed population. Among the monocot weeds, *Cynodon dactylon* was the most dominant weed and contributed 21.73 per cent of total weed population. Similar results were akin to those reported by Kumar and Patel *et al.* (2005) and Kumar *et al.* (2005).

5.2.2 Weed density

5.2.2.1 Monocot and Dicot weeds count at 20 DAS

The effect of vermicompost levels on weed count at 20 DAS were found non-significant (4.1.2). It showed that vermicompost treatment have not any significant effect among it.

The response of various treatments on density of monocot and dicot Table 4.1.2 at different stages were significant. At 20 DAS, results found that lower monocot weeds count were noticed in treatment of the hand weeding carried out at 20 & 40 DAS (W_2) which gave the best weed management among all the treatments followed by oxadiargyl @ 75 g ha⁻¹ PE *fb* HW at 30 DAS (W_8). Similar result was noticed by Patel *et al.* (2013) and Meena *et al.* (2013) in dill seed crop.

At 20 DAS, significantly the lowest dicot weed counts were recorded in treatment of hand weeding carried out at 20 & 40 DAS followed by application oxadiargyl @ 75 g ha⁻¹ PE *fb* HW at 30 DAS (W_8) and oxyfluorfen @ 80 g ha⁻¹ PE *fb* HW at 30 DAS (W_6) Similar results were noticed by Meena *et al.* (2013), Zalavadiya *et al.* (1999) and Meena and Maheta (2009) in fenugreek and coriander crops.

At all the stages, hand weeding twice carried out at 20 and 40 DAS (W_2) gave the best control of monocot and dicot weeds than other treatments because of initially weeds were controlled by hand weeding carried out at 20

DAS and whatever weeds emerged later were effectively removed by subsequent hand weeding carried out at 40 DAS. Effective control of weeds through cultural practices was also reported by Tripathi and Singh (2008), Sharma (2009) and Mehta *et al.* (2010) in fenugreek. Oxadiargyl @ 75 g ha⁻¹ PE *fb* HW at 30 DAS (W₈) and oxyfluorfen @ 80 g ha⁻¹ PE *fb* HW at 30 DAS (W₆) were also effective to control most of monocot and dicot weeds in fenugreek at initial stage due to effectiveness of its molecule on weeds which were noticed in the field. Similar result was also found by Meena and Mehta (2009) for oxadiargyl Sagarka *et al.* (2005) for oxyfluorfen.

5.2.2.2 Monocot and dicot weeds count at 40 DAS

The effect of vermicompost levels on weed count at 40 DAS were found non-significant (4.1.3). It showed that vermicompost treatment have not any significant effect on weed population.

At 40 DAS, treatment of hand weeding carried out at 20 & 40 DAS (W₂) recorded the lower weeds count of monocot (Table 4.1.3) followed by oxadiargyl @ 75 g ha⁻¹ PE *fb* HW at 30 DAS (W₈) and oxyfluorfen @ 80 g ha⁻¹ PE *fb* HW at 30 DAS (W₆). Similar result was reported by Meena and Mehta (2009), Sagarka *et al.* (2005) in coriander.

Hand weeding carried out at 20 & 40 DAS (W₂) observed lower value of weed counts of dicot (Table 4.1.3) Tiwari *et al.*, (2005) found similar result which was at par with oxadiargyl @ 75 g ha⁻¹ PE *fb* HW at 30 DAS (W₈) and oxyfluorfen @ 80 g ha⁻¹ PE *fb* HW at 30 DAS (W₆). The superiority of said treatment might be due to the fact that initially weeds were controlled by hand weeding carried out at 20 DAS and whatever weeds emerged later were

effectively removed by subsequent hand weeding carried out at 40 DAS and in herbicidal treatments prolonged persistence of herbicides and hand weeding carried out at 30 DAS provided to the weed free condition. Effective control of weeds through integrated methods were reported by Meena and Mehta (2009), Sagarka *et al.* (2005) and Sharma (2009).

5.2.3 Dry weight of weeds

All the weed control treatments significantly reduced the dry weight of weeds as compared to unweeded control during all the crop growth stages. The competition stress of weeds on crop can be understood. Significantly maximum dry weight of weeds was recorded under weedy check (W₁) due to no weed management and it was markedly reduced when different herbicides were applied as pre emergence as well as hand weeding carried out at 30 DAS. These results are in accordance with those reported by Kumar *et al.* (2005), Sharma (2009) and Dungarwal *et al.* (2002).

5.2.3.1 Dry weight of weeds at 20 DAS

The effect of vermicompost levels on weed dry weight at 20 DAS were found non-significant (4.1.4). It showed that vermicompost treatment have not any significant effect among it.

At 20 DAS, significantly the lowest dry weight of monocot weeds (Table 4.1.4) was recorded under hand weeding carried out at 20 & 40 DAS (W₂). In chemical treatments, application of oxadiargyl @ 75 g ha⁻¹ PE *fb* HW at 30 DAS (W₈) and oxyfluorfen @ 80 g ha⁻¹ PE *fb* HW at 30 DAS (W₆) record lower weed dry weight which was at par with pre-emergence application of oxadiargyl @ 75 g ha⁻¹. Hand weeding carried out at 20 & 40 DAS (W₂) recorded

significantly lower dry weight of dicot weeds followed by pre emergence application of oxadiargyl @ 75 g ha⁻¹ fb HW at 30 DAS (W₈) and oxyfluorfen @ 80 g ha⁻¹ fb HW at 30 DAS (W₆). Hand weeding carried out at 20 & 40 DAS (W₂) proved to be significant for lowering weed dry weight of total weeds (Table 4.1.4) at 20 DAS which was at par with oxadiargyl @ 75 g ha⁻¹ PE fb HW at 30 DAS (W₈) and the treatment W₈ was at par with application of oxyfluorfen @ 80 g ha⁻¹ PE fb HW at 30 DAS (W₆). Zalavadiya *et al.* (1999), Chaudhary (1999), Patel *et al.* (2006) and Meena and Mehta (2009) reported same type of results.

5.2.3.2 Dry weight of weeds at 40 DAS

The effect of vermicompost levels on weed dry weight at 40 DAS were found non-significant (4.1.5). It showed that vermicompost treatment have not any significant effect on weed dry weight.

At 40 DAS, the results showed that significantly the lower weed dry weight of monocot weeds (Table 4.1.5) were observed under the treatment of the hand weeding carried out at 20 & 40 DAS (W₂) which was at par with the treatment of pre emergence application of oxadiargyl @ 75 g ha⁻¹ PE fb HW at 30 DAS (W₈) and oxyfluorfen @ 80 g ha⁻¹ PE fb HW at 30 DAS (W₆). At 40 DAS, weeds dry weight of dicot weeds recorded under the treatment of hand weeding carried out at 20 & 40 DAS (W₂) was significantly lower but at par with pre emergence application of oxadiargyl @ 75 g ha⁻¹ PE fb HW at 30 DAS (W₈) and oxyfluorfen @ 80 g ha⁻¹ PE fb HW at 30 DAS (W₆). Hand weeding carried out 20 & 40 DAS recorded significantly the lower total weed dry weight followed by oxadiargyl @ 75 g ha⁻¹ PE fb HW at 30 DAS (W₈) and it was at par with oxyfluorfen @ 80 g ha⁻¹ PE fb HW at 30 DAS (W₆). Significantly higher weed dry weight of monocot, dicot and total weeds recorded under weedy check (W₁). The

prolonged persistence of above herbicides contributed to the weed free condition during crop weed competition period as well as integration with hand weeding at 30 DAS. The similar results were reported by Zalavadiya *et al.* (1999), Chaudhary (1999), Mehriya *et al.* (2008) and Meena and Mehta (2009).

5.2.3.3 Dry weight of weeds at harvest

The effect of vermicompost levels on weed dry weight at harvest were found non-significant (4.1.6). It showed that vermicompost treatment have not any significant effect on dry weight of weeds at harvest.

Among all the treatments, hand weeding carried out at 20 & 40 DAS (W₂) recorded significantly lower dry weight of weeds and it was at par with oxadiargyl @ 75 g ha⁻¹ PE *fb* HW at 30 DAS (W₈) and oxyfluorfen @ 80 g ha⁻¹ PE *fb* HW at 30 DAS (W₆). At the time of harvest of the fenugreek crop in integration, removal of weeds by hand weeding at later stages was more effective to control weeds which directly showed beneficial effect on growth of fenugreek. These results are in agreement with the findings of Zalavadiya *et al.* (1999), Chaudhary (1999) and Meena and Mehta (2009) .

5.2.4 Weed index

The treatment hand weeding carried out at 20 & 40 DAS (W₂) had the lowest weed index (0.0 %) followed by the treatments of oxadiargyl @ 75 g ha⁻¹ PE *fb* HW at 30 DAS (W₈) (4.55) and oxyfluorfen @ 80 g ha⁻¹ PE *fb* HW at 30 DAS (W₆) (5.04). The weedy check (W₁) recorded the maximum weed index (58.81 %). These results are in agreement with the results reported by Meena and Mehta (2009), Mehta *et al.* (2010) and Yadav *et al.* (2010).

5.2.5 Weed control efficiency

Maximum weed control efficiency at harvest (63.53 per cent) was registered under the treatment of hand weeding carried out at 20 & 40 DAS

(W₂) followed by treatments of oxadiargyl @ 75 g ha⁻¹ PE *fb* HW at 30 DAS (W₈) (61.05 per cent) and oxyfluorfen @ 80 g ha⁻¹ PE *fb* HW at 30 DAS (W₆) (58.82 per cent respectively). Higher efficacy of herbicides at early growth stage and one hand weeding at later stage was effective to control late emergent weeds thereby in reducing weed dry matter under these treatments. The well-developed foliage canopy, intercepting solar energy effectively covered maximum ground area and imparted smothering effect on weed which emerged after execution at weed control schedule. Under such conditions, the solar energy was almost unavailable to weeds competing with blackgram foliage canopy. About 85 per cent light penetration was limited to 15 cm of the plant. These results are akin to those reported by Chaudhary (1999), Mehriya *et al.* (2008) Meena and Mehta (2009) and Yadav *et al.* (2010).

5.3 EFFECT OF VERMICOMPOST AND WEED MANAGEMENT PRACTICES ON GROWTH PARAMETERS

Different weed management treatments influenced crop growth parameters are discussed under sub heads as mention below.

5.3.1 Plant population (No of plants per meter row length)

The plant population recorded at 15 DAS and at harvest were not significantly influenced due to various vermicompost levels and weed management treatments. It showed that there was no phototoxic effect of any herbicides on fenugreek crop. The uniformity in plant population of fenugreek could be accounted for identical growing conditions including vital production factors like seed rate, fertilizers and its application method etc. might be the reason for uniformity in plant density.

5.3.2 Plant height (cm)

Plant height showed increasing trend (almost linear) with advancement in plant age up to 50 DAS growth stage and then it was remained constant till at harvest.

Vermicompost levels also showed significant result in plant height at 30, 60 DAS and at harvest. The highest plant height recorded under treatment V₁ vermicompost 2 t ha⁻¹. This might be due to vermicompost provide good source of nutrient which help to increase plant height of fenugreek crop. These are in conformity with the results of Pandey *et al.* (2012)

A careful perusal of data presented in Table 4.2.2 indicated that all the weed control treatments gave significantly higher plant height than weedy check at 30, 60 DAS and at harvest. The treatment of hand weeding carried out at 20 & 40 DAS (W₂) recorded significantly higher plant height followed by the treatment of oxadiargyl @ 75 g ha⁻¹ PE *fb* HW at 30 DAS (W₈) and oxyfluorfen @ 80 g ha⁻¹ PE *fb* HW (W₆) at 30, 60 DAS and at harvest. which might be due to weed free environment up to 45 DAS (critical crop-weed competition period). Thus, it was apparent that hand weeding twice checks the weeds effectively and reduced the competition with crop plant which helped in growth of plant. Secondly it could be explained in the light of favourable growing condition in view of less weed crop competition stress. These are in conformity with the results of Mehta *et al.* (2009), Nagar *et al.* (2009) and Sharma (2009),

5.3.4 Dry weight of root nodules plant⁻¹

Different levels of vermicompost also recorded significant effect on dry weight of root nodules. The highest dry weight of root nodules was recorded under application of V₁ vermicompost 2 t ha⁻¹ application and the lowest dry weight of root nodules under treatment V₀ without vermicompost. Because of vermicompost provide friable condition to root development and also it help to increase bacterial population in soil. These are in conformity with the results of Rajkhowa *et al.* (2000) and Dhayal *et al.* (2012).

Influence of various weed control treatments was found significant with respect to dry weight of root nodules. Maximum dry weight of root nodules was recorded under the treatment of hand weeding carried out at 20 and 40 DAS (W_2) which was at par with oxadiargyl @ 75 g ha⁻¹ PE *fb* HW at 30 DAS (W_8) and oxyfluorfen @ 80 g ha⁻¹ PE *fb* HW at 30 DAS (W_6). This is might be due to less weed infestation and better root development of fenugreek.

5.3.5 Number of branches plant⁻¹

Different levels of vermicompost also recorded significant effect on number of branches plant⁻¹. The highest number of branches plant⁻¹ recorded under treatment V_1 vermicompost 2 t ha⁻¹ application and lowest number of branches plant⁻¹ found in treatment V_0 without vermicompost. This is because of vermicompost provide good source of major as well as micro nutrients to plant. The present results are in close conformity with the findings of Khiriyaa and Singh (2003).

A critical observation of data in Table 4.2.3 indicated that all the weed control treatments recorded significantly more branches plant⁻¹ as compared to weedy check. The treatment hand weeding carried out at 20 and 40 DAS recorded higher number of branches plant⁻¹ followed by oxadiargyl @ 75 g ha⁻¹ PE *fb* HW at 30 DAS (W_8) and oxyfluorfen @ 80 g ha⁻¹ PE *fb* HW at 30 DAS (W_6). Because of better soil physical condition and weed free environment for better growth and development of fenugreek crop in entire growing season. The present results are in close conformity with the findings of Chaudhary (1999), Patel *et al.* (2004) and Nagar *et al.* (2009).

5.3.4 Herbicides toxicity

Application of pendimethalin @ 500 g ha⁻¹ PE, oxadiargyl @ 75 g ha⁻¹ PE and oxyfluorfen @ 80 g ha⁻¹ PE were non phytotoxic to fenugreek crop (Table 4.2.5). It showed that herbicides included in the study either pre-emergence or were selective at selected dose of application in fenugreek.

5.4 EFFECT OF VERMICOMPOST AND WEED MANAGEMENT PRACTICES ON YIELD AND YIELD ATTRIBUTES

5.4.1 Number of pods plant⁻¹, number of seeds pod⁻¹, test weight (g) and days to 50 % flowering of fenugreek

Levels of vermicompost also recorded significant effect on number of pods plant⁻¹, seeds pod⁻¹ and test weight of fenugreek. The highest number of pods plant⁻¹, seeds pod⁻¹, test weight and days of 50 % flowering of fenugreek recorded under treatment V₁ vermicompost 2 t ha⁻¹ application and the lowest number of pods plant⁻¹, seeds pod⁻¹, test weight and days of 50 % flowering of fenugreek found in treatment V₀ without vermicompost. This might be because of vermicompost provide good source of major as well as micro nutrients to plant and favorable physical environment to plant. The present results are in close conformity with the findings of Kumari and Kumari (2002), Jat and Ahlwat (2004) and Dhayal *et al.* (2012).

Different weed management treatments showed significant influence on number of pods plant⁻¹, seeds pod⁻¹, test weight and days to 50 % flowering of fenugreek. Treatment hand weeding carried out at 20 and 40 DAS (W₂) recorded maximum number of pods plant⁻¹ and seeds per pod followed by most of the weed management treatments which was remained at par with oxadiargyl @ 75 g ha⁻¹ PE *fb* HW at 30 DAS (W₈) and oxyfluorfen @ 80 g ha⁻¹ PE

fb HW at 30 DAS (W₆). Same way higher test weight and lower days of 50 % flowering was found under treatment hand weeding carried out at 20 and 40 DAS (W₂) which was at par with oxadiargyl @ 75 g ha⁻¹ PE *fb* HW at 30 DAS (W₈) and oxyfluorfen @ 80 g ha⁻¹ PE *fb* HW at 30 DAS (W₆). These results might be due to the fact that increased uptake of nutrients under lower competition of weeds might have helped in more growth and development and thereby resulted in higher length of pod, seeds per pod and test weight. The lowest length of pod, seeds per pod and test weight were produced under treatment of weedy check (W₁). This could be attributed to severe crop weed competition, wherein, weeds had utilized nutrients and ultimately resulted in lower length of pod, number of seeds per pod and test weight. As stated earlier in the discussion, higher level of these parameters could be attributed to low competition in clean cultivation. These results are in line of the results reported by Chaudhary (1999), Patel *et al.* (2004), Meena and Mehta (2009), Mehta *et al.* (2009) and Nagar *et al.* (2009).

5.4.2 Seed yield (kg ha⁻¹)

Vermicompost levels showed significant effect on seed yield of fenugreek. The highest seed yield was recorded under application of V₁ vermicompost 2 t ha⁻¹ (2261 kg ha⁻¹) and the lowest was found under V₀ without vermicompost (1842.76 kg ha⁻¹). This might be due to vermicompost provide nutrients as well as good soil condition to the fenugreek crop which can help to increase uptake of nutrient by crop and it is directly affected on growth parameters help in increasing seed yield of fenugreek. These results are in accordance with the findings reported by Rajkhowa *et al.* (2000), Kumari and Kumari (2002), Jat and Ahlwat (2004) and Dhayal *et al.* (2012).

Significantly higher seed yield of fenugreek (2673.10 kg ha⁻¹) was recorded under treatment of hand weeding carried out at 20 and 40 DAS (W₂) and was at par with the treatments of oxadiargyl @ 75 g ha⁻¹ PE fb HW at 30 DAS (W₈) (2503.66 kg ha⁻¹) and oxyfluorfen @ 80 g ha⁻¹ PE fb HW at 30 DAS (W₆) (2490.86 kg ha⁻¹). Significantly the lowest seed yield (1080.25 kg ha⁻¹) was recorded under weedy check (W₁), might be due to higher infestation of weeds in the plot resulted in to strong competition of weeds with crop for growth factors (moisture, light, nutrients and space). These results are in accordance with the findings reported by Chaudhary (1999), Senthivel (2001), Kamboj *et al.* (2007) and Meena *et al.* (2013). The pre-emergence application of herbicides with one hand weeding at 30 DAS tested in the present study gave excellent control and suppression of weeds in the season were probably effective against secondary weed emergence at 25-35 DAS stage and onwards. The weed management schedule having low weed biomass and higher weed control efficiency would provide favourable situation for maximization of fenugreek yield potential.

5.4.3 Straw yield (kg ha⁻¹)

Vermicompost levels showed significant effect on straw yield of fenugreek. The highest straw yield was recorded under application of vermicompost 2 t ha⁻¹ (V₁) (4138.32 kg ha⁻¹) and the lowest was found under V₀ without vermicompost (3638.89 kg ha⁻¹). This is might be due to vermicompost provide nutrients as well as good soil condition to the fenugreek crop which can help to increase uptake of nutrient by crop and it is directly affected on increasing growth parameters and resulted into increasing straw yield. These results are in accordance with the findings reported by Jat and Ahlwat (2004) and Dhayal *et al.* (2012).

Weed management treatments produced significantly higher straw yield than weedy check (W₁). Significantly the higher haulm yield (4599.30 kg ha⁻¹) of fenugreek was recorded under the treatment of oxadiargyl @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS (W₈) which was remained at par with W₂ and W₆, yielded 4469.44 and 4475 kg ha⁻¹, respectively. These might be due to effective weed control resulted in to poor crop-weed competition which might have enhanced dry matter accumulation in the plant. Further, these treatments might have provided good physical conditions for proper growth and development of plants. Significantly the lowest haulm yield (2248 kg ha⁻¹) was recorded under treatment of weedy check (W₁) because of higher crop weed competition. These results are in accordance with the findings reported by Chaudhary (1999), Senthivel (2001), Kamboj *et al.* (2007) and Meena *et al.* (2013).

5.4.4 Harvest index (%)

Harvest index as influenced by various weed management treatments. The higher harvest index recorded under treatment of hand weeding carried out at 20 and 40 DAS (W₂) which was at par with application of oxadiargyl @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS (W₈) and oxyflourfen @ 75 g ha⁻¹ as PE *fb* HW at 30 DAS (W₆).

The highest harvest index recorded under treatment vermicompost 2 t ha⁻¹ (V₁) and the lowest harvest index found under treatment without vermicompost (V₀). The higher yield obtained in respective treatments is responsible for higher harvest index. these results are in accordance with the findings reported by Jat and Ahlwat (2004) and Dhayal *et al.* (2012).

5.5 INTERACTION EFFECT ON GROWTH, YIELD AND YIELD ATTRIBUTES

In present study, interaction were found significant in respect of growth and yield parameters of crop. This interaction have been discussed in brief in the present section.

5.5.1 Interaction effect on growth attributes

The interaction effect between vermicompost and weed management treatments with respect to number of branches plant⁻¹ were deduced to be significant (Table 4.2.4)

A perusal of data in Table 4.2.4 indicated that treatment combination of V₁W₂ (vermicompost 2 t ha⁻¹ conjunction with two hand weeding at 20 and 40 DAS) showed significant increase in number of branches per plant (6.33) which was remained at par with V₁W₈, V₁W₆, V₀W₂, V₀W₈ and V₀W₆. The significantly lower number of branches on other hand was recorded with V₀W₁ which did not differ significantly from V₀W₅, V₀W₇ V₁W₁ and V₀W₃. The highest number of branches under V₁W₂ must have been due to maximum uptake of nutrient by crop which provide by addition of vermicompost and lees weed competition during growth period by two hand weeding which provide favorable environment to crop growth. These results are in accordance with the findings reported by Upadhyay *et al.* (2012).

5.5.2 Interaction effect on yield attributes

The results presented in Table 4.3.2 were an evidence that treatment combination V₁W₂ (vermicompost 2 t ha⁻¹ conjunction with two hand weeding at 20 and 40 DAS) contributed to the significantly higher number of pods plant⁻¹ which was remained at par with combinations Vermicompost 2 t ha⁻¹ + Oxadiargyl @ 75 g ha⁻¹ as PE *fb* HW at 30 DAS (V₁W₈) and Vermicompost 2 t ha⁻¹ + Oxyflourfen @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS (V₁W₆). Nutrient rich vermicompost along with minimum crop-weed competition under two hand weeding, oxadiargyl and oxyflourfen might have created an ideal condition for crop growth, thus, ultimately yielding maximum number of pods plant⁻¹. These results are in accordance with the findings reported by Singh and Singh (2005).

5.5.3 Interaction effect on yield attributes

The results presented in Table 4.3.5 were an evidence that treatment combination V₁W₂ (Vermicompost 2 t ha⁻¹ conjunction with two hand weeding at 20 and 40 DAS) contributed to the significantly maximum seed yield which was at par with combinations Vermicompost 2 t ha⁻¹ + Oxadiargyl @ 75 g ha⁻¹ as PE *fb* HW at 30 DAS (V₁W₈) and Vermicompost 2 t ha⁻¹ + Oxyflourfen @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS (V₁W₆). This was might be due to vermicompost play important role to provide balance nutrients and less crop weed competition during entire crop growth period which help to increase seed yield. These results are in accordance with the findings reported by Upadhyay *et al.* (2012) and Singh and Singh (2005).

The results presented in Table 4.3.6 were an evidence that treatment V₁W₂ (Vermicompost 2 t ha⁻¹ conjunction with two hand weeding at 20 and 40 DAS) contributed to the significantly maximum straw yield which was at par with combinations Vermicompost 2 t ha⁻¹ + Oxadiargyl @ 75 g ha⁻¹ as PE *fb* HW at 30 DAS (V₁W₈) and Vermicompost 2 t ha⁻¹ + Oxyflourfen @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS (V₁W₆). This was might be due to vermicompost play important role to provide balance nutrient and less crop weed competition during entire crop growth period which help to increase nutrient uptake by crop and also increase straw yield. These results are in accordance with the findings reported by Upadhyay *et al.* (2012) and Singh and Singh (2005).

The results presented in Table 4.3.7 were an evidence that treatment combination of V₁W₂ (Vermicompost 2 t ha⁻¹ conjunction with two hand weeding at 20 and 40 DAS) contributed to the significantly maximum harvest index which was at par with combinations Vermicompost 2 t ha⁻¹ + Oxadiargyl @ 75 g ha⁻¹ as PE *fb* HW at 30 DAS (V₁W₈) and Vermicompost 2 t ha⁻¹ + Oxyflourfen @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS (V₁W₆). This might be due to higher seed and straw yield of fenugreek.

5.5 EFFECT OF VERMICOMPOST AND WEED MANAGEMENT PRACTICES ON ECONOMICS

Cost benefit analysis furnished in Table 4.4.1 indicated that the cost benefit ratio was higher (1:3.51) under the vermicompost treatment of 0 t ha⁻¹ (V₀) while lower benefit cost ratio was recorded under treatment of Vermicompost 2 t ha⁻¹ (V₁).

Cost benefit analysis furnished in Table 4.5 indicated that the cost benefit ratio was higher (1:4.16) under the treatment of hand weeding carried out at 20 & 40 DAS followed by treatments of application of oxyflourfen @ 80 g ha⁻¹ PE *fb* HW at 30 DAS (W₆) and oxadiargyl @ 75 g ha⁻¹ POE *fb* HW at 30 DAS (W₈). The respective values were 1:3.98 and 1:3.85, respectively. These results are in conformity with the findings of those reported by Nagar *et al.* (2009), Kamboj *et al.* (2009), Lahariya *et al.* (2013) and Meena *et al.* (2013).

In case of combine effect of vermicompost and weed management practices, the highest net realization of Rs. 64504.21 ha⁻¹ with CBR 1:3.85 was recorded under V₀W₂ (vermicompost 0 t ha⁻¹ conjunction with two hand weeding at 20 and 40 DAS) followed by V₀W₆ (net realization of Rs. 60159.7 ha⁻¹ and CBR 1:3.68) and V₀W₈ (net realization of Rs. 59242.7 ha⁻¹ and (CBR 1:3.53). This may have been due to no cost of vermicompost involved and cumulative effect of superior treatment.

VI. SUMMARY AND CONCLUSION

The present investigation was carried out during *rabi* season of the year 2012 on loamy sand soil at College Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand (Gujarat) to evaluate the "**Effect of vermicompost and weed management practices on growth and yield of fenugreek (*Trigonella foenum-graecum* L.) under middle Gujarat conditions**".

The experiment was laid out in factorial randomized block design with three replications. Combination of two vermicompost levels and eight weed control treatments were *viz.*, vermicompost 0 t ha⁻¹ + weedy check (V₀W₁), vermicompost 0 t ha⁻¹ + hand weeding at 20 and 40 DAS (V₀W₂), vermicompost 0 t ha⁻¹ + pendimethalin @ 500 g ha⁻¹ as pre-emergence (V₀W₃), vermicompost 0 t ha⁻¹ + pendimethalin @ 500 g ha⁻¹ as PE *fb* HW at 30 DAS (V₀W₄), vermicompost 0 t ha⁻¹ + oxyflourfen @ 80 g ha⁻¹ as PE (V₀W₅), vermicompost 0 t ha⁻¹ + oxyflourfen @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS (V₀W₆), vermicompost 0 t ha⁻¹ + oxadiargyl @ 75 g ha⁻¹ as PE (V₀W₇), vermicompost 0 t ha⁻¹ + oxadiargyl @ 75 g ha⁻¹ as PE *fb* HW at 30 DAS (V₀W₈), vermicompost 2 t ha⁻¹ + weedy check (V₁W₁), vermicompost 2 t ha⁻¹ + Hand weeding at 20 and 40 DAS (V₁W₂), vermicompost 2 t ha⁻¹ + pendimethalin @ 500 g ha⁻¹ as pre-emergence (V₁W₃), vermicompost 2 t ha⁻¹ + pendimethalin @ 500 g ha⁻¹ as PE *fb* HW at 30 DAS (V₁W₄), vermicompost 2 t ha⁻¹ + oxyflourfen @ 80 g ha⁻¹ as PE (V₁W₅), vermicompost 2 t ha⁻¹ +

oxyflourfen @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS (V₁W₆), vermicompost 2 t ha⁻¹ + oxadiargyl @ 75 g ha⁻¹ as PE (V₁W₇), vermicompost 2 t ha⁻¹ + oxadiargyl @ 75 g ha⁻¹ as PE *fb* HW at 30 DAS (V₁W₈) were tried in present investigation. Pre-emergence herbicides were sprayed with Knapsack sprayer fitted with flat fan nozzle using 500 liter of water ha⁻¹.

During the present investigation, effect of vermicompost levels and weed management treatments on weeds count at 20 and 40 DAS, dry weight of weeds at 20 and 40 DAS and at harvest, weed index, weed control efficiency, plant population at 15 DAS and at harvest, plant height at 30, 60 DAS and at harvest, dry weight of root nodule at 40 DAS, days of 50 % flowering, number of branches plant⁻¹ and number of pods plant⁻¹ at harvest, number of seeds pod⁻¹, test weight, seed and haulm yield and harvest index were recorded. The salient features are summarized here.

6.1 EFFECT OF TREATMENTS ON WEEDS

Vermicompost treatments showed non-significant results among the all weed parameters like weeds count at 20 and 40 DAS, dry weight of weeds at 20 and 40 DAS and at harvest, weed index and weed control efficiency.

Hand weeding carried out at 20 & 40 DAS recorded significantly less weed count of monocot at 20 DAS which was at par with pre emergence application of oxadiargyl @ 75 g ha⁻¹ *fb* + HW at 30 DAS (W₈) and oxyflourfen @ 80 g ha⁻¹ *fb* HW at 30 DAS (W₆).

Hand weeding carried out at 20 & 40 DAS recorded significantly the lowest Dry weight of monocot weeds while in chemical treatment

significantly lower monocot weed dry weight recorded under oxadiargyl @ 75 g ha⁻¹ PE *fb* + HW at 30 DAS (W₈), which was remained at par with oxyflourfen @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS.

Hand weeding carried out at 20 & 40 DAS recorded significantly lower dicot weeds at 20 DAS, which was remained at par with pre emergence application of oxadiargyl @ 75 g ha⁻¹ *fb* + HW at 30 DAS (W₈) and oxyfluorfen @ 80 g ha⁻¹ + HW at 30 DAS (W₆).

The weed dry weight of dicot weeds recorded at 20 DAS significantly lower under the treatments of hand weeding carried out at 20 & 40 DAS and was remained at par with pre emergence application of oxadiargyl @ 75 g ha⁻¹ *fb* + HW at 30 DAS (W₈) and oxyfluorfen @ 80 g ha⁻¹ + HW at 30 DAS (W₆). At 40 DAS, significantly the less weed count of monocots were registered under the treatment of hand weeding carried out at 20 & 40 DAS and was remained at par with pre emergence application of oxadiargyl @ 75 g ha⁻¹ *fb* + HW at 30 DAS (W₈) and oxyfluorfen @ 80 g ha⁻¹ + HW at 30 DAS (W₆). Hand weeding carried out at 20 and 40 DAS recorded significantly the lowest dry weight of monocot weeds but remained at par with treatment oxadiargyl @ 75 g ha⁻¹ *fb* + HW at 30 DAS (W₈) and oxyfluorfen @ 80 g ha⁻¹ + HW at 30 DAS (W₆). Lower weed count of dicot weeds at 40 DAS were recorded under treatment of hand weeding carried out at 20 & 40 DAS followed by oxadiargyl @ 75 g ha⁻¹ PE *fb* + HW at 30 DAS (W₈). Significantly less dry weight of dicot weeds at 40 DAS recorded under treatment hand weeding carried out at 20 and 40 DAS which was remained at par with the application of oxadiargyl @ 75 g

ha⁻¹ PE *fb* + HW at 30 DAS (W₈) and oxyfluorfen @ 80 g ha⁻¹ + HW at 30 DAS (W₆).

Hand weeding carried out at 20 & 40 DAS registered significantly the lowest dry weight of total weeds at 20 DAS, which was remained at par with the treatment of oxadiargyl @ 75 g ha⁻¹ PE *fb* + HW at 30 DAS (W₈) followed oxyfluorfen @ 80 g ha⁻¹ + HW at 30 DAS (W₆). At 40 DAS, significantly the lowest dry weight of total weed recorded at 40 DAS was registered under the treatment of hand weeding carried out at 20 & 40 DAS which was remained at par with the treatment of oxadiargyl @ 75 g ha⁻¹ PE *fb* + HW at 30 DAS (W₈) followed oxyfluorfen @ 80 g ha⁻¹ + HW at 30 DAS (W₆). At harvest, significantly lower total weed dry weight (33.83 kg ha⁻¹) was registered under the treatment of hand weeding carried out at 20 & 40 DAS and it was remained at par with the treatments of oxadiargyl @ 75 g ha⁻¹ PE *fb* + HW at 30 DAS (W₈) and oxyfluorfen @ 80 g ha⁻¹ + HW at 30 DAS (W₆). Significantly maximum dry weight of weed biomass were recorded in weedy check (W₁) at harvest.

At harvest, treatment of hand weeding carried out at 20 & 40 DAS recorded maximum weed control efficiency, WCE (63.53 %) followed by treatments of W₈ and W₆. The values were 61.05 and 58.82 %, respectively.

Significantly lower weed index observed under the treatments of oxadiargyl @ 75 g ha⁻¹ PE *fb* HW at 30 DAS (W₈) followed by oxyfluorfen @ 80 g ha⁻¹ PE *fb* HW at 30 DAS (W₆).

6.2 EFFECT OF TREATMENTS ON CROP

Plant populations recorded at 15 DAS and at harvest was non significant due to different vermicompost and weed management treatments. Pre-emergence application of herbicides included in the study did not show any phytotoxicity effect on fenugreek crop.

Significantly maximum plant height recorded at 30, 60 DAS and at harvest under the treatment of vermicompost 2 t ha⁻¹ (V₁) and lower plant height recorded under treatment vermicompost 0 t ha⁻¹ (V₀). Among the weed management treatments, the treatment of hand weeding carried out at 20 & 40 DAS recorded significantly higher plant height, which was remained at par with the treatment of oxadiargyl @ 75 g ha⁻¹ fb + HW at 30 DAS (W₈) and oxyfluorfen @ 80 g ha⁻¹ + HW at 30 DAS (W₆). Differences in dry weight of *Rhizobium* nodules among various vermicompost treatments were significant. Significantly maximum dry weight of *Rhizobium* nodules recorded under the treatment of vermicompost 2 t ha⁻¹ (V₁).

Differences in dry weight of *Rhizobium* nodules among various weed management treatments were significant. Significantly higher dry weight of *Rhizobium* nodules recorded under the treatment of hand weeding carried out at 20 & 40 DAS, which was remained at par with the treatments of oxadiargyl @ 75 g ha⁻¹ PE fb + HW at 30 DAS (W₈) and oxyfluorfen @ 80 g ha⁻¹ + HW at 30 DAS (W₆).

Vermicompost 2 t ha⁻¹ (V₁) recorded the highest number of branches plant⁻¹ and the lowest number of branches plant⁻¹ was registered under treatment of vermicompost 0 t ha⁻¹ (V₀). Among the various weed management

treatments, the hand weeding carried out at 20 and 40 DAS recorded higher number of branches plant⁻¹, which was remained at par with the treatments of oxadiargyl @ 75 g ha⁻¹ fb + HW at 30 DAS (W₈) and oxyfluorfen @ 80 g ha⁻¹ + HW at 30 DAS (W₆). Interaction of vermicompost and weed management treatments also showed the significant result on number of branches plant⁻¹. Treatment combination V₁W₂ (vermicompost 2 t ha⁻¹ + hand weeding carried out at 20 and 40 DAS) recorded higher number of branches plant⁻¹, which was remained at par with V₁W₈, V₀W₂, V₁W₆, V₀W₆, V₀W₈ and V₁W₇, respectively.

No any phytotoxic effect of pre-emergence herbicide was found during the experimentation.

Treatment of vermicompost 2 t ha⁻¹ registered significantly the highest pod plant⁻¹ of fenugreek. Among weed management treatments hand weeding carried out at 20 & 40 DAS registered significantly higher pod plant⁻¹ of fenugreek and was remained at par with the treatments of oxadiargyl @ 75 g ha⁻¹ fb + HW at 30 DAS (W₈) and oxyfluorfen @ 80 g ha⁻¹ + HW at 30 DAS (W₆). Pods plant⁻¹ also affected by the interaction of vermicompost and weed management practices. Higher number of pod plant⁻¹ were record under treatment combination of V₁W₂ (vermicompost 2 t ha⁻¹ + hand weeding carried out at 20 and 40 DAS), which was remained at par with the V₁W₈, V₁W₆ and V₀W₂.

Treatment vermicompost 2 t ha⁻¹ registered significantly the highest number of seeds pod⁻¹ of fenugreek. Hand weeding carried out at 20 &

40 DAS registered significantly higher number of seeds pod⁻¹ of fenugreek and was remained at par with the treatments of oxadiargyl @ 75 g ha⁻¹ fb + HW at 30 DAS (W₈) and oxyfluorfen @ 80 g ha⁻¹ + HW at 30 DAS (W₆).

Among the vermicompost treatments, treatment vermicompost 2 t ha⁻¹ (V₁) recorded significantly the highest test weight and among the weed management practices, Hand weeding carried out at 20 & 40 DAS recorded significantly higher test weight, which was remained at par with oxadiargyl @ 75 g ha⁻¹ PE fb + HW at 30 DAS (W₈) and oxyfluorfen @ 80 g ha⁻¹ + HW at 30 DAS (W₆). Treatment vermicompost 2 t ha⁻¹ (V₁) recorded significantly the highest seed (2261 kg ha⁻¹) and straw yield (4138 kg ha⁻¹). Among the weed management practices, Hand weeding carried out at 20 & 40 DAS recorded significantly higher seed yield (2623 kg ha⁻¹) and was remained at par with the treatments of oxadiargyl @ 75 g ha⁻¹ fb + HW at 30 DAS (W₈) and oxyfluorfen @ 80 g ha⁻¹ + HW at 30 DAS (W₆). While, oxadiargyl @ 75 g ha⁻¹ PE fb + HW at 30 DAS (W₈) recorded significantly higher straw yield (4599 kg ha⁻¹), which was remained at par with oxyfluorfen @ 80 g ha⁻¹ + HW at 30 DAS (W₆) and Hand weeding carried out at 20 & 40 DAS (W₂). While, the lowest seed and halum yield were recorded under treatment of weedy check (W₁). Interaction of vermicompost and weed management treatments also showed the significant results on seed and straw yield of fenugreek. The treatment combination of V₁W₂ (Vermicompost 2 t ha⁻¹ + Hand weeding carried out at 20 and 40 DAS) recorded higher seed yield (2817 kg ha⁻¹), which was remained at par with the V₁W₈ and V₁W₆. While, in straw yield The treatment combination of V₁W₆

(vermicompost 2 t ha⁻¹ + oxyflourfen @ 80 g ha⁻¹ as PE *fb* HW at 30 DAS recorded higher straw yield and was remained at par with V₁W₈ and V₁W₂.

The cost benefit ratio was higher (1:3.51) under the treatment of vermicompost 0 t ha⁻¹. Among the weed management practices maximum cost benefit ratio (1:4.16) was recorded under the treatment of Hand weeding carried out at 20 and 40 DAS (W₂) followed by oxyfluorfen @ 80 g ha⁻¹ + HW at 30 DAS (W₆) (1:3.98) and oxadiargyl @ 75 g ha⁻¹ PE *fb* + HW at 30 DAS (W₈) (1:3.89).

The cost benefit ratio was higher (1:3.85) under the treatment combination of vermicompost 0 t ha⁻¹ and hand weeding carried out at 20 & 40 DAS (V₀W₂) followed by the treatment combination of vermicompost 0 t ha⁻¹ and oxadiargyl @ 75 g ha⁻¹ PE *fb* + HW at 30 DAS (V₀W₈) and vermicompost 0 t ha⁻¹ and oxyfluorfen @ 80 g ha⁻¹ + HW at 30 DAS (V₀W₆).

CONCLUSION

In light of the results obtained from the present investigation, it is concluded that,

1. Among the different Vermicompost levels, Vermicompost 2 t ha⁻¹ produced the highest seed yield and realized maximum net returns of Rs. 51350 per hectare.
2. Among the various weed management treatments, hand weeding at 20 and 40 DAS produced higher seed yield and net profit of Rs. 71399 per hectare, followed by pre-emergence application of oxyflourfen @ 80 g

ha⁻¹ *fb* HW at 30 DAS and oxadiargyl @ 75 g ha⁻¹ as PE *fb* HW at 30 DAS with net profit of Rs. 66936 and Rs. 66547 per hectare, respectively.

3. In case of treatment combination, combination of vermicompost 2 t ha⁻¹ with hand weeding at 20 and 40 DAS produced maximum yield of 2817.28 kg ha⁻¹ and realized higher net profit of Rs. 67114.34 ha⁻¹, followed by vermicompost 2 t ha⁻¹ along with pre-emergence application of oxadiargyl @ 75 g ha⁻¹ *fb* HW at 30 DAS produced seed yield of 2817.28 kg ha⁻¹ and net return of Rs. 61383.15 ha⁻¹ and vermicompost 2 t ha⁻¹ along with pre-emergence application of oxyflourfen @ 80 g ha⁻¹ *fb* HW at 30 DAS produced seed yield 2677.78 kg ha⁻¹ and net return Rs. 61244 ha⁻¹.

Thus, from the yield and economics point of view, it is concluded that for securing higher yield and net returns from the fenugreek crop should be manured with vermicompost @ 2 t ha⁻¹, coupled with weed management either through hand weeding at 20 and 40 DAS or pre-emergence application of oxadiargyl @ 75 g ha⁻¹ *fb* HW at 30 DAS or oxyflourfen @ 80 g ha⁻¹ *fb* HW at 30 DAS under loamy sand soil for middle Gujarat conditions.

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* original not seen

APPENDICES

Appendix I (A) : Cost of cultivation of fenugreek

No.	Particulars	Cost (₹ ha ⁻¹)
I	Common cost	
A.	Land Preparation	
1.	Tractor cultivation (3 hrs @ Rs. 200.00 hr ⁻¹)	600
2.	Harrowing and planking (2 PB, 2L)	740
B.	Seeds and Sowing	
1.	Preparation of beds, bunds, irrigation channels (9 L)	1080
2.	Fertilizer application and sowing (12 L)	1440
3.	Cost of fertilizer (20-40-00 NPK kg ha ⁻¹); DAP (₹86.95 kg ⁻¹)	952
4.	Cost of seed (Rs. 52.00 kg ⁻¹) @ 20 kg ha ⁻¹	1040
5.	Total 6 irrigation (Irrigation cost @ Rs. 500.00 ha ⁻¹)	3000
C.	After- care	
1.	Thinning (12 L)	1440
2.	Plant protection measures Monocrotophos @ 0.07 % (36 EC) spraying @ 25 ml 10 l ⁻¹ (1.25 l ha ⁻¹) (Rs. 300 l ⁻¹)	375
3.	Furadan (2.5 kg 790 m ⁻²) (Rs. 80kg ⁻¹)	2532
D.	Harvesting (10 L)	1200
E.	Threshing and cleaning (25 L)	3000
F.	Land revenue	75
Cost of cultivation (A to F Cost)		17474
II	Variable cost	
T₁	Vermicompost 0 t ha ⁻¹ + weedy check	-
T₂	Vermicompost 0 t ha ⁻¹ + hand weeding at 20 and 40 DAS	3600
T₃	Vermicompost 0 t ha ⁻¹ + pendimethalin @ 500 gha ⁻¹ as pre-emergence	1415
T₄	Vermicompost 0 t ha ⁻¹ + pendimethalin @ 500 gha ⁻¹ as PE <i>fb</i> HW at 30 DAS	2615
T₅	Vermicompost 0 t ha ⁻¹ + oxyflourfen @ 80 gha ⁻¹ as PE	1632
T₆	Vermicompost 0 t ha ⁻¹ + oxyflourfen @ 80 gha ⁻¹ as PE <i>fb</i> HW at 30 DAS	2832
T₇	Vermicompost 0 t ha ⁻¹ + oxadiargyl @ 75 gha ⁻¹ as PE	2470
T₈	Vermicompost 0 t ha ⁻¹ + oxadiargyl @ 75 gha ⁻¹ as PE <i>fb</i> HW at 30 DAS	3670
T₉	Vermicompost 2 t ha ⁻¹ + weedy check	10360
T₁₀	Vermicompost 2 t ha ⁻¹ + hand weeding at 20 and 40 DAS	3600 + 10360

T₁₁	Vermicompost 2 t ha ⁻¹ + pendimethalin @ 500 gha ⁻¹ as pre-emergence	1415 + 10360
T₁₂	Vermicompost 2 t ha ⁻¹ + pendimethalin @ 500 gha ⁻¹ as PE <i>fb</i> HW at 30 DAS	2615 + 10360
T₁₃	Vermicompost 2 t ha ⁻¹ + oxyflourfen @ 80 gha ⁻¹ as PE	1632 + 10360
T₁₄	Vermicompost 2 t ha ⁻¹ + oxyflourfen @ 80 gha ⁻¹ as PE <i>fb</i> HW at 30 DAS	2832 + 10360
T₁₅	Vermicompost 2 t ha ⁻¹ + oxadiargyl @ 75 gha ⁻¹ as PE	2470 + 10360
T₁₆	Vermicompost 2 t ha ⁻¹ + oxadiargyl @ 75 gha ⁻¹ as PE <i>fb</i> HW at 30 DAS	3670 + 10360

L: Labour@₹ 120 day⁻¹,PB : paired bullock @ ₹ 250 day⁻¹,

Note : The total cost has been carried over to Appendix II (B) and II (C)

Note :

Vermicompost : 250 Rs/50 kg bag
DAP : 1190 Rs/50 kg bag
Stomp : 425 Rs/liter
Honcho : 2400 Rs/liter
Raft : 988 Rs/liter

Appendix-I (B) :Details of cost of vermicompost and weed management practices

Treatment	Cost (Rs)	Application Charges (Rs ha ⁻¹)	Total cost of treatment (Rs ha ⁻¹)
Vermicompost			
V₀ : Vermicompost 0 t ha⁻¹	0	0	0
V₁ : Vermicompost 2 t ha⁻¹	10000	360	10360
Weed management			
W₁ : weedy check	0	0	0
W₂ : Hand weeding at 20 and 40 DAS	3600	0	3600
W₃ :Pendimethalin @ 500 g ha⁻¹ as pre-emergence	1415	640	2055
W₄ : Pendimethalin @ 500 g ha⁻¹ as pre-emergence <i>fb</i>HW at 30 DAS	1415	640+1200	3255
W₅ : Oxyflourfen @ 80 g ha⁻¹ as PE	1632	640	2272
W₆ : Oxyflourfen @ 80 g ha⁻¹ as PE <i>fb</i>HW at 30 DAS	1632	640+1200	3472
W₇ : Oxadiargyl @ 75 g ha⁻¹ as PE	2470	640	3110
W₈ : Oxadiargyl @ 75 g ha⁻¹ as PE <i>fb</i>HW at 30 DAS	2470	640+1200	4310

*Herbicides application (2Skilled Labour @ 200₹ day⁻¹ + 2 L @ 120₹ day⁻¹) = 640+ 10 labour for HW = 1200 and 3 labour for vermicompost application

Selling price	
Seed : ₹35.0 kg ⁻¹	Haulm: ₹ 0.5 kg ⁻¹

Note: The cost of vermicompost and weed control practices have been carried over to Appendix II (C)

Appendix-I (C) : Total cost incurred for vermicompost and weed management practices

Treatments	Treatment combination cost (Rs ha ⁻¹)	Cost of cultivation (Rs ha ⁻¹)	Interest on column 3+4 @ (12 % per annum) for 4 months (Rs ha ⁻¹)	Supervision charge column 3+4 @ (10 % per annum) for 4 months (Rs ha ⁻¹)	Total cost of cultivation (3+4+5+6) (Rs ha ⁻¹)
Vermicompost					
V₀	0	17474	697	582	18753
V₁	10360	17474	1113	927	29874
Weed management					
W₁	0	17474	697	582	18753
W₂	3600	17474	843	702	22619
W₃	2055	17474	781	650	20960
W₄	3255	17474	829	690	22248
W₅	2272	17474	790	658	21193
W₆	3472	17474	838	698	22481
W₇	3110	17474	823	685	22093
W₈	4310	17474	871	725	23381

Appendix-I (D) Net income and CBR as influenced by vermicompost and weed management practices

Treatment	Gross income (Rs ha ⁻¹)	Total cost (Rs ha ⁻¹)	Net income (Rs ha ⁻¹)	CBR
Vermicompost	65872	18753	47120	3.51
V₀	81224	29874	51350	2.72
V₁				
Weed management	38933	18753	20180	2.08
W₁	94018	22619	71399	4.16
W₂	58499	20960	37539	2.79
W₃	76137	22248	53889	3.42
W₄	69673	21193	48480	3.29
W₅	89418	22481	66936	3.98
W₆	71780	22093	49687	3.25
W₇	89928	23381	66547	3.85
W₈	65872	18753	47120	3.51

Appendix-I (E) : Total cost incurred for treatment combinations

Sr. No.	Treatments	Treatment combination cost (₹ ha ⁻¹)	Cost of cultivation (₹ ha ⁻¹)	Interest on column 3+4 @ (12 % per annum) for 4 months (₹ ha ⁻¹)	Supervision charge column 3+4 @ (10 % per annum) for 4 months (₹ ha ⁻¹)	Total cost of cultivation (3+4+5+6) (₹ ha ⁻¹)
1	2	3	4	5	6	7
1	V ₀ W ₁	0	17474	698.96	581.88	18754.84
2	V ₀ W ₂	3600	17474	842.96	701.76	22618.72
3	V ₀ W ₃	2055	17474	781.16	650.32	20960.48
4	V ₀ W ₄	4455	17474	877.16	730.24	23536.4
5	V ₀ W ₅	2272	17474	789.84	657.54	21193.38
6	V ₀ W ₆	4672	17474	885.84	737.46	23769.3
7	V ₀ W ₇	3110	17474	823.36	685.45	22092.81
8	V ₀ W ₈	5510	17474	919.36	765.37	24668.73
9	V ₁ W ₁	10416.66	17474	1115.63	928.76	29935.05
10	V ₁ W ₂	14016.66	17474	1259.63	1048.64	33798.93
11	V ₁ W ₃	12471.66	17474	1197.83	997.19	32140.68
12	V ₁ W ₄	14871.66	17474	1293.83	1077.11	34716.6
13	V ₁ W ₅	12688.66	17474	1206.51	1004.42	32373.58
14	V ₁ W ₆	15088.66	17474	1302.51	1084.34	34949.5
15	V ₁ W ₇	13526.66	17474	1240.03	1032.32	33273.01
16	V ₁ W ₈	15926.66	17474	1336.03	1112.24	35848.93

Appendix-I (F) Net income and CBR as influenced by treatment combinations

Treatment	Gross income	Total cost	Net income	CBR
V ₀ W ₁	35087.19	18754.84	16332.35	1.87
V ₀ W ₂	87122.93	22618.72	64504.21	3.85
V ₀ W ₃	56256.17	20960.48	35295.69	2.68
V ₀ W ₄	66022.14	23536.4	42485.75	2.81
V ₀ W ₅	59484.26	21193.38	38290.88	2.81
V ₀ W ₆	82641.05	23769.3	58871.74	3.48
V ₀ W ₇	57742.51	22092.81	35649.71	2.61
V ₀ W ₈	82623.46	24668.73	57954.73	3.35
V ₁ W ₁	42778.7	29935.05	12843.66	1.43
V ₁ W ₂	100913.3	33798.93	67114.34	2.99
V ₁ W ₃	60742.13	32140.68	28601.45	1.89
V ₁ W ₄	86252.31	34716.6	51535.72	2.48
V ₁ W ₅	79861.56	32373.58	47487.98	2.47
V ₁ W ₆	96194.44	34949.5	61244.94	2.75
V ₁ W ₇	85816.51	33273.01	52543.5	2.58
V ₁ W ₈	97232.08	35848.93	61383.15	2.71

APPENDIX – II

Analysis of variance for weed count (m⁻²) at 20 DAS

Source of variation	df	Mean sum of square		
		Weed count (m ⁻²) at 20 DAS		
		Monocot	Dicot	Total
Replication	2	0.110	2.175	1.141
V	1	0.357	0.423	0.781
W	7	30.96*	38.01*	69.28*
V × W	7	0.241	0.742	0.195
Error	30	0.285	0.755	0.436

* Significant at 5 % level

APPENDIX – III

Analysis of variance for weed count (m⁻²) at 40 DAS

Source of variation	df	Mean sum of square		
		Weed count (m ⁻²) at 40 DAS		
		Monocot	Dicot	Total
Replication	2	0.093	0.034	0.057
V	1	0.007	0.992	0.376
W	7	5.003*	7.033*	12.04*
V × W	7	0.307	0.046	0.296
Error	30	0.198	0.302	0.238

* Significant at 5 % level

APPENDIX – IV

Analysis of variance for weed dry weight (g m⁻²) at 20 DAS

Source of variation	df	Mean sum of square		
		Weed dry weight (g m ⁻²) at 20 DAS		
		Monocot	Dicot	Total
Replication	2	0.093	0.019	0.044
V	1	0.123	0.061	0.182
W	7	2.643*	1.888*	4.713*
V × W	7	0.075	0.025	0.062
Error	30	0.042	0.056	0.048

* Significant at 5 % level

APPENDIX – V

Analysis of variance for weed dry weight (g m⁻²) at 40 DAS

Source of variation	df	Mean sum of square		
		Weed dry weight (g m ⁻²) at 40 DAS		
		Monocot	Dicot	Total
Replication	2	0.147	0.008	4.902
V	1	0.070	0.065	11.145
W	7	5.614*	0.574*	289.73*
V × W	7	0.307	0.024	15.595
Error	30	0.213	0.036	7.616

* Significant at 5 % level

APPENDIX – VI

Analysis of variance for weed dry weight (kg ha⁻¹)

Source of variation	df	Mean sum of square
		Weed dry weight (kg ha ⁻¹) at harvest
		Weed dry weight
Replication	2	0.368
V	1	5.080
W	7	69.75*
V × W	7	0.178
Error	30	1.094

* Significant at 5 % level

APPENDIX – VII

Analysis of variance for plant population at 15 DAS and at harvest (no. m⁻²)

Source of variation	df	Mean sum of square	
		plant population at 15 DAS (no. m ⁻²)	plant population at harvest (no. m ⁻²)
Replication	2	1.270	0.187
V	1	16.33	12.00
W	7	10.75	8.511
V × W	7	19.57	10.71
Error	30	8.493	4.676

* Significant at 5 % level

APPENDIX – VIII

Analysis of variance for plant height at 30 and 60 DAS and at harvest (cm)

Source of variation	df	Mean sum of square		
		Plant height (cm)		
		30 DAS	60 DAS	At harvest
Replication	2	4.555	2.942	20.37
V	1	25.34*	53.08*	103.2*
W	7	8.062*	27.02*	19.95*
V × W	7	2.426	6.725	7.045
Error	30	2.103	3.029	5.405

* Significant at 5 % level

APPENDIX – IX

Analysis of variance for dry weight of root nodules (mg plant⁻¹) and days of 50 % flowering

Source of variation	df	Mean sum of square	
		Dry weight of root nodules (mg plant ⁻¹)	Days of 50 % flowering
Replication	2	0.030	1.911
V	1	0.071*	39.85*
W	7	0.384*	4.736*
V × W	7	0.033	1.801
Error	30	0.016	1.591

* Significant at 5 % level

APPENDIX – X

Analysis of variance for number of branches plant⁻¹ and test weight (g)

Source of variation	df	Mean sum of square	
		Number of branches plant ⁻¹	Test weight (g)
Replication	2	0.437	0.902
V	1	5.07*	6.75*
W	7	2.405*	5.286*
V × W	7	0.382*	1.621
Error	30	0.121	0.728

* Significant at 5 % level

APPENDIX – XI

Analysis of variance for number of pods plant⁻¹ and number of seeds pod⁻¹

Source of variation	df	Mean sum of square	
		Number of pods plant ⁻¹	Number of seeds pod ⁻¹
Replication	2	1.965	1.172
V	1	38.16*	11.21*
W	7	157.7*	10.73*
V × W	7	11.77*	2.369
Error	30	2.488	1.604

* Significant at 5 % level

APPENDIX – XII

Analysis of variance for seed yield, straw yield (kg ha⁻¹) and harvest index (%)

Source of variation	df	Mean sum of square		
		Seed yield (kg ha ⁻¹)	Straw yield (kg ha ⁻¹)	Harvest index (%)
Replication	2	38419.14	137304.1	13.23598
V	1	2232220*	3144965*	29.83737*
W	7	1605795*	3420076*	19.94277*
V × W	7	70005.42*	191514.8*	21.63437*
Error	30	28023.01	81370.02	3.26726

* Significant at 5 % level

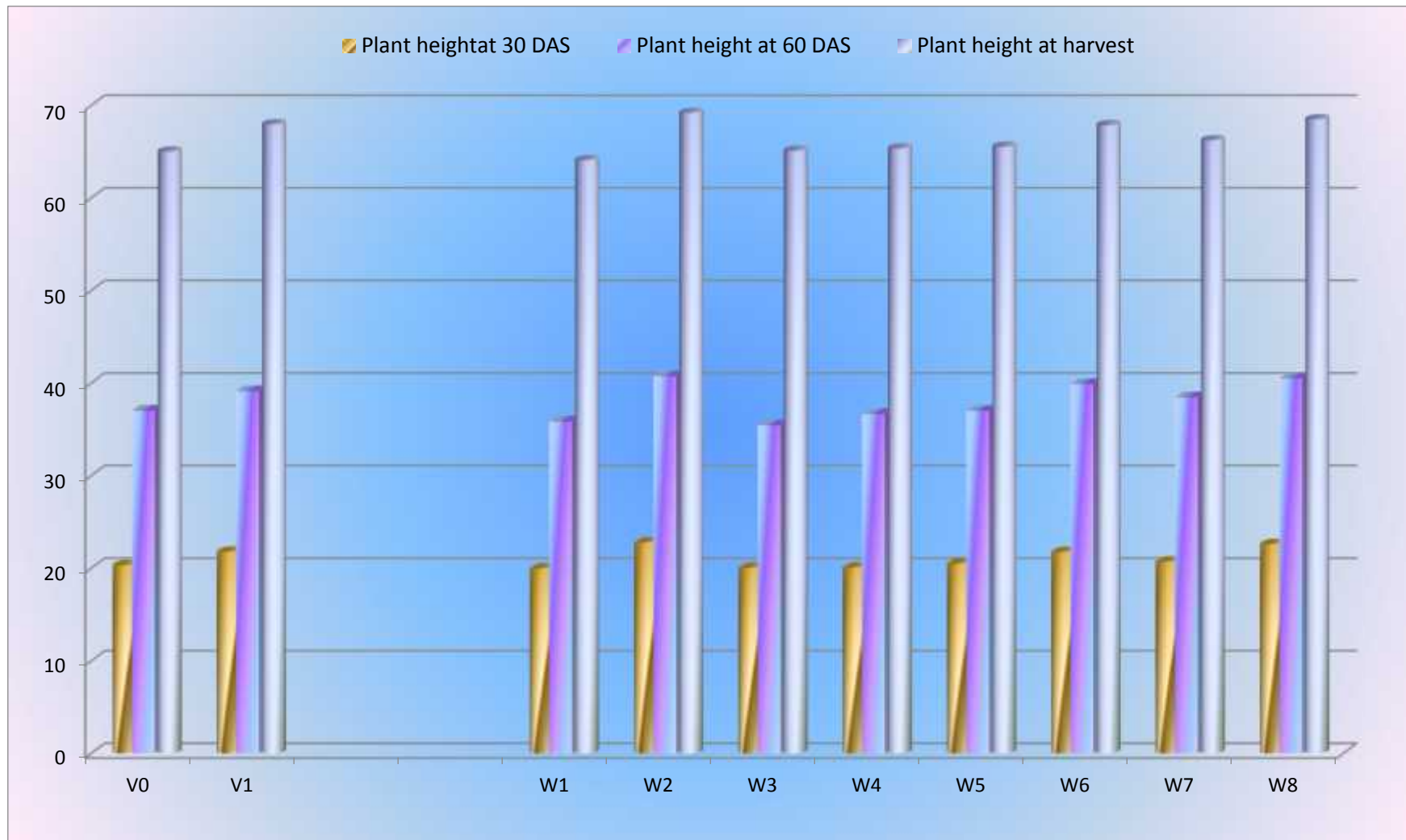


Fig 4.2.1 : Plant height as influenced by varying levels of vermicompost and weed management practices

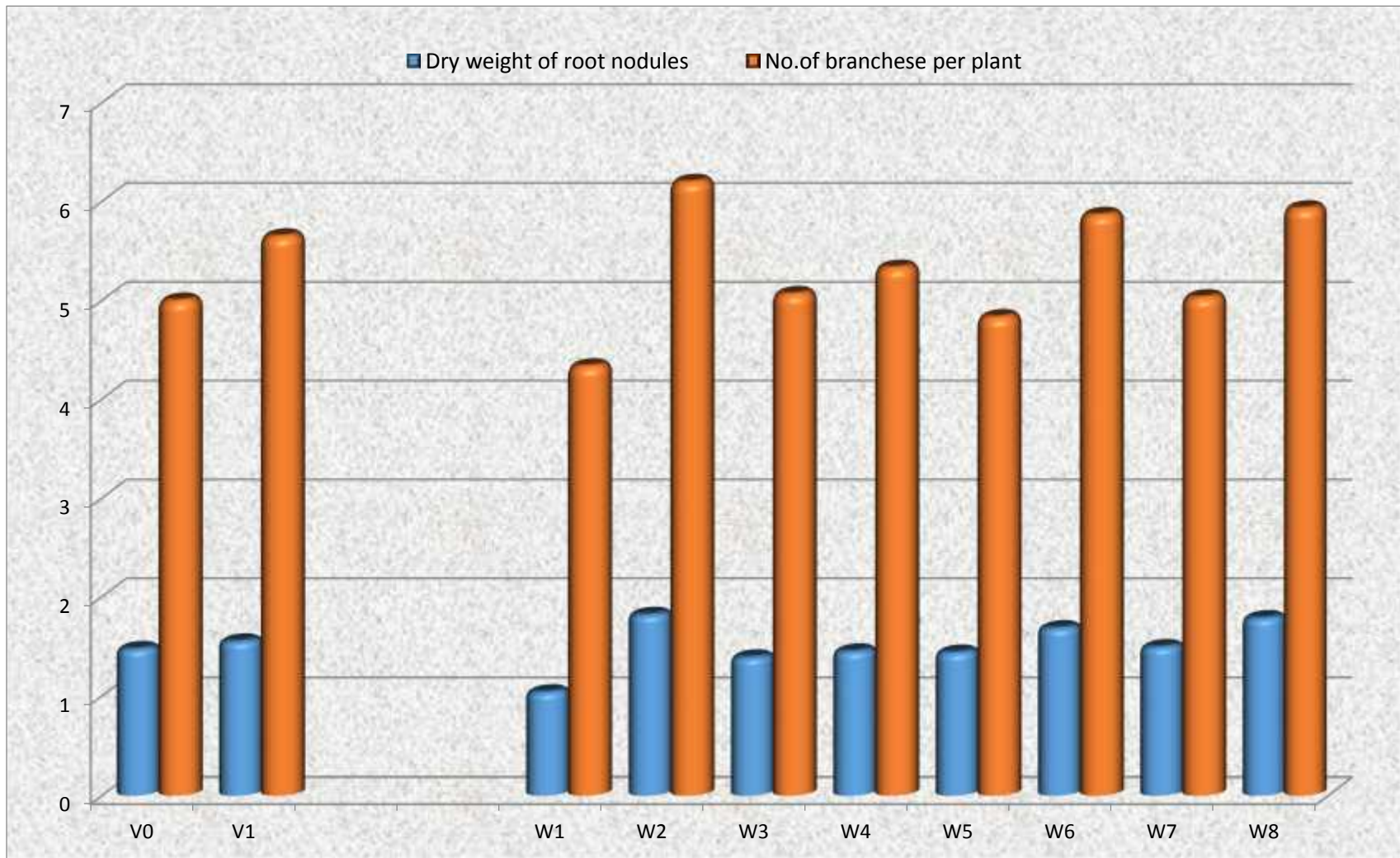


Fig 4.2.2 :Dry weight of root nodule and no of branches as influenced by varying levels of vermicompost and weed management practices

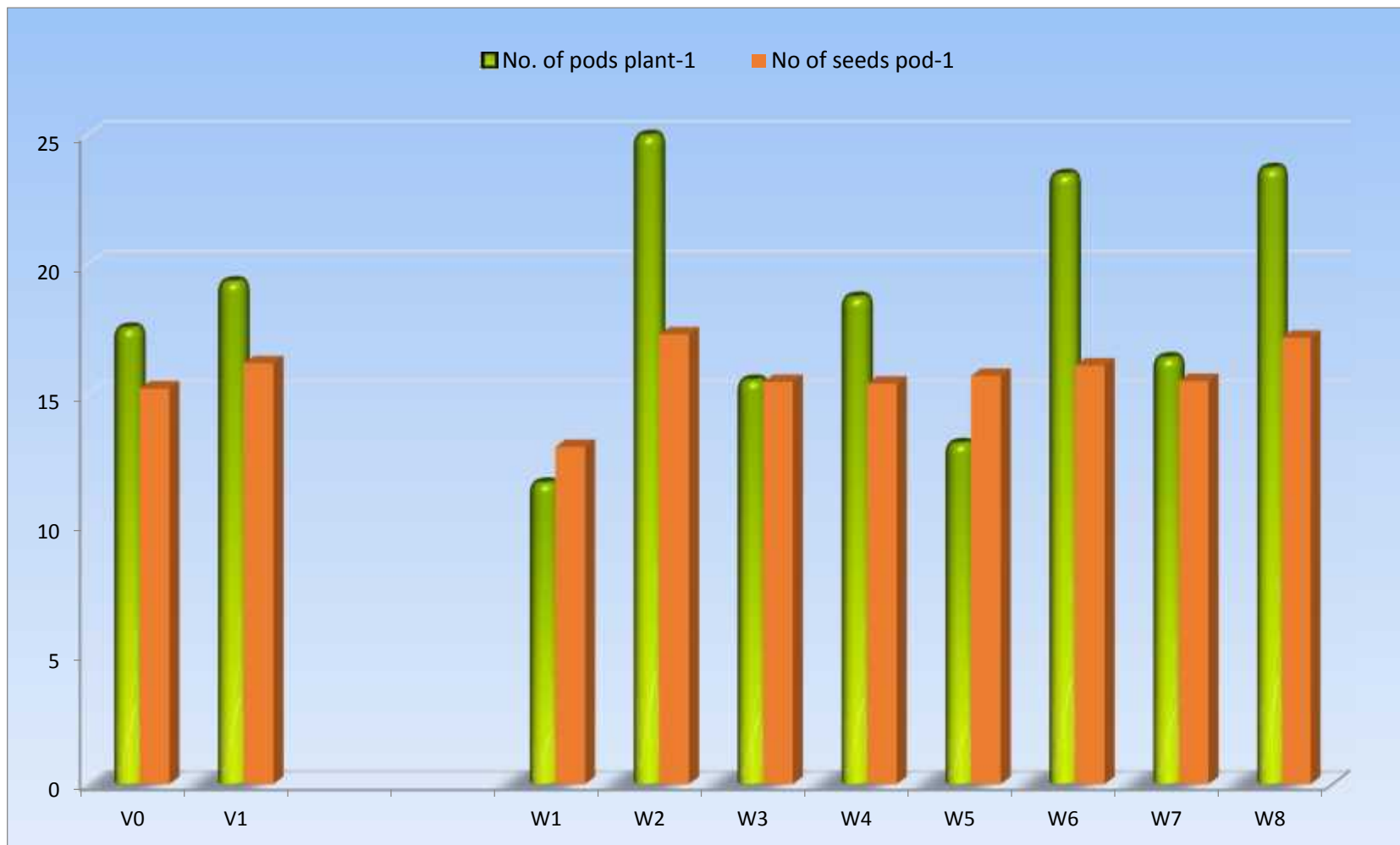


Fig 4.3.1 : Number of pods plant⁻¹ and number of seeds pod⁻¹ as influenced by varying levels of vermicompost and weed management practices

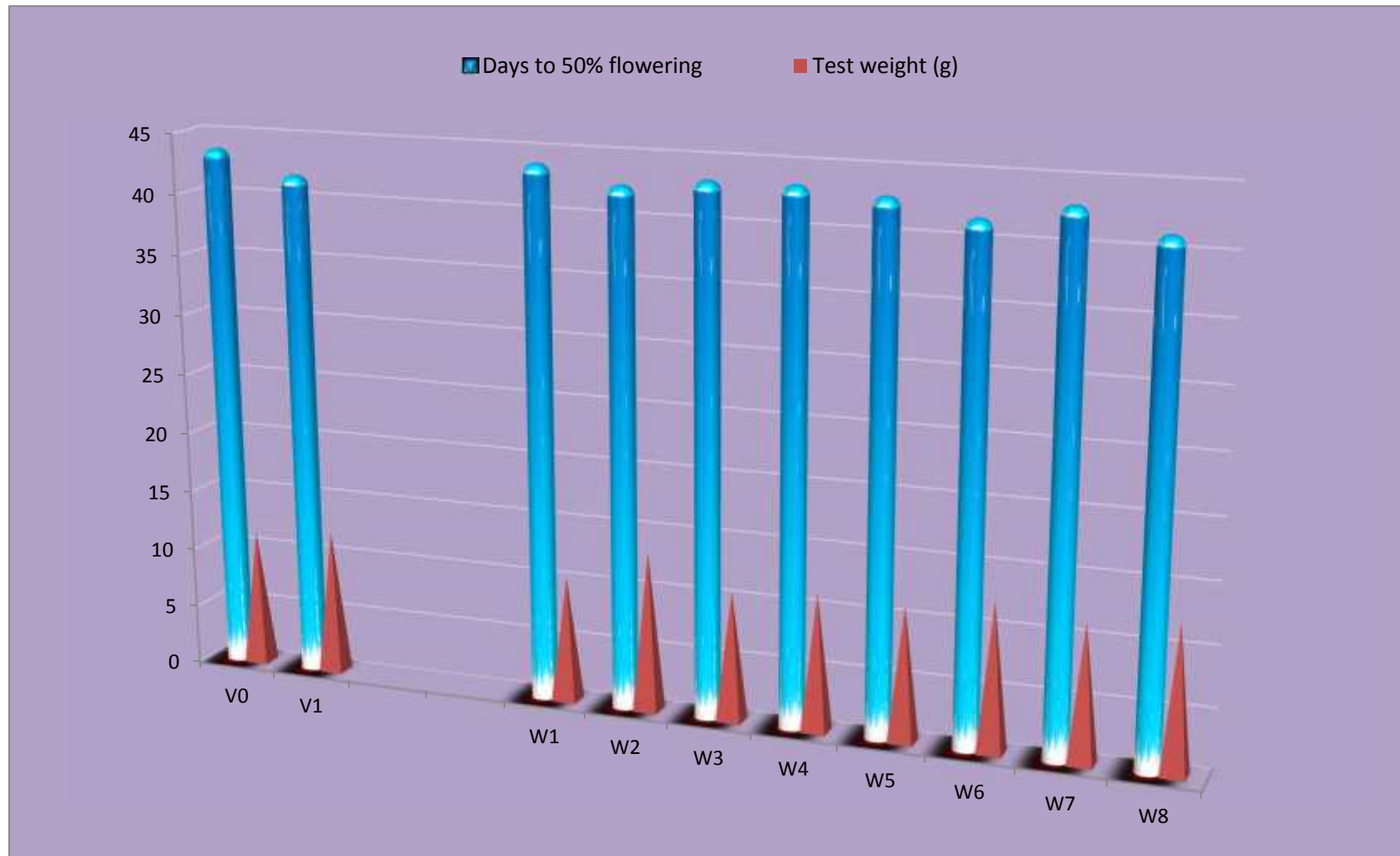


Fig 4.3.2 : Days to 50% flowering and test weight (g) as influenced by varying levels of vermicompost and weed management practices

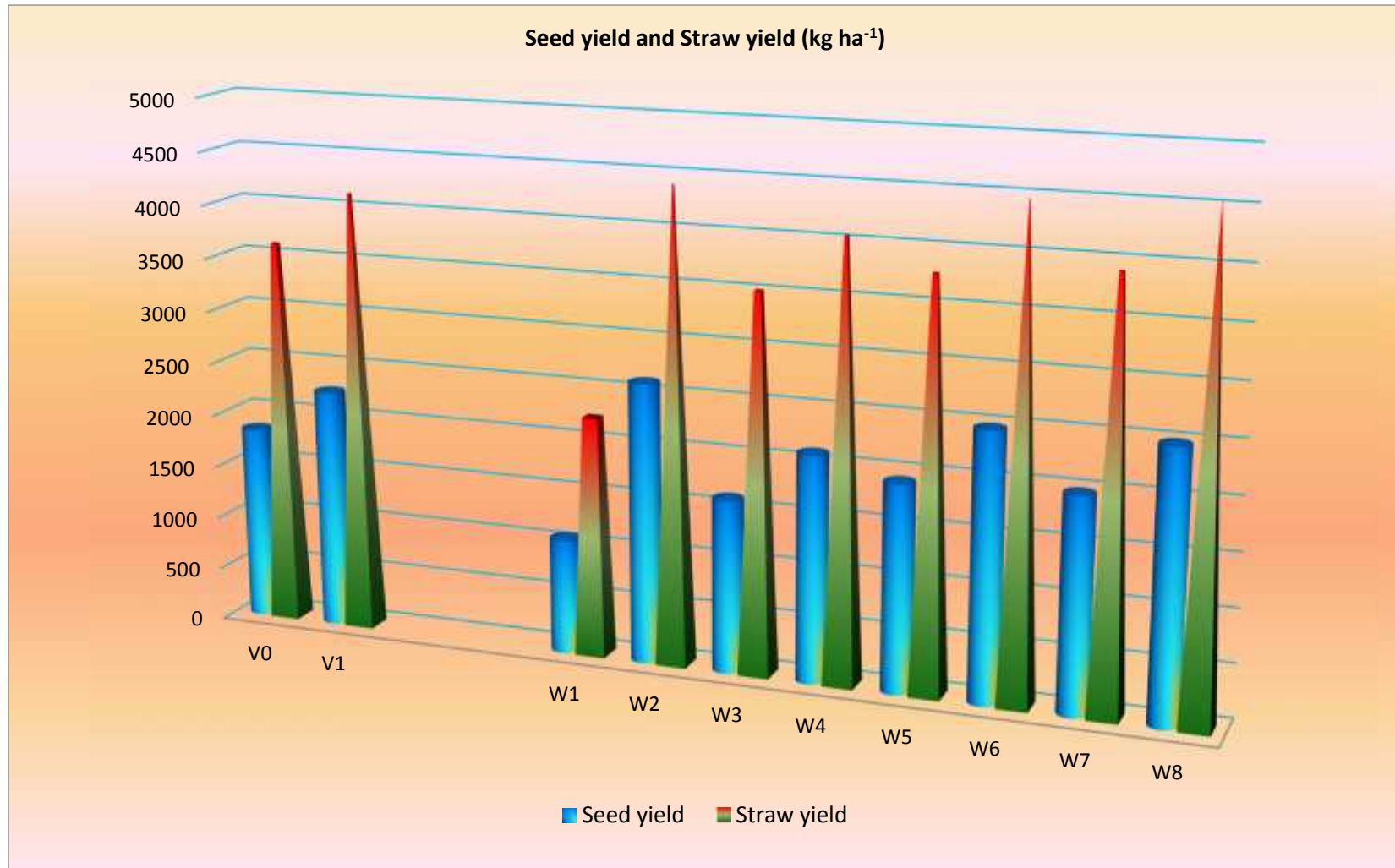


Fig 4.3.3: Seed yield and straw yield (kg ha⁻¹) as influenced by varying levels of vermicompost and weed management practices

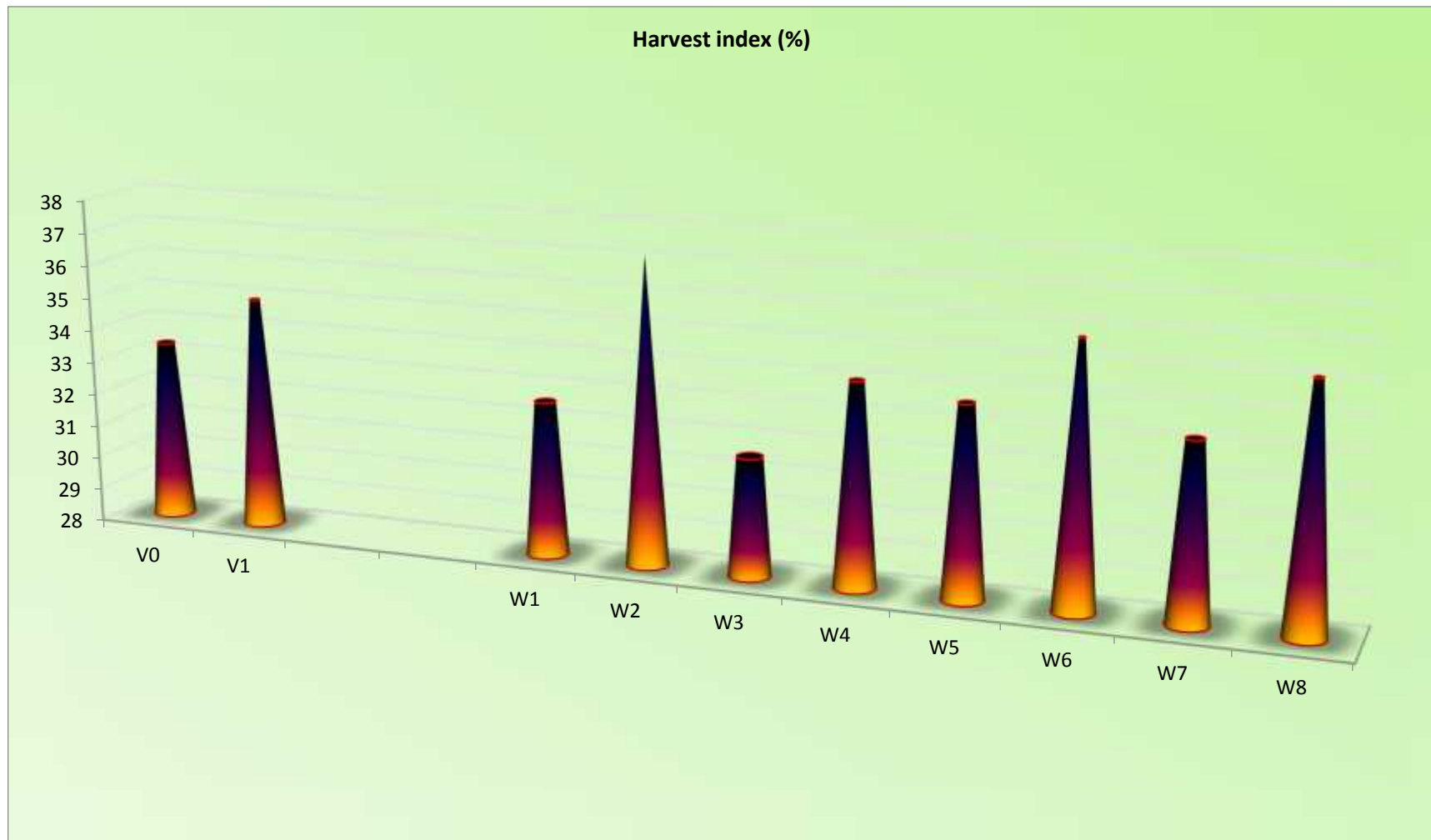


Fig 4.3.4: Harvest index (%) as influenced by varying levels of vermicompost and weed management practices

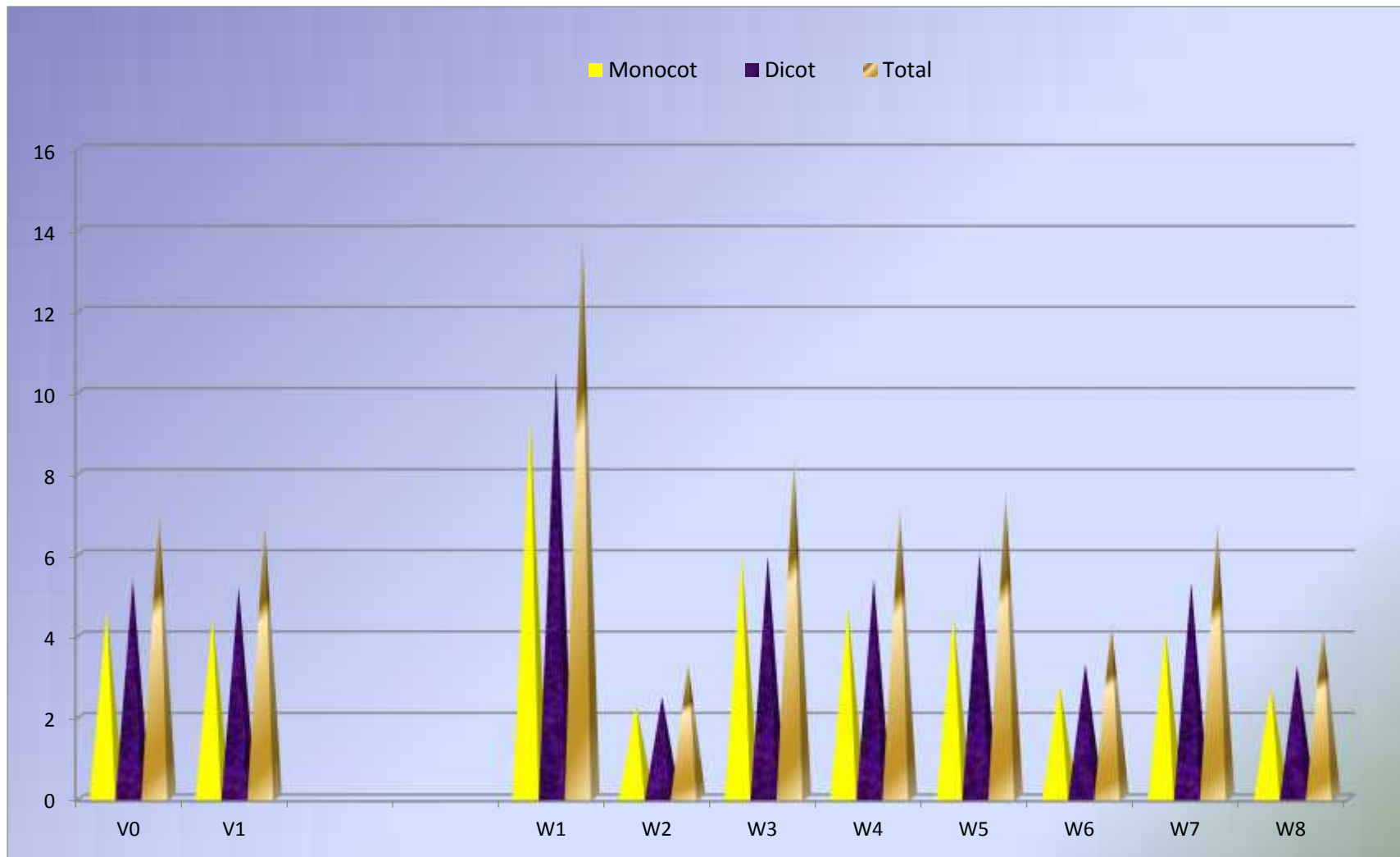


Fig 4.1.1: Weed count at 20 DAS (no. m⁻²) as influenced by varying levels of vermicompost and weed management practices

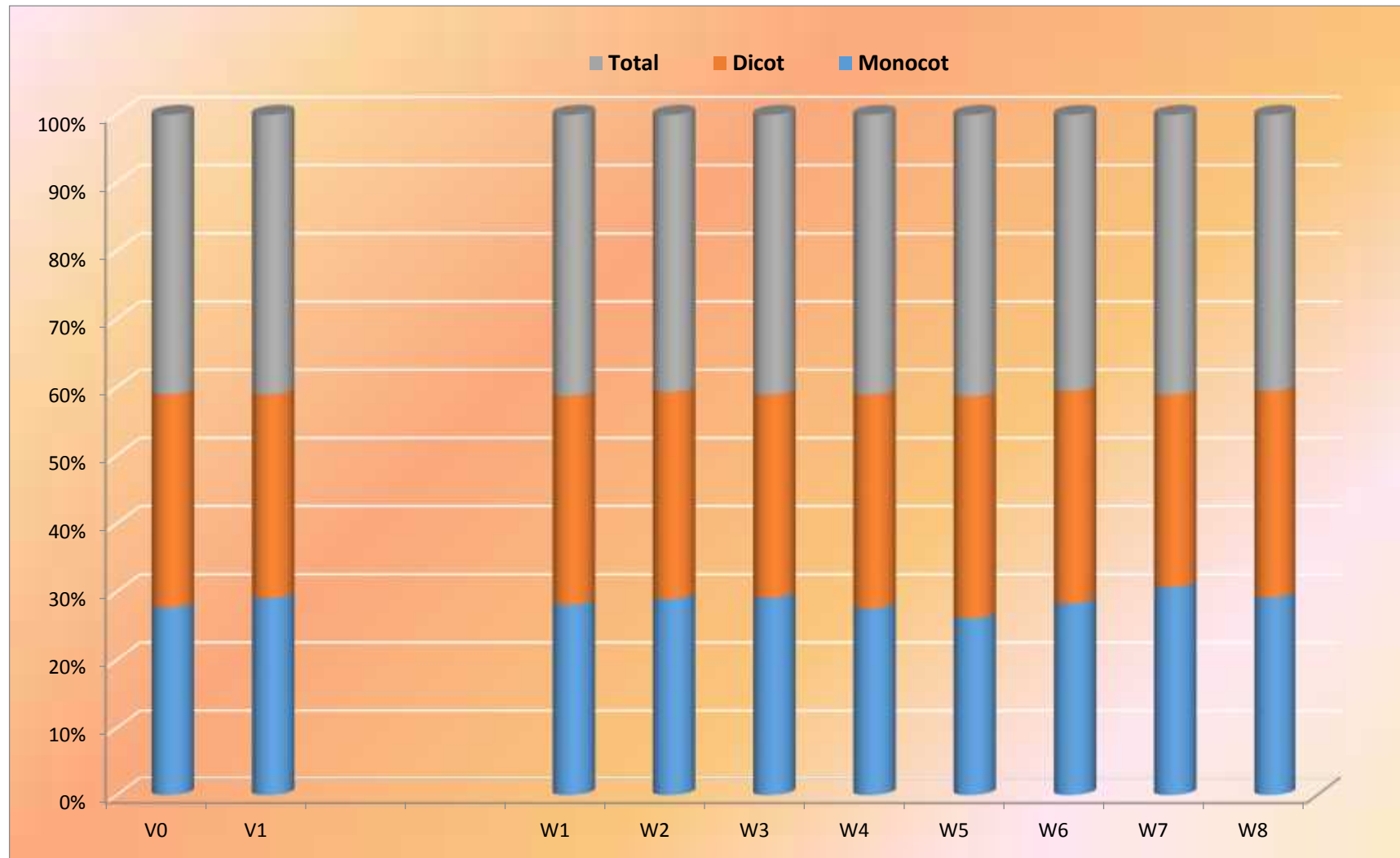


Fig 4.1.2: Weed count at 40 DAS (no. m⁻²) as influenced by varying levels of vermicompost and weed management practices

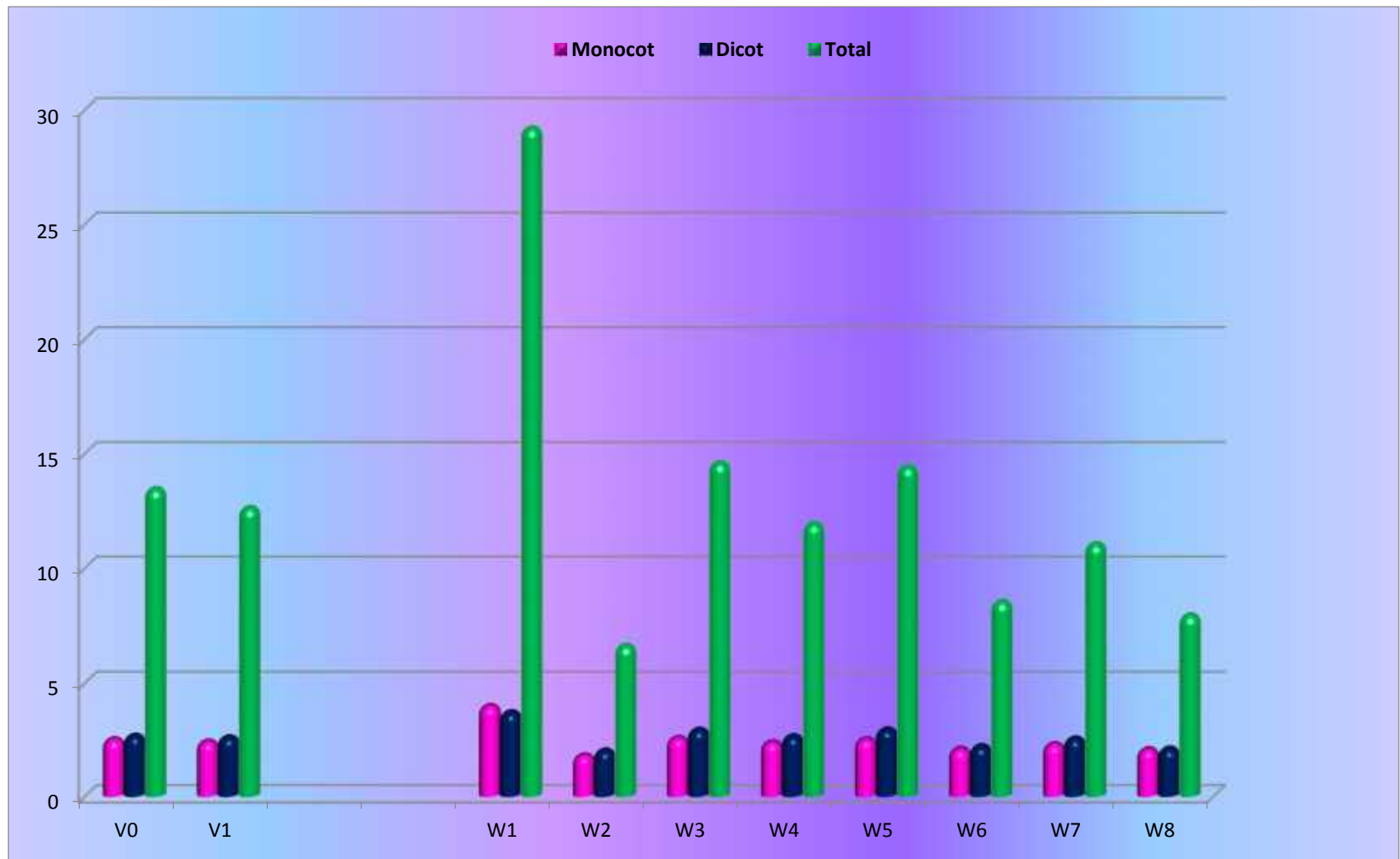


Fig 4.1.3: Weed dry weight (g m⁻²) at 20 DAS as influenced by varying levels of vermicompost and weed management practices

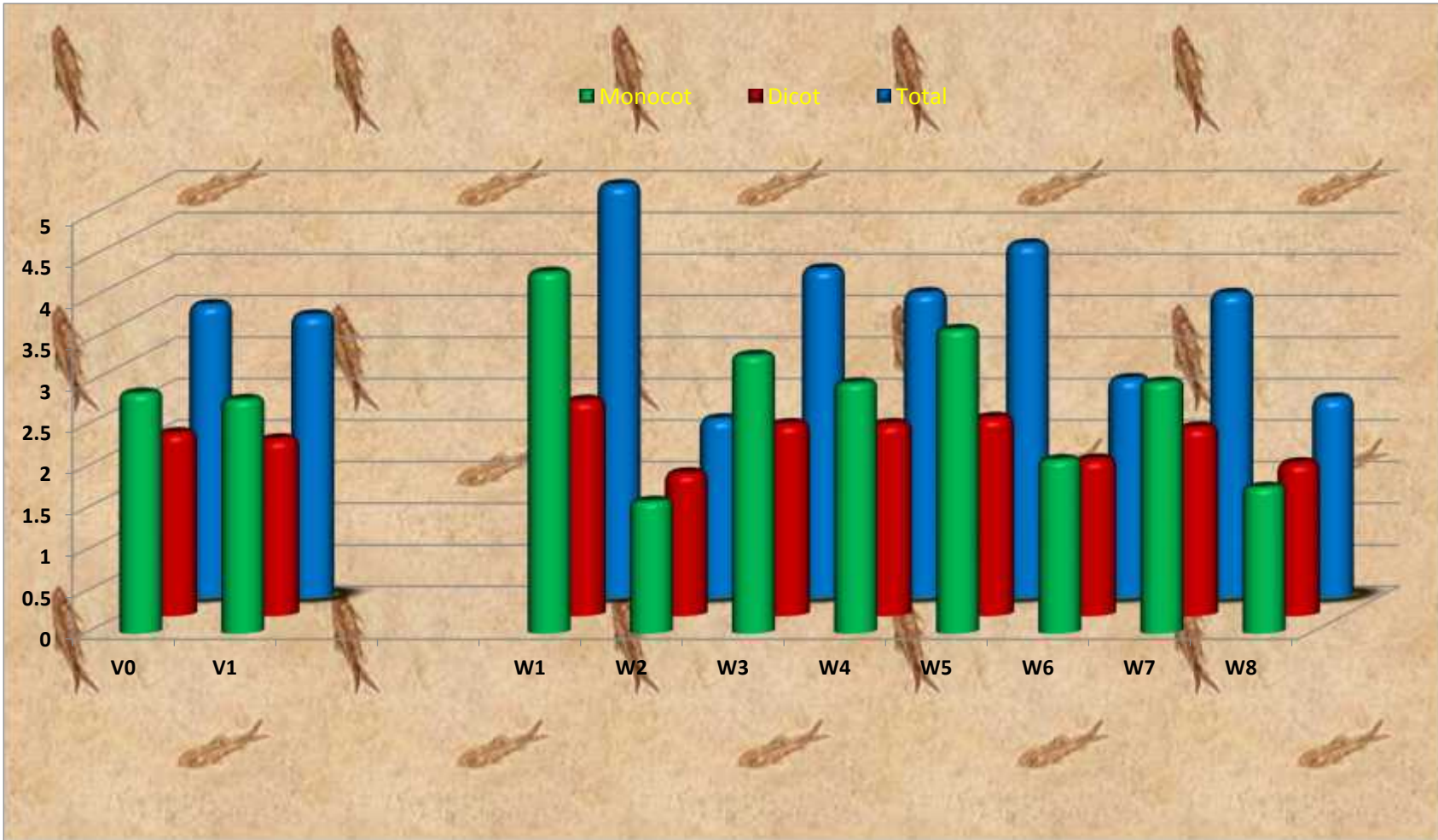


Fig 4.1.4: Weed dry weight (g m⁻²) at 40 DAS as influenced by varying levels of vermicompost and weed management practices

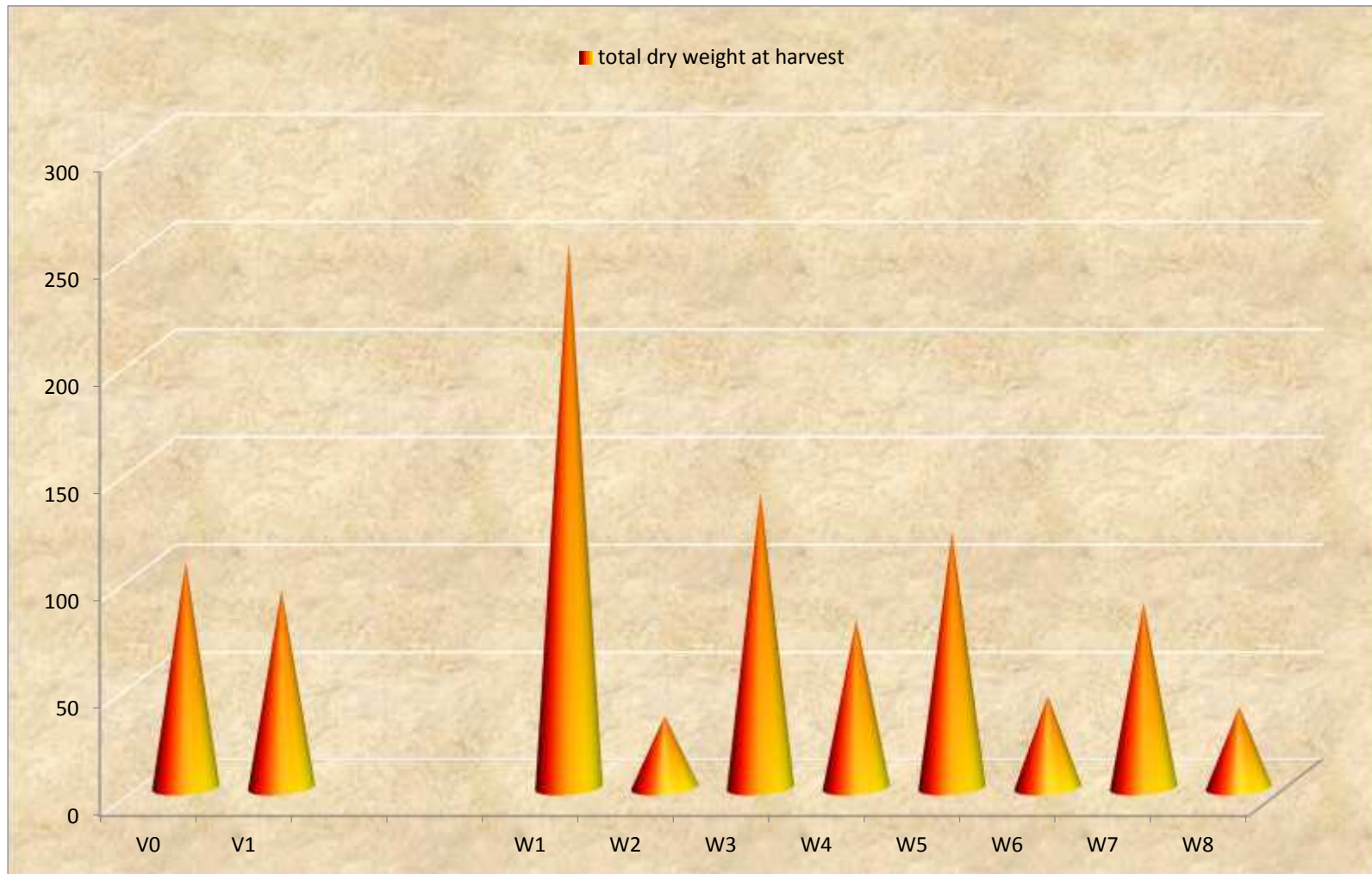


Fig 4.1.5: Weed dry weight (kg ha⁻¹) at harvest as influenced by varying levels of vermicompost and weed management practices

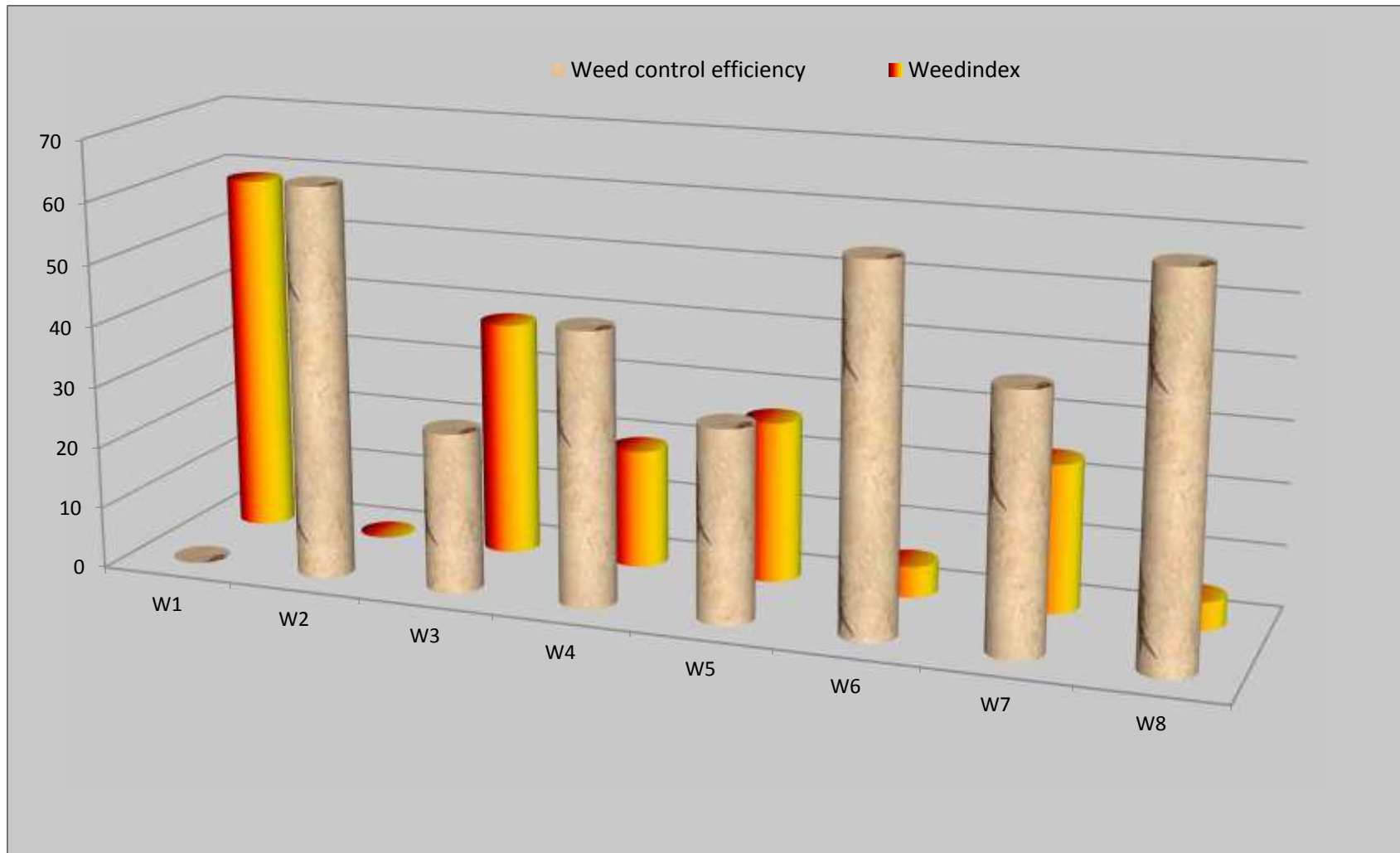


Fig 4.1.6: Effect of weed management practices on weed control efficiency (%) and weed index (%)

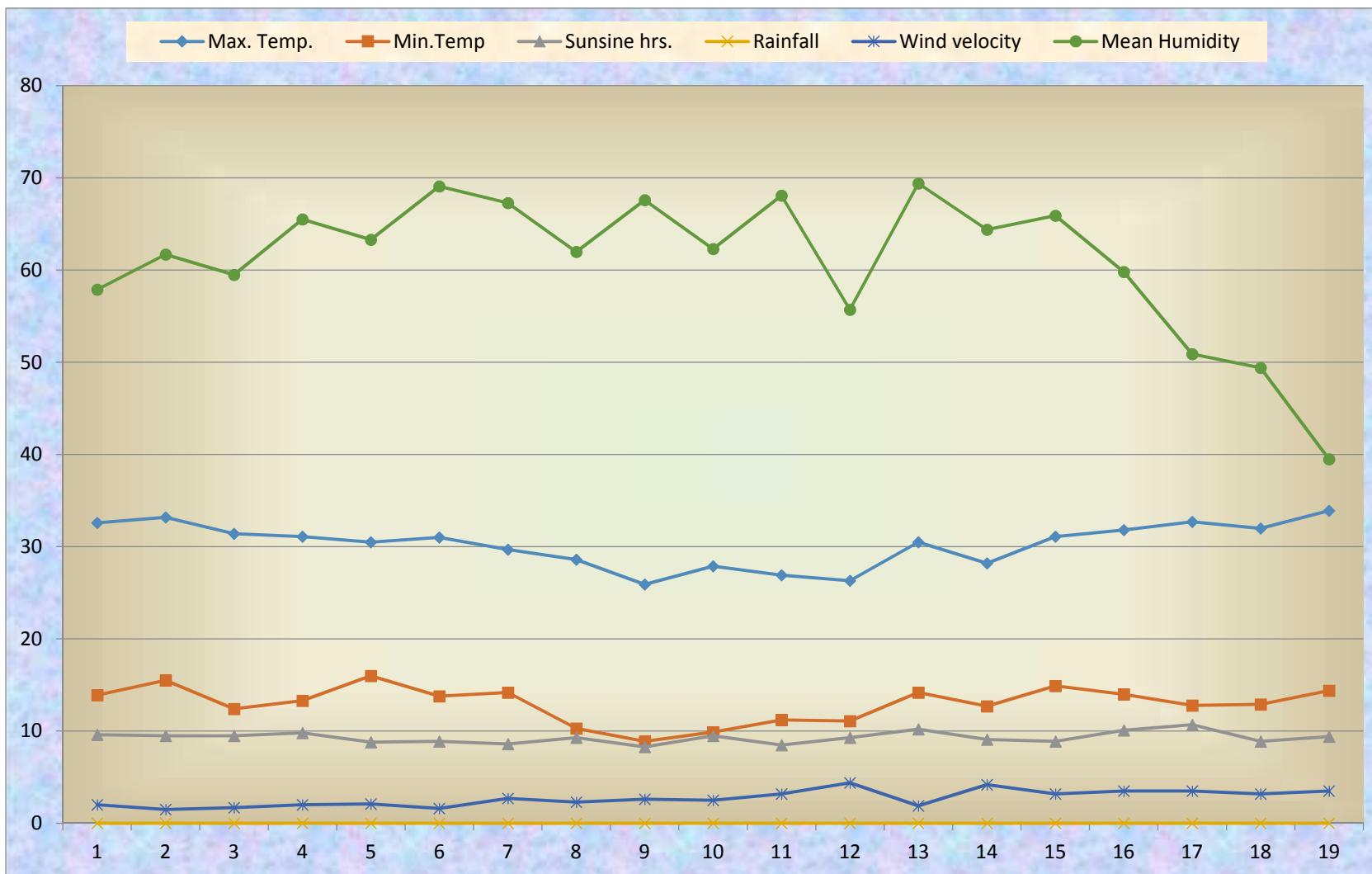


Fig. 3.1: Meteorological data recorded during crop season for the year 2012-13 (Weekly mean)



Plate 1: General view of experimental plot of fenugreek



Plate 2: Crop growth under the treatment of Vermicompost 2 t ha^{-1} + Weedy check (V_1W_1)



Plate 3: Crop growth under the treatment of Vermicompost 2 t ha^{-1} + Hand weeding at 20 and 40 DAS (V_1W_2)



Plate 4: Crop growth under treatment of Vermicompost 2 t ha^{-1} + Oxadiargyl @ 75 g ha^{-1} as PE fb HW at 30 DAS (V_1W_8)



Plate 5: Crop growth under treatment of Vermicompost 2 t ha^{-1} + Oxyflourfen @ 80 g ha^{-1} as PE fb HW at 30 DAS (V_1W_6)