

**INTEGRATED NUTRIENT MANAGEMENT STUDIES
IN JSABGOL (*Plantago ovata* Forsk)**

THESIS

**Submitted to
Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola
in partial fulfilment of the requirements
for the Degree of**

**MASTER OF SCIENCE
IN
AGRICULTURE
(HORTICULTURE)**

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Enrolment Number - FF-1222

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DECLARATION OF STUDENT

I hereby declare that, the experimental work and its interpretation of the Thesis entitled, "**INTEGRATED NUTRIENT MANAGEMENT STUDIES IN ISABGOL (*Plantago ovata* Forsk)**" or part thereof has neither been submitted for any other degree or diploma of any University, nor the data have been derived from any thesis / publication of any University or scientific organization. The source of materials used and all assistance received during the course of investigation have been duly acknowledged.

Place: Nagpur

Date: 12/06/2009



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Enrolment No. FF-1222

CERTIFICATE

This is to certify that thesis entitled **“INTEGRATED NUTRIENT MANAGEMENT STUDIES IN ISABGOL (*Plantago ovata* Forsk)”** submitted in partial fulfilment of the requirement for the degree of **“Master of Science in Agriculture (Horticulture)”** of Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola is a record of bonafide research work carried out by Shinde Sachin Mahadev under my guidance and supervision.

The subject of the thesis has been approved by the Student's Advisory Committee.

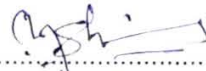

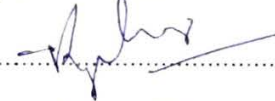
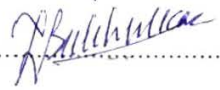
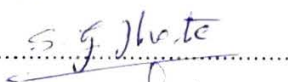
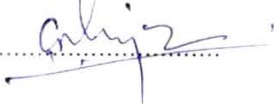
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Table of Contents

Sr. No.	Particulars	Page
A	List of Tables	i
B	List of Figures	ii
C	List of Plates	iii
D	List of Abbreviation	iv
E	Glossary	v
F	Thesis Abstract	vi
I	Introduction	1
II	Review of Literature	5
III	Material and Methods	11
IV	Results and Discussion	19
V	Summary and Conclusion	36
VI	Literature cited	39
	Vita	
	Appendix	

(A)**List of Tables**

Table	Title	Page
1	Soil properties of experimental site	12
2	Height of plant (cm) as influenced by integrated nutrient management	20
3	Number of tillers per plant as influenced by integrated nutrient management	21
4	Number of spikes per plant as influenced by integrated nutrient management	22
5	Length of spike (cm) as influenced by integrated nutrient management	23
6	Number of seeds per spikes as influenced by integrated nutrient management	25
7	Number of seeds per gram as influenced by integrated nutrient management	26
8	Weight of seeds per spikes (cm) as influenced by integrated nutrient management	27
9	Seed yield per plot (kg) and per hectare (q) as influenced by integrated nutrient management	28
10	Seed: Stover ratio as influenced by integrated nutrient management	29
11	Swelling capacity of seeds (cc g^{-1}) as influenced by integrated nutrient management	31
12	Test weight of seeds (g) as influenced by integrated nutrient management	32
13	Husk percentage as influenced by integrated nutrient management	33
14	Economics of Isabgol	35

(B)

List of Figures

Figures	Title	After Page
1	Plan of layout	13
2	Height of plant (cm) as influenced by integrated nutrient management	20
3	Number of tillers per plant as influenced by integrated nutrient management	21
4	Number of spikes per plant as influenced by integrated nutrient management	22
5	Length of spike (cm) as influenced by integrated nutrient management	23
6	Number of seeds per spikes as influenced by integrated nutrient management	25
7	Weight of seeds per spikes (gm) as influenced by integrated nutrient management	27
8	Seed yield per plot (kg), per hectare (q) as influenced by integrated nutrient management	28
9	Economics of Isabgol	35

(C)

List of Plates

Plate	Caption	After Page
Plate 1	View of experimental plot	13
Plate 2	Spikes of Isabgol crop	13
Plate 3	View of treatment plot	20
Plate 4	Seeds of Isabgol crop	28

(D)**Abbreviations**

%	Per cent
/	Per
@	At the rate of
cm	Centimeter
cm ²	Centimeter square
c.f.	Cited from
CD	Critical difference
cv.	Cultivar
DAS	Days after sowing
°C	Degree Celsius
<i>et al.</i>	et alia (and associates)
Fig.	Figure
FYM	Farm yard manure
N	Nitrogen
P ₂ O ₅	Phosphorus
PSB	Phosphate solubilizing bacteria
Azo	Azotobacter
ha	Hectare
i.e.	id est (that is)
mm	Millimeter
g.	Gram (s)
Kg	Kilogram
q	Quintal
NS	Non-significant
SE (m) ±	Standard error of mean
Sig.	Significant
var	Variety
viz	Namely
RBD	Randomized Block Design

(E)

Glossary

Abortifacient : An agent that promotes abortion.

Alterative : A drug which corrects disordered process of nutrition and restores the normal function of an organ or of the system.

Aphrodisiac: A drug, which promotes sexual desire.

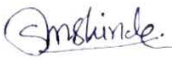
Diuretic: A drug, which increases the secretion and discharge of urine.


Medicinal plant : are those plants rich in secondary metabolites and, are potential sources of drugs.

Secondary metabolism : It includes alkaloids, glycosides, coumarins, flavonoids and steroids.

Test weight : Weight of 1000 seeds in gram.

(F) **THESIS ABSTRACT**

- a) **Title of the thesis** : **“INTEGRATED NUTRIENT MANAGEMENT STUDIES IN ISABGOL (*Plantago ovata* Forsk) ”**
- b) **Full name of student** : **Shinde Sachin Mahadev**
- c) **Name and address of Major Advisor** : **Shri. S. D. Khiratkar**
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ABSTRACT

An investigation entitled "Integrated nutrient management studies in isabgol (*Plantago ovata* Forsk)" was undertaken at the farm of Horticulture Section, College of Agriculture, Nagpur during rabi season 2008. The experiment was laid out in Randomized Block Design with nine treatments and three replications.

The experimental findings revealed that the growth in respect of height of plant, number of tillers per plant, number of spikes per plant, length of spike were found maximum in the treatment received 75% N + 2.5 t FYM + *Azotobacter* 4 kg + PSB 4 kg ha⁻¹.

The seed yield and contributing characters like, number of seeds per spike, number of seeds per gram, weight of seeds per spike, seed yield per hectare were found maximum in the treatment applied with 75% N + 2.5 t FYM *Azotobacter* 4 kg + PSB 4 kg ha⁻¹.

The quality parameter like, swelling capacity of seed, test weight of seed and husk percentage exhibited non-significant results. However the treatment received 75% N + 2.5 t FYM *Azotobacter* 4 kg + PSB 4 kg ha⁻¹ was found economically beneficial with B:C ratio of 2.34.

Chapter I

INTRODUCTION

1.1 Background information

India is endowed with rich wealth of medicinal plants. These plants have made a good contribution to the development of ancient Indian material- medica. The curative properties of drugs are due to the presence of complex chemical substances (present as secondary metabolites) in varied composition in one of more parts of these plants. These plants metabolites according their composition are grouped as alkaloids, glycosides, corticosteroids, essential oils, etc. During last two decades the pharmaceutical industry has made massive investment on pharmacological, clinical and chemical researcher all over the world in an effort to discover still more potent plant drugs. In fact, Agricultural studies on medicinal plants by its very nature demand on equally large investment and higher priority. India in a particular has a big scope for the development of pharmaceutical and phytochemical Industry (Gupta, 1982).

Nearly 8000 medicinal plants having curative properties are need for use in their medicinal and personal hygiene. Indian system of medicines such as Ayurveda, Unani and Sidha are emerging again popular and they are of great demand in the country. China is presently the world leader followed by India and other countries in the production of herbal raw material with transaction of over \$ 60 billion in the international market with an annual growth rate of over seven per cent. There is thus, an enormous scope for India to focus over the commercial cultivation of these crops.

Isabgol had been need in medicines since ancient times, but it is only cultivated as medicinal plant in recent decades (Gupta, 1982). It's seed contains mucilage, fatty oil, large quantities of albuminous matter the pharmacologically inactive glucoside, namely Aucubin ($C_{13}H_{19}O_8H_{20}$) and aplantiose sugar.

Isabgol plant is 10-45 cm high short stemmed annual herb belonging to the family Plantaginacea and genus *Plantago* which is known by different names

such as ashwagolam, aspaghol, bazaraqutuna, blond Psyllium, ch'-ch' lentu, ghoda, grappicol, Indian planto, indische, Isaphgol, vithali, issufgul, jiru, obeko, Psyllium, plantain, spogel seeds.

Isabgol is an irrigated winter season crop grown in the month of Nov. and harvested in the month of March. It requires cool and dry weather for its growth and maturity. It is native of Persia and derives its name from two Persian words "Isap" and "ghol" meaning a horse ear referring to its characteristics boat shaped seeds.

The dried mature seeds of isabgol are used in medicines as they are mucilageneous, cooling, demullent, mildly laxative, emollient mildly astringent and diuretic. The seed and husk are used to cure inflammation of the mucus membrane of gastro-intestinal and genitro-urinary system duodenal ulcer, gonorrhoea and piles, diarrhea, dysentery and spatic constipation. It is used as "cervical dilator" for termination of pregnancy. It is potentially used for lowering blood cholesterol level (Ansari and Ali, 1996).

1.2 Importance of the study

The fertilizer use in medicinal plants has only a recent history. Most of the crops are grown by marginal farmers on relatively poor lands and in variably under stress conditions. By and large organic manure has remained the main source of nutrient supply of these corps. However, studies made in last two decades in India have shown that these crops too remove sizable quantities of different major and micronutrients from the soil. Use of inorganic fertilizers in appropriate quantity form and stage of growth could upgrade the yield remarkably (Gupta 1982). It is universally accepted that the use of chemical fertilizer is an integral part of the package of practices (like use of improved seeds, proper soil and water management, improved cultural practices, plant protection measures, post harvest operation, etc.) for raising the production to a higher one. Studies conducted by the FAO have established beyond doubt that there is close relationship between the average crop yield and fertilizer consumption level.

The research work carried out under "All India Co-ordinated Research Project (AICRP) on Medicinal and Aromatic plant" At Akola revealed that isabgol crop can be very well grown under Vidarbha agro climatic condition (Paturde *et al.*, 1998) with optimum nutrient levels.

1.3 Objectives:

The present investigation "Integrated nutrient management studies in Isabgol." is undertaken with the following objective.

1. To find out the effect of organic, inorganic and biofertilizers on growth of isabgol.
2. To find out the effect of different combinations of organic, inorganic and biofertilizers on growth, seed yield and quality of isabgol.
3. To find out suitable combination of integrated nutrient management of isabgol.

1.4 Scope and Limitation:

Isabgol or blond Psyllium is one of the most important crop among the cultivated medicinal plants grown for its husk and seed. The mucilage present in its husk are having medicinal properties and is used against constipation, irritation of digestive tract, etc. India is a sole exporter of isabgol husk and seed to the world market (Maiti and Mandal, 2000). About 90 per cent of the produce of worth Rs. 250 crores is exported to Europe and mainly to USA. Isabgol plays an important role in agriculture economy in India and holds a monopoly in production and trade in the world and is a first ranking foreign exchange earner as it has acquired the place of "Dollar earner of North Gujarat". The approximate domestic sale ranges between Rs. 60-100 million (Anon., 1998). Psyllium husk is an important herb in India export basket of medicinal plants. At present Rajasthan and Gujarat together produce about 1,00,000 tones of Psyllium husk and seed, out of which about 30,000 tones Psyllium husk is obtained which is mostly processed in Gujarat. The husk also called 'isabgol' is tasteless which swells in water and is widely used in India as a laxative. Isabgol still not able to meet the

demand on account of low production per unit area. For further export promotion and to fulfil the international demand there is a need to increase the production and per unit area and to extend the cultivation of isabgol to new areas. The research work carried out at Akola centre revealed that isabgol crop can well grow under Vidarbha agro climatic condition (Paturde *et al.* 1998).

However very little information is available on the nutrient requirement of this crop on the perusal of research work carried out on this crop at various AICRP on Medicinal and Aromatic Plant Centers. In Vidarbha region, this crop is taken in limited scale and its cultivation is based on previous experiences. This crop did not receive much attention of the growers because of non availability of production technology, knowledge of processing, lack of assured market and fluctuation in prices.

1.5 Hypothesis:

- 1) Venkatesha and Kattimani (2007) concluded that, isabgol seed yield, higher in combination of 30 t FYM+1 t Vermicompost and 25:25:30 kg NPK per hectare.
- 2) Bose *et al.*(2001) observed that, growth and yield of isabgol higher with an application of 75% RDF +15 t Vermicompost per hectare.
- 3) Tiwari *et al.* (2005) concluded that, growth and yield is increased in isabgol by the application of half recommended dose + FYM 10 t per hectare.

Chapter II

REVIEW OF LITERATURE

Medicinal plants remove sizable quantities of different major and minor nutrients from soil. Use of organic and inorganic fertilizer is generally considered as the most important factor for promoting growth, productivity and quality. Proper plant growth could be conceivable with the application of macro-nutrient like nitrogen, phosphorus and potassium. The optimum and balanced nutrition is very essential for proper plant growth, development and maximum productivity of the plant with quality produce.

The effect of integrated nutrient management studies in isabgol was observed on growth, yield and quality of isabgol plant. Several factor viz. climate, soil, planting time, planting material used and nutrient of the crop influence the growth, yield and quality of isabgol. For getting higher returns, farmers are using chemical fertilizer abundantly and unknowingly deteriorating our surrounding, quality of the product, soil and economic condition of him.

Organic manures are indispensable from manurial schedule for crop production. They contain essential plant nutrients and growth promoting agents like enzymes and hormones while no chemical fertilizer can supply all together. Similarly bio-fertilizers also play an important role for quality production of isabgol.

Thus, literature so far generated on nutritional requirement through organic manures, inorganic fertilizer and biofertilizer for optimum growth, yield and quality of isabgol are very scanty. Hence the attempts have been made to narrate whatever available on isabgol and other crop pertaining to undertaken in present investigation are reviewed under following heads.

1. Effect of organic manures and biofertilizers on growth of isabgol and other crops

Bose *et al.* (2001) reported that, use of organic manures like vermicompost help to reduce the requirement of inorganic fertilizers.

Anonymous (2003) revealed that 10 t FYM ha⁻¹ provided good nutrient status to support healthy plant growth in isabgol.

Thosar (2004) reported that, 5 t FYM +10 kg *Azotobacter* per hectare was found beneficial for increase in the height (61.92cm), number of branches per plant (7.90) and minimum days (74.75) required for 50 per cent flowering in ashwagandha.

Sable *et al.* (2007) revealed that, organic mode of plant nutrient through various combinations of neem cake and vermicompost was found superior over chemical fertilizer alone in terms of increased number of branches and fruit yield in tomato.

Tiwari *et al.* (2007) revealed that, an increase of growth over control was found due to soil application of *Azotobacter* and PSB each at the rate of 3.0 kg per hectare in isabgol.

2. Effect of inorganic fertilizer on growth of isabgol and other crops :

Shakhela *et al.* (1985) reported that application of nitrogenous fertilizer above 30 kg N ha⁻¹ increased the vegetative growth significantly but decreased the resistance of crop to pest and diseases in isabgol crop.

Tandel (1989) concluded that, an application of nitrogen and phosphorus @ 20 kg each ha⁻¹ significantly increased the growth of isabgol crop over control.

Ramesh *et al.* (1989) found that, the application of 75 kg N ha⁻¹ and 25 kg P₂O₅ ha⁻¹ resulted in more number of spikes (32.5) per plant in isabgol.

Singh and Chouhan (1994) observed that, plant height was increased with an application of nitrogen and phosphorus @ 80 and 40 kg ha⁻¹ respectively in isabgol.

Nutritional study carried out at Udaipur on isabgol crop revealed that maximum height and effective tillers of crop plants was produced due to application of 45 kg N ha⁻¹ (Anon,1998).

Kulmi (1998) observed significant increase in number of tillers per plant when 40 kg N ha⁻¹ was applied to isabgol crop.

Mann and Vyas (1999) reported that, application of 45 kg N ha⁻¹ to isabgol crop increased the plant height and number of leaves per plant.

Solanki and Shaktawat (1999) observed that, plant height was significantly increased due to application of nitrogen in isabgol crop.

Singh *et al.* (2000) noted that, an application of nitrogen @ 30 kg ha⁻¹ significantly increased the plant height, number of leaves per plant and dry matter over control in isabgol crop

3. Effect of organic manures and biofertilizers on yield of isabgol and other crops :

Maheshwari *et al.* (2000) revealed that an application of FYM 5 t ha⁻¹ was found suitable for increasing the seed yield of ashwagandha.

An experiment was conducted on effect of FYM and biofertilizer on seed yield of ashwagandha during 2000-2001 and 2001-2002 consequently and result revealed that the soil inoculation of *Azotobacter* @ 10 kg ha⁻¹ showed higher seed yield (3.58 and 2.58q ha⁻¹) during both the years than that of uninoculated control (Anon., 2003^a).

In Isabgol crop the application of FYM @ 10 t ha⁻¹ gave significantly higher seed yield as compared to control (Anon., 2003).

Thosar (2004) found that 5 t FYM + *Azotobacter* 10 kg per hectare was found optimum for increasing the seed yield (0.176 kg per plot) of ashwagandha.

Tiwari *et al.* (2007) reported that an increase of 9.15 and 7.70% in seed yield over control due to soil application of *Azotobacter* and PSB each at the rate of 3.0 kg per hectare respectively in isabgol.

4. Effect of inorganic fertilizers on yield of isabgol and other crops :

Joshi *et al.* (1968) found that, the application of ammonium sulphate at the rate of 280 kg per ha⁻¹ and SSP 498 kg ha⁻¹ recorded an increase in seed yield by 38% and 29% respectively as compared to control in isabgol crop.

Modi *et al.* (1974) concluded that isabgol is a non-exhaustive crop with low nutrient requirement and recommended the application of 50 kg N ha⁻¹ and 25 kg P₂O₅ ha⁻¹ for maximum seed yield.

Kumarwat (1979) concluded that application of 50 kg N ha⁻¹ and 25 kg P₂O₅ ha⁻¹ at the time of last phoughing for maximum seed yield of Isabgol.

Application of 50 kg N ha⁻¹ and 25 kg P₂O₅ ha⁻¹ to isabgol crop gave significantly higher yield at Anand Research Station Gujrat (Anon 1998)

Kalyanasundaram *et al.* (1982) recommended the application of 50 kg N ha⁻¹ and 25 P₂O₅ kg ha⁻¹ and concluded that the nitrogen requirement of isabgol crop was much less and the crop need not be fertilized unless the soil is very low in available nitrogen.

Ramesh *et al.* (1989) reported that, an application of 75 kg N ha⁻¹ and 25 kg P₂O₅ ha⁻¹ resulted in the highest number of seed per plant in isabgol.

Tandel (1989) observed that, an application of nitrogen and phosphorus both @ 25 kg ha⁻¹ increased the seed yield of isabgol significantly over control.

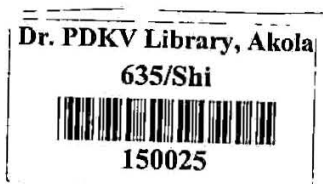
Jain and Kumarwat (1991) revealed that, application of 25 kg ha⁻¹ each of nitrogen and phosphorus before sowing was found optimum for better yield of isabgol.

Thakre *et al.* (1992) stated that isabgol crop has a low requirement for chemical fertilizer and suggested the application of 40-50 kg N ha⁻¹ and 20-25 kg P₂O₅ ha⁻¹ for maximum seed yield.

Singh and Chouhan (1994) concluded that isabgol seed yield was increased with increasing in nitrogen and phosphorus levels upto 60 kg ha⁻¹ and 30 kg ha⁻¹ respectively.

Sriram *et al.* (1994) conducted an experiment on isabgol and observed that isabgol crop requires very low nutrients of nitrogen and phosphorus and both @ 30 kg ha⁻¹ was found enough for yield.

Gokhale *et al.* (1995) suggested that application of 15 kg ha⁻¹ each of nitrogen and phosphorus to isabgol crop was enough for maximum seed yield.



Parihar and Singh (1995) reported that isabgol responded significantly only upto 20 kg ha⁻¹ of both nitrogen and phosphorus under Western Rajasthan conditions.

Patel *et al.* (1996^a) found that the seed yield was increased with increasing levels of nitrogen and phosphorus upto 20 kg ha⁻¹ each in isabgol crop.

Patel *et al.* (1996^b) conducted an experiment on isabgol and find out that the 20 kg ha⁻¹ each of nitrogen and phosphorus gave highest seed yield of isabgol crop.

Singh *et. at.* (1996) investigated to determine the economic viable combination of nitrogen and phosphorus levels in isabgol and concluded that highest net income was obtained with the combined application of 30 kg N + 15 kg P₂O₅ ha⁻¹.

Paturde *et al.* (1998a) reported that the significant increase in grain yield was due to application of nitrogen @ 25 and 50 kg ha⁻¹ but it was decreased with higher nitrogen levels i. e. 75 kg N ha⁻¹. The seed yield was also increased with application of 30 kg P₂O₅ ha⁻¹.

Maiti and Mandal (2000) suggested an application of 20-30 kg N ha⁻¹ and 15-25 kg P₂O₅ ha⁻¹ for isabgol crop.

Aishwath *et al.* (2005) found that, straw yield of isabgol was significantly enhanced by the application of nitrogen, and the yield obtained at 25 kg nitrogen ha⁻¹ was statistically at par with 50 kg N ha⁻¹.

5. Effect of organic, inorganic fertilizers and biofertilizers on yield and quality of isabgol and other crops :

Kalyanasundaram *et al.* (1980^a) observed that, with every increase in nitrogen levels there was decrease in swelling factor of seed. The control gave the maximum value in this respect.

Kalyanasundaram *et al.* (1982) found that swelling factor of seed was decreased with an increase in the rate of applied nitrogen from 0 to 50 kg N ha⁻¹.

Singh and Chouhan (1994) reported that the test weight of seed was increased with increasing nitrogen and phosphorus levels upto 30 and 60 kg ha⁻¹ in isabgol.

Solanki and Shakhawat (1999) reported that nitrogen had a significant effect on test weight of seed in isabgol.

Maheshwari *et al.* (2000) conducted the field experiment for two years on nutritional aspect of ashwagandha and found highest yield with maximum net return and (B:C) ratio by the application of 2.5 t FYM with 12.5 kg N + 25 kg P₂O₅ under rainfed condition in shallow black soil.

Bose *et al.* (2001) observed that the seed yield of isabgol was higher with an application of 75% RDF + 15 t vermicompost ha⁻¹.

Prabhu *et al.* (2002) while working on integrated nutrient management in okra var. Parbhani Kranti studies revealed that the treatment combination 2/3^d RDF + FYM + *Azospirillum* + PSB was found significant over all the treatments in respect of plant height, root length and yield per plot.

Anonymous (2003^a) observed that an application of FYM increased the nitrogen use efficiency with inorganic and biofertilizer use in isabgol.

Raut *et al.* (2003) revealed that maximum fruit weight (591 gm) and fruit yield (196.93 q ha⁻¹) were recorded with recommended dose of NPK (100:50:50) + 20 t FYM ha⁻¹ in tomato crop.

Tiwari *et al.* (2005) concluded that seed yield was increased in isabgol by the application of 10:20:10 kg NPK ha⁻¹ and 10.0 t FYM ha⁻¹.

Venkatesha and Kattimani (2007) concluded that isabgol seed yield was higher in treatment combination of 30 t FYM + 1 t vermicompost and 25:25:30 kg NPK ha⁻¹.

Chapter III

MATERIAL AND METHODS

The present investigation entitled "Integrated nutrient management studies in isabgol" was carried out at the field of Horticulture Section, College of Agriculture, Nagpur during rabi season of 2008-09. The details of material used and methods adopted during the course of investigation are presented in this chapter.

3.1 Weather and climatic condition :

Nagpur city is situated at an elevation of 321.26 m above mean sea level at 21⁰1 N latitude and 79⁰19 E longitudes and has subtropical climate. Hot and dry summer and fairly cold winter characterize Nagpur. The area is under wide diurnal fluctuation of temperature.

Total rainfall received from June 2008 to December 2008 was 928.8 mm with 46 rainy days. The minimum and maximum temperature ranged from 26.3 to 43.8 °c. The maximum evaporation was 7.4 mm/day and minimum 1.9 mm/day, respectively during crop period.

The meteorological data in respect of rainfall, humidity, maximum and minimum temperature during the course of study for the period of August 2008 to March 2009 are furnished in Appendix-1

3.1.1 Cropping history of experimental site :

The crop rotation followed during last preceding years at the experimental site is given below

Years	Season / Crop		
	Kharif	Rabi	Summer
2006-07	Brinjal	Brinjal	Fallow
2007-08	Fallow	Ashwagandha	Fallow

The field experiment was laid out during rabi season of 2008-09 in the experimental field of Horticulture Section, College of Agriculture Nagpur.

3.1.2 Soil :

The land selected for the experiment was fairly uniform having gentle slope and medium type with uniform textured and good drainage. The experimental plot was brought in to fine tilth by ploughing and cross wise harrowing. A composite soil sample was collected before sowing from 0 to 25 cm depth for analyzing the chemical and physical properties and the details are presented in the following Table 1.

Table 1: Physico-chemical characteristics of experimental site.

Sr. No.	Soil characteristics	Contents	Method of analysis
A]	Mechanical analysis on dry basis		
1.	Sand %	23.6	Standard International pipette method (Piper, 1976).
2.	Silt %	25.0	
3.	Clay %	51.4	
4.	Textural class	Clayey.	
B]	Physico-chemical properties		
1.	PH	7.6	Glass electrode PH metre (Jackson, 1967)
2.	Organic Carbon(g kg ⁻¹)	40.36	Walkely and black method (Jackson, 1967)
3.	Available 'N'	320.5	Alkaline potassium permanganate method. (Jackson, 1967)
4.	Available 'P'	16.36	Olsens method (Jackson, 1967)
5.	Available 'K'	420	Neutral normal ammonium acetate method (Jackson, 1967).

3.1.3 Experimental layout :

To conduct the experiment, the experimental field was laid out in Randomized Block Design with nine treatments and three replications. The layout of experiment is presented in Fig. 1.

3.2 Experimental details :

1. Site - Experimental field of Horticulture Section
2. Name of crop - Isabgol
3. Botanical name - *Plantago ovata* Farsk
4. Family - Plantaginaceae.
5. Variety - GI-1
6. Experimental design - Randomized Block Design.
7. Types of layout - Flat beds.
8. Number of treatment - 9
9. Number of replication - 3
10. Total number of plots - 27
11. Plot size - Gross -3 m x 2.4 m = 7.20 m²
Net -2.4 x 1.8 m = 4.32 m²
12. Spacing - 30 cm row to row
13. Date of sowing - 15 Nov.2008.
14. Season - Rabi-2008.

Treatment details :

- T₁ - RDF (50:25 N P kg ha⁻¹)
T₂ - 75% N + FYM (2.5 t ha⁻¹) + *Azotobactor* 4 kg + PSB 4 kg ha⁻¹
T₃ - 75% N + Vermicompost (1.0 t ha⁻¹) + *Azotobactor* 4 kg + PSB 4 kg ha⁻¹
T₄ - 50% N + FYM (5.0 t ha⁻¹) + *Azotobactor* 4 kg + PSB 4 kg ha⁻¹
T₅ - 50% N + Vermicompost (2 t ha⁻¹) + *Azotobactor* 4 kg + PSB 4 kg ha⁻¹
T₆ - 25% N + FYM (7.5 t ha⁻¹) + *Azotobactor* 4 kg + PSB 4 kg ha⁻¹
T₇ - 25% N + Vermicompost (3 t ha⁻¹) + *Azotobactor* 4 kg + PSB 4 kg ha⁻¹
T₈ - FYM (5.0 t ha⁻¹)
T₉ - Vermicompost (2.0 t ha⁻¹)

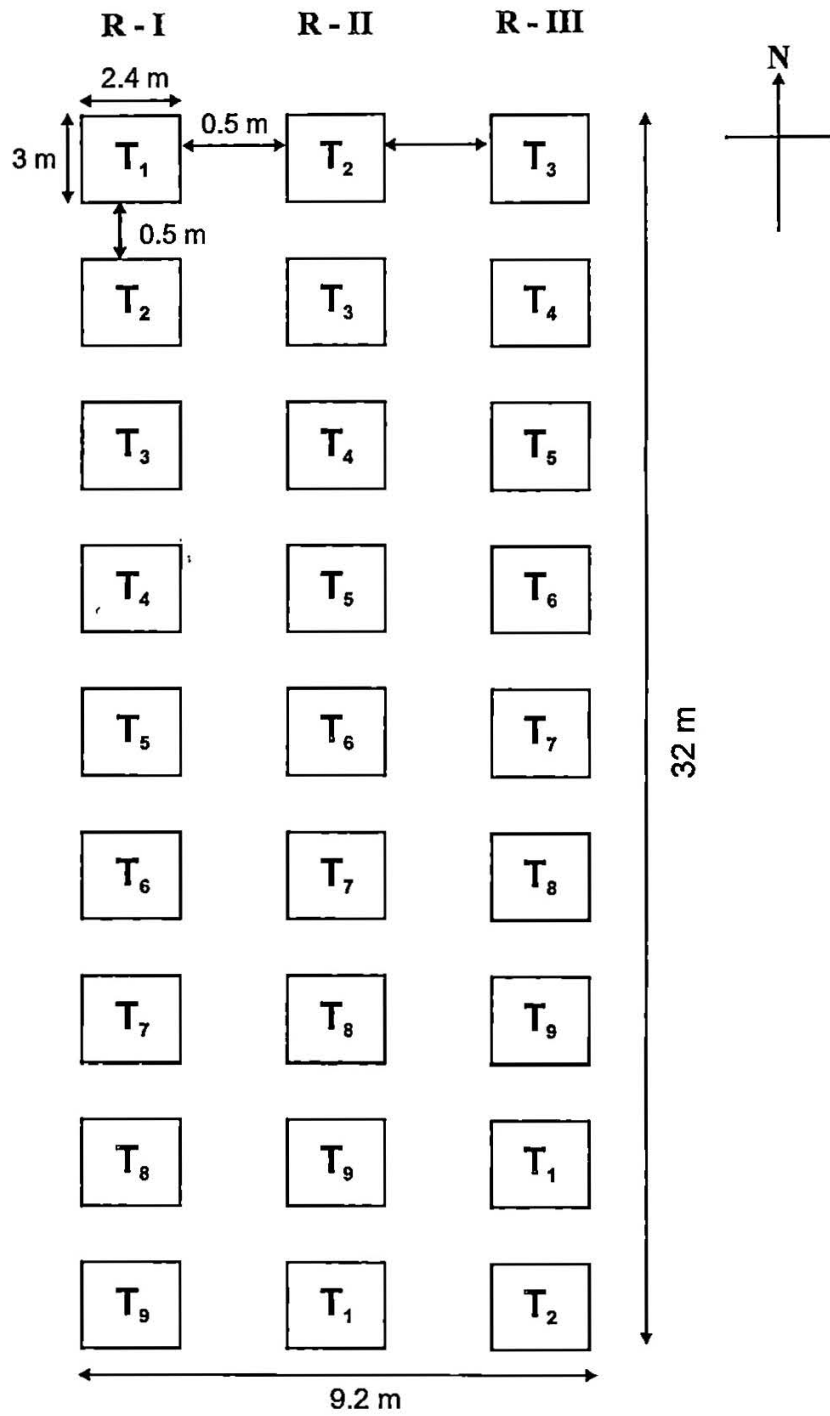


Fig. 1 - Plan of Layout (RBD)

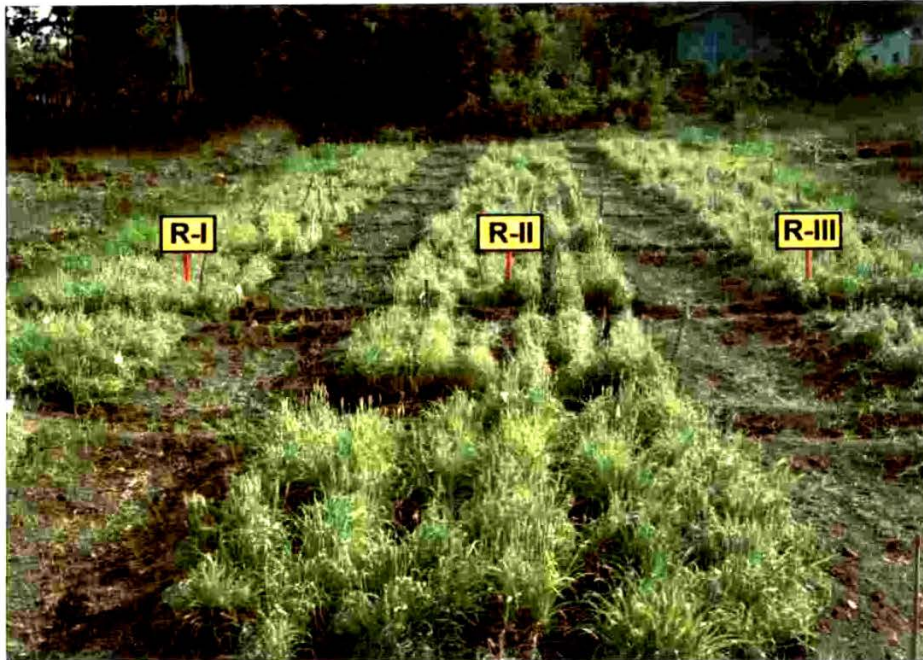


Plate 1 : View of Experimental Plot



Plate 2 : Spike of Isabgol crop

3.3 Cultural operations:

1. Seed :

The seed of isabgol were obtained from "All India co-ordinate Research Project (AICRP) on Medicinal and Aromatic Plant "Nagarjun Udyan Dr. PDKV Akola.

2. Sowing :

The seeds were sown on flat bed with a seed rate 5 kg per hectare keeping the spacing at 30 cm row to row

3. Irrigation :

The protective irrigations were given at timely interval as and when required.

4. Intercultural operation :

The field was kept free from weeds by adopting hand weeding from time to time.

5. Fertilizer application :

The urea was used as source of nitrogen. Nitrogen was applied treatments wise in two split doses. The first half dose of nitrogen was applied just before sowing. Remaining half dose of nitrogen was applied as top dressing at 30 days after sowing. A dose of Phosphorus is applied as per the treatment at the time of sowing through single super phosphate. The required quantity of chemical fertilizers, organic manure as FYM, vermicompost, were calculated as per plot size and treatments thoroughly incorporated in soil just before sowing. The calculated quantity of *Azotobacter* and PSB was applied in the soil by mixing it in little quantity of organic manure at the time of sowing.

6. Plant Protection :

The spraying of Dithane-M-45(0.3%) 30 days after sowing and matalaxil-M-Z-72 (0.2%) after 60 days of sowing was undertaken for control of downy mildew.

7. Harvesting :

Harvesting was done when the spikes were completely dried. The plants were cut from ground level and allowed for drying for seven days separately treatment wise. Then the seeds and husk were separated after threshing.

3.4 Observations recorded :

The five plants were selected randomly from each treatment plot for recording pre-harvest observation as well as post-harvest observations. The observations recorded and their details are mentioned below.

3.4.1 Pre- harvest observation :

1. Height of plant (cm) :

Plant height was measured by meter scale at 30 days interval and from 30 days after sowing to 90 days of crop growth and was recorded in cm.

2. Number of tillers per plant :

The tillers per plant were counted from observational plants at 60 days and 90 days after sowing and averages were worked out.

3. Number of spikes per plant :

After initiation of spikes completely the numbers of spikes per plant from the observational plants in each treatment plot were counted and averages were recorded.

4. Length of spike (cm) :

Five spikes per plant from each observational plant were selected randomly and their length was measure by meter scale and average were calculated and recorded as length of spike in cm.

3.4.2 Post- harvest observations :

1. Number of seed per spike :

From the observational plants five spikes were selected randomly and seeds were separated individually and numbers of seeds per spike were counted and averages were recorded.

2. Number of seed per gram :

One gram of seed harvested from each treatment plot, was taken out and the number of seeds were counted and averages were recorded.

3. Weight of seeds per spike (g) :

Five spikes per plant from observational plant randomly taken for recording the observations on length of spikes were considered for this observation and their seeds were separated. The seed weight was measured on electronic balance and averages were recorded in gram.

4. Seed yield per plot (kg) :

Plant harvested plot wise were threshed separately and the weight of seeds were taken on electronic balance and averages were recorded in gm as seed yield per plot.

5. Seed yield per hectare (q) :

From seed yield per plot, the yield per hectare was calculated by considering the net plot area.

6. Seed : Stover ratio :

Harvesting and threshing of five observation plants from each plot was taken separately and the weight of seeds and stover were taken separately on electronic balance and seed to stover ratio was computed and recorded treatment wise.

7. Swelling capacity of seeds (cc g⁻¹) :

Swelling capacity of the seeds recorded treatment wise by adopting the procedure described in Biannual Report (1978-80). AICRP on medicinal and Aromatic plants (Anonymous,1990) which is mentioned as below.

1. Take 1 g seed in 25 ml graduated stopper cylinder
2. Add 20 ml distilled water (up to 20 ml mark)
3. Agitate for thorough wetting.
4. Allow to stand for 20 minutes.
5. Again agitate for uniform distribution.
6. Allow to stand for 6 hrs.
7. Volume of swelling capacity of seed recorded in cc g⁻¹

8. Test weight (g) :

Weight of 1000 seeds per treatment was recorded in gm.

9. Husk percentage :

Husk percentage of seed recorded treatment wise by adopting the procedure described in Biannual report (1978-1980) of AICRP on Medicine and Aromatic plant (Anonymous, 1990) which is mentioned below.

- 1) Take 10 ml of 0.1 N HCL and boil it in 100 ml beaker.
- 2) After boiling remove the beaker from flame.
- 3) Add 1 g seed to the beaker (0.1 N HCl).
- 4) Heat the beaker till all seeds turn in to pale yellow colour (wheat colour) from original radish brown.
- 5) Take out the beaker from flame.
- 6) Allow the seed to settle.
- 7) Decant acidic solution (hot) through previously weighed porcelin gooch crucible.
- 8) The seed is to be washed twice with hot water (by decanting the water).
- 9) The crucible dried at 110⁰ C for 3 hours.

10) Record the weight of dried dehusked seed and calculate husk per cent.

$$\text{Husk \%} = \text{wt. of seed} - (\text{wt. of dehusked seed} \times 1.2) \times 100$$

3.5 B : C ratio :

The economics of seed yield production from isabgol was calculated by obtaining prevailing market rates of input and the produce. Accordingly the treatment wise cost of production and total return per hectare were estimated and benefit cost ratios (B: C ratio) were calculated as below.

$$\text{Benefit cost ratio} = \frac{\text{Total return}}{\text{Total cost of cultivation}}$$

Chapter IV

RESULTS AND DISCUSSION

An experiment entitled "Integrated nutrient management studies in isabgol (*Plantago ovata* Forsk)" was carried out during the year 2008-2009 at Horticulture Section College of Agriculture Nagpur. The observations recorded on various parameters and results obtained as influenced by different treatments are presented in this chapter under appropriate heading after analyzing the data statistically. -

- 4.1 Growth
- 4.2 Yield
- 4.3 Quality
- 4.4 Economic

4.1 Growth :

4.1.1 Effect of integrated nutrient management on height of plant (cm) :

The data in respect of height of plant as influenced by different treatments were recorded periodically at 30 days interval from 30 days after sowing upto 90 days of plant growth and presented in Table-2 and illustrated in Fig 2.

The data in respect of height of plant showed significant differences at all the stages of observation except 30 days after sowing where the results were found non- significant.

At 60 days after sowing maximum plant height (32.40 cm) was recorded in the treatment T₂, which was at par with treatment T₁ (30.66 cm), T₃ (30.26 cm), T₄ (28.80 cm) and T₅ (28.65 cm). Remaining treatments T₆ (27.35 cm), T₇ (26.67), T₈ (25.16 cm) and T₉ (24.09 cm) were found at par. The minimum plant height was recorded in the treatment T₉ (24.09 cm).

At 90 days after sowing maximum plant height (43.39 cm) was recorded in the treatment T₂ which was at par with treatments T₁ (40.09 cm) and T₃ (39.23 cm). The next effective treatment was T₄ (38.49 cm), T₅ (37.99 cm) T₆ (37.49 cm), and T₇ (36.96 cm) were found at par with each other. The minimum plant height

was recorded in the treatment T₉ (33.89 cm) which was at par with treatment T₈ (35.79).

Table 2 : Height of plant (cm) as influenced by integrated nutrient management in isabgol.

Abbreviation.	Treatments	Height of plant (cm)		
		30 DAS	60 DAS	90 DAS
T ₁	RDF (50 : 25 N P kg ha ⁻¹)	16.66	30.66	40.09
T ₂	75% N + FYM (2.5 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	16.83	32.40	43.39
T ₃	75% N + Vermicompost (1.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	15.63	30.26	39.23
T ₄	50% N + FYM (5.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	15.33	28.80	38.49
T ₅	50% N + Vermicompost (2.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	14.73	28.65	37.99
T ₆	25% N + FYM (7.5 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	14.50	27.35	37.49
T ₇	25% N + Vermicompost (3.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	14.16	26.67	36.96
T ₈	FYM (5 t ha ⁻¹)	14.03	25.16	35.79
T ₉	Vermicompost (2 t ha ⁻¹)	13.66	24.09	33.89
	'F' test	NS	Sig.	Sig.
	S.E. (m) ±	0.82	1.28	1.42
	C. D. at 5%	-	3.81	4.23

4.1.2 Effect of integrated nutrient management on number of tillers per plant :

The data in respect of tillers per plant as influenced by different fertilizer treatments were recorded periodically at 30 days interval from 60 days after sowing to 90 days after sowing is presented in Table 3 and illustrated in Fig 3.

The data on number of tillers per plant at 60 days after sowing showed that the treatment T₂ (7.95) produced maximum number of tillers which was at par with treatment T₁ (6.96), T₃ (6.90), T₄ (6.67), T₅ (6.60). The treatment T₆

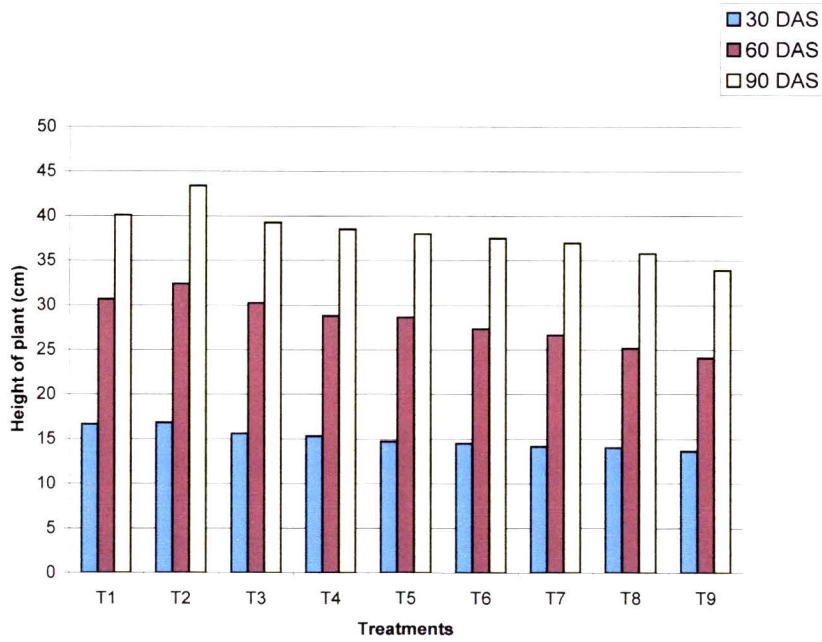


Fig. 2 : Height of plant (cm) as influenced by integrated nutrient management.



Plate 3 : Effect of integrated nutrient management on Isabgol crop

(6.42), T₇ (5.80) and T₈ (5.61) did not show any significant difference among themselves. The minimum number of tillers (4.41) per plant was recorded in treatment T₉.

Table 3 : Number of tillers per plant as influenced by integrated nutrient management in isabgol.

Abbrevia- tion.	Treatments	Number of tillers per plant	
		60 DAS	90 DAS
T ₁	RDF (50 : 25 N P kg ha ⁻¹)	6.96	7.90
T ₂	75% N + FYM (2.5 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	7.95	8.95
T ₃	75% N + Vermicompost (1.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	6.90	7.80
T ₄	50% N + FYM (5.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	6.67	7.67
T ₅	50% N + Vermicompost (2.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	6.60	7.30
T ₆	25% N + FYM (7.5 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	6.42	7.26
T ₇	25% N + Vermicompost (3.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	5.80	6.83
T ₈	FYM (5 t ha ⁻¹)	5.61	6.38
T ₉	Vermicompost (2 t ha ⁻¹)	4.41	6.13
	'F' test	Sig.	Sig.
	S.E. (m) ±	0.49	0.52
	C. D. at 5%	1.48	1.56

The data in respect of number of tillers per plant recorded at 90 days after sowing in isabgol indicated that the treatments T₂ (8.95) produced maximum number of tillers per plant which was at par with treatment T₁ (7.90), T₃ (7.80) and T₄ (7.67). Remaining all other treatments i.e. T₅ (7.30), T₆ (7.26), T₇ (6.83),

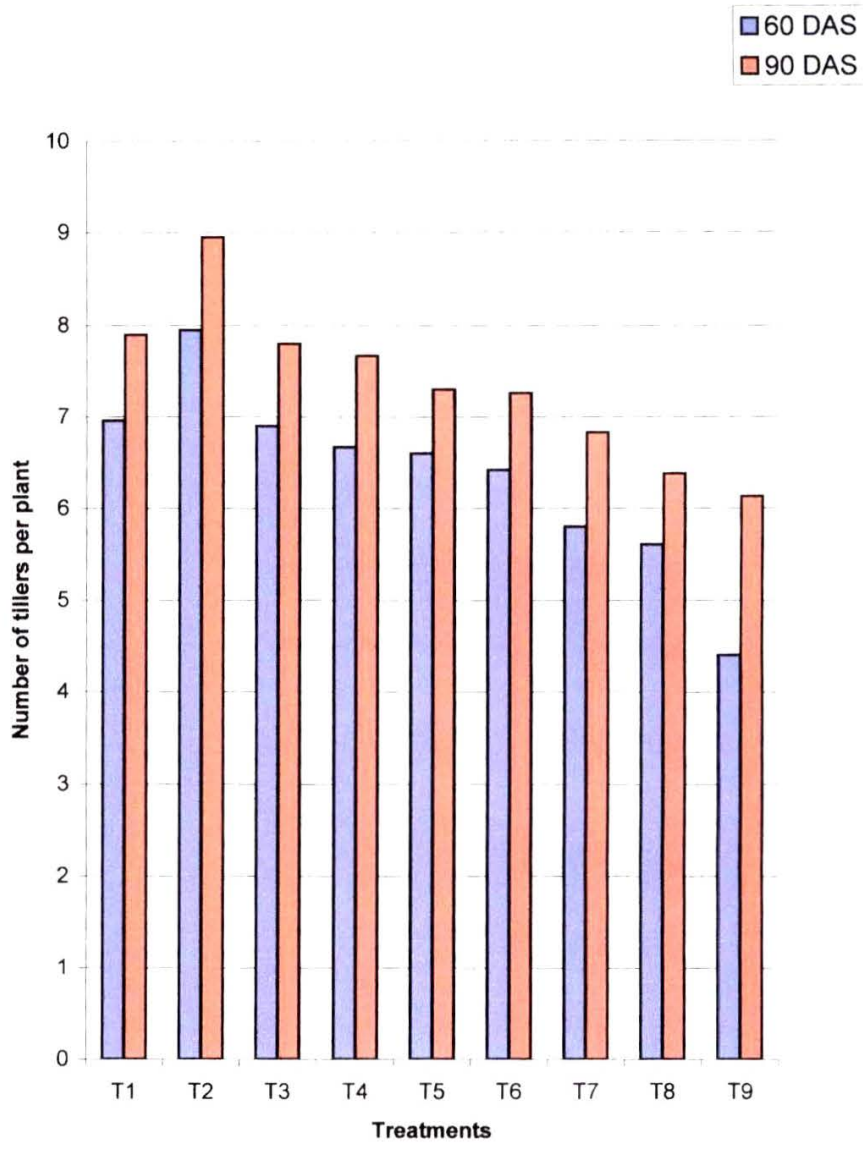


Fig. 3 : Number of tillers per plant as influenced by integrated nutrient management.

T₈ (6.38) and T₉ (6.13) were found at par. The minimum number of tillers per plant was recorded in treatment T₉ (6.13).

It is evident from the data in respect of number of tillers per plant that the treatment T₂ (8.95) produced maximum tillers per plant at all the growth stages.

The results clearly indicated that the treatment receiving more nitrogen and phosphorus through organic and inorganic fertilizers produced more number of tillers per plant. However minimum number of tillers per plant was noticed in the treatment T₉(6.13).

4.1.3 Effect of integrated nutrient management on number of spikes per plant :

The data in respect of number of spikes per plant recorded once at 90 days after sowing are presented in Table 4 and illustrated in Fig 4.

Table 4 : Number of spikes per plant as influenced by integrated nutrient management in Isabgol.

Abbrevia- tion.	Treatment	Number of spike per plant
		90 DAS
T ₁	RDF (50 : 25 N P kg ha ⁻¹)	26.88
T ₂	75% N + FYM (2.5 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	27.20
T ₃	75% N + Vermicompost (1.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	26.34
T ₄	50% N + FYM (5.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	26.20
T ₅	50% N + Vermicompost (2.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	25.04
T ₆	25% N + FYM (7.5 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	24.60
T ₇	25% N + Vermicompost (3.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	24.04
T ₈	FYM (5 t ha ⁻¹)	22.63
T ₉	Vermicompost (2 t ha ⁻¹)	21.24
	'F' test	Sig.
	S.E. (m) ±	1.23
	C. D. at 5%	3.65

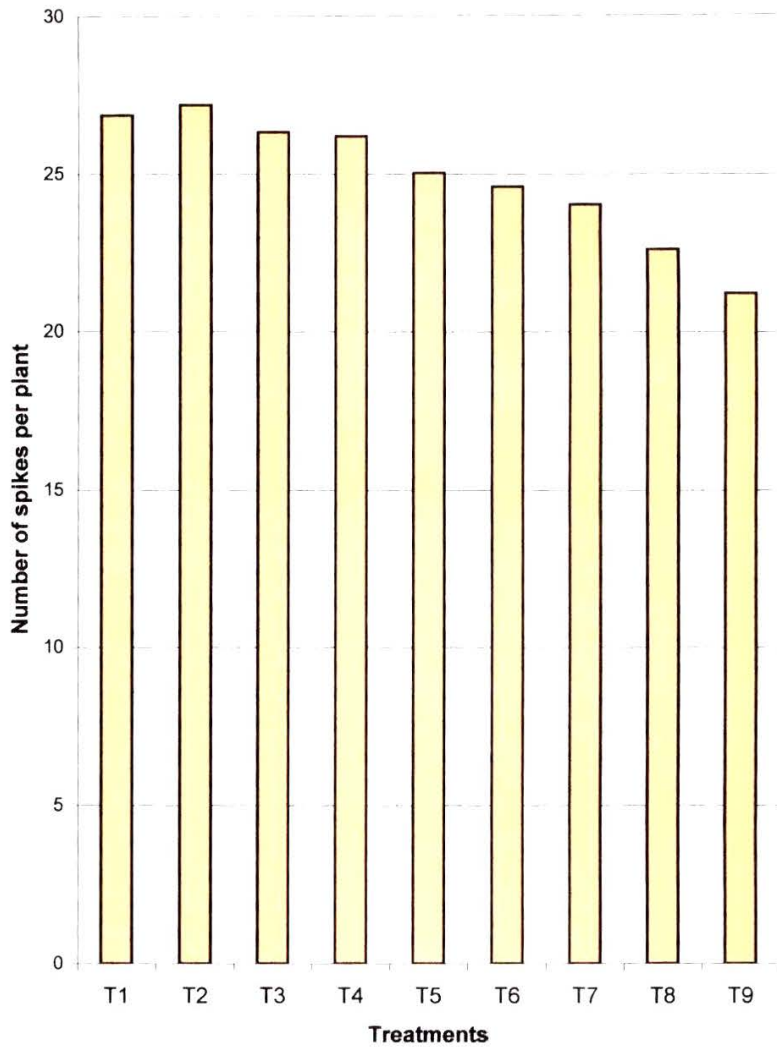


Fig. 4 : Number of spikes per plant as influenced by integrated nutrient management.

The data from Table 4 revealed that number of spikes at 90 DAS was significantly influenced by the treatments of integrated nutrient management. It is revealed from data that maximum number of spikes per plant (27.20) was recorded in the treatment T₂ which was at par with T₁ (26.88), T₃ (26.34), T₄ (26.20), T₅ (25.04), T₆ (24.60) and T₇ (24.04). The minimum number of spike per plant (21.24) was observed in T₉ and it was also found at par with treatment T₈ (22.63):

4.1.4 Effect of integrated nutrient management on length of spike (cm) :

The data in respect of length of spike per plant was recorded once at 90 days after sowing and presented in Table 5 and illustrated in Fig.5.

Table 5 : Length of spikes (cm) as influenced by integrated nutrient management in isabgol.

Abbrevia- tion.	Treatment	Length of spike (cm)
		90 DAS
T ₁	RDF (50 : 25 N P kg ha ⁻¹)	3.25
T ₂	75% N + FYM (2.5 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	3.57
T ₃	75% N + Vermicompost (1.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	3.11
T ₄	50% N + FYM (5.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	3.08
T ₅	50% N + Vermicompost (2.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	3.06
T ₆	25% N + FYM (7.5 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	2.96
T ₇	25% N + Vermicompost (3.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	2.81
T ₈	FYM (5 t ha ⁻¹)	2.70
T ₉	Vermicompost (2 t ha ⁻¹)	2.64
	'F' test	Sig.
	S.E. (m) ±	0.17
	C. D. at 5%	0.53



Fig. 5 : Length of spike (cm) as influenced by integrated nutrient management.

The data obtained from observation showed significant differences among the treatments. Significantly maximum length of spike was recorded in the treatment T₂ (3.57 cm) which was at par with treatment T₁ (3.25 cm), T₃ (3.11 cm), T₄ (3.08 cm) and T₅ (3.06 cm). Remaining treatments T₆ (2.96 cm), T₇ (2.81 cm), T₈ (2.70 cm) and T₉ (2.64 cm) were found at par. The minimum length of spikes (2.64 cm) was found in the treatment T₉.

It is evident from the data in respect of growth i.e. plant height, number of tillers per plant, number of spikes per plant, length of spikes were influenced significantly and recorded higher value under the treatments receiving more FYM, vermicompost boosted with nitrogen and biofertilizers.

In general it can be concluded that 75% N + FYM 2.5 t + Azotobactor 4 kg + PSB 4 kg per hectare was found most effective in accelerating the vegetative growth of isabgol crop.

It is well known that FYM and vermicompost is a good source of balanced nutrients, which also favours the intake of nutrients supplied through chemical fertilizers by improving the physical condition of soil. Nitrogen plays important role in increasing the vegetative growth of crop.

Very few reports are available on the nutrient aspect of isabgol therefore the results on other medicinal and horticulture crops have been mentioned for confirmation of the present results.

These results were proved with the findings of following research workers.

- 1) Tiwari 2007 reported that, maximum plant height, tillers per plant in isabgol by application of 10:20:10 NPK + FYM 10 t/ha.
- 2) Venkatesha 2007 obtained maximum plant growth with 30 t FYM + 1t vermicompost + 50:25:30 kg NPK/ha in isabgol crop.
- 3) Singh 2003 concluded that, nitrogen @ 30 kg ha⁻¹ significantly increased plant height in isabgol.
- 4) Modi 1974 suggested an application of 50 kg N and 25 kg P₂O₅ per ha for maximum vegetative growth in Psyllium.

4.2 Yield :

4.2.1 Effect of integrated nutrient management on number of seeds per spike:

The data in respect of number of seed per spike presented in Table 6 and illustrated in Fig.6, revealed that number of seeds per spike due to the different treatments was statistically significant.

Table 6 : Number of seeds per spike as influenced by integrated nutrient management in isabgol:

Abbrevia- tion.	Treatment	Number of seed per spike
		120 DAS
T ₁	RDF (50 : 25 N P kg ha ⁻¹)	78.63
T ₂	75% N + FYM (2.5 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	84.63
T ₃	75% N + Vermicompost (1.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	76.58
T ₄	50% N + FYM (5.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	72.62
T ₅	50% N + Vermicompost (2.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	70.79
T ₆	25% N + FYM (7.5 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	69.55
T ₇	25% N + Vermicompost (3.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	67.42
T ₈	FYM (5 t ha ⁻¹)	66.76
T ₉	Vermicompost (2 t ha ⁻¹)	65.70
	'F' test	Sig.
	S.E. (m) ±	3.81
	C. D. at 5%	11.32

Significantly maximum number of seeds per spike (84.63) was recorded in the treatment T₂ and it was at par with T₁ (78.63) and T₃ (76.58). The treatments T₄ (72.62), T₅ (70.79), T₆ (69.55), T₇ (67.42), T₈ (66.76) and T₉ (65.70) were

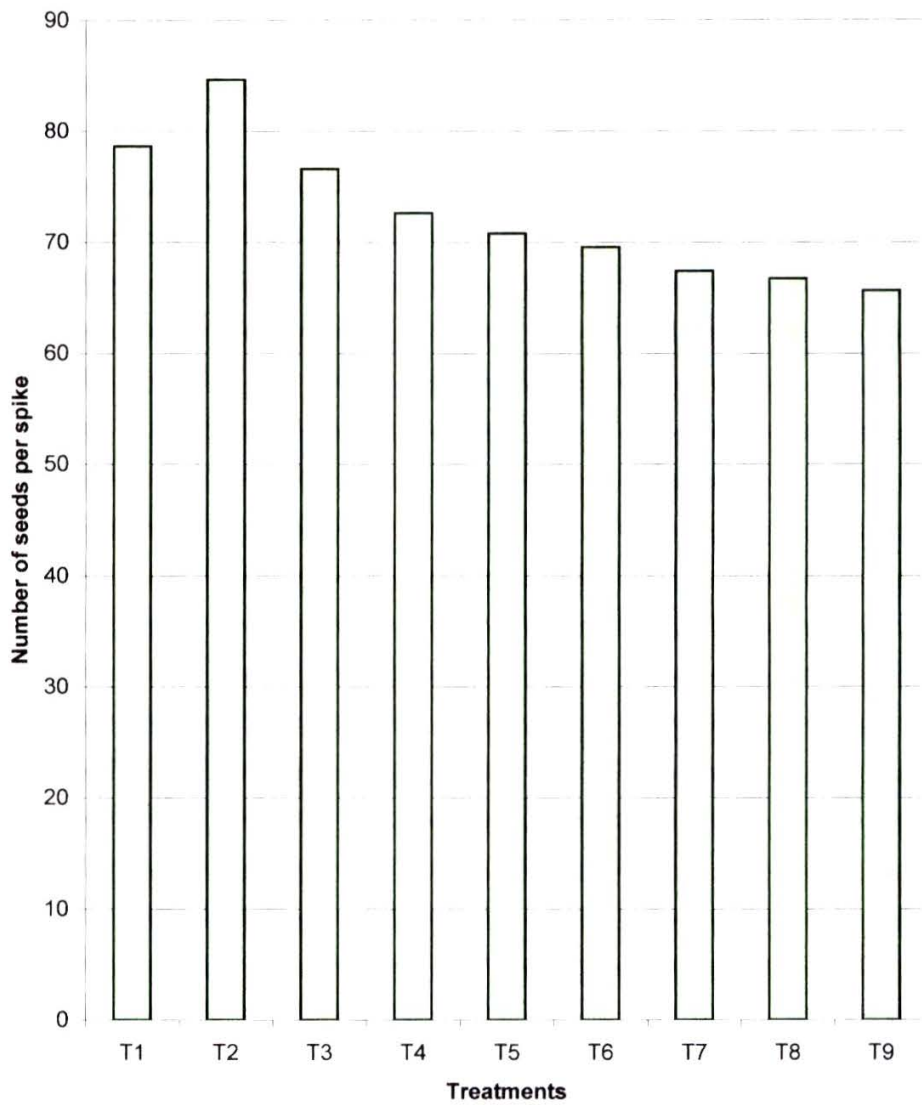


Fig. 6 : Number of seeds per spike as influenced by integrated nutrient management.

found at par with each other. The minimum number of seed per spike (65.70) was found under the treatment T₉.

4.2.2 Effect of integrated nutrient management on number of seeds per gram :

The data presented in Table 7 in respect of number of seeds per gram of isabgol due to effect of different treatments was found non-significant. However it was found that maximum in treatment T₂ (769.68gm). Minimum number of seed per gram was recorded in treatment T₉ (703.55 gm).

Table 7 : Number of seed per gram as influenced by integrated nutrient management in isabgol.

Abbrevia- tion.	Treatment	Number of seed per gram
T ₁	RDF (50 : 25 N P kg ha ⁻¹)	754.97
T ₂	75% N + FYM (2.5 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	769.68
T ₃	75% N + Vermicompost (1.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	742.73
T ₄	50% N + FYM (5.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	729.03
T ₅	50% N + Vermicompost (2.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	724.24
T ₆	25% N + FYM (7.5 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	720.90
T ₇	25% N + Vermicompost (3.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	713.96
T ₈	FYM (5 t ha ⁻¹)	706.10
T ₉	Vermicompost (2 t ha ⁻¹)	703.55
	'F' test	NS
	S.E. (m) ±	39.48
	C. D. at 5%	-

4.2.3 Effect of integrated nutrient management on weight of seeds per spikes (g) :

The data presented in Table 8 and illustrated in Fig.7 in respect of weight of seeds per spikes of isabgol due to effect of different treatments was found significant.

Table 8 : Weight of seed per spike (g) as influenced by integrated nutrient management in isabgol.

Abbrevia- tion	Treatment	Weight of seed per spike (g)
T ₁	RDF (50 : 25 N P kg ha ⁻¹)	0.160
T ₂	75% N + FYM (2.5 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	0.171
T ₃	75% N + Vermicompost (1.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	0.163
T ₄	50% N + FYM (5.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	0.157
T ₅	50% N + Vermicompost (2.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	0.152
T ₆	25% N + FYM (7.5 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	0.152
T ₇	25% N + Vermicompost (3.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	0.151
T ₈	FYM (5 t ha ⁻¹)	0.151
T ₉	Vermicompost (2 t ha ⁻¹)	0.150
	'F' test	Sig.
	S.E. (m) ±	0.004
	C. D. at 5%	0.012

The data from Table revealed that, maximum weight of seed per spike (0.171 g) was recorded under the treatment T₂ which was at par with treatment T₁ (0.160 g), T₃ (0.163 g) and T₄ (0.157 g). Remaining all treatments i.e. T₅ (0.152 g), T₆ (0.152 g), T₇ (0.151 g), T₈ (0.151 g) and T₉ (0.150 g) were found at

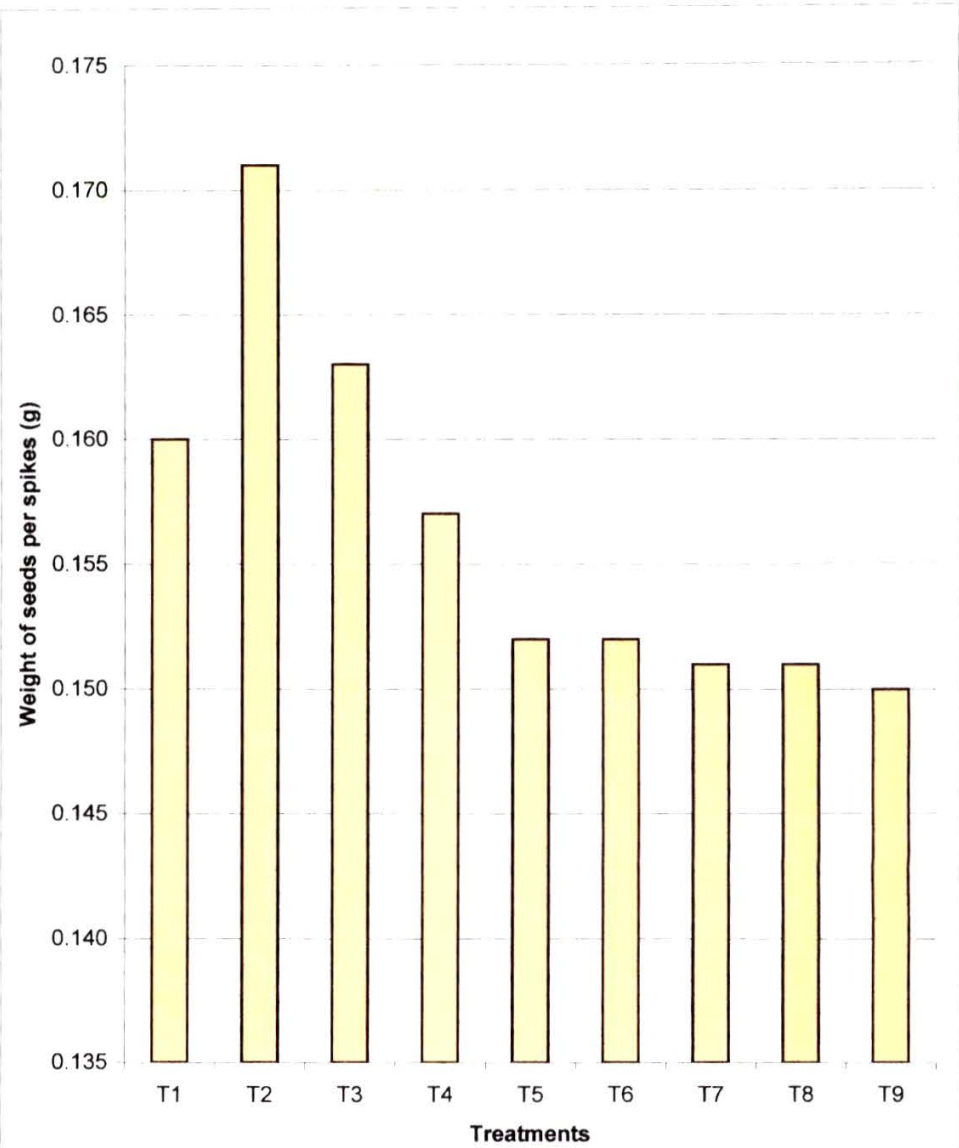


Fig. 7 : Weight of seeds per spikes (g) as influenced by integrated nutrient management.

par. The minimum weight of seed per spike (0.150 g) was noticed under treatment T₉.

4.2.4 Effect of integrated nutrient management on seed yield per plot (kg) and per hectare (q) :

The data regarding seed yield per plot and per hectare as influenced by integrated nutrient management are presented in Table 9 and illustrated in Fig. 8

Data presented in Table 9 revealed that the seed yield was significantly influenced by various treatments. Significantly maximum seed yield per plot (0.664 kg) was recorded in treatment T₂ and it was found at par with treatment T₁ (0.616 kg) and T₃ (0.603 kg). The remaining all treatments i.e. T₄ (0.536 kg), T₅ (0.550 kg), T₆ (0.531 kg), T₇ (0.529 kg), T₈ (0.485 kg) and T₉ (0.479 kg) were found at par. The minimum seed yield per plot (0.479 kg) was noticed under treatment T₉.

Table 9 : Seed yield as influenced by integrated nutrient management in isabgol.

Abbrevia- tion.	Treatments	Seed yield per plot. (kg)	Seed yield per ha. (q)
T ₁	RDF (50 : 25 N P kg ha ⁻¹)	0.616	8.61
T ₂	75% N + FYM (2.5 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	0.664	9.21
T ₃	75% N + Vermicompost (1.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	0.603	8.37
T ₄	50% N + FYM (5.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	0.556	7.70
T ₅	50% N + Vermicompost (2.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	0.550	7.66
T ₆	25% N + FYM (7.5 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	0.531	7.39
T ₇	25% N + Vermicompost (3.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	0.529	7.34
T ₈	FYM (5 t ha ⁻¹)	0.485	6.73
T ₉	Vermicompost (2 t ha ⁻¹)	0.479	6.64
	'F' test	Sig.	Sig.
	S.E. (m) ±	0.03	0.49
	C. D. at 5%	0.09	1.48

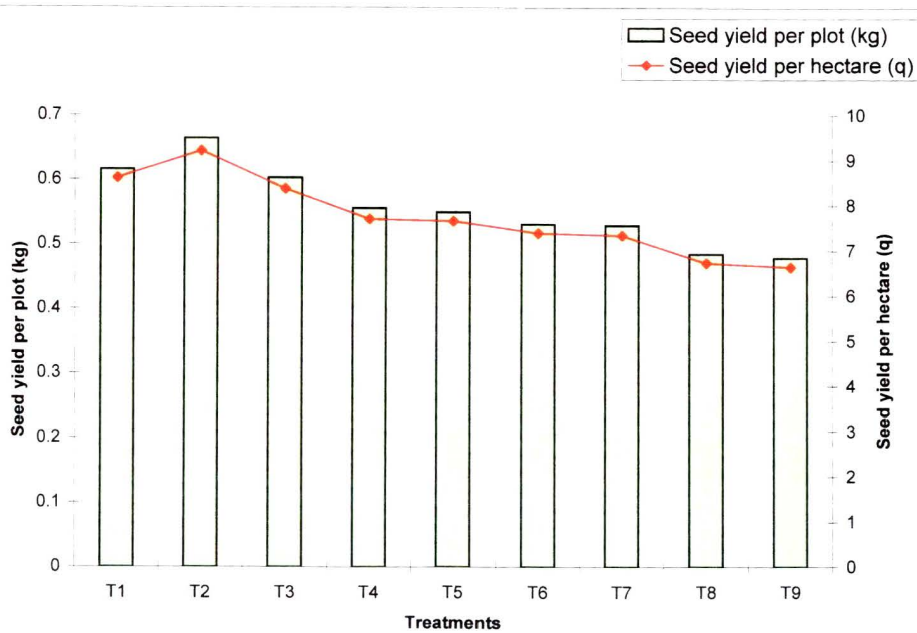


Fig. 8 : Seed yield per plot (kg) and per hectare (q) as influenced by integrated nutrient management.



Plate 4 : Seed of isabol.

Significantly the maximum seed yield (9.21 g) per hectare was obtained in the treatment T₂ and it was found at par with treatment T₁ (8.61 g) and T₃ (8.37 g). The other treatments found at par were T₄ (7.70 g), T₅ (7.66 g), T₆ (7.39 g), T₇ (7.34 g), T₈ (6.73 g) and T₉ (6.64 g). The minimum seed yield (6.64 g) was obtained in the treatment T₉.

The application of inorganic, organic and biofertilizers have significantly influenced the seed yield per plot and per hectare. The maximum seed yield per plot (0.664 kg) and per hectare (9.21 q) was recorded under the treatment T₂. The minimum seed yield plot⁻¹ (0.479 kg) and ha⁻¹. (6.64 q) was found in the treatment T₉.

4.2.5 Effect of integrated nutrient management on seed: stover ratio:

The data regarding seed to stover ratio are presented in Table 10 which is found non-significant.

Table 10 : Seed : Stover ratio as influenced by integrated nutrient management in isabgol.

Abbreviation	Treatment	Seed: Stover ratio
T ₁	RDF (50 : 25 N P kg ha ⁻¹)	7.90
T ₂	75% N + FYM (2.5 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	7.34
T ₃	75% N + Vermicompost (1.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	7.81
T ₄	50% N + FYM (5.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	7.73
T ₅	50% N + Vermicompost (2.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	7.60
T ₆	25% N + FYM (7.5 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	7.48
T ₇	25% N + Vermicompost (3.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	7.40
T ₈	FYM (5 t ha ⁻¹)	7.31
T ₉	Vermicompost (2 t ha ⁻¹)	7.18
	'F' test	NS
	S.E. (m) ±	0.10
	C. D. at 5%	—

The data from Table revealed that, higher seed: stover ratio was recorded under the treatment T₁ (7.9). The minimum seed: stover ratio (7.18) was found in treatment T₉.

An increase in seed yield in the treatments receiving more FYM, optimum nitrogen and biofertilizers might be due to better vegetative growth in term of maximum number of tillers and spikes ultimately the maximum seed yield. The results are closely confirmed with the findings of following research workers.

- 1) Parihar *et al.* 1995 reported an increase in seed yield of psyllium with 20 kg + 20 kg P₂O₅ ha⁻¹.
- 2) Tiwari *et al.* 2007 reported 31.17 % increase in seed yield of isabgol with 10:20:10 kg NPK + 10 t FYM ha⁻¹.
- 3) Vanketsha *et al.* 2007 obtained higher yield of isabgol with 30 t FYM + 1 t vermicompost + 25:25:30 kg NPK ha⁻¹.
- 4) Singh *et al.* 1994, obtained highest seed yield in isabgol with 60 kg N + 30 kg P₂O₅ ha⁻¹.

4.3 Quality :

4.3.1 Effect of integrated nutrient management on swelling capacity of seeds (cc g⁻¹) :

The data presented in Table 11 in respect of swelling capacity of seeds in isabgol due to effect of different treatments was found non-significant.

The data from the Table revealed that, maximum swelling capacity of seeds was recorded under the treatment T₉ (12.53 ccg⁻¹). However minimum swelling capacity of seeds was found in treatment T₃ (10.68 ccg⁻¹).

Table 11 : Swelling capacity of seeds (cc g⁻¹) as influenced by integrated nutrient management in Isabgol.

Abbreviation	Treatment	Swelling capacity of seed
T ₁	RDF (50 : 25 N P kg ha ⁻¹)	10.58
T ₂	75% N + FYM (2.5 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	10.50
T ₃	75% N + Vermicompost (1.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	10.68
T ₄	50% N + FYM (5.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	11.35
T ₅	50% N + Vermicompost (2.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	11.45
T ₆	25% N + FYM (7.5 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	11.67
T ₇	25% N + Vermicompost (3.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	11.77
T ₈	FYM (5 t ha ⁻¹)	12.49
T ₉	Vermicompost (2 t ha ⁻¹)	12.53
	'F' test	NS
	S.E. (m) ±	0.80
	C. D. at 5%	-

4.3.2 Effect of integrated nutrient management on test weight of seeds (g):

The data presented in Table 12 in respect of test weight of seed due to effect of different treatments was found non-significant.

The data from the Table revealed that maximum weight of 1000 seeds was recorded under the treatment T₉ (1.43 g). However minimum swelling capacity of seeds was found in treatment T₂ (1.29 g).

Table 12 : Test weight of seed (g) as influenced by integrated nutrient management in isabgol:

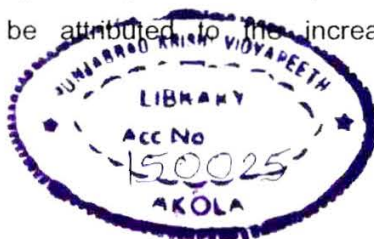
Abbrevia- tion	Treatment	Test weight of seed (g)
T ₁	RDF (50 : 25 N P kg ha ⁻¹)	1.33
T ₂	75% N + FYM (2.5 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	1.29
T ₃	75% N + Vermicompost (1.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	1.34
T ₄	50% N + FYM (5.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	1.37
T ₅	50% N + Vermicompost (2.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	1.38
T ₆	25% N + FYM (7.5 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	1.39
T ₇	25% N + Vermicompost (3.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	1.40
T ₈	FYM (5 t ha ⁻¹)	1.42
T ₉	Vermicompost (2 t ha ⁻¹)	1.43
	'F' test	NS
	S.E. (m) ±	0.04
	C. D. at 5%	--

4.4.3 Effect of integrated nutrient management on husk percentage :

The data presented in Table 13 in respect of husk percentage in isabgol due to different treatments was found non-significant.

The data from the Table revealed that, maximum husk percentage was recorded under the treatment T₁ (30.57). However minimum husk percentage was found in treatment T₉ (27.90).

The different treatment of integrated nutrient management did not influenced the quality of isabgol seeds when judged in terms of swelling factor, test weight and husk percentage. Adequate availability of nitrogen in soil due to nitrogen fertilization could be attributed to the increased vegetative and



reproductive growth of plants. Proper translocation of photosynthates and metabolites from shoot to root might have promoted growth of roots and their functional activity resulting in higher exploration of available nutrients from soil environment and translocation of these to aerial parts. Similar were the findings found by the following research workers.

- 1) Kurnawat 2001 observed that, nitrogen fertilizer increased the yield and net returns of isabgol without influencing its quality.
- 2) Sharma *et al.* 2006 reported that nitrogen fertilizer did not influence quality of isabgol above 40 kg N ha⁻¹.
- 3) Aishwath *et al.* 2005 concluded that, the quality of isabgol was not influenced by increasing levels of nitrogen.

Table 13 : Husk percentage as influenced by integrated nutrient management in isabgol.

Abbreviation	Treatment	Husk percentage
T ₁	RDF (50 : 25 N P kg ha ⁻¹)	30.57
T ₂	75% N + FYM (2.5 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	30.39
T ₃	75% N + Vermicompost (1.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	29.51
T ₄	50% N + FYM (5.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	29.35
T ₅	50% N + Vermicompost (2.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	28.51
T ₆	25% N + FYM (7.5 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	28.44
T ₇	25% N + Vermicompost (3.0 t ha ⁻¹) + Azotobacter 4 kg + PSB 4 kg ha ⁻¹	28.35
T ₈	FYM (5 t ha ⁻¹)	28.30
T ₉	Vermicompost (2 t ha ⁻¹)	27.90
	'F' test	NS
	S.E. (m) ±	1.14
	C. D. at 5%	--

4.4 Economics of isabgol :

The economic i.e. cost of cultivation was calculated by obtaining the current market rates of inputs and selling rates of the produce both seed and husk. Accordingly the benefit cost ratio as influenced by the different treatments are calculated and presented in Table 14 and illustrated in Fig 9. On verification of the benefit: cost ratio presented in Table, higher B:C ratio i.e. (2.34), was recorded in the treatment T_2 - 75%N + 2.5t FYM + 4 kg *Azotobactor* + 4 kg PSB ha^{-1} followed by treatment T_3 - 75%N + 1t vermicompost + 4kg *Azotobactor* + 4 kg PSB ha^{-1} (2.00). Lower B: C ratio (1.41) was recorded in the treatment T_7 - 25%N + 3 t vermicompost + 4 kg *Azotobactor* + 4 kg PSB ha^{-1} .

As organic produce of medicinal plants are generally preferred for the manufacture of Ayurvedic medicines and due to low price of organic inputs, treatment T_2 is found economically beneficial over all other treatments being acquired higher B:C ratio.

Table 14 : B:C Ratio

Abbreviation	Common Cost (Rs.)	Treatment Cost (Rs.)	Total Cost (Rs.)	Husk yield		Seed yield		Total income (Rs.)	Net Profit (Rs.)	B:C Ratio
				Yield (kg)	Income (Rs)	Yield (q)	income (Rs)			
T ₁	26293	8675	34968	262	20968	8.61	43050	64018	29050	1.83
T ₂	26293	2768	29061	275	22000	9.21	46050	68050	38989	2.34
T ₃	26293	4893	31186	258	20640	8.37	41850	62490	31304	2.00
T ₄	26293	4505	30798	247	19760	7.70	38500	58260	27462	1.89
T ₅	26293	8755	35048	242	19360	7.66	38300	57660	22612	1.64
T ₆	26293	6243	32536	235	18800	7.39	36950	55750	23214	1.71
T ₇	26293	12618	38911	228	18240	7.34	36700	54940	16029	1.41
T ₈	26293	3750	30043	215	17200	6.73	33650	50850	20807	1.69
T ₉	26293	8000	34293	212	16960	6.64	33200	50160	15867	1.46

FYM - Rs. 750/t
 Vermicompost - Rs. 4000/t
 Nitrogen - Rs. 10/kg
 Phosphorus - Rs. 25/kg

Azotobacter - Rs. 60/kg
 PSB - Rs. 60/kg

Market price

Seed - Rs. 50/kg
 Husk - Rs. 80/kg

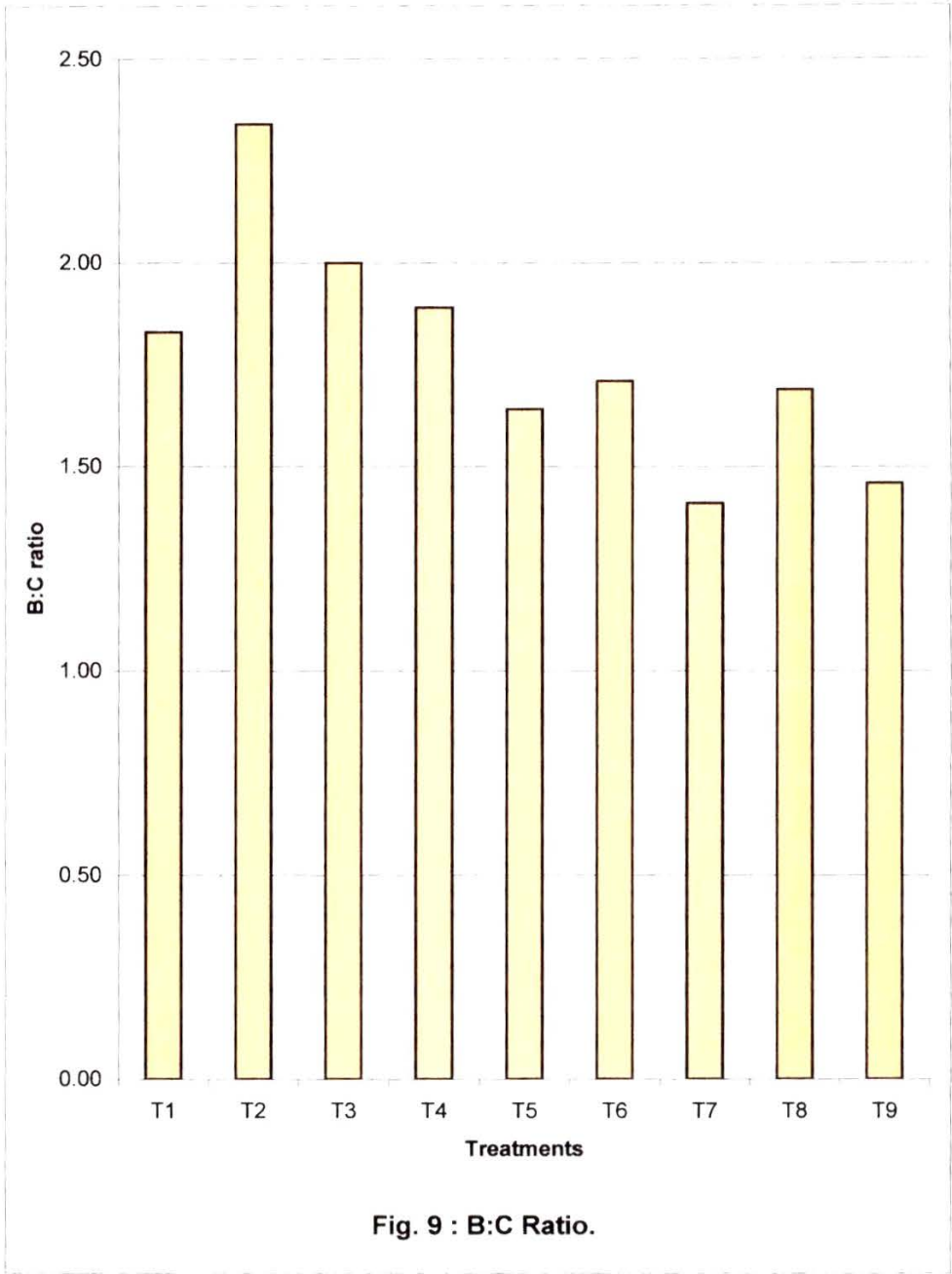


Fig. 9 : B:C Ratio.

Chapter V

SUMMARY AND CONCLUSION

The present investigation entitled, integrated nutrient management studies in isabgol. (*plantago ovata* Forsk) was conducted at the farm of Horticulture Section, College of Agriculture, Nagpur during the rabi season of year 2008 in Randomized Block Design with the following objectives.

- i) To find out the effect of organic, inorganic and biofertilizer on growth of isabgol.
- ii) To find out the effect of different combinations of organic, inorganic and biofertilizer on growth, seed yield and quality of isabgol.
- iii) To find out suitable combination of integrated nutrient management of isabgol.

In present investigation nine different combinations of organic, inorganic and biofertilizers were tried to study the effect on growth, seed yield and quality of isabgol.

The treatment combinations were.

T₁ - RDF (50:25 NP kg ha⁻¹)

T₂ - 75% N + FYM (2.5 t ha⁻¹) + *Azotobacter* 4 kg + PSB 4 kg ha⁻¹

T₃ - 75% N + Vermicompost (1 t ha⁻¹) + *Azotobacter* 4 kg + PSB 4 kg ha⁻¹

T₄ - 50% N + FYM (5 t ha⁻¹) + *Azotobacter* 4 kg + PSB 4 kg ha⁻¹

T₅ - 50% N + Vermicompost (2 t ha⁻¹) + *Azotobacter* 4 kg + PSB 4 kg ha⁻¹

T₆ - 25% N + FYM (7.5 t ha⁻¹) + *Azotobacter* 4 kg + PSB 4 kg ha⁻¹

T₇ - 25% N + Vermicompost (3 t ha⁻¹) + *Azotobacter* 4 kg + PSB 4 kg ha⁻¹

T₈ - FYM (5 t ha⁻¹)

T₉ - Vermicompost (3 t ha⁻¹)

The observations were recorded in respect of growth parameters viz. plant height, number of tillers, length of spikes, number of seeds per spikes, number of seeds per gram, weight of seeds per spikes, seed yield per plot, per hectare, seed: stover ratio. Quality parameter viz. swelling capacity of seed, test weight of seeds and husk percentage.

Growth parameter:

In respect of growth parameter, it was inferred that effect of various treatments on height of plant, tillers per plant, and numbers of spikes and length of spikes was found significant.

The maximum plant height (43.39 cm), number of tillers per plant (8.95), number of spikes per plant (27.2) and length of spikes (3.57 cm) were recorded in the treatment T₂ receiving 75% N + FYM 2.5 t + *Azotobacter* 4 kg + PSB kg ha⁻¹.

Minimum plant growth viz. height of plant (33.89 cm), number of tillers per plant (6.13), number of spikes per plant (21.24), length of spikes (2.64 cm) were noticed in the treatment T₉.

Yield parameter :

Regarding the seed yield parameter significantly more seed yield per plot (0.664 kg) and seed yield per hectare (9.21 q) were recorded in treatment (T₂) receiving 75% N + FYM 2.5 t ha⁻¹ + *Azotobacter* 4 kg + PSB kg ha⁻¹. However, significantly minimum seed yield per plot (0.479 kg) and per hectare (6.64 q) were noticed in the treatment T₉.

Quality parameter :

Regarding the quality parameter the swelling capacity of seed, test weight of seed and husk percentage exhibited non-significant results. The maximum swelling capacity of seed (12.53 cc g⁻¹) was observed in treatment T₉. Minimum swelling capacity of seed (10.50 cc g⁻¹) was recorded in treatment T₂.

Regarding test weight, the maximum test weight of seed (1.43 g) was recorded in treatment T₉. Minimum test weight of seed (1.29 g) was recorded in treatment T₂. Regarding the husk percentage, maximum husk percentage (30.57) was recorded in treatment T₁. And minimum husk percentage (27.90) was recorded in treatment T₉.

Benefit cost ratio :

In respect of benefit cost ratio the treatment T₂ -75% N + FYM 2.5 t + *Azotobactor* 4 kg + PSB 4 kg ha⁻¹ was found economically beneficial over all the other treatments.

Conclusion :

From the present investigation on nutritional aspect in isabgol it can be concluded that the application of 75% N + 2.5 t FYM + 4 kg *Azotobactor* + 4 kg PSB ha⁻¹ was found effective for better vegetative growth, seed yield and quality in isabgol. In regards to benefit cost ratio the treatment 75% N + 2 t FYM + 4 kg *Azotobactor* + 4 kg PSB ha⁻¹ acquired higher B: C ratio (2.34).

The observations are based on the result of experiment conducted for only one season and therefore these results are suggestive and not conclusive, hence the findings obtained in present investigation need further confirmation.

Chapter VI

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* Original not seen.

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APPENDIX

Weekly meteorological data for the year 2008-2009 (1st August 2008 to 28th February 2009)
recorded at Agriculture College Farm, Nagpur.

Date	Met. Week	Temperature °C		Humidity		Total rainfall (mm)	No. of rainy days	Bright sunshine hrs.	Evapo-ration (mm)
		Max.	Min.	Morn.	Even.				
30 to 5 Aug	31	29.3	24.3	89	82	61.4	4	0.4	1.9
6 to 12	32	28.8	23.9	90	83	114.7	4	0.0	2.0
13 to 19	33	31.5	24.5	80	63	39.7	3	3.5	3.1
20 to 26	34	31.9	24.2	77	61	1.9	-	4.9	3.5
27 to 2 Sep	35	32.9	24.1	82	65	13.6	2	3.3	1.9
3 to 9	36	32.5	23.7	85	73	33.8	2	4.7	2.9
10 to 16	37	31.7	23.8	82	68	56.2	3	4.8	2.6
17 to 23	38	31.6	24.0	78	62	3.1	1	3.4	2.6
24 to 30	39	34.2	22.7	67	42	-	-	8.6	3.8
1 to 7 Oct	40	34.2	22.6	72	64	48.5	4	5.7	2.6
8 to 14	41	34.3	21.5	68	38	-	-	7.0	2.5
15 to 21	42	33.7	19.4	59	33	-	-	9.2	3.2
22 to 28	43	32.8	15.7	49	24	-	-	9.6	4.0
29 to 4 Nov	44	34.1	15.4	47	23	-	-	9.6	3.4
5 to 11	45	32.8	15.3	59	31	-	-	8.6	2.7
12 to 18	46	30.8	18.5	65	39	-	-	5.8	3.0
19 to 25	47	31.7	17.3	61	40	13.4	1	8.9	3.0
26 to 2 Dec	48	30.3	14.1	52	29	-	-	7.0	2.8
3 to 9	49	30.9	12.1	50	21	-	-	9.0	3.0
10 to 16	50	31.4	14.8	70	34	-	-	6.1	2.0
17 to 23	51	30.7	12.7	51	27	-	-	7.7	2.8
24 to 31	52	29.8	9.9	56	21	-	-	8.0	2.4
1 to 7 Jan. 2009	1	29.8	13.4	66	35	-	-	7.2	2.4
8 to 14	2	29.6	15.6	72	39	-	-	5.1	2.5
15 to 21	3	30.4	13.5	57	29	-	-	8.2	2.5
22 to 28	4	33.1	13.0	49	20	-	-	9.3	3.3
29 to 4 Feb.	5	33.6	15.1	19	23	-	-	9.0	4.6
5 to 11	6	33.7	16.0	45	23	-	-	9.1	4.8
12 to 18	7	33.0	15.1	45	18	-	-	9.4	4.9
19 to 25	8	35.4	18.4	36	19	-	-	-	5.4
26 to 4 Mar.	9	37.8	17.4	32	11	-	-	10	7.4
5 to 11	10	38.5	20.3	29	13	-	-	9.3	6.5
12 to 18	11	36.00	19.8	33	16	5.0	1	7.7	6.5
19 to 25	12	37.3	19.9	38	18	1.2	-	8.7	6.8

1) June 2008 to December Rainfall 928.8 mm, Rainy days 46 days

