EFFECT OF ORGANIC MANURES AND INORGANIC FERTILIZERS ON GROWTH AND YIELD OF GREEN PEA AND ITS RESIDUAL EFFECT ON SUCCEEDING SUMMER FORAGE MAIZE

By

Ilhe Rakesh Sopan

(Reg. No. 03/001)

A Thesis submitted to the
MAHATMA PHULE KRISHI VIDYAPEETH,
RAHURI - 413 722, DIST.AHMEDNAGAR,
MAHARASHTRA, INDIA

in partial fulfilment of the requirements for the degree

of

MASTER OF SCIENCE (AGRICULTURE)

in

AGRONOMY

DEPARTMENT OF AGRONOMY

POST GRADUATE INSTITUTE
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CERTIFICATE

This is to certify that the thesis entitled, "EFFECT OF ORGANIC MANURES AND INORGANIC FERTILIZERS ON GROWTH AND YIELD OF GREEN PEA AND ITS RESIDUAL EFFECT ON SUCCEEDING SUMMER FORAGE MAIZE", submitted to the Mahatma Phule Krishi Vidyapeeth, Rahuri for the award of the degree of MASTER OF SCIENCE (AGRICULTURE) in AGRONOMY, embodies the results of a *bona fide* research carried out by Mr. RAKESH SOPAN ILHE, under my guidance and supervision and that no part of the thesis has been submitted for any other Degree or Diploma.

The assistance and help received during the course of this investigation have been acknowledged.

Place : MPKV, Rahuri (A.V. Solanke)
Dated : / /2007. Research Guide

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Associate Dean,
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Maharashtra State (INDIA)

CERTIFICATE

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Place : MPKV, Rahuri (A.S. Jadhav)

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Place : (R.S. Ilhe)

Date :

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LIST OF ABBREVIATIONS

@	:	At the rate of
CD	:	Critical difference
cm	:	Centimetre
^{0}C	:	Degree Celsius
DAP	:	Days after planting
Ec	:	Electrical conductivity
et al.	:	et alli (and others)
etc.	:	Etcetra
Fig.	:	Figure
FYM	:	Farm yard manure
g	:	Gram (s)
ha	:	Hectare
HPS	:	Hybrid Potato Seed
i.e.	:	id est (That is)
INM	:	Integrated Nutrient Management
K	:	Potassium
kg	:	Kilogram (s)
m	:	Meter
N	:	Nitrogen
No.	:	Number (s)
NS	:	Non-significant
ppm	:	Parts per million
P	:	Phosphorus
P_2O_5	:	Phosphorus pentoxide
q	:	Quintal (s)
RH	:	Relative humidity
S.Em.	:	Standard error of means
Sig.	:	Significant
t	:	Tonne(s)
TPS	:	True potato seed
viz.,	:	Videlicet (Namely)
%	:	Per cent
/	:	Per

ABSTRACT

EFFECT OF ORGANIC MANURES AND INORGANIC FERTILIZERS ON GROWTH AND YIELD OF GREEN PEA AND ITS RESIDUAL EFFECT ON SUCCEEDING SUMMER FORAGE MAIZE

By

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A candidate for the degree

of

MASTER OF SCIENCE (AGRICULTURE)

in

AGRONOMY

2007

Research Guide	:	Dr. A.V. Solanke
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The present agronomic investigation entitled “Effect of organic manures and inorganic fertilizers on growth and yield of green pea and its residual effect on succeeding summer forage maize” was conducted during *rabi* - summer season 2004-05 on sandy clay loam texture soil, alkaline in reaction, at Post Graduate Institute Research Farm of Mahatma Phule Krishi Vidyapeeth, Rahuri. The experiment was laid out in Factorial Randomised Block Design with twelve treatment combinations replicated three times with three treatments of organic manures viz., FYM @ 5 t/ha and vermicompost 2.5 t/ha and one control

treatment and four levels of fertilizers viz., control, 50 per cent RDF, 75 per cent RDF and 100 per cent RDF for pea.

At harvest FYM @ 5 t/ha was recorded maximum mean plant height (43.10 cm), number of functional leaves (65.59), plant spread (26.88 cm), leaf area (4.52 dm^2) and total dry matter per plant (26.20 g). Treatment FYM @ 5 t/ha recorded the highest number of pods (28.87), length of pods (6.32 cm), weight of green pods (26.23) and total pod yield (43.92 q/ha). Maximum gross monetary returns (Rs. 52704/ha), net monetary returns (Rs. 23792/ha) and benefit : cost ratio (1.82) was recorded in treatment FYM @ 5 t/ha.

Maximum mean plant height (48.01 cm), plant spread (28.96 cm), leaf area (4.45 dm^2), number of functional leaves (71.98) were recorded by fertilizer level 100 per cent RDF. Fertilizer level 100 per cent RDF recorded the highest mean number of green pods (31.84), weight of green pods (28.71 g), length of green pods (6.56 cm) and total green pod yield (51.43 q/ha). The highest gross monetary returns (Rs. 61716/ha), net monetary returns (Rs. 31900/ha) and benefit : cost ratio (2.07).

In case of summer forage maize crop, the maximum mean plant height (108.23 cm), stem girth (6.98 cm), number of functional leaves (7.92), leaf area (27.35 dm^2), dry matter (43.39 g) and green forage yield (189.97 q/ha) was recorded in FYM @ 5

t/ha applied to preceding crop pea. The treatment vermicompost applied @ 2.5 t/ha recorded highest gross monetary returns (Rs. 14085/ha), net monetary returns (Rs. 3633/ha) and benefit : cost ratio (1.34)

The higher plant height (102.54 cm), stem girth (6.91 cm), number of functional leaves (7.89), leaf area (26.20 dm^2), dry matter (42.65 g) and green forage yield (182.64 q/ha) was recorded in 100 per cent RDF applied to preceding crop. The fertilizer level 100 per cent RDF recorded highest gross monetary returns (Rs. 15918/ha), net monetary returns (Rs. 5446/ha) and benefit : cost ratio (1.52).

Based on one year experimental data, it could be inferred that the application of FYM @ 5 t/ha in combination with fertilizer level 100 per cent RDF (15:60:60 N, P_2O_5, K_2O kg/ha) to preceding crop pea enhanced the yield of pea (43.92 q/ha) as well as residual effect of succeeding summer forage maize yield (189.97 q/ha).

1. INTRODUCTION

Pea (*Pisum sativum* L.) is one of the most important vegetable crop grown throughout the world particularly in Asia, USA and Europe. Pea is an irrigated cold weather crop sown during October to December. The peak marketing period for green pea is during February – March and lean period during December – January.

In Maharashtra it is grown in few districts like Pune Poona, Ahmednagar, Satara and Nashik. Area under this crop in Maharashtra is 3,547 thousand ha with production of 2,047 thousand tonnes (Anonymous, 2003).

Pea is highly nutritive vegetable containing high percentage of digestible proteins (22.5 g) alongwith carbohydrates (62.1 g), Calcium (64 mg), Iron (48 mg) and vitamins. Pea has high level of amino acid and lysine which is relatively low in cereal grains. It is primarily used for human consumption or an a livestock feed. Pea contain high level of carbohydrates, low in fibre content and 86.87 per cent total digestible nutrients which makes them an excellent livestock feed. Fresh peas are consumed as such or canned, curried and dehydrated. Dried and shelled peas are mostly reconstituted by keeping them in water for overnight and substituted for fresh grade pea for use as green vegetable by road side restaurants and hotels in making curried ‘aloo matar’, ‘matar paneer’ etc.

Indian scientists however, have developed different varieties of peas which can be cultivated in different period of

year. Thus, now a days, green peas are available in India throughout the year. The use of greenhouse technology allows their cultivation in off season even in nontraditional areas also.

Fertilizer plays an important role in crop production. A sustainable increase in production can be obtained by use of fertilizer. Only a few farmers can afford to apply chemical fertilizers as per recommended dose.

The present level of fertilizer production in India is not enough to meet the total plant nutrient requirement. The continuous use of high level of chemical fertilizer is adversely affecting the sustainability of agriculture production. In coming decades, a major issue to design sustainable agriculture system will be the management of soil organic matter and the rational use of organic inputs such as animal manures, crop residues, green manures, sewage, sludges and food industry waste. However, since organic manures can't meet the total nutrient need of modern agriculture, integrated use of nutrients from fertilizer, organic manures seems to be need of the time.

Integrated use of organic manures and inorganic fertilizers in sustainable combination plays a crucial role in boosting up the agricultural production and productivity so as to feed the increasing population of the country. The basic concept behind this is to maintain soil fertility for sustaining crop production on long term basis. In other words, this concept refers to the maintenance of soil fertility and supply of the plant nutrients, on desired level for obtaining optimum or higher yield

of pea through all possible sources as inorganic, organic etc., in an integrated manner.

Use of organic manures with inorganic fertilizers check the emerging deficiency of nutrients other than NPK. It brings economy and most efficiency in fertilizer use. The incorporation of bulky organic manures such as vermicompost, FYM play important role in plant nutrition, especially nitrogen. The decomposition of organic matter results into formation of humus which not only bring out physical and chemical changes in soil but also plays important role in maintaining soil fertility in both light and heavy textured soil.

Pea is short duration crop and highly responsive to irrigation and fertilizers. It is leguminous crop which fixes the nitrogen into the soil, considered as a suitable crop for inclusion in multiple cropping system. Fertilizer applied to pea leaves some residual effect on succeeding crop. The residual nitrogen and potash are generally adequate. Therefore, growing of exhaustive crop after pea may be helpful in utilizing the left over fertilizers from the pea. The maize crop can be grown with one or two tillage operations after harvest of pea leading to reduction in mechanical energy inputs.

Therefore, the present investigation with various doses of nutrients applied through organic manure, fertilizer or combination of these to pea crop during *rabi* season of 2004 on cv. Arkel was undertaken at Post Graduate Institute Farm, Mahatma Phule Krishi Vidyapeeth, Rahuri with following objectives.

1. To study the effect of organic manure and inorganic fertilizer on growth and yield of green pea.
2. To study the residual effect of preceding pea on succeeding summer forage maize.
3. To study the nutrient uptake.
4. To study the economics.

2. REVIEW OF LITERATURE

Application of organic manures with inorganic fertilizers is becoming very popular among the farmers. Very less research work is done on this topic which is reviewed below.

2.1 Inorganic fertilizer management

2.1.1 Growth attributing characters

Mactaggart (1921) reported that vegetative growth in different legumes due to phosphatic fertilizers was higher.

Dhimale (1957) observed in his experiment that maximum plant height with application of phosphorus to pea at the rate of 60 kg P_2O_5 per acre.

Scheffer and Offermann (1961) reported the marked effect of phosphorus than potash in vegetative phase.

Ahmed and Shafi (1975) conducted an experiment in Pakistan on 0, 60 or 90 lb N and P and 0 or 60 lb K_2O/acre application, number of pods per plant, pod weight, plant dry matter increased with increasing application of N or P but K application had no effect to pea crop.

Fageria (1977) reported that plant growth was maximum with application of 100 or 125 kg nitrogen and 25 kg P_2O_5 ha^{-1} to pea crop.

Saimbhi and Grewal (1986) conducted an experiment in Punjab and reported that the maximum growth and dry matter accumulation of pea was obtained with application of 50 kg N and 60 kg P_2O_5/ha.

Sabesan and Sathananda (1986) observed that application of 30 kg N + 40, 70 and 100 kg P_2O_5/ha to soybean increased in leaf area index and dry matter accumulation per plant with increased level of phosphorus.

Prasad *et al.* (1987) reported that N application to pea as basal dose at 20 kg/ha and K_2O at 25 kg/ha + P_2O_5 at 0-120 kg/ha, plant growth and dry matter accumulation increased.

Jayapaul and Ganeshraja (1990) from Tamil Nadu reported that plant height was significantly higher at 40 kg N/ha and 120 kg P_2O_5/ha in soybean.

Singh and Gopalswami (1991) observed from their experiment conducted at Coimbatore (T.N.) that leaf area index and dry matter accumulation increased with the application of 40 kg N/ha to soybean crop.

Kanaujia *et al.* (2000) conducted experiment in *rabi* season in Himachal Pradesh and reported that the growth characters such as pod length, pod weight and dry matter increased significantly upto 60 kg each of phosphorus and potassium to pea crop.

Kasturikrishna and Ahlawat (2000) observed that the application of 26.2 kg P/ha recorded higher value of root and growth parameter when compared to 13.1 kg P/ha and no P for pea crop.

Gupta *et al.* (2000) conducted experiment in Madhya Pradesh on effect of P at 0, 25, 50 and 100 kg ha^{-1} on pea crop and observed that increasing P level resulted in corresponding

increase in pod length, number of grains per pod and pod weight.

Deibert and Utter (2004) conducted experiment on clay soil and reported that application of nitrogen fertilizer to pea at the high rate increased the plant height, number of leaves and dry matter.

2.1.2 Yield contributing characters

Scheffer and Offermann (1961) reported that good yield of green pea obtained with moderate phosphorus and potash levels.

Sharma and Mishra (1961) studied the response of fertilizers on pea yield and observed linear response to phosphorus application upto 67.12 kg per hectare over control but there was no response to nitrogen.

Shekhawat *et al.* (1967) revealed that pea crop with application of 38 : 67.12 : 67.12 kg NPK/ha yielded more. Two levels of P_2O_5 i.e. 33.56 and 67.12 kg/ha significant variation in yield of pea but not observed in nitrogen and potash.

Gautam and Lenka (1968) reported that application of nitrogen increased pea yield where initial soil nitrogen content was low but application of phosphorus increased yield at both high and low level of soil nitrogen.

Berry (1973) reported that increased yield of field pea with application of 160 lb nitrogen per acre only when soil nitrogen residue was below 3.5 lb/acre.

Lazic *et al.* (1980) revealed that the highest yield was obtained with low levels of nitrogen and high level of P and K i.e. 60 or 106 kg N : 92 kg P_2O_5 : 124 kg K_2O/ha to pea.

Cutcliffe and Munro (1980) reported that haulm length tended to increase as the rate of NPK increased but the seed/haulm ratio was not affected with application of 30:60:90 kg NPK ha^{-1} to pea.

Lovato and Montanari (1980) reported that the pea grown on fertile loamy clay soil with 100-120 kg P_2O_5 ha^{-1} or 100-200 kg K_2O did not respond markedly but seed yield was reduced when 50-100 kg N ha^{-1} was applied, particularly with 200 kg K_2O/ha.

Shrivastava and Verma (1984) revealed that application of 20 kg N per ha and 60 kg P_2O_5 per ha increased the number of pods/plant and seed yield of pea.

Naik (1989) reported in his experiment on pea with 25 kg and 75 kg N ha^{-1}, 25 and 100 kg P_2O_5 ha^{-1}, that highest dose of nitrogen and phosphorus had given highest yield of pea.

Tripathi *et al.* (1999) revealed that application of 60 kg P_2O_5 and K_2O ha^{-1} with rhizobium produced maximum green pod yield. Further observation revealed that application of P and K upto 73.73 and 56.59 kg ha^{-1}, respectively was optimum in pea crop.

Vimala and Natrajan (2000) conducted field experiment in Tamil Nadu and reported that the application of 120 kg N, 80 kg P ha^{-1} with biofertilizer registered the highest yield

of 3.98 kg plot^{-1}, which also showed highest value of pea pod length and pod weight.

Kushwaha (2000) conducted experiment in Uttar Pradesh during winter season and reported that the application of 90 kg N ha^{-1} and 60 kg K_2O ha^{-1} produced higher seed yield compared to 0 kg N and K_2O ha^{-1} from pea crop.

Kocon (2002) revealed in his experiment that K deficiency in the soil, recorded limited number of flowers and pods on the plant, the number of seeds in a pod and seed yield.

Uddin *et al.* (2001) conducted experiment in Bangladesh in *rabi* season and observed that the application of 80 kg P_2O_5 ha^{-1} had significant impact on number of pods per plant, pod yield and seed yield of garden pea.

Sharma *et al.* (2002) in Rajasthan reported that the highest green pod yield of pea was observed with 40:90:60 kg NPK ha^{-1} fertilizer.

2.1.3 Uptake of nutrients

Tiwari and Nigam (1985) conducted a experiment on sandy loam soil in Uttar Pradesh and reported that K application on sandy loam soil markedly increased the biomass and K uptake of pea crop.

El-Behidi *et al.* (1985) reported that uptake of N, P and K was maximum at flowering in all plants parts of pea crop excepts the pods where it was maximum at harvest.

Ageev and Demkin (1987) concluded that application of 40 kg N, 80 kg P_2O_5 and 30 kg K_2O ha^{-1} resulted 67-68 kg N, 16-17 kg P_2O_5 and 19 kg K_2O nutrient uptake in seed +

associated straw also pea accumulated 35-40 kg N, 7-10 kg P_2O_5 and 27-33 kg K_2O ha^{-1} in roots + stabble.

Kanaujia *et al.* (2000) conducted an experiment in Himachal Pradesh during *rabi* season and reported that NPK content in plant and seed significantly increased with the increase in level of P. These parameters were higher at 90 kg ha^{-1} of P and K.

Bhat *et al.* (2002) in Jammu Kashmir reported that increased level of phosphorus application upto 60 kg P_2O_5 ha^{-1} enhanced nutrient uptake significantly.

Deibert and Ulter (2004) conducted experiment on clay soil and revealed that application of nitrogen fertilizer at the high rate increased pea dry matter from 500 to 700 kg ha^{-1}.

2.2 Organic manures and inorganic fertilizer management

2.2.1 Growth attributing characters

Singh *et al.* (1979) studied comparative efficiency of FYM on soybean and reported that the dry matter yield was increased with an application of FYM.

Nimje and Seth (1987) reported that an application of FYM @ 15 t ha^{-1} to soybean increased branches and dry matter accumulation per plant over unmanured crop.

Deshmukh *et al.* (1995) reported that application of FYM 10 t ha^{-1} + 25 kg N + 50 kg P_2O_5 ha^{-1} significantly influenced plant height at 45 and 75 days of plant growth stage over N_2P_2 alone in pea.

Sankar *et al.* (1999) reported that the application of FYM at 12.5 t ha^{-1} + P at 30 kg ha^{-1} resulted in the greatest plant height and number of roots per plant in cowpea in sequential croppings.

Rao and Shaktawat (2001) concluded experiment in Rajasthan and reported that application of organic manures to pea significantly increased the number of branches, leaf area index and dry matter accumulation.

Sharma *et al.* (2002) in Rajasthan conducted a experiment and revealed that P at 60 kg ha^{-1} with FYM to soybean improves plant growth parameters except branches/ plant and increases dry matter accumulation in plant.

2.2.2 Yield contributing characters

Fedorov and Makarov (1981) concluded that the application of 7.5 t FYM + 83.3 kg NPK ha^{-1} increased the yield of pea crop in rotation.

Sharma and Dixit (1987) observed that the grain and straw yield of soybean were significantly increased by the combined use of fertilizer and FYM over chemical fertilizer alone or control.

Nimje and Seth (1987) reported that an application of FYM @ 15 t ha^{-1} to soybean significantly increased the yield by combined use of fertilizer and FYM over chemical fertilizer and FYM alone and control.

Acharya *et al.* (1988) revealed that the treatment receiving FYM + 100 per cent of the recommended N, P and K

improved the organic carbon and gave significantly higher crop yield than other treatments.

Sagar *et al.* (1992) reported that fertilizers applied 25 kg N + 50 kg P_2O_5 ha^{-1}, half through chemical fertilizer and half through enriched FYM to pea significantly increased pod and straw yield over same dose of NP but applied fully through chemical fertilizers.

Sharma *et al.* (1990) conducted a experiment in Rajasthan and revealed that the applications of half recommended dose of nutrient through chemical fertilizers and 8 t ha^{-1} FYM to soybean crop gave significant higher yield of soybean.

Deshmukh *et al.* (1995) reported that application of 37.5 kg N ha^{-1} (urea) + 75 kg P_2O_5 ha^{-1} (SSP) to pea gave highest pod yield which was not significantly different from 25 kg N + 50 kg P_2O_5 + 10 t FYM ha^{-1}.

Ramaswamy *et al.* (2000) concluded a experiment in Tamil Nadu and reported that the enriched FYM application to soybean crop recorded the highest grain yield of 1259 kg ha^{-1} in summer and 1499 kg ha^{-1} in kharif.

Shelge *et al.* (2000) conducted a experiment on clay loam black soil deficient in zinc and boron and revealed that the application of macronutrients with different levels with FYM significantly increased the yield of soybean.

Malligawad *et al.* (2000) conducted a experiment on medium black clay soil and reported that application of FYM at 4 t ha^{-1} with 50 per cent RDF recorded significantly higher dry pod

yield (3232 kg ha^{-1}) compared with other RDF or no application to pea.

Saxena *et al.* (2001) conducted a experiment in Uttaranchal and revealed that the highest seed yield was obtained with 25 kg N + 5 t FYM ha^{-1} application to pea than other treatments.

Bhattaria *et al.* (2003) conducted a experiment during winter season in Manipur and reported that the application of full dose of nutrients along with farm yard manure recorded the highest pods per plant (19.66) and seed yield (2.0 t ha^{-1}) in pea crop.

Rajput and Pandey (2004) revealed that soil application of FYM increased seed yield by 20.5 and 23.5 per cent higher than NPK at 50 per cent while FYM and NPK at 50 per cent of the recommended rate was equivalent in effectiveness compared to NPK at 100 per cent in pea crop.

2.2.3 Uptake of nutrients

Acharya *et al.* (1988) revealed that the treatment receiving FYM + 100 per cent of the recommended N, P and K improves the organic carbon content and available N, P and K status of soil.

Bachhav (1994) conducted experiments on soybean with FYM application 5 t ha^{-1} increases the uptake of nutrients significantly.

Deshmukh *et al.* (1995) from their field experiment on pea reported that maximum uptake of N, P and K in grain was

recorded when 25 kg N ha^{-1} + 50 kg P_2O_5 ha^{-1} applied with FYM at the rate of 5 t ha^{-1}.

Ghosh *et al.* (2000) reported that the total P removal by grain and straw of soybean significantly increased by NPK + 10 t FYM ha^{-1} application.

Kanaujia *et al.* (2000) conducted an experiment in Himachal Pradesh during *rabi* season and reported that NPK content in plant and seed significantly increased with 5 t FYM and 90 kg ha^{-1} of P and K.

Muneshwar *et al.* (2000) reported that the application of fertilizer N and farm yard manure increased the K uptake by the soybean crop.

Bhat *et al*. (2002) in Jammu Kashmir reported that increased level of phosphorus application up to 60 kg P_2O_5 ha^{-1} with 5 t FYM enhance nutrient uptake significantly.

Datt *et al.* (2003) conducted experiment during rabi season on pea crop and revealed that the application of 30:39.3:37.5 kg NPK ha^{-1} and FYM @ 10 t ha^{-1} increased the nutrient uptake than NPK and FYM alone.

2.3 Residual effect of organic manures and inorganic fertilizers

2.3.1 Residual effect on soil fertility

Mandal and Pain (1965) conducted experiment at Central Sericulture Research Station, Barhampur (West Bengal) which showed that the soil fertility was increased with cow dung application.

Dhar (1968) reported that organic matter not only improved physical properties of soil but it plays an important role in nitrogen fixation.

Rai and Sinha (1986) conducted experiment in New Delhi on pea – maize sequence and concluded that the positive balance of N and available P in soil after peas becoming negative after maize and P fertilization increased N fixation in soil.

Sagar and Ray (1987) reported in his experiment that the organic manures improved the soil fertility.

Acharya *et al.* (1988) reported that improved availability of NPK in soils due to application of FYM and chemical fertilizers than NPK alone.

Sharma *et al.* (1989) reported that the residual fertility of soil was improved significantly due to an addition of organic waste in combination with earthworms.

Ritamoni *et al.* (1999) reported that the organic matter treated soil showed a better residual effect as compared to the chemical fertilizer applied soil and significant increase in the available NPK.

Kuldip *et al.* (2000) revealed that not N gain due to nitrogen fixation plays important role in the N benefits to subsequent crop and contributed to increase soil N fertility.

Navale *et al.* (2000) conducted experiment in Maharashtra during kharif season and revealed that the FYM treatment to soybean crop resulted in higher soil nutrient content.

Ranjan *et al.* (2004) conducted a experiment in Uttaranchal and reported that organic carbon content in soil in significantly higher in FYM treated plot in soybean.

2.3.2 Residual effect on succeeding crop

Sharma *et al.* (1990) observed in soybean - wheat cropping sequence that an application of half dose of nutrient through chemical fertilizers and 8 tonnes FYM ha^{-1} to soybean gave significantly higher yield of succeeding wheat as compared to full dose of fertilizer FYM alone and control.

Bahl and Pasricha (2000) concluded that 30 per cent increase in maize yield grown in rotation with field pea residues were incorporated in soil.

Pal and Shehu (2001) revealed in his experiment that the residual N from the soybean crop to succeeding maize was 18.4 – 20 kg ha^{-1}.

Bloem and Barnard (2001) in his experiment concluded that the average nitrogen advantage after cow pea, soybean and groundnut was 32, 22 and 7 kg ha^{-1} respectively to succeeding maize crop.

Sanginga *et al.* (2002) reported that the maize grain yield was generally higher when crop was planted following soybean than in continuous maize cultivation.

Phoomthaisong *et al.* (2003) reported that the maize grown after groundnut had the highest total dry weight and total N uptake. Maize yield was directly related to the amount of residue N returned.

Ghosh *et al.* (2004) conducted an experiment on deep vertisol of Bhopal and reported that soybean an preceding crop recorded highest seed yield of wheat with FYM and chemical fertilizer to soybean.

Reddy (2004) revealed in his experiment that the organic manures supply on the preceding crop groundnut, produced higher maize growth and yield.

2.4 Economics of pea cultivation

Bhagat (2001) conducted experiment in Bihar on groundnut crop concluded that the highest net return of Rs. 32489 ha^{-1} were obtained from the treatment with 50 per cent NPK of 50 per cent FYM.

Datt et al. (2003) conducted a experiment in Himachal Pradesh during *rabi* and reported that FYM at 10 t ha^{-1} with NPK at recommended rate to pea crop gave highest net return (Rs. 21556 ha^{-1}) and cost benefit ratio (2.74).

Bhat *et al.* (2002) conducted a experiment in Jammu and Kashmir during rabi and reported that the highest net returns per rupee invested were obtained at 30 kg P_2O_5 ha^{-1} in field pea.

Bhattarai *et al.* (2003) conducted a experiment in Manipur during winter season and reported that the organic manure with full dose of nutrients recorded the highest net returns (Rs. 25.4 thousand ha^{-1}) in pea crop.

Siddiqui *et al.* (2004) conducted a experiment in Pakistan and reported that the soybean crop under N fertilization (50 kg ha^{-1}) gives net returns (Rs. 3220.47 ha^{-1}) and cost benefit ratio (1 : 1.31).

3. MATERIAL AND METHODS

The present investigation was carried out during 2004-05. The details of the material used and standard methods adopted during the course of investigation are described in this chapter.

3.1 Details of the experimental material

3.1.1 Location of the experimental site

The experiment was laid out in Survey No. 47 of the Instructional Research Farm, Post Graduate Institute, Central Campus, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar, Maharashtra during *rabi* and summer season of 2004-05.

3.1.2 Soil

The topography of experimental field was uniform and leveled with well drained soil. In order to know the physical and chemical properties of the experimental soil, the surface soil sample was collected (30 cm) randomly from the experimental field before sowing and analysed for various properties. The results and methods used for analysis are presented in Table 1.

The soil of the experimental field was sandy clay loam in texture. The soil was alkaline in reaction (pH 8.2) with electrical conductivity (0.28 dSm^{-1}). The soil available nitrogen was low (202.73 kg ha^{-1}). Whereas, available phosphorus and potassium were high (18.16 and 360.8 kg ha^{-1}).

Table 1. Physical and chemical properties of soil from experimental field and method used

Sr. No.	Particulars	Results	*Methods used*	References
A.	Physical properties			
1.	Coarse sand (%)	12.18	Bouyoucos hydrometer method	Bouyoucos and Gee (1962)
2.	Fine sand (%)	34.40	---- " -----	---- " -----
3.	Silt (%)	20.78	---- " -----	---- " -----
4.	Clays (%)	22.56	---- " -----	---- " -----
5.	Textural class	Sandy clay loam	---- " -----	---- " -----
B.	Chemical properties			
1.	Available N (kg/ha)	202.7	Alkaline $KMnO_4$	Subbiah and Asija, 1956
2.	Available P_2O_5 (kg/ha)	18.2	0.5 M $NaHCO_3$ (pH 8.5)	Olsen *et al.* (1954)
3.	Available K_2O (kg/ha)	360.8	N N NH_4OAC	Knudsen *et al.* (1982)
4.	Organic carbon (%)	0.66	Walkely and Black method	Nelson and Sommers (1982)
5.	pH (1 : 2.5)	8.2	Potentiometric	Piper, 1966
6.	EC (dSm^{-1})	0.28	Conductometric	Piper, 1966
C.	Chemical properties of FYM			
1.	Total N (%)	0.62	Macrokjeldhal	Saharawat and Burford (1982)
2.	Total P_2O_5 (%)	0.40	Pumberton	Olsen *et al.* (1954)
3.	Total K_2O (%)	0.28	Flame photometer method	Knudsen *et al.* (1982)

3.1.3 Climatic conditions

3.1.3.1 General

Geographically, the Post Graduate Instructional Research Farm, M.P.K.V., Rahuri is situated between 19^{0}47' and 19^{0}57' North latitude and 74^{0}19' and 74^{0}32 east longitude. The altitude varies from 395 to 565 meter above mean sea level.

Agroclimatically, this area falls in the semi arid tropics with the annual rainfall ranging from 307 to 619 mm. The average annual precipitation is about 520 mm, out of which about 80 per cent is received from South-West monsoon from June to September which was erratically distributed in 15-45 rainy days. Rest of the rainfall is received in the month of October and November from North-East monsoon.

The annual mean maximum temperature is 37.7^{0}C with a range of 33^{0}C and 43^{0}C. The annual mean minimum temperature is 18.2^{0}C with a range of 4 to 18^{0}C. The mean relative humidity in the morning and evening is 78.2 and 28.5 per cent, respectively. Agro-climatically the location is in the drought prone area of Maharashtra, characterized by low and erratic rainfall with few rainy days coupled with long dry spell.

3.1.3.2 Nature of season during the experimental period

The climatic conditions prevailed during the period of experimentation, the meteorological data on important parameters were recorded at the central metrological observatory located in 'B' Block, Central Campus, Mahatma Phule Krishi Vidyapeeth, Rahuri and are presented in Table 2 and graphically depicted in Fig. 1.

Table 2. Meteorological data recorded during the crop season

Meteor-ological week	Dates	Temperature (°C)		Relative humidity (%)		Rainfall (mm)	Daily pan evaporation (mm)
		Maximum	Minimum	Morning	Evening		
2004 November							
44	29-04	30.1	15.8	83.9	41.0	0.0	3.3
45	05-11	29.8	15.2	88.4	53.3	2.50	3.7
46	12-18	31.3	16.1	83.4	46.1	0.40	3.6
47	19-25	30.7	10.0	81.4	34.6	0.0	3.6
48	26-02	29.8	8.8	84.3	28.1	0.0	3.6
December							
49	03-09	28.3	7.5	83.3	30.4	0.0	3.4
50	10-16	28.8	6.7	84.4	29.1	0.0	3.4
51	17-23	29.2	9.4	85.1	29.3	0.0	3.4
52	24-31	29.0	10.4	85.5	33.8	0.0	3.5
2005 January							
1	01-07	28.4	11.2	85.9	42.1	0.0	3.6
2	08-14	28.1	6.9	83.0	35.9	0.0	3.2
3	15-21	27.8	5.5	86.4	30.9	0.0	3.4
4	22-28	28.6	11.5	86.0	35.6	0.0	3.2
5	29-04	28.4	11.3	85.0	39.1	0.0	3.5
February							
6	05-11	31.7	10.6	88.9	30.4	0.0	4.4
7	12-18	33.0	9.8	88.6	29.9	0.0	4.5
8	19-25	29.4	7.2	84.7	28.7	0.0	3.8
9	26-04	33.7	13.9	87.3	29.6	0.0	5.6
March							
10	05-11	32.5	12.5	87.2	31.7	0.8	5.2
11	12-18	33.8	10.6	88.1	23.1	0.0	7.1
12	19-25	35.7	13.3	87.0	24.6	0.0	9.4
13	26-01	36.3	13.2	86.4	23.3	0.0	10.4
April							
14	02-08	37.9	17.2	85.3	23.3	0.0	10.3
15	05-15	37.0	16.9	86.3	31.6	0.0	10.0
16	16-22	38.8	19.9	83.6	22.7	0.0	10.7
17	23-29	37.4	19.1	83.7	25.9	0.0	9.4
May							
18	30-06	37.4	19.2	85.4	29.6	0.0	10.5
19	07-13	38.7	20.3	84.6	27.1	0.0	11.9
20	14-20	40.5	19.6	84.3	23.6	0.0	14.0
21	21-27	40.9	21.3	84.3	22.9	0.0	13.4
22	28-03	36.9	22.6	84.1	34.9	0.5	11.2

From data presented in Table 2, revealed that the mean maximum temperature ranged between 27.8^{0}C and 40.9^{0}C while the mean minimum temperature ranged between 5.5^{0}C and 22.6^{0}C. The relative humidity during morning and evening ranged between 83.00 and 88.9 per cent and between 22.7 and 53.3 per cent, respectively. Daily pan evaporation ranged between 3.2 and 14 mm.

3.1.4 Cropping history of the experimental field

The cropping history of the experimental field for the previous three years is presented in Table 3.

Table 3. Cropping history of the experimental field for previous three years

Year	*Kharif*	*Rabi*	Summer
2001-02	Soybean	Onion	Fallow
2002-03	Maize	Wheat	Fallow
2003-04	Soybean	Green gram	Fallow
2004-05	Fallow	(Present investigation)	

3.2 Methods

3.2.1 Experimental details

The present investigation was laid out in Randomized Block Design (Factorial) with twelve treatment replicated three times. The experiment was carried out on the same site without changing the randomization in both the seasons.

Crop details :

Sr. No.	Crop	Variety	Seed rate	Spacing (cm)
1.	Pea	Arkel	80 kg ha^{-1}	30 x 15
2.	Forage maize	African tall	75 kg ha^{-1}	60 x 20

3.2.2 Treatment details

The treatment details along with the symbols used are presented in Table 4 and plan of layout is depicted in Fig. 2.

Table 4. Details of the treatment and symbols used

Sr. No.	Treatment	Symbols used
A.	Organic manures	
1.	Control	T_1
2.	FYM @ 5 t ha^{-1}	T_2
3.	Vermicompost @ 2.5 t ha^{-1}	T_3
B.	Inorganic fertilizers	
1.	Control	F_1
2.	50 % RDF	F_2
3.	75 % RDF	F_3
4.	100 % RDF	F_4

Note : RDF for pea is 15:60:60 N, P_2O_5 and K_2O kg ha^{-1}
Common biofertilizer seed treatment was given

3.2.3 Cultural operations of pea

The schedule of various cultural operations carried out during the period of experimentation is given in Table 5.

3.2.3.1 Preparation of land and layout of experiment

The field was ploughed with tractor drawn plough and was brought to friable condition by harrowing. The remains of various crops were collected.

Table 5. Schedule of cultural operations

Sr. No.	Cultural operation	Frequency	Date
A.	Preparatory tillage		
1.	Ploughing	1	30.10.2004
2.	Discing and harrowing	2	3.11.2004
3.	Preparation of layout	1	4.11.2004
B.	Manuring and sowing		
1.	Application of manures and fertilizers	1	19.11.2004
2.	Seed treatment	1	20.11.2004
3.	Sowing	1	20.11.2004
C.	Inter cultivation		
1.	Gap filling	1	1.12.2004
2.	Weeding	3	5.12.2004, 1.1.2005, 16.1.2005
3.	Top dressing	1	21.12.2004
4.	Irrigation	10	Presented in Table 6
D.	Plant protection		
1.	Thimate application	1	19.11.2004
E.	Harvesting	2	12.2.2005, 21.2.2005

The field was laid out in 36 beds each having gross plot size 4.50 x 3.00 m^2 and net plot size 3.90 x 2.40 m^2. The treatments were allotted to different experimental units within replication by random method.

3.2.3.2 Fertilizer application

In *Rabi* season, pea crop was fertilized as per the treatment, involving half dose of nitrogen and full dose of phosphorus and potassium as basal application and half dose of nitrogen as top dressed at 30 days after sowing as per treatment. A common seed treatment of biofertilizer was given to the pea seed at the time of sowing. FYM and vermicompost were applied before sowing of pea as per treatment.

3.2.3.3 Seed treatment

Seed treatment was done with Rhziboium culture @ 250 g 10 kg^{-1} of pea seed to enhance nitrogen fixation in soil.

3.2.3.4 Sowing of pea

Pea seeds were dibbled in plot at 30 cm x 15 cm distance at proper depth in the soil.

3.2.3.5 Irrigation

The plots were given light irrigation immediately after sowing of pea. After that plot were irrigated at an interval of 10-12 days by surface method.

Table 6. Irrigation schedule followed during crop growth

Sr. No.	Date
1.	20.11.2004
2.	28.11.2004
3.	6.12.2004
4	21.12.2004
5.	30.12.2004
6.	10.1.2005
7.	19.1.2005
8.	28.1.2005
9.	9.2.2005
10.	18.2.2005

3.2.3.6 Gap filling

The germination started at 10-12 days after planting. Gap was filled at 20 days after planting. A due care was taken to maintain the 100 per cent plant population.

3.2.4 Biometric observations of pea

The detailed of biometric observations were recorded during the crop growth period (Table 7).

3.2.4.1 Sampling techniques

Five plants selected at random were fixed with bamboo and tagged in each net plot for recording various growth parameters. All the biometric observations were recorded periodically (Table 7).

Table 7. Schedule of biometric observation

Sr. No.	Observation	Frequency	Sample size	Days after sowing (DAS)
A.	Pre harvest studies			
1.	Initial plant count	5	Net plot	12, 14, 16, 18, 20
2.	Final plant count	1	Net plot	At harvest
B.	Growth studies			
1.	Plant height (cm)	5	5 plants	30, 45, 60, 75 and at harvest
2.	Plant spread (cm)	5	5	30, 45, 60, 75 and at harvest
3.	Number of functional leaves per plant	5	5	30, 45, 60, 75 and at harvest
4.	Leaf area/plant (dm^2)	5	5	30, 45, 60, 75 and at harvest
5.	Number of green pods/plant	5	5	30, 45, 60, 75 and at harvest
6.	Weight of green pods/plant	5	1	30, 45, 60, 75 and at harvest
7.	Length of pod (cm)	5	1	30, 45, 60, 75 and at harvest
C.	Dry matter studies			
1.	Dry matter of leaves and stem (g/plant)	5	1	30, 45, 60, 75 and at harvest
D.	Post harvest studies			
1.	Green pod yield per plot	1	Net plot	At harvest
2.	Straw yield per plot	1	Net plot	At harvest
E.	Chemical studies			
1.	Analysis of plant parts for N, P and K content	1	1	At harvest
2.	Analysis of soil for available N, P and K at harvest	1	1	At harvest
3.	Uptake of N, P, K by crop (kg/ha)	1	1	At harvest

3.2.4.2 Initial and final plant count

The initial plant count was recorded by counting all the plants from each net plot from 12 days after planting till 20 days at alternate day.

Final plant count was taken at the time of harvesting.

3.2.4.3 Growth studies

The detail regarding observations on growth characters are presented in Table 7.

i. Plant height

The plant height was measured from the ground level to the base of last open leaf at 30, 45, 60, 75 DAS and at harvest, respectively.

ii. Plant spread

Plant spread was recorded by measuring the horizontal space occupied by plant between tips of two extreme leaves.

iii. Number of leaves per plant

Number of functional leaves per plant was recorded at 30, 45, 60, 75 DAS and at harvest, respectively.

iv. Leaf area

Five compound leaves from each plant were randomly selected and area of same was measured with automatic leaf area meter CI-203 CA.

v. Number of green pods per plant

The total number of pods on the observational plants were recorded at the time of each harvest. They were computed and total number of pods per plant was noted.

vi. Length of pods per plant

Length of pods recorded from randomly selected five pods from each observational plant. They were measured and average length was worked out.

vii. Weight of green pods per plant

Weight of green pods from observational plant was recorded. Weight of pods at every picking was added and total weight of pods per plant was calculated.

viii. Dry matter accumulation study

Dry matter accumulation in leaves, stem, pods and total dry matter accumulation was recorded treatment wise at 30, 45, 60 DAS and at harvest from two uprooted plants.

3.2.5 Post harvest observations

3.2.5.1 Green pod yield per plot

The green pod yield per plot was recorded at each picking. The total of each picking was recorded as green pod yield of that net plot.

3.2.5.2 Straw yield per plot

The straw yield from each plot was recorded after final harvesting of green pea. The straw of pea in each net plot was weighed and recorded.

3.2.6 Cultural operations of forage maize

The schedule of various cultural operations carried out for the experimental plot is given in Table 8.

Table 8. Schedule of cultural operations carried out in the experimental plot during summer season

Sr. No.	Cultural operation	Freque-ncy	Date
1.	Harrowing	2	6.3.2005
2.	Preparation of layout	1	7.3.2005
3.	Sowing	1	11.3.2005
4.	Fertilizer (No fertilizer application)	-	-
5.	Gap filling	1	23.3.2005
6.	Thinning	1	3.4.2005
7.	Spraying	-	-
8.	Weeding	2	14.4.2005, 6.5.2005
9.	Irrigation	8	11.3.2005, 18.3.2005, 23.3.2005, 3.4.2005, 14.4.2005, 25.4.2005, 6.5.2005, 18.5.2005
10.	Harvesting	1	26.5.2005

3.2.6.1 Preparation of land and layout of experiment

The field was harrowed and the remains of previous crop were collected. The experiment was carried out on the same site without changing the layout and randomization.

3.2.6.2 Seeds and sowing

The maize variety African tall was used for the study. The seed was dibbled at 60 cm x 20 cm spacing, at 5 cm depth.

3.2.6.3 Fertilizer application

In case of maize, forage crop grown without fertilizer application only residual effect of applied fertilizers to preceding pea.

3.2.6.4 Gap filling and thinning

Experimental plot required gap filling which was done on the 12th days after sowing and thinning was done after three weeks.

3.2.6.5 Plant protection measures

The seeds were treated with mercurial fungicide Agroson @ 2 gm kg^{-1} seed, against seed borne diseases.

3.2.6.6 Weeding

Two hand weedings were carried out with the help of manual labour to check the weed growth.

3.2.6.7 Irrigation

The plot was given light irrigation after sowing of maize seed. Irrigation was given by surface method at an interval of 8-10 days.

3.2.6.8 Harvesting

The crop was harvested for green forage as per treatment at 50 per cent flowering stage. At the time of harvest, the border area was harvested separately. The harvesting was done with the help of sickles. The produce of each net plot i.e. green forage was harvested treatment wise and weighed separately.

3.2.7 Biometric observations of maize

The details of biometric observations recorded during the crop growth period are presented in Table 9.

Table 9. Details of biometric observations recorded on forage maize

Sr. No.	Observations	Frequency	Days after sowing (DAS)	Sample size
1.	Initial plant count	1	At 15 DAS	Net plot
2.	Final plant count	1	At harvest	Net plot
3.	Plant height (cm/plant)	4	30,45,60 and at harvest	5 plants
4.	Number of functional leaves per plant	4	30,45,60 and at harvest	5 plants
5.	Leaf area per plant (dm^2)	4	30,45,60 and at harvest	5 plants
6.	Stem girth (cm/plant)	4	30,45,60 and at harvest	5 plants
7.	Dry matter (g/plant)	4	30,45,60 and at harvest	2 plants
8.	Green forage yield ($q\ ha^{-1}$)	1	At harvest	Net plot

3.2.7.1 Sampling technique

The growth observations on randomly selected five plants were recorded from each plot. The paper labels were tied to each plant for identification from the five observational plants.

3.2.7.2 Growth studies

i. Plant height

The observation on plant height was recorded at an interval of 15 days starting from 30^{th} days after sowing upto harvest. The plant height was measured from the ground level to the base of last fully opened leaf.

ii. Number of functional leaves per plant

The number of fully opened leaves on the plant was noted on the same date on which the height observations were recorded.

iii. Leaf area per plant

The leaf area was measured with automatic leaf area meter CI-203 CA.

iv. Stem girth

The stem girth was measured in cm at the center of the middle internode on the same dates on which the height observations were recorded.

vi. Dry matter studies

The dry matter estimation was made at an interval of 15 days beginnings from 30th day after sowing upto harvest.

3.2.8 Chemical analysis

3.2.8.1 Plant sample

Five observation plants were harvested separately and were used for dry matter study and after recording dry matter these plant sample were powdered in willey mill grinding machine and used for chemical analysis viz., nitrogen, phosphorus and potassium by adopting standard methods (Table 1).

3.2.8.2 Soil analysis

Composite surface soil sample from 0-30 cm soil depth from each net plot was collected after harvest of the crop. It was powdered in wooden mortar and pestle after drying and passed through 2 mm sieve for chemical analysis viz., soil available NPK and physical properties of soil by standard methods (Table 1).

3.2.9 Economic studies

3.2.9.1 Cost of cultivation

The treatmentwise cost of cultivation was worked out by considering prices of input given in Appendix-I.

3.2.9.2 Gross monetary returns

The treatmentwise gross monetary returns were worked out by considering the prevailing prices of the produce during the year of experimentation.

3.2.9.3 Net monetary returns

Net monetary returns were worked out by subtracting the cost of cultivation from gross monetary returns.

3.2.9.4 Benefit : cost ratio

The benefit : cost ratio was worked out by using the following formula.

$$\text{Benefit : Cost ratio} = \frac{\text{Gross monetary returns (Rs.)}}{\text{Cost of cultivation (Rs.)}}$$

3.2.10 Statistical analysis and interpretation of data

The experimental data obtained on various selected variables were analysed statistically by a statistical method of 'Analysis of Variance'. The 'F' test of significance was used for testing null hypothesis and appropriate standard error (S.E.) for each treatment effect was worked out. Whenever, the difference were significant the critical difference (C.D.) at 5 per cent probability level was computed at appropriate places for testing the significance of treatment differences. Suitable graphical illustrations of the data have been given at appropriate places.

4. RESULTS AND DISCUSSION

The results of this investigation are presented and discussed in this chapter.

4.1 Performance of pea

4.1.1 Emergence and final plant count

The data pertaining to the percent emergence as influenced by various treatments of fertilizers are presented in Table 10. The emergence of pea was noticed on 10th day after sowing and it was rapid during 12th to 18th days and almost completed at 20th days after sowing.

The mean per cent emergence was 61.74, 71.26, 77.91, 83.30 and 91.83 at 12, 14, 16, 18 and 20 days after sowing respectively. The mean final plant population at harvest was 89.53 percent.

4.1.1.1 Effect of organic manure

The different treatments of organic manures did not show any significant effect on emergence and final plant count.

4.1.1.2 Effect of inorganic fertilizer

The various levels of fertilizers did not influenced significantly the emergence and final plant count.

4.1.1.3 Interaction

The mean emergence and final stand was not significant due to interaction.

4.1.2 Growth studies

4.1.2.1 Plant height

The data in respect to mean plant height as influenced by organic manures and inorganic fertilizer levels are presented in Table 11 and graphically depicted in Fig. 3.

The mean plant height was increased as crop age advanced upto harvest. The mean plant height under various treatments was 14.57, 25.20, 36.04 and 40.45 cm at 30, 45, 60 and at harvest, respectively. The magnitude of increase in plant height was rapid during 30 to 60 DAS and then slowed down towards the maturity.

a. Effect of organic manures

The mean plant height differed significantly due to different organic levels under study at all the stages of crop growth.

The application of 5 t FYM ha^{-1} recorded the maximum plant height at 30, 45, 60 and at harvest (15.51, 27.82, 38.93 and 43.10 cm, respectively). It was at par with application of vermicompost @ 2.5 t ha^{-1} at 30, 45, 60 DAS and at harvest (14.78, 26.76, 37.24 and 41.22 cm, respectively). The control treatment showed the lowest plant height at all stages of observation (13.42, 21.04, 31.96 and 37.04 cm, respectively). In comparison with inorganic fertilizer, organic manure was might be less effective because of slow release of nutrient to plant.

b. Effect of inorganic fertilizers

The difference in plant height due to various fertilizer levels was significant at all the days of observation. Application

of 100 per cent RDF produced significantly more plant height as compared to rest of fertilizer levels at 30, 45, 60 DAS and at harvest (16.57, 30.34, 43.34 and 48.01 cm, respectively). The application of inorganic fertilizer @ 50 and 75 per cent RDF were at par at 45 DAS. The lowest plant height was recorded by the control treatment at all stages of crop growth.

Increase in plant height might be because of response to the applied nutrient through full dose of N, P and K. These results are inconformity with Saimbhi and Grewal (1986) and Deibert and Utter (2004).

c. Effect of interaction

The interaction was present at harvest. The interaction Table 12 indicate that highest mean plant height (53.82 cm) was obtained in the treatment combination of 100 per cent RDF with FYM @ 5 t ha^{-1}. The lowest mean plant height was recorded in control treatment.

Table 12. Mean plant height (cm/plant) of pea at harvest as influenced by interaction

Treatments	Inorganic fertilizers			
	Control	50 % RDF	75 % RDF	100 % RDF
A. Organic manure				
Control	26.13	33.42	38.05	39.29
FYM @ 5 t ha^{-1}	34.81	43.66	47.34	53.82
Vermicompost @ 2.5 t ha^{-1}	32.27	40.52	44.26	50.92
S.E. $\pm$	2.48			
CD at 5 %	7.84			

4.1.2.2 Plant spread

The data recorded on plant spread as influenced by different treatments are shown in Table 13. The mean plant spread at 30, 45, 60 DAS and at harvest was 9.83, 17.12, 24.40 and 25.16 cm, respectively. It was progressively increased from 9.83 to 24.40 cm/plant during 30 to 60 DAS.

a. Effect of organic manure

The difference in plant spread due to different treatments were significant during the crop growth. The treatment FYM @ 5 t/ha recorded more plant spread i.e. 10.42, 17.93, 25.73 and 26.88 cm at 30, 45, 60 DAS and at harvest respectively, than the rest of treatments under investigation which was at par with the treatment vermicompost @ 2.5 t/ha.

b. Effect of inorganic fertilizer

The difference in plant spread due to fertilizer levels was significant during crop growth. The fertilizer level 100 per cent RDF recorded maximum plant spread 11.22 cm at 30 DAS and 28.96 cm/plant at harvest which was at par with 75 per cent RDF (10.40 and 27.67 cm/plant) at 30 DAS and at harvest. The lowest plant spread 8.62 cm/plant at 30 DAS was recorded by control treatment.

With the increase in fertilizer dose of N, P and K, the plant spread might be increased due to availability of nutrients in maximum amount. Similar results were also reported by Prasad *et al.* (1987).

c. Interaction

The plant spread was not influenced significantly due to interaction.

4.1.2.3 Number of functional leaves per plant

The data pertaining to mean number of functional leaves per plant influenced periodically by various treatments are presented in Table 14 and graphically depicted in Figure 4. The mean number of functional leaves per plant at 30, 45, 60 and at harvest was 18.58, 35.93, 56.47 and 62.25 respectively. The number of functional leaves per plant increased with the advancement of crop age up to 60 DAS.

a. Effect of organic manure

At 30, 45, 60 DAS and harvest the mean maximum number of functional leaves per plant was 20.29, 38.75, 58.95 and 65.59, respectively with application of FYM @ 5 t ha^{-1} than the rest of the treatment which was at par with the treatment vermicompost @ 2.5 t/ha. The lowest number of functional leaves per plant was recorded in the control.

b. Effect of inorganic fertilizer

The mean number of functional leaves differed significantly due to differed levels of fertilizers. Treatment 100 per cent RDF recorded significantly maximum mean number of functional leaves per plant which were 23.30, 42.40, 67.09 and 71.98 at 30, 45, 60 DAS and at harvest, respectively followed by the treatment 75 per cent RDF. The lowest number of functional leaves was recorded with control treatment.

Increase in number of functional leaves might be because of response to the applied nutrient through increased application of N, P and K. Similar results were also reported by Deibert and Utter (2004).

c. Effect of interaction

The number of functional leaves per plant was not influenced significantly by interaction.

4.1.2.4 Leaf area per plant

The data pertaining to mean leaf area (dm^2) per plant as influenced by different treatments are presented in Table 15. The mean leaf area per plant at 30, 45, 60 DAS and at harvest was 1.74, 3.45, 4.92 and 4.15 dm^2/plant respectively. The mean leaf area per plant increased with advancement of crop age up to 60 DAS.

a. Effect of organic manure

At 45, 60 DAS and at harvest, the mean leaf area was 3.65, 5.46 and 4.52 dm^2/plant more in treatment FYM @ 5 t/ha and it was at par with vermicompost @ 2.5 t/ha. The lowest mean leaf area (dm^2) per plant was recorded in control treatment.

b. Effect of inorganic fertilizer

The difference in leaf area (dm^2/plant) due to fertilizer levels was significant during crop growth. The fertilizer level 100 per cent RDF recorded significantly higher leaf area (1.98, 3.69, 5.52 and 4.45 dm^2/plant) which was followed by 75 per cent RDF at 30, 45, 60 DAS and at harvest. Treatment 75 and 50 per

cent RDF was on par at 45 and 60 DAS. The lowest leaf area was recorded by control treatment.

Increase in leaf area might be due to increased fertilizer dose of N, P and K and more availability of plant nutrients. Similar results were also reported by Saimbhi and Grewal (1986).

c. Effect of interaction

The interaction was presented at 60 DAS. The interaction Table 16 indicate that highest mean leaf area (6.01 dm^2/plant) was obtained in the treatment combination of 100 per cent RDF with FYM @ 5 t ha^{-1}. The lowest mean leaf area was recorded in control treatments.

Table 16. Mean leaf area (dm^2/plant) of pea at 60 DAS as influenced by interaction

Treatments	Inorganic fertilizers			
	Control	50 % RDF	75 % RDF	100 % RDF
A. Organic manure				
Control	2.88	4.39	4.72	5.14
FYM @ 5 t ha^{-1}	4.97	5.08	5.82	6.01
Vermicompost @ 2.5 t ha^{-1}	4.78	4.84	5.29	5.68
S.E. $\pm$	0.36			
CD at 5 %	1.10			

4.1.2.5 Number of pods per plant

The data in respect of mean number of pods per plant at various days of observations as influenced by different treatments are presented in Table 17 and graphically depicted in Fig. 5.

The mean number of pods per plant at 45, 60 DAS and at harvest was 12.61, 19.40 and 21.47 respectively. The mean number of pods per plant increased with advancement in the age of crop upto harvest.

a. Effect of organic manures

The mean number of pods per plant was differed significantly due to different organic manures at all the days of the observation. Treatment FYM @ 5 t/ha recorded maximum mean numbers of pods (13.88, 21.63 and 28.87 per plant at 45, 60 DAS and at harvest, respectively) which was at par with the Vermicompost @ 2.5 t/ha (13.32, 20.42 and 27.25, respectively). The lowest number of pods was recorded in the control treatment.

b. Effect of inorganic fertilizer

The mean number of pods per plant differed significantly due to various levels of fertilizer at 45, 60 DAS and at harvest. Hundred per cent RDF was recorded maximum number of pods (15.56, 23.63 and 31.84 per plant at 45, 60 DAS and at harvest, respectively). The treatment 75 per cent RDF was at par with 50 per cent RDF at 60 DAS. The lowest number of pods was recorded observed in the control treatment.

Increase photosynthetic activity might be because of increased leaf area due to increased fertilizer level and thus number of pods was increased. Similar results were also reported by Shrivastava and Verma (1984) and Bhattaria *et al.* (2003).

c. Effect of interaction

The interaction was present at 60 DAS. The interaction Table 18 indicate that the highest mean number of pods (20.76 per plant) was obtained in the treatment combination of 100 per cent RDF with FYM @ 5 t ha^{-1}. The lowest mean number of pods was recorded in the control treatment.

Table 18. Mean number of pods at 60 DAS as influenced by interaction

Treatments	Inorganic fertilizers			
	Control	50 % RDF	75 % RDF	100 % RDF
A. Organic manure				
Control	10.43	15.41	18.89	19.87
FYM @ 5 t ha^{-1}	15.82	21.38	23.20	26.76
Vermicompost @ 2.5 t ha^{-1}	12.37	20.12	22.64	24.48
S.E. $\pm$	1.44			
CD at 5 %	3.56			

4.1.2.6 Length of pods per plant

The data pertaining to mean length of pods per plant as influenced by different treatments are presented in Table 17. The data indicated that the mean length of pod per plant was 3.94, 5.83 and 6.10 cm at 45, 60 DAS and at harvest respectively. It was observed that length of pod per plant was increased with advancement in age of crop upto harvest.

a. Effect of organic manure

The length of pod per plant was significantly influenced by different organic manure levels at all the days of growth observation. Application of FYM @ 5 t/ha was recorded more length of pod 4.14, 6.04 and 6.32 cm at 45, 60 DAS and at harvest respectively, which was at par with vermicompost @ 2.5 t ha^{-1}. The control treatment recorded the lowest length of pod.

b. Effect of inorganic fertilizers

The different levels of fertilizer influenced significantly the mean length of pods per plant at all days of growth observation. Application of 100 per cent RDF recorded maximum length of pods 6.38 and 6.56 cm per plant at 60 DAS and at harvest. It was at par with 75 per cent RDF. Whereas, treatment 50 per cent RDF was at par with 75 % RDF at 45 DAS. The lowest mean length of pod was recorded in control treatment.

Increased in length of pod might be because of increased of photosynthetic activity due to increased leaf area by increased fertilizer application. Similar results were also reported by Kanaujia *et al.* (2000) and Gupta et al. (2000).

c. Effect of interaction

The mean length of pods per plant was not significantly affected by interaction.

4.1.2.7 Fresh weight of pods per plant

The data pertaining to mean fresh weight of pods per plant as influenced by different treatments are presented in Table 20 and graphically depicted in Fig. 7. The mean fresh weight of pods per plant were 12.47, 19.12 and 23.64 g/plant at

45, 60 DAS and at harvest respectively. The data revealed that mean fresh weight of pods per plant was increased with the advancement in the age of crop till harvest.

a. Effect of organic manure

The mean fresh weight of pods per plant differed significantly due to different organic manure treatments at all the days of observation.

The treatment FYM @ 5 t/ha recorded the highest mean fresh weight of pods 13.45, 22.10 and 26.23 g/plant, at 45, 60 DAS and at harvest, respectively. Treatment vermicompost @ 2.5 t/ha was at par with 5 t FYM/ha. The lowest fresh weight of pods was recorded in the control treatment.

b. Effect of inorganic fertilizer

The mean fresh weight of pods per plant was significantly influenced by application of different levels of fertilizer at all the days of growth observation.

Application of 100 per cent RDF produced 17.46, 23.89 and 28.71 g/plant mean fresh weight of pods per plant at 45, 60 DAS and at harvest respectively. It was significantly superior over rest of the treatments. The treatment 50 per cent RDF was at par with 75 per cent RDF at harvest. The control treatment produced the lowest mean fresh weight of pods per plant.

The weight of pod was increased due to increased fertilizer level of N, P and K to pea. Similar results were also reported by Kanaujia *et al.* (2000).

c. Effect of interaction

The interaction was present at harvest.

The interaction Table 21 indicated that the highest mean fresh weight of pods (34.31 g/plant) was obtained in the treatment combination of 100 per cent RDF with FYM @ 5 t/ha. The lowest mean fresh weight of pods was recorded in the control treatment.

Table 21. Mean fresh weight (g/plant) of pods at harvest as influenced by various interaction effect

Treatments	Inorganic fertilizers			
	Control	50 % RDF	75 % RDF	100 % RDF
A. Organic manure				
Control	14.49	20.81	21.41	22.42
FYM @ 5 t ha^{-1}	17.12	26.18	29.40	34.31
Vermicompost @ 2.5 t ha^{-1}	14.79	24.19	27.26	29.65
S.E. $\pm$	1.63			
CD at 5 %	4.57			

4.1.2.8 Total dry matter per plant

The data pertaining to the mean dry matter accumulation per plant as influenced by different treatments are presented in Table 22 and graphically depicted in Fig. 7. The data indicate that the total dry matter accumulation per plant was 1.18, 5.50, 19.89 and 22.59 g/plant at 30, 45, 60 DAS and at harvest respectively. It was observed that the total dry matter per plant increased with advancement in age of the crop up to harvest.

a. Effect of organic manure

The total dry matter accumulation was significantly influenced by different organic manure levels at all the days at growth observation. The total dry matter in treatment FYM @ 5 t/ha was 1.27, 5.59, 24.16 and 26.20 g/plant at 30, 45, 60 DAS and at harvest respectively. Which was at par with vermicompost @ 2.5 t/ha. The control recorded the lowest dry matter per plant.

b. Effect of inorganic fertilizer

The different levels of fertilizer significantly influenced the total dry matter per plant at all the days of growth observations.

Application of 100 per cent RDF recorded significantly more total dry matter 1.47, 6.65, 28.89 and 30.92 g/plant at 30, 45, 60 DAS and at harvest, respectively. Which was followed by the treatment 75 per cent RDF except the treatment 50 per cent RDF which was at par with 75 RDF at harvest. The lowest mean dry matter was recorded by the control treatment.

Due to the increased application of N, P and K, the total dry matter of pea might be increased. These findings are inconformity with Saimbhi and Grewal (1986) and Prasad *et al.* (1987).

c. Effect of interaction

The mean dry matter accumulation per plant was significantly affected by interaction at harvest (Table 23).

The highest total dry matter accumulation (34.46 g/plant) was recorded in treatment combination of 100 per cent

RDF with FYM @ 5 t/ha. The lowest total dry matter (10.12 g/plant) was recorded in treatment combination of control.

Table 23. Mean total dry matter (g/plant) at harvest as influenced by interaction

Treatment	Inorganic fertilizers			
	Control	50 % RDF	75 % RDF	100 % RDF
A. Organic manure				
Control	10.12	19.17	22.48	25.81
FYM @ 5 t ha^{-1}	14.98	25.67	29.72	34.46
Vermicompost @ 2.5 t ha^{-1}	12.46	23.74	26.82	32.49
S.E. $\pm$	1.79			
CD at 5 %	5.72			

4.1.3 Post harvest studies

4.1.3.1 Green pod yield

The data in respect of green pod yield (q/ha) as influenced by different treatments are presented in Table 24 and graphically depicted in Fig. 8. The mean yield of green pod at harvest was 38.96 q/ha.

a. Effect of organic manure

The green pod yield of pea at harvest was significantly influenced by organic manures. The green pod yield recorded by FYM @ 5 t/ha was 43.92 q/ha which was maximum and at par with vermicompost @ 2.5 t/ha (40.17 q/ha). The lowest green pod yield was recorded in control treatment (27.16 q/ha).

The organic manure found to be less effective might be because of slowly availability of nutrients to plant.

b. Effect of inorganic fertilizer

The green pod yield at harvest was significantly influenced by different fertilizer levels under study.

Application of 100 per cent RDF recorded highest green pod yield (51.43 q/ha) at harvest and was significantly superior over rest of treatments followed by 75 per cent RDF (45.19 q/ha). The lowest green pod yield was recorded by control treatment (26.32 q/ha).

The green pea pod yield was increased might be because of more availability of nutrients by increased fertilizer level of N, P and K. Similar results were also reported by Tripathi *et al.* (1999), Gupta *et al.* (2000) and Sharma *et al.* (2002).

c. Effect of interaction

The mean green pod yield was significantly influenced by interaction between organic manure and inorganic fertilizer.

The data from Table 25 indicate that the highest green pod yield (54.19 q/ha) was with treatment combination of 100 per cent RDF and FYM @ 5 t/ha, which was at par with 100 per cent RDF with vermicompost @ 2.5 t/ha.

Table 25. Mean fresh yield (q/ha) of green pods at harvest as influenced by various interaction effect

Treatments	Inorganic fertilizers			
	Control	50 % RDF	75 % RDF	100 % RDF
A. Organic manure				
Control	21.25	31.38	36.34	41.61
FYM @ 5 t ha^{-1}	29.84	43.94	46.42	54.19
Vermicompost @ 2.5 t ha^{-1}	27.12	40.87	45.76	50.47
S.E. $\pm$	2.78			
CD at 5 %	8.34			

4.1.3.2 Straw yield

The data in respect of straw yield as influenced by various treatments are presented in Table 24. The mean straw yield was 12.85 q/ha.

a. Effect of organic manure

The treatment FYM @ 5 t/ha recorded the highest straw yield (13.22 q/ha) and it was at par with vermicompost @ 2.5 t/ha (11.76 q/ha). The lowest straw yield was recorded in control treatment.

b. Effect of inorganic fertilizer

The different fertilizer levels significantly influenced straw yield of pea.

The fertilizer level 100 per cent RDF produced the highest straw yield (16.67 q/ha) which was significantly superior over rest of the treatments under study and it was followed by treatment 75 per cent RDF (15.22 q/ha). The lowest straw yield was observed in control treatment.

c. Effect of interaction

The straw yield was not significantly influenced by interaction.

4.1.4 Chemical studies

4.1.4.1 Percent N, P and K content of plant at harvest

The data pertaining to per cent nitrogen, phosphorus and potassium content in grain and straw at harvest as influenced by various treatments are presented in Table 26. Mean percent nitrogen, phosphorus and potassium content in plant was 5.41, 0.45 and 2.40 per cent, respectively.

a. Effect of organic manure

The mean content of nitrogen, phosphorus and potassium in plant was significantly influenced by various treatments of organic manure.

i. Nitrogen

The nitrogen content in plant at harvest was 6.10 per cent due to application of FYM @ 5 t/ha which was maximum and at par with vermicompost @ 2.5 t/ha (5.91 %). The lowest nitrogen content was observed in the control treatment.

ii. Phosphorus

The phosphorus content in plant at harvest was 0.49 per cent in application of FYM @ 5 t/ha which was maximum and significantly superior over rest of treatments followed by vermicompost @ 2.5 t/ha (0.45 %) and control treatment.

iii. Potassium

The potassium content in plant was 2.83 per cent due to application of FYM @ 5 t/ha which was significantly superior over rest of the treatments and followed by the vermicompost @ 2.5 t/ha. The lowest potassium was observed in control treatment.

b. Effect of inorganic fertilizer

The mean content of nitrogen, phosphorus and potassium in plant was significantly influenced by various levels of fertilizer under study.

i. Nitrogen

The nitrogen content in plant was 6.38 per cent due to application of 100 per cent RDF which was significantly

superior over rest of fertilizer levels under study and it was followed by 75 per cent RDF. Control treatment showed the lowest nitrogen content in plant.

ii. Phosphorus

The highest per cent (0.51 %) of phosphorus observed in plant was in treatment 100 per cent RDF which was at par with 75 per cent and 50 per cent RDF.

iii. Potassium

The highest per cent (2.92 %) of potassium observed in plant was with application of 100 per cent RDF which was followed by the 75 per cent RDF. The lowest potassium observed in the treatment control.

Similar results were also reported by Acharya *et al.* (1988) and Datt *et al.* (2003).

c. Effect of interaction

The interaction effect of different treatments under study was not influenced the per cent nitrogen, phosphorus and potassium content in plant of pea crop.

4.1.4.2 Uptake of nitrogen, phosphorus and potassium by grain and straw of pea crop

The data pertaining to uptake of nitrogen, phosphorus and potassium as influenced by different organic and inorganic fertilizer levels are presented in Table 27.

The mean uptake of nitrogen, phosphorus and potassium pea was 206.14, 12.63 and 17.32 kg/ha and by straw was 14.91, 1.62 and 29.91 kg/ha.

a. Effect of organic manures

The mean uptake of nitrogen, phosphorus and potassium by grain and straw was significantly influenced by various treatments of organic manure under study.

i. Uptake of nitrogen

The uptake of nitrogen by grain and straw in treatment FYM @ 5 t/ha was the highest (253.42 kg/ha and 15.73 kg/ha) and it was significantly superior over other treatments. It was followed by vermicompost @ 2.5 t/ha. The control treatment showed the lowest nitrogen uptake.

ii. Uptake of phosphorus

The uptake of phosphorus by grain and straw in the treatment FYM @ 5 t/ha was 14.88 and 1.86 kg/ha.

The lowest uptake was found in the control treatment.

iii. Uptake of potassium

The uptake of potassium by grain and straw in FYM @ 5 t/ha was the highest (20.41 and 31.07 kg/ha) and significantly superior over other treatments. It was followed by the vermicompost @ 2.5 t/ha. The treatment control showed the lowest potassium uptake by grain and straw.

b. Effect of inorganic fertilizer

Application of different levels of fertilizer significantly affected the uptake of nitrogen, phosphorus and potassium in grain and straw.

i. Uptake of nitrogen

The fertilizer treatment 100 per cent RDF recorded maximum uptake of nitrogen in grain and straw (292.29 and 20.17 kg/ha) and it was significantly superior over rest of treatments, followed by 75 per cent RDF (244.96 and 17.95 kg/ha).

ii. Uptake of phosphorus

The uptake of phosphorus was significantly higher in treatment 100 per cent RDF (17.24 kg/ha and 2.50 kg/ha) in grain and straw over the rest of fertilizer levels, followed by the treatment 75 per cent RDF (14.07 kg/ha and 1.98 kg/ha).

iii. Uptake of potassium

The uptake of potassium was significantly higher in 100 per cent RDF (23.95 kg/ha and 40.34 kg/ha) in grain and straw over the rest of fertilizer levels, followed by the treatment 75 per cent RDF (19.45 kg/ha and 33.48 kg/ha). The lowest uptake of potassium was observed in control treatment.

c. Effect of interaction

The mean uptake of nitrogen, phosphorus and potassium was not influenced significantly by the interaction.

4.1.4.3 Total uptake of nitrogen, phosphorus and potassium by pea crop

The data pertaining to the total uptake of nitrogen, phosphorus and potassium as influenced by different organic and inorganic fertilizer levels are presented in Table 27.

The total uptake of nitrogen, phosphorus and potassium by pea plant were 220.39, 14.30 and 44.53 kg/ha.

a. Effect of organic manures

The total uptake of nitrogen, phosphorus and potassium by pea plant was significantly influenced by various treatment.

i. Uptake of nitrogen

The total uptake of nitrogen by pea plant with the application of FYM @ 5 t/ha was 269.15 kg/ha and it was significantly superior over rest of the treatments followed by vermicompost @ 2.5 t/ha (246.10 kg/ha). The control treatment showed the lowest nitrogen uptake.

ii. Uptake of phosphorus

The total uptake of phosphorus with an application of FYM @ 5 t/ha was 16.74 kg/ha and it was significantly superior over rest of the treatments followed by vermicompost @ 2.5 t/ha (14.67 kg/ha). The lowest was in control treatment.

iii. Uptake of potassium

The total uptake of potassium with the application of FYM @ 5 t/ha by plant was the highest (51.48 kg/ha) and it was significantly superior over rest of the treatment followed by treatment vermicompost @ 2.5 t/ha. The control treatment showed the lowest potassium uptake by plant.

b. Effect of inorganic fertilizers

Application of different levels of fertilizer significantly affected the total uptake of nitrogen, phosphorus and potassium in plant.

i. Uptake of nitrogen

The fertilizer treatment, 100 per cent RDF recorded maximum uptake of nitrogen in plant (312.46 kg/ha) and it was significantly superior over rest of treatments followed by 75 per cent RDF (262.91 kg/ha). Control treatment showed the lowest uptake of nitrogen.

ii. Uptake of phosphorus

The uptake of phosphorus in plant was significantly higher in treatment 100 per cent RDF (19.74 kg/ha) over rest of fertilizer levels followed by treatment 75 per cent RDF (15.04 kg/ha). The control treatment was showed the lowest uptake of phosphorus.

iii. Uptake of potassium

The uptake of potassium was significantly higher in plant by the treatment 100 per cent RDF (64.29 kg/ha) over rest of fertilizer levels followed by the 75 per cent RDF (52.93 kg/ha). The lowest uptake of potassium was observed in control treatment.

c. Effect of interaction

The mean total uptake of nitrogen, phosphorus and potassium was not influenced significantly by interaction.

4.1.4.4 Available N, P, K and organic carbon content status of soil after harvest

The data regarding soil available N, P, K (kg/ha) and organic carbon (%) status in soil at harvest of pea crop as influenced by various treatments are presented in Table 27. The soil available N, P, K and organic carbon content after harvest of

pea crop was 216.01, 18.87, 389.35 kg/ha and 0.68 per cent respectively.

a. Effect of organic manures

The soil available N, P, K and organic carbon content in soil at harvest was significantly affected by various organic manures treatments under study.

1. Available nitrogen

The maximum available nitrogen in soil was observed in treatment FYM 5 t/ha (229.6 kg/ha) followed by vermicompost @ 2.5 t/ha (226.3 kg/ha). The lowest available nitrogen in soil was in treatment control (188.4 kg/ha).

2. Available phosphorus

The highest available phosphorus in soil was observed in treatment FYM @ 5 t/ha (22.1 kg/ha), which was at par with the treatment vermicompost @ 2.5 t/ha (21.8 kg/ha). The lowest available phosphorous in treatment where no application of any manures (12.6 kg/ha).

3. Available potassium

The soil available potassium was significantly more in treatment FYM @ 5 t/ha (415.3 kg/ha) over the rest of treatments which was at par with the treatment vermicompost @ 2.5 t/ha (410.1 kg/ha). Control treatment showed the lowest available potassium (344.1 kg/ha) in soil.

4. Organic carbon

The highest soil organic carbon content was observed in the treatment FYM 5 t/ha (0.72 %), which was at par with the

treatment vermicompost @ 2.5 t/ha. The lowest organic carbon in soil was observed in control treatment.

These results are inconformity with Acharya *et al.* (1988), Ritamoni *et al.* (1999).

b. Effect of inorganic fertilizer

Application of different levels of fertilizer significantly influenced the soil available nitrogen, phosphorus, potassium and organic carbon content in soil at harvest.

i. Available nitrogen

Application of 100 per cent RDF recorded maximum soil available nitrogen (232.00 kg/ha). Which was significantly superior over rest of the fertilizer levels followed by 75 per cent RDF (227.1 kg/ha). It was followed by 50 per cent RDF (220.9 kg/ha). The lowest soil available nitrogen was showed by the control treatment.

ii. Available phosphorus

Application of 100 per cent RDF recorded maximum soil available phosphorus (22.6 kg/ha). Which was significantly superior over rest of the fertilizer levels followed by 75 per cent RDF (21.7 kg/ha) and 50 per cent (19.0 kg/ha). Control treatment showed the lowest available phosphorus in soil.

iii. Available potassium

Application of 100 per cent RDF recorded maximum available potassium (425.9 kg/ha) followed by the 75 per cent RDF treatment (406.3 kg/ha). No application of fertilizer showed the lowest available potassium in soil.

iv. Organic carbon

Application of 100 per cent RDF showed maximum organic carbon content (0.71 %) in soil. Which was followed by 75 per cent RDF (0.68 %). The lowest organic carbon content was observed in control treatment (0.64 %).

c. Effect of interaction

The available nitrogen, phosphorus, potassium and organic carbon content in soil at harvest of pea crop was non significant by various treatment.

4.1.5 Economics of pea cultivation

The data in respect of economics of pea under organic manures and inorganic fertilizer management under different treatment are presented in Table 29.

The mean value for cost of cultivation (Rs/ha), gross monetary returns, net monetary returns and benefit : cost ratio were Rs. 28470, Rs. 46757, Rs. 18287 and 1.64 respectively.

a. Effect of organic manure

The highest cost of cultivation (Rs. 30729/ha) was recorded by treatment vermicompost @ 2.5 t/ha.

Gross monetary returns were the highest in treatment FYM @ 5 t/ha (Rs. 52704/ha) followed by vermicompost @ 2.5 t/ha (Rs. 48204/ha).

The net monetary returns were maximum in treatment FYM @ 5 t/ha (Rs. 23792/ha), followed by vermicompost @ 2.5 t/ha (Rs. 17475/ha). The lowest net monetary returns was recorded in control treatment (Rs. 6233/ha).

The benefit cost ratio was maximum (1.82) in FYM @ 5 t/ha, followed by vermicompost @ 2.5 t/ha (1.57) and minimum in control (1.23).

b. Effect of inorganic fertilizer

The highest gross monetary returns, net monetary returns and benefit : cost ratio were recorded in 100 per cent RDF (Rs. 61716, Rs. 31900/ha and 2.07), followed by 75 per cent RDF. Whereas, treatment control recorded lowest gross monetary returns, net monetary returns and benefit : cost ratio which were Rs. 31584, Rs. 5224/ha and 1.20, respectively.

4.2 Performance of succeeding forage maize

4.2.1 Initial and final plant count

The data regarding per cent initial and final plant count as affected by various treatments are presented in Table 30.

The data indicated that the mean per cent initial and final plant count was 97.03 and 95.12.

a. Effect of organic manure

There was uniform initial and final plant stand in all the experimental plots and plant it was not affected by any of the factor under study.

b. Effect of inorganic fertilizer

The various levels of fertilizer did not influence initial and final plant count.

c. Effect of interaction

The mean initial and final plant stand was not significantly influenced by interaction.

4.2.2 Plant height

The data in respect of plant height of maize as affected by different treatment are presented in Table 31 and graphically depicted in Fig. 10. The mean plant height was 13.16, 28.70, 62.02 and 82.17 cm at 30, 45, 60 DAS and at harvest, respectively.

a. Effect of organic manure

The plant height was significantly increased at all stages of crop growth. The mean plant height registered by residual effect of FYM @ 5 t/ha was significantly the highest and superior at 30, 45 and 60 DAS and at harvest. The mean value of plant height by FYM @ 5 t/ha at harvest was 108.23 cm.

b. Effect of inorganic fertilizer

The plant height of maize was found to be significantly higher at all stages of crop growth, due to residual effect of inorganic fertilizers applied to preceding *rabi* pea.

The mean plant height with fertilizer level 100 per cent RDF was 15.92, 33.42, 78.92 and 102.54 cm at 30, 45, 60 DAS and at harvest, respectively and it was significantly superior over rest of fertilizer levels followed by treatment 75 per cent RDF. The treatment 75 per cent RDF was found to be at par with 50 per cent RDF at 45, 60 DAS and at harvest. The lowest plant height was exhibited by control treatment.

c. Effect of interaction

The mean plant height was not significantly influenced by the interaction between various treatments.

4.2.3 Number of functional leaves per plant

The data pertaining to mean number of functional leaves per plant influenced by various treatment at different crops growth stages are presented in Table 32 and graphically depicted in Fig. 11. The data indicate that steady increase in mean functional leaves per plant was from 4.35 to 7.02 at 30 to 60 DAS and declined to 6.77 at harvest.

a. Effect of organic manure

The mean number of functional leaves per plant differed significantly due to organic manures applied to preceding pea crop. Application of FYM @ 5 t/ha was recorded significantly higher number of functional leaves 5.22 and 6.03, 8.14 and 7.92 at 30, 45, 60 DAS at harvest, respectively. It was at par with vermicompost @ 2.5 t/ha at 60 and at harvest. Minimum number of functional leaves was recorded in control treatment.

b. Effect of inorganic fertilizer

The mean number of functional leaves in treatment 100 per cent RDF was 6.02 and 8.18 at 45 and 60 DAS followed by the treatment 75 per cent RDF. The 100 per cent RDF was at par with 75 per cent RDF at 30 DAS and at harvest for their number of functional leaves. The lowest number of functional leaves were recorded by control treatment.

c. Effect of interaction

The mean number of functional leaves per plant was not influenced by the interaction between various treatment.

4.2.4 Stem girth

The data presented in Table 33 revealed that the mean stem girth of maize was significantly influenced by various treatment. The mean stem girth was 3.45, 3.99, 5.96 and 6.23 cm at 30, 45, 60 DAS and at harvest.

a. Effect of organic manure

The stem girth was significantly influenced due to organic manures to preceding *rabi* pea at all stages of crop growth during experimentation. The mean stem girth in treatment FYM @ 5 t/ha was 4.12, 4.65 and 6.56, 6.98 cm at 30, 45, 60 DAS and at harvest respectively. It was followed by the treatment vermicompost @ 2.5 t/ha. The application of FYM @ 5 t/ha was found at par with vermicompost @ 2.5 t/ha at 60 DAS and at harvest. The lowest stem girth was recorded in control treatment.

b. Effect of inorganic fertilizer

The stem girth was significant due to application of inorganic fertilizer to the preceding *rabi* pea.

The mean stem girth in the treatment 100 per cent RDF was 4.09, 4.56, 6.79 and 6.91 cm at 30, 45, 60 DAS and at harvest, respectively and it was significantly superior over rest of the treatments, followed by the treatment 75 per cent RDF. The lowest stem girth was recorded in control treatment.

c. Effect of interaction

Effect of interaction between organic manures and inorganic fertilizers was significant at 60 DAS (Table 34). The highest mean stem girth (7.78 cm) was recorded under treatment

combination of 100 per cent RDF and FYM @ 5 t/ha. The lowest mean stem girth was reported in the control treatment (4.25 cm).

Table 34. Mean stem girth (cm) at 60 DAS as influenced by interaction

Treatments	Inorganic fertilizers			
	Control	50 % RDF	75 % RDF	100 % RDF
A. Organic manure				
Control	4.25	5.20	5.39	5.42
FYM @ 5 t ha^{-1}	5.43	6.12	6.85	7.78
Vermicompost @ 2.5 t ha^{-1}	5.11	5.98	6.70	7.18
S.E. $\pm$	0.25			
CD at 5 %	0.65			

4.2.5 Leaf area per plant

The data pertaining to mean leaf area per plant of maize as influenced periodically by various treatments are presented in Table 35. It could be revealed from the data that the mean leaf area per plant was found to increase progressively with the advancement in the crop age and reached maximum at 60 DAS and further declined at harvest. The mean value of leaf area per plant ranged during crop growth period from 5.86 to 25. 64 dm^2 at 30 to 60 DAS and 21.70 dm^2 at harvest.

a. Effect of organic manure

The mean leaf area per plant was influenced significantly due to organic manures to preceding *rabi* pea. The mean leaf area recorded significantly the highest by FYM @ 5 t/ha than rest of the treatments. The use of vermicompost @ 2.5

t/ha was at par with FYM @ 5 t/ha at 45 DAS. The value of leaf area recorded by FYM @ 5 t/ha was 7.19, 10.28, 33.28 and 27.35 dm^2 at 30, 45, 60 DAS and at harvest, respectively. The lowest mean leaf area per plant was recorded in the treatment control.

b. Effect of inorganic fertilizer

The leaf area per plant was found to be significantly influenced due to residual effect of inorganic fertilizer to the preceding *rabi* pea.

The mean leaf area per plant with fertilizer level 100 per cent RDF was 6.73, 9.90 and 32.82 and 26.20 dm^{-2} at 30, 45, 60 DAS and at harvest, respectively and it was significantly superior over rest of the fertilizer levels followed by treatment 75 per cent RDF. The lowest leaf area per plant was recorded by the control treatment.

c. Effect of interaction

The mean leaf area per plant was not influenced significantly by the interaction effect of different treatment at all days of observations except at 60 DAS.

The interaction data in Table 36 indicate that the highest mean leaf area per plant (43.86 dm^2) was obtained in the treatment combination of 100 per cent RDF and FYM @ 5 t/ha. The lowest mean leaf area of maize (14.52 dm^2/plant) was recorded in control treatment.

Table 36. Mean leaf area of maize (dm^2/plant) at 60 DAS as influenced by interaction

Treatments	Inorganic fertilizers			
	Control	50 % RDF	75 % RDF	100 % RDF
A. Organic manure				
Control	14.52	17.62	18.88	20.12
FYM @ 5 t ha^{-1}	21.72	26.68	34.87	43.86
Vermicompost @ 2.5 t ha^{-1}	18.41	22.45	29.10	40.48
S.E. $\pm$	1.65			
CD at 5 %	4.99			

4.2.6 Dry matter per plant

The data related to mean dry matter per plant as influenced by various treatments are presented in Table 37. The mean dry matter per plant was 2.46, 8.99. 18.42 and 29.73 g at 30, 45, 60 DAS and at harvest, respectively. It can be seen from the table that dry matter per plant was increased with the advancement in crop age.

a. Effect of organic manures

Data in Table 37 indicate that the organic manures to preceding *rabi* pea significantly influenced the dry matter per plant at all stages of crop growth. The mean dry matter per plant in treatment FYM @ 5 t/ha was 3.26, 14.78, 29.82 and 43.39 g at 30, 45, 60 DAS and at harvest respectively and significantly higher than rest of the treatments. The lowest dry matter accumulation was found in control treatment.

b. Effect of inorganic fertilizers

The mean difference in dry matter per plant was significant due to inorganic fertilizer application to preceding *rabi* pea.

The mean dry matter per plant with fertilizer level 100 per cent RDF was 3.12, 14.31, 29.34 and 42.65 g at 30, 45, 60 DAS and at harvest respectively and it was significantly superior over rest of the fertilizer levels. It was followed by treatment 75 per cent RDF. The lowest dry matter accumulation was recorded by control treatment.

c. Effect of interaction

The mean dry matter per plant was influenced significantly by interaction at 45 DAS only. The interaction data in Table 38 indicated that the highest mean dry matter per plant (22.78 g) was recorded with treatment combination of 100 per cent RDF and FYM @ 5 t/ha. The lowest mean dry matter per plant (2.39 g) was recorded in control treatment.

Table 38. Mean dry matter per plant (g) at 45 DAS as influenced by interaction

Treatment	Inorganic fertilizer			
	Control	50 % RDF	75 % RDF	100 % RDF
A. Organic manure				
Control	2.39	3.46	3.56	4.30
FYM @ 5 t ha^{-1}	4.84	8.06	15.37	22.78
Vermicompost @ 2.5 t ha^{-1}	2.91	4.47	11.14	16.86
S.E. $\pm$	0.76			
CD at 5 %	2.33			

4.2.7 Green forage yield

The data related to mean green forage yield as influenced by preceding *rabi* pea by various treatment are presented in Table 39 and graphically depicted in Fig. 8. The data indicated that the mean green forage yield was 150.99 q/ha.

a. Effect of organic manure

The differences in mean green forage yield of maize due to residual effect of preceding *rabi* pea were significant and the green forage yield obtained by FYM @ 5 t/ha was the highest (189.97 q/ha) and significantly higher than the rest of treatments followed by treatment vermicompost @ 2.5 t/ha (175.21 q/ha). The lowest green forage yield was observed in control treatment.

b. Effect of inorganic fertilizer

The mean green forage yield was increased significantly with each successive increase in fertilizer level to preceding *rabi* pea. The highest and significantly more green forage yield was recorded in 100 per cent RDF (182.64 q/ha) than rest of the treatment. It was followed by the treatment 75 per cent RDF (171.09 q/ha). Treatment 75 per cent RDF was at par with 50 per cent RDF. The lowest green forage yield was observed in control treatment.

c. Effect of interaction

The interaction between organic and inorganic treatments was found significant.

The interaction data in Table 40 indicate that the highest green forage yield of maize (230.18 q/ha) was recorded with treatment combination of 100 per cent RDF and FYM @ 5 t/ha. The lowest mean green forage yield of maize (52.95 q/ha) with the control treatment.

Table 40. Mean green forage yield (q/ha) as influenced by interaction

Treatments	Inorganic fertilizer			
	Control	50 % RDF	75 % RDF	100 % RDF
A. Organic manure				
Control	52.95	98.57	108.17	130.46
FYM @ 5 t ha^{-1}	89.18	192.96	216.41	230.18
Vermicompost @ 2.5 t ha^{-1}	80.12	176.12	196.26	221.98
S.E. $\pm$	6.75			
CD at 5 %	20.40			

4.2.8 Economics of forage maize cultivation

The data in respects to economics of forage maize under residual effect of organic manure and inorganic fertilizer to pea under different treatments are presented in Table 41.

The mean value for cost of cultivation, gross monetary returns, net monetary returns and benefit: cost ratio were Rs. 10452, Rs. 12002, Rs. 1550/ha and 1.15, respectively.

a. Effect of organic manures

The highest gross monetary returns, net monetary returns and benefit : cost ratio were recorded in treatment FYM @ 5 t/ha (Rs. 14085, Rs. 3633 and 1.34) followed by

vermicompost @ 2.5 t/ha. The lowest gross monetary returns, net monetary returns and benefit : cost ratio (Rs. 7236/ha, Rs. –3216/ha and -0.69) was recorded in control treatment.

b. Effect of inorganic fertilizers

The highest gross and net monetary returns and benefit : cost ratio were recorded in fertilizer level 100 per cent RDF (Rs. 15918, Rs. 5446/ha and 1.52) followed by 75 per cent RDF whereas, control treatment recorded the lowest gross and net monetary returns and benefit : cost ratio (Rs. 6926/ha, Rs. -3526/ha and -0.66).

5. SUMMARY AND CONCLUSIONS

5.1 Summary

The present agronomic investigation entitled, “Effect of organic manures and inorganic fertilizers on growth and yield of green pea and its residual effect on succeeding summer forage maize” was carried out during *rabi* season 2004-05 at Post Graduate Institute Farm of Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar, Maharashtra.

The experiment was laid out in Factorial Randomized Block Design (FRBD) with three organic sources and four fertilizer levels replicated thrice with three treatments of organic manure *viz.,* control, FYM @ 5 t/ha, vermicompost 2.5 t/ha and four levels of fertilizer *viz.,* control, 50 per cent RDF, 75 per cent RDF 100 per cent RDF for pea. The experiment was conducted on same site without changing randomization of treatments for successive season to assess the residual effect on green forage maize.

The sowing of pea was done on 20 November 2004 and sowing of maize was done on 11 March 2005 with 60 cm x 20 cm spacing. The gross and net plot sizes were 4.50 x 3.00 m^2 and 3.90 x 2.40 m^2, respectively. The soil type of experimental plot was sandy clay loam in texture. It was low in available nitrogen (202.7 kg/ha), high in available phosphorus (18.2 kg/ha) and high in potassium (360.8 kg/ha). It was alkaline in reaction (pH 8.2). The manures were applied as FYM and Vermicompost. The fertilizer levels of RDF applied through urea, single superphosphate and muriate of potash. At the time of pea sowing, half dose of nitrogen was given and remaining half dose of nitrogen was given after one

month of sowing as per the treatment. Whereas, full dose of phosphorus, potassium and whole quantity of FYM and Vermicompost were applied at the time of sowing of pea as per treatment while fertilizer to succeeding crop of maize was not given.

The data in respect to important growth and yield attributes of pea and maize crops were recorded. The crops were also assessed through gross and net monetary returns, B:C ratio and nutrient uptake by both the crops.

The periodical studies on pea crop revealed that mean maximum growth of pea at harvest in respect of plant height, plant spread, number of functional leaves, leaf area and total dry matter per plant were 40.45 cm, 25.16 cm, 62.25, 4.15 dm^2 and 19.62 g respectively.

The mean maximum number of pods and length of pods per plant at harvest was 21.47 and 6.10 cm. Whereas, mean fresh weight of pods was 23.64 g/plant. The mean green pea yield and straw yield was 38.96 and 12.85 q/ha. The pea crop removed 220.39 kg nitrogen, 14.30 kg phosphorus and 44.53 kg potassium ha.

The maize crop was also studied periodically and observed that the mean maximum growth of crop at harvest in respect of plant height, stem girth, number of functional leaves, leaf area and dry matter were 69.08 cm, 6.29 cm, 6.79, 21.70 dm^2 and 28.30 g, respectively. The mean forage yield of 150.03 q/ha was recorded.

The important findings of investigation are summarized as follows.

5.1.1 Performance of pea (*rabi*)

5.1.1.1 Effect of organic manures

The plant population of pea both at initial and final stage of crop was satisfactory. The difference in population at both the stages in different treatments were non-significant indicate that the treatments under study were exposed to exhibit their performance on equal basis.

The treatments differ significantly from each other in respect of all growth and yield contributing characters. The maximum plant height (43.10 cm), plant spread (26.88 cm), number of functional leaves (65.59), leaf area (4.52 dm^2) and total dry matter per plant (16.20 g) was observed in treatment application of FYM @ 5 t/ha which was at par with treatment Vermicompost @ 2.5 t/ha.

At harvest the mean number of pods per plant was the highest (28.87) in FYM @ 5 t/ha which was at par with Vermicompost @ 2.5 t/ha (27.25) whereas, the lowest pods were recorded in control (22.07) treatment. The mean length of pod per plant was maximum in treatment FYM 5 t/ha (6.32 cm), which was at par with treatment Vermicompost @ 2.5 t/ha (6.20 cm). It was minimum in control (5.64 cm) treatment. The mean fresh weight of pods per plant was maximum in treatment FYM @ 5 t/ha (26.23 g), which was at par with treatment Vermicompost @ 2.5 t/ha (24.49 g) whereas minimum was observed in control treatment (19.78 g).

At harvest maximum total dry matter per plant (16.20 g) was showed in treatment FYM @ 5 t/ha which was at par with treatment Vermicompost @ 2.5 t/ha (15.84 g) whereas, minimum in treatment control (12.46 g).

All treatments differed significantly in respect of total pod yield and straw yield/ha. Application of FYM @ 5 t/ha recorded maximum total pod yield and straw yield *viz.,* 43.92 q/ha and 13.22 q/ha. Which was at par with the treatment vermicompost @ 2.5 t/ha (40.17 q/ha and 11.76 q/ha).

Application of organic manures significantly influenced the content of nitrogen, phosphorus and potassium in plant at harvest. The maximum values were exhibited by treatment with FYM @ 5 t/ha as nitrogen (6.10 %), phosphorus (0.49 %) and potassium (2.83 %).

The nitrogen, phosphorus and potassium uptake by plant was significantly affected. The maximum uptake of nitrogen (269.15 kg/ha), phosphorus (16.74 kg/ha) and potassium (51.48 kg/ha) was observed in application of FYM @ 5 t/ha. The maximum residual nitrogen (229.6 kg/ha), phosphorus (22.10 kg/ha), potassium (415.3 kg/ha) and organic carbon (0.72 %) were observed in the treatment of vermicompost @ 2.5 t/ha.

The lowest cost of cultivation was recorded by treatment control (Rs. 26,359/ha) and the highest in Vermicompost @ 2.5 t/ha (Rs. 30,729/ha). The highest gross monetary return (Rs. 52704/ha), net monetary returns (Rs. 23792/ha) and benefit : cost ratio (1.82) were recorded in treatment FYM @ 5 t/ha.

5.1.1.2 Effect of inorganic fertilizer

The plant population of pea crop was not influenced significantly to different inorganic fertilizer level. The growth of pea crop measured in terms of plant height (48.01 cm), plant spread (28.96 cm), number of leaves (71.98) and leaf area (4.45 dm^2) were maximum under fertilizer application of 100 per cent RDF.

The mean number of pods per plant was the highest (31.84) due to application of 100 per cent RDF followed by fertilizer level 75 per cent RDF (29.01). Which was further followed by 50 per cent RDF (26.25) and the lowest in control (17.16). The mean length of pod per plant was the highest (6.56 cm) due to application of 100 per cent RDF which was at par with 75 per cent RDF (6.39 cm) which was further, followed by 50 per cent RDF (5.91 cm) and the lowest in control treatment (5.37 cm). The mean fresh weight of green pods was observed maximum in 100 per cent RDF (28.71 g), followed by 75 per cent RDF (26.11 g), which was at par with 50 per cent RDF (23.73 g). The lowest green pod weight was observed in control treatment (15.46 g).

At harvest maximum dry matter per plant was showed by 100 per cent RDF (30.92 g) followed by 75 per cent RDF (26.48 g). Which was at par with 50 per cent RDF however, the least dry matter was recorded by control treatment (12.57 g).

Total green pod and straw yield was recorded highest under 100 per cent RDF (51.43 q/ha and 16.67 q/ha), which was followed by 75 per cent RDF (45.19 q/ha and 15.22 q/ha). The lowest values were observed in treatment control (26.32 q/ha and 9.51 q/ha).

The N, P, K content in plant was significantly influenced by different fertilizer levels. The highest values were recorded by 100 per cent RDF as nitrogen (6.38 %), phosphorus (0.51 %) and potassium (2.92 %).

Application of 100 per cent RDF showed maximum nitrogen uptake (312.46 kg/ha), phosphorus (19.74 kg/ha) and potassium (64.29 kg/ha).

The maximum residual nitrogen (232 kg/ha), phosphorus (22.6 kg/ha), potassium (425.9 kg/ha) and organic carbon (0.71 %) was recorded in 100 % RDF. The highest gross monetary returns (Rs. 61716/ha), net monetary returns (Rs. 31900/ha) and benefit : cost ratio (2.07) were recorded in fertilizer level 100 per cent RDF.

5.1.1.3 Effect of interaction

Application of FYM @ 5 t/ha reported maximum weight of pods (34.31 g) per plant at harvest in combination with fertilizer level 100 per cent RDF.

Application of FYM @ 5 t/ha in combination with fertilizer level 100 per cent RDF produced maximum total green pod yield (50.59 q/ha) which was followed by 75 per cent RDF in combination with FYM @ 5 t/ha (48.90 q/ha).

5.1.2 Performance of forage summer maize

5.1.2.1 Effect of organic manure

The treatments with organic manures were significantly influenced in respect to growth and yield of crop. The initial and final plant stand was almost uniform in all the treatments.

The maximum plant height was observed (108.23 cm) due to treatment of application of FYM @ 5 t/ha followed by vermicompost @ 2.5 t/ha (95.74 cm).

The highest mean stem girth (6.98 cm) was noticed in treatment of FYM @ 5 t/ha while the lowest value (5.36 cm) exhibit in control treatment.

At harvest the mean number of functional leaves was maximum (7.92) due to the treatment with application of FYM @ 5 t/ha which was at par with vermicompost @ 2.5 t/ha (7.81).

Whereas, least value of functional leaves showed by control treatment (4.12).

At harvest mean leaf area was maximum (27.35 dm^2) in treatment of FYM @ 5 t/ha followed by application of vermicompost @ 2.5 t/ha (23.25 dm^2). The minimum leaf area (15.91 dm^2) was recorded in control treatment.

The mean dry matter per plant at harvest recorded the highest value (43.39 g) with the application of FYM @ 5 t/ha and least (16.08 g) value by control treatment.

The mean green forage yield showed the highest value (198.97 q/ha) with application of FYM @ 5 t/ha. Whereas, treatment with vermicompost @ 2.5 t/ha (173.21 q/ha) was next in order to merit. The least value related to the control treatment (90.45 q/ha).

The treatment vermicompost @ 2.5 t/ha recorded the highest gross monetary returns (Rs. 14085), net monetary returns (Rs. 3633/ha) and benefit : cost ratio (1.34).

5.1.2.2 Effect of inorganic fertilizers

The various levels of fertilizer did not influence the initial and final plant count.

The growth and yield contributing characters were significantly differed by various levels of inorganic fertilizers. The highest mean plant height (102.54 cm) was recorded in 100 per cent RDF to preceding pea crop followed by treatment 75 per cent RDF (96.47 cm) which was at par with 50 per cent RDF (91.22 cm). The lowest plant height was showed in control treatment (38.89 cm).

The highest mean stem girth was due to application of 100 per cent RDF (6.91 cm) and minimum (5.42 cm) due to control treatment.

The mean number of functional leaves at harvest showed maximum (7.89) in treatment 100 per cent RDF and it was at par with 75 per cent RDF (7.85). The minimum value was recorded by control treatment (4.29).

The mean leaf area per plant was maximum (20.20 dm^2) exhibited by treatment with 100 per cent RDF to pea followed by 75 per cent RDF (24.97 dm^2/plant) and minimum in control treatment (15.82 dm^2/plant).

At harvest the mean dry matter per plant was the highest (42.65 g) due to application of 100 per cent RDF to preceding pea and the lowest in control treatment (15.89 g).

The mean green forage yield of maize showed the highest value (182.64 q/ha) due to application of 100 per cent RDF, followed by 75 per cent RDF (171.09 q/ha) and lowest value was exhibited in control treatment (86.57 q/ha).

The fertilizer level 100 per cent RDF to proceeding pea crop recorded the highest gross monetary returns (Rs. 15918/ha), net returns (Rs. 5446/ha) and benefit : cost ratio (1.52).

5.1.2.3 Effect of interaction

The growth attributes such as leaf area, stem girth, dry matter accumulation and green forage yield of maize were significantly influenced by interaction effect of preceding crop of *rabi* pea.

The highest mean stem girth of plant (7.78 cm) was recorded under treatment combination of 100 per cent RDF and FYM @ 5 t/ha at 60 DAS.

Application of 100 per cent RDF reported maximum leaf area per plant (43.86 dm^2) at 60 DAS in combination with FYM @ 5 t/ha.

The maximum mean dry matter accumulation at 45 DAS was 22.78 g/plant with treatment combination of 100 per cent RDF and FYM @ 5 t/ha.

The highest green forage yield of maize 230.18 q/ha was recorded with treatment combination of FYM @ 5 t/ha and 100 per cent RDF which was followed by the treatment combination of vermicompost @ 2.5 t/ha and 100 per cent RDF (221.98 q/ha). Whereas the lowest mean green forage yield of maize 52.95 q/ha was recorded with the control treatment.

5.2 Conclusions

Based on one year experimentation following conclusions are drawn.

1. Application of FYM @ 5 t/ha in combination with 100 per cent RDF (15:60:60 N, P_2O_5, K_2O kg/ha) to green pea produced maximum yield (43.92 q/ha).
2. Application of FYM @ 5 t/ha in combination with fertilizer 100 per cent RDF (15:60:60 NPK kg/ha) to preceding crop pea enhanced the residual effect to succeeding summer forage maize.
3. Among the various organic treatments to pea, FYM @ 5 t/ha gave maximum gross monetary returns (Rs. 52704/ha), net monetary returns (Rs. 23792/ha) and benefit : cost ratio

(1.82). In case of inorganic fertilizer 100 per cent RDF (15:60:60 N, P_2O_5, K_2O/ha) gave maximum gross monetary returns (Rs. 61716/ha), net monetary returns (31900/ha) and benefit : cost ratio (2.07).

For rational comparison and valid conclusion experiment needs conformation.

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* Originals are not seen

7. APPENDIX

Details of prices used for calculation of economics

Sr. No.	Particular	Rate (Rs.)
1.	Tractor ploughing	1200/ha
2.	Tractor discing	600/ha
3.	Tractor harrowing	600/ha
4.	Labour charges/head	50/day
5.	Cost of seed	
	i. Pea	18/kg
	ii. Maize	15/kg
6.	Cost of organic manures	
	i. FYM	350/t
	ii. Vermicompost	3/kg
7.	Cost of chemical fertilizers	
	i. Urea	4.80/kg
	ii. Single super phosphate	3.40/kg
	iii. Murate of potash	4.40/kg
8.	Cost of biofertilizers	
	i. Rhizobium	20/packet
9.	Irrigation charges/turn	200/ha
10.	Plant protection	
	i. Thimate	60/kg
11.	Main product	
	i. Green pea yield	1200/q
	ii. Green forage maize	800/t

8. VITA

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A candidate for the degree

of

MASTER OF SCIENCE (AGRICULTURE)

in

AGRONOMY

2007

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