STUDIES ON THE EFFECT OF ORGANIC MANURES AND INORGANIC FERTILIZERS ON PRODUCTION AND QUALITY OF OKRA (*Abelmoschus esculentus* L.)

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**THESIS SUBMITTED TO THE
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CERTIFICATE

This is to certify that the thesis entitled "**STUDIES ON THE EFFECT OF ORGANIC MANURES AND INORGANIC FERTILIZERS ON PRODUCTION AND QUALITY OF OKRA (*Abelmoschus esculentus* L.)**" is submitted in partial fulfilment of the requirements for the degree of **"MASTER OF SCIENCE IN HORTICULTURE"** of the **Acharya N.G. Ranga Agricultural University, Hyderabad**, is a record of the bonafide research work carried out by **Mr. C. RAMA KRISHNA** under our guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee.

No part of the thesis has been submitted for any other degree or diploma. The published part has been fully acknowledged. All assistance and help received during the course of the investigation have been duly acknowledged by the author of the thesis.

(Dr. N. VIJAYA)
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CERTIFICATE

Mr. C. RAMA KRISHNA has satisfactorily prosecuted the course of research and that the thesis entitled **"STUDIES ON THE EFFECT OF ORGANIC MANURES AND INORGANIC FERTILIZERS ON PRODUCTION AND QUALITY OF OKRA (*Abelmoschus esculentus* L.)"** submitted is the result of original research work and is of sufficiently high standard to warrant its presentation to the examination. I also certify that the thesis or part thereof has not been previously submitted by him for a degree of any university**.**

Date :	**(Dr. N. VIJAYA)**
Place : Hyderabad	Chairman of the Advisory committee

DECLARATION

I, C. RAMA KRISHNA hereby declare that the thesis entitled "**STUDIES ON THE EFFECT OF ORGANIC MANURES AND INORGANIC FERTILIZERS ON PRODUCTION AND QUALITY OF OKRA (*Abelmoschus esculentus* L.)"** submitted to **ACHARYA N.G. RANGA AGRICULTURAL UNIVERSITY** for the degree of **MASTER OF SCIENCE IN HORTICULTURE** is the result of original research work done by me. It is also further declared that the thesis or any part thereof has not been published earlier in any manner.

Date : **(C. RAMA KRISHNA)**

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LIST OF ABBREVIATIONS

a.i.	-	active ingredient
CD	-	Critical deviation
cm	-	centimeter
cv	-	cultivar
DAS	-	Days after sowing
dSm^{-1}	-	desi simen per meter
E.C.	-	Electrical conductivity
et al.	-	at all bi (and others)
Fig	-	Figure
FYM	-	Farmyard manure
Kg ha^{-1}	-	Kilogram(s) per hectare
m	-	meter
m^2	-	square meter
N	-	Nitrogen
$plant^{-1}$	-	per plant
q ha^{-1}	-	quintal per hectare
RDNF	-	Recommended dose of nitrogen fertility
S.Em.	-	Standard error of mean
t ha^{-1}	-	tonnes per hectare
VC	-	Vermicompost
viz.	-	namely

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ABSTRACT

A field experiment was conducted during February to April, 2001 at Students' Farm, College of Agriculture, Rajendranagar, Hyderabad to "study the effect of organic and inorganic sources of nitrogen on yield and quality of okra". Two cultivars *viz.*, cv. Arka Anamika and cv. Parbhani Kranthi were selected for this study. The treatments consisted of 4 levels (25, 50, 75 and 100 per cent substitution to recommended nitrogen) each of farmyard manure and vermicompost along with 100 per cent recommended nitrogen through inorganic form of fertilizer and a control. The experiment was laid out in a randomized block design with three replications.

The results indicated that application of 50 per cent RDNF through vermicompost and 50 per cent through inorganic fertilizer recorded maximum plant height, pod yield and dry matter production of pod. Among the two cultivars studied, cv. Arka Anamika recorded maximum pod yield followed by cv. Parbhani Kranthi.

Maximum number of nodes and pods per plant were recorded with the application of 50 per cent RDNF through vermicompost and 50 per cent RDNF through inorganic fertilizer.

Among the two cultivars Parbhani Kranthi recorded less number of days for first flower appearance. But the effect of organic and inorganic sources of nitrogen did not influence the number of days taken from flowering to harvesting.

The application of organic manures improved the quality parameters of okra *viz.,* pod length, crude fibre development. The influence was highly significant with vermicompost applied plots. Maximum pod length and low crude fibre content was observed with 50 per cent RDNF through vermicompost and 50 per cent RDNF through inorganic fertilizers in both the cultivars studied.

Among the two cultivars the gross costs (Rs.35,529), gross returns (Rs.87,425) and cost benefit ratio (2.46) were highest with 50 per cent RDNF through vermicompost and 50 per cent RDNF through inorganic fertilizer in cv. Arka Anamika, followed by cv. Parbhani Kranthi.

CHAPTER – I

INTRODUCTION

Bhendi or okra (*Abelmoschus esculentus* (L.) Moench) is one of the most important vegetable crops of India, especially in Southern States. The crop is grown over a wide range of soil and climatic conditions throughout the year. Presently, according to Centre for Monitoring Indian Economy (2001) the estimated area and production of okra in India is about 3.48 lakh hectares and 34.12 lakh tonnes, respectively along with growth rate of 0.95 and 1.12 during the last decade. The average productivity of okra in India is only 9.8 t ha^{-1}. The ineffective nutrient management is one of the reason for low productivity.

The organic matter content of cultivated soils of the tropics and subtropics is low due to high temperature and intensive microbial activity. India’s share in overall soil organic carbon stock of the world is only about 3 per cent, although it covers 11.9 per cent of the total geographical area of the world (Singh and Biswas, 2000). Therefore, soil humus has to be replenished through periodic addition of organic manures as increased cost of fossil fuels, shortages in energy and production of chemical fertilizers are expected to accentuate in the near future. Apart from this yield responses to applied fertilizers are fast declining from 15 kg yield per kg nutrient applied to a level of 8 kg yield per kg of nutrient applied (Saxena, 1998). Hence there is a need for use of organic manures for supplementing chemical fertilizers.

The advent of modern varieties and increased area under assured irrigation facilities led to a major shift from organic based nutrient application to chemical fertilizer. Consequently, the consumption of organic manures, which traditionally were important nutrient resources declined substantially. Excessive use of inorganic fertilizers to obtain high yields resulted in several hazards to soil like heavy withdrawal of nutrients (Prasad and Singh, 1981), deficiency of micronutrients (Kanwar and Randhawa, 1978) and nutrient imbalance (Singh *et al.,* 1989), ultimately resulting in the reduction of crop yields. Besides, the continuous use of chemical fertilizers affected the soil fertility and also caused ground water pollution. Hence, proper blending of chemical fertilizers with organic manures will improve soil health and also helps in maximizing production.

Application of organic manures alone (or) in combination with chemical fertilizers play a vital role in keeping the soil productivity high. The organic manure acts as a source of major and micronutrients, improves soil texture, increases water holding capacity, increases soil microbial activity, reduces phosphate fixing capacity of soil, helps in slow release of nitrogen and also reduces leaching losses and improves fertilizer use efficiency. The importance of integrated nutrient management in increasing and sustaining crop production has been amply documented (Subba Rao, 1991; Meelu, 1996).

Among several organic manures, vermicompost helps to improve the soil texture, protects soil fertility and helps to boost productivity. Continuous use of vermicompost over the years has resulted in reduction of pest and disease problems, besides building resistance to pests and diseases in plants (Ranganathan and Christopher, 1996). Number of workers have reported that the use of vermicompost in vegetables (Huang and Zhao, 1987), fruit crops (Baphna, 1992) flowering plants (Kale *et al.,* 1987) and field crops (Hooger Kamp *et al.,* 1983) has increased the yields both quantitatively and qualitatively with reduced disease and pest incidence.

Though much work has been reported on nutrient management in okra involving inorganic fertilizers but no systematic investigation has been carried out on the use of organic manures along with inorganic fertilizers on production of okra.

Hence, the present investigation entitled “Studies on the effect of organic manures and inorganic fertilizers on production and quality of okra (*Abelmoschus esculentus* L.)” was carried out at Students Farm, College of Agriculture, with the following objectives :

1. To study the effect of organic manures alone and in combination with inorganic fertilizers on growth and yield of okra.

2. To study the effect of organic manures and inorganic fertilizers on quality parameters of okra.

3. To study the best combination of organic and inorganic fertilizers for commercial production of okra.

4. To study the cost benefit ratio of organic and inorganic fertilizers and their combination for production of okra.

CHAPTER –

REVIEW OF LITERATURE

India is the largest producer of vegetables with 12 per cent share to the worlds total vegetable production. However, per capita uptake was only 135 g per day against the requirement of 285 g per day for maintaining proper health (Sharma and Rana, 1993). The scope of brining additional area under this group of crops is very limited. To bridge this gap, use of chemical fertilizers has increased because of quick availability of nutrients but they are costly and at times not readily available; besides in the long run they have resulted in soil health and ecological problems. Farming with organic manures gained importance as it has been claimed that crops raised with them grow and taste well and are more nutritious. The beneficial effects of organic manures in vegetable production have been demonstrated (Singh *et al.*, 1970; and Abusaleha and Shanmugavelu, 1988).

Jwanker *et al.*, (1992) estimated the potentials of some important biological wastes such as cattle dung manure, crop residues, farm litter, rural compost, city refuse, sewage sludge and pressmud which are available to the extent of 279.8, 273.3, 18.7, 285.0, 14.0, 0.5 and 3.2 million tones respectively. From all these sources put together 5.76, 5.02 and 7.67 million tones of N, P_2O_5 and K_2O respectively are available for the purpose of recycling them for crop use. Besides, they also contain

Sulphur, Iron, Zinc, Manganese, Boron and Molybdenum in different amounts.

The use of organic manures like farmyard manure, green manure, poultry manure, vermicompost, castor cake, neem cake, sewage sludge, pressmud etc. along with inorganic fertilizers are reported to increase the yield and quality of produce by supplementing all the nutrients to the crop. Not much work has been done on the use of vermicompost in the integrated nutrient management system in many horticultural crops, particularly in okra. Therefore, the literature on the organic manures and inorganic fertilizers pertaining to other crops is reviewed in this Chapter for interpreting the results obtained in the present investigation.

ORGANIC MANURES AS POTENTIAL SOURCE OF NUTRIENTS

Farmyard manure

Farmyard manure occupies an important position among bulky organic manures. Cattle excreta based FYM in India can potentially supply approximately, 3.3 million tones of N, P and K per year (Gaur *et al.,* 1992).

Gaur (1991) reported that the farmyard manure on an average contains 0.5 to 1 per cent nitrogen, 0.15 to 0.2 per cent P_2O_5 and 0.5 to 0.6 per cent K_2O and has been estimated that a tonne of farm yard manure would supply 3.6 kg N, 1.9 Kg P_2O_5 and 1.8 kg K_2O. Tandon (1992) observed that addition of one tonne of farm yard manure substituted 3.6 kg N + P + K in the ratio of 2 : 1 :1. It has been reported that FYM contains 0.6 to 1.3 per cent N, 0.3 to 0.8 per cent P_2O_5 and 0.4 to 1 per cent K_2O (Chhonker, 1995). Nutrient content of the manures varies considerably depending upon type of animal and nature of feed as protein rich diet result in nitrogen rich excreta.

Vermicompost

Organic manure produced due to activity of earthworms is commonly referred to as vermicompost. It is a mixture of worm costs, which is a rich source of macro and micro nutrients, vitamins, growth hormones and microflora (Bhavalkar, 1991). Curry and Byrne (1992) found that earthworms derived nitrogen could supply 30 per cent of total crop requirement as it is a potential source of readily available nutrients for plant growth. Shinde *et al.* (1992) reported that the Phosphorus content of vermicompost was more than FYM. They also reported the contents of DTPA extractable micronutrinets in vermicompost viz. Fe (17.8 ppm), Mn (24.6 ppm), Zn (19.2 ppm) and Cu (7.6 ppm).

Studies have shown that earthworms contribute about 250 to 500 kg N/ha in a year. In 45-60 days, one kilogram of earthworms can produce approximately 10 kg of vermicastings. Laboratory analysis showed that vermicompost contains 3.0 per cent N, 1 per cent phosphorus and 1.5 kg potash (The Hindu Farmers Note Book, 1994). Jambhelkar (1994) reported that vermicompost contains 2 to 2.5 per cent available nitrogen, 1 – 1.5 per cent available phosphorus ,1 – 1.5 per cent available potassium and also secondary nutrients like calcium, magnesium, micronutrients like Fe, Zn, Mn, Cu and Mo in ample quantities. Further, it contains enzymes like phosphotase, invertase, chitinase etc. and also growth hormones like Indole acetic acid and Gibberellic acid. Microbial analysis confirms that vermicompost is rich in microbes viz., bacteria like Azatobacter, Azospirillum besides number of actinomycetes.

EFFECT OF VERMICOMPOST

Soil Characters

The earth worm as Charles Darwin said “is nature’s plough”. It has been reported that earthworms are regarded as safe, cheap and tireless farm hands. This is so, as earthworms are beneficial soil annelids that play a vital role in nature by improving the condition of the soil.

Bhandari *et al.* (1967) reported that the soil particles in the wormcasts are stabilized by polysaccharide gums produced by earthworm intestinal bacteria. They form water stable soil aggregates which reduces soil erosion. In general earthworm burrows and structural aggregation due to their casting activities promote water entry into the soil and therefore reduced surface runoff, thus reduce soil erosion.

Earthworms help for increasing infiltration rate due to construction of cemented macropores.

Noble *et al.* (1970) also reported that earthworms make extensive burrows which make soil loose and porous, these macropores thus improve water absorption, drainage, aeration for roots and also facilitates root penetration.

Plant growth, yield and quality parameters

Hopp and Slater (1949) related the improved yield of various crops to increase in level of readily available nitrogen either in the presence of dead worms or live worms. They first time made the quantification of crop yield in relation with earthworms. On the contrary, Agarwal (1958) reported that the adverse effects on the soil structure and plant growth by earthworms. Earthworms retarded seed germination, growth and root development of tobacco plants in Gujarat (Patel and Patel, 1959).

On the other hand, beneficial effects of earth worms on growth was reported by several workers. Nielson (1965) observed improved growth in pastures and in other crops which was contributed to the richness of the earthworms fauna and linked to the chemical exudates of earthworms and microbes in association with them.

Hoogercamp *et al.* (1983) reported that the increase in dry matter production in pasture was due to earthworm activity. It was proved that wormcasts can promote lush growth of plants. It may be due to presence of plant growth promoters like cytokinins and auxins in casts (Krishnamoorthy and Vajranabhaiah, 1986).

Application of earthworm casts in cucumber increased yield by 42.5 per cent over control while direct release of earthworms in tangerine, grape, orange, apple and nuts increased the fruit yield (Huang and Zhao, 1987). Kale *et al.* (1987) observed an increase in number of inflorescences per plant as well as early flowering in salvia and increase in stem girth, leaf area index and flower dry matter in aster.

Tomali *et al.* (1990) observed that incorporation of vermicompost increased protein synthesis by 24 and 3 per cent in lettuce and radish respectively.

An extensive study was conducted by Kale *et al.* (1991) on balsam, zinnia, coleus, marigold and lady's lace and observed that vermicompost effect was on par with farmyard manure and chemical fertilizers. They also reported that quantity of fertilization could be reduced by 5 to 30 per cent in radish, tomato, carrot and brinjal with application of vermicompost.

Baphna (1992) reported that *in situ* vermiculture of 2 lakh earthworms per acre resulted 15 tonnes of best manure that was sufficient for improving quality, sweetness, keeping quality and harvest period in sapota. In grape, the input cost was reduced from Rs.1 lakh to RS.40,000/- ha^{-1} by application of vermicompost at the rate of 5 t/ha and increased concentrations of nutrients in petioles with yield at with fertilizer applied plots. The quality of grape bunch, berry attachment, taste and attractive luster were better in vermculture plots. It was also reported that banana plants made good growth without application of any chemicals and with same quantity of vermicompost (Brave, 1992).

Beto *et al.* (1992) found that the inoculation of *Prontoscolex conrothrurus* earthworms significantly increased plant biomass production in tropical fruit tree, *Bixa orellena*. While Desai (1992) reported application of 1 t ha^{-1} vermicompost in capsicum resulted little less yield compared to chemical plot but net profit was more due to less total input cost.

Gunjal and Nikam (1992) found that grape cultivation through *in situ* vermiculture at the rate of 100 worms/vine in combination with heavy mulching of agricultural waste proved successful in grape cultivation without application of chemical fertilizers. The increase in yield was to the tune of 40 to 36 per cent due to application of chemical fertilizers and vermiculture respectively over the control.

Khankar (1992), obtained better quality product in *Coccinia cardifolia* with the application of vermicompost. Application of vermicompost along with oil cake in sapota resulted in increased yield and better quality of fruit (Patil, 1992).

Application of vermicompost in custard apple also improved the quality and size of fruits (Patnaik, 1992). Rose, marigold and ixora showed good result. However, the performance of lawn grass was not good.

Vermicompost as potting mixture significantly increased the height, number of leaves per plant, number of roots per plant, length of root, fresh and dry weight in cardamom seedlings (Vadiraj, 1992).

Kulkarni *et al.* (1996) studied the effect of vermicompost and *in situ* vermiculture on growth and yield of China aster cv Ostrich Plume Mixed. The results revealed that the growth and flower yield at recommended dose of fertilizer + farmyard manure, 75 per cent recommended dose of fertilizer + 2.5 t ha^{-1} vermicompost, 50 per cent recommended dose of fertilizer + 5 t ha^{-1} vermicompost and *in situ* vermiculture at 2 lakh earthworms ha^{-1} were on par. Further the results indicated that by adopting vermiculture one can reduce the usage of chemical fertilizers to the extent of 25 to 50 per cent and without application of any chemical fertilizers by adopting *in situ* vermiculture.

Guptha (1996) observed better quality in terms of luster, taste, keeping quality and stability in yield of grapes in earthworm farming and also saved around Rs.13,000/- ha^{-1} in the first year over fertilizer application.

Ravignanam and Gunathilagaraj (1996) reported that application of recommended dose of NPK fertilizers and earthworm + cowdung + mulch significantly increased the plant height, number of leaves, leaf area, and leaf weight of mulberry in pot culture trail and to a lesser degree in the field trail.

In an experiment, cucumber grown in a plastic in a plastic tunnel and a plastic tunnel and a carrot crop grown in the field were fertilized with vermicompost and mineral fertilizers. In both the cases crop quality was greater with vermicompost than with mineral fertilizers (Kolodziej and Kostecka, 1997).

Sharma and Arya (2001) reported that the application of farm-yard manure @ 20 t/ha significantly increased the cabbage yield (18.7 t/ha) compared to control (14.59 t/ha) and attributed it due to the additional nutrients supplied by the farmyard manure.

Singh *et al.* (2001) reported that the average weight per bulb and bulb yield of onion increased significantly with an increase in level of farmyard manure. Application of farmyard manure @ 10 tonnes/ha increased the yield by 14.2 per cent over control and 5.2 per cent over farmyard manure at 5 t/ha.

Effect of inorganic nitrogen fertilizers on growth, yield and quality parameters of Okra

Chhokor and Singh (1963) found that increase in nitrogen concentration upto 210 ppm stimulated the height of plants but further increase retarded the height of plants.

Sharma and Shukla (1963) obtained highest yields with 120 kg N, 34 to 88 kg P_2O_5 and 49.8 kg K_2O ha^{-1}.

Singh and Singh (1965) reported that a dose of 68 kg of N ha^{-1} in the form of urea applied to soil produced taller plants with better yield compared with other nitrogen sources.

Singh *et al.* (1967) in a three year experiment found a linear increase in the plant height with increasing levels of nitrogen from 37 to 150 kg ha^{-1} added to the soil.

Ahmed and Tulloch Reid (1968) from their experimental studies conducted at Trinidad with bhendi reported significant increase in drymatter production due to application of nitrogen upto 112 kg ha^{-1}. They also reported that the highest yields were obtained with 112 kg N, 168 kg P_2O_5 and 280 kg K_2O ha^{-1}. The fertilization of nitrogen upto 112 kg ha^{-1} and phosphorus upto 280 kg ha^{-1} resulted in an yield increase of 39 and 33 per cent respectively over that of control.

Janardhan and Satyanarayana (1968) observed significant increase in yield with increasing levels of NPK applicaton (56 to 226 kg ha^{-1}). A maximum of 170 q ha^{-1} of pod yield was recorded with 226 kg ha^{-1} each of N, P_2O_5 and K_2O application.

Randhawa and Punnun (1969) reported maximum plant height in Okra with the application of 66 kg N ha^{-1}.

Saimbhi and Padda (1970) reported that an increase in the level of nitrogen application from 67 to 134 kg ha^{-1} increased green pod yield, but higher levels of nitrogen (168 to 201 kg ha^{-1}) were not beneficial.

Verma *et al.* (1970) observed an increase in the number of pods per plant i.e., 3.6 over control with 90 kg N ha^{-1} and 6.27 over control with 90kg N ha^{-1} + 80 kg P_2O_5 ha^{-1}. An increase in pod length of 2.5 cm over control was observed with 120 kg N ha^{-1}.

Asif and Greig (1972) reported that nitrogen application (0 to200 kg ha^{-1}) significantly increased the total pod yield of okra. A maximum pod yield of 132.5 q ha^{-1} was obtained with 135 kg N ha^{-1}. They also reported that more than 60 per cent of the increase in yield came from the first 60 kg N ha^{-1}.

Increase in the level of nitrogen had increased the yield of green pods. Significantly and the maximum yield of 80.4 q green pod per hectare was obtained from the plots applied with highest dose of nitrogen 67.5 kg ha^{-1} (Chauhan and Gupta, 1973). They also reported that higher dose of nitrogen gave maximum number of flowers and fruits per plant.

Verma *et al.* (1974) recorded highest pod yield of 173.8 q ha^{1-} with the application of nitrogen at 150 kg ha^{-1}. The yield increased from 90.7 to 173.8 q ha^{-1} as the level of nitrogen applied increased form 50 to 150 kg ha^{-1}. They observed maximum plant height of 59.9 cm at 200 kg N ha^{-1} and maximum number of pods per plant (9.46) with the application of 150 kg N ha^{-1}. They observed maximum number of nodes per plant with the application of 200 kg N ha^{-1}.

Subbi Reddy (1977) observed an increase in the drymatter production of okra plants with the increase in the levels of nitrogen from 0 to 40 kg ha^{-1}.

Gupta and Rao (1979) reported maximum number of fruits per plant with the application of N upto 100 kg ha^{-1}. They also reported that the optimum level of nitrogen fertilizer application was found to be 116.9 kg ha^{-1} yielding marketable pods of 112.1 q ha^{-1}.

Singh *et al.* (1979) observed that higher doses of nitrogen viz., 75 and 150 kg N ha^{-1} were on par with each other with regard to increase in the height of the plants. These two treatments recorded maximum number of pods per plant.

Hooda *et al.* (1980) applied N at 40 to 120 kg ha^{-1} and P_2O_5 at 30 to 60 kg ha^{-1} and observed highest average pod yield of 126.45 q ha^{-1} with 120 kg N ha^{-1}. The highest number of pods per plant (21.7) was observed at 120 kg N ha^{-1}.

Mani and Ramanathan (1981) reported that the crude fibre content of the okra fruits was significantly decreased by N fertilization. Increasing levels of N application causing an increase in the succulence could have decreased the crude fibre content. Application of 80 kg N ha^{-1} recorded the lowest crude fibre content of 12.91 per cent as against 14.52 per cent in control.

Maximum dry matter production (26.098, 29.3 and 27.94 g plant $^{-1}$ at 30, 60 and 90 DAS respectively) was observed with nitrogen at the highest dose of 200 kg N ha^{-1} (Venugopal, 1981).

Abusaleha and Shanmugavelu (1988) reported highest plant height (144 cm) stem girth (163 cm), leaves (26.6 plant $^{-1}$) and pods (12.4 plant^{-1}) with the application of 40 kg N ha^{-1} through ammonium sulphate. They also reported higher pod yield (108 q ha^{-1}) in fertilizer treated plot than control plot (76 q ha^{-1}).

Dwivedi *et al.* (1993) applied N at 80 to 160 kg ha^{-1} and observed N 120 kg ha^{-1} recorded significant increase in plant height over N 80 kg ha^{-1}. Similarly significant increase in fruits per plant and seed yield (q ha^{-1}) was noted under N 120 kg ha^{-1} as compared to N 80 kg ha^{-1} and N 60 kg ha^{-1}.

Ahmed and Tanki (1997) reported that the plant height, number of branches per plant, number of pods per plant, pod length and number of pods per plant increased significantly with increasing levels of nitrogen application.

Effect of conjunctive use of organic manures and inorganic fertilizers on growth, yield and quality parameters

Organic matter plays a key role in the maintenance of soil fertility and productivity as source of plant nutrients and by providing the physical and physico-chemical properties of soil. Organic matter is known to be related to soil bulk density and aggregate formation in soil. The water retention capacity of the soil is more pronounced with high organic matter content.

Acharya (1945) reported that yields of groundnut, maize and chillies receiving town compost were better than yields obtained from FYM application. Vlamis and Williams (1971) also reported that application of garbage compost increased yields of tomato and lettuce.

Kumar and Mathur (1965) reported that application of plentiful organic matter is essential for carrot cultivation and recommended that 23 tonnes of well rotten manure should be applied to the soil to a depth of 20-25 cm. When organic manure was applied, the need for fertilizer was reduced to 50 kg N, 40 kg P and 60 kg K ha^{-1} as against 80 kg N, 60 kg P and 60 kg K ha^{-1} without organic manure.

Badrova and Gavrilova (1973) reported that application of FYM at 40 t ha^{-1} along with 60 kg ha^{-1} each of N, P and K gave highest tuber yield in potato compared with single application of NPK. Application of poultry manure and fertilizers supplying 80 kg N ha^{-1} have exhibited better response in terms of height (33.15 cm), number of shoots (4.66) and number of leaves in potato (Krithi Singh *et al.,* 1973).

Puskarnath (1976) reported that application of groundnut cake @ 9 q ha^{-1} to potato resulted an yield of 20, 27, 32 and 36 q ha^{-1} at Bihar, U.P., Punjab and West Bengal respectively.

Saraswat and Chettiar (1976) observed that FYM application substantially met the nitrogen requirement in Cassava crop. An yield of 32 t ha^{-1} was recorded when 66.6 per cent of N was applied as FYM and the rest as Calcium ammonium nitrate.

Khan *et al.* (1977) obtained highest onion yields (18.24 t ha^{-1}), and largest bulbs (5-8 cm) with the application of 50 kg ha^{-1} each of N, P and K alone with 15 t FYM ha^{-1}. Mandal and Mazumdar (1980) also obtained the highest potato tuber yield with the application of 90 : 80 : 70 kg NPK ha^{-1} along with FYM @ 15 t ha^{-1}.

Saxena and Singh (1980) reported that application of castor cake at 25 q ha^{-1} significantly increased potato tuber yield and N, P and K uptake in comparison with 250 q ha^{-1} FYM, 15 and 20 q ha^{-1} castor cake.

Subbaiah *et al.* (1982) found that equal split application of 120 kg N ha^{-1} along with 25 t ha^{-1} FYM recorded highest yields of dry chilli pods (33.92 q ha^{-1}) and maximum uptake of N (190.35 kg ha^{-1}), P (40.30 kg ha^{-1}) and K (30.10 kg ha^{-1}).

Subbaiah *et al.* (1983) in a trial on brinjal recorded the highest yield of 59.65 t ha^{-1} over the control (29.70 t ha^{-1}) with application of 50 per cent recommended dose of fertilizer along with 12.5 t ha^{-1} FYM on sandy loam soil of Coimbatore.

Addition of organic matter primarily provides nitrogen to the crops (Larson and Clapp, 1984). The organically bound form of nitrogen becomes available to the crops after undergoing the process of decomposition followed by mineralization into inorganic forms from organic forms. The two processes viz., mineralization and immobilization are simultaneous and opposite in direction. The magnitude of these two reactions control the available nitrogen status in the soil.

Grewal and Treham (1984) reported that application of 40 kg P ha^{-1} significantly enhanced the large tuber (>75 g) producion in potato.

Further significant increase in the production of large tubers was noticed with 80 kg P or 30 tonnes of FYM ha^{-1}. The higher yield was mainly due to improvement in tuber size.

Sahota and Gobinda Krishnan (1984) reported that economic optimum aggregate and medium sized tuber yield of potato could be obtained with 20 t FYM ha^{-1} supplemented with 120 kg N + 22.5 kg P or 60 kg N + 17.2 kg P ha^{-1}.

Eggert and Kaharamann (1984) observed that the yield of marketable beans (four year trial) was consistently higher under organic soil management than under the conventional systems. Tomato yields were also higher under organic soil management treatments for years 2 and 4 and the overall 4 years period. The overall concentration of ascorbic acid was highest in tomatoes grown under the organic treatments.

Sharma *et al.* (1986) found that 105 kg N ha^{-1} was required when urea was blended with neem cake as against 205 kg N ha^{-1} thorugh urea for producing 100 q ha^{-1} yield in radish.

Ravindran and Balanambisan (1987) observed that under low land situation the combination of FYM 10 t ha^{-1} and N, P_2O_5 and K_2O at 70, 50 and75 kg ha^{-1} in inorganic form respectively recorded a maximum yield of 19.6 t ha^{-1} in sweet potato.

Abusaleha and Shamugavelu (1988) observed maximum plant height of 36.2 cm, 115.0 cm and 184.3 cm at 30 , 60 and 90 DAS, respectively with the application of ammonium sulphate @ 20 kg N ha^{-1} plus poultry manure @ 20 kg N ha^{-1}. The application of farm yard manure plus ammonium sulphate to crop recorded 31.5 cm, 99.0 cm and 168.8 cm, height at 30, 60 and 90 DAS respectively as against 26.3 cm, 86.2 cm and 144.0 cm in control plot with inorganic N fertilizer application alone. They also reported more number of nodes (39.3, 33.9 and 26.6 nodes plant^{-1}) with the conjunctive use of ammonium sulphate plus poultry manure, ammonium sulphate plus farmyard manure and ammonium sulphate alone respectively. These treatments correspondingly recorded pod yield of 180, 130 and 108 a ha^{-1}. They also reported that the crude fibre content of pod decreased from 15.23 to 13.3 per cent when organic manures were applied in conjunction with inorganic fertilizers when compared to the application of inorganic fertilizers alone.

Jose *et al.* (1988) in an experiment with brinjal applied 120 kg recommended nitrogen in different combination as urea, FYM, poultry manure and sheep manure. Application of half of recommended nitrogen (60 kg) as poultry manure and remaining half (60 kg) in inorganic form recorded maximum plant height (75.2 cm), drymatter production (95.08 g plant^{-1}) and yield (51.03 t ha^{-1}).

Hilman and Suwandi (1989) obtained highest yield of 2.16 kg plant^{-1} with the application of sheep manure at 30 t ha^{-1} in tomato. Seed *et al.* (1990) reported that FYM @ 20 t ha^{-1} increased the potao tuber yield potential by 77 q ha^{-1} and it decreased the N dose marginally from 181 to 163 kg ha^{-1}.

Wang (1993) obtained 11.3% higher yield with organic manure than with inorganic fertilizers in autumn sweet corn, winter potatoes and garlic in pure strands.

Jagadish *et al.* (1994) reported that substitution of nitrogen by biogas slurry at 25 per cent level has increased the chilli pod yield by 47 per cent over control (100 per cent N as urea). When the substitution level was increased from 25 to 100 per cent, the yield was on par with control.

In a trial on carrots with cv. Nantes supplied with cattle manure at 0, 3 or 9 tonnes (dunam^{-1} (1 dunam = 0.1 ha) or composted municipal waste at 3 tonnes dunam^{-1} in addition 0, 10, 20 or 30 kg N per dunam was applied. Sugiv *et al.* (1994) revealed that N fertilizer application had a significant effect on yield in the treatments without organic manure. The yields in the cattle manure treatments without N were doubled those of controls. The highest yields (8.3 and 7 tonnes total and marketable yields respectively) were obtained with the combination of organic manure and N @ 30 kg dunam^{-1}. In this treatment, total N, P and K uptake were 22 kg, 5.2 kg and 48 kg dunam^{-1}.

Govindan *et al.* (1995) studied the influence of vermicompost in the field performance of okra in lateritic soil and reported that the application of 100 per cent vermicompost gave maximum yield compared to control and 100 per cent farmyard manure application and also observed that the yield recorded was in increasing order with increased substitution of farmyard manure with vermicompost. They attributed it due to the accumulation of mobile substances in earthworm casts as earthworms are reported to excrete plant growth promoting substances in to the castes.

Krishnamurthi *et al.* (1995) observed an increase in weight of okra pod from 163.66 g to 207.66 g plant^{-1} with FYM and vermicompost treatments respectively. The increase in yield over FYM treatment was 27 per cent with the application of vermicompost. They also obtained 7.73 fruits per plant using FYM and 9.06 pods plant^{-1} using vermicompost.

Synergic effect of nitrogen and FYM was observed in increasing the yield characters viz., plant height, head length, girth, number of non-wrapper leaves per head and marketable yield upto 160 kg N ha^{-1} without FYM (174.1 t ha^{-1}) in cabbage. However, the effect of nitrogen was significant upto 120 kg ha^{-1} FYM (Dixit, 1997).

Kamalakar Reddy (1997) reported that the dry matter production and yield attributes viz., number of fruits per vine, weight of fruit and volume of fruit increased upto 80 kg ha^{-1} N and 30 t ha^{-1} vermicompost in bittergourd.

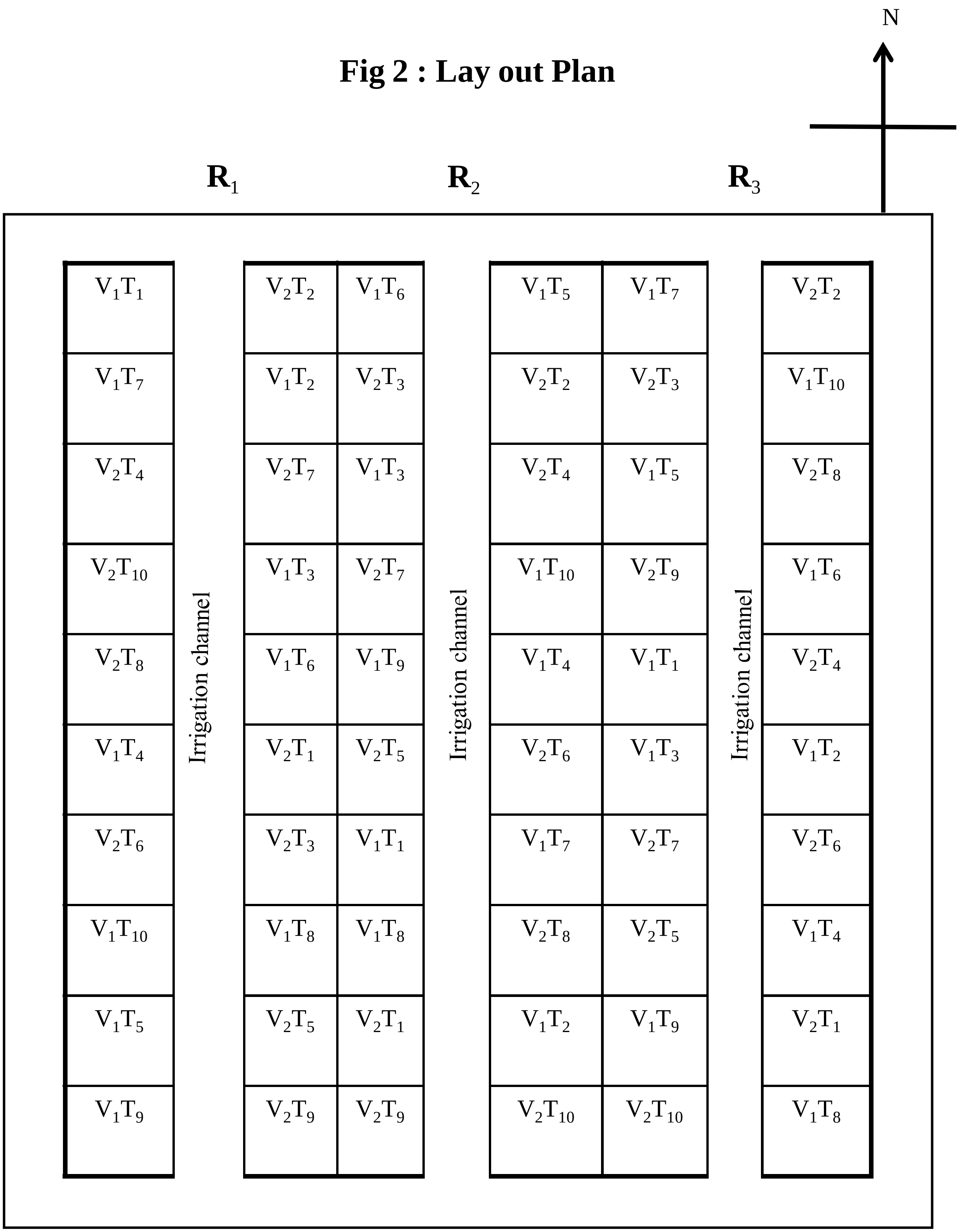
Maheswari (1998) observed that the crude fibre content in Okra decreased by combined application of recommended dose of fertilizer and vermicompost. Crude fibre content decreased from 19.23 per cent and 18.95 per cent, respectively from control and recommended dose of fertilizer to 11.56 per cent at $F_{100}V_{15}$ (100 per cent recommended dose of fertilizer and vermicompost @ 15 t/ha) and 12.1 per cent in F_{50} V_{15} (50 per cent recommended dose of fertilizer and vermicompost @ 15 t/ha).

Sandhya Rani (1998) found that castor cake at 6 t ha^{-1} recorded significantly higher yield (26.89 t ha^{-1}) over other levels but was on par with 4 t ha^{-1} (25.61 t ha^{-1}) in radish. Among the nitrogen levels, 100 per cent recommended dose (150 kg ha^{-1}) recorded significantly higher yield (28.94 t ha^{-1}) over other levels. Further it was reported that the combination of castor cake at 4 t ha^{-1} and N at 150 kg ha^{-1} were the best doses for obtaining higher root yield under irrigated conditions in radish Cv. Pusa Chetki on sandy loam soils of Telangana region of Andhra Pradesh.

Usha Kumari *et al.* (1999) reported that application of vermicompost as organic source along with full recommended dose of inorganic fertilizers in bhendi produced highest yield (5663 kg/ha) and it was significantly higher than control (no manure) which recorded the yield (609 kg/ha).

Shelka *et al.* (2001) noticed higher yield (581 q/ha) in brinjal due to the application of nitrogen in inorganic and organic combination. This was significantly higher than control (432 q/ha) alone. They also reported highest dry matter production when 60 per cent of urea nitrogen was replaced by poultry manure.

Fig 2 : Lay out Plan



Design – Factorial RBD

Replications– 3

V_1 – cv. Arka Anamika

Gross plot size = 3.6 m x 3.6 m

Net plot size = 3 m x 3 m

V_2 – cv. Parbhani Kranthi

CHAPTER – III

MATERIALS AND METHODS

3.1 LOCATION OF EXPERIMENTAL SITE

A field experiment entitled "Studies on the effect of organic manures and inorganic fertilizers on production and quality of okra (*Abelmoschus esculentus* L.)" was conducted during February to April, 2001 at the Students Farm, College of Agriculture, Rajendranagar, Hyderabad, Andhra Pradesh.

The experiment farm is located at an altitude of 542.3 m above mean sea level with a geographical bearing of 17° 19' North latitude and 79° 23' East longitude.

3.2 METEOROLOGICAL DATA

Hyderabad falls under semi-arid tropical climate zone with an average annual rainfall of 800 mm. Meteorological data pertaining to rainfall, mean minimum and maximum temperatures, relative humidity and sunshine hours in weekly averages from 1^{st} week of February to last week of May, 2001 are presented in Appendix 'I' and the trends are depicted in Figure 1.

3.3 CHARACTERISTICS OF EXPERIMENTAL SOIL

The soil was of sandy loam with good drainage and moderate water holding capacity. The initial soil samples were collected before experimentation to a depth of 0-22 cm, from 15-20 randomly selected spots. The soil was air dried and ground to pass through 2 mm sieve for analysis.

Table 1 : Salient physical and chemical properties of the experimental soil

Property	Quantity	Method of Analysis
I. Soil fraction (%)		
Sand	64.2	International pipette method (Piper, 1950)
Silt	19.2	
Clay	16.6	
Textural class : Sandy loam		
II Chemical composition		
Soil pH	7.7	Digital pH meter (DI-707) (Jackson, 1967)
Electrical conductivity (dSm^{-1})	0.16	Conductivity bridge (Jackson, 1967)
Organic carbon (%)	0.52	Wet digestion procedure (Walkley & Black, 1934)
Available N (kg ha^{-1})	195	Alkaline permanganate method (Subbaiah and Asija, 1956)
Available P (kg ha^{-1})	19	Olsen's method (Olsen *et al*. 1954)
Available K (kg ha^{-1})	257	Flame photometer method (Muhr *et al*, 1965)

3.4 CROPPING HISTORY

The following crops were grown during preceding two years.

Season	Year	Crop grown
Kharif	2000	Ridgegourd
Rabi	2000	--
Kharif	2001	--

3.5 EXPERIMENTAL DETAILS

3.5.1 Cultivars

Two varieties of okra *viz.*, “Arka Anamika and Parbhani kranthi” were used for this study.

“Arka Anamika” is a yellow vein mosaic resistant variety evolved by Indian Institute of Horticulture Research, Bangalore. Plants are medium tall of about 100 cm with short internodal length and less branched. It is an early maturing cultivar, takes about 50 days for first flowering and 55 days for first picking. Fruits are medium, green, rough, 5 ridged and start from 5 – 6th node onwards. It is high yielding variety and yields 11.5 t ha^{-1}.

Parbhani kranthi

Yellow vein mosaic virus resistant variety developed at Marathwada agricultural University, Parbhani from interspecific cross between *Abelmoschus esculentus* cv Pusa Sawani and *Abelmoschus manihot*. Plants are of single stem, tall with dark-green foliage. Flowering starts in 40- 45 days after sowing. The fruits are smooth, dark green, slender, 5 ridged with long beak. Average yield varies from 8.5 – 9 t ha^{-1} during spring summer and 11.5 t ha^{-1} during rainy season.

3.5.2 Lay out

The experiment was laid out in randomized block design with two factors and three replications. The lay out plan of the experiment is depicted in Figure 2.

3.5.3 Plot size

Gross plot size = 3.6m x 3.6m

Net plot size = 3m x 3m

3.5.4 Spacing

A spacing of 40 cm between rows and 20 cm within the row was adopted for all treatments. In each plot, there were 128 plants and 5 plants from individual plot were used for destructive sampling.

3.5.5 Treatments

Factor I : Varieties

V_1 : Arka Anamika

V_2 : Parbhani Kranthi

Factor II : Manures and fertilizer and their combinations

T_1	-	100% (RDNF) in the form of farmyard manure
T_2	-	100%(RDNF) in the form of vermicompost
T_3	-	100% (RDNF) in the inorganic form
T_4	-	25% (RDNF)in the form of farmyard manure + 75% in the inorganic form
T_5	-	50% (RDNF) in the form of farmyard manure + 50% in the inorganic form
T_6	-	75% (RDNF) in the form of farmyard manure +25% in the inorganic form
T_7	-	25%(RDNF) in the form of vermicompost + 75% in the inorganic form
T_8	-	50% (RDNF) in the form of vermicompost + 50% in the inorganic form
T_9	-	75% (RDNF) in the form of vermicompost + 25% in the inorganic form
T_{10}	-	Control (without fertilizer and manure)
RDNF	-	Recommended dose of nitrogen fertilizer in the form of urea (100 kg N ha^{-1})

Quantities of FYM or Vermicompost used to substitute RDNF

	FYM		Vermicompost	
	t ha^{-1}	**kg / plot**	**t ha^{-1}**	**kg / plot**
25% (RDNF)	5.21	4.68	1.15	1.03
50% (RDNF)	10.41	9.36	2.29	2.06
75% (RDNF)	15.62	14.05	3.44	3.09
100% (RDNF)	20.83	18.74	4.59	4.13

3.6 CULTIVATION DETAILS

3.6.1 Preparatory cultivation

The experimental plot was brought to fine tilth by repeated ploughings, followed by harrowing. Finally, it was levelled and divided into plots as per the lay out plan.

3.6.2 Manures and fertilizers

Manuring and fertilization was done as per the treatments. Nitrogen, phosphorus and potassium were applied in the form of urea, single super phosphate and muriate of potash, respectively. Vermicompost and farmyard manure were applied 10 days before sowing.

Nitrogen was applied in three equal splits, half as basal and remaining half in two equal splits at 35 and 55 days after sowing as per the treatments. A uniform dose of P_2O_5 and K_2O @ 50 kg/ha each was applied as basal dose for all treatments except control.

Manures used in the experiment were analysed for their nutrient composition before their application to the soil. The nutrient composition and method of analysis are given in table 2.

Table 2 : Nutrient composition of manures used in the experiment

Content (%)	Vermicompost	FYM	Procedure
N	2.18	0.48	Microkjeldhal method outlined by Chopra and Kanwar (1976)
P_2O_5	1.19	0.26	Wet digestion method as described by Chopra and Kanwar (1976)
K_2O	1.13	0.28	Wet digestion method as described by Chopra and Kanwar (1976)
OC	26.28	20.24	Walkley and Black's method (1934)

3.6.3 Sowing

Sowing of seed was done on 1st February, 2001 with a spacing of 40 cm between rows and 20 cm within the row @ two seeds per hill. Gap filling was done 6 days after sowing. Finally thinning was done 7 days after germination to maintain one plant per hill and to maintain the plant population.

3.6.4 Irrigation

The first irrigation was given immediately after sowing while subsequent irrigations were given as and when required depending upon soil moisture status and weather conditions.

3.6.5 Weeding

Pendimethalin 30 EC @ 1.5 kg a.i. ha^{-1} was sprayed on 3^{rd} day after sowing as a pre-emergence spray to control weeds. Hand weedings were done as and when required.

3.6.6 Plant protection

Monochrotophos 36 EC was sprayed at the rate of 1.5 ml per litre to control sucking pests. Phosolone 50 EC was also sprayed at the rate of 2.0 ml per litre to control the spread of jassids and fruit borers.

3.6.7 Harvesting

The okra pods were picked in morning hours on alternate days.

3.7 BIOMETRIC OBSERVATIONS

Five plants were tagged at random in each plot and observations were recorded on growth, yield and quality parameters periodically at regular intervals.

3.7.1 Plant height

Plant height from base to the top of the plant was measured from selected plants in each replication of the treatment plot at 30, 60 and 90 days after sowing and their averages were worked out.

3.7.2 Number of nodes

The number of nodes per plant including those on main stem as well as on branches were counted at 30, 60 and 90 days after sowing from selected plants and their averages were worked out.

3.7.3 Number of days taken for first flower appearance

The period from the day of sowing to appearance of 1st flower was counted from selected plants and the averages were worked out.

3.7.4 Number of days taken from flowering to harvesting

The number of days taken from flowering to harvest of pods was counted and the averages were worked out.

3.7.5 Number of pods per plant

The number of pods per plant were recorded as per the treatments and the averages were worked out.

3.7.6 Pod length (cm)

The length of the pods of 5th and final pickings was measured with the help of a scale and averages were worked out.

3.7.7 Pod yield (t ha^{-1})

Fresh weight of pods from each picking from net plot area was recorded and expressed in tonnes per hectare.

3.7.8 Dry matter production of pod (kg ha^{-1})

Five pods were selected from each treatment at 60^{th} and 90^{th} day after sowing. The pods were sun dried for two days followed by oven drying at 60°C till constant weight was obtained and the average dry weight was recorded.

3.7.9 Crude fibre content of the pods

Crude fibre content of the pod was estimated as per the procedure outlined by Ranganna (1961).

Crude fibre is the organic fraction left after the sequential extraction with solution of 1.25% H_2SO_4 and 1.25% NaOH.

Pod samples from each treatmental plot were collected from the 4^{th} picking, oven dried at 65°C and one g of oven dried sample was weighed and 200 ml of 1.25 per cent hot sulphuric acid was added and placed on a preheated hot plate of the digestion apparatus. It was digested for 30 minutes by rotating the beaker periodically to keep the solids or materials from adhering to the sides. At the end of the digestion period, the mixture was filtered through a muslin cloth and the residue was washed with hot water till it was free from acid. The material was then transferred to the same beaker and 200 ml of 1.25 per cent hot NaOH was added and placed on the hot plate for 30 minutes. The mixture was filtered through muslin cloth. The residue was washed with water till it was free from alkali. It was then transferred to a crucible, heated overnight at 80 - 100°C and weighted (W_1). The crucible was kept over a low flame till all the material was completely charred and was kept in a muffle furnace at 600°C for 30 minutes, cooled and weighted (W_2).

$$\text{Crude fibre 1\%} = \frac{W_1 - W_2}{\text{Weight of sample}} \times 100$$

3.8 COST BENEFIT RATIO ANALYSIS

Gross and net returns per hectare were computed considering the existing market price of inputs and outputs. Cost benefit ratio was worked out for different treatments by dividing the gross returns by corresponding cost of cultivation.

3.9 STATISTICAL ANALYSIS

The data were statistically analyzed at University Computer Centre, Rajendranagar, Hyderabad.

The data pertaining to various parameters were subjected to statistical analysis following the method of analysis of variance for factorial randomized block design (Panse and Sukhatme, 1978).

CHAPTER – IV

RESULTS

The experimental findings of the investigation entitled "Studies on the effect of organic manures and inorganic fertilizers on production and quality of okra (*Abelmoschus esculentus* L.)" are presented in this chapter.

4.1 Effect of organic and inorganic sources of nitrogen on plant height(cm) at 30, 60 and 90 DAS in okra

The data on plant height at 30, 60 and 90 DAS presented in the table revealed that there were significant differences among the treatments at all stages of crop growth. The rate of increase in plant height was more from 30 DAS to 60 DAS than from 60 DAS to 90 DAS in both the cultivars.

30 Days after sowing

Among the treatments, the mean plant height ranged from 10.16 cm to 28.78 cm. The treatment T_8 i.e. 50% RDNF through vermicompost plus 50% RDNF through inorganic form recorded mean maximum (28.78 cm) plant height, while control recorded the mean lowest (10.16 cm) plant height. Among the individual sources T_3 (100% RDNF through inorganic fertilizer) recorded mean maximum (18.75 cm) plant height

There was significant difference between the mean plant height of two cultivars. Mean highest plant height (21.22 cm) was recorded in cv. Parbhani Kranthi followed by the cv. Arka Anamika (17.35 cm).

The interaction effect between the treatments and cultivars was found to be significant. The treatment T_8 (50% RDNF through vermicompost + 50% through inorganic fertilizer) recorded highest (31.00 cm) plant height in cv. Parbhani Kranthi followed by T_7 (25% RDNF through vermicompost + 75% RDNF through inorganic fertilizer) of the same cultivar. Control recorded the lowest plant height in both the cultivars (11.6 cm in Parbhani Kranthi, 8.73 cm in Arka Anamika).

60 Days after sowing

T_8 (50% RDNF through vermicompost + 50% RDNF through inorganic fertilizer) recorded mean maximum (90.06 cm) plant height. Mean lowest (30.56 cm) plant height was recorded in the control.

Among FYM combinations, T_5 (50% RDNF through FYM + 50% through inorganic fertilizer) recorded mean maximum (59.13 cm) plant height, which was on par with T_4 (25% RDNF through FYM + 75% RDNF through inorganic fertilizer). The vermicompost combinations performed better when compared to their corresponding combinations of FYM.

There was significant difference between the mean plant heights of two cultivars. Mean highest (60.08 cm) plant height was recorded in the cv. Parbhani Kranthi followed by the cv. Arka Anamika (57.96 cm).

Interaction effect between the cultivars and treatments was found not significant.

90 Days after sowing

Mean maximum (105.5 cm) plant height was recorded in the treatment T_8 (50% RDNF through vermicompost + 50% RDNF through inorganic fertilizer) followed by T_7 (25% RDNF through vermicompost + 75% RDNF through inorganic fertilizer). Control recorded the mean lowest (37.8 cm) plant height.

T_5 (50% RDNF through FYM + 50% RDNF through inorganic fertilizer) recorded mean maximum (69.83 cm) plant height among FYM combinations, which was on par with T_4 (25% RDNF through FYM + 75% RDNF through inorganic fertilizers).

The two cultivars differ significantly in their mean plant height. Mean highest (70.52 cm) plant height was recorded in cv. Parbhani Kranthi followed by the cv. Arka Anamika (68.25cm).

Interaction effect between the treatments and cultivars was found to be not significant.

4.2 Effect of organic and inorganic sources of nitrogen on number of nodes at 30, 60 and 90 DAS in okra

The data on number of nodes at 30, 60 and 90 DAS presented in the table revealed that there were significant differences among the treatments at all stages of crop growth.

30 Days after sowing

Among the treatments the mean number of nodes ranged from 5.33 to 11.16. Mean maximum (11.16) number of nodes were recorded in the treatment T_8 which received 50% RDNF through vermicompost plus 50% RDNF through inorganic fertilizer. Control recorded the mean lowest (5.33) number of nodes, which was on par with the treatment T_1 (100% RDNF through FYM).

T_3 (100% RDNF through inorganic fertilizer) recorded mean maximum (8.5) number of nodes among the individual sources, which was on par with T_2 (100% RDNF through RDNF through vermicompost).

Among FYM combinations T_5 (50% RDNF through FYM + 50% RDNF through inorganic fertilizer) recorded mean highest (10.16) no of nodes, which was followed by T_4 (25% RDNF through FYM + 75% RDNF through inorganic fertilizer).

There was significant difference between the mean number of nodes of two cultivars. The mean highest (8.4) number of nodes were recorded in cv. Arka Anamika followed by the cv. Parbhani Kranthi (7.3).

Interaction effect between the cultivars and treatments was not significant. In both the cultivars T_8 recorded maximum number of nodes.

60 Days after sowing

Mean highest (30.66) number of nodes were recorded in the treatment T_8 which received 50% RDNF through vermicompost + 50% RDNF through inorganic fertilizer followed by T_9 (75% RDNF through vermicompost + 25% RDNF through inorganic fertilizer). Control recorded the mean lowest (14.16) number of nodes.

Among the individual sources the mean highest (19.66) number of nodes were recorded in T_2 (100% RDNF through vermicompost), which was on par with T_6 (75% RDNF through FYM + 25 % RDNF through inorganic fertilizer).

T_5 (50% RDNF through FYM + 50% RDNF through inorganic fertilizer) recorded mean maximum (27.00) number of nodes among FYM combinations.

There was significant difference between mean number of nodes of two cultivars studied. Mean maximum (22.06) number of nodes were recorded in cv. Arka Anamika followed by the cv. Parbhani Kranthi (20.8).

Interaction effect between the cultivars and treatments were found to be not significant.

90 Days after sowing

T_8 (50% RDNF through vermicompost + 50% RDNF through inorganic fertilizer) recorded mean maximum (38.0) number of nodes. Control recorded mean lowest (16.16) number of nodes.

Among the individual sources T_2 (100% RDNF through vermicompost) recorded mean maximum (27.66) number of nodes, which was on par with T_4 (25% RDNF through FYM + 75% RDNF through inorganic fertilizer).

T_5 (50% RDNF through FYM + 50% RDNF through inorganic fertilizer) recorded mean maximum (33.66) number of nodes among FYM combinations. The vermicompost combinations performed better when compared to their corresponding combinations of FYM.

Mean number of nodes of the two cultivars differ significantly. Mean highest (28.56) number of nodes were recorded in cv. Arka Anamika followed by the cv. Parbhani Kranthi (27.36).

No significant differences were found between the cultivars and treatments studied.

4.3 Effect of organic and inorganic sources of nitrogen on number of days taken for first flower appearance in okra

The data on number of days taken for first flower appearance presented in the table 9 revealed that there were significant differences among the treatments. The mean number of days taken for flowering ranged from 43 to 45 days. The mean minimum (43 days) number of days taken for flowering was recorded in the treatment T_8 (50% RDNF through vermicompost + 50% RDNF through inorganic fertilizer), which was on par with the treatments T_2 (100% RDNF through vermicompost), T_5 (50% RDNF through FYM + 50% RDNF through inorganic fertilizer), T_6 (75% RDNF through FYM +25% RDNF through inorganic fertilizer), T_7 (25% RDNF through vermicompost + 75% RDNF through inorganic fertilizer) and T_9 (75% RDNF through vermicompost + 25% through inorganic fertilizer). The mean maximum (45 days) number of days taken for flowering was recorded in control, which was on par with the treatments T_1 (100% RDNF through FYM), T_3 (100% RDNF through inorganic fertilizer), T_4 (25% RDNF through FYM + 75% RDNF through inorganic fertilizer) and T_7 (25% RDNF through vermicompost + 75% RDNF through inorganic fertilizer).

There was significant difference in mean number of days taken for flowering between the two cultivars studied. The mean minimum (40.06 days) number of days taken for flowering was recorded in cv. Parbhani Kranthi followed by the cv. Arka Anamika (47.83 days).

The interaction between the treatments and cultivars was found to be not significant.

4.4 Effect of organic and inorganic sources of nitrogen on number of days taken from flowering to harvesting

The data presented in the table 10 revealed that there was no significant effect of organic and inorganic sources of nitrogen on number of days taken from flowering to harvesting of pod in okra.

4.5 Effect of organic and inorganic sources of nitrogen on pod number in okra

The data on pod number per plant presented in the table 11 indicated that there were significant differences among the treatments. The mean pod number ranged from 8.83 to14. The treatment T_8 which received 50% recommended nitrogen through vermicompost plus 50% through inorganic fertilizer recorded mean maximum (14) number of pods, which was on par with T_7 (25% RDNF through vermicompost + 75% RDNF through inorganic fertilizer) and T_9 (75% RDNF through vermicompost + 25% RDNF through inorganic fertilizer). Control recorded the mean lowest (8.83) number of pods, which was on par with the treatment which received 100% RDNF through FYM (T_1).

Among FYM combinations the treatment T_5 which received 50% recommended nitrogen through FYM plus 50% through inorganic fertilizer recorded mean maximum (12.83) number of pods, which was on par with the treatments T_3 (100% RDNF through inorganic fertilizer), T_4 (25% RDNF through FYM + 75% RDNF through inorganic fertlizer) and T_9 (75% RDNF through vermicompost + 25% RDNF through inorganic fertilizer) .

Among the individual sources the treatment which received 100% RDNF through inorganic fertilizer (T_3) recorded mean maximum (12.0) number of pods followed by T_2 which received 100% RDNF through vermicompost.

There were no significant differences between the mean pod number of two cultivars. The mean highest (11.86) pod number was recorded in cv. Arka Anamika followed by the cv. Parbhani Kranthi (11.53).

The interaction between the cultivars and treatments was found to be not significant.

4.6 Effect of organic and inorganic sources of nitrogen on pod length (cm) in okra

The data on pod length presented in the table revealed that there were significant differences among the treatments at both stages of crop growth.

4.6.1 At maximum harvest (5th harvest)

T_8 (50% RDNF through vermicompost + 50% RDNF through inorganic fertilizer) recorded mean maximum (18.21 cm) pod length compared to all other treatments. Control recorded mean lowest (9.45 cm) pod length.

Among individual sources T_2 (100% RDNF through vermicompost) recorded mean maximum (16.13 cm) pod length, which was on par with T_5 (50 RDNF through FYM + 50% RDNF through inorganic fertilizer) T_7 (25% RDNF through vermicompost + 75% RDNF through inorganic fertilizer) and T_9 (75% RDNF through vermicompost + 25% RDNF through inorganic fertilizer).

T_5 (50% RDNF through FYM + 50% RDNF through inorganic fertilizer) recorded mean maximum (16.86 cm) pod length among FYM combinations. The vermicompost combinations were superior when compared to their corresponding combinations of FYM.

There was significant difference between the mean pod length of two cultivars. The mean maximum (15.81 cm) pod length was recorded in cv. Arka Anamika followed by the cv. Parbhani Kranthi (14.51 cm).

Interaction effect between the cultivars and treatments was found not significant.

4.6.2 At final harvest

T_8 (50% RDNF through vermicompost + 50% RDNF through inorganic fertilizer) recorded mean maximum (17.53 cm) pod length. Mean lowest (9.21 cm) pod length was observed in control.

Among the individual sources T_2 (100% RDNF through vermicompost) recorded mean maximum (15.56 cm) pod length, which was on par with T_5 (50% RDNF through FYM + 50% RDNF through inorganic fertilizer), T_7 (25% RDNF through vermicompost + 75% RDNF through inorganic fertilizer) and T_9 (75% RDNF through vermicompost + 25 % RDNF through inorganic fertilizer).

T_5 (50% RDNF through FYM + 50% RDNF through inorganic fertilizer) recorded mean maximum (16 cm) pod length among FYM combination.

The two cultivars differed significantly in their mean pod length. The mean highest (15.14 cm) pod length was recorded in cv. Arka Anamika followed by the cv. Parbhani Kranthi (14.20 cm).

Interaction between the treatments and cultivars was found to be not significant.

4.7 Effect of organic and inorganic sources of nitrogen on pod yield (t ha^{-1}) of okra

Data on pod yield in tonnes per hectare presented in the table 14 revealed that there were significant difference among the treatments. The mean pod yield ranges from 5.86 to 13.008 t ha^{-1}. The mean highest (13.008 t ha^{-1}) pod yield was recorded in the treatment T_8 which received 50% recommended nitrogen through vermicompost plus 50% through inorganic fertilizer. Mean lowest (5.86 t ha^{-1}) pod yield was recorded in the control.

Among the FYM combinations the mean highest (10.52 t ha^{-1}) pod yield was recorded in the treatment T_5 i.e. 50% recommended nitrogen through FYM plus 50% through inorganic fertilizer, which was followed by T_4 (25% RDNF through FYM + 75% RDNF through inorganic fertilizer). Among the combinations the vermicompost combinations performed better than their corresponding combinations of FYM.

Among the individual sources the treatment which received 100% RDNF through inorganic fertilizer recorded the mean highest(8.89 t ha^{-1}) pod yield, which was on par with the treatment T_2 which received 100% RDNF through vermicompost (8.46 t ha^{-1}).

There was significant difference between the mean pod yield of two cultivars. The mean highest (9.62 t ha^{-1}) pod yield was recorded in cv. Arka Anamika followed by the cv. Parbhani Kranthi (9.22 t ha^{-1}).

Interaction between the cultivars and treatments was found to be not significant.

4.8 Effect of organic and inorganic sources of nitrogen on drymatter production (kg ha^{-1}) of pod in okra

The data on drymatter production of pod at maximum harvest (5^{th} harvest) and final harvest presented in the table (15 and 16) revealed that there were significant differences among the treatments at both stages of crop growth.

4.8.1 At maximum harvest (5^{th} harvest)

Among the treatments, the treatment T_8 which received 50% recommended nitrogen through vermicompost plus 50% through inorganic fertilizer recorded the mean highest (1155.16 kg ha^{-1}) drymatter production. Control recorded the mean lowest (486.16 kg ha^{-1}) drymatter production.

Among the individual sources the treatment T_2 which received 100% RDNF through vermicomost recorded mean highest (903.5 kg ha^{-1}) drymatter production, which was on par with T_7 (25% RDNF through vermicompost + 75% RDNF through inorganic fertilizers).

T_5 (50% RDNF through FYM + 50% RDNF through inorganic fertilizer) recorded mean maximum (972 kg ha^{-1}) drymatter production of pod among FYM combinations. Vermicompost combinations performed better when compared to their corresponding combinations of FYM.

There was significant difference between the mean drymatter production of two cultivars. The mean highest (844.50 kg ha^{-1}) drymatter production of pod was recorded in cv. Arka Anamika followed by the cv. Parbhani Kranthi (923.63 kg ha^{-1}).

Interaction between the cultivars and treatments was found to be not significant.

4.8.2 At final harvest

T_8 (50% RDNF through vermicompost + 50% RDNF through inorganic fertilizer) recorded mean highest (1627.33 kg ha^{-1}) drymatter production, which was on par with T_9 (75% RDNF through vermicompost + 25% RDNF through inorganic fertilizer). Mean lowest (1077.83 kg ha^{-1}) drymatter production of pod was recorded in control, which was on par with T_3 (100% RDNF through inorganic fertilizer).

T_5 (50% RDNF through FYM + 50% through inorganic fertilizer) recorded mean highest (1381 kg ha^{-1}) drymatter production among FYM combinations, which was on par with T_2 (100% RDNF through vermicompost), T_6 (75% RDNF through FYM + 25% RDNF through inorganic fertilizer) and T_7 (25% RDNF through vermicompost + 75% RDNF through inorganic fertilizer).

T_2 (100% RDNF through vermicompost) recorded mean highest (1344.66 kg ha^{-1}) drymatter production among individual sources, which was on par with T_4 (25% RDNF through FYM + 75% RDNF through inorganic fertilizer), T_5 (50% RDNF through FYM + 50% RDNF through inorganic fertilizer) and T_6 (75% RDNF through FYM + 25% RDNF through inorganic fertilizer).

There were no significant differences between the mean drymatter production of two cultivars studied.

Interaction between cultivars and treatments found to be non-significant.

4.9 Effect of organic and inorganic sources of nitrogen on crude fibre content (per cent) of pod in okra

The data pertaining to crude fibre content of pod is presented in the table 17 revealed that there were significant differences among the treatments. The mean crude fibre content of pod ranged from 13.53 to 18.25 per cent. The mean lowest (13.53%) crude fibre content of pod was recorded in the treatment T_8 which received 50% recommended nitrogen through vermicompost + 50% through inorganic fertilizer. This was on par with the treatments T_9 (75% RDNF through vermicompost + 25% RDNF through inorganic fertilizer) and T_5 (50% RDNF through FYM + 50% RDNF through inorganic fertilizer). The mean highest (18.25%) crude fibre content of pod was recorded in the control.

Among the individual sources, 100% RDNF through vermicompost (T_2) recorded the mean lowest (14.56%) crude fibre content followed by 100% RDNF through FYM (15.99%).

Among the FYM combinations the treatment T_5 which received 50% RDNF through FYM plus 50% through inorganic fertilizer recorded the mean lowest (13.88%) crude fibre content.

Among the combinations the verrmicompost combinations recorded lower crude fibre content when compared to their corresponding combinations of FYM.

There was no significant difference in the mean crude fibre content of the two cultivars. The mean lowest (15.16%) crude fibre content was recorded in cv. Arka Anamika followed by the cv. Parbhani Kranthi (15.25%).

The interaction between the cultivars and treatments was found to be not significant.

4.10 Cost benefit ratio of each treatment

The data on cost benefit ratio of each of the treatment are presented in the table 18.

The highest gross returns and cost benefit ratio were obtained from the treatment T_8 which received 50% RDNF through vermicompost plus 50% RDNF through inorganic fertilizer followed by T_7 (25% RDNF through vermicompost + 75% RDNF through inorganic fertilizer) in both the cultivars. Among the FYM combinations T_5 (50% RDNF through FYM + 50% RDNF through inorganic fertilizer) recorded the highest gross returns and cost benefit ratio in both the cultivars. The gross returns and cost benefit ratio of vermicompost combinations were higher when compared to their corresponding combinations of farmyard manure. Control recorded the lowest gross returns and cost benefit ratio in both the cultivars.

Among the two cultivars the gross costs, gross returns and cost benefit ratio of the cv. Arka Anamika were highest compared to corresponding treatments of cv. Parbhani Kranthi.

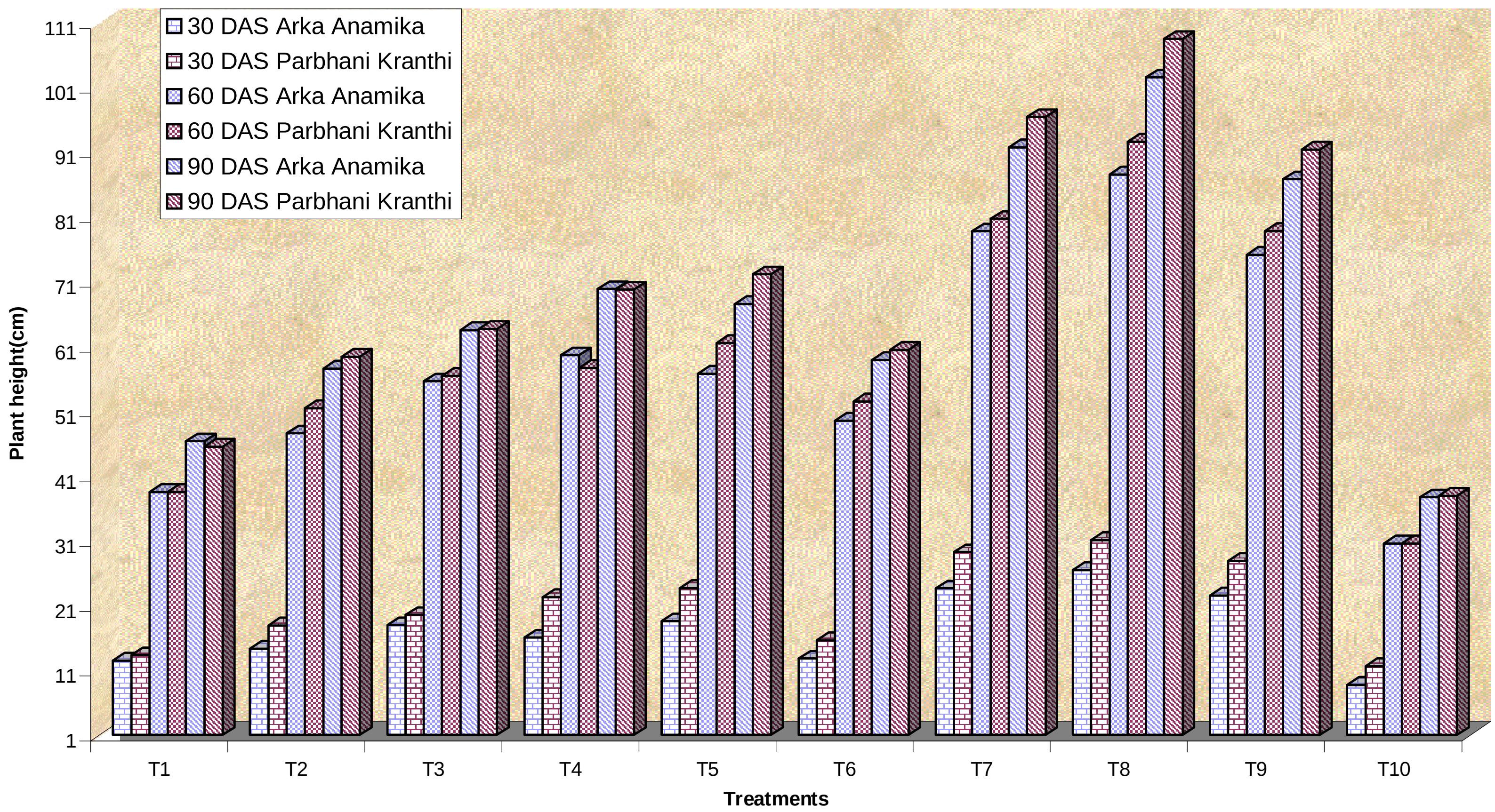


Figure 2 : Effect of organic and inorganic sources of nitrogen on plant height (cm) at 30, 60 and 90 DAS in okra

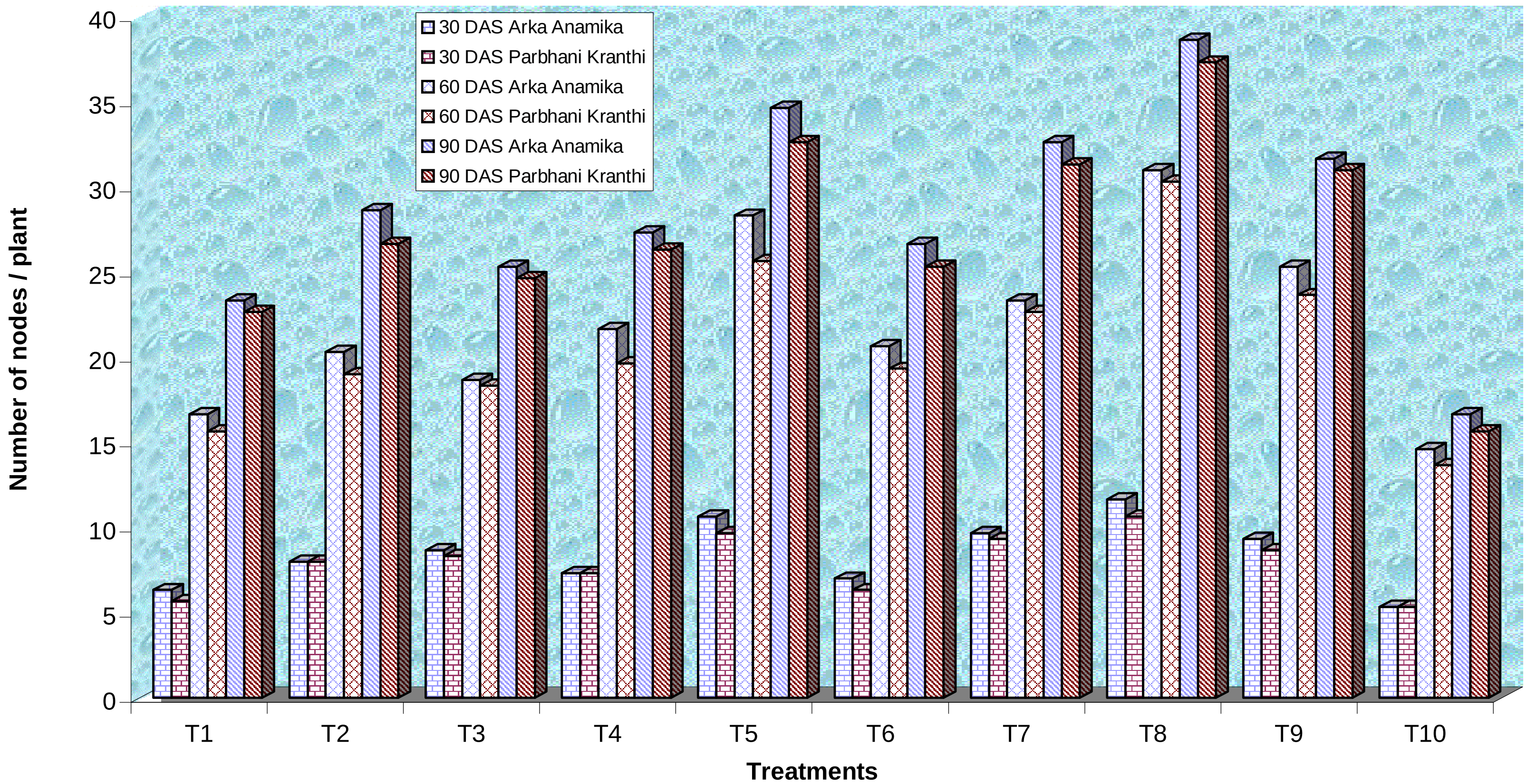


Figure 3 : Effect of organic and inorganic sources of nitrogen on number of nodes at 30, 60 and 90 DAS in okra

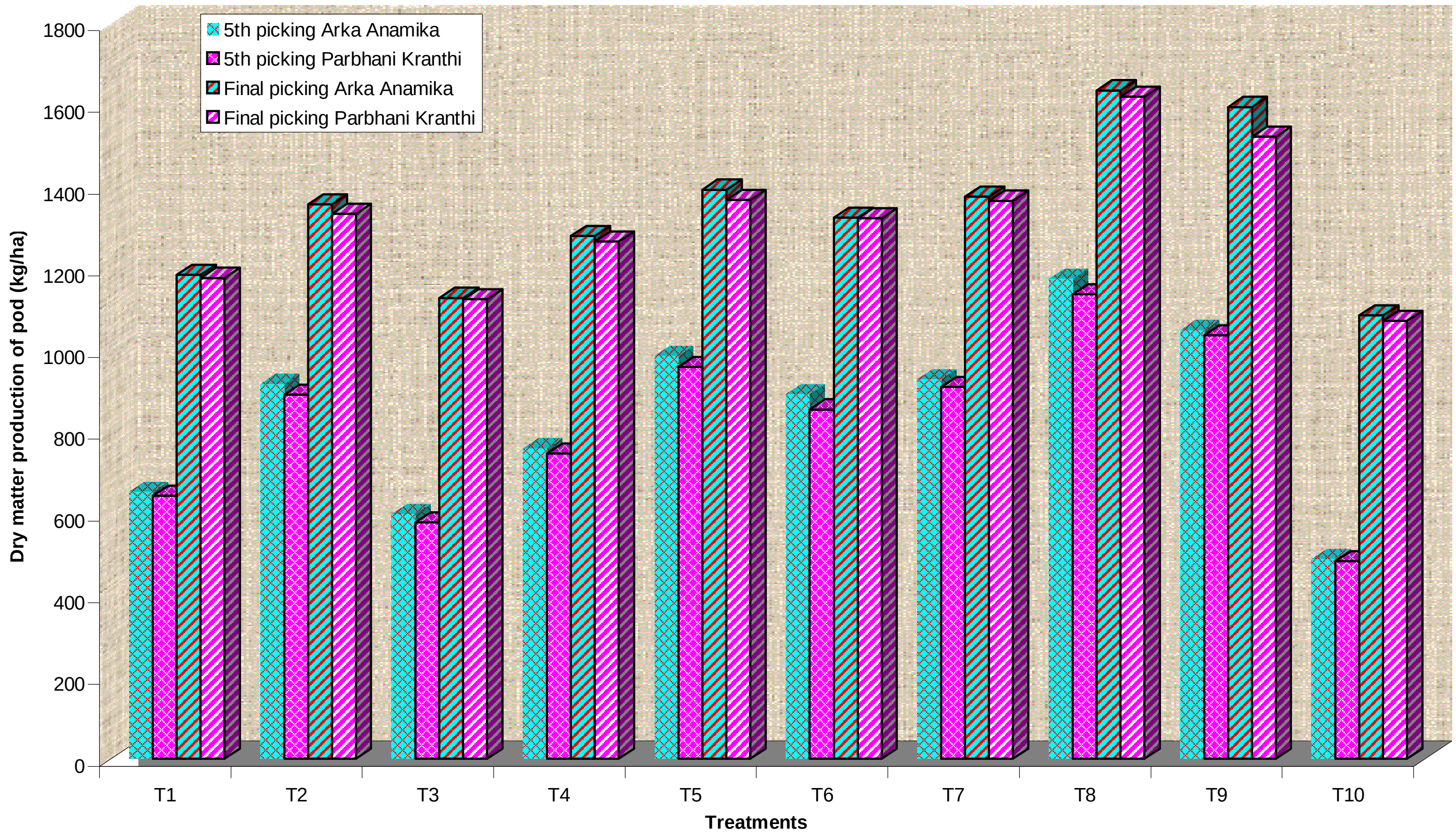


Figure 6 : Effect of organic and inorganic sources of nitrogen on dry matter production (kg/ha) of pod in okra

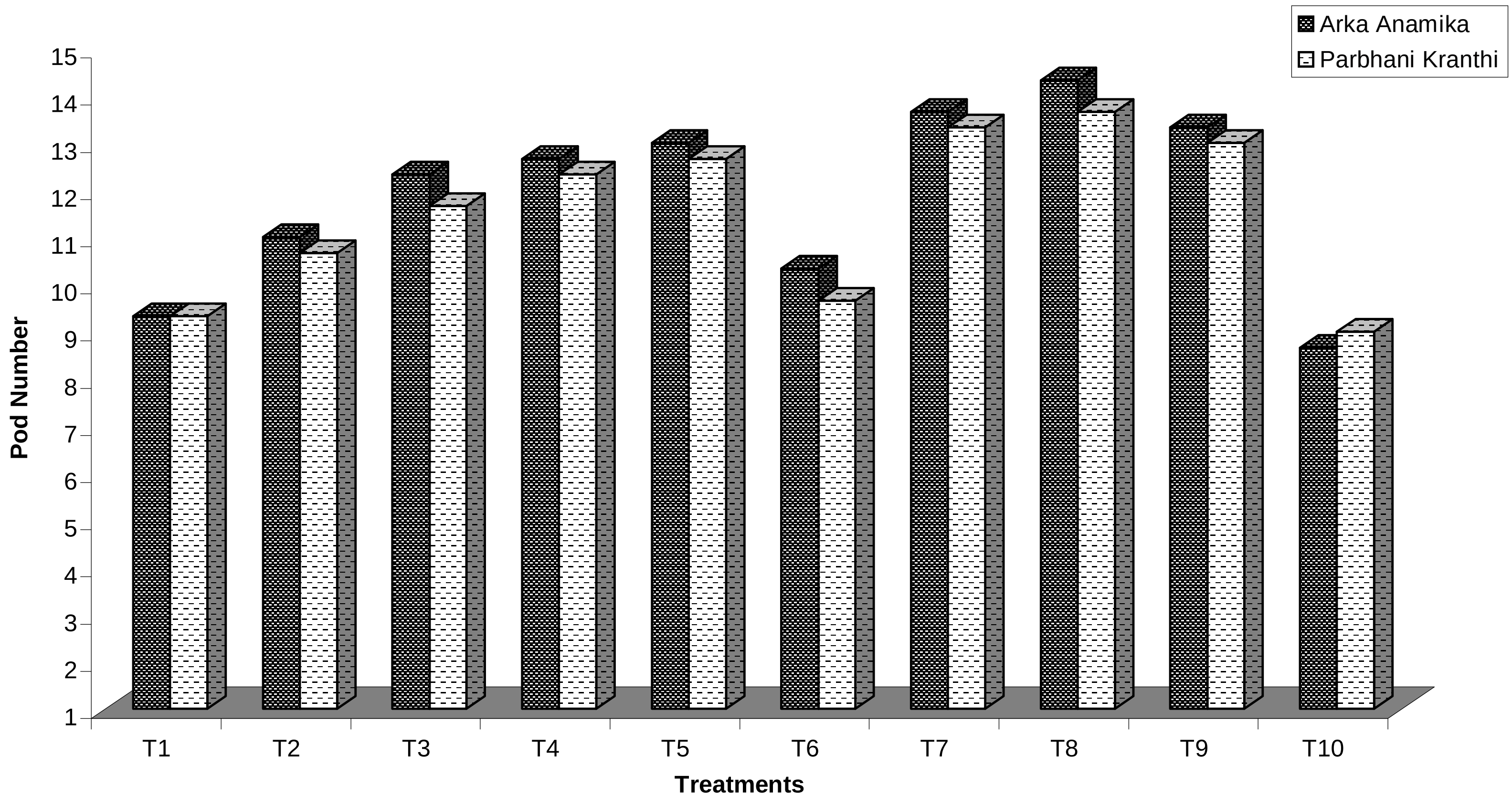


Figure 4 : Effect of organic and inorganic sources of nitrogen on pod number in okra

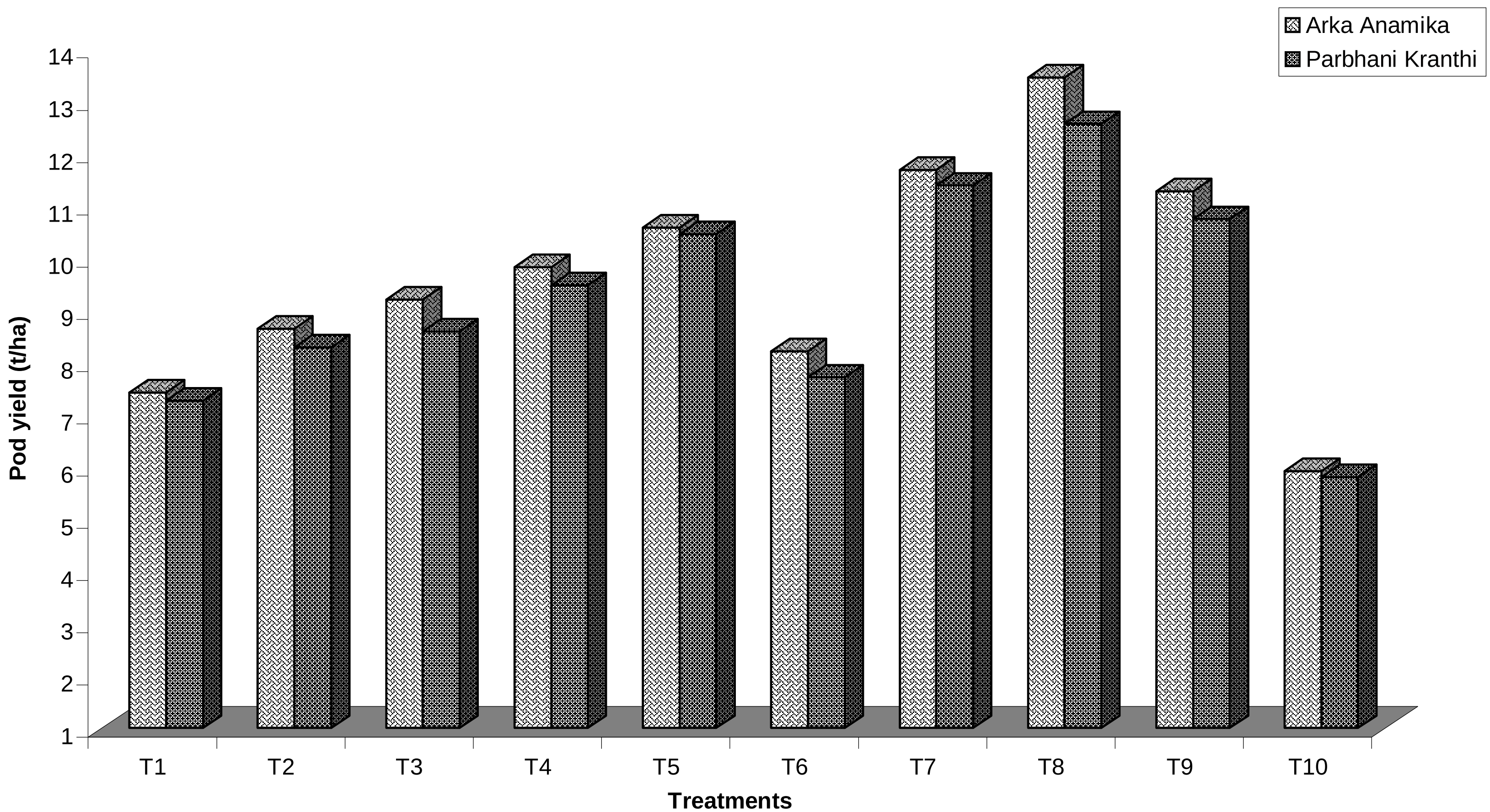


Figure 5 : Effect of organic and inorganic sources of nitrogen on pod yield (t/ha) in okra

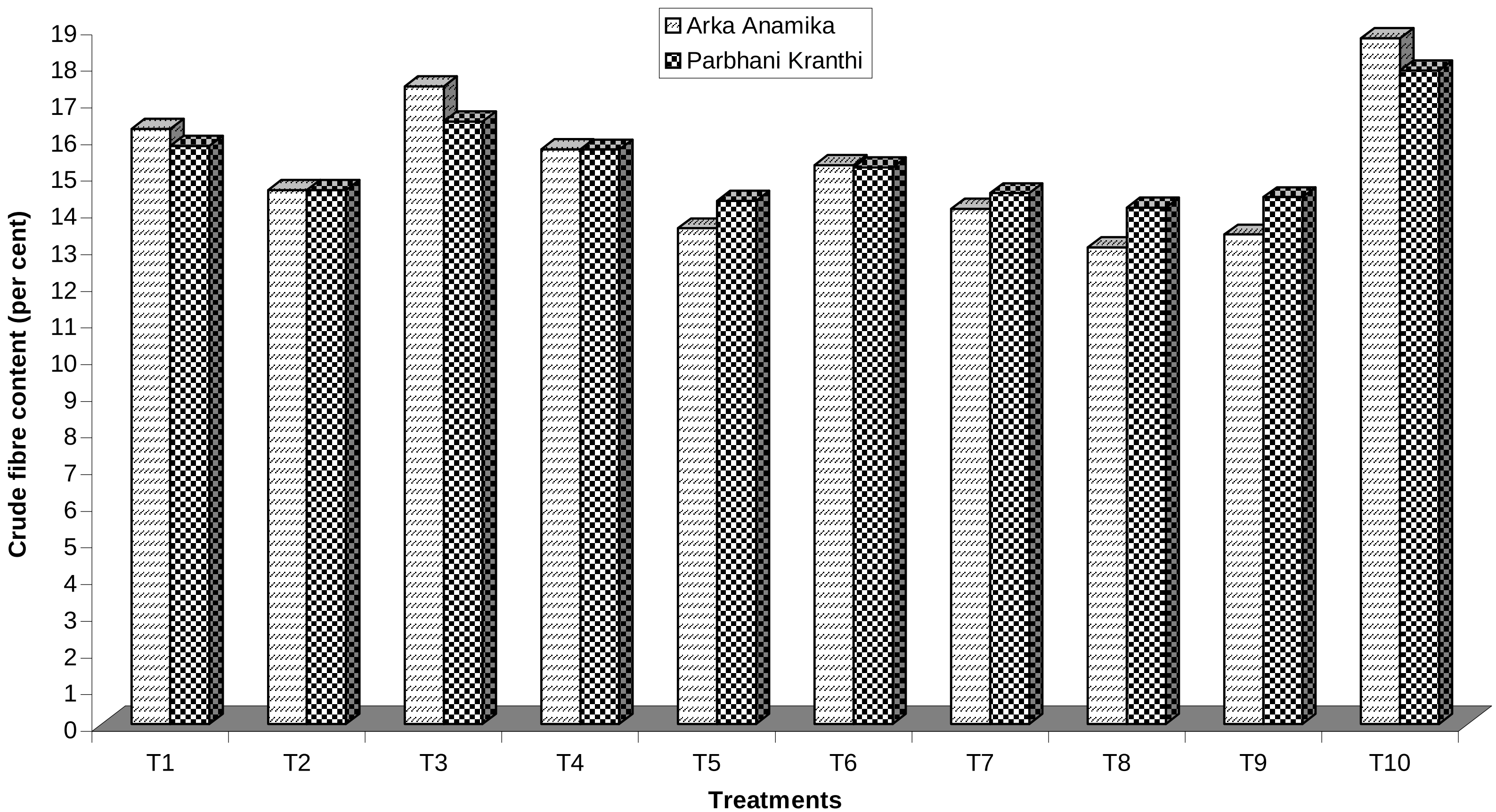
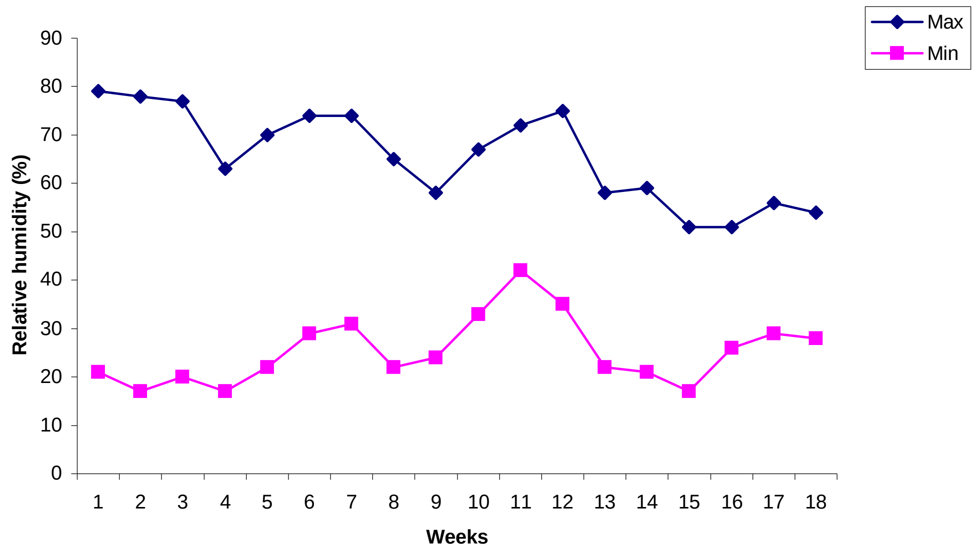
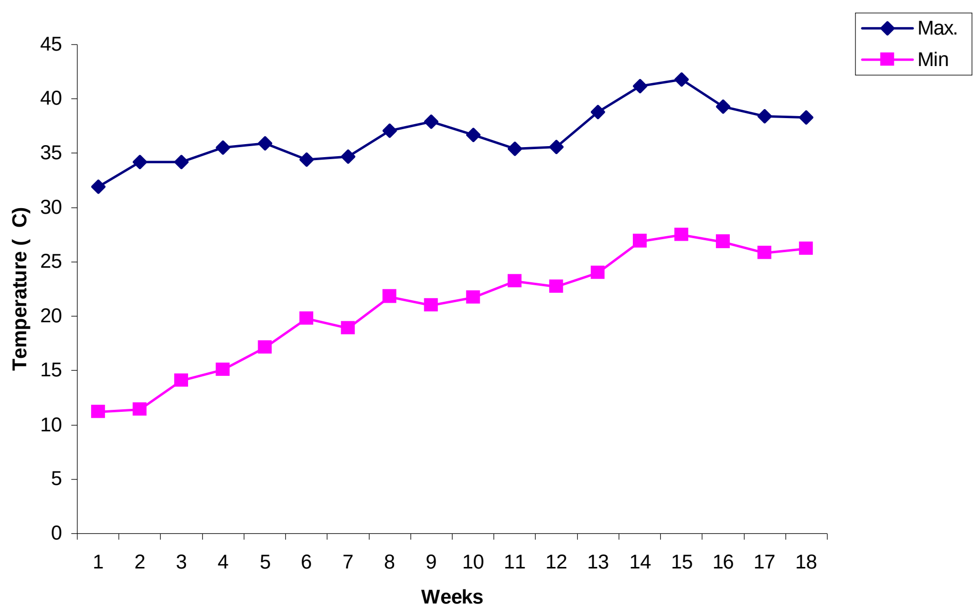


Figure 7 : Effect of organic and inorganic sources of nitrogen on crude fibre content of pod (per cent) in okra

Figure – 1 : Meteorological data during the crop growth period (February to May – 2001)



Relative humidity



Temperature

Table 3 : Effect of organic and inorganic sources of nitrogen on plant height (cm) at 30 DAS in okra

Treatments	Varieties		Mean
	Arka Anamika	Parbhani Kranthi	
T_1 : 100% RDNF – FYM	12.50	13.33	12.91
T_2 : 100% RDNF – VC	14.30	17.93	16.11
T_3 : 100% RDNF – Fertilizer	17.96	19.53	18.75
T_4 : 25% RDNF – FYM + 75% RDNF – Fertilizer	16.03	22.30	19.16
T_5 : 50% RDNF – FYM + 50% RDNF – Fertilizer	18.56	23.66	21.11
T_6 : 75% RDNF – FYM + 25% RDNF – Fertilizer	12.80	15.66	14.23
T_7 : 25% RDNF – VC + 75% RDNF – Fertilizer	23.63	29.23	26.43
T_8 : 50% RDNF – VC + 50% RDNF – Fertilizer	26.46	31.10	28.78
T_9 : 75% RDNF – VC + 25% RDNF – Fertilizer	22.53	27.86	25.20
T_{10} : Control	8.73	11.60	10.16
Mean	17.35	21.22	19.28

	F_1	F_2	$F_1 \times F_2$
S.Em	0.26	0.58	0.82
CD (0.05)	0.74	1.67	2.36

NS - Non significant
F_1 - Varieties
F_2 - Treatments (organic & inorganic sources of nitrogen)
F_1x F_2 - Interaction
RDNF - Recommended dose of nitrogen fertilizer
FYM - Farmyard manure
VC - Vermicompost

Table 4 : Effect of organic and inorganic sources of nitrogen on plant height (cm) at 60 DAS in okra

Treatments	Varieties		Mean
	Arka Anamika	Parbhani Kranthi	
T_1 : 100% RDNF – FYM	38.53	38.53	38.53
T_2 : 100% RDNF – VC	47.56	51.46	49.51
T_3 : 100% RDNF – Fertilizer	55.60	56.46	56.03
T_4 : 25% RDNF – FYM + 75% RDNF – Fertilizer	59.63	57.66	58.65
T_5 : 50% RDNF – FYM + 50% RDNF – Fertilizer	56.76	61.50	59.13
T_6 : 75% RDNF – FYM + 25% RDNF – Fertilizer	49.53	52.50	51.01
T_7 : 25% RDNF – VC + 75% RDNF – Fertilizer	78.76	80.70	79.73
T_8 : 50% RDNF – VC + 50% RDNF – Fertilizer	87.53	92.60	90.06
T_9 : 75% RDNF – VC + 25% RDNF – Fertilizer	75.13	78.83	76.98
T_{10} : Control	30.56	30.56	30.56
Mean	57.96	60.08	59.02

	F_1	F_2	F_1 x F_2
S.Em	0.54	1.22	1.73
CD (0.05)	1.56	3.50	NS

NS - Non significant
F_1 - Varieties
F_2 - Treatments (organic & inorganic sources of nitrogen)
F_1x F_2 - Interaction
RDNF - Recommended dose of nitrogen fertilizer
FYM - Farmyard manure
VC - Vermicompost

Table 5 : Effect of organic and inorganic sources of nitrogen on plant height (cm) at 90 DAS in okra

Treatments	Varieties		Mean
	Arka Anamika	Parbhani Kranthi	
T_1 : 100% RDNF – FYM	46.36	45.53	45.95
T_2 : 100% RDNF – VC	57.56	59.43	58.50
T_3 : 100% RDNF – Fertilizer	63.50	63.70	63.60
T_4 : 25% RDNF – FYM + 75% RDNF – Fertilizer	69.86	69.76	69.81
T_5 : 50% RDNF – FYM + 50% RDNF – Fertilizer	67.53	72.13	69.83
T_6 : 75% RDNF – FYM + 25% RDNF – Fertilizer	58.90	60.46	59.68
T_7 : 25% RDNF – VC + 75% RDNF – Fertilizer	91.76	96.43	94.10
T_8 : 50% RDNF – VC + 50% RDNF – Fertilizer	102.53	108.46	105.50
T_9 : 75% RDNF – VC + 25% RDNF – Fertilizer	86.80	91.40	89.10
T_{10} : Control	37.70	37.90	37.80
Mean	68.25	70.52	69.38

	F_1	F_2	F_1 x F_2
S.Em	0.74	1.65	2.34
CD (0.05)	2.12	4.75	-

NS - Non significant
F_1 - Varieties
F_2 - Treatments (organic & inorganic sources of nitrogen)
F_1x F_2 - Interaction
RDNF - Recommended dose of nitrogen fertilizer
FYM - Farmyard manure
VC - Vermicompost

Table 12 : Effect of organic and inorganic sources of nitrogen on pod length (cm) at maximum (5^{th}) harvest in okra

Treatments	Varieties		Mean
	Arka Anamika	Parbhani Kranthi	
T_1 : 100% RDNF – FYM	14.10	13.96	14.03
T_2 : 100% RDNF – VC	16.96	15.30	16.13
T_3 : 100% RDNF – Fertilizer	15.26	14.16	14.71
T_4 : 25% RDNF – FYM + 75% RDNF – Fertilizer	15.93	14.56	15.25
T_5 : 50% RDNF – FYM + 50% RDNF – Fertilizer	17.96	15.76	16.86
T_6 : 75% RDNF – FYM + 25% RDNF – Fertilizer	15.66	14.40	15.03
T_7 : 25% RDNF – VC + 75% RDNF – Fertilizer	16.46	15.00	15.73
T_8 : 50% RDNF – VC + 50% RDNF – Fertilizer	19.13	17.30	18.21
T_9 : 75% RDNF – VC + 25% RDNF – Fertilizer	17.16	15.50	16.33
T_{10} : Control	9.43	9.46	9.45
Mean	15.81	14.51	15.17

	F_1	F_2	F_1 x F_2
S.Em	0.14	0.32	0.45
CD (0.05)	0.41	0.92	-

NS - Non significant
F_1 - Varieties
F_2 - Treatments (organic & inorganic sources of nitrogen)
F_1x F_2 - Interaction
RDNF - Recommended dose of nitrogen fertilizer
FYM - Farmyard manure
VC - Vermicompost

Table 13 : Effect of organic and inorganic sources of nitrogen on pod length (cm) at final harvest in okra

Treatments	Varieties: Arka Anamika	Varieties: Parbhani Kranthi	Mean
T_1 : 100% RDNF – FYM	13.26	13.36	13.31
T_2 : 100% RDNF – VC	16.10	15.03	15.56
T_3 : 100% RDNF – Fertilizer	14.90	13.86	14.38
T_4 : 25% RDNF – FYM + 75% RDNF – Fertilizer	15.33	14.33	14.83
T_5 : 50% RDNF – FYM + 50% RDNF – Fertilizer	16.46	15.53	16.00
T_6 : 75% RDNF – FYM + 25% RDNF – Fertilizer	14.93	14.00	14.46
T_7 : 25% RDNF – VC + 75% RDNF – Fertilizer	15.90	14.56	15.23
T_8 : 50% RDNF – VC + 50% RDNF – Fertilizer	18.03	17.03	17.53
T_9 : 75% RDNF – VC + 25% RDNF – Fertilizer	16.20	15.16	15.68
T_{10} : Control	9.26	9.16	9.21
Mean	15.04	14.20	14.62

	F_1	F_2	F_1 x F_2
S.Em	0.19	0.42	0.60
CD (0.05)	0.54	1.21	-

NS - Non significant
F_1 - Varieties
F_2 - Treatments (organic & inorganic sources of nitrogen)
F_1x F_2 - Interaction
RDNF - Recommended dose of nitrogen fertilizer
FYM - Farmyard manure
VC - Vermicompost

Table 11 : Effect of organic and inorganic sources of nitrogen on pod number in okra

Treatments	Varieties		Mean
	Arka Anamika	Parbhani Kranthi	
T_1 : 100% RDNF – FYM	9.33	9.33	9.33
T_2 : 100% RDNF – VC	11.00	10.66	10.83
T_3 : 100% RDNF – Fertilizer	12.33	11.66	12.00
T_4 : 25% RDNF – FYM + 75% RDNF – Fertilizer	12.66	12.33	12.50
T_5 : 50% RDNF – FYM + 50% RDNF – Fertilizer	13.00	12.66	12.83
T_6 : 75% RDNF – FYM + 25% RDNF – Fertilizer	10.33	9.66	10.00
T_7 : 25% RDNF – VC + 75% RDNF – Fertilizer	13.66	13.33	13.50
T_8 : 50% RDNF – VC + 50% RDNF – Fertilizer	14.33	13.66	14.00
T_9 : 75% RDNF – VC + 25% RDNF – Fertilizer	13.33	13.00	13.16
T_{10} : Control	8.66	9.00	8.83
Mean	11.86	11.53	11.70

	F_1	F_2	F_1 x F_2
S.Em	0.18	0.41	0.59
CD (0.05)	--	1.19	--

NS - Non significant
F_1 - Varieties
F_2 - Treatments (organic & inorganic sources of nitrogen)
F_1x F_2 - Interaction
RDNF- Recommended dose of nitrogen fertilizer
FYM - Farmyard manure
VC - Vermicompost

Table 17 : Effect of organic and inorganic sources of nitrogen on crude fibre content (per cent) of pod in okra

Treatments	Varieties		Mean
	Arka Anamika	Parbhani Kranthi	
T_1 : 100% RDNF – FYM	16.22	15.76	15.99
T_2 : 100% RDNF – VC	14.55	14.56	14.56
T_3 : 100% RDNF – Fertilizer	17.38	16.42	16.90
T_4 : 25% RDNF – FYM + 75% RDNF – Fertilizer	15.67	15.66	15.66
T_5 : 50% RDNF – FYM + 50% RDNF – Fertilizer	13.51	14.26	13.88
T_6 : 75% RDNF – FYM + 25% RDNF – Fertilizer	15.23	15.17	15.20
T_7 : 25% RDNF – VC + 75% RDNF – Fertilizer	14.04	14.47	14.25
T_8 : 50% RDNF – VC + 50% RDNF – Fertilizer	12.99	14.07	13.53
T_9 : 75% RDNF – VC + 25% RDNF – Fertilizer	13.34	14.36	13.85
T_{10} : Control	18.70	17.81	18.25
Mean	15.16	15.25	15.21

	F_1	F_2	F_1 x F_2
S.Em	0.15	0.33	0.47
CD (0.05)	--	0.96	--

NS - Non significant
F_1 - Varieties
F_2 - Treatments (organic & inorganic sources of nitrogen)
F_1x F_2 - Interaction
RDNF - Recommended dose of nitrogen fertilizer
FYM - Farmyard manure
VC - Vermicompost

Table 15 : Effect of organic and inorganic sources of nitrogen on dry matter production (kg ha^{-1}) of pod at maximum (5^{th}) harvest in okra

Treatments	Varieties		Mean
	Arka Anamika	Parbhani Kranthi	
T_1 : 100% RDNF – FYM	652.66	643.33	648.00
T_2 : 100% RDNF – VC	917.00	890.00	903.50
T_3 : 100% RDNF – Fertilizer	599.00	578.00	588.50
T_4 : 25% RDNF – FYM + 75% RDNF – Fertilizer	759.33	746.66	753.00
T_5 : 50% RDNF – FYM + 50% RDNF – Fertilizer	985.33	958.66	972.00
T_6 : 75% RDNF – FYM + 25% RDNF – Fertilizer	891.66	854.66	873.16
T_7 : 25% RDNF – VC + 75% RDNF – Fertilizer	928.33	909.00	918.66
T_8 : 50% RDNF – VC + 50% RDNF – Fertilizer	1174.00	1136.33	1155.16
T_9 : 75% RDNF – VC + 25% RDNF – Fertilizer	1048.66	1036.33	1042.50
T_{10} : Control	489.00	483.33	486.16
Mean	844.50	823.63	864.23

	F_1	F_2	F_1 x F_2
S.Em	7.21	16.14	22.82
CD (0.05)	20.66	46.21	--

NS - Non significant
F_1 - Varieties
F_2 - Treatments (organic & inorganic sources of nitrogen)
F_1x F_2 - Interaction
RDNF - Recommended dose of nitrogen fertilizer
FYM - Farmyard manure
VC - Vermicompost

Table 16 : Effect of organic and inorganic sources of nitrogen on dry matter production (kg ha^{-1}) of pod at final harvest in okra

Treatments	Varieties: Arka Anamika	Varieties: Parbhani Kranthi	Mean
T_1 : 100% RDNF – FYM	1183.66	1176.33	1180.00
T_2 : 100% RDNF – VC	1356.33	1333.33	1344.66
T_3 : 100% RDNF – Fertilizer	1127.33	1123.66	1125.50
T_4 : 25% RDNF – FYM + 75% RDNF – Fertilizer	1278.33	1265.66	1272.00
T_5 : 50% RDNF – FYM + 50% RDNF – Fertilizer	1392.33	1367.66	1381.00
T_6 : 75% RDNF – FYM + 25% RDNF – Fertilizer	1323.33	1322.33	1322.83
T_7 : 25% RDNF – VC + 75% RDNF – Fertilizer	1375.66	1365.00	1370.33
T_8 : 50% RDNF – VC + 50% RDNF – Fertilizer	1635.33	1619.33	1627.33
T_9 : 75% RDNF – VC + 25% RDNF – Fertilizer	1594.66	1522.33	1558.50
T_{10} : Control	1084.66	1071.00	1077.83
Mean	1335.16	1316.83	1326.33

	F_1	F_2	F_1 x F_2
S.Em	11.76	26.31	37.21
CD (0.05)	--	75.34	--

NS - Non significant
F_1 - Varieties
F_2 - Treatments (organic & inorganic sources of nitrogen)
F_1x F_2 - Interaction
RDNF - Recommended dose of nitrogen fertilizer
FYM - Farmyard manure
VC - Vermicompost

Table 14 : Effect of organic and inorganic sources of nitrogen on pod yield (t ha^{-1}) of okra

Treatments	Varieties		Mean
	Arka Anamika	Parbhani Kranthi	
T_1 : 100% RDNF – FYM	7.42	7.26	7.34
T_2 : 100% RDNF – VC	8.64	8.28	8.46
T_3 : 100% RDNF – Fertilizer	9.20	8.59	8.89
T_4 : 25% RDNF – FYM + 75% RDNF – Fertilizer	9.82	9.47	9.65
T_5 : 50% RDNF – FYM + 50% RDNF – Fertilizer	10.58	10.45	10.52
T_6 : 75% RDNF – FYM + 25% RDNF – Fertilizer	8.21	7.71	7.96
T_7 : 25% RDNF – VC + 75% RDNF – Fertilizer	11.68	11.38	11.53
T_8 : 50% RDNF – VC + 50% RDNF – Fertilizer	13.45	12.56	13.00
T_9 : 75% RDNF – VC + 25% RDNF – Fertilizer	11.27	10.74	11.00
T_{10} : Control	5.92	5.80	5.86
Mean	9.62	9.22	9.42

	F_1	F_2	F_1 x F_2
S.Em	0.13	0.29	0.41
CD (0.05)	0.37	0.84	--

NS - Non significant
F_1 - Varieties
F_2 - Treatments (organic & inorganic sources of nitrogen)
F_1x F_2 - Interaction
RDNF- Recommended dose of nitrogen fertilizer
FYM - Farmyard manure
VC - Vermicompost

Table 6 : Effect of organic and inorganic sources of nitrogen on number of nodes at 30 DAS in okra

Treatments	Varieties		Mean
	Arka Anamika	Parbhani Kranthi	
T_1 : 100% RDNF – FYM	6.33	5.66	6.00
T_2 : 100% RDNF – VC	8.00	8.00	8.00
T_3 : 100% RDNF – Fertilizer	8.66	8.33	8.50
T_4 : 25% RDNF – FYM + 75% RDNF – Fertilizer	7.33	7.33	7.33
T_5 : 50% RDNF – FYM + 50% RDNF – Fertilizer	10.66	9.66	10.16
T_6 : 75% RDNF – FYM + 25% RDNF – Fertilizer	7.00	6.33	6.66
T_7 : 25% RDNF – VC + 75% RDNF – Fertilizer	9.66	9.33	9.50
T_8 : 50% RDNF – VC + 50% RDNF – Fertilizer	11.66	10.66	11.16
T_9 : 75% RDNF – VC + 25% RDNF – Fertilizer	9.33	8.66	9.00
T_{10} : Control	5.33	5.33	5.33
Mean	8.40	7.93	8.16

	F_1	F_2	F_1 x F_2
S.Em	0.14	0.31	0.45
CD (0.05)	0.40	0.91	--

NS - Non significant
F_1 - Varieties
F_2 - Treatments (organic & inorganic sources of nitrogen)
F_1x F_2 - Interaction
RDNF - Recommended dose of nitrogen fertilizer
FYM - Farmyard manure
VC - Vermicompost

Table 7 : Effect of organic and inorganic sources of nitrogen on number of nodes at 60 DAS in okra

Treatments	Varieties		Mean
	Arka Anamika	**Parbhani Kranthi**	
T_1 : 100% RDNF – FYM	16.66	15.66	16.16
T_2 : 100% RDNF – VC	20.33	19.00	19.66
T_3 : 100% RDNF – Fertilizer	18.66	18.33	18.50
T_4 : 25% RDNF – FYM + 75% RDNF – Fertilizer	21.66	19.66	20.66
T_5 : 50% RDNF – FYM + 50% RDNF – Fertilizer	28.33	25.66	27.00
T_6 : 75% RDNF – FYM + 25% RDNF – Fertilizer	20.66	19.33	20.00
T_7 : 25% RDNF – VC + 75% RDNF – Fertilizer	23.33	22.66	23.00
T_8 : 50% RDNF – VC + 50% RDNF – Fertilizer	31.00	30.33	30.66
T_9 : 75% RDNF – VC + 25% RDNF – Fertilizer	25.33	23.66	24.50
T_{10} : Control	14.60	13.66	14.16
Mean	22.06	20.80	21.43

	F_1	F_2	F_1 x F_2
S.Em	0.15	0.34	0.49
CD (0.05)	0.44	0.99	--

NS - Non significant
F_1 - Varieties
F_2 - Treatments (organic & inorganic sources of nitrogen)
F_1x F_2 - Interaction
RDNF - Recommended dose of nitrogen fertilizer
FYM - Farmyard manure
VC - Vermicompost

Table 8 : Effect of organic and inorganic sources of nitrogen on number of nodes at 90 DAS in okra

Treatments	Varieties		Mean
	Arka Anamika	Parbhani Kranthi	
T_1 : 100% RDNF – FYM	23.33	22.66	23.00
T_2 : 100% RDNF – VC	28.66	26.66	27.66
T_3 : 100% RDNF – Fertilizer	25.33	24.66	25.00
T_4 : 25% RDNF – FYM + 75% RDNF – Fertilizer	27.33	26.33	26.83
T_5 : 50% RDNF – FYM + 50% RDNF – Fertilizer	34.66	32.66	33.66
T_6 : 75% RDNF – FYM + 25% RDNF – Fertilizer	26.66	25.33	26.00
T_7 : 25% RDNF – VC + 75% RDNF – Fertilizer	32.66	31.33	32.00
T_8 : 50% RDNF – VC + 50% RDNF – Fertilizer	38.66	37.33	38.00
T_9 : 75% RDNF – VC + 25% RDNF – Fertilizer	31.66	31.00	31.33
T_{10} : Control	16.66	15.66	16.16
Mean	28.56	27.36	27.96

	F_1	F_2	F_1 x F_2
S.Em	0.25	0.57	0.81
CD (0.05)	0.73	1.64	--

NS - Non significant
F_1 - Varieties
F_2 - Treatments (organic & inorganic sources of nitrogen)
F_1x F_2 - Interaction
RDNF - Recommended dose of nitrogen fertilizer
FYM - Farmyard manure
VC - Vermicompost

Table 9 : Effect of organic and inorganic sources of nitrogen on number of days taken for first flower appearance in okra

Treatments	Varieties		Mean
	Arka Anamika	Parbhani Kranthi	
T_1 : 100% RDNF – FYM	48.66	40.66	44.66
T_2 : 100% RDNF – VC	47.33	39.66	43.50
T_3 : 100% RDNF – Fertilizer	48.66	40.66	44.66
T_4 : 25% RDNF – FYM + 75% RDNF – Fertilizer	47.66	40.33	44.00
T_5 : 50% RDNF – FYM + 50% RDNF – Fertilizer	47.33	39.33	43.33
T_6 : 75% RDNF – FYM + 25% RDNF – Fertilizer	47.66	39.66	43.66
T_7 : 25% RDNF – VC + 75% RDNF – Fertilizer	47.33	40.66	44.00
T_8 : 50% RDNF – VC + 50% RDNF – Fertilizer	47.00	39.00	43.00
T_9 : 75% RDNF – VC + 25% RDNF – Fertilizer	47.66	39.66	43.66
T_{10} : Control	49.00	41.00	45.00
Mean	47.83	40.06	43.95

	F_1	F_2	F_1 x F_2
S.Em	0.18	0.41	0.58
CD (0.05)	0.52	1.17	--

NS - Non significant
F_1 - Varieties
F_2 - Treatments (organic & inorganic sources of nitrogen)
F_1x F_2 - Interaction
RDNF- Recommended dose of nitrogen fertilizer
FYM - Farmyard manure
VC - Vermicompost

Table 10 : Effect of organic and inorganic sources of nitrogen on number of days taken from flowering to harvesting

Treatments	Varieties		Mean
	Arka Anamika	Parbhani Kranthi	
T_1 : 100% RDNF – FYM	7.33	7.66	7.50
T_2 : 100% RDNF – VC	7.33	7.00	7.16
T_3 : 100% RDNF – Fertilizer	7.00	7.33	7.16
T_4 : 25% RDNF – FYM + 75% RDNF – Fertilizer	6.67	7.00	6.83
T_5 : 50% RDNF – FYM + 50% RDNF – Fertilizer	6.00	6.33	6.16
T_6 : 75% RDNF – FYM + 25% RDNF – Fertilizer	7.66	7.66	7.66
T_7 : 25% RDNF – VC + 75% RDNF – Fertilizer	6.33	6.33	6.33
T_8 : 50% RDNF – VC + 50% RDNF – Fertilizer	5.66	5.33	5.50
T_9 : 75% RDNF – VC + 25% RDNF – Fertilizer	6.00	6.66	6.33
T_{10} : Control	8.00	8.33	8.16
Mean	6.80	6.97	6.88

	F_1	F_2	F_1 x F_2
S.Em	0.26	0.58	0.83
CD (0.05)	--	--	--

NS - Non significant
F_1 - Varieties
F_2 - Treatments (organic & inorganic sources of nitrogen)
F_1x F_2 - Interaction
RDNF - Recommended dose of nitrogen fertilizer
FYM - Farmyard manure
VC - Vermicompost

CHAPTER – V

DISCUSSION

Continuous use of inorganic fertilizers without organic manures cause unsustainable soil productivity by reducing microbial activity and affecting soil health apart from causing nutritional imbalance in soil. Hence, it is necessary to establish an alternate solution to reduce the application of inorganic fertilizers without affecting productivity. Work on this aspect has been carried out using organic manures in combination with inorganic fertilizers on various crops. It has been reported by various scientists that vermicompost is a better organic manure which helps in maintaining the sustainable soil productivity besides improving the yield and quality characters of the produce (Brave, 1992; Desai, 1992; Gunjal and Nikam, 1992 and Kulkarni *et al.*, 1996). Therefore, the present investigation was carried out to elucidate the effect of vermicompost, FYM and inorganic fertilizers alone and in combination on yield and quality of okra.

5.1 Effect of organic and inorganic sources of nitrogen on growth parameters

Application of 50 per cent RDNF through vermicompost plus 50 per cent RDNF through inorganic fertilizer recorded significantly the highest plant height. This might be due to the presence of several plant growth hormones like cytokinins and auxins in casts of earthworms which have positive beneficial effect on yield parameters (Krishnamoorthy and Vajranabaiah, 1986). Kale *et al.,* 1992, reported that the increase in plant height was due to higher supply of nutrients by vermicompost upon its decomposition in soil besides its effect on increasing the efficiency of inorganic fertilizers. It could also be due to increased availability of nutrients, organic carbon content and water holding capacity (Gunjal and Nikam, 1992). Higher nitrogen doses increase vegetative growth of plants mainly by elongation of cells and partly by cell division and this might have resulted in taller plants (Singh *et al.*, 1967; Randhawa and Punnum, 1969; Chauhan and Gupta, 1973; Verma *et al.,* 1974). Garvilov (1962) reported that certain metabolites produced from earthworms may be responsible for plant growth. The plant height increased rapidly from 30 DAS to 60 DAS compared to 60 DAS to 90 DAS. The reduced rate of plant height beyond 60 DAS was because of diversion of more photosynthates from source (leaves) to sink (fruits) which is a common biological phenomenon in almost all crops (Neeraja, 1998 and Sandhya Rani, 1998).

The increase in pod weight might be due to an increase in amount of food manufactured and translocated into the pods, size of the pod and number of seeds per pod (Verma *et al.*, 1974; and Singh, 1979). Increase in number of pods per plant with increase in N levels might be due to an increase in number of nodes and branches per plant (Randhawa, 1962;

Verma *et al.,* 1970; Chauhan and Gupta, 1973; Verma *et al.,* 1974; Gupta and Rao, 1979 and Singh *et al.*, 1970).

The increase in growth and quality parameters with the application of chemical fertilizers was earlier reported by Chhonker and Singh (1963); Singh *et al.* (1967); Verma *et al.* (1974); Singh (1979); Rao (1981) and Pandey and Dubey (1996). It could be due to adequate supply of all the three major nutrients which are essential for growth and development of various plant parts. Nitrogen being constituent of protoplasm and its favourable effect on chlorophyll content of leaves might have resulted in increased synthesis of carbohydrates (Tisdale *et al.,* 1985). Phosphorus being a part of various enzymes, co-enzymes and energy rich ATP might have increased the vegetative growth (Mangal, 1985). Similarly, potassium ions help to maintain cell turgor, which in young leaves has a direct effect on the size of the cells and on growth rate of entire plant with respect to its physiological and biochemical functions (Mengal and Kirkby, 1987). Decreased plant height and dry matter accumulation under inadequate supply of fertilizers could be due to decreased leaf area index and increase in ABA level in plants (Dale *et al.,* 1979).

Application of vermicompost in combination with inorganic fertilizers at 50 per cent RDNF through vermicompost plus 50 per cent RDNF through inorganic fertilizer recorded significantly higher plant height, number of nodes, number of pods per plant. This could be due to the fact that vermicompost with its richness in both macro and micro nutrients besides having certain growth promoters, humus forming microbes and sustained availability of nutrients through out the crop growth period by the nitrogen fixers in it might have helped in increasing the various growth parameters by exerting its synergistic effect with inorganic fertilizers (Bano *et al.*, 1987). Similar observations were reported by Kulkarni *et al.* (1996) in china aster and Ravignanam and Gunathilagaraj (1996) in mulberry.

5.2 Effect of organic and inorganic sources of nitrogen on pod length (cm) in okra

The data on pod length (table 12, 13) revealed that the application of 50 per cent recommended does of nitrogen through vermicompost and 50 per cent nitrogen through inorganic fertilizer recorded mean highest pod length. This might be due to the increased photosynthetic activity and uptake of nutrients by okra crop in this treatment. Similar results were reported by Maheswari (1998) and Abusaleha and Shanmugavelu (1988) in okra.

Application of 50 per cent recommended dose of nitrogen through FYM and 50 per cent in the form of inorganic fertilizer recorded mean maximum pod length among FYM levels. It might be due to gradual availability of nutrients during the crop growth period.

Increase in pod length with increase in N levels may be due to an increase in shoot and leaf growth which are capable of synthesizing greater amount of carbohydrates and proteins that lead to an increase in pod length (Verma *et al.,* 1970; Verma *et al.*, 1974; Gupta and Rao, 1979 and Singh, 1979).

Among the two cultivars cv. Arka Anamika recorded mean maximum pod length at both maximum (5^{th}) and final harvest.

5.3 Effect of organic and inorganic sources of nitrogen on pod yield (t ha^{-1}) in okra

The treatment T_8 which received 50 per cent RDNF through vermicompost plus 50 per cent RDNF through inorganic fertilizer recorded mean highest (13.008 t ha^{-1}) pod yield. This might be due to the immediate release of nitrogen through inorganic fertilizer and later by mineralization of nitrogen from organic sources and thereby ensuring better availability of nutrients throughout the crop growth period. The yield of okra is directly correlated with the length and thickness of pod and the number of pods produced per plant (Kolhe and Chavan, 1967). It may be due to the fact that nitrogen is the major constituent of chlorophyll, proteins and amino acids, the synthesis of which is accelerated by the increased supply of nitrogen in soil (Arnon, 1943; Gupta and Rao, 1979; Singh, 1979; Verma *et al.*, 1974). Increased vegetative growth due to better availability of nutrients and the balanced C/N ratio might have increased synthesis of carbohydrates which ultimately promoted greater yield (Jose *et al.*, 1988). The increase in yield due to the application of half recommended nitrogen in the form of organic manure and half in inorganic form corroborated with findings of Abusaleha and Shanmugavelu (1988) in okra and Jose *et al.* (1988) in brinjal.

Kale *et al.* (1992) observed that vermicompost application enhanced the activity of beneficial microbes and colonization of mycorrhizal fungi which play an important role in mobilization of nutrients by plants. Thus, leading to better availability of nutrients and uptake by plants and resulting in better growth and yield.

The better performance of vermicompost treated plots can be attributed to the presence of growth promoting substances like auxins, gibberellic acid and indole acetic acid (Jambhaker, 1994) which have beneficial effects on yield parameters. Similar increase in yield due to application of vermicompost was reported by Govindan *et al.* (1995) and Usha Kumari *et al.* (1999) in okra.

Application of 50 per cent recommended dose of nitrogen through FYM and 50 per cent in the form of inorganic fertilizer recorded mean highest (10.52 t ha^{-1}) pod yield among FYM levels. Among the two cultivars the mean highest (9.66 t ha^{-1}) pod yield was recorded in the cv. Arka Anamika.

5.4 Effect of organic and inorganic sources of nitrogen on drymatter production of pod (kg ha^{-1}) in okra

Application of 50 per cent RDNF through vermicompost plus 50 per cent RDNF through inorganic fertilizer (T_8) recorded mean highest drymatter production at both maximum (5^{th}) and final harvest. Among the two cultivars the mean maximum drymatter production of pod was recorded in the cv. Arka Anamika at both maximum (5^{th}) and final harvest.

The drymatter production of okra is an important character which indicates the extent of accumulation of photosynthates and is an indirect indication of photosynthetic activity. A close perusal of the data set out on the table (15, 16) indicated an increase in the drymatter production with the age of crop.

Increase in drymatter production at different growth stages due to different sources of nutrients on equivalent basis could be attributed to availability of nutrients through inorganic sources at early stages and later from mineralization of organic manures ensuring nutrient supply throughout the crop growth. The conjunctive application of organics with inorganic sources sets a congenial soil environment and thereby ensuring better availability and uptake of nutrients resulting in increased drymatter production. Similar increase in drymatter due to conjunctive use of organic and inorganic sources of nitrogen was reported by Jose *et* *al.* (1988) and Shelke *et al.* (2001) in brinjal. The better performance of vermicompost over the farmyard manure might be due to the higher nutrient status especially micro-nutrients which are key elements in enzyme system which in turn responsible for synthesizing plant products during growth process and might have provided holistic nutrition to plant resulting in higher productivity. Apart from this vermicompost have growth promoting substances which have beneficial effects on yield parameters.

Significantly lower drymatter production of pod at all stages of crop growth was obtained in control which was due to poor crop establishment and lack of nutrient supply. Significant increase in drymatter production of vegetable crops with the application of organic manures and inorganic fertilizers have been reported by several workers (Chinnaswamy and Maria Kulandai, 1966; Singh *et al.*, 1970; Barker, 1975; Kale *et al.*, 1992 and Govindan *et al.*, 1995).

5.5 Effect of organic and inorganic sources of nitrogen on crude fibre content (per cent) of pod in okra

The mean lowest (13.52%) crude fibre content was found in pods of plants from T_8 which received 50 per cent of RDNF through vermicompost plus 50 per cent of RDNF through inorganic fertilizer. The pods of plants in control (T_{10}) recorded the mean highest (18.25%)

crude fibre content. Among the two cultivars the mean lowest (15.16%) crude fibre content was found in the cv. Arka Anamika.

Low crude fibre content is considered to be a desirable character. Application of organic form of nitrogen combined with inorganic form has lowered the crude fibre content, thereby enhancing the palatability. Among the application of nitrogen from a single source, vermicompost was superior to farmyard manure and inorganic fertilizer. This might be due to the presence of several plant growth hormones like auxins and cytokinins in casts of earthworms enhancing the vegetative growth resulting in high photosynthetic activity. Such a decrease in crude fibre content with the combined application of organic and inorganic sources of nitrogen was reported by Abusaleha and Shanmugavelu (1988). Similar decrease in crude fibre content by conjunctive use of inorganic fertilizer with vermicompost was reported by Maheswari (1998). It was obvious that increased crude fibre content of the okra pods was observed by the advancement in the stages of pickings. It might be due to the reduced succulence resulting from the cell wall thickening and reduced uptake of N with the advancement of crop growth.

Cost benefit ratio of each treatment

The highest gross returns and cost benefit ratio were obtained from the treatment with 50% RDNF through vermicompost plus 50% through inorganic fertilizer in both the cultivars. Among the two cultivars the gross costs (Rs.35,529), gross returns (Rs. 87,425) and cost benefit ratio (2.46) were highest with 50% RDNF through vermicompost and 50% through inorganic fertilizer in cv. Arka Anamika than in cv. Parbhani Kranthi. As the benefits of vermicompost are extended to more than one season, addition of vermicompost in the long run may give higher net returns than that of fertilizers alone through improvement of soil physical conditions besides supplying the plant nutrients.

CHAPTER - VI

SUMMARY

The present study entitled "Studies on the effect of organic manures and inorganic fertilizers on production and quality of okra (*Abelmoschus esculentus* (L.) Moench)" was conducted at the Students' Farm, College of Agriculture, Rajendranagar during February to April, 2001 on a sandy loam soil to study the effect of organic and inorganic sources of nitrogen at different levels and combinations on yield and quality of okra.

A field experiment was conducted in a randomized block design with three replications using two factors. The treatments comprised of four levels (25, 50, 75 and 100 per cent substitution to recommended nitrogen) each of farmyard manure and vermicompost along with 100 per cent recommended nitrogen through inorganic fertilizer. Two cultivars *viz.*, Arka Anamika and Parbhani Kranthi were used in this study. The experimental findings of the investigation are briefly summarized as below.

The plant height and number of nodes (30, 60 and 90 DAS) were significantly increased by the application of organic manures in combination with inorganic fertilizer. The treatment with 50 per cent recommended nitrogen through vermicompost and 50 per cent through

inorganic fertilizer recorded the average highest plant height (28.78, 90.06, 105.5 cm at 30, 60 and 90 DAS respectively) and number of nodes (11.16, 30.66, 38.0 per plant at 30, 60 and 90 DAS, respectively). The average highest plant height (21.22, 60.08, 70.52 cm at 30, 60 and 90 DAS, respectively) was recorded in the cv. Parbhani Kranthi, while average maximum number of nodes (8.40, 22.06, 28.56 per plant) were recorded in the cv. Arka Anamika.

In both the cultivars the minimum number of days taken for flowering was recorded in the treatment with 50 per cent recommended nitrogen through vermicompost plus 50 per cent through inorganic fertilizer. Among the two cultivars the average minimum (40.06) number of days taken for flowering was recorded in the cv. Parbhani Kranthi. But the effect of organic and inorganic sources of nitrogen on number of days taken from flowering to harvesting was not significant.

The maximum number of pods per plant were recorded in the treatment with 50 per cent recommended nitrogen through vermicompost plus 50 per cent through inorganic fertilizer in both the cultivars. The average highest (11.86) number of pods per plant were recorded in the cv. Arka Anamika.

Maximum (13.0 t ha^{-1}) pod yield was recorded in the treatment with 50 per cent recommended nitrogen through vermicompost plus 50 per cent through inorganic fertilizer. The mean highest (9.62 t ha^{-1}) pod yield was recorded in the cv. Arka Anamika. Among the two cultivars the cv. Arka Anamika recorded maximum dry matter production of pod at both maximum (5^{th}) and final harvest (1174.00 kg ha^{-1}, 1594.66 kg ha^{-1}, respectively).

Combined application of organic manures and inorganic fertilizers had a significant influence on quality parameters compared to application of inorganic fertilizers alone and control. Among the treatments with 50 per cent RDNF through vermicompost and 50 per cent recommended nitrogen through inorganic fertilizer showed increase in pod length in both the cultivars at both maximum harvest (19.13 cm in Arka Anamika and 17.3 cm in Parbhani Kranthi) and final harvest (18.03 cm in Arka Anamika, 17.03 cm in Parbhani Kranthi). Low crude fibre content which is a desirable character for okra pod was also recorded in the same treatment in both the cultivars. Among the two cultivars Parbhani Kranthi recorded mean low (15.16%) crude fibre content when compared to Arka Anamika.

The highest gross returns and cost benefit ratio were obtained from the treatment with 50% RDNF through vermicompost plus 50% through inorganic fertilizer in both the cultivars. Among the two cultivars the gross costs (Rs.35,529), gross returns (Rs.87,425) and cost benefit ratio (2.46) were higher with 50% RDNF through vermicompost and 50% through inorganic fertilizer in cv. Arka Anamika as compared to cv. Parbhani Kranthi.

Keeping in view the long term benefits for sustainable crop production, application of nutrients through vermicompost along with inorganic fertilizers can be recommended for higher production and quality of the crop.

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The pattern of “Literature Cited” presented above is in accordance with the “Guidelines” for thesis presentation for Acharya N.G. Ranga Agricultural University.

APPENDIX – I

Weekly meteorological data ARI, Rajendranagar

Week Period	Temperature (°C)		Relative humidity (%)		Rainfall (mm)	Sunshine (hrs)	Wind speed (km/hr)	Evaporation (mm)
	Max.	Min	Max.	Min.				
29-4 Feb	31.9	11.2	79	21	0.0	8.9	2.0	4.4
05-11	34.2	11.4	78	17	0.0	0.09	2.3	5.5
12-18	34.2	14.1	77	20	0.0	10.1	2.8	5.4
19-25	35.5	15.1	63	17	0.0	10.0	2.5	6.1
26-04 Mar	35.9	17.1	70	22	0.0	9.96	3.4	6.8
05-11	34.4	19.8	74	29	0.0	7.5	3.7	5.8
12-18	34.7	18.9	74	31	0.0	7.1	3.1	5.7
19-25	37.1	21.8	65	22	8.4	6.8	2.5	6.2
26-01 April	37.9	21.0	58	24	0.0	9.0	3.0	7.7
02-08	36.7	21.7	67	33	7.8	8.3	3.7	5.8
9-15	35.4	23.2	72	42	15.0	6.0	3.7	5.8
16-22	35.6	22.7	75	35	66.4	8.3	2.5	5.5
23-29	38.8	24.0	58	22	0.0	10.5	2.2	7.7
30-06 May	41.2	26.9	59	21	0.0	10.1	3.0	8.5
07-13	41.8	27.5	51	17	0.0	9.9	4.2	10.9
14-20	39.3	26.8	51	26	0.0	7.3	3.5	8.7
21-27	38.4	25.8	56	29	0.0	9.6	6.1	10.0
28-03 Jun	38.3	26.2	54	28	0.0	10.6	9.1	11.8

Table 18 : Cost benefit ratio of okra in given treatments

Treatments	Arka Anamika				Parbhani Kranthi			
	Net yield (kg ha^{-1})	**Gross costs (Rs. ha^{-1})**	**Gross returns (Rs ha^{-1})**	**Cost benefit ratio**	**Net yield (kg ha^{-1})**	**Gross costs (Rs. ha$^{-1=)}$**	**Gross returns (Rs. ha^{-1})**	**Cost benefit ratio**
T_1	7,420	31,129	48,230	1.54	7,260	31,129	47,190	1.51
T_2	8,640	31,317	56,160	1.79	8,280	31,317	53,820	1.71
T_3	9,200	31,486	59,800	1.89	8,590	31,486	55,835	1.77
T_4	9,820	33,038	63,830	1.93	9,470	33,038	61,555	1.86
T_5	10,580	34,589	68,770	1.98	10,450	34,589	67,925	1.96
T_6	8,210	36,140	53,365	1.47	7,710	36,140	50,115	1.38
T_7	11,680	33,508	75,920	2.26	11,380	33,508	73,970	2.2
T_8	13,450	35,529	87,425	2.46	12,560	35,529	81,640	2.17
T_9	11,270	37,551	73,255	1.95	10,740	37,551	69,810	1.85
T_{10}	5,920	30,400	38,480	1.26	5,800	30,400	37,700	1.24

Fruits sold @ Rs. 6.50 / kg; FYM - Rs.350/ton; Vermicompost - Rs 2000/ton