ROLE OF ORGANIC MANURES IN COMBINATION WITH INORGANIC FERTILIZER IN TOMATO PRODUCTION CV HISAR ARUN

BY
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MASTER OF SCIENCE

IN

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2007

DEDICATED
TO MY
PARENTS

CERTIFICATE-I

This is to certify that this thesis entitled, **"Role of organic manures in combination with inorganic fertilizer in tomato production cv Hisar Arun",** submitted for the degree of **Master of Science** in the subject of **Vegetable Science** of the Chaudhary Charan Singh Haryana Agricultural University, Hisar, and is a bonafide research work carried out by **Mr. Rajesh Kumar, Adm. No. 2004A102M** under my supervision and that no part of this thesis has been submitted for any other degree.

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

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CERTIFICATE-II

This is to certify that this thesis entitled, **"Role of organic manures in combination with inorganic fertilizer in tomato production cv Hisar Arun"** submitted by **Mr. Rajesh Kumar, Adm. No. 2004A102M,** to the Chaudhary Charan Singh Haryana Agricultural University, in the partial fulfillment of the requirements for the degree of **Master of Science** in the subject of **Vegetable Science** has been approved by the Student's Advisory Committee after an oral examination on the same.

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DEAN, POST-GRADUATE STUDIES

CONTENTS

LIST OF TABLES

Acknowledgement

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Hisar **(Rajesh Kumar)**

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CHAPTER-I

Introduction

Tomato (*Lycopersicon esculentum* Mill.) is one of the most popular vegetable crops grown all over the world. Its fruits are good source of minerals, vitamins, and organic acids. It has been identified as one of the vegetable crops for export market. In India, the crop is grown in an area of 4.86 lakh ha with production of 74.42 lakh tonnes (Arora *et al*. 2002). In Haryana, the total production of tomato is 257282 metric tonnes from an area of 17116 ha (Anonymous, 2007).

Tomato requires ample supply of plant nutrient for satisfactory growth, yield, and quality (Rafi *et al,* 2002). The soil of the Haryana are poor in N, medium in P and high in K content hence, they need sufficient application of nutrients to meet out the crop required ment. Continuous applications of fertilizers particularly nitrogenous fertilizers may have ill effect on soil health which ultimately declines the production potential of soil as well as the quality of the produce.

Tomato requires high dose of inorganic fertilizers for maximizing production However, the use of higher application of chemical fertilizers particularly to meet out not only enhance the cost of production but

decrease the biological activity of soil, and imbalanced the availability of different nutrient elements, ultimately deteriorates the soil quality. High use of inorganic nitrogenous fertilizers also leads to accumulation of nitrates in furits, which are health hazardous to the human being.

To minimize, these problems effects are being made to grow vegetables recent trends in vegetable farming is the use of organic inputs, these inputs organically which not only improve the soil health but also increase the efficiency of applied chemicals and quality fruits. Inorganic fertilizers contain one or two nutrients whereas organic manures consists almost all essential nutrients required by plants which enrich the soil and improve soil health. Thus organic farming can play an important role in ensuring stability and sustainability of vegetables production. Organic materials such as FYM, green manures and crop residue etc offer sustainable and ecologically sound alternative for meeting the nutrient requirement of the crop. Different studies have indicated considerable increase in Vegetable production and quality improvement by using organic martial without any harmful effect on soil suface. However, the yield per unit area obtained under organic cultivation are show effectively low. Therefore, it is worthwhile to use organic and inorganic fertilizers both together

The huge nutritional demand of vegetables in general is difficult to be met out through organic source of nutrients only. Application of organic and inorganic source have because they have synergistic effects and increase the fertilizer use efficiency, ensure high

yield, result in lesser loss of costly fertilizer inputs and maintain the soil and ecosystem healthy for sustain productivity. This integrated nutrient management is also gaining important in the recent years. Keeping in view the above facts, the present study was carried out with the following objectives:

1. To compare the effects of organic and inorganic fertilizers in tomato.
2. To reduce the use of inorganic fertilizers by supplementing through organic manures.
3. To work out economics of the treatments.

CHAPTER-II

Review of Literature

Tomato is an important vegetable having high nutrient value and is cultivated for fresh market. It requires ample supply of nitrogen fertilizers through inorganic fertilizers to ensure satisfactory growth and yield. The indiscriminate use of chemical fertilizers caused serious damage to the soil and ecology. This problem can be overcome by the application of additional amount of organic residues and manures. Therefore, a combination of using organic manure and fertilizers may be helpful in increasing vegetable productivity. This integrated nutrient management is gaining importance in recent years. In this chapter an attempt has been made to review the information available on the role of organic manure in combination with inorganic fertilizers in tomato production cv. Hisar Arun on growth yield and quality. As the scientific information on the above subject is meager in case of tomato crop, it was felt that work done in other vegetables will be reviewed.

Fritz and wonnebeger (1973) reported that the efficiency of inorganic fertilizers is increased when they are combined with organic fertilizers. Yadav *et al,* (2001) observed improvement in physical properties of soil when organic manure applied alone or in combination with inorganic fertilizers only. Similar results were also given by Geissler and Schmidt (1978). Nehra and Grewal (2001) noted that application of organic manures (FYM @ 15t /ha) increased the organic carbon content and available NPK in soil significantly. Similar results were also given by Geissler and Schmid (1978). Singh *et. al.,* (1994) also reported that application of nitrogenous fertilizers along with continuous use of FYM improved the efficiency of fertilizers and nutrients applied.

Ovchinnikova (1972) reported that application of FYM @ 20t /ha + NP at 60:60 kg /ha gave good vegetative growth in tomato. Shelke *et. al.,* (1999) while working on brinjal found that plant height and number of branches were significantly increased due to the application of N through organic and inorganic fertilizers. Similar results were also given by Youssef *et. al.*, (2001). Shelke *et. al.*, (1999) while working on brinjal reported that the plant height, numbers of branches, leaves per plant and leaf area were significantly increased due the application of N through organic and inorganic combination. Krishna and Krishnappa (2002) reported increase in the plant height of tomato with the application of NPK+Agrimagic @ 250:250:250 + (17.87t /ha).

An increase in the plant height was recoded with the application of 50% recommended dose of NPK (100:50:50) and 50% FYM (Rafi *et. al.*, 2002). The highest plant height was recorded with an application of nitrogen @ 150 kg /ha along with phosphorus @ 75 kg / ha. (Sahoo *et. al.*, 2002) An increase in the plant height of tomato was observed as compared to control when FYM @500g per plant was applied (Chaudhary *et. al.*, 2003). Kaur *et. al.,* (2003) recorded highest plant height with an application of Nitrogen @ 220 kg /ha and K @100 kg / ha in tomato. Yadav *et. al.,* (2004) recorded highest plant height of tomato with an application of FYM @ 20t /ha + half dose of NPK 180:120:180 kg /ha. An increase in plant height (30:60:90 DAS) as compared to control was recoded with the application of 50% N (urea) +50% FYM (Yadav *et. al.,* 2004). Similar result was also given by Kaur *et. al.*, 2003).

Yadav *et al,* (2004) found increase in number of branches per plant at 30:60:90 DAS when 50% N were applied through Urea and reaming in the form of organic manures (FYM). Krishna and Krishnappa (2002) reported highest number of branches per plant (8.27 cm) in tomato with an application of NPK + Agrimagic @ 250:250: 250. The application of 50% recommended dose of NPK (100:50:50kg /ha) + 50% FYM found most effective for improvement in number of branches per plant of tomato (Rafi *et. al.,* 2002). Sahoo *et. al.,* (2002) recorded highest number of branches per plant (13.81 cm) with an application of

N 150 kg/ha along with K @ 150 kg / ha. Similar results were also given by (Kaur *et. al.,* 2003).

Early flowering has been noticed in the plants supplied with inorganic fertilizers as stated by Abusaleha (1981) in okra and Dhandpani (1982) in cauliflower. Kumar and Shrivastva (2006) recorded minimum days taken to first harvesting in tomato, when NPK @ 100:60:60 kg/ha was applied. Gianquinto Borin (1990) observed that tomato ripening delayed when NPK (200:100:280 kg /ha) was applied alone as compared to FYM 20t /ha + NPK (100:50:140 kg /ha) in tomato. Similar results were also given by the Mallanagouda *et. al.*, (1995) and Singh *et. al.*, (2000). Rafi *et al*, (2002) while working on tomato found that minimum number of days taken to 50% flowering with the application of 50% + RDF of NPK (100:50:50kg /ha) + 50% FYM.

Renuka and Shankar (2001) recorded an increase in number of fruits per plant in tomato with an application of FYM +NPK as compared to control. The highest number of fruits per plant (52.00) and average fruit weight (45.06) in tomato were observed with an application of 50% RDF of NPK (100:50:50) +50% FYM (Rafi *et. al.*, 2002). Krishna and Kishnappa (2002) recorded highest fruit weight (93.92) with an application of NPK+ Agrimagic @ 250:250:250 in tomato. An increase in the number of fruits per plant in tomato as compared to control was recorded with application of FYM @ 500g /plant (Chaudhary *et.al*, 2003). Kaur *et. al.,* (2003) recorded highest

number of fruits per plant (41.5 &42.0) and average fruit weight (50.3&51.1) with an application of N @ 220 kg /ha and K @ 100 kg /ha respectively in tomato. The application of 50% N (Urea) + 50% (FYM) found effective in increasing the number of fruits per plant in tomato as compared to control (Yadav *et. al.,* 2004).

Jose *et. al.*, (1988) noted the combination of 50kg N as organic form and higher uptake of NPK and then the other treatments and the ultimately leads to increased uptake by the plant. Organic manures increased the available nitrogen in soil and this ultimately lead to increased N uptake by the plant.

The yield response of tomato crop to added nitrogen through inorganic fertilizers was present to a considerable level. Dhar (1962) cautioned that the nitrates produced in the soil form the inorganic fertilizers can react with organic matter of the soil and deteriorate the soil health. This problem can be overcome by the application of organic manures. Kumaran *et. al.,* (1998) reported that a combination of organic + inorganic fertilizers gave the best results in terms of yield. Yadav *et. al.,* (2004) while working on production of tomato under organic condition observation that integrated nutrient management is giving importance in which inorganic fertilizers + organic manures keep the soil healthy and increases the production of the crop. Bagal *et al.*, (1989) reported that application of FYM @ 20t/ha with NPK at 200:100:100 kg/ha produce the highest yield (300q/ha) of tomato. Annanurova *et. al.,* (1992) observed that application of NPK alone

increases yield per plant by 43.4% as compared to control but on other hard when supplemented with FYM @ 30t/ha by 161.8%.Ahmed (1993) Compared the three doses of FYM (10t/ha 20t/ha 30t/ha)and it was found that the total production decreases as was increase the quantity of FYM similar results was also given by Alexivel *et al.,* (1997) The application of 40 kg N /ha as a basal dose + 40 kg N /ha as top dressing were found most effective as compared to control and other treatment in tomato (Singh *et. al.,* (2000). Sahoo *et. al.,* (2002) reported height yield (333.28 q /ha) in tomato with an application of N @ 150 kg /ha along with K @75 kg /ha in tomato. The highest yield (523. & 517 2 /ha) was recorded on improvement in yield with an application of FYM @ 500g per plant in tomato. An application of NPK @ 180:120:1801 kg /ha found most effective in increasing the yield of tomato when applied along with FYM @ of 20t /ha (Yadav *et al*, 2004). An increased in the yield of okra cv. Varsha Uphar was observed with an application of 50% N (Urea) + 50% FYM Yadav *et. al.,* (2004). Highest yield (47.66t/ha) was recorded with an application of FYM along with biogas slurry (Renuka and Sankar, 2001).Krishna and Krishappa, (2002*)* recorded height fruit yield per plant (386 kg) and total yield (82.92t/ha) with an application of NPK+Agrimagic @ 250:250:250 in tomato. The height yield per plant (2.34 kg) and total yield (586.57q/ha) were recorded with an application of 50% RDF (100:50:50) 50% FYM in tomato (Raf*i et.al.* 2002).Sahoo *et. al.,* (2002) recorded height yield (333.28 q /ha) in tomato with an application N @

150q /ha along with K @ 75 kg /ha in tomato. The highest yield (523.2 and 517 q/ha) was recorded in tomato with an application of N@ 220 kg /ha and K 100 kg /ha respectively in tomato (Kaur *et. al.,* 2003). Chaudhary *et. al.,* (2003) recorded on improvement in yield with an application of FYM @ 500g per plant in tomato. An application of NPK @ 180:120: 180 kg /ha) found most effective in increasing the yield of tomato when applied along with FYM @ of 20t /ha

Tomato is a nutritive Vegetable consume as raw as well as in cooked form. Quality of tomato is decided by parameters like pericarp thickness, TSS, titrable acidity ascorbic acid, lycopene contents. Generally organically grown products are higher in quality (Sankarran 1996). Kumraran *et. al.,* (1998) reported that quality parameters were comparatively higher in organically grown tomato as compared to other treatments. Yadav *et. al.,* (2006) while working in okra reported that quality of the crop increased with the application of different organic manures in combination with inorganic fertilizers as compared to control whereas Bahadur *et. al.*, (2006) noticed that FYM @ 10t /ha significantly enhanced the quality of Pea.

Prabakaran and Pitchai., (2002) recorded significantly higher TSS (4.9) Acidity (0.53%) and ascorbic acid (20.20) in tomatoes due to the application of nitrogen in the form of FYM @ 75q/ha. Yadav *et. al.,* (2004) studied the effect of tomato production under organic condition in tomato hybrid ARTH-3 TSS percent (4.6%) with the application of 40t FYM alone lowest was recorded (3.5%) when NPK was applied alone,

lowest was recorded (3.5%) when NPK was applied alone. Bahadur *et. al.,* (2006) recorded significantly higher ascorbic acid content in tomato due to application of FYM @ 20t/ha+half dose of NPK (90:60:40 kg) on the other found Kaur *et. al.,* (2003) found no effect of N and K on pericarp thickness and T.S.S. acidity increased with increasing fertilizer applied up to rates of NPK 200kg, 100kg and 100kg /ha after which there were no further increase. Increased with of K results in an increase in lycopene content whereas had the opposite effect. Meier *et. al.*, (1989) reported that composted FYM gave the superior results of desirable nutrients. Lacatus *et. al.*, (1994) reported that the best quality tomatoes for processing was obtained with NPK @ 300,150 and 75 kg/ha, respectively plus 20t FYM/ha.

CHAPTER-III

Materials and Methods

3.1 Experimental site

Studies on the "Role of organic manures in combination with inorganic fertilizer in tomato production *cv Hisar Arun*", were carried out at Vegetable Research Farm and Laboratories of Department of Vegetable Science, Chaudhary Charan Singh Haryana Agricultural University, Hisar during the spring summer season of 2006-2007.

3.2 Meteorological observations

Hisar is situated at latitude $29^0.10'$ North and longitude $75^0.46'$ east at an altitude of 215.2 meter. The climate of Hisar is semi-arid with hot and dry winds during summer months and warm humid in monsoon. The mean maximum and minimum temperature shows a wide range. A maximum temperature of 44^0 C to 47^0 C during summer and temperature up to freezing point accompanied by occurrence of frost in winter is common in this region. Most of rainfall is received during Months of July to September along with showers during January to late spring.

The meteorological data on various aspects recorded during the period of experiment are presented in Table 1.

Table 1: Mean monthly meteorological data during the crop season.

Month	Temperature (°C)		Relative humidity (%)		Evaporation (mm)	Rain fall (mm)
	Max	Min	Morning	Evening		
January	19.7	4.7	88.6	47.5	1.9	-
February	22.8	6.8	85.9	43.0	3.0	-
March	36.2	11.0	80.8	35.7	4.7	-
April	40.2	17.2	61.6	22.4	8.5	-
May	40.0	22.8	51.0	33.3	11.4	-
June	36.2	26.0	59.0	54.2	11.0	-

3.2 Soil condition

The field selected for these studies was uniform in fertility. A composite soil sample from 0-30cm soil depth was taken randomly at ten places from the field before layout of the experiment. The samples were mixed thoroughly, dried and were subjected to mechanical and chemical analysis. The physico-chemical analysis of the soil is presented in Table 2. The data shows that the soil of the field was sandy loam in texture, medium organic carbon, medium in phosphorus and rich in potash content.

Table 2: Physico-chemical analysis of the soil

Sr. no.	Particular	Value observed
A.	**Before layout of experiment**	
1.	Soil texture	Sandy loam
2.	pH	8.3
3.	Organic carbon (%)	0.39
4.	Available nitrogen (kg/ha)	100
5.	Available phosphorus (kg/ha)	22.00
6.	Available potassium (kg/ha)	370.00
7.	EC (ds/m)	0.70
B.	**After harvest of crop**	
1.	Soil texture	Sandy loam
2.	pH	8.2
3.	Organic carbon (%)	0.50
4.	Available nitrogen (kg/ha)	96
5.	Available phosphorus (kg/ha)	20.00
6.	Available potassium (kg/ha)	220.00
7.	EC (ds/m)	0.68

Details of experiment

The experiment was laid out in a randomized block design (fig-1) with three replications having a plot size of 3 x 2.70sq meters with 60 x 45cm spacing.

3.4.1 Treatment detail:

Thirteen different treatments were given as below

T_1	Control (without FYM and inorganic fertilizers)	
T_2	N: P_2O_5 : K_2O 40:25:20 kg/acre through inorganic fertilizer (100% RDF)	
T_3	10tFYM /acre	
T_4	15t FYM/acre	
T_5	17.5t FYM/acre	
T_6	10tFYM /acre N: P_2O_5 :K_2O- 40:25:20 kg/acre through inorganic fertilizer (100% RDF)	
T_7	15t FYM/acre + N: P_2O_5 : K_2O	30:18.7:15kg/acre through inorganic fertilizer (75% RDF)
T_8	17.5t FYM/acre + N : P_2O_5 : K_2O	17.5t +20:12.5:10kg /acre through Inorganic fertilizer (50 % RDF)
T_9	Green manuring	- (During kharif season i.e.preceding to tomato)
T_{10}	Green manuring	+ 5t FYM/acre
T_{11}	Green manuring	+10t FYM/acre
T_{12}	Green manuring + N: P_2O_5:K_2O	-20:12.5:10kg/acre (50 % RDF)
T_{13}	Green manuring + N: P_2O_5: K_2O	40:25:20kg/acre (100 % RDF)

RDF- Recommended dose of fertilizer

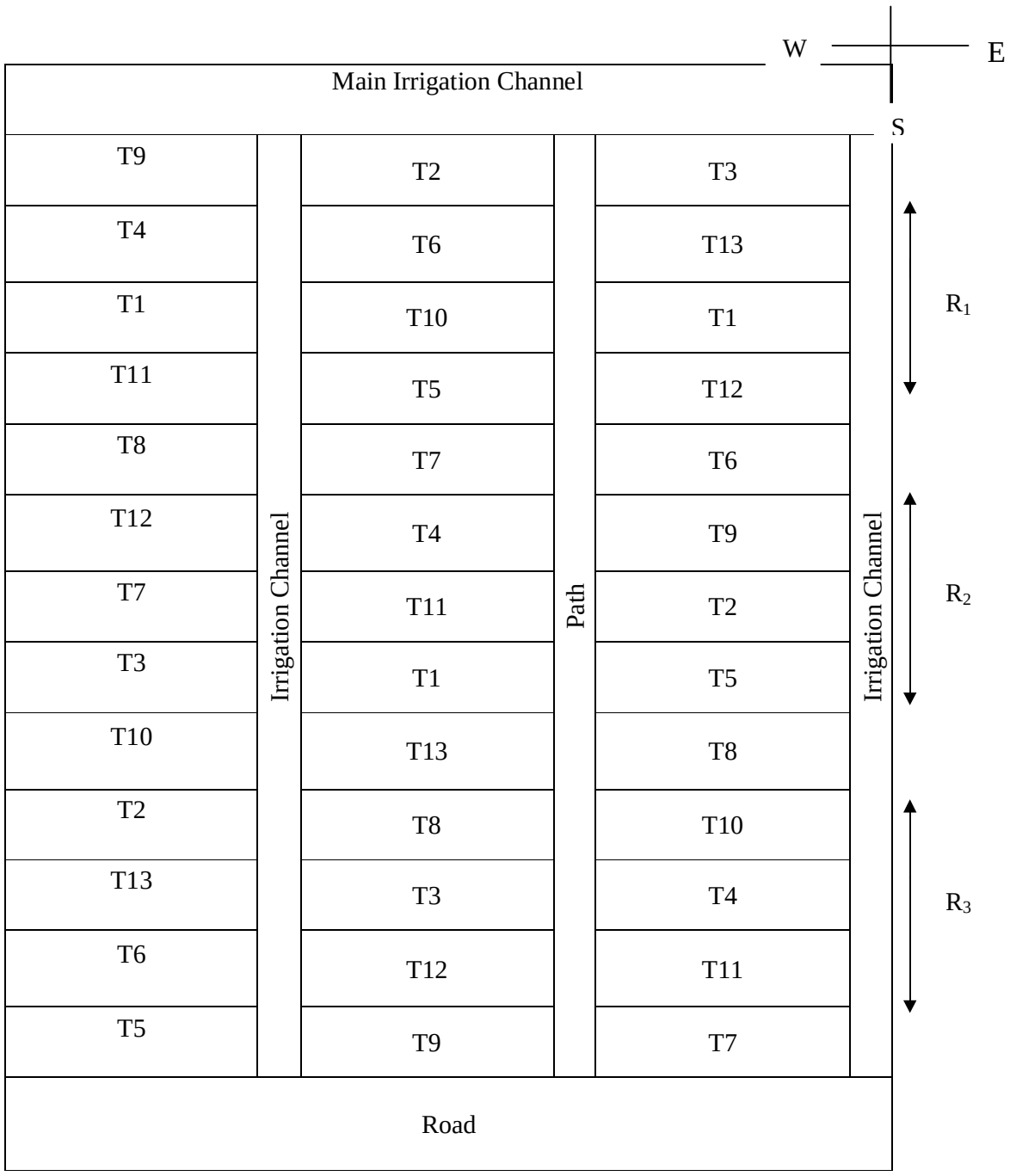

Fig.1:- Layout plan of experiment

Field preparation & layout:-

As per treatment FYM was incorporated in soil during field preparation and field was prepared to final tilth. The field was divided in to different plots measuring 3.0 x 2.70 sq meters.

There required quantity of the each organic manure was added in the allocated plot and mixed well before preparing the ridges. For application of inorganic fertilizer half dose of nitrogen entire dose of phosphorus and potassium as per treatments was applied as a basal dose at the time of transplanting and half dose of nitrogen was applied at 20-40 days after transplanting in equal splits as per treatment

3.7 Raising of seedling

Genetically pure seed of tomato variety Hisar Arun was obtained from department of Vegetable Science CCS HAU, Hisar and sown in the well prepared nursery beds on Dec. 25, 2006. After the sowing nursery beds were irrigated daily with the help of water cane till the seed germination. The nursery bed was covered with polythene sheet during night to protect against frost. The seedlings were transplanted on raised bed on 3rd February, 2007.All other cultural practices were carried out as per package of practices during the growth period of the crop.

Transplanting

The seedlings of tomato were transplanted on Feb 03, 2007. Seedlings ready for transplanting were taken from the nursery beds carefully without causing injury to their root and foliage system. Uniformly selected healthy seedlings were transplanted at 45 cm apart

on the ridges, made 60 cm distance. Experimental field was irrigated immediately after transplanting.

3. Observation recorded:-

3.1 Growth characters:-

For recording data on vegetative growth characters, five plants were selected at random from each treatment and tagged. The average value was calculated from the total of the data recorded from five plants as sample to represent the population.

3.1.1 Plant height

The height of plants was measured in centimeters from the base of the plant to apex of main shoot at 90 days after transplanting.

3.1.2 Number of primary branches per plant

The total numbers of primary branches were counted per plant at 90 days after transplanting.

3.1.3 Days to 50% flowering

The number of days taken from the date of transplanting to the opening of first flower in 50 percent population under each treatment was recoded as days to 50 flowering.

3.2 Fruit & yield characters:-

3.2.1 Days to first harvesting: - The numbers of days taken from the data of transplanting to the data of first harvesting under each treatment from five tagged plants were recorded.

3.2.2 Number of fruits per plant

The total numbers of fruits from five selected plants on each picking were summed up and fruits per plant were calculated by dividing the total number of fruits by total number of plants.

3.2.3 Average fruit weight (gm)

The weight of fruits from five selected plants in each treatment on each picking was recorded. Fruit weight per plant was calculated by dividing the total weight by five.

3.2.4 Fruit yield per plant

Fruit yield recorded from all the pickings was added to calculate that yield in kg per plot from which the yield per hectare (q) was calculated.

3.2.5 Yield (q/ha)

Fruit yield recorded from all the pickings was added to calculate that yield in kg per plot from which the yield per hectare (q) was calculated.

3.3 Quality characters:-

3.3.1 Pericarp thickness (mm)

The Pericarp (epicarp + mesocarp) thickness was measured in mm with Vernier caliper by dissecting equatorial plane of the fruits.

3.3.2 Total soluble solids (TSS)

Total soluble solids were determined with the help of Erma Hand Refract meter and expressed as per cent TSS.

3.3.3 Ascorbic acid

Ascorbic acid content in tomato fruits was determined by 2, 6-dichlorophenol indophenol titration method (A.O.A.C., 1975) and expressed in mg per 100 g of fruit weight.

3.3.4 Acidity

Acid content of extracted juice was determined by titrating the fruit juice against N/10 NaOH using phenolphthalein as an indicator (A.O.A.C., 1975).

3.3.5 Lycopene contents

The content of lycopene was estimated using the procedure outlined by Adsule and Amba Dan (1979).

3.4 Economics of treatments

The economics of treatments was worked out taking into consideration the cost of cultivation or production of crop. Net returns were counted with the following formula:

Net returns = Gross returns – Cost of cultivation

3.5 Uptake of nutrients (NPK)

Nitrogen uptake in plant samples was determined by colorimetric (Nesslers reagent) method (Lindner, 1994). Phosphorous in plant samples was determined by Vanadomoly bdophoshoric yellow color method (Koenig & Johason, 1992).

Potassium in the acid digest of plant can be determined by using flame photometer.

Analysis of variance

Source	d.f.	S.S	M.S	F. cal
Replication	r-1	SS_r	MS_r	$\underline{MS_r}$
Treatment	t-1	SS_t	MS_t	$\underline{MS_t}$
Error	(r-1) (t-1)	SS_e	MS_e	
Total	rt-1			

S.E. is the standard error of the difference of the treatment means which was calculated as follows:

$$S.Ed. = \sqrt{\frac{2\ ems}{r}}$$

In order to compare the means of different treatments, the critical difference (C.D.) was calculated by using the below mentioned formula.

C.D. = S.E. x t

Where,

ems = Error mean sum of squares

r = Number of replication

t = Tabulated value of 't' at 5% level of significance for error degree of freedom

CHAPTER-IV

Experimental Results

4.1 Growth character

4.1.1 Plant height: - The plant height as influenced by the application of different organic manures and inorganic fertilizers is presorted in Table-3. The different treatments influenced the plant height significantly as compared to control. Maximum plant height (60.0 cm) was recorded in treatment T_8 (17.5 t FYM +50% RDF) which was closely followed by the treatment T_{13} (Green manuring + 100% RDF) Minimum plant height (54.50cm) was recorded in T_1 where no organic manure and fertilizer was applied.

4.1.2 Branches per plant

The data presented in Table - 3 revealed that the numbers of branches per plant were significantly influenced by different organic manures and inorganic fertilizers. Maximum number of branches (7.23) per plant were recorded in T_8 (17.5t FYM/acre + 50% RDF) which was found significantly superior to all other treatments except in T_{13} where the plots which were green manured and applied full dose of NPK.

Minimum number of branches (5.20 and 5.73) were recorded in treatment T_1 control and T_3 (10t FYM/acre).

Table: 3 Effect of different organic manures and inorganic fertilizers on plant height and number of branches per plant.

Treatment Symbol	Treatments	Plant height (cm)	No. of branches/plant
T_1	Control	54.50	5.20
T_2	100%RDF	58.40	6.56
T_3	10t FYM /acre	54.40	5.73
T_4	15t FYM /acre	55.66	5.66
T_5	17.5t FYM /acre	57.06	5.90
T_6	10t FYM/ acre + 100% RDF	57.80	6.00
T_7	15t FYM/acre + 75% RDF	57.46	6.80
T_8	17.5t FYM/acre + 50% RDF	60.00	7.23
T_9	Green Manuring	54.73	5.90
T_{10}	Green Manuring +5t FYM /acre	56.86	6.00
T_{11}	Green Manuring + 10t FYM /acre	57.63	6.36
T_{12}	Green Manuring + 50% RDF	57.53	6.80
T_{13}	Green Manuring + 100% RDF	58.60	7.00
CD at 5%		2.60	0.44

4.1.3 Days to 50 per cent flowering:

Data pertaining to days taken for 50 per cent plants to flower is presented in Table-4. No significantly variations among the various treatments were observed regarding 50 per cent flowering. However days to 50 per cent flowering varied from 40.76 days to 43.06 days and minimum number of days taken to flowering (41.00) was recording in treatment T_8 (17.5t FYM + 50% RDF) which was followed by treatment T_{13} (Green manuring + 100% RDF). Maximum number of days (43.06) to 50 per cent flowering was recorded in control.

4.2 Fruiting and yield characters

4.2.1 Days to first harvesting

The perusal of the data presented in Table-5 indicated that application of different organic manures and inorganic fertilizers alone or in combination has significant effect on days taken to first harvest. Minimum number of days (81.50) taken to first harvesting was recorded in treatment T_8 (17.5t FYM/acre +50% RDF) which was found significantly superior to all other treatments except T_{13} in which the plot were Green manured and applied with full dose of NPK. Maximum number of days taken (92.00) to first harvest were recorded in T_1 when no organic manures and fertilizers were applied.

Table: 4 Effects of different organic manures and inorganic fertilizers on days to 50 % flowering.

Treatment Symbol	Treatments	Days to 50% flowering
T_1	Control	43.06
T_2	100%RDF	41.00
T_3	10t FYM /acre	42.06
T_4	15t FYM /acre	42.40
T_5	17.5t FYM /acre	42.06
T_6	10t FYM/ acre + 100% RDF	41.30
T_7	15t FYM/acre + 75% RDF	41.00
T_8	17.5t FYM/acre + 50% RDF	41.93
T_9	Green Manuring	42.00
T_{10}	Green Manuring +5t FYM /acre	41.86
T_{11}	Green Manuring + 10t FYM /acre	41.40
T_{12}	Green Manuring + 50% RDF	41.20
T_{13}	Green Manuring + 100% RDF	40.76
CD at 5%		NS

Table: 5 Effects of different organic manures and inorganic fertilizers on days to first harvesting.

Treatment Symbol	Treatments	Days to first harvest
T_1	Control	92.00
T_2	100%RDF	82.10
T_3	10t FYM /acre	86.50
T_4	15t FYM /acre	85.96
T_5	17.5t FYM /acre	84.20
T_6	10t FYM/ acre + 100% RDF	83.53
T_7	15t FYM/acre + 75% RDF	82.63
T_8	17.5t FYM/acre + 50% RDF	81.50
T_9	Green Manuring	85.93
T_{10}	Green Manuring +5t FYM /acre	84.93
T_{11}	Green Manuring + 10t FYM /acre	82.93
T_{12}	Green Manuring + 50% RDF	82.73
T_{13}	Green Manuring + 100% RDF	82.10
CD at 5%		1.90

4.2.2 Number of Fruits per plant

Data on number of fruits per plant as influenced by various treatments are presented in Table-6. Significant treatment effects were observed on total number of fruits per plant. Maximum number of fruits (36.46) per plant were recorded under treatment T_8 (17.5t FYM/acre + 50% RDF) which was followed by T_{13} (33.56). And both the treatments were found significantly superior to all other treatments. All the other treatments were found significantly superior to control in which the lowest (22.96) number of fruits per plant was observed

4.2.3 Average fruit weight (g)

The data recorded on average fruit weight (g) is presented in Table-7. It is clear from the table that all the treatments increased the size of the fruit significantly over control. The maximum fruit size (40.83) was recorded in T_8 when the fruits were harvested where the FYM was applied @ 17.5t /ha and 50% RDF was applied through inorganic fertilizers, which was significantly superior to all other treatments except T_{13} (Green manuring + 100 %RDF).Among all the treatments the smallest fruits (24.76) was found where no manures and fertilizers were applied.

Table: 6 Effect of different organic manures and inorganic fertilizers on number of fruit /plant and Average fruit weight (g).

Treatment Symbol	Treatments	No. of fruits /plant	Average fruit weight
T_1	Control	22.96	24.76
T_2	100%RDF	32.56	40.54
T_3	10t FYM /acre	30.46	28.92
T_4	15t FYM /acre	31.20	36.62
T_5	17.5t FYM /acre	32.26	39.16
T_6	10t FYM/ acre + 100% RDF	33.66	38.28
T_7	15t FYM/acre + 75% RDF	35.00	40.83
T_8	17.5t FYM/acre + 50% RDF	36.46	43.76
T_9	Green Manuring	30.33	34.95
T_{10}	Green Manuring +5t FYM /acre	31.70	38.37
T_{11}	Green Manuring + 10t FYM /acre	32.33	39.33
T_{12}	Green Manuring + 50% RDF	34.36	39.68
T_{13}	Green Manuring + 100% RDF	33.56	41.69
CD at 5%		2.73	2.63

4.2.4 Yield per plant (kg):

The data on fruit yield per plant is presented in Table -7. The perusal of the data indicated that highest yield per plant (0.850 kg) was recorded in treatment T_8 (17.5t FYM/acre + 50% RDF) which was found significantly superior to all other treatments, except T_{13} (0.840 kg) Lowest fruit yield per plant (0.700kg) was recorded in control.

4.2.5 Yield (q/ha):

Total marketable yield (q/ha) worked out on the basis of yield per plot under different treatments is presented in Table-7. A perusal of the data indicated that different treatments of organic manures and fertilizers significantly effect the total fruit yield. It is clear form the table that all the treatment increased fruit the yield as compared to control. Maximum fruit yield was recorded (284.81q/ha), in the treatment T_8 (17.5t FYM/acre + 50 % RDF). Which was followed by the treatment T_{13} (Green manuring + 100 % RDF) and both the treatments were found statistically at par with each other and significantly superior to all other treatment

Table: 7 Effect of different organic manures and inorganic fertilizers on yield /plant and yield (q/ha.) in tomato.

Treatment Symbol	Treatments	Yield/plant (kg)	Yield (q/ha)
T_1	Control	0.700	198.60
T_2	100%RDF	0.760	265.00
T_3	10t FYM /acre	0.740	218.50
T_4	15t FYM /acre	0.750	227.00
T_5	17.5t FYM /acre	0.790	233.10
T_6	10t FYM/ acre + 100% RDF	0.830	244.50
T_7	15t FYM/acre + 75% RDF	0.800	262.53
T_8	17.5t FYM/acre + 50% RDF	0.850	284.81
T_9	Green Manuring	0.690	215.20
T_{10}	Green Manuring +5t FYM /acre	0.780	229.03
T_{11}	Green Manuring + 10t FYM /acre	0.820	240.00
T_{12}	Green Manuring + 50% RDF	0.830	250.23
T_{13}	Green Manuring + 100% RDF	0.840	275.52
CD at 5%		0.070	14.40

4.3 Quality characters

4.3.1 Pericap thickness (mm):

The observation recorded in Table-8 showed significant difference in pericarp thickness under different treatments. The thickness of per carp varied significantly from 3.33 to 4.63 mm. Treatment T_8 (17.5t FYM/acre + 50% RDF) had the maximum per carp thickness (4.83mm) while the lowest per carp thickness was found in control (3.33 mm).

4.3.2 Lycopene contents (mg /100g of juice):-

The data regarding lycopene content are presented in Table -8 showed that lycopene content of fruit were not influenced significantly by the application of different treatments. Maximum accumulation of lycopene (2.22 mg/ 100g) was recorded in treatment T_8 (17.5t FYM/acre + 50% RDF) and minimum (1.93mg/100g) in control where no manures and fertilizers were applied.

Table: -8 Effect of different organic manures and inorganic fertilizers on Pericarp thickness and lycopene content.

Treatment Symbol	Treatments	Pericarp Thickness (mm)	Lycopene (Mg/100) of juice
T_1	Control	3.33	1.93
T_2	100%RDF	3.60	2.18
T_3	10t FYM /acre	4.10	2.19
T_4	15t FYM /acre	3.83	2.10
T_5	17.5t FYM /acre	4.40	2.12
T_6	10t FYM/ acre + 100% RDF	4.06	2.13
T_7	15t FYM/acre + 75% RDF	4.63	2.13
T_8	17.5t FYM/acre + 50% RDF	4.83	2.22
T_9	Green Manuring	3.63	2.10
T_{10}	Green Manuring +5t FYM /acre	4.00	2.19
T_{11}	Green Manuring + 10t FYM /acre	4.33	2.17
T_{12}	Green Manuring + 50% RDF	4.23	2.15
T_{13}	Green Manuring + 100% RDF	4.60	2.20
CD at 5%		0.47	NS

4.3.3 Total soluble solids (%)

The data presented in Table-9 indicated significant differences in T.S.S content due to the application of organic manures and inorganic fertilizers alone or in combination. Maximum T.S.S was (5.00) recorded in T_5 (17.5t FYM/ acre) followed by T_8 (4.80). The minimum T.S.S was found in control (3.96) when no manures and fertilizers were applied.

4.3.4 Ascorbic acid (mg/100g %):

Data presented in Table-9 showed that these were significant differences in ascorbic acid content due to application of different treatments. It is clear from the table that all the treatments increased the ascorbic acid content as compared to control. Maximum ascorbic acid content (25.38 mg/100g %) was recorded in T_8 (17.5t FYM/acre +50% RDF) followed by T_7 (15t FYM /acre + 75% RDF). Both the treatment was found significantly superior to all other treatments except T_6 (10t FYM/acre + 100% RDF).

4.3.5 Acidity (%):

Data with respect to acid content of fruits showed significant difference due to application of organic manures and inorganic fertilizers (Table-9). Maximum acid content (0.61) was noticed in treatment T_8 (17.5t FYM +50 % RDF). This was found significantly superior to all other treatments. Lowest acidic content (0.42) of fruits recorded in control, when no manures and fertilizers were applied.

Table: 9 Effect of different organic and inorganic fertilizers on TSS, Ascorbic acid and Acidity (%).

Treatment Symbol	Treatments	TSS (%)	Ascorbic acid (mg/g)	Acidity (%)
T_1	Control	3.96	19.57	0.42
T_2	100%RDF	4.13	23.18	0.50
T_3	10t FYM /acre	4.46	20.19	0.46
T_4	15t FYM /acre	4.50	20.76	0.47
T_5	17.5t FYM /acre	5.00	21.14	0.48
T_6	10t FYM/ acre + 100% RDF	4.60	23.76	0.56
T_7	15t FYM/acre + 75% RDF	4.70	23.59	0.57
T_8	17.5t FYM/acre + 50% RDF	4.80	25.38	0.61
T_9	Green Manuring	4.30	20.15	0.49
T_{10}	Green Manuring +5t FYM /acre	4.10	20.14	0.52
T_{11}	Green Manuring+ 10tFYM /acre	4.20	20.03	0.53
T_{12}	Green Manuring + 50% RDF	4.00	22.53	0.52
T_{13}	Green Manuring + 100% RDF	4.20	23.16	0.51
CD at 5%		0.29	1.76	0.05

4.4 Uptake of nutrients: -

The extent of uptake of nitrogen, phosphorus and potash has been presented in Table-10. Uptake of nitrogen was found higher with the treatment T_8 (17.5t FYM /acre + 50% RDF) and T_{13} (Green manuring + 100% RDF) as compared to T_1 (control) phosphorus uptake voned between 0.05 to 0.19 per cent in plants. Maximum uptake of phosphorus was noticed in T_8 (0.19) which was followed by T_7 (0.17) uptake of Potassium content in the plant was found significantly higher in treatments T_8 (0.35) as compared to control.

4.5 Economics

Economics of the best treatment presented in Table-11 indicated that maximum net profit (Rs 40200.00/ha) with cost benefit ratio (1:1.29) was worked out in treatment when FYM was applied at 17.5t/acre with 50% RDF) followed by green manuring + 100% RDF (Rs 36884.00) with cost benefit ratio 1.1.25 as compared to control.

Table: -10 Effect of different organic manures and inorganic fertilizer on Uptake of nutrients (g/plant).

Treatment Symbol	Treatments	N content	P Content	K content
T_1	Control	0.70	0.05	0.30
T_2	100%RDF	0.72	0.16	0.33
T_3	10t FYM /acre	0.71	0.12	0.32
T_4	15t FYM /acre	0.70	0.11	0.32
T_5	17.5t FYM /acre	0.70	0.11	0.32
T_6	10t FYM/ acre + 100% RDF	0.82	0.12	0.33
T_7	15t FYM/acre + 75% RDF	1.10	0.17	0.33
T_8	17.5t FYM/acre + 50% RDF	1.20	0.19	0.35
T_9	Green Manuring	0.70	0.11	0.30
T_{10}	Green Manuring +5t FYM /acre	0.78	0.10	0.31
T_{11}	Green Manuring + 10t FYM /acre	0.98	0.11	0.31
T_{12}	Green Manuring + 50% RDF	1.10	0.12	0.32
T_{13}	Green Manuring + 100% RDF	1.15	0.13	0.33
CD at 5%		0.05	0.02	0.03

Table: 11 Comparisons of economics of yield for the best treatments with control in tomato variety Hisar Arun.

Treatment Symbol	Treatments	Total yield (q/ha)	Gross income	Approximate cost of cultivation (Rs/ha)	Net profits (Rs/ha)	Cost benefit ratio
T_2	100% RDF	254.90	63725	28146.98	35579.00	1:1.26
T_8	17.5t FYM/ acre + 50% RDF	284.81	71200	31000.00	40200.00	1:1.29
T_{13}	Green Manuring + 100% RDF	265.50	66250	29426.91	36824.00	1:1.25
Control		168.60	496125	27000	17500	1:1.17

CHAPTER-IV

Discussion

The experimental finding on the study entitled Effect of organic manures and inorganic fertilizers on growth yield and quality of tomato was carried out to compare the effect of organic manure and inorganic fertilizer, and to reduce the use of inorganic fertilizer by supplementary through organic manures. Frits and winragerg (1973) reported that efficiency of inorganic fertilizer is increased when they are combined with organic fertilizers. Study was also under taken to work out the economics of the different treatments. The results have been presented in previous chapter and the same are discussed here under.

In the present investigation the results revealed that plant height and number of branches recorded at harvest was maximum in treatment T_8 (17.5t FYM /acre + 50RDF kg/ha) whereas it was found at par when the plants were green manures and supplement with N: P_2O_5: K_2O:: @ 40:25:20 kg /acre (T_{13}). Shelke *et. el.,* (1999) while working on brinjal also found that plant height and number of branches were significantly increased due to the application N through organic manures and inorganic fertilizers. The shortest plants and less number of branches were recorded in control (Table-3). The beneficial effect of

application of organic manures along with inorganic fertilizers in increasing the growth of plants can be attributed to the synergistic effect of organic manures in making available more plant nutrients by improving the soil physical condition and salubilizing the nutrients in soil. Yadav *et. al.*, (2001) observed improvement in physical properties of soil when organic manures applied alone or combination with inorganic fertilizer. Moreover, the organic manures are also significantly sources of major and micronutrients much needed by the plants increase the organic carbon content and available NPK in soil significantly Similar increase in plant growth due to organic and inorganic fertilizers application was noticed by Yadav *et al* (2004) and Bahadur *et. al.,* (2006).

Days taken to 50% flowering were significantly influenced by various treatments (Table-4). The least number of days (41.93) required for 50% flowering was observed in T_8 when (17.5t FYM /acre+ 50% RDF) was applied similar observation was also reported by Rafi *et al.* (2002). This earliness in this case could be attributed to the faster enhancement of vegetative growth and storing sufficient reserved found for differentiation of buds in to flower buds. The delayed flowering was recorded when no Fertilizers was applied. Similar finding have been reported by Kuppusswamy *et. al.,* (1992).

In tomato large size fruits are preferred. In the present study application of FYM 17.5t /acre +50% RDF kg/ha have recorded maximum fruit weight (43.76 g) including more number of fruits per

plant (36.46) while the minimum was (22.96) recorded in control Table-6) Rafi *et al*. (2002) and similar observers was also reported by Renuka and Ravisankar., (2001). It is attributed that combined application of organic + inorganic sources of fertilizers helped to produce more number of fruits /plant and fruit weight.

Beneficial effect of organic manures with inorganic fertilizers might be due to favorable influence on the productivity of the crop which depends upon the physiological phenomena of the plants that are controlled by many factors in which hormones play very important roles. The synthesis of these hormones in play might be influence by nutrients applied through organic manures. The increased nutrients available form Farm Yard Manures might have increased the various endogenous hormone levels in plant tissue which enhanced pollan germination and ultimately increased the fruit set and number of fruits per plant.

Application of FYM @ 17.5t /ha +50 % RDF kg /acre contributed highest yield /plant (850 g) and fruit yield (284.81q/ha) with B: C ratio of 1.1.29 and was at par when the plots green manured applied +full dose of NPK 40:25:20 kg/acre (Table-7). Kumaran *et al*.(1998) The reason for higher yield per plant and per hectare can be explained that in this treatment might be due to better vegetative growth (Table-3) early flowering (Table-4) more number of fruits/plant and present size of fruit (Table-6), because these all are yield contributing character. These findings were supported by those of Yadav *et al*. (2004) where they have reported that application of NPK was effective in increasing the yield of tomato when applied along with FYM.

Chaudhary *et.al.*, (2003) reported that higher tomato yield obtained with the combined use of FYM and inorganic fertilizers may be possible due to supply of balanced nutrition. Paul *et al.*, (2004) observed that the integration of inorganic with organic sources prated superior over Recommend dose of fertilizers. The other possible reason for higher yield may be due to higher chlorophyll content of those treatments Krishana and Krishanappa (2002).

The quality attribute was also markedly influenced by use of fertilizers and manures (Table 8). Pericarp thickness, Lycopene content, total soluble solids (TSS), and ascorbic acid content increased with combined application of organic manures and inorganic fertilizers as compared to other treatments. The present observations are similar to Kishana and Kishanappa (2002). Maximum pericarp thickness (4.83mm) and Lycopene content (2.20) was observed with the application of FYM 17.5 /acre + 50% RDF kg/acre (Table-8). It might be due to the fact that application of FYM with inorganic fertilizers improved the quality paramters because FYM contain all the macro and micronutrients which are necessary for improving the quality (Kishana and Krishanppa (2002).

Total soluble solids (TSS) of fruits was increased by all the treatments as compared to control. Highest TSS (5.33%) was obtain in the treatment which received 17.5t /acre + N: P_2O_5: K_2O @ 20:12.5:10 kg/ha and lowest (3.96%) was in the control. These findings are in confirmatory with the finding of Yadav *et. al.,* (2004) who reported that TSS was found to be higher when the plants were supplied either with

organic components alone or in combination of organic and inorganic components.

The perusal of data in Table-5 showed that ascorbic acid content (Vitamin C) of tomato fruit was significantly increased by the application of organic and inorganic fertilizers. Application of 17.5t FYM/ acre+ NPK applied @ 20:12.5:10 kg /acre increased the ascorbic acid content of fruits while least content was observed in untreated control.

Acidity was maximum with the application of FYM (17.5t /acre + N: P_2O_5: K_2O: 20:12.5:10 kg/ha). It might be due to increase in the improved in soil physical properties and chemical properties like enzymatic activity and hormone etc with the application of organic manures similar observation was also reported by Rafi *et al* (2002) and Seen *et. al.,* (1997). They reported that it might due to increase in the activity of the enzyme acetose.

Maximum net profit and cost benefit ratio was found in treatment 17.5t /acre + N: P_2O_5: K_2O: 20:12.5:10 kg/ha) due to maximum total yield (Table-11).

CHAPTER-VI

Summary and Conclusion

The present investigation entitled Role of organic manures in combination with inorganic fertilizers in tomato production Cv. Hisar Arun was conducted during spring summer Season of 2006-07 at Vegetable Research Farm and Laboratory of CCS Haryana Agricultural University Hisar to find out the effect of organic manures and inorganic fertilizers on growth yield and quality of tomato. The experiment was laid out in a Randomized block design in tree replication having thirteen treatments. The observations were recorded on Vegetative growth, flowering, yield and fruit quality. The data on these characters were subjected to statistical analysis. The results obtained under different treatments are summarized below.

1. Plant height and branches per plant were significantly influenced by different treatments over control. Maximum plant height and branches per plant were recorded when the plant was applied 17.5t FYM /acre + 50% RDF (T_8).

2. The different manures and fertilizer treatment had no significantly influenced on days to 50 per cent flowering. Minimum number of days taken to 50 % flowering was obtained when plots was green manuring and applied 100% RDF.
3. Minimum number of days taken to first harvesting was recording in the treatment T_8 (17.5t FYM /acre + 50% RDF) which was found significantly superior to all other treatment except T_{13} (Green manuring + 100% RDF).
4. Maximum numbers of fruits per plant were recorded in treatment T_8 (17.5t FYM /acre + 50% RDF) which were followed by T_{13} (Green manuring + 100% RDF). Both the treatments were found significantly superior to all other treatments.
5. Fruit size significantly influenced by the application of different organic manures and inorganic fertilizer dose in combination. Maximum fruit size was observed when the fruit were harvested form the plants applied with 17.5t FYM /acre + 50% RDF (T_8).
6. Total yield was significantly influenced by the different treatments. Highest total yield was recorded when the plants was applied 17.5t FYM/ acre +50% RDF (T_8) which was found significantly higher then all other treatments except T_{13} (Green manuring + 100% RDF).
7. Pericarp thickness was found maximum in T_8 (17.5t FYM/ acre +50% RDF) followed by T_7 (15tFYM/acre 75% RDF) lowest was found in control.

8. Lycopene content was not affected significantly by the application of different treatments.
9. TSS and acidity was found to be maximum with the application of combination of organic manures and inorganic fertilizers.
10. Maximum Ascorbic acid content of fruits was recorded in T_5 (17.5t FYM/acre) followed by T_8 (17.5t FYM/ acre +50% RDF).
11. Among the different treatments applied uptake of NPK was recorded maximum in T_8 (17.5t FYM/ acre +50% RDF) and it was recorded minimum in control.

CONCLUSION

On the basis of our findings it can be concluded that the application of 17.5t FYM + 50% RDF produced significantly maximum fruit yield that rest of the treatments except when the plant were Green manured and applied 100% RDF.

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ABSTRACT

Title of Dissertation	**Role of organic manures and in combination with inorganic fertilizers in tomato production Cv. Hisar Arun**
Name of Degree Holder	Rajesh Kumar
Admission No.	2004A102M
Title of Degree	Master of Science
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Total No. of Pages in the Thesis	**45+vi**
No. of words in the abstracts	Apro. 200 words
Key words-	Tomato crop, Organic manures, inorganic fertilizers,Greenmanuring,FYM, Economics, Growth and quality parameters

The present investigation entitled Role of organic manures in combination with inorganic fertilizers in tomato production Cv. Hisar Arun was conducted during spring summer Season of 2006-07 at Vegetable Research farm and Laboratory of CCS Haryana Agricultural University Hisar to find out the effect of organic manures and inorganic fertilizers on growth yield and quality of tomato. The experiment was laid out in a Randomized block design in tree replication having thirteen treatments. The observations were recorded on Vegetative growth flowering, yield and fruit quality. Each treatment and replicated three times in plot having area 3 x 2.7 m^2. The results indicated that organic manures and inorganic fertilizer was marked effect on growth and yield parameters. The yield attributing characters like number of fruits/ plant, Average fruit weight, yield /plant and yield (q/ha). Were maximum with the application of 17.5t FYM +50% RDF. Among the quality parameters like pericarp thickness, lycopene, total soluble solids, ascorbic acid (mg/100%), acidity (%) were also significant influenced by the combination of organic manures and inorganic fertilizers

Major Advisor **Signature of the Student**

Head of the Department