"RESPONSE OF SOIL AND FOLIAR APPLICATION OF NUTRIENTS ON GROWTH AND YIELD ATTRIBUTES OF TOMATO (*Lycopersicon esculentum* Mill.)"

M. Sc. (Ag.) THESIS

by

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"RESPONSE OF SOIL AND FOLIAR APPLICATION OF NUTRIENTS ON GROWTH AND YIELD ATTRIBUTES OF TOMATO (*Lycopersicon esculentum* Mill.)"

Thesis

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CERTIFICATE – I

This is to certify that the thesis entitled **"RESPONSE OF SOIL AND FOLIAR APPLICATION OF NUTRIENTS ON GROWTH AND YIELD ATTRIBUTES OF TOMATO (*Lycopersicon esculentum* Mill.)"** submitted in partial fulfillment of the requirements for the degree of "Master of Science in Agriculture (Horticulture)" of the Indira Gandhi Krishi Vishwavidyalaya, Raipur, is a record of the bonafide research work carried out by **Shri KAMAL NARAYAN** under my guidance and supervision. The subject of the thesis has been approved by Student's Advisory Committee and the Director of Instructions.

No part of the thesis has been submitted for any other degree or diploma (certificate awarded etc.) or has been published/ published part has been fully acknowledged. All the assistance and help received during the course of the investigations have been duly acknowledged by him.

Date:

Chairman
Advisory Committee

THESIS APPROVED BY THE STUDENT'S ADVISORY COMMITTEE

Chairman : Shri Prashant Dubey _____

Member : Dr. Dhananjay Sharma _____

Member : Dr. Arti Guhey _____

Member : Dr. R. R. Saxena _____

CERTIFICATE – II

This is to certify that the thesis entitled **"RESPONSE OF SOIL AND FOLIAR APPLICATION OF NUTRIENTS ON GROWTH AND YIELD ATTRIBUTES OF TOMATO (*Lycopersicon esculentum* Mill.)"** submitted by Shri **KAMAL NARAYAN** to the Indira Gandhi Krishi Vishwavidyalaya, Raipur in partial fulfillment of the requirements for the degree of **M.Sc. (Ag.)** in the **Department of Horticulture** has been approved by the Student's Advisory Committee after oral examination in collaboration with the external examiner.

Date **EXTERNAL EXAMINER**

Major Advisor _____

Dean/Faculty _____

Head of the Department _____

Director of Instructions _____

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LIST OF ABBREVIATIONS

ABBREVIATIONS	DESCRIPTION
%	Per cent
/ or $^{-1}$	Per
@	At the rate of
cm	Centimeter
DAT	Day after transplanting
et. al.	And co-workers
Fig.	Figure
g	Gram
ha	Hectare
i.e.	That is
Kg	Kilogram
m	Meter
m^2	Square meter
mg	Milligram
mm	Millimeter
mt	Million tonnes
MT	Metric tonnes
no	Number
NS	Non significant
pH	Hydrogen ion concentration
q	Quintal
RDF	Recommended dose of fertilizer
t	Tonne
TSS	Total Soluble Solids
WSF	Water soluble fertilizer

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CHAPTER – I

INTRODUCTION

Tomato ***(Lycopersicon esculentum*** Mill.*)* is one of the most important vegetable crop. It belongs to family solanaceae and is believed to be a native of western South America. This crop is also known as an industrial crop because of its outstanding processing qualities. It has worldwide utility both as fresh as well as in the processed forms and is a good source of vitamins and minerals. It possesses 750 I.U. of vitamin 'A' and 25-30 mg of ascorbic acid/100 gm of edible part.

It is cultivated in an area of 52.55 million hectares world over producing 130.53 million tonnes of tomato with an average yield of 27.98 tonnes/ha (Anon, 2009). In India, it is mainly grown in Bihar, Karnataka, Uttar Pradesh, Orissa, Andhra Pradesh, Maharashtra, Madhya Pradesh, Assam and Chhattisgarh, accounting for a total production of 11149 thousand MT from an area of 599 thousand hectares with an average productivity of 18.6 MT per hectare. In Chhattisgarh, tomato is being cultivated as commercial crop in Raipur, Durg, Sarguja, Bilaspur, Jashpur, Raigarh and Bastar districts occupying an area 39.2 thousand hectares with production and productivity of 420.4 thousand MT and 10.7 MT per ha respectively (Anon, 2009).

Production of crop depends on several factors i.e. soil, nutrition, irrigation and plant protection measures etc. Plant nutrition is one of the most important factors responsible for the proper growth and development of the plants. The methods of nutrient application play an important role in supplying the nutrients to the plants because the efficacy of fertilizers applied in soil being low due to various losses and fixations while foliar nutrition is designed to eliminate the above problems, particularly with respect to macro nutrients. Now a days application of N, P and K in different ratios through foliar spray is resorted to vegetable as these crops are heavy feeder of nutrients. The sufficient information regarding the use of water soluble fertilizer is not available so the present experiment was planned and conducted.

The yield of tomato in the tropics is very low. Among the various factors limiting the yield of tomato, a nutrition problem is one of them. For getting higher yield adequate supplies of balance nutrients are needed. Nutrition plays a key role in the yield as well as quality of fruit. For getting higher production of tomato adequate fertilizers should be provided. Many researchers have worked on the nutritional requirement of tomato, but their

results have been varying, often influenced by the ambient climatic conditions as well as soils. The present study was carried to determine the optimum fertilizer dose of tomato for the particular climate prevalent and soil condition of Chhattisgarh plains.

Traditionally supply of nutrients to tomato crop has been through the conventional fertilizer i.e., Urea, SSP, MOP etc. However with changing scenario water soluble fertilizers (WSF) are used both for drip as well as foliar application has been found to be a good complementary source of nutrition beneficial for boosting the yield as well as productivity of tomato crop. The present investigation is a study in the step to standardize the optimum mix of both the conventional as well as foliar application of fertilizer in order to get the maximum yield from the crop.

Several studies have found foliar application of various macro and micro nutrient to be beneficial. Foliar feeding is relatively new technique of feeding plants by applying liquid fertilizer directly to their leaves.

Among the fertilizers nitrogen, phosphorus and potassium are the main elements from which, the plants are often affected. It promotes the setting of flowers and fruits, also improves the quality of fruits and imparts disease resistance to plant. Keeping in mind the above facts an experiment entitled **"Response of soil and foliar application of nutrients on growth and yield attributes of tomato (*Lycopersicon esculentum* Mill.)"** has been formulated and will be conducted at the research cum instructional farm, Department of Horticulture, IGKV, Raipur (C.G.) with the following objectives.

1. To study the effect of foliar application of fertilizers on growth and yield of tomato.
2. To standardize the optimum dose of 'soil applied' fertilizers in combination with foliar spray.
3. To study the effect of foliar application of fertilizers on quality parameters in tomato.
4. Economics of tomato production using water soluble fertilizers as foliar spray.

CHAPTER-II

REVIEW OF LITERATURE

In this chapter, an attempt has been made to present research work done on the effect of soil and foliar application of fertilizer on growth, yield and quality attributes of tomato in Chhattisgarh India, and abroad under the fallowing heads:

2.1 Effect of foliar application of water soluble fertilizers on growth and yield of tomato.

2.2 Standardization of the optimum dose of 'soil applied' fertilizers in combination with foliar spray.

2.3 Effect of foliar application of water soluble fertilizers on quality parameters in tomato

2.4 Economics of tomato production using water soluble fertilizers as foliar spray.

2.1 Effect of foliar application of water soluble fertilizers on growth and yield of tomato

Dhuria and Shukla (1973) observed that foliar spray of urea was effective only when these were supplemented with the soil application. It increases the growth and yield of tomato.

Chaudhuri and De-R (1975) observed that foliar application of N and P was 2.02 and 1.63 times more efficient than corresponding soil application, respectively, increasing in tomato yield

Jules Janick (1984) reported that the foliar nutrition increases the yield of plants and it might be due to the increased uptake of nutrients and water resulting in increased photosynthesis and enhanced food accumulation in the edible part of fruits.

Adams *et al*. (1986) reported that tomato plant height and fruit yield were much higher with foliar spray of potassium nitrate than only urea.

Vibhute *et al*. (1988) found that the growth and yield of tomatoes were increased with foliar spray of water soluble fertilizer. It might be due to supply of more nutrients during flowering and fruit set.

Fagaria *et al*. (1992) studied that the increase in quality character (TSS) of tomato might be due to the growth promoting substances, which could be achieved by foliar spray of water soluble fertilizer.

Ibrahim (1992) reported that yield of tomato increased by 40 per cent under fertigation with water soluble fertilizers over the band placement.

Singh and Singh (1992) observed that the foliar spray of nutrients increases the availability and uptake of

nutrients and water resulting in more photosynthesis and enhanced food accumulation in edible part of the fruits.

Dhake (1995) reported that highest numbers of fruits per plant were obtained under liquid fertilizer treatment. This could be due to continuous and uniform supply of NPK from liquid fertilizer through drip irrigation to tomato crop resulting invigourous plant growth.

Jeybal *et al*. (1998) found that the increase in plant height, number of branches, number of fruits and individual fruit weight were high with foliar sprays. It might be due to more supply nutrients at the critical stage, *i.e.* flowering and fruit set.

Kadam and Karthikeyan (1999) reported that the yield contributing characters, yields and quality parameters are influenced by fertigation with graded fertilizers i.e. 13:05:26, 13:40:13, 19:06:06 and 06:12:36 to tomato cv. Dhanshree.

Nanthakumar and Veeraragavathatham (1999) reported that the foliar spray of water soluble fertilizer increases the fruit weight of brinjal. The increase in fruit weight might be due to the better utilization of photosynthates and increased allocation of photosynthates towards the economic parts.

Palaniappan *et al.* (1999) observed that the foliar spray of water soluble fertilizer increases the yield of tomato. It might be due to greater availability and uptake of nutrients and water.

Guievence and Budence (2000) observed that the foliar spray of nutrients increases the yield of tomato. It might be due to greater availability and uptake of nutrients and water, resulting in more photosynthesis and enhanced food accumulation in edible part of fruits.

Sharma *et al*. (2000) reported that compound liquid fertilizer containing most macro and micro nutrients "Polyfeed and Multi" along with NPK provide nutrients to the plant by foliar application and significant effect on growth and yield of chillies.

Patil and Biradar (2001) applied foliar fertilizer 'Polyfeed' and found significant effect on growth and yield of chillies.

Clapp (2002) found that tomato growth was enhanced with foliar application of urea-triazone relative to that obtained from ammonium nitrate or urea.

Narayanamma *et al.* (2002) observed that the plant height, number of main branches per plant, number of fruits per plant and individual fruit weight were high in all the treatments receiving foliar sprays of water soluble fertilizer compared to no spray.

Naik *et al.* (2002) revealed that the growth and yield were high with foliar sprays of water soluble fertilizer.

Prabhu *et al.* (2003) reported that the yield and quality parameters of hybrid brinjal differed significantly with the foliar application of water soluble fertilizers.

Singandhupe *et al*. (2003) reported that foliar application of NPK significantly increased the yield of tomato.

Hebber *et al.* (2004) reported that the tomato requires heavy supply of plant nutrients specially nitrogen, phosphorus and potassium fertilizers for ensuring good plant growth and higher yields. The specialty fertilizers (water soluble fertilizer) are the better source of nutrients for tomato.

Karpagam *et al.* (2004) reported that growth and yield of brinjal hybrid COBH-1 differed significantly with foliar application of water soluble fertilizer

Sundaram and Kanthaswamy (2004) revealed that foliar spray of water soluble fertilizer had no significant effect on traits like fruit length, fruit girth and individual fruit weight but sinificant effect on number and yield of fruits per plant.

Yadav *et al.* (2004) revealed that foliar spray of water soluble fertilizers had significant effect on marketable yield of tomato.

Jiskani (2005) reported that significant effect on crop yield in chilli was recorded when micronutrients were applied in combination with NPK as a foliar spray instead of alone.

Lovatt (2005) observed that foliar spray of 1% either Polyfeed or Multi 'K' at 45, 60 and 75 days after planting increased the crop yield by about 10% over unsprayed.

Chaurasia *et al.* (2006) observed that foliar spray of water soluble fertilizers significantly increased the plant height, number of branches, number of fruits, average fruit weight, fruit length, fruit diameter, yield and net profit of tomatoes.

Anonymous (2007) applied a foliar fertilizer "Fetrilon Combi" in chilli and found considerable improvement in fruit development and crop yield.

Baloch *et al*. (2008) observed that foliar spray of macro and micro nutrients had consecutive improvement in growth and yield components of chillies.

Li-Rui Hai *et al.* (2008) observed that foliar fertilizers could not only increases tomato yield, but also enable to plant to rapidly absorb N, P and K through its leaves, thus markedly increasing their contents in the plants.

Law-ogbomo and Egharerba (2009) revealed that a combination of planting density and foliar application of NPK (15:15:15) fertilizer increased the productivity of tomato as they positively influenced the plant height at maturity, 50% flowering, fruit yield and percentages marketable yield.

Premsekhar and Rajshree (2009) revealed that among the different grades of water soluble fertilizer, foliar spray with NPK (19:19:19) in tomato recorded the tallest plant, highest fruit weight, fruits per plant and fruit yield.

2.2 Standardization of the optimum dose of 'soil applied' fertilizers in combination with foliar spray

Chaudhuri and De-R (1975) observed that foliar application of N and P was 2.02 and 1.63 times more efficient, respectively, increasing tomato yield than corresponding soil application. The amount of fertilizer necessary for optimum yield was reduced by applying part of the N and the P to the foliage.

Adams *et al*. (1986) reported that tomato plant height and fruit yield were much higher with foliar spray of potassium nitrate than only urea.

Ahmed *et al.* (1992) reported that the application of different formulation of foliar fertilizers as supplements to soil nitrogen were reported to induce significant increase in the yields of tomato.

Radulovic (1996) applied foliar fertilizers of N, P, K, Ca, Mg and Fe, B, Zn, Mn and Cu and resultantly these nutrients were established in leaves, indicating the possibility of reducing the application of nitrogenous fertilizers.

Vasane *et al.* (1998) reported that the possibility of cutting back of fertilizers to the extent of 15 to 25 per cent by fertigation with water soluble fertilizers without significant yield reduction.

Valavan and Senthil (1999) revealed that the soil application of 50% NPK + foliar spray of water soluble fertilizer found to be the best combination on the basis of cost benefit ratio (1: 3.29) which had enhanced the fruit yield and quality i.e. ascorbic acid, TSS and total sugar content as against the NPK control.

Veeranna (2000) reported that the rate of fertilizer application could be reduced up to 15 to 25 per cent by fertigation with water soluble fertilizers without significant yield reduction.

Jiskani (2005) reported that significant effect on crop yield in chilli was recorded when micronutrients were applied in combination with NPK as a foliar spray instead of alone.

Anonymous (2007) applied a foliar fertilizer "Fetrilon Combi" in chilli and found considerable improvement in fruit development and crop yields as compared to those supplied only with straight chemical

fertilizers.

2.3 Effect of foliar application of water soluble fertilizer on quality parameters in tomato

Dhuria and Shukla (1973) observed that foliar spray of urea was effective only when these were supplemented with the soil application. It improves the quality of tomato.

Fagaria *et al*. (1992) studied that the increase in quality character (TSS) of tomato might be due to the growth promoting substances, which could be achieved by foliar spray of water soluble fertilizer.

Kadam and Karthikeyan (1999) found that the quality parameters are influenced by fertigation with graded fertilizers i.e. 13:05:26, 13:40:13, 19:06:06 and 06:12:36 to tomato cv. Dhanshree.

Prabhu *et al.* (2003) reported that the yield and quality parameters (TSS) of hybrid brinjal differed significantly with the foliar application of water soluble fertilizers.

Premsekhar and Rajshree (2009) revealed that among the different grades of water soluble fertilizer, foliar spray with NPK (19:19:19) in tomato recorded better quality of fruits with 4.46 ^{0}Brix

2.4 Economics of tomato production using water soluble fertilizers as foliar spray.

Chaurasia *et al.,* (2006) observed that the highest benefit-cost ratio (4.12) was recorded in treatment that received 5 sprays of NPK 19:19:19. This might be due to higher fruit yield obtained in this treatment than the other treatments.

Premsekhar and Rajshree (2009) revealed that among the different grades of water soluble fertilizers, foliar spray with 5 spray of NPK (19:19:19) in tomato recorded the highest BC ratio (4.42).

Valavan and Senthil (1999) revealed that the soil application of 50% NPK + foliar spray of water soluble fertilizer was found to be the best combination on the basis of benefit- cost ratio (1: 3.29).

Chapter-Iii

MATERIALS AND METHODS

This chapter deals with the concise description of the materials used and the techniques adopted during the course of investigation.

The present investigation entitled “Response of soil and foliar application of nutrients on growth and yield attributes of tomato (*Lycopersicon esculentum* Mill.)” was conducted at the Research cum Instructional Farm, Deptt. of Horticulture, College of Agriculture, IGKV, Raipur, (C.G.) during the Rabi 2009-2010.

3.1 Geographical situation

Raipur is situated in the central part of Chhattisgarh at 21°16' N latitude, 81°36' E longitude and at an altitude of 289.56 m from mean sea level. The climate of Raipur is characterized as dry sub-humid with normal rainfall of 1200 mm per annum, mostly concentrated during the monsoon months i.e., June to September. The pattern of rainfall, particularly during June to September months has great variation from year to year. The maximum temperature goes as high as 46 ^{0}C during summer and minimum as below 6 ^{0}C during winter months. The atmospheric humidity is high from June to October. The meteorological data recorded at Agro meteorological observatory, IGKV, Raipur during the period of study are given in Appendix I and illustrated through figure 3.1.

3.2 Cropping History

Pea, tomato and cucurbitaceous crop rotation is being used since last 3 years. The recommended doses of fertilizers were used in the cultivation of these crops.

3.3 Physico-chemical properties of experimental Soil

Random soil samples were collected up to 15- 20 cm depth from five places to determine the Physico-chemical properties of the soil. The procedure adopted for analysis and values obtained are given in Table 3.1.

Table 3.1: Physico-chemical properties of the experimental soil

No.	Particulars	Values	Rating	Methods used
A. Physical properties				
1.	***Mechanical composition***			
	Sand (%)	25.67	Clay loam (*Dorsa*)	International pipette method (Black, 1965)
	Silt (%)	32.54		
	Clay (%)	41.79		
B. Chemical composition				
1.	Available N (kg ha^{-1})	218	Low	Alkaline permanganate method (Subbiah & Asija, 1956)
2.	Available P (kg ha^{-1})	17.2	Medium	Olsen's method (Olsen, 1954)
3.	Exchangeable K (kg ha^{-1})	311	High	Flame photometric method (Jackson, 1967)
4.	Soil reaction pH	7.1	Neutral	Glass electrode pH meter (Piper, 1967)
5.	Organic carbon %	0.50	medium	Walky and black's

3.4 Field preparation

The preparation of field was done by tractor drawn cultivator followed by two cross harrowing to pulverize the soil. Finally, the field was leveled then the experiment was laid out.

3.5 Details of Experiment

Crop	:	Tomato (*Lycopersicon esculentum* Mill)
Variety	:	Pant T-3.
Planting distance	:	60 x 45 cm
Design of the experiment	:	Randomized Block Design (RBD)
Number of Replications	:	4
Number of Treatments	:	6
Number of plots	:	24
Number of rows per plot	:	4
Number of plants per row per plot	:	17
Number of plants per plot	:	68
Gross plot size	:	8.0 m x 2.5 m
Net plot size	:	7.4m x 2.05m
Distance between replications	:	1 m.
Distance between treatments	:	1 m.
Crop duration	:	115 Days
Seed sowing in nursery	:	15-11-2009
Date of planting	:	09-12-2009

3.6 List of treatments

Treat-ments	NPK dose & application as per the University Recommendation	+	Sujala product & spray		Spray application stage as per Schedule
			Product	Spray (No)	
A	B	C	D	E	F
T1	100% of NPK dose and application as per University recommendation	+	Nil	Nil	Nil
T2	100% of NPK dose and application as per University recommendation	+	19:19:19	2	At interval of 15-20 days after planting during vegetative stage
		+	0:52:34	1	During flowering
		+	13:0:45	2	Fruit development cum ripening stage
		+	19:19:19	1	After 1st plucking
T3	87.5% of NPK dose and application as per University recommendation	+	19:19:19	2	At interval of 15-20 days after planting during vegetative stage
		+	0:52:34	1	During flowering
		+	13:0:45	2	Fruit development cum ripening stage
		+	19:19:19	1	After 1st picking
T4	75% of NPK dose and application as per University recommendation	+	19:19:19	2	At interval of 15-20 days after planting during vegetative stage
		+	0:52:34	1	During flowering
		+	13:0:45	2	Fruit development cum ripening stage
		+	19:19:19	1	After 1st picking
T5	62.5% of NPK dose and application as per University recommendation	+	19:19:19	2	At interval of 15-20 days after planting during vegetative stage
		+	0:52:34	1	During flowering
		+	13:0:45	2	Fruit development cum ripening stage
		+	19:19:19	1	After 1st picking
T6	50% of NPK dose and application as per University recommendation	+	19:19:19	2	At interval of 15-20 days after planting during vegetative stage
		+	0:52:34	1	During flowering
		+	13:0:45	2	Fruit development cum ripening stage
		+	19:19:19	1	After 1st picking

3.7 Nursery management

Nursery beds of 10 m x 1 m x 0.15 m were prepared for raising the seedlings on well-ploughed and leveled field keeping 30 cm distance between two beds. Seed were sown in lines 10 cm apart @ 500 g seed per ha. At the rate of 10 kg FYM, 25 g urea and 50 g super phosphate per metre square was also applied at the time of nursery bed preparation.

3.8 Transplanting

The 25 days old healthy seedlings were treated with biolla @ 50g/litre for 5 minutes and transplanted at a spacing of 60 x 45 cm in the experimental plot.

3.9 Manure and Fertilizer application

Recommended dose of fertilizer (100 kg N, 80 kg P_2O_5 and 60 kg K_2O per hectare) with levels of 100%, 87.5%, 75%, 62.5% and 50% were maintained and applied through urea, single super phosphate, murate of potash as soil application. After establishment of the plants water soluble fertilizers i.e., 19:19:19, 0:52:34 and 13:0:45 @ 2 per cent solution were sprayed at different stages of growth and development.

3.10 Irrigation

The nursery bed was irrigated one day before transplanting to uproot the seedlings conveniently and next irrigation was applied just after the seedlings were transplanted in the experimental plots. Subsequent irrigation was applied as per the need of the crop during the entire period of experiment.

3.11 Intercultural operations and weed control

The weeds were completely removed at the time of field preparation. At later growth stages, two hands weeding at 15 and 45 DAT were done to keep the plot free from weed.

3.12 Staking

Staking is a very essential operation in open pollinated/hybrid cultivars of tomato for getting high yield and good quality fruits. Staking is done by using bamboo stick, wire and rope at vegetative phase of growth. The beneficial effect of stacking are:-

1. It improves the yield and quality of tomato.
2. Protect the fruits from insect and diseases.
3. Easy in harvesting
4. Easy in spraying of chemical.

3.13 Plant protection measures

Adequate plant protection measures were adopted to control the major insect pest during crop period. To control the leaf curl virus and insect; spraying of Nuvacron @ 2 ml/ liter and Imidacloprid @ 0.4 ml/ liter was done as and when needed.

3.14 Harvesting

The pickings of fruits were done at turning stage of the fruits. In whole experimental period 6 pickings were done. Five plants of each treatment were selected randomly and five fruits of each plant were picked up separately for studying various growth, yield and quality attributes. The weight of fruits recorded from each net plot was converted into quintal per ha.

3.15 Observations

3.15.1 Plant height (cm)

The plant heights of five randomly selected plants were recorded from the base of the plant to the tip of the main stem just before last picking of the fruits and the average height per plant was calculated.

3.15.2 Number of primary branches per plant

The total numbers of primary branches of five randomly selected plants were counted at the end of flowering stage and the average was workout.

3.15.3 Number of secondary branches per plant

The total numbers of secondary branches of five randomly selected plants were counted at the end of flowering stage and the average was workout.

3.15.4 Days to first flowering

Days to first flowering was noted in terms of days from the date of sowing of seed to first flower appearance in each plot. The observation was taken on whole plot basis and the average of all the replication was calculated.

3.15.5 Days to 50 % flowering

Days to 50 % flowering was noted in terms of days from the date of sowing of seed to the date when at least 50% of the plants shows flower open in each plot. The observation was taken on whole plot basis and the average of all the replication was calculated.

3.15.6 Days to first fruit set

Days of first fruiting was noted in terms of days from the date of sowing to first fruit appearance in each plot.

3.15.7 Number of flower clusters per plant

The total number of the cluster of five randomly selected plants was counted at flowering stage and the average was calculated.

3.15.8 Number of fruits per cluster

The total number of the fruits per cluster of five randomly selected plants was counted at marketable stage and the average was calculated.

3.15.9 Number of fruits per plant

The total number of the fruit of five randomly selected plants was counted at near maturity stage and the average was calculated.

3.15.10 Days to first fruit harvesting

Days to first fruit harvesting was noted in terms of days from the date of sowing to first fruit harvesting in each plot. To be noted at breaker stage (80% maturity).

3.15.11 Fruit weight (g)

The fruit weight (g) of five randomly selected fruits of each treatment and each replication was recorded at near maturity stage and the average fruit weight was calculated.

3.15.12 Fruit diameter (cm)

The fruit diameter (cm) of five randomly selected fruit of each treatment and each replication was recorded at near maturity stage and the average fruit weight was workout.

3.15.13 Fruit pericarp thickness (mm)

The fruit pericarp thickness (mm) of five randomly selected fruit of each treatment and each replication was recorded by using vernier callipers at near maturity stage and the average fruit weight was workout.

3.15.14 Fruit yield per plant (kg)

To be recorded as average of cumulative yield of all pickings of five randomly selected plants at near maturity stage.

3.15.15 Total soluble solids (%)

Five fruits from each treatment were randomly taken from the harvested lot and thoroughly washed under tap water. The fruits were cut into small pieces and squeezed to obtain the juice and with the help of hand refractometer, TSS (%) of fruit was determined.

3.15.16 Acidity (%)

Five fruits from each treatment were randomly taken from the harvested lot and thoroughly washed under tap water. The fruits were cut into small pieces and squeezed to obtain the juice. The acidity of fruit juice was determined by titrating 10g of fruit juice against standard solution of N/10 NaOH, using phenolphthalein as an indicator. The end point appeared as light pink colour.

$$\text{Acidity (\%)} = \frac{\text{Titre} \times \text{Normality of alkali} \times \text{Volume made up} \times \text{Equivalent weight of acid} \times 100}{\text{Volume of sample taken for estimation} \times \text{Volume of sample taken} \times 1000}$$

3.16 Statistical analysis

The data collected from different characters were processed and were analyzed by the method of analysis of variance given by Gomez and Gomez (1984) for randomized block design. The skeleton ANOVA was given as under:-

Source of variation	**d.f**	**SS**	**MSS**	**F cal**
Replication	r-1	SSr	MSr	MSr \ Mse
Treatments	t-1	SSt	MSt	MSt/Mse
Error	(r-1) (t-1)	SSe	MSe	----------
Total	(rt-1)	----------	----------	----------

Where,

r = number of replications

t = number of treatments

SS_r = Sum of square for replication.

SS_t = Sum of square for treatment

SS_e = Sum of square for error.

MS_r = Mean sum of square for replication.

MS_t = Mean Sum of square for treatment.

MS_e = Mean Sum of square for error

The significance of treatment difference was determined by comparing the calculated value of F with the tabulated value of F at five per cent and or one per cent level of significance. When calculated value of F was greater than the tabulated value of F with treatment (t-1), and error [(r-1) (t-1)] degree of freedom at specified level of significance then the F value was considered significant other wise non significant.

Chapter – IV
RESULTS AND DISCUSSION

An investigation entitled **"Response of soil and foliar application of nutrients on growth and yield attributes of tomato (*Lycopersicon esculentum* Mill.)"** was conducted at Horticultural Research cum Instructional Farm, Department of Horticulture, Indira Gandhi Krishi Vishwavidyalaya, during 2009-10, Raipur (C. G.). The experimental findings of this work are presented in the following heads;

4.1 Analysis of variance (ANOVA)

4.2 Effects on growth and yield attributes

4.3 Effects on quality attributes

4.4 Economics

4.1 Analysis of variance (ANOVA)

Analysis of variance for character under investigation is presented in Table-4.1. The analysis of variance for all the characters were found significant this indicates the variability in different treatments

4.2 Effects on growth and yield attributes

4.2:1 Plant height (cm)

The data regarding plant height are shown in table 4.2:1 and fig. 4.1:1.The plant height ranged from 75.22cm to 122.71cm. The maximum plant height (122.71cm) was recorded under 87.5 % recommended dose of NPK along with foliar spray of water soluble fertilizers which was found statistically at par with 100% recommended dose of NPK + foliar spray of water soluble fertilizers (116.33cm).

The minimum plant height (75.22cm) was recorded in control, where fertilizers were applied as only soil application which was significantly at par with 50 % recommended dose of NPK + foliar spray of water soluble fertilizers (87.01cm)

The maximum plant height was observed in 87.5 % recommended dose of NPK along with foliar spray of water soluble fertilizers (122.7cm) followed by 100 % recommended dose of NPK + foliar spray of water soluble fertilizers (116.33cm) and 75 % recommended dose of NPK + Foliar spray of water soluble fertilizers(104.67cm). The plant height was increased with the foliar application of nutrients. The increase in plant height might be due to

the increased cell division and elongation at higher level of N. Similar findings were reported by Prabhu *et al.* (2003) and Karpagam *et al.* (2004) in hybrid brinjal.

4.2:2 Number of primary branches per plant

The data regarding number of primary branches per plant are shown in table 4.2:2 and fig. 4.1:2. The tomato crop that supplied with 87.5% recommended dose of fertilizer (100:80:60) along with foliar spray of water soluble fertilizers (i. e. 19:19:19, 13:0:45 and 0:52:34) produced maximum number of primary branches (4.73) followed by 75 % recommended dose of NPK + foliar spray of water soluble fertilizers (4.13) and 100 % recommended dose of NPK + foliar spray of water soluble fertilizers (3.76).

However, the minimum number of primary branches (2.81) was recorded in control plots, where only NPK fertilizers were applied as a soil application. Higher level of N and P at early crop stage could have encouraged more number of auxiliary buds and ultimately resulted in more number of primary braches. Similar result of better branching with foliar application of nutrients was reported by Chaurasia *et al*. (2006).

4.2:3 Number of secondary branches per plant

The data regarding to number of secondary branches per plant is shown in table 4.2:3 and fig. 4.1:3. The number of secondary branches per plant ranged from 9.51 to 14.73. The highest number of secondary branches (14.73) were counted in 87.5% recommended dose of fertilizer (100:80:60) along with foliar spray of water soluble fertilizers (i. e. 19:19:19, 13:0:45 and 0:52:34) which was found statistically at par with 100 % recommended dose of NPK + foliar spray of water soluble fertilizers (14.03), 75 % recommended dose of NPK + foliar spray of water soluble fertilizers (13.19) as well as 62.5 % recommended dose of NPK + foliar spray of water soluble fertilizers (12.69) and significantly differed from the control. Where as, minimum number of secondary branches per plant (9.80) were counted in 100% recommended dose of fertilizers (control).

The maximum number of secondary branches per plant was found in 87.5% recommended dose of fertilizer + foliar spray of water soluble fertilizers (14.73 per plant) and it may be due to higher availability of nitrogen which promotes vegetative growth and development of plants and produced more number of secondary branches per plant. Thus combination of soil application and foliar application of water soluble fertilizer was found effective. The similar result was also reported by Sahoo *et al.* (2002).

Higher level of N and P at early crop stage could have encouraged more number of auxiliary buds and ultimately resulted in more number of secondary branches. Similar result of better branching with foliar application of nutrients was reported by Chaurasia *et al*. (2006).

4.2:4 Days to first flowering

The table 4.2:4 and fig. 4.1:4 is showing data regarding to days to first flowering. Days taken to first flowering ranged from 50.60 to 64.45. Early days to first flowering was recorded in the control (50.60) followed by 50% recommended dose of NPK + foliar spray of water soluble fertilizers (51.56) and 75 % recommended dose of NPK + foliar spray of WSF (56.20). Whereas, delayed flowering was observed in the treatment 87.5 % recommended dose of NPK + foliar spray of WSF (64.45) which was at par with 100 % recommended dose of NPK + foliar spray of WSF (59.95) and 62.5 % recommended dose of NPK + foliar spray of WSF (56.41).

The early flowering was recorded in control (50.60) and it may be due to increased level of nitrogen, as compared to where only soil application was done. Similar finding was also reported by Ahmad and Choudhary (1990) that the application of N delayed the flowering of tomato.

4.2.5 Days to 50% flowering

The table 4.2:5 and fig. 4.1:5 is showing data regarding to days to 50% flowering. Days taken to 50% flowering ranged from 58.16 to 75.20. Early days to 50% flowering was recorded in the control (58.16) which was statistically at par with 50 % recommended dose of NPK + foliar spray of WSF (58.71) and 62.5 % recommended dose of NPK + foliar spray of WSF (65.87), whereas, late 50% flowering was recorded in 87.5 % recommended dose of NPK + foliar spray of WSF (75.20) which was statistically at par with 100 % recommended dose of NPK + foliar spray of WSF (68.79) and 75 % recommended dose of NPK + foliar spray of WSF (67.09).

The early 50% flowering was recorded in control (58.16) and it may be due to residual effect of nitrogen, as the control does not received foliar N. Similar finding was also reported by Ahmad and Choudhary (1990) that the application of N delayed the flowering of tomato.

4.2:6 Days to first fruit set

The data regarding to days to first fruit set is shown in the table 4.2:6 and fig.4.1:6. Days to first fruiting ranged from 54.81 to 69.02. The early fruiting was recorded in control (54.81) which was significantly similar with 50 % recommended dose of NPK + foliar spray of WSF (55.89) and 62.5 % recommended dose of NPK + foliar

spray of WSF (61.42) whereas, the late fruiting was recorded in 87.5 % recommended dose of NPK + foliar spray of WSF (69.02) followed by 100 % recommended dose of NPK + foliar spray of WSF (65.58) and 75 % recommended dose of NPK + foliar spray of WSF (62.01).

The early fruit setting was observed in control (54.81), may be due to early flowering of the plants in the same. Similar finding was reported by Ahmad and Choudhary (1990) who reported that increased nitrogen delayed the flowering.

4.2:7 Number of flower clusters per plant

The data regarding to number of clusters per plant is shown in table 4.2:7 and fig. 4.1:7. The number of clusters per plant ranged from 49.42 to 71.25. The maximum number of clusters per plant were obtained in 87.5 % recommended dose of NPK + foliar spray of WSF (71.25) which was statistically at par with 100 % recommended dose of NPK + foliar spray of WSF (70.04), 75 % recommended dose of NPK + foliar spray of WSF (61.42) and 62.5 % recommended dose of NPK + foliar spray of WSF (59.94). The minimum number of clusters per plant was obtained in control (49.42) followed by 50 % recommended dose of NPK + foliar spray of WSF (56.13).

The maximum number of clusters per plant (71.25) was recorded in 87.5 % recommended dose of NPK + foliar spray of WSF. However the minimum number of clusters per plant was recorded in control (49.42). The increase in number of clusters per plant might be due to supplying more nutrients at the critical growth stages i. e. flowering Jeybal *et al.* (1998) and Vibhute (1988) also reported the same results. An optimum level of synthesis of cytokinin at high level of N and P would have resulted in setting of more favourable sink to produce more number of productive flowers, which might have resulted in setting of more number of clusters per plant.

4.2:8 Number of fruits per cluster

The data regarding to number of clusters per plant is shown in table 4.2:8 and fig. 4.1:8. The number of fruits per cluster ranged from 3.44 to 5.55. The maximum number of fruits per cluster were obtained in 87.5 % recommended dose of NPK + foliar spray of WSF (5.55) which was statistically at par with 100 % recommended dose of NPK + foliar spray of WSF (4.61) and 75 % recommended dose of NPK + foliar spray of WSF (4.48). The minimum number of fruits per cluster was obtained in control (3.44) which was at par with 62.5 % recommended dose of NPK + foliar spray of WSF (4.02).

The maximum number of fruits per cluster (5.55) was recorded in 87.5 % recommended dose of NPK + foliar spray of WSF. However the minimum number of fruits per cluster was recorded in control (3.44). The

increase in number of fruits per cluster might be due to supplying more nutrients at the critical growth stages i. e. flowering and fruit set Jeybal *et al.* (1998) and Vibhute (1988). An optimum level of synthesis of cytokinin at high level of N and P would have resulted in setting of more favourable sink to produce more number of productive flowers, which might have resulted in setting of more number of fruits per cluster.

4.2:9 Number of fruits per plant

The data regarding to number of fruit per plant is shown in the table 4.2:9 and fig. 4.1:9. The total number of fruits per plant was varied from 46.45 to 69.52. The maximum number of fruits per plant was found in 87.5 % recommended dose of NPK + foliar spray of WSF (69.52) which was statistically similar with 100 % recommended dose of NPK + foliar spray of WSF (65.94) and 75 % recommended dose of NPK + foliar spray of WSF (60.60). The minimum number of fruits per plant was recorded in control (46.45) which was significantly differed with all the treatments of investigation followed by 50 % recommended dose of NPK + foliar spray of WSF (57.48) and 62.5 % recommended dose of NPK + foliar spray of WSF (57.56).

The maximum number of fruits per plant was recorded in 87.5 % recommended dose of NPK + foliar spray of WSF (69.52). However the lowest fruits per plant (46.45) were observed in control (100 % recommended dose of fertilizers). An optimum level of synthesis of cytokinin at high level of N and P would have resulted in setting of more favourable sink to produce more number of productive flowers, which might have resulted in setting of more number of fruits per plant. The increase in fruits per plant might be due to supply of more nutrients at the critical growth stage i.e. flowering and fruit set (Naik *et al*., 2002). Jeybal *et al.* (1998) and Vibhute (1988) also reported similar findings.

4.2:10 Days to first fruit harvesting

The table 4.2:10 and fig. 4.1:10 are showing days to first fruit harvesting of the investigation. The data regarding to this attributes varied from 67.12 to 84.07. The early harvesting was noted in control (67.12) which was significantly similar with the 50 % recommended dose of NPK + foliar spray of WSF (67.72) and 62.5 % recommended dose of NPK + foliar spray of WSF (76.42). The late fruit harvesting was found in 87.5 % recommended dose of NPK + foliar spray of WSF (84.07) followed by 100 % recommended dose of NPK + foliar spray of WSF (80.58), 75 % recommended dose of NPK + foliar spray of WSF (76.99) and 62.5 % recommended dose of NPK + foliar spray of WSF (76.42).

Late harvesting was found in 100% recommended rose of NPK + foliar spray of WSF (84.07) and it may be due to high N, which delayed the first picking of tomato. The similar finding was also reported by Kumar and Maurya (2003).

4.2:11 fruit weight (g)

The data regarding to days to fruit weight is shown in the table 4.2:11 and fig.4.1:11. Fruit weight was ranges from 36.51g to 53.14g. The maximum fruit weight (53.14g) was recorded in 87.5 % recommended dose of NPK + Foliar spray of WSF which was at par with 100 % recommended dose of NPK + foliar spray of WSF (51.43g) and 75 % recommended dose of NPK + foliar spray of WSF (46.88g). The lowest fruit weight was recorded in control (36.51g) which was significantly at par with 62.5% recommended dose of NPK + foliar spray of WSF (41.57g) and 50 % recommended dose of NPK + foliar spray of WSF (41.43g).

The maximum fruit weight (53.14g) was recorded in 87.5% recommended dose of NPK + foliar spray of WSF. The increase in fruit weight might be due to the better utilization of photosynthates and increased allocation of photosynthates towards the economic part. These findings are conformity with the result of Nanthakumar and Veeraragavathatham (1999) and Narayanamma *et al.* (2006) in brinjal.

4.2:12 fruit diameter (cm)

The table 4.2:12 and fig. 4.1:12 are showing the diameter of fruit of the investigation. The fruit diameter was ranges from 3.58cm to 5.30cm. The highest fruit diameter was recorded in 87.5 % recommended dose of NPK + foliar spray of WSF (5.30cm) which was statistically similar with 100 % recommended dose of NPK + foliar spray of WSF (4.76cm), 75 % recommended dose of NPK + foliar spray of WSF (4.67cm) and 62.5 % recommended dose of NPK + foliar spray of WSF (4.47cm). However the lowest fruit diameter was recorded in control (3.58cm) which was at par with 50 % recommended dose of NPK + foliar spray of WSF (3.98cm).

The highest fruit diameter was recorded in 87.5 % recommended dose of NPK + foliar spray of WSF (5.30cm). The increase in fruit diameter might be due to supply of more nutrients at the critical growth stage i.e. flowering and fruit set (Naik *et al*., 2002). Jeybal *et al*., 1998) and Vibhute (1988) also reported similar findings.

4.2:13 Fruit pericarp thickness (mm)

The table 4.2:13 and fig. 4.1:13 are showing the pericarp thickness of fruits of the investigation. The fruit pericarp thickness was ranges from 3.53mm to 5.02 mm. The highest fruit pericarp thickness was recorded in 87.5

% recommended dose of NPK + foliar spray of WSF (5.02mm) which was statistically similar with 100 % recommended dose of NPK + foliar spray of WSF (4.69mm) and 75 % recommended dose of NPK + foliar spray of WSF (4.45mm). However the lowest fruit diameter was recorded in control (3.53mm) which was at par with 75 % recommended dose of NPK + foliar spray of WSF (4.45mm), 62.5 % recommended dose of NPK + foliar spray of WSF (4.01mm) and 50 % recommended dose of NPK + foliar spray of WSF (3.80mm).

The highest fruit diameter was recorded in 87.5 % recommended dose of NPK + foliar spray of WSF (5.02mm). The increase in fruit pericarp thickness might be due to supply of more nutrients at the critical growth stage i.e. flowering and fruit set (Naik *et al*., 2002). Jeybal *et al.* (1998) and Vibhute (1988) also reported similar findings.

4.2:14 Fruit yield per plant (Kg)

The data regarded to fruit yield per plant (Kg) in shown in table 4.2:14 and fig.4.1:14.The fruit yield per plant was ranges from 1.97 Kg to 3.44 Kg. The highest fruit yield (3.44 Kg) was obtained in 87.5 % recommended dose of NPK + foliar spray of WSF which was statistically at par with 100 % recommended dose of NPK + foliar spray of WSF (3.31 Kg), 75 % recommended dose of NPK + foliar spray of WSF (2.84 Kg) and 62.5 % recommended dose of NPK + foliar spray of WSF (2.75 Kg). The minimum fruit yield (1.97 Kg) was found in control, which was statistically similar with 50 % recommended dose of NPK + foliar spray of WSF (2.68 Kg).

The maximum fruit yield was found in 87.5 % recommended dose of NPK + foliar spray of WSF (3.44 Kg). The increase in fruit yield might be due to greater availability of nutrients, increased uptake of nutrients and water, resulting in more photosynthesis and enhanced food accumulation in edible parts of the fruits (Guievence and Badem, 2000). Similar response in tomato was reported by Palaniappan *et al*. (1999). The minerals deposited penetrate the cuticle and epidermal wall by diffusion and they are absorbed on surface of plasmatic membrane and enter cytoplasm. There is also active transport across plasmalemma to leaf cell and also symplastic pathway to vascular tissue and enter free space and gets deposited to sieve tubes. The high effectiveness, rapid plant responses, convenience and elimination or reduction of toxicity symptoms brought by excessive soil accumulation of given elements due to foliar nutrition makes it more reliable (Jules Janick, 1984).

4.3 Effects on quality attributes

4.3.1 Total soluble solids (%)

The table 4.2:15 and fig. 4.1:15 revealed that, the TSS content of fruits was ranges from 4.03% to 5.05%. The maximum TSS (5.05%) was recorded in 87.5 % recommended dose of NPK + Foliar spray of WSF which was statistically at par with 100 % recommended dose of NPK + foliar spray of WSF (4.48%). However the lowest TSS content was noted in control (4.03%) which was at par with 75 % recommended dose of NPK + foliar spray of WSF (4.34%), 62.5 % recommended dose of NPK + foliar spray of WSF (4.20%) and 50 % recommended dose of NPK + foliar spray of WSF (4.16%).

The maximum TSS content was recorded in 87.5 % recommended dose of NPK + foliar spray of WSF (5.05%). The increased level of N and P through foliar spray was found to increase TSS, but the optimum level of N and P resulted the higher TSS in 87.5 % recommended dose of NPK + foliar spray of WSF (5.05%). The increase in quality character (TSS) might be due to the growth promoting substances which could have accelerated synthesis of carbohydrate, vitamins and other quality character. These results are in conformity with those of Fagaria *et al.* (1992) and Singh and Singh (1992).

The similar result of TSS was also reported by Prabhakaran and Pitachi (2002).

4.3.2 Acidity (%)

The acidity content is shown in table 4.2:16 and fig. 4.1:16. The data regarding to acidity content varied from 0.53% to 0.65%. The maximum acidity (0.65%) was observed in 100 % recommended dose of NPK (control) which was significantly similar from all the treatments of investigation except 100 % recommended dose of NPK + foliar spray of WSF (0.53). The lowest acidity (0.53%) was recorded in 100 % recommended dose of NPK + foliar spray of WSF followed by 50 % recommended dose of NPK + foliar spray of WSF (0.58%), 87.5 % recommended dose of NPK + foliar spray of WSF (0.58%), 62.5 % recommended dose of NPK + foliar spray of WSF (0.59%) and 75 % recommended dose of NPK + foliar spray of WSF (0.61%).

The foliar spray of water soluble fertilizers significantly reduces the acidity content of fruits. The low acidity content in foliar sprayed treatments might be due to the dilution effect which was reported by Bafna (1988).

Similar result was reported by Kadam (1990) and Dhake (1995) using fertigation with water soluble fertilizers.

4.4 ECONOMICS

The economics was calculated by total variable cost and decipited in the table 4.2:17. The highest net return (Rs. 125890.05) and benefit – cost ratio (2.73) was calculated in 87.5 % recommended dose of NPK + foliar spray of WSF followed by 100 % recommended dose of NPK + foliar spray of WSF (2.53), 75 % recommended dose of NPK + foliar spray of WSF (2.51), 50 % recommended dose of NPK + foliar spray of WSF (2.43) and 62.5.5 % recommended dose of NPK + foliar spray of WSF (2.40). The minimum net return (Rs 73966.04) and benefit – cost ratio (1.59) was calculated in control where only soil applied fertilizers are incorporated.

The highest net return (Rs. 125890.05) and benefit – cost ratio (2.73) was calculated in 87.5 % recommended dose of NPK + foliar spray of WSF. The increase in net return and benefit-cost ratio, it is due to higher fruit yield obtained in the treatment than the other treatments.

CHAPTER – V
SUMMARY, CONCLUSIONS AND SUGGESTIONS FOR FUTURE RESEARCH WORK

5.1 Summary

The present investigation entitled **"Response of soil and foliar application of nutrients on growth and yield attributes of tomato (*Lycopersicon esculentum* Mill.)"** was conducted at Horticultural Research cum Instructional Farm, Department of Horticulture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) during *Rabi* 2009-10.

The experiment was laid in RBD with four replications. There were six treatments comprising of soil and foliar application of nutrients. Recommended dose of fertilizers was given 100: 80: 60 kg per ha N, P_2O_5, and K_2O respectively. The treatments are 100 % recommended dose of NPK, 100 % recommended dose of NPK + foliar spray of water soluble fertilizers, 87.5 % recommended dose of NPK + foliar spray of water soluble fertilizers, 75 % recommended dose of NPK + foliar spray of water soluble fertilizers, 62.5 % recommended dose of NPK + foliar spray of water soluble fertilizers and 50 % recommended dose of NPK + foliar spray of water soluble fertilizers were used in experiment. Seed were sown in nursery on 15 November, 2009 and seedlings were transplanted 09 December, 2009.

The result indicated that the plant height ranged from 75.22 cm to 122.71 cm. The maximum plant height (122.71cm) was recorded under 87.5% recommended dose of NPK along with foliar spray of water soluble fertilizers which was found statistically at par with 100 % recommended dose of NPK + foliar spray of water soluble fertilizers (WSF). The least plant height (75.22 cm) was recorded in control, where only soil applied fertilizers were used.

The number of primary branches per plant varied from 2.81 to 4.73. The maximum number of primary branches per plant were counted in 87.5 % recommended dose of NPK + foliar spray of water soluble fertilizers (4.73) followed by 75 % recommended dose of NPK + foliar spray of water soluble fertilizers (4.13) and 100 % recommended dose of NPK + foliar spray of water soluble fertilizers (3.76). The minimum number of primary branches per plant was found in control (2.81).

The number of secondary branches per plant ranged from 9.51 to 14.73. The highest number of secondary branches (14.73) were counted in 87.5% recommended dose of fertilizer (100:80:60) along with foliar spray of

water soluble fertilizers (i. e. 19:19:19, 13:0:45 and 0:52:34) which was found statistically at par with 100 % recommended dose of NPK + foliar spray of water soluble fertilizers (14.03) and significantly differed from the control. Whereas, minimum number of secondary braches per plant was counted in control (9.51).

Days taken to first flowering ranged from 50.60 to 64.45. Early days to first flowering was recorded in the control (50.60) followed by 50% recommended dose of NPK + foliar spray of water soluble fertilizers (51.56), 75% recommended dose of NPK + foliar spray of WSF (56.20) and 62.5 % recommended dose of NPK + foliar spray of WSF (56.41). Whereas, treatment 87.5 % recommended dose of NPK + foliar spray of WSF (64.45) were at par with 100 % recommended dose of NPK + foliar spray of WSF (59.95).

Days taken to 50% flowering ranged from 58.16 to 75.20. Early days to 50% flowering was recorded in the control (58.16) which was statistically at par with 50 % recommended dose of NPK + foliar spray of WSF (58.71) and 62.5 % recommended dose of NPK + foliar spray of WSF (65.87), whereas, late 50% flowering was recorded in 87.5 % recommended dose of NPK + foliar spray of WSF (75.20) which was statistically at par with 100 % recommended dose of NPK + foliar spray of WSF (68.79) and 75 % recommended dose of NPK + foliar spray of WSF (67.09).

Days to first fruiting ranged from 54.81 to 69.02. The early fruiting was recorded in control (54.81) which was significantly similar with 50 % recommended dose of NPK + foliar spray of WSF (55.89) and 62.5 % recommended dose of NPK + foliar spray of WSF (61.42), whereas, the late fruiting was recorded in 87.5 % recommended dose of NPK + foliar spray of WSF (69.02) followed by 100 % recommended dose of NPK + foliar spray of WSF (65.58) and 75 % recommended dose of NPK + foliar spray of WSF (62.01).

The number of clusters per plant ranged from 49.42 to 71.25. The maximum number of clusters per plant were obtained in 87.5 % recommended dose of NPK + foliar spray of WSF (71.25) which was statistically at par with 100 % recommended dose of NPK + foliar spray of WSF (70.04), 75 % recommended dose of NPK + foliar spray of WSF (61.42) and 62.5 % recommended dose of NPK + foliar spray of WSF (59.94). The minimum number of clusters per plant was obtained in control (49.42) followed by 50 % recommended dose of NPK + foliar spray of WSF (56.13).

The number of fruits per cluster ranged from 3.44 to 5.55. The maximum number of fruits per cluster were obtained in 87.5 % recommended dose of NPK + foliar spray of WSF (5.55) which was statistically at par with 100 % recommended dose of NPK + foliar spray of WSF (4.61) and 75 % recommended dose of NPK + foliar spray of

WSF (4.48). The minimum number of fruits per cluster was obtained in control (3.44) which was at par with 62.5 % recommended dose of NPK + foliar spray of WSF (4.02).

The total number of fruits per plant was varied from 46.45 to 69.52. The maximum number of fruits per plant was found in 87.5 % recommended dose of NPK + foliar spray of WSF (69.52) which was statistically similar with 100 % recommended dose of NPK + foliar spray of WSF (65.94) and 75 % recommended dose of NPK + foliar spray of WSF (60.60). The minimum number of fruits per plant was recorded in control (46.45) which was significantly differed with all the treatments of investigation followed by 50 % recommended dose of NPK + foliar spray of WSF (57.48) and 62.5 % recommended dose of NPK + foliar spray of WSF (57.56).

The data regarding to fruit harvesting varied from 67.12 to 84.07 days. The early harvesting was noted in control (67.12) which was significantly similar with the 50 % recommended dose of NPK + foliar spray of WSF (67.72) and 62.5 % recommended dose of NPK + foliar spray of WSF (76.42). The late fruit harvesting was found in 87.5 % recommended dose of NPK + foliar spray of WSF (84.07) followed by 100 % recommended dose of NPK + foliar spray of WSF (80.58), 75 % recommended dose of NPK + foliar spray of WSF (76.99) and 62.5 % recommended dose of NPK + foliar spray of WSF (76.42).

The data regarding to fruit weight was ranges from 36.51g to 53.14g. The maximum fruit weight (53.14g) was recorded in 87.5 % recommended dose of NPK + Foliar spray of WSF which was at par with 100 % recommended dose of NPK + foliar spray of WSF (51.43g) and 75 % recommended dose of NPK + foliar spray of WSF (46.88g). The lowest fruit weight was recorded in control (36.51g) which was significantly at par with 62.5% recommended dose of NPK + foliar spray of WSF (41.57g) and 50 % recommended dose of NPK + foliar spray of WSF (41.43g).

The fruit diameter was ranges from 3.58cm to 5.30cm. The highest fruit diameter was recorded in 87.5 % recommended dose of NPK + foliar spray of WSF (5.30cm) which was statistically similar with 100 % recommended dose of NPK + foliar spray of WSF (4.76cm), 75 % recommended dose of NPK + foliar spray of WSF (4.67cm) and 62.5 % recommended dose of NPK + foliar spray of WSF (4.47cm). However the lowest fruit diameter was recorded in control (3.58cm) which was at par with 50 % recommended dose of NPK + foliar spray of WSF (3.98cm).

The fruit pericarp thickness was ranges from 3.53mm to 5.02mm. The highest fruit pericarp thickness was recorded in 87.5 % recommended dose of NPK + foliar spray of WSF (5.02mm) which was statistically similar with

100 % recommended dose of NPK + foliar spray of WSF (4.69mm) and 75 % recommended dose of NPK + foliar spray of WSF (4.45mm). However the lowest fruit diameter was recorded in control (3.53mm) which was at par with 75 % recommended dose of NPK + foliar spray of WSF (4.45mm), 62.5 % recommended dose of NPK + foliar spray of WSF (4.01mm) and 50 % recommended dose of NPK + foliar spray of WSF (3.80mm).

The fruit yield per plant was ranges from 1.97 Kg to 3.44 Kg. The highest fruit yield (3.44 Kg) was obtained in 87.5 % recommended dose of NPK + foliar spray of WSF which was statistically at par with 100 % recommended dose of NPK + foliar spray of WSF (3.31 Kg), 75 % recommended dose of NPK + foliar spray of WSF (2.84 Kg) and 62.5 % recommended dose of NPK + foliar spray of WSF (2.75 Kg). The minimum fruit yield (1.97 Kg) was found in control, which was statistically similar with 50 % recommended dose of NPK + foliar spray of WSF (2.68 Kg).

The TSS content of fruits was ranges from 4.03% to 5.05%. The maximum TSS (5.05%) was recorded in 87.5 % recommended dose of NPK + Foliar spray of WSF which was statistically at par with 100 % recommended dose of NPK + foliar spray of WSF (4.48%). However the lowest TSS content was noted in control (4.03%) which was at par with 75 % recommended dose of NPK + foliar spray of WSF (4.34%), 62.5 % recommended dose of NPK + foliar spray of WSF (4.20%) and 50 % recommended dose of NPK + foliar spray of WSF (4.16%).

The acidity content varied from 0.53% to 0.65%. The maximum acidity (0.65%) was observed in 100 % recommended dose of NPK (control) which was significantly similar from all the treatments of investigation except 100 % recommended dose of NPK + foliar spray of WSF (0.53). The lowest acidity (0.53%) was recorded in 100 % recommended dose of NPK + foliar spray of.

The highest net return (Rs. 125890.05) and benefit – cost ratio (2.73) was obtained from 87.5 % recommended dose of NPK + foliar spray of WSF. However the minimum net return (Rs 73966.04) and benefit – cost ratio (1.59) was obtained from control where only soil applied fertilizers are incorporated.

5.2 Conclusions:

1. Among the different treatments, 87.5 % recommended dose of NPK (100:80:60) along with foliar spray of water soluble fertilizers (i. e. 19:19:19, 13:0:45 and 0:52:34) recorded the tallest

plant, number of primary branches, number of secondary branches per plant.

2. Flowering, fruiting, maturity, and harvesting were recorded earlier in control (100% recommended dose of fertilizer) as compared to other treatments.
3. Yield contributing characters such as number of flower clusters per plant, number of fruits per cluster, number of fruits per plant, fruit weight, fruit diameter, fruit pericarp thickness and fruit yield per plant were recorded higher in 87.5 % recommended dose of NPK (100:80:60) along with foliar spray of water soluble fertilizers (i. e. 19:19:19, 13:0:45 and 0:52:34), followed by 100 % recommended dose of NPK (100:80:60) along with foliar spray of water soluble fertilizers (i. e. 19:19:19, 13:0:45 and 0:52:34).
4. The TSS (%) content of fruits were found higher in 87.5 % recommended dose of NPK + foliar spray of water soluble fertilizers while, the acidity (%) content of fruits were found higher in control where only soil applied fertilizers were incorporated.
5. The highest net return (Rs. 125890.05) and benefit – cost ratio (2.73) was obtained from 87.5 % recommended dose of NPK + foliar spray of WSF. Hence application of 87.5% soil application of NPK along with foliar application of water soluble fertilizers is beneficial in increasing tomato fruit yield and its quality.

5.3 Suggestions for future research work:

On the basis of experience gained and results obtained after completion of present investigation the following suggestion are given to conduct further research:

1. Similar experiment may be conducted where treatments consist of different levels of fertilizers along with foliar spray of different grades of water soluble fertilizers.
2. Similar experiment may be conducted in different soil and environment with different level of soil applied fertilizer in combination with foliar spray of different grades of water soluble fertilizers.
3. The highest net return (Rs. 125890.05) and benefit – cost ratio (2.73) was obtained from 87.5 % recommended dose of NPK + foliar spray of WSF, it can be used for getting better return.
4. Since the results of present investigation belongs to only one year of experiment, for reaching to any definite conclusion and recommendation, it needs further confirmation for atleast two successive year.

"RESPONSE OF SOIL AND FOLIAR APPLICATION OF NUTRIENTS ON GROWTH AND YIELD ATTRIBUTES OF TOMATO

(*Lycopersicon esculentum* Mill.)"

By

KAMAL NARAYAN

ABSTRACT

The experiment entitled "Response of soil and foliar application of nutrients on growth and yield attributes of tomato (***Lycopersicon esculentum*** Mill.)" was carried out at Horticultural Research cum Instructional Farm, Department of Horticulture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) during *Rabi* season 2009-10. The experiment was laid out in Randomized Block Design with four replication and 6 treatments with and without combination of water soluble fertilizer.

The results revealed that the growth characters i.e. plant height, number of primary and secondary branches per plant were found superior in 87.5% recommended dose of NPK along with foliar spray of water soluble fertilizers followed by 100% recommended dose of NPK + foliar spray of water soluble fertilizers. The yield contributing characters i.e. number of fruits per plant, number of fruits per cluster, fruit weight, fruit diameter and fruits per plant were recorded higher in 87.5% recommended dose of NPK + foliar spray of water soluble fertilizers followed by 100 % recommended dose of NPK + foliar spray of water soluble fertilizers. The TSS content were found better in 87.5% recommended dose of NPK + foliar spray of water soluble fertilizers and acidity content were high in 100 % recommended dose of NPK (control). The flowering, fruiting, maturity and harvesting were found earlier under control as compared to other treatments applied in the investigation.

Economically 87.5% recommended dose of NPK + foliar spray of water soluble fertilizer was recorded highest net return and benefit – cost ratio, Rs. 125890.05 and 2.73 respectively.

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*Original not seen.

Appendix I: Weekly Meteorological Parameters during crop growth period (2009-10)

Standard Meteorological Weeks	Month and Date	Temperature (°C)		Rainfall (mm)	Relative Humidity (%)		Wind Velocity (Kmph)	Evaporation (mm)	Sunshine (hour)
		Max.	Min		I	II			
45	November 05-11	30.4	20.9	00.0	90	56	3.4	3.3	4.6
46	12-18	29.8	21.6	49.5	91	68	4.0	3.7	3.6
47	19-25	26.4	13.0	00.0	93	40	4.8	2.5	7.8
48	December 26-02	26.9	10.8	00.8	93	32	1.6	2.8	8.9
49	03-09	28.6	13.1	00.0	93	36	1.5	2.6	7.7
50	10-16	29.5	14.9	00.0	93	39	1.7	2.8	7.1
51	17-23	26.1	13.5	19.2	94	52	2.0	2.5	6.4
52	24-31	26.1	11.6	00.1	91	36	2.0	2.6	7.1
1	January 01-07	25.6	08.6	00.0	88	29	2.2	2.9	8.4
2	08-14	26.6	14.7	15.4	87	49	2.0	2.5	5.1
3	15-21	25.7	9.3	00.0	94	32	1.3	2.6	7.6
4	22-28	27.8	8.7	00.0	84	21	1.9	3.3	9.5
5	29-04	28.5	11.1	00.0	85	34	2.3	3.6	8.2
6	February 05-11	28.6	13.2	01.4	86	29	2.0	2.8	7.0
7	12-18	31.7	17.4	00.0	88	43	1.7	4.1	8.6
8	19-25	32.1	15.0	05.6	80	26	3.0	5.2	9.4
9	26-04	34.4	16.7	00.0	70	21	2.8	5.4	10.1
10	March 05-11	36.0	20.2	00.0	63	23	3.8	6.8	9.7
11	12-18	36.3	19.3	00.8	64	24	3.7	6.2	8.1
12	19-25	39.7	20.4	00.0	58	14	3.3	7.6	9.4

Appendix – II: Variable cost of cultivation of tomato ha $^{-1}$

S. No	Particular	Inputs	Rate	Cost incurred Rs ha^{-1}
1.	Land preparation and fertilizer application	12 man days	Rs 104.96 day $^{-1}$	1259.52
2	Cost of FYM	½ trolly	Rs 500 trolly $^{-1}$	250.00
3	Seed and seed sowing			
a	Cost of seed	Pant T-3 @500g ha^{-1}	Rs 600 kg^{-1}	300.00
b	Sowing of seed and fertilizer application	6 man days	Rs 104.96 day $^{-1}$	629.76
4	Pesticides Bavistin (twice) 500 g $^{-1}$	50 g	Rs 240/ 500 g^{-1}	24.00
5	Weeding, hoeing and spraying of pesticide	15 man days	Rs 104.96 day $^{-1}$	1574.40
	Irrigation	2 man days	Rs 104.96 day $^{-1}$	209.92
	B. Crop Production			
1	Land preparation			
a	Ploughing (once	1 tractor for 4 hrs	Rs 200 hr $^{-1}$	800.00
b	Harrowing (once)	1 tractor for 4 hrs	Rs 200 hr $^{-1}$	800.00
2	Bed preparation, manuring and fertilization	25 man days	Rs 104.96 day $^{-1}$	2624.00
3.	Transplanting	25 man days	Rs 104.96 day $^{-1}$	2624.00
4.	FYM	5 trolly	Rs. 500	2500.00
5	Fertilizers			
A	Urea @ 217kg. N ha^{-}		Rs 5.0 kg $^{-1}$	1085.00
B	SSP @ 500 kg P ha^{-1}		Rs 3.38 kg $^{-1}$	1690.00
C	MOP @ 100kg K ha^{-1}		Rs 6.64 kg $^{-1}$	664.0
6	Application of fertilizers	10 man days	Rs 104.96 day $^{-1}$	1040.96
7	Water soluble fertilizers			
A	19:19:19@ 50 kg ha^{-1} (twice)		Rs 126 kg $^{-1}$	6250.00
B	0:52:34@ 25 kg ha^{-1}		Rs 165 kg $^{-1}$	4125.00
C	13:0:45@ 25 kg ha^{-1}		Rs 165 kg $^{-1}$	4125.00
8.	Foliar spray	5 man days	Rs 104.96 day $^{-1}$	524.80
9.	Stacking			
A	labour	30 man days	Rs 104.96 day $^{-1}$	3148.8
B	Rope	20 kg	Rs 40 kg $^{-1}$	800.00
C	Wire	70 kg	Rs 40 kg $^{-1}$	2800.00
10.	Plant protection measure			
1.	Cost of chemical			
A	Bavistin (twice) 500 g ha^{-1}	1000 g	Rs 240/500 g^{-1}	480.00
B	Nuvacron 40 EC 750 ml ha^{-1} (twice)	1.5 liter	Rs 160/ 500 ml^{-1}	480.00
C	Imidachlorpid @ 500 ml ha $^{-1}$	500 ml	Rs 1250/ 500 ml	1250.00
2.	Application cost	15 man days	Rs 104.96 day $^{-1}$	1574.40
11.	Weeding (twice	40 man days	Rs 104.96 day $^{-1}$	4198.40
12.	Land rent	For six month	Rs 800 ha $^{-1}$	800.00
13.	Harvesting	40 man days	Rs 104.96 day $^{-1}$	4198.40
Sub total				**42455.36**
Interest on capital investment		For six month	@ 14%	5943.75
Grand total				**48399.11**
Price of tomato @ Rs 400 q^{-1}				

Table: 4.2:1 Effect of soil and foliar application of nutrients on plant height (cm)

S. No	***Treatments***	***Mean***
T_1	100 % Recommended Dose of NPK (control)	75.22
T_2	100 % Recommended Dose of NPK + Foliar spray of WSF	116.33
T_3	87.5 % Recommended Dose of NPK + Foliar spray of WSF	122.71
T_4	75 % Recommended Dose of NPK + Foliar spray of WSF	104.67
T_5	62.5 % Recommended Dose of NPK + Foliar spray of WSF	92.54
T_6	50% Recommended Dose of NPK + Foliar spray of WSF	87.01
	SE(d) $\pm$	7.28
	CD at (P=0.05)	15.51

Table: 4.2:2 Effect of soil and foliar application of nutrients on number of primary branches per plant

S. No	***Treatments***	***Mean***
T_1	100 % Recommended Dose of NPK (control)	2.81
T_2	100 % Recommended Dose of NPK + Foliar spray of WSF	3.76
T_3	87.5 % Recommended Dose of NPK + Foliar spray of WSF	4.73
T_4	75 % Recommended Dose of NPK + Foliar spray of WSF	4.13
T_5	62.5 % Recommended Dose of NPK + Foliar spray of WSF	3.64
T_6	50% Recommended Dose of NPK + Foliar spray of WSF	3.40
	SE(d) $\pm$	0.38
	CD at (P=0.05)	0.81

Table: 4.2:3 Effect of soil and foliar application of nutrients on number of secondary branches per plant

S. No	***Treatments***	***Mean***
T_1	100 % Recommended Dose of NPK (control)	9.51
T_2	100 % Recommended Dose of NPK + Foliar spray of WSF	14.03
T_3	87.5 % Recommended Dose of NPK + Foliar spray of WSF	14.73
T_4	75 % Recommended Dose of NPK + Foliar spray of WSF	13.19
T_5	62.5 % Recommended Dose of NPK + Foliar spray of WSF	12.69
T_6	50% Recommended Dose of NPK + Foliar spray of WSF	11.84
	SE(d) $\pm$	1.28
	CD at (P=0.05)	2.74

Table: 4.2:4 Effect of soil and foliar application of nutrients on days to first flowering

S. No	***Treatments***	***Mean***
T_1	100 % Recommended Dose of NPK (control)	50.60
T_2	100 % Recommended Dose of NPK + Foliar spray of WSF	59.95
T_3	87.5 % Recommended Dose of NPK + Foliar spray of WSF	64.45
T_4	75 % Recommended Dose of NPK + Foliar spray of WSF	56.20
T_5	62.5 % Recommended Dose of NPK + Foliar spray of WSF	56.41
T_6	50% Recommended Dose of NPK + Foliar spray of WSF	51.56
	SE(d) $\pm$	4.10
	CD at (P=0.05)	8.73

Table: 4.2:5 Effect of soil and foliar application of nutrients on days to 50% flowering

S. No	***Treatments***	***Mean***
T_1	100 % Recommended Dose of NPK (control)	58.16
T_2	100 % Recommended Dose of NPK + Foliar spray of WSF	68.79
T_3	87.5 % Recommended Dose of NPK + Foliar spray of WSF	75.20
T_4	75 % Recommended Dose of NPK + Foliar spray of WSF	67.09
T_5	62.5 % Recommended Dose of NPK + Foliar spray of WSF	65.87
T_6	50% Recommended Dose of NPK + Foliar spray of WSF	58.71
	SE(d) $\pm$	5.33
	CD at (P=0.05)	11.37

Table: 4.2:6 Effect of soil and foliar application of nutrients on days to first fruit set

S. No	***Treatments***	***Mean***
T_1	100 % Recommended Dose of NPK (control)	3.45
T_2	100 % Recommended Dose of NPK + Foliar spray of WSF	4.61
T_3	87.5 % Recommended Dose of NPK + Foliar spray of WSF	5.56
T_4	75 % Recommended Dose of NPK + Foliar spray of WSF	4.48
T_5	62.5 % Recommended Dose of NPK + Foliar spray of WSF	4.36
T_6	50% Recommended Dose of NPK + Foliar spray of WSF	4.03
	SE(d) $\pm$	0.58
	CD at (P=0.05)	1.13

Table: 4.2:7 Effect of soil and foliar application of nutrients on number of flower clusters per plant

S. No	***Treatments***	***Mean***
T_1	100 % Recommended Dose of NPK (control)	49.42
T_2	100 % Recommended Dose of NPK + Foliar spray of WSF	70.04
T_3	87.5 % Recommended Dose of NPK + Foliar spray of WSF	71.25
T_4	75 % Recommended Dose of NPK + Foliar spray of WSF	61.42
T_5	62.5 % Recommended Dose of NPK + Foliar spray of WSF	59.94
T_6	50% Recommended Dose of NPK + Foliar spray of WSF	56.13
	SE(d) $\pm$	6.83
	CD at (P=0.05)	14.55

Table: 4.2:8 Effect of soil and foliar application of nutrients on number of fruits per cluster

S. No	***Treatments***	***Mean***
T_1	100 % Recommended Dose of NPK (control)	3.44
T_2	100 % Recommended Dose of NPK + Foliar spray of WSF	4.61
T_3	87.5 % Recommended Dose of NPK + Foliar spray of WSF	5.55
T_4	75 % Recommended Dose of NPK + Foliar spray of WSF	4.48
T_5	62.5 % Recommended Dose of NPK + Foliar spray of WSF	4.30
T_6	50% Recommended Dose of NPK + Foliar spray of WSF	4.02
	SE(d) $\pm$	0.58
	CD at (P=0.05)	1.23

Table: 4.2:9 Effect of soil and foliar application of nutrients on number of fruits per plant

S. No	***Treatments***	***Mean***
T_1	100 % Recommended Dose of NPK (control)	46.45
T_2	100 % Recommended Dose of NPK + Foliar spray of WSF	65.94
T_3	87.5 % Recommended Dose of NPK + Foliar spray of WSF	69.52
T_4	75 % Recommended Dose of NPK + Foliar spray of WSF	60.60
T_5	62.5 % Recommended Dose of NPK + Foliar spray of WSF	57.56
T_6	50% Recommended Dose of NPK + Foliar spray of WSF	57.48
	SE(d) $\pm$	4.72
	CD at (P=0.05)	10.07

Table: 4.2:10 Effect of soil and foliar application of nutrients on days to first fruit harvesting

S. No	***Treatments***	***Mean***
T_1	100 % Recommended Dose of NPK (control)	67.12
T_2	100 % Recommended Dose of NPK + Foliar spray of WSF	80.58
T_3	87.5 % Recommended Dose of NPK + Foliar spray of WSF	84.07
T_4	75 % Recommended Dose of NPK + Foliar spray of WSF	76.99
T_5	62.5 % Recommended Dose of NPK + Foliar spray of WSF	76.42
T_6	50% Recommended Dose of NPK + Foliar spray of WSF	67.72
	SE(d) $\pm$	5.64
	CD at (P=0.05)	12.03

Table: 4.2:11 Effect of soil and foliar application of nutrients on fruit weight (g)

S. No	***Treatments***	***Mean***
T_1	100 % Recommended Dose of NPK (control)	36.51
T_2	100 % Recommended Dose of NPK + Foliar spray of WSF	51.43
T_3	87.5 % Recommended Dose of NPK + Foliar spray of WSF	53.14
T_4	75 % Recommended Dose of NPK + Foliar spray of WSF	46.88
T_5	62.5 % Recommended Dose of NPK + Foliar spray of WSF	41.57
T_6	50% Recommended Dose of NPK + Foliar spray of WSF	41.43
	SE(d) $\pm$	5.14
	CD at (P=0.05)	10.96

Table: 4.2:12 Effect of soil and foliar application of nutrients on fruit diameter (cm)

S. No	***Treatments***	***Mean***
T_1	100 % Recommended Dose of NPK (control)	3.58
T_2	100 % Recommended Dose of NPK + Foliar spray of WSF	4.76
T_3	87.5 % Recommended Dose of NPK + Foliar spray of WSF	5.30
T_4	75 % Recommended Dose of NPK + Foliar spray of WSF	4.67
T_5	62.5 % Recommended Dose of NPK + Foliar spray of WSF	4.47
T_6	50% Recommended Dose of NPK + Foliar spray of WSF	3.98
	SE(d) $\pm$	0.54
	CD at (P=0.05)	1.15

Table: 4.2:13 Effect of soil and foliar application of nutrients on fruit

pericarp thickness (mm)

S. No	***Treatments***	***Mean***
T_1	100 % Recommended Dose of NPK (control)	3.53
T_2	100 % Recommended Dose of NPK + Foliar spray of WSF	4.69
T_3	87.5 % Recommended Dose of NPK + Foliar spray of WSF	5.02
T_4	75 % Recommended Dose of NPK + Foliar spray of WSF	4.45
T_5	62.5 % Recommended Dose of NPK + Foliar spray of WSF	4.01
T_6	50% Recommended Dose of NPK + Foliar spray of WSF	3.80
	SE(d) $\pm$	0.45
	CD at (P=0.05)	0.97

Table: 4.2:14 Effect of soil and foliar application of nutrients on fruit

yield per plant (Kg)

S. No	***Treatments***	***Mean***
T_1	100 % Recommended Dose of NPK (control)	1.97
T_2	100 % Recommended Dose of NPK + Foliar spray of WSF	3.31
T_3	87.5 % Recommended Dose of NPK + Foliar spray of WSF	3.44
T_4	75 % Recommended Dose of NPK + Foliar spray of WSF	2.84
T_5	62.5 % Recommended Dose of NPK + Foliar spray of WSF	2.75
T_6	50% Recommended Dose of NPK + Foliar spray of WSF	2.68
	SE(d) $\pm$	0.37
	CD at (P=0.05)	0.79

Table: 4.2:15 Effect of soil and foliar application of nutrients on total soluble solids (TSS %)

S. No	***Treatments***	***Mean***
T_1	100 % Recommended Dose of NPK (control)	4.03
T_2	100 % Recommended Dose of NPK + Foliar spray of WSF	4.48
T_3	87.5 % Recommended Dose of NPK + Foliar spray of WSF	5.05
T_4	75 % Recommended Dose of NPK + Foliar spray of WSF	4.34
T_5	62.5 % Recommended Dose of NPK + Foliar spray of WSF	4.20
T_6	50% Recommended Dose of NPK + Foliar spray of WSF	4.16
	SE(d) $\pm$	0.30
	CD at (P=0.05)	0.64

Table: 4.2:16 Effect of soil and foliar application of nutrients on acidity (%)

S. No	***Treatments***	***Mean***
T_1	100 % Recommended Dose of NPK (control)	0.65
T_2	100 % Recommended Dose of NPK + Foliar spray of WSF	0.53
T_3	87.5 % Recommended Dose of NPK + Foliar spray of WSF	0.58
T_4	75 % Recommended Dose of NPK + Foliar spray of WSF	0.61
T_5	62.5 % Recommended Dose of NPK + Foliar spray of WSF	0.59
T_6	50% Recommended Dose of NPK + Foliar spray of WSF	0.58
	SE(d) $\pm$	0.033
	CD at (P=0.05)	0.071

Table 4.2:17 Economics of tomato as influenced by different treatments

Treatment	Total cost Rs / ha	Marketable yield q /ha	Gross return Rs / ha	Net return Rs / ha	BC ratio
100 % Recommended Dose of NPK (control)	46297.96	300.66	120264	73966.04	1.59
100 % Recommended Dose of NPK + Foliar spray of WSF	48399.11	428.05	171220	122820.89	2.53
87.5 % Recommended Dose of NPK + Foliar spray of WSF	46029.95	429.80	171920	125890.05	2.73
75 % Recommended Dose of NPK + Foliar spray of WSF	45468.6	392.00	156800	114331.4	2.51
62.5 % Recommended Dose of NPK + Foliar spray of WSF	44907.2	382.00	152800	107892.8	2.40
50% Recommended Dose of NPK + Foliar spray of WSF	44345.85	381.25	152500	108154.15	2.43

Table. 4.1: Analysis of variance for growth, yield and quality attributes in

tomato (2010)

S. N.	Observations		Mean sum of square		
			Replication's	**Treatment's**	**Error**
		df	***03***	***05***	**15**
1.	Plant height (cm)		13.68	1313.82*	105.89
2.	Number of primary branches per plant		0.27	1.70*	0.29
3.	Number of secondary branches per plant		0.67	13.63*	3.30
4.	Days to first flowering		14.19	107.53*	33.57
5.	Days to 50% flowering		33.48	165.86*	56.89
6.	Days to first fruit set		41.28	122.82*	42.07
7.	Number of flower clusters per plant		28.99	276.24*	93.26
8.	Number of fruits per cluster		0.34	1.94*	0.67
9.	Number of fruits per plant		0.25	0.97*	0.27
10.	Days to first fruit harvesting		21.83	186.40*	63.74
11.	Fruit weight (g)		46.89	166.11*	52.84
12.	Fruit diameter (cm)		0.15	2.02*	0.59
13.	Fruit pericarp thickness (mm)		0.20	1.28*	0.41
14.	Fruit yield per plant (Kg)		0.25	0.97*	0.27
15.	Total Soluble solids (TSS %)		0.03	0.53*	0.18
16.	Acidity (%)		0.0028	0.0066*	0.0022

* Significant at 5%

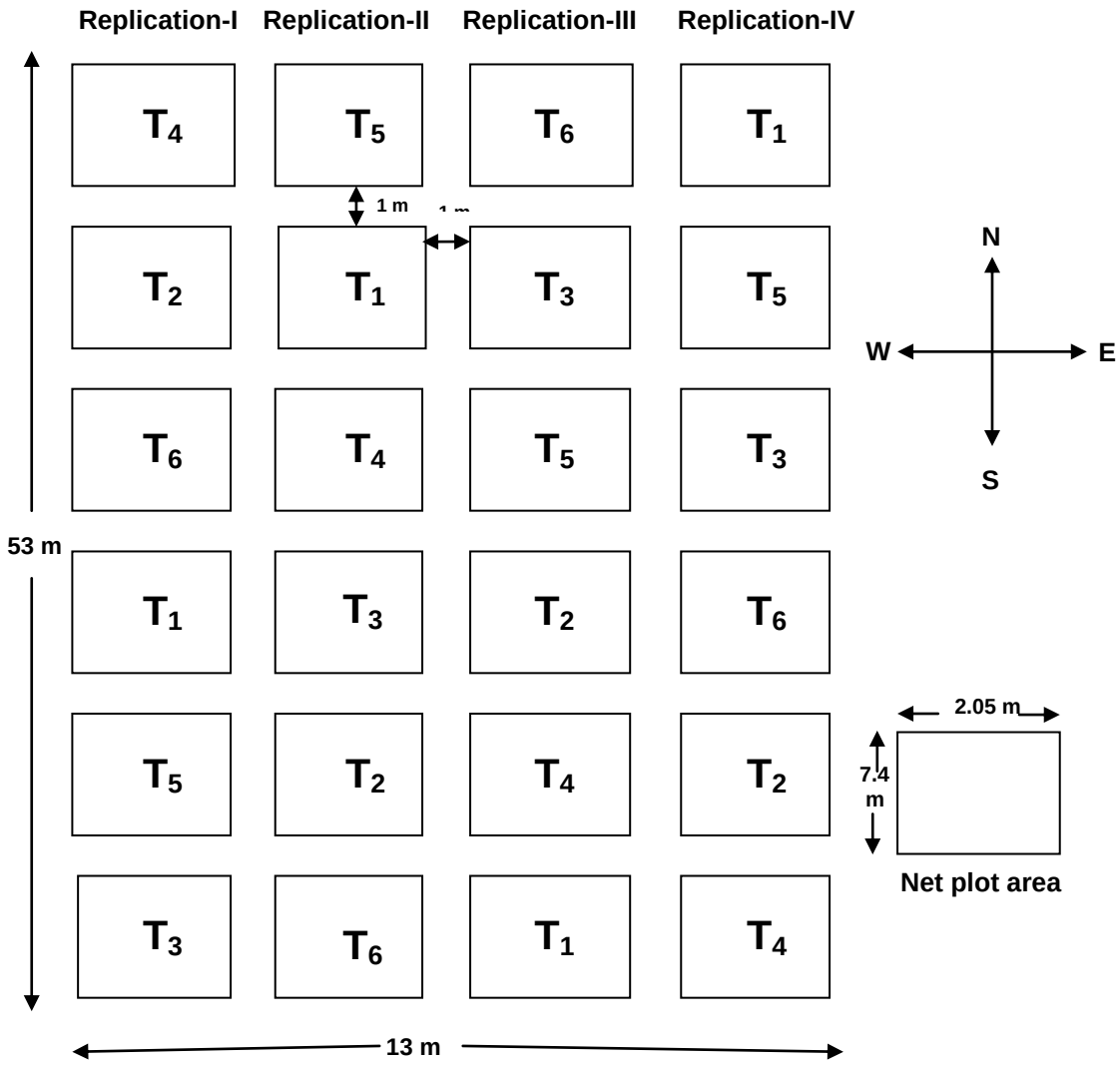

Fig. 3.1: Layout plan

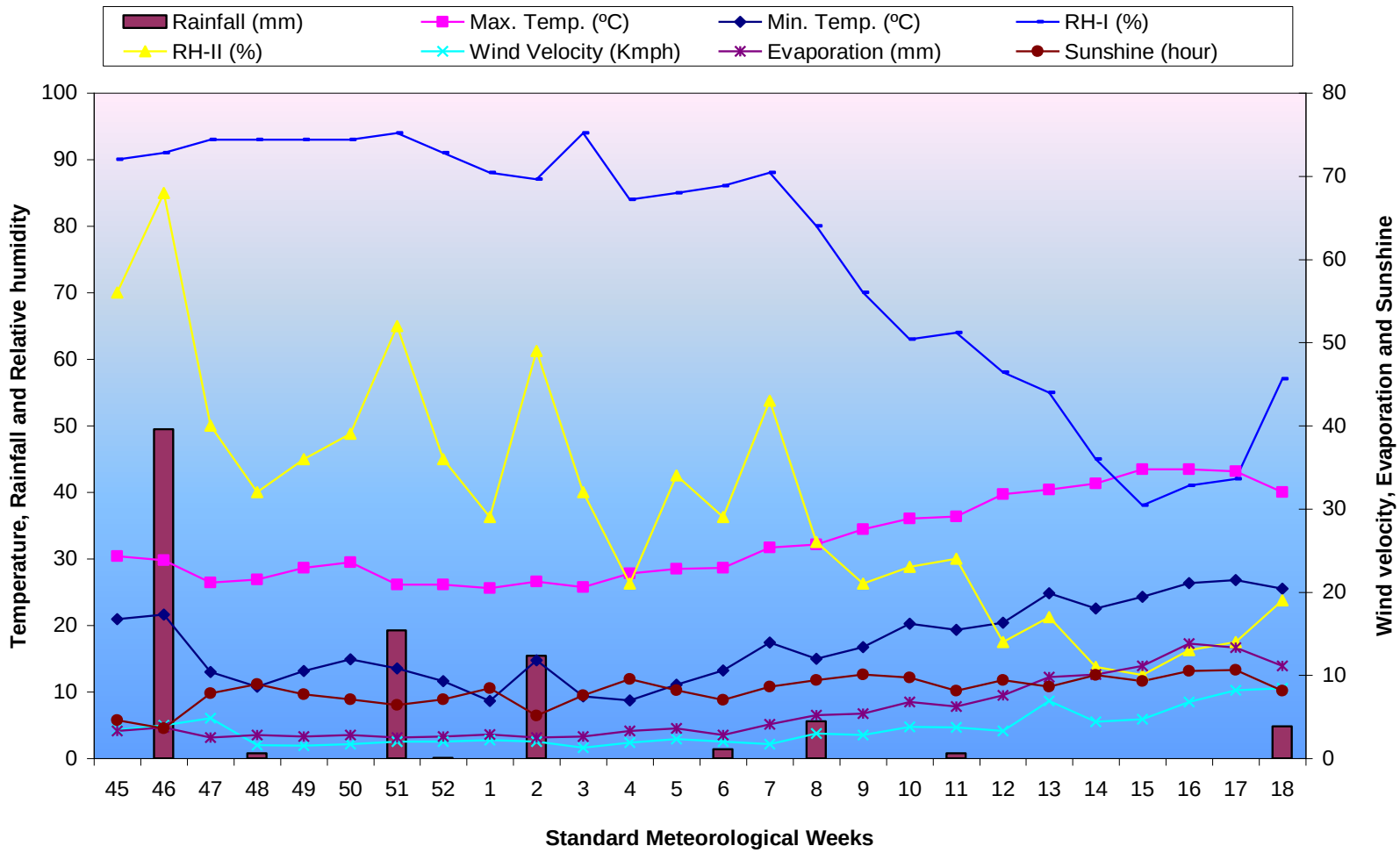

Fig.3.1: Weekly meteorological data during crop period of Tomato

Plate- I: Views of experimental field

Layout of field

Vegetative growth in treatment T3

Flowering in treatment T_3

Fruiting in treatment T_3

Staking of plants

Ripen fruits of treatment T_3

Plate-II: Layout, staking and growth stages of tomato