

**EFFECT OF FERTIGATION LEVELS IN CAPSICUM
(*Capsicum annuum* var. *grossum*) UNDER PROTECTED
CONDITIONS (POLYHOUSE)**

By

AJAYKUMAR SHAMARAOJI RAUT

Reg. No. 98098

A Thesis submitted to the

**MAHATMA PHULE KRISHI VIDYAPEETH,
RAHURI-413 722, DIST. AHMEDNAGAR,
MAHARASHTRA STATE (INDIA)**

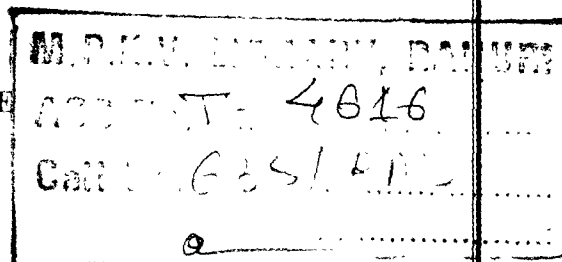
in partial fulfilment of the requirements for the degree

of

MASTER OF SCIENCE (AGRICULTURE)

in

HORTICULTURE



**DEPARTMENT OF HORTICULTURE,
POST GRADUATE INSTITUTE,
MAHATMA PHULE KRISHI VIDYAPEETH,
RAHURI-413 722. DIST. AHMEDNAGAR (M.S.)
INDIA.**

2001

MPKV LIBRARY



T04616

**EFFECT OF FERTIGATION LEVELS IN CAPSICUM
(*Capsicum annuum* var. *grossum*) UNDER PROTECTED
CONDITIONS (POLYHOUSE)**

By

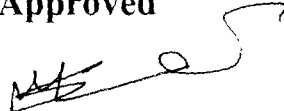
AJAYKUMAR SHAMARAOJI RAUT

Reg. No. 98098

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

in partial fulfilment of the requirements for the degree
of
MASTER OF SCIENCE (AGRICULTURE)
in
HORTICULTURE

Approved




(S. N. Ambad)

Chairman and Research Guide



(T. A. More)

Committee Member



(B. L. Lad)

Committee Member



(B. H. Khan)

Committee Member

**DEPARTMENT OF HORTICULTURE,
POST GRADUATE INSTITUTE,
MAHATMA PHULE KRISHI VIDYAPEETH,
RAHURI-413 722. DIST. AHMEDNAGAR(M.S.), INDIA.**

2001

CANDIDATE'S DECLARATION

I hereby declare that this thesis or part

thereof has not been submitted by

me or other person to any other

University or Institute

for a Degree or

Diploma.

Place : MPKV, Rahuri

Dated : 1st January, 2001

(**A. S. Raut**)

Dr. S.N. Ambad

Assistant Professor of Horticulture,
Plasticulture Development Centre,
Mahatma Phule Krishi Vidyapeeth,
Rahuri-413 722, Dist. Ahmednagar
Maharashtra State (India)

CERTIFICATE

This is to certify that the thesis entitled, “**EFFECT OF FERTIGATION LEVELS IN CAPSICUM (*Capsicum annuum* var. *grossum*) UNDER PROTECTED CONDITONS (POLYHOUSE)**” submitted to the Faculty of Agriculture, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar, Maharashtra State in partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE (AGRICULTURE)** in **HORTICULTURE**, embodies the results of a *bonafide* research work carried out by MR. **AJAYKUMAR SHAMARAOJI RAUT**, under my guidance and supervision and that no part of the thesis has been submitted for any other degree, diploma or publication.

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

Place : Rahuri,

Date : 1 January, 2001



(**S.N. Ambad**)

Research Guide

Dr. S.S. Kadam

Associate Dean,
Post Graduate Institute,
Mahatma Phule Krishi Vidyapeeth,
Rahuri-413 722, Dist. Ahmednagar
Maharashtra State (India)

IV

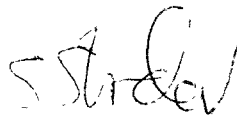
CERTIFICATE

This is to certify that the thesis entitled, “**EFFECT OF FERTIGATION LEVELS IN CAPSICUM (*Capsicum annuum* var. *grossum*) UNDER PROTECTED CONDITONS (POLYHOUSE)**”

submitted to the Faculty of Agriculture Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar, Maharashtra State in partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE (AGRICULTURE)** in **HORTICULTURE**, embodies the results of a *bonafide* research work carried out by **MR. AJAYKUMAR SHAMARAOJI RAUT**, under the guidance and supervision of **Dr. S. N. Ambad**, Assistant Professor of Horticulture, Plasticulture Development Centre, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar, Maharashtra State and that no part of the thesis has been submitted for any other degree, diploma or publication.

Place : Rahuri,

Date : January, 2001


(S. S. Kadam)

Associate Dean (PGI)

ACKNOWLEDGEMENTS

I avail this golden opportunity to express my sense of gratitude and indebtedness towards the man of golden heart and my honourable chairman of advisory committee Dr. S.N.Ambad, Assistant Professor of Horticulture, Plasticulture Development Centre, MPKV, Rahuri for suggestion of reeseach problem timely and inspiring guidance, constructive criticism and constant encouragement throughout the course of investigation and in the completion of thesis.

I am equally indebted to the members of my Advisory Committee, Dr. T.A. More, Head, Department of Horticulture, Dr. B.L. Lad, Professor of Botany and Dr.B.H. Khan, Associate Professor, Department of Agricultural Statistics for their constant encouragement and valuable suggestions during the span of this investigation and critically going throughout the manuscript.

I express my sincere thanks to Prof. M.C. Bankar, Principal Investigator, Plasticulture Development Centre, Dr. ASCAE, MPKV, ~~Rahuri~~ for providing me all sort of facilities for conducting the experiment.

I am also thankful to Dr. A.R. Karale, Dr. S.D. Warade, Dr. R.S. Patil, Dr. K.U. Sanghavi, Dr. K.G. Kadam, Prof. V.S. Supe, Prof. Bhalekar M.N., Dr. S.D. Masalkar, Prof A.B. Kamble, Prof. Dhakare, Prof. Sawant, Shri. Shelke and other staff members of Department of Horticulture and Shri. R.L. Takte, Shri. B.C. Dhawale, Shri. K.T. Thorat

and Shri. M.N. Gagare of Plasticulture Development Centre for their help rendered during the course of these studies.

I am thankful to Indian Council of Agriculture Research for giving me Junior Research Fellowship for prosecuting the higher study.

It gives me immense pleasure to express my heartfelt indebtedness to colleagues and friends who rendered direct or indirect help during the present investigation.

I think words with me are insufficient to express the feeling of my heart to acknowledge my parent for their hard job to educate me and shadowing me by showing their backs towards sun without which this work could not have seen the light of day at all. I am very much thankful to my sisters Archu Tai, Ranju and brother Vijay for heart warming affection, moral support and enlived my ability and evoked me to complete this task.

I also extend my thanks to Nilesh Computer Works, Mulanagar for neat and correct typing of the manuscript.

Place : Rahuri,

Date : 1st January, 2001

(Ajaykumar S. Raut)

LIST OF TABLES

Table No.	Title	Page No.
1	Chemical properties of the soil media	20
2	Treatment details	21
3	Quantity of fertilizer as per the crop growth stages	22
4	Effect of fertigation on height of plant	28
5	Effect of fertigation on number of leaves	29
6	Effect of fertigation on days to 50% flowering	29
7	Effect of fertigation on length of fruit	30
8	Effect of fertigation on diameter of fruit	31
9	Effect of fertigation on weight of fruit	32
10	Effect of fertigation on number of fruits/plant	33
11	Effect of fertigation on thickness of pericarp	33
12	Effect of fertigation on weight of seed	34
13	Effect of fertigation on weight of placenta	35
14	Effect of fertigation on weight and length of stalk	36
15	Effect of fertigation on yield per plant and per hectare	37
16	Cost of cultivation for capsicum in polyhouse	38
17	Cost economics of capsicum under polyhouse	39

LIST OF FIGURES

Figure	Title	Between page
1	Experimental layout	20-21
2	Plant height as influenced periodically by different water soluble fertilizer treatments	28-29
3	Number of leaves as influenced by different water soluble fertilizer treatments	29-30
4	Diameter of fruit as influenced by different water soluble fertilizer treatments	31-32
5	Weight of fruit as influenced by different water soluble fertilizer treatments	31-32
6a	Yield per plant as influenced by different water soluble fertilizer treatments	37-38
6b	Yield per hectare as influenced by different water soluble fertilizer treatments	37-38

LIST OF PLATES

Plate	Title	Between page
1	Experimental polyhouse	18-19
2	Crop stands in polyhouse	27-28
3	Fruit bearing in capsicum	37-38
4	Fruiting affected due to treatment T ₂	37-38

LIST OF ABBREVIATIONS

@	:	At the rate of
°C	:	Degree celcius
B:C	:	Benefit : Cost
C.D.	:	Critical difference
cm	:	Centimeter
CO ₂	:	Carbon dioxide
Conc.	:	Concentration
<i>et al.</i>	:	And others
etc.	:	Et cetra
Fig.	:	Figure
g	:	Gram
ha	:	hectare
i.e.	:	That is
kg	:	Kilogram
m	:	meter
m.ha	:	Million hectare
m.t.	:	Million tonnes
m ²	:	Square meter
mm	:	millimeter
ml	:	milliliter
NPK	:	Nitrogen: Phosphorus: Potash
%	:	Per cent
/	:	Per
pH	:	Negative logarithum of hydrogen ions
q	:	Quintal
Rs.	:	Rupees
S.E.	:	Standard error
sq.m.	:	Square meter
t	:	tonnes
viz.,	:	Namely
WSF	:	Water soluble fertilizer

T-4616

ABSTRACT

EFFECT OF FERTIGATION LEVELS IN CAPSICUM (*Capsicum annuum* var. *grossum*) UNDER PROTECTED CONDITIONS (POLYHOUSE)

By

RAUT AJAYKUMAR SHAMARAOJI

A candidate for the degree of

MASTER OF SCIENCE (AGRICULTURE)

in

HORTICULTURE

**MAHATMA PHULE KRISHI VIDYAPEETH,
RAHURI-413 722 (M.S.), INDIA.**

Research Guide	:	Dr. S.N. Ambad
Department	:	Horticulture

An experimental trial on capsicum was conducted to study “Effect of fertigation levels in capsicum (*Capsicum annuum* var. *grossum*) under protected conditions (polyhouse)” during January-October, 1999. The experiment was laid out in a Randomized Block Design with four (4) treatments and five (5) replications.

The results indicated that the yield obtained (107.26 t/ha) by application of 80 per cent of the recommended dose (280:32:416 kg NPK/ha) through water soluble fertilizer was found to be superior over the application of recommended dose through conventional fertilizer (82.48 t/ha) and it was at par with 100 per cent recommended dose through water soluble fertilizer. There was saving of fertilizer (NPK) to the extent of 20 per cent by application of water soluble fertilizer as compared to conventional method.

Contd...

The vegetative parameters of plant i.e. plant height (249.40 cm), number of leaves (872.80) were found to be superior by application of 80 per cent of the recommended dose through water soluble fertilizer over the application of conventional fertilizers.

Fruit characters like average length and average number of fruit were found to be non-significant in various fertigation treatments while highest diameter (8.13 cm) and weight (202.80 g) of fruit was found to be significantly superior in 80 per cent recommended dose through water soluble fertilizer than all other fertigation treatments.

Fruit quality parameters such as average thickness of pericarp and average weight of seed per fruit ^{were} not significantly affected by fertigation. But maximum average weight of placenta (15.41 g), weight of stalk (6.76 g) and length of stalk (4.10 cm) were highest in 80 per cent recommended dose through water soluble fertilizer and at par with 100 per cent recommended dose through water soluble fertilizers and significantly superior over other treatments.

The maximum net return ^{of} Rs. 1,18,650/- was obtained with application of 80 per cent recommended dose through water soluble fertilizer with benefit cost ratio 1.79:1.

Summing up the results it is recommended to apply 80 per cent recommended dose through water soluble fertilizers for capsicum under protected conditions (polyhouse) for better fruit characters, high yield and maximum net return.

X^{11a}

INTRODUCTION

1. INTRODUCTION

Attaining food security has been major challenge for the nation since independence. In order to meet demand of our increasing population growing at the rate of 1.8 per cent, we need 260-264 m.t. food grain in 2030. In addition 151-183 m.t. vegetables and 84-100 m.t. of fruit (Paroda, 2001) would be required to provide adequate nutrition to the population of 1.3 billion people.

The great impact of population explosion and rapid economic growth has aroused a concern about future situation on the earth. At present the world population is more than six billion. The efforts are being made to increase arable land but can't match the speed of urbanization.

In Maharashtra most of land lies in semi-arid tropics. The total geographical command area is 30.8 m.ha. out of which 20.32 m.ha is cultivable, total area under irrigation is 16.2 per cent (Anon., 1994) and may increase to it's maximum extend of 30 per cent reported in Barve Commission. So there is the limitation to increase the area under irrigation.

This emphasize the necessity of producing more food at an accelerated pace. The pressure will be further compounded in view of the shrinkage of arable land and depleting natural resource. To achieve the desirable changes there is need to implement effectively various technological options. Hi-tech agriculture can provide a solution to overcome this situation.

T-4616

- Cultivation in controlled atmosphere or protected cultivation of horticultural crops.
- Use of hybrid varieties.
- Efficient water management.
- Adoption of advanced techniques of cultivation.

The climatic requirement of crop viz., temperature, humidity, light, CO₂ concentration, radiation should be in permissible range of the crop to obtain higher yield. If crop is grown in adverse climatic conditions, yield may be reduced to a alarming low level. The atmospheric conditions cannot be controlled in open field conditions. The environmental factors can be controlled in protective cultivation and optimization of growing conditions enhance the production in multifold than open field conditions.

Polyhouses are widely used for crop production under controlled environment in temperate and arid region on commercial basis. It plays a vital role in increasing crop production and productivity worldwide.

In general the main purpose of growing horticultural crops in protective environment for production of high value crops, blemish free product, quality planting materials, easy to control pests and diseases, cultivation of tissue culture and ornamental species and gives high yield throughout the year.

More (1998) also stated the advantages of greenhouse. The greenhouse being categorically used to protect the crops from extreme high temperature, excessive rainfall, timely harvest as per demand and better quality of produce.

The use of polyhouses for commercial vegetable production and maximum net return has been most common in western countries (Chandra, 1985). It has been estimated that in India about 200 to 220 ha area is under greenhouse cultivation (Attavar, 1997). Maharashtra has the largest area under plasticulture and the technology is spreading to other states such as Madhya Pradesh, Rajasthan, Tamilnadu and Orissa (Peter, 1999).

In India, the demand for vegetables is 84 m.t. in year 2000 (Paroda, 2001). It is challenge to technology processes and resources of agricultural production to produce vegetable of several times to meet the need of fast increasing population. Greenhouse technology is relevant to such challenge.

Generally high value vegetable crops and ornamental plants of export orientation can be considered for growing in the greenhouses as cost of construction and maintenance at environmental factor is very high. Capsicum, tomato, cucumber among the vegetables and roses, gerbera, carnation, chrysanthemum, orchids among the ornamentals can be grown in greenhouse.

The capsicum genus is member of *Solanaceae* family. Sweet pepper is generally regarded as *Capsicum annuum* var. *grossum* fruit is seeded berry, large-smooth, thick flesh, blocky 3-4 lobed, square to rectangular colour usually green when immature, turning red at maturity and perfectly bell shaped at maturity in F₁ hybrids grown in polyhouse. Mostly fruit are not pungent. Bell pepper or Simla mirch (Syn. sweet pepper, *Capsicum*) is often looked upon as a luxury vegetable. Consumption being greater in and around cities. Bell pepper is an annual or short lived perennial herb upto 150-200 cm height. It has well developed tap root system with many lateral stem are branched erect often woody at the base.

Sweet pepper, green or red, may be eaten cooked or raw, sliced in salads, stuffed with sauteed pizza, meat loaf, dehydrated processed meat, potato and used for dressing of food. Its various forms are also used for pickling in brine with cucumber. It is cool season crop and is commercially grown in Himachal Pradesh, Punjab, hills of Uttar Pradesh, Maharashtra, Karnataka, parts of Madhya Pradesh, Bihar and Tamil Nadu during cooler part of the year. The exact requirement of crop make it impossible for successful cultivation during summer in the open field, so it fetch high prices during off season and almost throughout the year.

Fertigation is an essential component of pressurized irrigation. It is a process in which fertilizers are applied with water directly into the rootzone of the crop in which leaching and percolation losses are less and cause economy in the use of fertilizers and water to be applied. Fertilizers can be applied as and when necessary and with every rotation of water depending upon crop need. The past research conducted shows that by means of fertigation it is possible to save fertilizers upto 25 per cent (Kale, 1995).

The present status of *Capsicum* grown in plasticulture in India is negligible and it is a steps towards standardizing the production technology of *Capsicum* as a high value crop with good export potential. Taking into consideration the importance of hi-tech production of *Capsicum* trial was undertaken with following objectives :

1. To study of effect of water soluble fertilizers on fruit characters in *Capsicum*.
2. To study the production potential of *Capsicum* under protected conditions at Rahuri.
3. To study the cost : benefit ratio under protection condition.

4a

**REVIEW OF
LITERATURE**

2. REVIEW OF LITERATURE

Greenhouses are meant for the best quality production of vegetables, flowers and scented herbs worldwide. Early establishment in greenhouse production fetched remunerative price for capsicum up to Rs. 100-125 per kg. The attractive returns from capsicum encouraged many farmers to carry on the protected cultivation and it emerged as a first choice crop in greenhouse.

Fertigation refers to application of fertilizers through drip irrigation. In this method water soluble fertilizers are being applied to root zone of the crop. The availability and uptake of nutrients is much higher (80-90%) than conventional (18-30%) system of application. Nutrients directly reach to the rhizosphere in liquid form with least or no loss especially through leaching and volatilization. The major and minor nutrients are supplied through water solution. It gives better root absorption and consequently higher yield (10.30%) and good quality.

The literature available in this regard is discussed under proper sub-heading.

2.1 Vegetative growth

Effect of water soluble fertilizers on the vegetative growth of plant viz., plant height, number of leaves, days to 50% flowering were observed and reviewed as under.

2.1.1 Plant height

Singh and Singh (1978) reported that the rate of increase in plant height was faster upto 60-90 days after transplanting in tomato. Stroehlein and Oebkar (1979) observed moderate rate of nitrogen (100-150 kg/ha) trends to produce more height of pepper.

Rylski (1986) conducted an experiment on pepper under greenhouse and found that solar radiation was reduced throughout growth period and plant height was also increased. Kongsrud (1992) reported that in fertigation trial positive correlation between average shoot length and fertigation in apple.

Malfa (1993) conducted a greenhouse trial for vegetable production and concluded that higher temperature was negatively correlated with plant height in aubergine and tomato. Buczkowska (1994) observed that in typical polyethylene tunnel system, crop shows earliness and maximum plant height in capsicum, broccoli and aubergine than in field.

Shrivastava (1996) conducted an experiment on effect of different levels of fertilizer on capsicum and found that plant height was increased at the higher dose of fertilizers (250:200:200 kg/ha). The plant height in tomato was higher in 75 per cent recommended dose of fertilizers through liquid fertilizers as compared to surface irrigation method with 100 per cent band placement of fertilizers (Kartikayan, 2000).

2.1.2 Number of leaves

Daubenmire (1970) noticed that under drip irrigation, higher rate of photosynthesis and higher photosynthetic capacity of plant resulted in more number of leaves per plant. Stroehlein and Oebkar (1979) observed that

pepper plants with higher nitrogen (100-150 kg/ha) dose have high amount of foliage as compared to less nitrogen.

Gupta (1988) reported that in tomato under drip irrigation method number of leaves were more than furrow irrigation. Kadam (1990) in an experiment effect of different methods of irrigations on tomato observed that high leaf canopy was noticed in drip irrigation system.

In greenhouse, higher temperature is negatively correlated with leaves in tomato and brinjal (Malfa, 1993). Vasane (1995) concluded from his experiment that continuous and uniform supply of NPK through liquid fertilizer results in vigorous plant and leaf growth.

2.1.3 Days to 50% flowering

Stroehlein and Oebkar (1979) observed that higher rate of nitrogen delayed flowering by 4-5 day in pepper. Rylski *et al.* (1994) conducted an experiment on effect of temperature on vegetable crop in greenhouse and found that low temperature seriously affected flowering of tomato and capsicum with malformed flowers.

Buczowska (1994) reported that in many vegetable species flowering may be obtained earlier than the open field condition. Shrivastava (1996) in an experiment on effect of fertilizer dose of capsicum found delayed flowering in capsicum at higher dose of NPK (300:250:250 kg/ha).

2.2 Fruit characters

Various research workers carried out research to study the effect of fertigation on fruit characters of vegetable crops are reviewed below.

branches at two node. Kongsrud (1992) observed in fertigation effect on apple positive correlation between weight of fruit and fertigation.

In greenhouse cultivation of tomato, Malfa (1993) noticed that high temperature is negatively correlated with fruit weight of capsicum. Lorenzo and Castilla (1995) reported that in greenhouse condition higher fruit weight of capsicum was obtained at 3.2 plant/m² as compared to 2 plant/m².

Neary *et al.* (1995) reported that in sandy loam soil weight of capsicum fruit was positively responding to additional dose of fertilizer upto 230 kg/ha. Shrivastava (1996) carried out an experiment on effect of fertigation levels on cv. Bharat of capsicum and concluded that highest fruit weight (128 g) of capsicum was obtained in dose of 250:200:200 kg/ha in field trial.

2.2.3 Number of fruits

Adam *et al.* (1973) conducted an experiment on different methods of irrigation for tomato. They observed that drip method of irrigation gave maximum number of fruits as compared to conventional method of irrigation. Macraw and Grieg (1986) carried out an experiment on greenhouse in which number of fruits were increased due to pruning of capsicum.

In plastic greenhouse, 60 x 60 cm spacing and pruning of primary branches at two node achieved highest number of fruits of cucumber (More *et al.*, 1991). Dhake (1995) reported in tomato that highest number of fruits/plant were obtained under fertigation.

Vasane (1995) observed that uniform supply of NPK through fertigation to tomato crop resulted into maximum number of fruits due to vigorous vegetative growth. Shrivastava (1996) found in his experiment on

effects of different levels of fertigation on capsicum that highest number of fruits were recorded in plants treated with 250:200:200 kg/ha. Bracy *et al.* (1995) reported that more number of fruits were obtained by optimum dose of NPK through fertigation in pepper.

2.3 Quality and yield

A brief account of research work carried out to study the effect of fertigation on yield and quality of vegetable crops are given below.

Thomas and Heilman (1964) reported that in greenhouse nitrogen level of 500 ppm gave maximum yield in pepper. Aziz (1971) compared trickle method of irrigation with surface method and reported that average yield was 11.4 and 16.0 per cent due to drip irrigation in cabbage and melon, respectively.

Channappa (1979) reported 40 per cent increase in yield of tomato crop due to the fertigation over band placement. Miller *et al.* (1979) conducted an experiment on nutrient uptake especially 'N' in pepper and observed that nitrogen uptake was more in fruit development stage which improved the quality and yield of pepper. O'sullivan (1979) noticed that increase in irrigation with an application of fertilizer gave higher yield on account of better fruit set in capsicum.

Sivanappan (1979) evaluated furrow and drip irrigation with number of vegetables including okra. The results indicated that yield was increased 10-40 per cent under drip. Stroehlein and Oebkar (1979) noticed that each addition of nitrogen increased yield upto certain extent while P_2O_5 treatment had no effect in pepper.

Sivanappan and Padmakumari (1980) found in a fertigation experiment that in chilli yield was increased by 44 per cent due to fertigation through drip irrigation. Frequent irrigation and nitrogen gave quality capsicum with good yield in pepper (Batal and Smittle, 1981).

Cattleflis (1981) compared drip irrigation and sprinkler irrigation under greenhouse conditions and found that tomato gave higher yield with enhanced fruit quality due to fertigation through drip than sprinkler. Locascio *et al.* (1981) noticed that maximum yield obtained in pepper with split application of fertilizers than all preplant application.

Patil and Kale (1982) compared drip and furrow irrigation method for okra and reported that there was a water saving to the extent of 55.41 per cent and yield was increased by 10 per cent. Rudich *et al.* (1982) observed that with the help of fertigation through drip irrigation yield of tomato crop was extended upto 8 to 17 per cent.

O'Dell (1983) reported that tomato crop gave 40 per cent more yield by drip irrigation system than conventional method of irrigation. Rylski (1986) reported that in greenhouse solar radiation was reduced through out crop growth period of capsicum resultant in greater yield and top quality fruits.

Gorantiwar and Pampattiwar (1987) compared conventional furrow and improved drip method. The yield of cabbage was higher (16.94 t/ha) in drip irrigation than that of furrow irrigation (14.67 t/ha). Goyal (1988) observed in cultivation of sweet pepper that pepper response heavy yield in drip fertigation than conventional furrow method of irrigation.

Moshe Sne (1988) recommended the dose of 350:40:520 kg NPK/ha for capsicum under protected conditions.

Payero *et al.* (1990) observed that capsicum yield highest at the rate of 0-240 kg/ha and additional application of fertilizer decrease fruit yield. Thiagarajan (1990) reported that highest seed yield was obtained in capsicum with 140:35:00 and seed germination was 98%.

Aidy (1991) concluded from his study on cucumber that yield was significantly influenced by regular frequency of fertigation. Gowda (1991) concluded that fertigation beside saving labour also result in increased yield and improved the quality of many vegetable crops.

Gutal *et al.* (1991) compared drip irrigation with conventional irrigation and observed that yield of tomato crop in drip irrigation was much higher (48 t/ha) than conventional method (32 t/ha).

Madramootoo (1991) reported that fertigation with trickle irrigation not only increase fruit yield but also quality was improved in pepper. The research work conducted on different varieties of capsicum viz., California Wonder, Yellow Wonder and HW-Yello-Long, in greenhouse shows that California Wonder is best for cultivation in plastic greenhouse with average yield of 445 q/ha (Nimje and Shyam, 1991).

Rylski and Aloni (1991) reported that in capsicum at 8-10°C fruits were seedless and deformed where as at 18-20°C they were well shaped and contained approximately 150 seed/fruit. Ibrahim (1992) observed 40 per cent increase in yield of tomato through trickle irrigation and fertigation.

Papadopoulos (1992) suggested that fertigation properly used with trickle irrigation could help to increase crop yield and improve quality of vegetable crops under protected conditions. Rakh (1992) conducted experiment on cabbage crop to assess the effect of liquid fertilizer through drip. The result revealed that the liquid fertilizer treatments were superior in respect of yield and its components.

Bafna *et al.* (1993) observed in experiment of effect of different irrigation methods and nitrogen doses that nitrogen fertigation through drip gave 40-42 per cent more yield than conventional method. Golez *et al.* (1993) compared the different source of nitrogen fertilizer and its effect on pepper and observed that Ammonium sulphate gave highest yield than Ammonium nitrate and Urea.

Hartz *et al.* (1993) on experiment of different levels of fertilizer in pepper and noticed that highest fruit yield and quality was obtained in 252 kg N/ha and additional application of 'N' retard fruit yield. Kaul (1993) reported from greenhouse experiment that productivity of different vegetable and fruit crops was increased by 40-100 per cent as compared to field condition.

Nimje and Shyam (1993) conducted a trial under UV-stabilized plastic film covering pipe framed greenhouse indicated that capsicum gave significantly higher yield and was to the tune of 2.5 to 3 fold in greenhouse than open field condition.

Rylski *et al.* (1994) reported that flowering in greenhouse was affected by low temperature and increased fruit set but parthenocarpic fruit were maximum in capsicum. Kafkafi (1994) reported that with use of trickle

irrigation with liquid fertilizer yield of tomato and cucumber crop was increased.

Leonardi (1994) observed in greenhouse experiment that in plastic greenhouse increase in yield and advanced harvesting but had not deteriorate effect on fruit quality of capsicum. Monlerio (1994) concluded from his greenhouse study that with the help of fertigation in greenhouse quality and productivity of various vegetable crops can be improved.

Bracy *et al.* (1995) showed that nitrogen and irrigation rates had linear effect on fruit yield and quality of pepper. Neary *et al.* (1995) noticed that yield of bell pepper was good in response to the additional fertilizer upto (230 kg/ha) in sandy loam soil.

In okra, 75 per cent recommended dose of liquid fertilizer through drip irrigation showed better performance in respect of yield over conventional method. The increase in the yield was found to be 21.73 per cent over conventional dose (Anon., 1996^a).

In Maharashtra condition, yield of chilli in greenhouse is 4 to 4.5 time more than field condition (Anon., 1996^b). Shrivastava (1996) reported that in capsicum higher yield per plant (628 g) and yield per hectare (92.95 q) was observed in plant treated with 250:200:200 kg/ha fertigation.

Vasane *et al.* (1996) compared fertigation through different irrigation method at various levels found ^{and} that in tomato maximum yield (948 g) was recorded when 100 per cent recommended dose through liquid fertilizer were applied to drip irrigation. In greenhouse first fruit was picked earlier by 10-17

day than field and total and early fruit yield in tomato and capsicum was higher (More, 1997).

Griffin (1997) suggested the use of drip irrigation and liquid fertilizers for saving in operational cost and 20 per cent higher yield and quality as compared to the sprinkler irrigation in tomato. Capsicum yield in polyhouse was maximum in 2nd and 3rd planting as compared to 1st planting (Anon., 1997).

More (1997) studied vegetable production under controlled conditions and found fertigation system is adopted in greenhouse and analysis of irrigation water and soil is necessary. Drip irrigation system should be followed to reduce temperature and to increase the yield of vegetable crops.

Under Maharashtra condition, in polyhouse there was total 2 to 10 times increase in production over field condition due to optimization of environmental conditions and proper management. Maximum utilization of land and number of harvesting also increased (More, 1998).

Nafade (1998) reported that in India greenhouse cultivation of vegetable viz., tomato, capsicum, cucumber and okra enhanced the yield than outside conditions. Kartikayan (2000) carried out an experiment on fertigation through drip irrigation in which he found that application of liquid fertilizer through drip irrigation yield by 40 per cent and also leads to improvement in quality of tomato fruits.

2.4 Economics and returns

Padamakumari and Sivanappan (1987) conducted studies in brinjal and reported the improvement in cropping scheme with drip irrigation resulted in

an average net gain of Rs. 4711/ha against Rs. 3290/ha in conventional method. Yadav (1989) conducted an experiment on water optimization studies under drip, furrow and pitcher method of irrigation for watermelon in vertisol. He found the benefit : cost ratios of 2.87 and 1.92 in drip and furrow method of irrigation, respectively.

Aidy (1991) conducted an experiment on different vegetable sequence of vegetable crops and observed that best return value was from tunnel at cultivation of capsicum and cucumber and also found that tomato and pepper was best combination in production of net income.

Gutal *et al.* (1991) reported that in tomato drip irrigation and fertigation gave maximum (5.15) benefit:cost ratio in tomato than flood irrigation method (2.96). Abdou (1991) conducted studies in plastic greenhouse to ensure economic rationality to produce high value vegetable crops at least twice in a year.

Chandra and Majumdar (1993) found that high labour requirement per unit cultivable land was employed in greenhouse than field condition. Nimje *et al.* (1991) recommended that cropping sequence of capsicum-capsicum-okra in polyhouse gives maximum return per polyhouse and ^{was}so widely adopted.

Dutta (1993) noticed that capsicum-tomato-cucumber combination gave maximum benefit : cost ratio (1.86) which was much higher than other sequence. Yosef and Gan mor (1993) conducted experiment on labour requirement for tomato in polyouse and found that in greenhouse for fresh market labour requirement was 4-4.5 working days per tonne and for export purpose 5.2-5.9 working days per tonne.

Monlerio (1994) conducted survey of polyhouse cultivator and found that cultivators use cheap technology to reduce the investment and cost of production. More (1997) studied vegetable production under controlled conditions and found that it is possible to cultivate the capsicum through out the year and get maximum net profit.

Under Maharashtra condition, pepper gives 2-10 time increase in production as compare to field and also found to be more profitable than tomato and cucumber (More, 1998).

Tilekar (2000) carried out economic analysis at small size polyhouse with respect to capsicum and found that cultivation of red and yellow colour variety fetch better price and return (Rs. 136000/polyhouse) than green colour variety. Kartikayan (2000) conducted an experiment on fertigation on tomato yield of tomato increased by 40 per cent over surface irrigation having benefit : cost ratio of 2.65.

From the foregoing review it could be concluded that drip irrigation method result in better growth with higher production as compared to conventional method of irrigation.

The review of literature on effect of water soluble fertilizer amply brought out that water soluble fertilizer proved their superiority.

17a

**MATERIAL AND
METHODS**

3. MATERIAL AND METHODS

The experiment "Effect of fertigation levels in capsicum (*Capcicum annum* var. *grossum*) under protected conditions (polyhouse)" was conducted during January-October, 1999 at Plasticulture Development Centre, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar.

Rahuri comes under semi-arid plain zone of Maharashtra state. Geographically situated in subtropical zone. It lies on 19°24' N latitude and 27°31' E altitude. It is 657 m above the mean sea level. The average rainfall is 560 mm. The annual maximum temperature 42°C and minimum temperature is 8.7°C.

3.1 Materials

3.1.1 Polyhouse

Greenhouse is a framed or inflated structure covered with transparent or translucent material large enough to grow ^{crops} under partial or fully controlled environmental conditions to get optimum growth and productivity. Orientation of polyhouse is in North-South direction. The polyhouse was semi-circular at the top with partially controlled system (GH-2 type) in which air temperature and humidity is under control. The height of polyhouse is 4.5 m. The polyhouse is having area of 225 sq.m. The polyethylene film used for covering was 200 micron thick and ultra violet stabilizing. The drip system is installed to irrigate the crop ^(plate-1). Drippers were placed to each plant at recommended spacing of 50 cm. Polyhouse was provided with shading net and foggers to



Plate 1. Experimental polyhouse

protect the crop from excessive heat and controlled atmosphere comprising temperature and humidity, respectively.

3.1.2 Selection of variety

The variety grown was Dutch type viz. “Evident” procured from importing agency which was F₁ hybrid bred for polyhouse cultivation. Some important characters of the variety are as follows. It is having height of 1.5-2 m in polyhouse, fruit medium to large, red colour with perfect bell shape and having moderate shelf life and performing well under polyhouse.

3.1.3 Nursery details

In polyhouse, raised seed bed of size 3 x 1m² and 25 cm height were prepared. 10 kg FYM and 20 g Blitox per bed was applied and mixed well in soil. the seed of cv. Evident was sown on the raised bed with 10 cm distance between two successive rows.

After 10 days of germination Thimate (10% phorate) was applied @ 25 g/bed between row as a precautionary measure against insect pest. Recommended spray of Dithane M-45 (Mancozeb 2.5 g/l) and Monocrototophos (Nuvacron 1.5 ml/l of water) were given at an interval of 10 days to control disease and pest in nursery bed.

3.1.4 Media for growth

Soil based media was used for crop cultivation and made up of sieved sand, red soil and compost having proportion of 1:1:1 and a gunny bag of rice husk in each bed. The thorough mixing of these ingredients was done. The area was fully saturated a day before disinfection and actual disinfection was

done on next day. The formalin was applied @ 20 ml/l of water and 2 litre of solution per cu.ft. was pour into media. It was made air proof with black polythene covered on an media for 36 hours. It was perfect uniform tilth well leveled. A composite sample was prepared and soil analysis was conducted to test the chemical properly of the media and given in Table 1.

Table 1. Chemical propeties of the soil media.

Sr. No.	Characteristics	Compo-sition	Method adopted	Reference
	A. Chemical properties			
1.	Available nitrogen (kg ha ⁻¹)	354	Alkaline permagnate method	Subbiah and Asija (1956)
2.	Available phosphorus (kg ha ⁻¹)	6.3	0.5 m NaHCO ₃	Olsen (1954)
3.	Available potassium (kg ha ⁻¹)	1041.0	1 N NH ₄ OAC (Flame photometric)	Jackson (1973)
4.	Soil pH	7.7	Potentiometric	Jackson (1973)

3.2 Experimental details

Experiment was carried out during January 1999 to October 1999 having following details.

- I. Design : Randomized Block Design
- II. Treatments : Four (4)
- III. Replications : Five (5)
- IV. Plot size : 9 m x 1 m
- V. Crop spacing : 50 x 60 cm

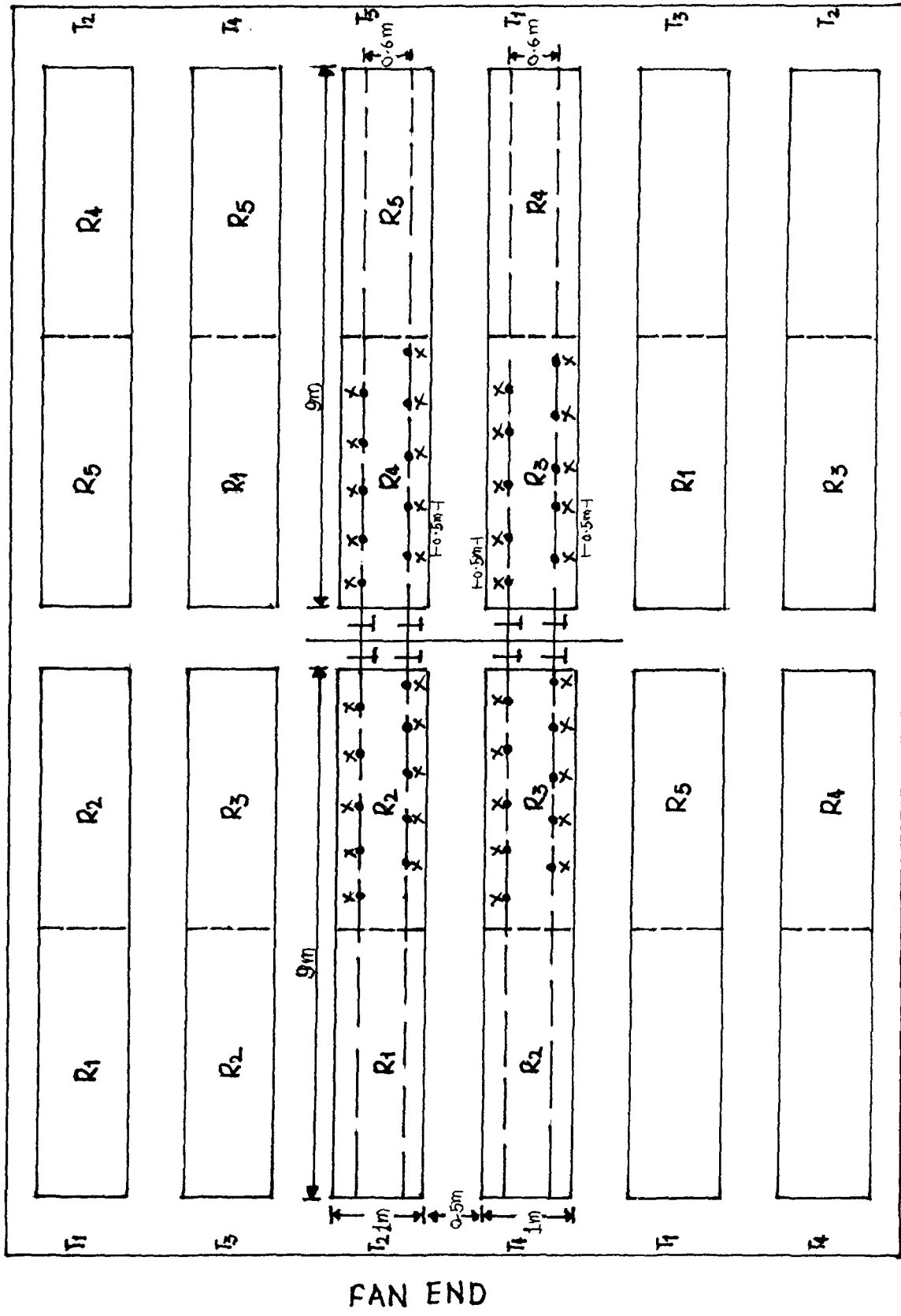


Fig1 Layout of experiment.

3.2.2 Treatment details

The standard dose of 350:40:520 kg NPK/ha was referred for studies and different levels of fertigation were subjected to test as treatments of fertigation and were as under (Table 2).

Table 2. Treatment details

Sr. No.	Treatment	Treatment details
1.	T ₁	60% recommended dose through water soluble fertilizer (210:24:312 kg/ha)
2.	T ₂	80% recommended dose through water soluble fertilizer (280:32:416 kg/ha)
3.	T ₃	100% recommended dose through water soluble fertilizer (350:40:520 kg/ha)
4.	T ₄	100% recommended dose through conventional fertilizer (350:40:520 kg/ha)

3.2.2 Fertilizer application

As per schedule of treatment (Table 3) the quantity of water soluble fertilizers were applied through drip irrigation and conventional fertilizers were as follows :

- 1) Water soluble fertilizer : Urea (46%), 12:6:8 and 0:0:51.
- 2) Conventional fertilizer : Urea, ammonium phosphate and muriate of potash

Table 3. Quantity of fertilizers as per the crop growth stage.

Sr. No.	Days	Grade	Quantity kg/ha/day	N	P	K
1.	1 to 30 (30 days)	12:6:18	1.0	3.6	1.8	5.4
2.	30 to 75 (45 days)	12:6:18	4.0	21.6	10.8	32.4
3.	75 to 105 (30 days)	0:0:51 + Urea	15.5 10.7	- 147.6	- -	237.15
4.	105 to 225 (120 days)	18:46:0 (DAP) + Urea + 0:0:51	0.5 3.0 4.0	10.8 166.32 -	27.6 - -	- - 244.8
			Total	349.92	40.2	519.75

3.2.3 Transplanting

Transplanting at one month old healthy seedling was done on 8-2-1999 at the spacing of 50 x 60 cm on raised bed. Placement of plant was zigzag. Each replication was having fifteen plants in R.B.D. with five replication.

3.2.4 Fertigation

Drip irrigation system was installed for application of water and fertilizer as per schedule (Table 3). Fertigation was done through water soluble fertilizers and with conventional fertilizer through soil in control throughout the cropping period. Water soluble fertilizers were applied at an alternate day and conventional fertilizer were applied at an interval of 15 days.

3.2.5 Cultural practices

Plants were trained vertically with the help of nylon thread. Primary stem was pinched off at one feet height and two secondary branches were promoted to grow, each secondary branches was having two vertical branches making four bearing stems. Nodal secondaries on bearing stem were pinched weekly.

Various interculture operations like weeding, earthing up, staking were done time to time. Plant protection measures were carried out as per the recommendation for protected cultivation.

The measurement of air temperature, humidity and solar radiation were noted twice in a day during the crop period (Appendix I).

3.3 Details of observations

Five plants were selected in each replication as observational plants to record the data on defined characters in research trial.

3.3.1 Growth observations

3.3.1.1 Height of plant (cm)

Average plant height was recorded at 30 days interval from the transplanting until the last harvesting from the ground level to tip of main stem with the help of meter scale.

3.3.1.2 Number of leaves/plant

Average number of leaves per plant were recorded from each treatment at the time of last harvesting.

3.3.1.3 Days to 50% flowering

Days to 50% flowering from date of transplanting were recorded and average number of days required for flowering for each treatment were worked out.

3.3.2 Fruit characters

3.3.2.1 Length of fruit (cm)

Longitudinal length of harvested fruit (cm) exclusive of stalk were measured with vernier caliper from observational plants and average value were presented in data.

3.3.2.2 Diameter of fruit (cm)

Horizontal diameter of harvested fruit (cm) was recorded from the centre of fruit with the help of vernier caliper and average value of diameter of fruit was presented in data.

3.3.2.3 Weight of fruit (g)

Harvested fruits from the observational plants were taken and weight was recorded of each fruit at every harvesting. Then sum total of weight of all fruits at each harvesting and divided by total number of fruits and compute the average weight of fruit.

3.3.2.4 Number of fruits/plant

From the observational plants total number of harvested fruits were recorded in each harvesting and then sum total of number of fruits were taken and presented in data.

3.3.3 Quality aspects

3.3.3.1 Thickness of pericarp (cm)

From observational plants harvested fruits were taken and average thickness of pericarp were recorded with the help of vernier caliper.

3.3.3.2 Weight of seed/fruit (g)

Harvested fruits from observational plants were taken seeds were extracted from each fruit and recorded the average weight of seed at two stages i.e. (1) fresh weight and (2) dry weight. Weight of seeds was recorded with the help of electronic weighing balance.

3.3.3.3 Weight of placenta (g)

From observational plants harvested fruits were taken and average weight of placenta was recorded with the help of electronic weighing balance.

3.3.3.4 Weight of stalk/fruit (g)

From observational plants fruits were harvested and stalk was taken off. The average weight of stalk was recorded with the help of electronic weighing balance.

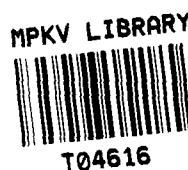
3.3.3.5 Length of stalk/fruit (cm)

From observational plants harvested fruits were taken and recorded average length of stalk was recorded using thread and meter scale.

3.3.4 Yield attributes

3.3.4.1 Yield per plant (g)

From the observational plants total yield was calculated by sum total of weight recorded at each harvesting.



T-4616

3.3.4.2 Yield per hectare (t)

Total yield per plot was calculated from total yield obtained per plant and then plot yield was converted into yield per hectare.

3.4 Statistical analysis

A standard method of statistical analysis suggested by Panse and Sukhatme (1984) was adopted for analysis of data recorded for various characters under study.

3.5 Economics

To work out the cost of cultivation of capsicum and benefit : cost ratio under protected condition.

The production cost of capsicum under polyhouse was worked out in each fertilizer treatment. The variable cost include planting material, soil media, sterilization, labour cost, supervision, plant protection, packaging and transport, treatmentwise fertilizer cost, and interest on working capital was considered.

Cost economics of capsicum under polyhouse was calculated by standard procedure of cost economics under polyhouse, given at National Seminar on Polyhouse organized by NCPA, at New Delhi, in 1999.

The gross monetary returns or total revenue was worked out by considering the yield from different treatments and the prevailing market price of the produce.

**EXPERIMENTAL
RESULTS**

4. EXPERIMENTAL RESULTS

An experiment, "Effect on fertigation levels in capsicum (*Capsicum annuum* var. *grossum*) under protected conditions (polyhouse)" was conducted during the year 1999 at Plasticulture Development Centre, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar. The present investigation include different aspects of study viz., to study the effect of water soluble fertilizer on fruit characters in capsicum, to study production potential of capsicum under protected conditions at Rahuri and to study cost benefit under protected conditions.

The results obtained during course of experiment are presented under suitable headings separately.

4.1 Height of plant (cm)

The data recorded on average height of plant is presented in Table 4 and illustrated in ^{Fig 2 and} ~~Plate 2~~. It is revealed that the average height of plant was significantly influenced by various treatments of fertigation. The average height of plant was significantly superior in T₂ (80% of recommended dose through WSF) at all the stages i.e. at 30, 60, 90, 120 and 150 days after planting. The maximum height of 249.40 cm was noticed in T₂ at last harvesting i.e. after 150 days after planting. The average height of plant was gradually decreased in T₃, T₁ and T₄. This character showed non-significance between T₁/T₄ and T₂ /T₃. The lowest height of 227.00 cm was recorded in T₄ i.e. 100% recommended dose through conventional fertilizers.

27a



Plate 2 . Crop stand in the polyhouse

Table 4. Effect of fertigation on height of plant.

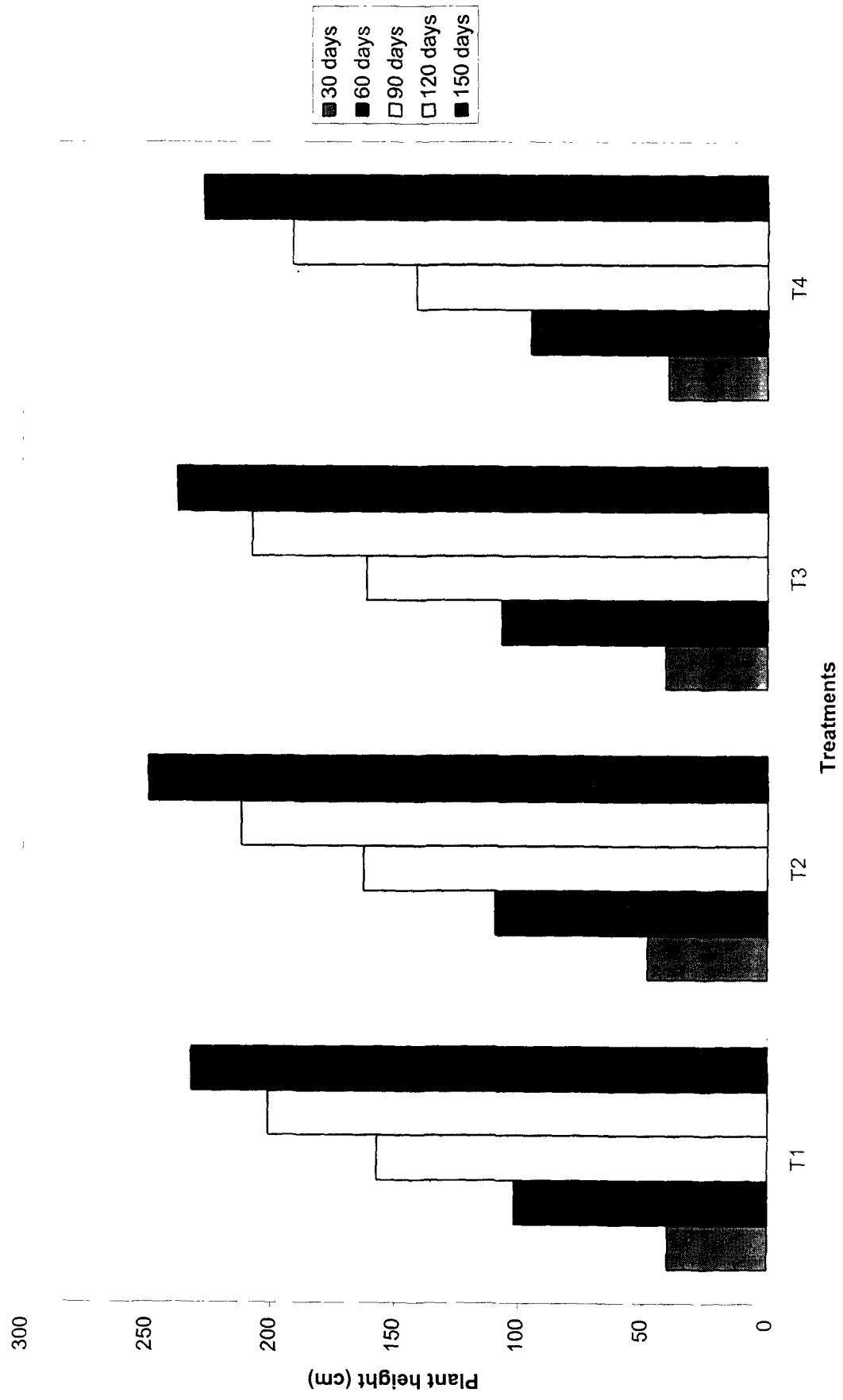
Sr. No.	Treatment	Treatment details	Plant height (cm)				
			30 days	60 days	90 days	120 days	150 days
1.	T ₁	60% recommended dose through water soluble fertilizer	39.80	101.60	157.20	201.40	232.20
2.	T ₂	80% recommended dose through water soluble fertilizer	48.00	109.40	162.60	212.20	249.40
3.	T ₃	100% recommended dose through water soluble fertilizer	40.80	106.80	161.40	207.80	237.80
4.	T ₄	100% recommended dose through conventional fertilizer	39.60	95.00	141.40	191.40	227.00
	S.E.±		1.91	2.19	4.95	6.13	5.12
	C.D. at 5%		5.90	6.77	15.28	17.28	15.79

4.2 Number of leaves/plant

The data pertaining to the average number of leaves per plant at the time of last harvesting was influenced by various water soluble fertilizers and are presented in Table 5 and illustrated in Fig. 3.

It is seen that average number of leaves were significantly higher in treatment T₂ and produced maximum (872.80) average number of leaves than treatment T₁ and T₄ while treatment T₃ was on par to the treatment T₂. The minimum number of leaves (836.20) was recorded in treatment T₄ i.e. control.

Fig. 2. Plant height as influenced periodically by different water soluble fertilizer treatments



In all the treatment effects of water soluble fertilizer, results were significant over conventional fertilizer.

Table 5. Effect of fertigation on number of leaves

Sr. No.	Treatment	Treatment details	Number of leaves
1.	T ₁	60% recommended dose through water soluble fertilizer	851.80
2.	T ₂	80% recommended dose through water soluble fertilizer	872.80
3.	T ₃	100% recommended dose through water soluble fertilizer	867.80
4.	T ₄	100% recommended dose through conventional fertilizer	836.20
	S.E.±		4.63
	C.D. at 5%		14.26

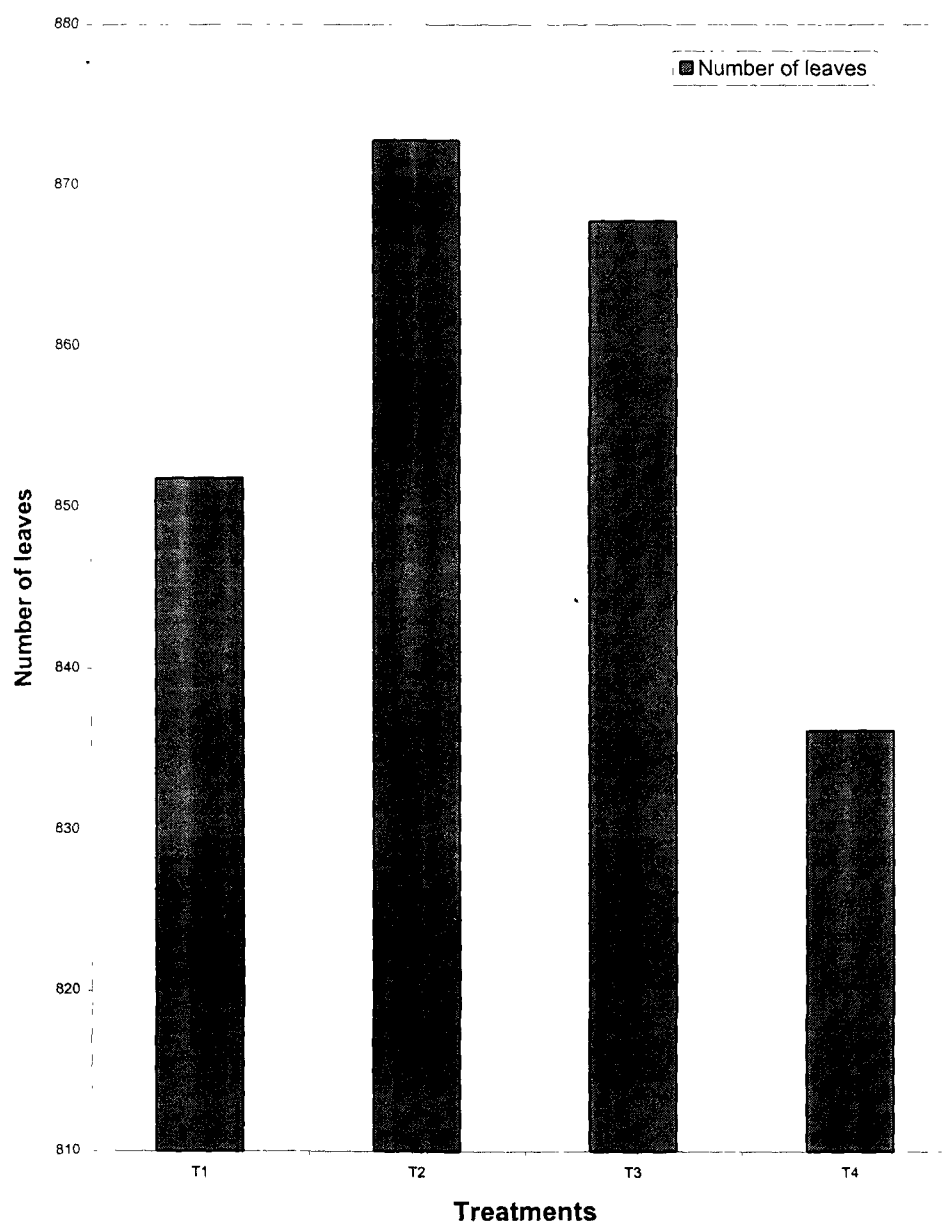
4.3 Days to 50% flowering

From the data recorded on average number of days required for 50% flowering in Table 6, indicated that the days to 50% flowering per plant was non-significant in all the treatments. The average days to 50% flowering were 46 days in T₂ (80% recommended dose through WSF) and 47 days in control.

Table 6. Effect of fertigation on days to 50% flowering

Sr. No.	Treatment	Days to 50% flowering
1.	T ₁	46.0
2.	T ₂	46.0
3.	T ₃	46.0
4.	T ₄	47.0
	S.E.±	0.289
	C.D. at 5%	N.S.

Fig. 3. Number of leaves as influenced by different water soluble fertilizer treatments



4.4 Length of fruit (cm)

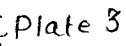
The data pertaining to average length of fruit at each harvesting was recorded and cumulative values were presented in Table 7.

The average length of fruit was maximum in T₂ (80% per cent recommended dose through WSF) and had average length (9.07 cm). This was followed by T₃ (100% recommended dose through WSF) recording (8.60 cm) of length and T₁ (60% recommended dose through WSF) 8.55 cm. In treatment T₄ i.e. control (100% recommended dose through conventional fertilizer) average length was lowest (8.35 cm). However, the difference in fruit length in various treatment was simple arithmetic and results were non-significant.

Table 7. Effect of fertigation on length of fruit

Sr. No.	Treatment	Length of fruit (cm)
1.	T ₁	8.55
2.	T ₂	9.07
3.	T ₃	8.60
4.	T ₄	8.35
	S.E.±	0.20
	C.D. at 5%	N.S.

4.5 Diameter of fruit (cm)

The data pertaining to the average diameter of fruits as influenced by various fertilizer treatment is presented in Table 8 and illustrated in Fig. 4. 

It is seen from the data that the average diameter of fruit was significantly influenced by water soluble fertilizers. In treatment T₂ (80% of recommended dose through WSF) maximum diameter of fruit (8.13 cm) was recorded, which was significantly superior over T₁ and T₄. In T₄ i.e. control (100% recommended dose of conventional fertilizers) average diameter of fruit recorded was (7.47 cm). T₂ and T₃ treatment was found to be statistically superior over the T₄. There was negligible difference in the values of T₂ and T₃ and were on par to each other.

Table 8. Effect of fertigation on diameter of fruit

Sr. No.	Treatment	Diameter of fruit (cm)
1.	T ₁	7.58
2.	T ₂	8.13
3.	T ₃	8.08
4.	T ₄	7.47
	S.E.±	0.09
	C.D. at 5%	0.30

4.6 Weight of fruit (g)

The data in respect of average weight of fruit per plant as influenced by various fertilizer doses was recorded at harvesting and presented in Table 9 and illustrated in Fig. 5.

It is observed from the data that average weight of fruit per plant was significantly influenced by fertigation. The highest weight of fruit was recorded in treatment T₂ (80% of recommended dose of fertilizer through

Fig. 4. Diameter of fruit as influenced by different water soluble fertilizer treatments

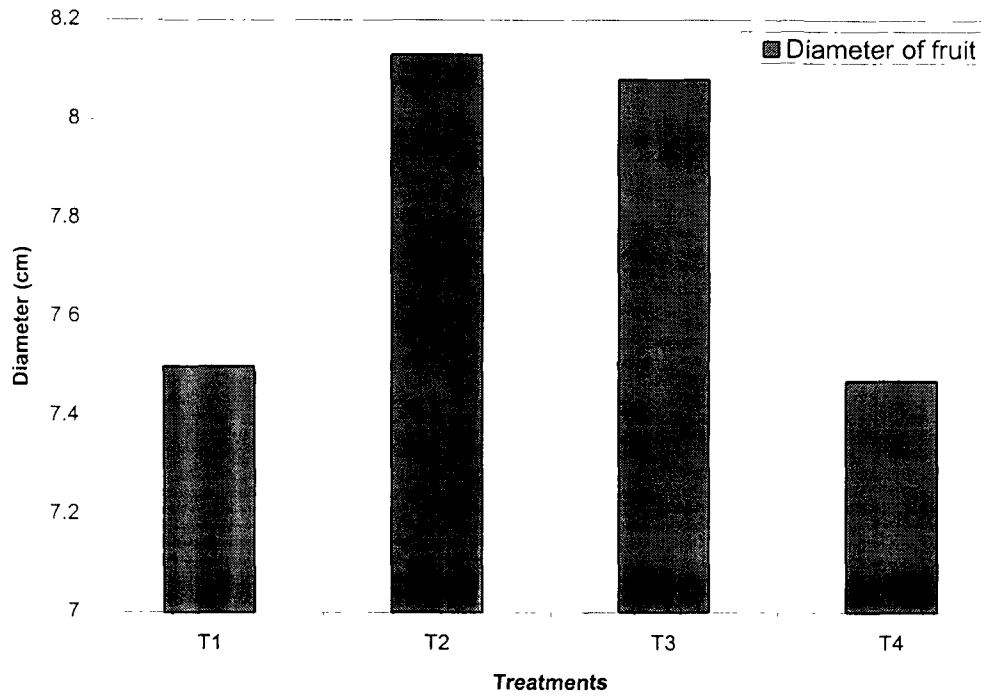
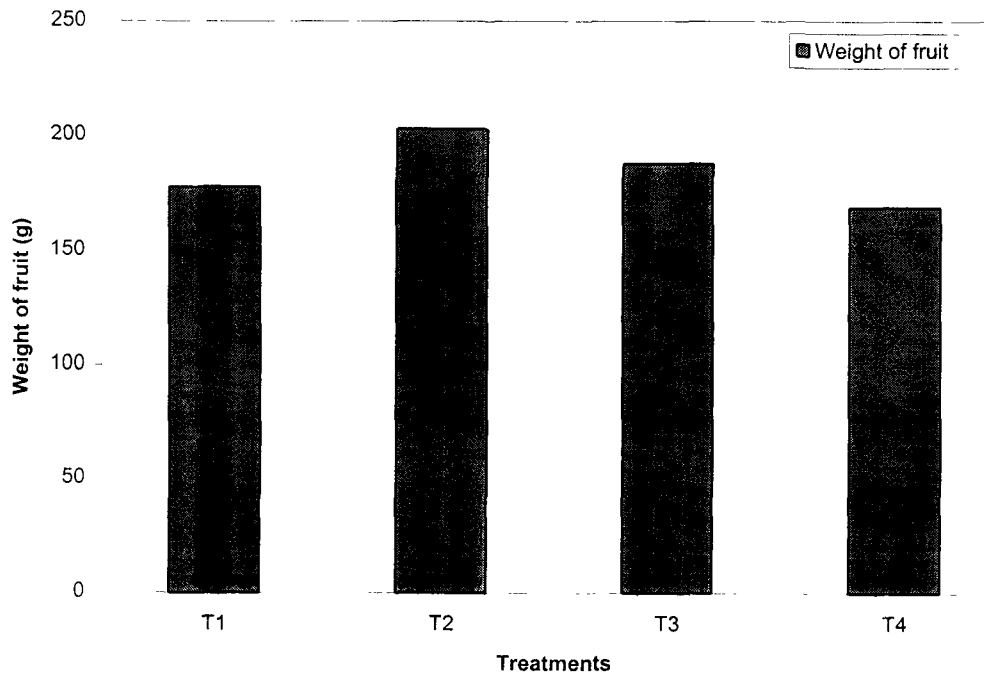


Fig. 5. Weight of fruit as influenced different water soluble fertilizer treatments



WSF) was 202.80 g. It is significantly higher than all other treatments. The minimum or lowest average weight of fruits per plant was recorded in control (169.00 g).

The effect due to water soluble fertilizers viz., T₁, T₂ and T₃ was superior over control.

Table 9. Effect of fertigation on weight of fruit

Sr. No.	Treatment	Weight of fruit (g)
1.	T ₁	177.55
2.	T ₂	202.80
3.	T ₃	187.70
4.	T ₄	169.00
	S.E.±	2.59
	C.D. at 5%	7.99

4.7 Number of fruits/plant

The data on average number of fruits per plant is presented in Table 10.

Number of fruits harvested at each harvesting were recorded and average total number of fruits per plant was noted. In treatment T₂ (80% of recommended dose through WSF) had highest average number of fruits per plant and was 15.86. This was followed by T₃ (100% of recommended dose through WSF) where number of fruits recorded were 15.66, T₁ (60% recommended dose through WSF) 14.99. In treatment T₄ i.e. control (100% of recommended dose through conventional fertilizer) average number of fruit

recorded were 14.60. Difference in average number of fruits per plant was simple arithmetic and results were non-significant.

Table 10. Effect of fertigation on number of fruits

Sr. No.	Treatment	Number of fruit/plant
1.	T ₁	14.99
2.	T ₂	15.86
3.	T ₃	15.66
4.	T ₄	14.60
	S.E.±	0.36
	C.D. at 5%	N.S.

4.8 Thickness of pericarp of fruit (cm)

The data in respect of average pericarp thickness of capsicum fruit as influenced by various treatments recorded on each harvesting is presented in Table 11.

Table 11. Effect of fertigation on thickness of pericarp

Sr. No.	Treatment	Thickness of pericarp (cm)
1.	T ₁	0.62
2.	T ₂	0.66
3.	T ₃	0.64
4.	T ₄	0.61
	S.E.±	0.01
	C.D. at 5%	N.S.

It is revealed from the data that the thickness of pericarp of fruit was not significantly influenced by water soluble fertilizer. In treatment T₂ (80% of recommended dose through WSF) had highest thickness of pericarp (0.66 cm). This was followed by T₃ (100% of recommended dose through WSF) (0.64 cm) and T₁ (80% recommended dose through WSF) (0.62 cm).

The minimum thickness of pericarp of fruits was recorded under treatment T₄ i.e. control, was (0.61 cm) (100% recommended dose through conventional fertilizers).

4.9 Weight of seed (g)

The data recorded on average weight of seed on fresh and dry basis was recorded on harvesting is presented in Table 12.

Table 12. Effect of fertigation on weight of seed

Sr. No.	Treatment	Weight of seed (g)	
		Fresh	Dry
1.	T ₁	1.46	0.98
2.	T ₂	1.96	1.12
3.	T ₃	1.36	0.82
4.	T ₄	1.31	0.79
	S.E.±	0.19	0.09
	C.D. at 5%	N.S.	N.S.

From the data it is observed that the average weight of seed on fresh and dry basis was highest in treatment T₂ (80% of recommended dose through

WSF) was (1.96 g) and (1.12 g), respectively. This was followed by T₁ (60% of recommended dose through WSF) and T₃ (100% of recommended dose through WSF) in both i.e. fresh and dry weight basis. In treatment T₄ i.e. control the average weight of seed was lowest at fresh and dry weight basis and was (1.31 g and 0.79 g) respectively. Difference in average weight of seeds per fruit in all the treatment was statistically non-significant.

4.10 Weight of placenta (g)

The data recorded on average weight of placenta of fruit on harvesting is presented in Table 13.

It is observed that average weight of placenta of fruit differed significantly due to application of various doses of water soluble fertilizers. The highest average weight of placenta (15.41 g) was recorded under treatment T₂ which was at par with T₃. The minimum weight of placenta (12.62 g) was recorded under treatment T₄ i.e. control, which is at par with treatment T₁ (12.92 g).

Table 13. Effect of fertigation on weight of placenta

Sr. No.	Treatment	Weight of placenta (g)
1.	T ₁	12.92
2.	T ₂	15.41
3.	T ₃	13.78
4.	T ₄	12.62
	S.E.±	0.63
	C.D. at 5%	1.95

4.11 Weight and length of stalk/fruit

The data pertaining to the average weight and length of stalk of fruit as influenced by various water soluble fertilizer treatment is presented in Table 14.

It is observed that average weight of stalk differed significantly due to various fertilizer treatment. The highest average weight of stalk recorded with treatment T₂ (6.76 g) which was at par with treatment T₃ (100% recommended dose through WSF) and significantly superior over rest of the treatments. T₁ treatment (60% recommended dose through WSF) being at par were proved significantly superior over T₄ i.e. control. The lowest weight of stalk (5.38 g) was observed in control.

The maximum length of stalk was recorded under treatment T₂ (4.10 cm) and was at par with treatment T₃. Both T₂ and T₃ treatment were found significantly superior over T₁ and T₄ i.e. control. The minimum length of stalk (3.55 cm) was observed in T₄ i.e. control.

Table 14. Effect of fertigation on weight and length of stalk

Sr. No.	Treatment	Weight of stalk (g)	Length of stalk (cm)
1.	T ₁	5.88	3.74
2.	T ₂	6.76	4.10
3.	T ₃	6.14	3.76
4.	T ₄	5.38	3.55
	S.E.±	0.22	0.06
	C.D. at 5%	0.68	0.20

4.12 Yield per plant and per hectare

The data pertaining to the average yield per plant and average yield per hectare given in Table 15 and illustrated in Fig. 6a and 6b.

The data reveals that the yield of capsicum per plant was significantly influenced due to water soluble fertilizer treatments. The maximum yield per plant (3218.00 g) recorded in treatment T₂. It is significantly higher than treatment T₁ and T₄, but at par with treatment T₃ (2940.60 g). The minimum yield per plant (2474.80 g) was recorded in T₄ i.e. control.

Similar trend was observed in yield per hectare. The maximum yield per hectare recorded in treatment T₂ (107.26 t) which is significantly higher than treatment T₁ and T₄, but at par with treatment T₃. The minimum yield per hectare (82.48 t) recorded in T₄ i.e. control.

Table 15. Effect of fertigation on yield of plant and yield per hectare

Sr. No.	Treatment	Yield/plant (g)	Yield/ha (t)
1.	T ₁	2663.00	88.87
2.	T ₂	3218.00	107.26
3.	T ₃	2940.60	98.01
4.	T ₄	2474.80	82.48
	S.E.±	128.82	4.30
	C.D. at 5%	397.07	13.25

37a



Plate 5. Fruit bearing in capsicum



Plate 4. Fruiting affected due to Treatment T₂

Fig. 6a. Yield per plant (g) as influenced by different water soluble fertilizer treatments

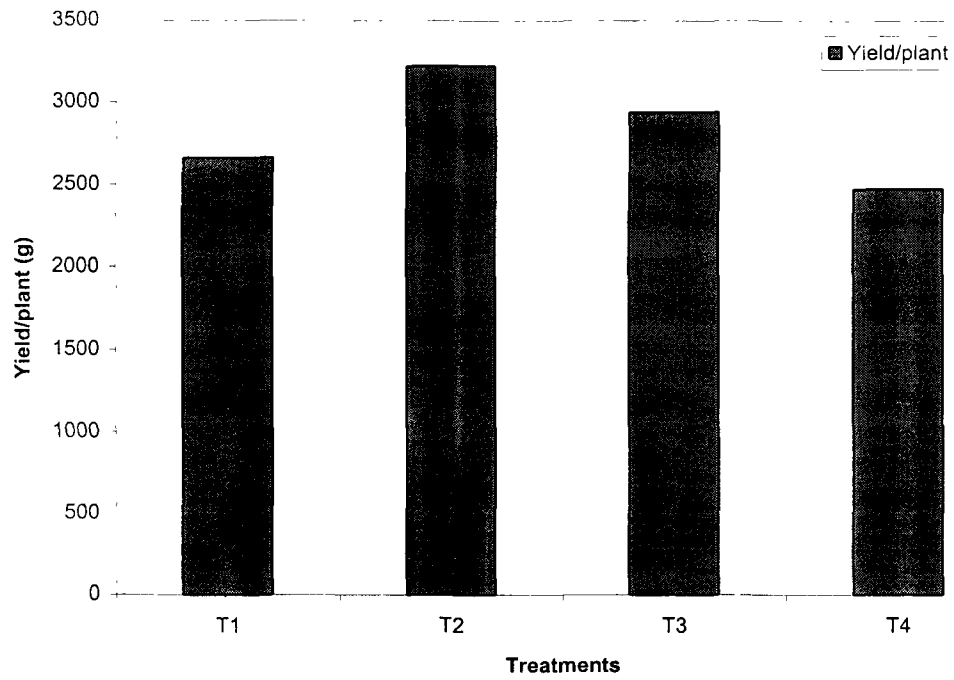
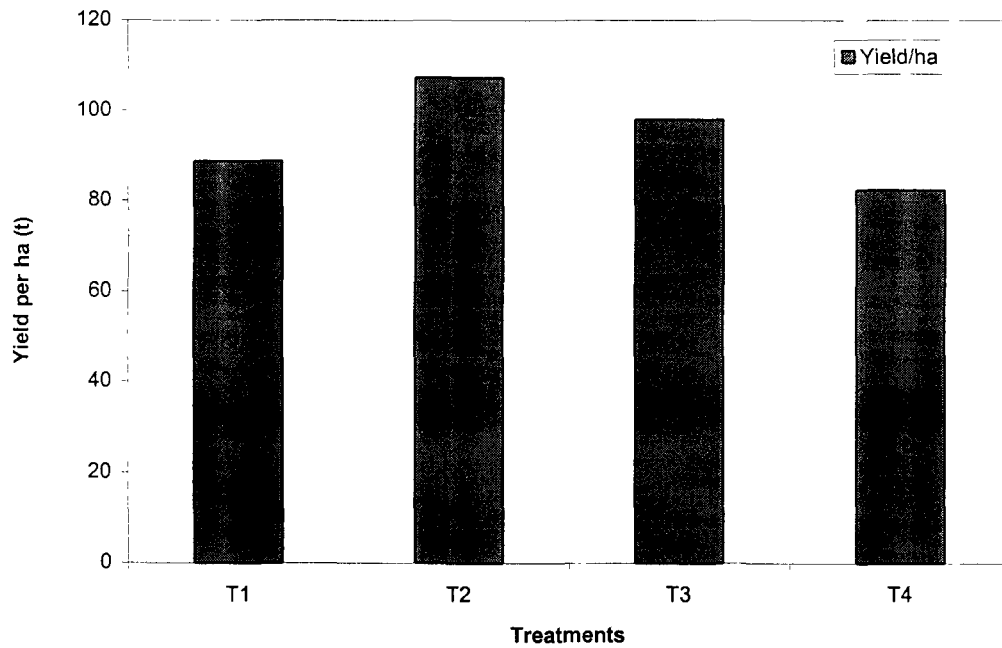


Fig. 6b. Yield per hectare as influenced by different water soluble fertilizer treatments



4.13 Economics

The data pertaining to ^{the} cost of cultivation of capsicum under protected conditions are presented in Table 16. The economic analysis under differs in term of benefit : cost (B:C) ratio, total revenue and net profit due to different water soluble fertilizer levels as compared to conventional fertilizer have been described in Table 17.

Table 16. Cost of cultivation for capsicum in polyhouse (500 sq.m.)

Sr. No.	Item	Quantity	T ₁ (60%)	T ₂ (80%)	T ₃ (100%)	T ₄ (100% conventional)
A) Production cost						
1.	Planting material	1389 @ Rs.5/-	6945/-	6945/-	6945/-	6945/-
2.	Media		5000/-	5000/-	5000/-	5000/-
3.	Soil sterilization		2000/-	2000/-	2000/-	2000/-
4.	Labour cost		25000/-	25000/-	25000/-	25000/-
5.	Supervision		40000/-	40000/-	40000/-	40000/-
6.	Regular insecticide, fungicide		5000/-	5000/-	5000/-	5000/-
7.	Fertilizers		1103/-	1470/-	1838/-	395/-
8.	Packaging and transport		19000/-	19000/-	19000/-	19000/-
9.	Interest on working capital @ 10%		10405/-	10441/-	10478/-	10334/-
			114453/-	114856/-	115261/-	113674/-

Table 17. Cost economics of capsicum under polyhouse (500 sq.m.)

Sr. No.	Particulars	Cost			
		T ₁	T ₂	T ₃	T ₄
1.	Fixed cost				
	(a) Cost of structure (Excluding cladding material)	360000/-	360000/-	360000/-	360000/-
	(b) Life of structure (years)	25 y	25 y	25 y	25 y
	(c) Depreciation (a/b) Rs.	14,400/-	14,400/-	14,400/-	14,400/-
	(d) Cost of cladding material	40,000/-	40,000/-	40,000/-	40,000/-
	(e) Life of cladding material (Years)	5 y	5 y	5 y	5 y
	(f) Depreciation (d/e) Rs.	8,000/-	8,000/-	8,000/-	8,000/-
2.	Repair and maintenance cost	8250/-	8250/-	8250/-	8250/-
3.	Interest rate $a \times 18\%$ $d \times 18\%$ ----- + ----- 25 5	4032/-	4032/-	4032/-	4032/-
4.	Total operational cost (Rs.) (1c+1f+2+3)	34682/-	34682/-	34682/-	34682/-
5.	Cost of cultivation	114453/-	114856/-	115261/-	113674/-
6.	Total cost of cultivation (4+5)	149135/-	149538/-	149943/-	148356/-
7.	Average yield of produce (kg)	2.66 kg x 1389 pl. = 3698.90	3.21 kg x 1389 pl. = 4469.80	2.94 kg x 1389 pl. = 4083.66	2.47 kg x 1389 pl. = 3436.38
8.	Average market price (Rs./kg)	60/-	60/-	60/-	60/-
9.	Revenue (Rs./polyhouse)	221934/-	268188/-	245020/-	206183/-
10.	Net profit/polyhouse (9-6)	72799/-	118650/-	95077/-	57827/-
11.	B:C ratio (9/6)	1.48	1.79	1.63	1.38

4.13.1 Cost of production

Data regarding cost of production under polyhouse reported in Table 17 shows that the maximum cost of production (Rs. 1,49,943/-) was recorded in treatment T₃ (100% at recommended dose through WSF) which was

followed by treatment T₂ (Rs. 1,49,538/-) and T₁ (Rs. 1,49,135/-). In case of treatment T₄ the cost of production was lowest (Rs. 1,48,356/-).

4.13.2 Revenue/polyhouse

The gross revenue differed due to various water soluble fertilizers was presented in Table 17. In treatment T₂ (80% of recommended dose WSF) the maximum gross revenue was observed (Rs. 2,68,188/-) and this was followed by treatment T₃ (Rs. 2,45,020/-) and T₁ (Rs. 2,21,934/-). Minimum gross revenue were observed to the extent of Rs. 2,06,183/- in treatment T₄ (100% recommended dose through conventional fertilizer).

4.13.3 Net profit and benefit : cost ratio

The data of net profit received from different fertigation treatments in polyhouse are presented in Table 17. The maximum net profit under polyhouse was observed in treatment T₂ (Rs. 1,18,650/-) subsequently followed by treatment T₃ (Rs. 95,077/-) and treatment T₁ (Rs. 72,799/-). In treatment T₄ the net profit was minimum (Rs. 57,827/-).

From Table 17 it is noted that the computed values of benefit : cost (B:C) ratio in various treatments were in range of 1.38 to 1.79. The lowest B:C ratio (1.38) was found in treatment T₄ (100% recommended dose through conventional fertilizer) while it was highest in treatment T₂ (1.79) i.e. 80% recommended dose through water soluble fertilizer.

40a

DISCUSSION

5. DISCUSSION

The present investigation “Effect of fertigation levels in capsicum (~~*Capsicum annuum* var. *grossum*~~) under protected conditions (polyhouse)” was carried out at Plasticulture Development Centre, Mahatma Phule Krishi Vidyapeeth, Rahuri, during January to October, 1999. The results obtained have been presented in previous chapter (IV) and discussed briefly under appropriate headings.

5.1 Vegetative growth

5.1.1 Plant height (cm)

Results are presented in Table 4 and illustrated in Fig. 2. The results showed treatment T₂ recorded maximum plant height at all the growth stages of plant this was followed by treatment T₃, T₁ and T₄. The increase in height with treatments of water soluble fertilizers in protected conditions appeared to be natural and represented throughout the growth period and at final stage of the crop the height of plant at T₂ (249.40 cm), T₃ (237.80 cm), T₁ (232.20 cm) and T₄ (227.00 cm) indicated gradual decrease towards control.

It is clear that water soluble fertilizers are applied in active root zone through fertigation and thus absorbed more efficiently as compared to conventional fertilizer. This might have resulted in an increase in plant height and overall growth of plant. Moreover WSF are supplied continuously and uniformly that was also a probable reason of getting better plant growth in all treatments. Similar results were obtained by Singh and Singh (1978) in bell pepper and Vasane (1995) in tomato. Higher dose of WSF in T₃ could not

gave highest values of height than T_2 and it may be due to negative effect of fertigation than the desired level of requirement of the plant. Similar findings were also found by Shrivastava (1996) in bell pepper and Kartikayan (2000) in tomato.

5.1.2 Number of leaves

The significant results obtained in respect of number of leaves per plant at the last harvesting presented in Table 5 and illustrated in Fig. 3 indicated that water soluble fertilizers were beneficial for increase in not only the plant height but also in the number of leaves per plants. The maximum number of leaves (872.80) was recorded in treatment T_2 and this was followed by treatment T_3 (867.80), T_1 (851.80) and T_4 (836.20).

Balanced supply of nutrients from the soil and availability of moisture at root zone make plant unable to produce higher biomass in term of number of leaves and height of the plant. Regular supply of nutrients and optimum climatic conditions in polyhouse was the net effect reflected in growth of the plant in T_2 . Any additional quantity of fertilizer than requirement of the plant could not produce unique significant increase in biomass therefore results in T_2 and T_3 was on par to each other. In control although 100% recommended dose applied through conventional fertilizers could not produce higher biomass because non-availability of nutrients in T_4 and only part of it was available to plant, noticed by Stroehlein and Oebkar (1979) in pepper, Gupta (1988) and Vasane (1995) in tomato.

5.1.3 Days to 50% flowering

Data regarding the days required for 50% flowering are presented in Table 6.

The data shows that in different treatments days to 50% flowering were at par and statistically similar to control. Stroehlein and Oebkar (1979) and Shrivastava (1996) in capsicum reported that 50% flowering were delayed in plants which received the higher level of fertilizer dose in open field. But in the case under study the plant did not show significant difference regarding days to 50% flowering. This may be due to controlled atmospheric condition which favour uniform flowering.

Flowering is caused due to the mobilization of food material from leaves to the economic part of the plant. Initiation of flowering does not need heavy mobilization of food material and flowering can be seen at low levels of food material hence result in 50% flowering were non-significant in all the treatments. The initial growth of plant is very well supported the initiation of flowering in all the treatments without any significant difference due to various levels of fertigation treatment noticed by Buczkowska (1994) in many vegetable crops.

5.2 Fruit characters

5.2.1 Diameter of fruit (cm)

The data regarding diameter of fruit is presented in Table 8 and illustrated in Fig. 4.

Diameter of fruit is a qualitative character of fruit and size of fruit also decided by diameter of fruit. The maximum diameter of fruit was recorded in T₂ and can be rightly correlated with production of biomass of treatment i.e. number of leaves and height of plant. The productive growth is supported by

biometric growth of plant and was appeared in T₂ and followed by other treatment with specific value of fruit diameter and biomass.

Treatment T₂ recorded highest fruit diameter (8.13 cm) followed by T₃ (8.08 cm) and T₁ (7.58 cm). All these treatments were significantly superior over T₄ i.e. control; however, treatment T₂ and T₃ were at par and statistically superior over T₁. In treatment T₂ (8.13 cm) maximum diameter was recorded and with further increase in fertilizer, diameter recorded found to be decreasing. This might be due to the fact that 80% of recommended dose of water soluble fertilizer is optimum due to frequent and timely application. Moreover, leaching losses; in fertigation are less and nutrient are applied in a active root zone. More or less similar trend of observation was recorded by Hartz *et al.* (1993), Neary *et al.* (1995) and Bracy *et al.* (1995) in capsicum.

5.2.2 Length of fruit (cm)

Data on average length of fruit per plant are presented in Table 7.

The data showed maximum (9.07 cm) length of fruit recorded in 80% of recommended dose through WSF followed by T₃ (8.60 cm), T₁ (8.55 cm) and T₄ (8.35 cm). From the data it is observed that there was no statistically significant difference however in general fertigation improved average length of fruit.

The size of fruit is decided by length and breadth (diameter) and there was significant effect of fertigation on diameter of fruit which gave better size fruit in T₂. It is not necessary that incremental growth should appear on both axis i.e. length and diameter of fruit. Hence, the results of length of fruit affected due to fertigation, was non-significant.

5.2.3 Weight of fruit (g)

Data regarding average weight of fruits per plant is presented in Table 9 and illustrated in Fig. 5.

The data showed that treatment T₂ (80% of recommended dose through WSF) was applied through water soluble fertilizers recorded highest average weight of fruit per plant (202.80 g) followed by T₃ (187.70 g), and T₁ (177.55 g). All these treatments were significantly superior over control. Moreover treatment T₂ was significantly superior over T₃ and T₁ similarly T₃ was superior over T₁. The increase in weight of fruit is due to increased diameter and length of fruit which was result of favourable effect of soluble fertilizer applied in active root zone and resulted in overall better growth of plant and ultimately in average weight of fruit per plant. Shrivastava (1996) recorded increase in weight of fruit per plant with increasing dose of fertilizer upto certain extent in capsicum. Kongsrud (1992) recorded increase in weight of fruit in apple with increased fertigation which confirms present findings.

5.2.4 Number of fruits/plant

Average number of fruits per plant are presented in Table 10, indicated highest average number of fruit per plant in treatment T₂ (15.86) where 80% of recommended dose fertilizer was applied through water soluble fertilizers, followed by T₃ (15.66), T₁ (14.99) and T₄ (14.60) where 100% conventional fertilizer were applied. The average number of fruits per plant in different treatments does not show significant difference however, in general fertigation improved average number of fruits per plants. There was no numeric significance in number of fruit per plant but significant difference was recorded in size of fruit and thereby having a significance in yield per plant.

5.3 Quality parameters

5.3.1 Thickness of pericarp (cm)

The data on thickness of pericarp per fruit recorded in Table 11 indicated that pericarp thickness did not influence by the fertigation treatments however in general thickness of pericarp was improved in fertigation treatment than control.

5.3.2 Weight of seed (g)

The data regarding fresh seed weight and dry seed weight is tabulated in Table 12. The data showed that weight of seed both fresh and dry basis was not significantly influenced by water soluble fertilizer treatment. But seed weight showed improvement through fertigation.

The ancillary character viz. thickness pericarp and weight of seed didn't show significance because the varieties bred for polyhouse cultivation bears either no seeds or a minimum quantity of seed. Hence, there was no variation in seed weight. The surface area in bigger fruit was naturally higher due to it's size but thickness of pericarp was unaffected due to fertigation as hardly there was any possibility to have a quantum difference in this varietal character. Hence the results were non-significant.

5.3.3 Weight of placenta (g)

Data on weight of placenta was presented in Table 13 indicated that average weight of placenta of fruit was significantly influenced by various water soluble fertilizer treatments. The highest placenta weight (15.41 g) was recorded in treatment T₂. It was at par with treatment T₃. The lowest minimum

weight of placenta (12.62 g) was recorded in 100% recommended dose through conventional fertilizer from the above discussion the fertigation significantly improved placenta and quality than conventional fertilizer this may be due to their direct relationship between weight of fruit and weight of placenta.

5.3.4 Length and weight of stalk/fruit

The data on average length and average weight of stalk presented in Table 14. The data indicated that highest length and weight of stalk recorded in treatment T₂ (4.10 cm, 6.76 g) was significantly superior over treatment T₃, T₁ and T₄, while treatment T₂ and T₃ was at par. The minimum weight of stalk (5.38 g) and length (3.55 g) was observed in treatment T₄. This might be due to efficient and easily availability of nutrient through fertigation at the time of stalk development i.e. fruit development.

Weight of placenta, length and weight of stalk was superior in T₂ as it was proportionately reflected due to overall size of fruit affected by various levels of fertigation. The fruits of maximum size and weight were recorded in T₂ to bear the fruit weight the stalk of fruit is always proportionate. The placenta also was comparatively bigger in this treatment. Same results reported by Griffin (1997) in tomato, Miller *et al.* (1979) in pepper; Batal and Smittle (1981) in pepper, Cattleflis (1981) in tomato, and Papadopoulos (1992) in many vegetable crops.

5.4 Yield

The yield/plant and per hectare was the highest (3218 g, 107.26 t/ha) respectively in treatment T₂ i.e. 80 per cent of recommended dose through

water soluble fertilizer and was at par with treatment T₃ (Table 15, Fig. 6a & 6b).

This indicated that the dose of 80 per cent recommended dose through water soluble fertilizer is sufficient for maximum yield in protected condition which showed that beside saving of 20 per cent of water soluble fertilizers yield increased by 8.5 per cent.

Yield per plant and per hectare is a net result of balanced nutrition, optimum climatic condition, increased biometric growth and mobilization of food material from vegetative part to the productive part of plant. In T₂ the diameter of fruit and length of fruit was higher, the ancillary fruit characters like placenta, pericarp were also maximum. Therefore the yield has cumulative effect of all these characters and was significantly superior over other treatments except T₃. Whereas the results are on par with T₂ indicating no positive effect due to additional dose of fertigation.

The similar results had been reported by Channappa (1979) in tomato, who observed that tomato yield significantly improved by 40 per cent with fertigation as compared to band placement. Sivanappan and Padmakumari (1980) also quoted the similar result in chilli and reported that availability of nutrients increased through drip irrigation which may reflected in yield by 44 per cent as compared to conventional method. Rudich *et al.* (1982) also recorded that increase in yield of tomato by 8-17 per cent with the help of fertigation. O'Dell (1983) also observed that in tomato fertigation not only save the fertilizer but also increased yield by 30-40 per cent.

Similar results were obtained by Aidy (1991) in cucumber, Goyal (1988) in tomato, Shrivastava (1996) in capsicum and Nafade (1999) in tomato.

5.5 Economics

The highest net profit (Rs. 1,18,650/-) were obtained in treatment T₂ i.e. 80 per cent recommended dose through water soluble fertilizer while benefit : cost ratio taken into consideration. It was highest (1.79) in same treatment i.e. treatment T₂ as compared to other treatments. As availability of straight fertilizer in market is easier and are relatively less costly than water soluble fertilizer. Among the water soluble fertilizer treatment, treatment T₂ (80% recommended dose through WSF) recorded maximum benefit : cost ratio however application of 80% of water soluble fertilizer will have definitely advantage over straight fertilizer in realizing higher yield and even though the water soluble fertilizer are costly than straight fertilizers they may be useful for plant growth and yield (Table 17).

The benefit : cost ratio in T₂ was maximum due to highest yield/ha. In the treatment at the same time there was also 20 per cent saving in fertigation. The 20 per cent saving in fertilizer in these treatment does not mean that the B : C ratio in T₁ should also be higher. There was not so because eventhough in T₁ the fertilizer applied were 20 per cent less than T₂ and 40 per cent less than recommended dose but yield was less. Hence the B : C ratio could not match to that of T₂. So the major contributing factor in higher B : C ratio is the highest yield achieved in T₂ and saving on account of fertilizer was just an intensive to have the maximum B : C ratio in the said treatment.

In present study the water soluble fertilizer applied through drip and results were encouraging. Nevertheless, recently it is shown that N, P_2O_5 and K_2O could be given through drip in the form of urea, phosphoric acid and muriate of potash are less expensive compared to water soluble fertilizer used under present study. In turn this may further increase the magnitude of net profit. Therefore, research on this line called for.

Summarized by the results, it is recommended to apply 80 per cent recommended dose through water soluble fertilizer through drip for capsicum under protected conditions for good plant growth, quality of fruit, high yield and net profit in polyhouse.

T-4616

50a

**SUMMARY AND
CONCLUSIONS**

6. SUMMARY AND CONCLUSIONS

The present investigation on “Effect of fertigation levels on capsicum (*Capsicum annuum* var. *gossium*) under protected conditions (Polyhouse)” was conducted during January to October, 1999 at Plasticulture Development Centre, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar.

The experiment was laid out in Randomised Block Design with four treatments and five replication.

Levels of fertilizer.

1. T₁ - 60 per cent recommended dose through water soluble fertilizer.
2. T₂ - 80 per cent recommended dose through water soluble fertilizer.
3. T₃ - 100 per cent recommended dose through water soluble fertilizer.
4. T₄ - 100 per cent recommended dose through conventional fertilizer.

Recommended dose of capsicum under polyhouse 350:40:520 kg/ha.

For an experimental study under polyhouse standard cultural practices such as pruning, staking, weeding and regular plant protection measures were adopted.

The media for plant growth is made up of sand : red soil : FYM in the proportional of 1:1:1 nutrient status of media was as under.

Sr. No.	Nutrient	Quantity (kg/ha)
1	Available nitrogen	354
2	Available phosphorus	6.3
3	Available potassium	1041

Media was slightly alkaline in reaction with pH 7.7.

The mean minimum and maximum temperature was in the range of 18.5°C to 29.8°C and the relative humidity 53.3 to 89.3 in polyhouse throughout the crop period.

The irrigation was given through drip irrigation.

The observations on biometric growth, fruit characters and yield were recorded. The results obtained in an experimental findings are summarized below.

Summary

A) Vegetative parameters

1) Plant height

The highest plant height is achieved in T₂ (80% recommended dose through water soluble fertilizer) at all growth stages of crop and final average plant height was 249.40 cm in T₂ least minimum plant height was recorded in control.

2) Number of leaves

The average number of leaves per plant were highest (872.80) in 80 per cent recommended dose through water soluble fertilizer and was

significantly superior over other treatment except 100 per cent recommended dose through water soluble fertilizer.

3) Days to 50% flowering

Days to 50% flowering were unaffected and there was no any significant difference due to fertigation over control.

B) Fruit characters

1) Length of fruit

The average length of fruit was not significantly affected due to any of fertigation levels.

2) Diameter and weight of fruit

The maximum average diameter (8.13 cm) and weight (202.80 g) of fruit was recorded from 80 per cent recorded dose through water soluble fertilizers and significantly superior over all other treatment.

3) Number of fruit/plant

The various levels of fertigation did not show any significant different on average number of fruits per plant.

C) Quality parameter

1) Thickness of pericarp

In this character none of the treatments showed its superiority and were on par to each other, although numerical value of pericarp thickness was highest (0.66 cm) in T₂.

2) Weight of seed/fruit

Average fresh weight and dry weight of seed per fruit did not significantly influenced by any of the treatment.

3) Weight of placenta

Average weight of placenta per fruit was highest (15.41 g) in T₂ (80 per cent recommended dose through water soluble fertilizers) and at par to that of 100 per cent recommended dose through water soluble fertilizer and significantly superior on rest of the treatments.

4) Weight and length of stalk

Treatment of 80 per cent recommended dose through water soluble fertilizer recorded highest average weight of stalk (6.76 g) and average length of stalk (4.10 cm) per fruit and significantly superior over other treatment except T₃.

D) Yield

The highest yield per plant (3218 g) was recorded from T₂ (80 per cent recommended dose through water soluble fertilizer) was at par to T₃ and significantly superior over other treatments. Similar trend was noticed in respect of yield per hectare.

Economics

The highest net income (Rs. 1,18,650/-) was obtained from 80 per cent recommended dose through water soluble fertilizers with benefit : cost ratio of (1.79) hence 80 per cent recommended dose through water soluble fertilizers

was found to be most remunerative and to get higher yield and return in capsicum under polyhouse conditions at Rahuri.

Conclusion

The application of water soluble fertilizer was found beneficial in improving vegetative growth, fruit characters and yield of capsicum.

Application of 80 per cent recommended dose (T_2 280:32:416 kg/ha) through water soluble fertilizer through drip was found to be best to increase the yield with superior fruit quality and saving of 20 per cent fertilizer was exhibited in this treatment as compared to conventional fertilizer.

These findings are based on one year data and hence need further confirmation.

55a

**LITERATURE
CITED**

7. LITERATURE CITED

- Abdou, A.T. (1991). Economics of greenhouse structures. Horticultural Production in Egypt. *Acta Horticulture*, 270:141-144.
- Adam, P., Winsor, G.W. and Donald, J.D. (1973). The effect of N, P and sub-irrigation on yield-quality and composition of single trass tomato. *J. Hort. Sci.* 48:123-133.
- Aidy, F.E. (1991). The advantage of using plastic cover on the production of some vegetable crops in the Northern Coastal region of Egypt. XI. *Inern. Cong. on the Plastics in Agricultue.* E. 13-19.
- Anonymous (1994). Ground water statistics, Central Water Board, Ministry of Water Resource, Government of India.
- Anonymous (1996^a). Use of liquid fertilizer through drip irrigation for different crops. Annual Progress Report, IWM, MPKV, Rahuri, pp. 21-24.
- Anonymous (1996^b). A report published by Chaitanya Grape Growers Co-operative Society, Palus, Dist. Sangli, Maharashtra.
- Anonymous (1997). *Shetkari Shikshan Mala*, Editeed by Shri. A.B. Patil.
- Attavar, Manmohan (1997). Relevance of greenhouse technology in India. *Proceedings of International Seminar on Protected Cultivation in India.* pp. 3-4.
- *Aziz, M.H. (1971). Trickle irrigation in Kuwait. Dept. Agri., State of Kuwait.

- Bafna, A.M., Daftardar, S.Y., Khade, K.K., Patil, P.V. and Dhotre, R.S. (1993). Utilization of nitrogen and water by tomato under drip irrigation system. *J. Water Management*. 1(1):1-5.
- Batal, K.M. and Smittle, D.A. (1981). Response of bell pepper to irrigation nitrogen and plant population. *J. Amer. Soc. Hort. Sci.* 106:259-262.
- Bracy, R.P., Edling, R.J. and Mosar, E.O. (1995). Drip irrigation management and fertilizer of bell pepper in humid area. *American Society of Agriculture Engineers*. pp. 181-186.
- Buczowska, H. (1994). Usefulness of slidable foil tunnel accelerated vegetative growing. *Acta Horticulture No. 371*, pp. 297-304.
- Cattleflis, M. (1981). Amount of water for drip irrigation of tomato under cover. *Acta Horticulture No. 119*, pp. 343-347.
- Chandra, P. (1985). Application of greenhouse technology. *Proceedings of Summer Institute on Greenhouse Design and Environmental Control. Technical Report, CIAE/ENT/85/35:A 21-31.*
- Chandra, P. and Majumdar, G. (1993). *Greenhouse Technology*. National conference on plastic in agriculture. 19-20 May, 1993, pp. 85-91.
- *Channappa, T.C. (1979). Drip irrigation increase water use efficiency. *Trans. Indian Soc. Desert Technol. and Univ. Centre of Desert Studies*, 4(1):15-21.
- Daubenmire, R.F. (1970). *Plants and environment. A text book of plant autecology*. Wiley Eastern Private Limited, New Dehli.

- Dhake, A.V. (1995). Studies on liquid fertilizer (NPK) application through drip irrigation to tomato in entisol. M.Sc.(Agri.) thesis, M.P.K.V., Rahuri (M.S.).
- Dutta, T. (1993). Protected cover cultivation for high humid region. National conference on plastic in agriculture, May 19-20, 1993, pp. 95-98.
- Gutal, G.B., Jadhav, S.S. and Chougule, A.A. (1991). Cost economics of the drip irrigation system for tomato crop. XI. International Congress on the Use of Plastics in Agriculture, pp. 171-176.
- *Golez, A., Dilc, M., Pudelski, T. (1993). Effect of fertilization with nitrogen on yield of capsicum grown in polyethylene bags. *Roczniki Akademic Rolniczej Poznanii agroclnichneae*. 21:21-26.
- Gorantiwar, S.D. and Pampattiwar, P.S. (1987). Response of cabbage crop to trickle irrigation method. Proc. of National Seminar on Drip and Sprinkler Irrigation Methods Adoption, held at MPAU, Rahuri, April 10-11, p. 142.
- Gowda, T. (1991). A brief review of drip irrigation in Karnataka. XI. International Congress on the Use of Plastic in Agriculture, B.131-147.
- Goyal, M.R. (1988). Tomato response to furrow, micro-sprinkler and drip irrigation. *American Socl. of Agri. Engineers*. 88-251, pp. 13.
- Griffin, R. (1997). Experience of twelve growers in row crops irrigations. Proc. International Agricultural Plastic Congress. April 11-16, pp. 197.
- Gupta, U.S. 1988. Progress in crop physiology. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

- Hartz, T.K., Legstrange, M. and Mary, D.M. (1993). Nitrogen requirement of drip irrigated pepper. Hort. Science, 18(11):1097-1099.
- *Ibrahim, A. (1992). Fertiliation and irrigation management for tomato production under arid condition. Egyptian J. Soil Sci. 32(1):81-96.
- Jackson, M.L. (1973). Soil chemical analysis. Prentice Hall of India Pvt. Ltd., New Delhi, pp. 113-124.
- Kadam, J.R. (1990). Evaluatin of soil water plant and atmospheric parameter in relation to furrow sprinkler and drip irrigation methods for tomato in vertisols. Ph.D. thesis, M.P.K.V., Rahuri (M.S.), India.
- *Kafkafi, U. (1994). Combined irrigation and fertilization in arid zone. Israel J. of Plant Sciences, 42(4): 301-320.
- Kale, S.S. (1995). Irrigation water and N fertilizer management through drip irrigation for brinjal (*Solanum melongena* L.) cv. Krishna on Entisols. M.Sc.(Agri.) thesis, M.P.K.V., Rahuri (M.S.), India.
- Kartikayan, Y. (2000). Effect of different combination of soluble NPK fertilizers through drip irrigation on the uptake of nutrient and yield and quality of tomato (cv. Dhanashree). M.Sc.(Agri.) thesis, M.P.K.V., Rahuri (M.S.), India.
- Kaul, G.L. (1993). Development of Horticulture a boost in the VII plan. Indian Horticulture, pp. 10-15.
- *Kongsrud, K.L. (1992). Effect of fertigation and soil covering with brown plastic for three apple cultivar. Norsk-Landbruksforskning. 6:4,401-412.

*Leonardi, C. (1994). Response of greenhouse pepper to minimum temperature. *Colture Protette*, 23(5):75-85.

Locascio, S.J., Fiskall, J.C.A. and Martin, F.G. (1981). Response of bell pepper to nitrogen source. *J. Amer. Soc. Hort. Sci.* 106:628-632.

Lorenzo, P. and Castilla, N. (1995). Bell pepper yield response to plant density and radiation in unheated plastic greenhouse. *Acta Horticulture No.* 412, pp. 330-334.

Macraw, B.D. and Greiq, J.K. (1986). Effect of transplant age and pruning procedure on yield and fruit set of bell pepper. *Hort. Science*, 21(b):430-431.

~~*Madramootoo, C.A.(1991). Effect of trickle irrigation on growth and sunscald of bell pepper. *Agriculture Water Management*, 19(2):181-189.~~

~~*Malfa, G.L. (1993). Comparative response of *Solanacea* to maximum temperature level in the green house. *Agricoltura Mediterranea* 123(3): 267-272.~~

Miller, C.H., McCollum, R.E. and Clarman, S. (1979). Relationships between growth of bell pepper (*Capsicum annuum* L.) and nutrient accumulation during ontogeny in field environment. *J. Amer. Soc. hort. Sci.* 104-852-857.

Monlerio, A.A. (1994). Outlooks of growing technique of greenhouse solanacea in winter climate. *Acta Horticulture No.* 366:21-32.

- More, T.A., Chandra, P., Majumdar, G. and Singh, J.K. (1991). Some observations on growing cucumber under plastic house. Proc. XI. Intern. Cong. on the Use of Plastics in Agriculture. F. 49-53.
- More, T.A. (1997). Greenhouse tantradnyan (Marathi) Ist Ed. Continental Publication, Vijaynagar, Pune-30, pp. 63-64.
- More, T.A. (1998). Cultivation of vegetable under greenhouse. Plasticulture technology training class, MPKV, Rahuri, pp. 4.
- Moshe, Sne. (1988). Fertigation, Published by Ministry of Agriculture, State of Israel, pp. 9.
- Nafade, A.S. (1998). Greenhouse technology. Shetkari Shikshan Mala, Greenhouse Technology, Spl. Issue, January, p.14.
- Neary, P.E., Storlie, C.A. and Paterson, M.A. (1995), Fertilizer requirement for drip irrigation of bell pepper grown in loamy sandy soil. Amer. Soci. of Agri. Engg. : 187-195.
- Nimje, P.M. and Shyam, N. (1991). Greenhouse as an alternate technology for commercial vegetable crop production. Indian Journal of Agril. Sciences, 61(3):185-189.
- Nimje, P.M., Wanjari, G.D. and Shyam, M. (1991). Greenhouse technology for vegetable crop production. Proc. XI International Congress on the Use of Plastics in Agriculture, F. 83.
- Nimje, P.M. and Shyam, M.(1993). Effect of plastic greenhouse in plant micro-climate and vegetable crop production. Farming System, 9(1-2):13-19.

- O'Dell, C. (1983). Trickle did the trick. *American Vegetable Grower*, 31(4):56.
- O'sullivan, I. (1979). Response of peppers to irrigation and nitrogen. *Can. J. Plant Sci.* 59:1085-1091.
- Olsen, R.A. (1954). Estimation of available phosphorus by extraction with sodium carbonate. U.S.D.A. Cir. 939.
- Padmakumari, O. and Sivanappan, R.K. (1987). Drip irrigation in brinjal, it's economics and adaptability in water scarcity area. *Madras agric. J.* 65(9): 608-609.
- Panse, V.G. and Sukhatme, P.V. (1984). *Statistical Methods for Agricultural Workers*, ICAR, New Delhi.
- Papadopoulos, L. (1992). Fertigation of vegetable in plastic house and present situation and future prospects. *Acta Horticulture*, 323:151-174.
- Paroda, R.S. (2001). Policy support for Agricultural Research is a must for a food secure in India. *Souvenir Indian Science Congress, 88th Session*, pp. 83.
- Patil, S.B. and Kale, S.R. (1982). Evaluation of drip irrigation for bhendi. Design Report submitted to M.P.K.V., Rahuri.
- Payero, J.O., Bhangoo, M.S. and Steiner, P.J. (1990). Nitrogen fertilizer management practices to enhance seed production by Anaheim Chilli pepper. *J. Amer. Soci. Hort. Sci.* 115:245-251.

- Peter, K.V. (1999). Plasticulture getting popularity in State. Floriculture Today, Vol. 3(10):40.
- Rakh, A.J. (1992). Efficiency of liquid fertilizer through drip and surface irrigation method in cabbage (*Brassica oleraceae* var. *capitata*) in Entisol. M.S. (Agri.) thesis, M.P.K.V., Rahuri.
- *Rudich, J., Sagir, B., Gesenberg, H. and Gerg, A. (1982), Response of processing tomatoes to nitrogen fertilization applied through trickle irrigation. Hassadch. 63(1): 52-56.
- Rylski, I. (1986). Improvement in pepper fruit quality and timing of harvest by shading under high solar radiation conditions. Acta Horticulture No. 191, pp. 221-228.
- Rylski, I. and Aloni, B. (1991). Parthenocarpic fruit set and development in *Cucurbitaceae* and *Solanaceae* under protected condition in mild winter climate. Acta Horticulture No. 287, pp. 117-126.
- Rylski, I., Aloni, B., Karnil, Zaidman, Z., Cockshull, K.E., Tuzel and Gul, A. (1994). Flowering, fruit set, fruit development and fruit quality under different environmental conditions in tomato and pepper crops. Acta Horticulture No. 366, pp. 45-55.
- Shrivastava, A.K. (1996). Effect of fertilizer levels and spacing on flowering, fruit set and yield of sweet pepper (*Capsicum annuum* var. *grossum*) cv. Bharat. Advances in Plant Sciences. 9(2):171-175.

- Singh, S.D. and Singh, P. (1978). Value of drip irrigation compared with conventional irrigation for vegetable crops in hot arid climate. *Agron.J.* 70:945-947.
- Sivanappan and Padmakumari, O. (1980). Drip irrigation. T.N.A.U. Coimbatore, SVND, Report 87:15.
- Sivanappan, R.K. (1979). Conservation of water energy in drip irrigation. 9th Intern. Congr. on Agril. Engg., U.S.A.
- Stroehlein, J.L. and Oebkar, N.F. (1979). Effects of nitrogen and phosphorus on yield and tissue analysis of chilli peppers. *Commun. Soil Sci. Plant Anal.* 10:551-563.
- Subhiah, B.V. and Asija, G.I. (1956). A rapid procedure for the determination of available 'N' in soil. *Curr. sci.* 25:259-260.
- *Sun, H.D., Park, S.K. and Kwon, Y.S. (1987). Effect of amount and intervals of irrigation on yield of hot pepper, raddish and chinease cabbage. Report on Rural Dev. Admin. Hort. Korea, Reupl. 29(1):24-29.
- Thiagarajan, C.P. (1990). Influence of NPK on the yield and quality of chilli seeds. *South Indian Horticulture*, 38(3):159-160.
- Thomas, J.R. and Heilman, M.D. (1964). Nitrogen and phosphorus content of leaf tissue in relation to sweet pepper yields. *J. Amer. Soc. Hort. Sci.* 85:419-425.
- Tilekar, S.N. (2000). Economic analysis of small size polyhouse studies of carnation and capsicum vegetable. Annual Report, Economics, M.P.K.V., Rahuri, pp. 131-134.

- Vasane, S.R. (1995). Studies on efficiency of liquid fertilizers (Grade 8:8:8) through drip irrigation in tomato during rabi season (cv. Dhanashree). M.Sc. (Agri.) thesis, M.P.K.V., Rahuri (M.S.), India.
- Vasane, S.R., Bhoi, P.G., Patil, A.S. and Tumbare, A.D. (1996). Effects of liquid fertilizer through drip irrigation on yield and NPK uptake of tomato. *J. Maharashtra agric. Univ.* 21(3):488-499.
- Yadav, S.S. (1989). Effect of soil moisture regime and levels of nitrogen on yield and quality of sunflower. M.Sc.(Agri.) thesis, M.P.K.V., Rahuri (M.S.), India.
- *Yosef, S. and Gan-Mor, S. (1993). Mechanization and work improvement in tomato greenhouse. *Hassadeh*, 74.3:335-338.

*** Originals not seen.**

65a

APPENDIX

8. APPENDIX

Appendix-I. Climatical data inside polyhouse during crop growth period

Sr. No.	Month	Temperature (°C)		Relative humidity (%)		Light intensity (Lux) X140			
		Min.	Max.	Min.	Max.	Inside polyhouse		Outside polyhouse	
						Min.	Max.	Min.	Max.
1.	Jan.	15.1	23.6	53.6	83.9	154.0	617.7	360.0	1045.5
2.	Feb.	18.5	24.0	61.6	89.3	150.6	506.3	328.3	997.0
3.	March	22.5	24.3	79.5	84.7	169.5	431.0	334.7	1285.2
4.	April	26.3	27.5	73.5	81.0	192.0	544.0	375.0	1383.2
5.	May	26.7	29.8	70.5	74.0	238.0	451.0	496.2	1144.2
6.	June	27.6	28.8	79.3	83.5	141.2	271.5	359.2	441.3
7.	July	24.8	27.8	83.5	87.7	52.6	129.8	192.0	328.4
8.	August	24.6	28.5	68.0	81.0	64.0	276.0	335.0	636.0
9.	Sept.	26.8	28.0	70.8	83.4	107.6	555.0	351.6	632.6
10.	Oct.	23.3	25.5	53.0	83.0	146.0	322.0	386.6	1063.0

66a

VITA

9. VITA

AJAYKUMAR SHAMARAOJI RAUT

A candidate for the degree
of
MASTER OF SCIENCE (AGRICULTURE)
in
Horticulture

Title of thesis : Effect of fertigation levels in capsicum
(*Capsicum annuum* var. *grossum*) in
protected condition (polyhouse).

Major field : Horticulture (Olericulture)

Biographical information

- **Personal** : Born at Nagpur city, Dist. Nagpur on 20th January,
1977. Son of Sau. Jijabai and Shri. Shamaraoji C.
Raut of Nagpur.

- **Educational** : Passed SSC Examination from Shri. Rajendra High
School, Mahal, Nagpur in 1992 with Ist class.
Passed HSC from Sh. S.M. Mohata College of
Science, Nagpur in 1994 with Ist class.
Received Bachelor of Science (Agri.) degree from
College of Agriculture, Nagpur, Dr. P.D.K.V. Akola
in 1998 with Ist class.

- **Scholarships/ Awards** : Recipient of Dr. P.D.K.V. University Merit
Scholarship during the Undergraduate studies
(1994-1998).
Indian Council of Agricultural Research, New Delhi
awarded Junior Research Fellowship during
Post Graduate studies (1998-2000).

- **Others** : Selected as "Agriculture Officer (Class II)"
through Agriculture, M.P.S.C. in 2000.

-x-x-x-x-x-



T-4616