RESPONSE OF VEGETABLE CHILLI cv. JWALASAKHI TO GRADED LEVELS OF N AND K UNDER VARYING SOIL MOISTURE LEVELS

BY

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THESIS
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Dedicated to my
beloved parents

DECLARATION

I hereby declare that this thesis entitled "Response of vegetable chilli cv.Jwalasakhi to graded levels of N and K under varying soil moisture levels" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title of this or any other University or Society.

Vellayani,
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CERTIFICATE

Certified that this thesis entitled "Response of vegetable chilli cv.Jwalasakhi to graded levels of N and K under varying soil moisture levels" is a bonafide record of research work done independently by Smt. Sherly,C.M, under my guidance and supervision and that this has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to her.

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LIST OF ABBREVIATIONS

g	gram
i	irrigation
l	litre
m	metre
q	quintal
t	tonnes
cm	centimetre
ha	hectare
kg	Kilogram
mg	milligram
mt	million tonne
Ep	Pan evaporation
K	potassium
M	manures
N	nitrogen
P	phosphorus
ET	Evapotranspiration
IW	Irrigation water
ASM	Available soil moisture
CPE	Cumulative pan evaporation
DAT	days after transplanting
DMP	Dry matter production
WUE	Water use efficiency

INTRODUCTION

1. INTRODUCTION

Ever increasing population and growing industrial development in the world coupled with increased standard of living have resulted in greater demand for food and water. The available land resources have almost reached a plateau in terms of availability. The only alternative to meet the food requirement of the growing population is to make maximum exploitation of land resources through intensive cultivation of crops which grow quickly and give high yield per unit area. The problem of water lies largely in conservation, management and efficient use of irrigation water. In India, only 40% of the total gross cultivated area is irrigated and by efficient use of irrigation water, area under irrigation can be increased.

Though our country has made substantial progress in the "Green Revolution" in respect of self-sufficiency in the production of cereals, it is quite evident that the minimum dietary needs of a common man have not been met so far. India is gifted with varied agroclimatic conditions for growing an array of vegetable crops to combat the present ill balanced diet. To meet the full dietary needs of the common man, to eliminate malnutrition, deficiency diseases and to relieve the over stress on cereals, there is greater need of vegetables. Considering the special relevance of vegetables in Indian diet, and the higher economics they possess, vegetable cultivation must be given the much deserving thrust.

As per the allowance recommendations a minimum vegetable supply of 284 g day^{-1} adult^{-1} is required (KAU, 1992). Hardly half of it is provided at present in our country. The annual requirement of vegetable at present is 52 mt. The low per capita consumption is mainly due to low production level of vegetable. Hence vegetable production needs to be augmented on a large scale.

Chilli (*Capsicum annum* L.) one of the most important solanaceous vegetable has got a prominent position among the minor crops of India. It is an indispensable adjunct to the diet of people. Chilli imparts pungency to culinary purpose and is used for adding red colour and seasoning. It is a rich source of vitamin C in its fresh state.

India is one of the leading producers of chilli accounting for about 50% of the world's share both in area and production. The principal chilli growing states in India are Andhra Pradesh, Maharashtra, Karnataka, Orissa and Tamilnadu which cover 75% of the country's area and production under this crop. Every homestead of Kerala has a small area occupied by this crop. Moreover, with the increase in population and demand, there is every need to step up the production of chillies. Recently, more attention is being paid to increase the production of vegetable chilli.

Jwalasakhi is a newly developed high yielding vegetable chilli variety by Kerala Agricultural University. It has resulted from a cross between Vellanotchi a popular local cultivar of Southern Kerala and Pusa Jwala. It is ideal for culinary purpose. The pungency is low and the vitamin C content is high. It is also ideal for high density planting.

Among the basic factors of agricultural productivity, adequate and timely supply of irrigation water and nutrients is crucial. Water being a scarce rescource, efficient use of available water has become extremely important. It is in this context that, the novel and the highly water saving irrigation methods viz, sprinkler and drip irrigation can be pressed into the irrigation practice and their advantage can be availed of. Trickle irrigation is the slow application of water on or beneath the soil surface by drip, subsurface and spray systems. Of this, drip irrigation is found to be efficient in reducing conveyance and application losses particularly in soil with high infiltration rates. Hardly any other new development in irrigation technique has met, in past few years, with as much interest as drip irrigation in the world (Ramesh, 1986). Several earlier studies in chilli (as out lined in chapter 2) have indicated the positive response of vegetable chillies to drip irrigation.

Chilli is a fertilizer responsive crop and it requires a good amount of nutrient supply. High rate of fertilizer is required for promoting vigorous growth and quality especially for the improved varieties (Saji John, 1989).

Water is key to plant growth. The full potentiality of fertilizer can be achieved when sufficient water is available in close proximity to root system. This can be achieved by drip irrigation with minimum labour requirement. Utilization efficiency of nutrients added is also high. However, the practice has not become popular, because of high initial cost and infrastructural facilities.

The nutrient requirements of vegetable chilli cv.Jwalasakhi have been worked out only under rainfed condition in Kerala. Its optimum nutrient requirement under varying levels of irrigation if worked out would be of great help to vegetable growers raising the crop during dry seasons in the suburbs of Thiruvananthapuram city where cultivation of this crop is gaining momentum.

In this study, besides evaluating the relative merits of drip and furrow irrigation, an attempt has been made to ascertain the possibilities of minimising the quantity of irrigation water and nutrients for optimum yield. For the above reasons, a field experiment entitled "Response of vegetable chilli cv. Jwalasakhi to graded levels of N and K under varying soil moisture levels" was carried out in red loam soils of the Instructional Farm, College of Agriculture, Vellayani, with the following objectives.

1. To find out the nutrient soil moisture interaction for yield maximisation of vegetable chilli cv.Jwalasakhi.

2. To work out the economics of different treatments.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

A review of salient research work done on the effect of different levels of nitrogen, potassium, drip and furrow irrigation on the growth, yield, quality, moisture characters and nutrient uptake in chilli is presented below.

2.1. Effect of Nitrogen

2.1.1. Effect on growth characters

2.1.1.1. Height of Plant

Joseph (1982) from his experiment on chilli for two seasons concluded that, incremental doses of nitrogen increased the height of plant at all the stages of growth in both the seasons. Increase in plant height in chilli with enhancement of nitrogen has been reported by Ramachandran and Subbiah (1982). Increase in level of nitrogen resulted in a sequential increase in plant height as noticed by Srinivas (1983). Sundstrom et al. (1984) observed that, plant height of tabasco pepper increased with increase in nitrogen rate from 0 to 112 $Kgha^{-1}$. According to Prabhakar et al. (1987) nitrogen application at the rate of 90 $Kgha^{-1}$ recorded the maximum plant height in chilli. Similar effects of nitrogen in chilli was also observed by Shukla et al. (1987); Kulvinder Singh and Srivastava (1988); Saji John (1989); Natarajan (1990); Nazeer Ahmed and Tanki (1991) and Pandey et al. (1992).

2.1.1.2. **Number of branches plant^{-1}**

Nitrogen application in chilli at 160 $Kgha^{-1}$ recorded the maximum number of branches as reported by Ramachandran and Subbiah (1981). Joseph (1982) noticed that branching in chilli was significantly increased by nitrogen application. Srinivas (1983) observed significant increase in number of branches per chilli plant with increase in nitrogen. Increase in number of branches with increased nitrogen application in chilli was also recorded by Paraminder Singh et al. (1986); Prabhakar et al. (1987); Kulvinder Singh and Srivastava (1988); Saji John (1989); Natarajan (1990); and Pandey et al. (1992).

2.1.1.3. **Dry matter production**

Joseph (1982) noticed an increase in total dry matter production in chillies due to application of nitrogen. A positive correlation between nitrogen application and total dry matter production in chilli was observed by Dod et al. (1983). Paraminder Singh et al. (1986) showed that, higher doses of nitrogen significantly increased the total weight of dry matter produced per plant of chilli. Hedge (1987) observed that, increase in nitrogen application increased the dry matter production in chilli through higher Leaf Area Index and Crop Growth Rate. Increased dry matter production with increase in nitrogen application in chilli was also noted by Manchanda and

Bhopal Singh (1987); Hedge (1988); Kulvinder Singh and Srivastava (1988); Hedge (1989); Saji John (1989) and Prabhakar and Naik (1993).

2.1.1.4. **Shoot-root ratio**

According to Leskovar et al. (1989), graded doses of nitrogen stimulated shoot and root growth. Saji John (1989) reported that, shoot-root ratio in chilli increased progressively with incremental doses of nitrogen.

2.1.1.5. **Spread of canopy**

Sundstrom et al. (1984) noticed that, canopy spread in chilli increased with nitrogen application from 0 to 112 $Kgha^{-1}$. Thomas and Leong (1984) observed that, increase in nitrogen application increases the foliar growth resulting in more canopy spread. Increase in nitrogen application enhanced the cell division and elongation in chilli resulting in more spread of canopy as reported by Nazeer Ahmed and Tanki (1991).

2.1.2. **Effect on moisture characters**

2.1.2.1. **Moisture distribution pattern**

Goyal et al. (1988) reported that, when nitrogen was applied at the rate of 15 g per plant, more than 80% of chilli roots are concentrated in 0-22 cm soil depth. This depth corresponds to the wetting zone by the dripper and, there is more uptake of nitrogen which in turn increased the distribution of roots.

2.1.2.2. Water use efficiency

Hegde (1988) observed that, nitrogen application in chilli at the rate of 120 $Kgha^{-1}$ increased the WUE by 96% over control. Palled et al. (1988) noted an increase in WUE in chilli with increase in nitrogen application. Hegde (1989) noticed that, there was significant increase in WUE with increase in nitrogen application. Prabhakar and Naik (1993) found that, nitrogen at the rate of 180 Kg ha^{-1} recorded maximum WUE of 28 $qha^{-1}cm^{-1}$ while in control it was only 12.4 $qha^{-1}cm^{-1}$.

2.1.3. Effect on yield attributes and yield

2.1.3.1. Time of 50% flowering

Rao and Gulshanlal (1986) noted a significant increase in the number of days to 50% flowering with the increased levels of nitrogen upto 150 $Kgha^{-1}$. Saji John (1989) pointed out that, time taken for 50% flowering significantly delayed with graded levels of nitrogen. Plants with 125 $Kgha^{-1}$ nitrogen took about 36 days while that with 75 $Kgha^{-1}$ took only 32 days for 50% flowering. Subhani et al. (1990) reported that, 120 $Kgha^{-1}$ nitrogen recorded minimum time for 50% flowering.

2.1.3.2. **Number of flowers plant^{-1}**

Splittstosser and Gerber (1986) found that number of flowers plant^{-1} increased with increased dose of nitrogen. Kulvinder Singh and Srivastava (1988) reported that, number of flowers plant^{-1} increased with increase in nitrogen application upto 120 Kgha^{-1}. According to Saji John (1989), maximum flower production was obtained with 100 Kg nitrogen hectare^{-1}.

2.1.3.3. **Number of fruits plant^{-1}**

Ramachandran and Subbiah (1981) shown that, number of fruits plant^{-1} increased with increasing nitrogen upto 120 Kgha^{-1}. Number of fruits plant^{-1} was highest with 120 Kg nitrogen hectare^{-1} (Joseph, 1982). Shukla et al. (1987) reported that, number of fruits plant^{-1} was significantly influenced by varying levels of nitrogen. Similar results were noted by Kulvinder Singh and Srivastava (1988); Saji John (1989); Natarajan (1990); Nazeer Ahmed and Tanki (1991); Ajay Kumar and Thakral (1993); Lata and Singh (1993) and Prabhakar and Naik (1993).

2.1.3.4. **Setting percentage of fruit**

Significant increase in setting percentage by the application of graded doses of nitrogen as reported by Joseph (1982). Splittstoesser and Gerber (1986) observed an increasing trend in setting percentage by the application of higher doses of nitrogen. According to Kulvinder Singh and Srivastava (1988), increase in nitrogen application increases the setting percentage of fruit. Similar results were noted by Goyal et al. (1989) and Saji John (1989).

2.1.3.5.**100 fruit weight**

Weight of 100 fruits was increased by graded doses of nitrogen (Ramachandran and Subbiah, 1981). Joseph (1982) observed that, the weight of 100 fruits increased significantly with increased doses of nitrogen. Similar effect were reported by Goyal et al. (1989), Saji John (1989) and Nazeer Ahmed and Tanki (1991).

2.1.3.6.**Total yield of chilli**

Ramachandran and Subbiah (1981) observed significant increase in the yield of dry fruits with the application of higher doses of nitrogen. Srinivas and Prabhakar (1982) reported that mean fruit yield was 111.3 qha^{-1} by the application of 150 Kg nitrogen $hectare^{-1}$ while in control it was only 25.71 qha^{-1}. According to Srinivas (1983), increase in nitrogen application increases the yield of chilli. Ahmed (1984) reported that, highest yield was obtained by the application of 80 Kg nitrogen $hectare^{-1}$. Narasappa et al. (1985) observed that, application of 150 $Kgha^{-1}$ nitrogen recorded maximum yield of 17.07 qha^{-1}. Application of nitrogen fertilizer five times from anthesis to harvest increased yield by 167 to 232% over those of control plants (Song, 1987). Nitrogen fertilization upto 120 $Kgha^{-1}$ increased the yield by 119% over control (Hegde, 1988). Shibhila Mary and Balakrishnan (1990) reported that, increase in nitrogen application increases the yield of chilli. Similar results were reported by Thiagarajan (1990); Jayaraman and Balasubramanian (1991); Nazeer Ahmed and Tanki (1991); Pandey et al. (1992); Prabhakar and Naik (1993); Subbiah (1993) and Gulati et al. (1995).

2.1.4. Effect on ascorbic acid content of fruits

Joseph (1982) observed that incremental doses of nitrogen significantly increased the ascorbic acid content of fruits. Dod et al. (1983) reported profound effect of nitrogen fertilization on the ascorbic acid content of fruits. Ascorbic acid content was increased by nitrogen application (Thomas and Leong, 1984). Paraminder Singh et al. (1986) showed that, Vitamin C content was increased with enhanced levels of nitrogen and the response was linear upto 90 $Kgha^{-1}$. Manchanda and Bhopal Singh (1987) noted that Vitamin C content in bell pepper increased significantly with incremental rates of nitrogen and ranged from 55.42 mg per 100g of fruit at 0 Kg nitrogen to 97.12 mg per 100g of fruit at 160 $Kgha^{-1}$. Application of 87.5 Kg nitrogen $hectare^{-1}$ recorded maximum ascorbic acid content (Amritalingam, 1988). Shibhila

Mary and Balakrishnan (1990) stated that, increase in nitrogen application increased the ascorbic acid due to enhancement of enzymatic activities for amino acid synthesis. Similar results were reported by Demirovska et al. (1992) and Lata and Singh (1993).

2.2. Effect of Potassium

2.2.1. Effect on growth characters

2.2.1.1. Height of Plant

Joseph (1982) found that potassium exerted appreciable influence on plant height at the time of final harvest. Significant increase in plant height due to application of potassium was reported by Lakatos (1982). According to Dolkova et al. (1984) increased potassium application increased the height of plant. Similar results were reported by Everett and Subramanya (1984); Zayed et al. (1985); Shukla et al. (1987) and Damke et al. (1988).

But a number of works in chilli crop showed that potassium exerted little effect in increasing the height of plant. Saji John (1989) noted that increased doses of potassium did not significantly influence the height of plant.

2.2.1.2. **Number of branches plant^{-1}**

Branching of chilli was significantly increased by increased doses of potassium (Lakatos, 1982). Dolkova et al. (1984) reported increase in number of branches plant^{-1} with increase in potassium. According to Zayed et al. (1985) number of branches plant^{-1} increased upto 160 Kg potassium application.

Contrary to the above findings Joseph (1982) observed no significant difference in number of branches due to graded levels of potassium. Similar result was reported by Saji John (1989).

2.2.1.3. **Dry matter production**

Pandev et al.(1980) reported that, low potassium application decreased the dry matter production of plant. Increase in potassium application increased the dry matter production (Lakatos, 1982). Joseph (1982) found that higher doses of potassium significantly increased the total dry matter yield plant^{-1}. Similar results were reported by Zayed et al. (1985), Belichki (1988) and Saji John (1989).

2.2.1.4. **Shoot-root ratio**

Application of higher doses of potassium increased the shoot growth more than the root growth (Lakatos, 1982).

Saji John (1989) observed that there was little effect of applied potassium on the shoot-root ratio of the plant.

2.2.1.5. **Spread of canopy**

According to Dolkova et al. (1984) increase in potassium increased the spread of canopy.

2.2.2. **Effect on moisture characters**

2.2.2.1. **Water use efficiency**

El-Beheidi et al. (1994) reported that K_2O at 92 Kg fedden^{-1} resulted in WUE of 0.586 $m^3 Kg^{-1}$ for surface irrigation, 0.525 m^3 Kg^{-1} for movable sprinkler and 0.442 m^3 Kg^{-1} for fixed sprinkler irrigation system in tomato.

2.2.3. **Effect on yield attributes and yield**

2.2.3.1. **Time of 50% flowering**

Joseph (1982) observed that effect of potassium on earliness of flowering was not significant in the first season, but in the second season, the effect was significant. Saji John (1989) stated the effect of potassium in reducing the mean number of days required for 50% flowering. Potassium at 65 Kgha^{-1} induced earliness in flowering significantly.

2.2.3.2. Number of flowers $plant^{-1}$

Saji John (1989) found that potassium application has not resulted in any significant influence in increasing the number of flowers $plant^{-1}$.

Contrary to this, Jayaraman and Balasubramanian (1991) reported that potassium application increased the number of flowers $plant^{-1}$.

2.2.3.3. Number of fruits $plant^{-1}$

Zayed et al. (1985) found that, number of fruits $plant^{-1}$ was highest with 160 $Kgha^{-1}$ of K_2O. Increasing potassium increases the number of fruits $plant^{-1}$ (Belickhi, 1988). Similar result was reported by Jayaraman and Balasubramanian (1991).

However, Joseph (1982) showed that, higher doses of potassium had not influenced the number of fruits $plant^{-1}$. Saji John (1989) noted that, there was no significant influence in increasing the number of fruits $plant^{-1}$ with increased doses of potassium.

2.2.3.4. Setting percentage of fruit

Jayaraman and Balasubramanian (1991) shown that there was an increase in setting percentage of fruit with increased doses of potassium upto 105 $Kgha^{-1}$.

But Joseph (1982) found that, potassium had no significant influence on setting percentage. Similar result was reported by Saji John (1989).

2.2.3.5.**100 fruit weight**

Joseph (1982) observed that the dry weight of 100 fruits was increased by increased doses of potassium. Application of 320 $Kgha^{-1}$ potassium recorded the maximum weight of 100 fruits (Belichki, 1988). Dharmatti and Kulkarni (1988) noted that increase in potassium application increases the weight of 100 fruits. Similar results were reported by Saji John (1989) and Jayaraman and Balasubramanian (1991).

2.2.3.6.**Total yield of chillies**

Application of 200 $Kgha^{-1}$ potassium increased the yield by 106% over control (Lakatos, 1982). Joseph and Pillai (1985) reported that the yield of chilli was maximum at 30 $Kgha^{-1}$ of potassium. Maximum yield of chilli was reported by the application of 75 Kg ha^{-1} of potassium (Narasimhan and Alagianagalingam, 1986). Increase in potassium application increased the yield of chilli (Wankhade and Morey, 1986). Similar results in chilli was reported by Damke et al. (1988); Dharmatti and Kulkarni (1988); Shamima Nasreen and Islam (1989); Shibhila Mary and Balakrishnan (1990); Subhani et al. (1990);

Jayaraman and Balasubramanian (1991) and Kaminwar and Rajagopal (1993).

2.2.4. Effect on ascorbic acid content of fruits

Bubicz et al. (1981) noted that application of 130 $Kgha^{-1}$ of potassium recorded the highest ascorbic acid content of fruit. According to Shibhila Mary and Balakrishnan (1990) application of 52.5 Kg potassium $hectare^{-1}$ recorded maximum ascorbic acid content due to increase in protein synthesis which is important in improving the quality. Uddin and Begum (1990) observed an increase in ascorbic acid content of fruits with increased doses of potassium.

However Joseph (1982) observed that potassium had no significant effect on fruit ascorbic acid content. Saji John (1989) noted that the effect due to increased levels of potassium on ascorbic acid content of fresh fruits was not significant.

2.3. Effect of nutrient interaction on growth, moisture characters, yield, yield attributes and quality

2.3.1. Effect on growth characters

Pandev et al. (1980) reported that deficiency of NPK in the medium adversely affect the dry matter production in chilli. Increasing NPK levels increased both shoot growth and dry matter production in chilli (Lakatos, 1982). Dolkova et al. (1984)

observed that vegetative growth in chilli increased with NPK application. Everett and Subramanya (1984) reported that plant height in chilli increased by the application of 205 Kg N along with 415 Kg K_2O. Application of NPK at the rate of 240 Kg $feddan^{-1}$ each recorded maximum plant height and number of branches (Zayed et al. 1985). Prabhakar et al. (1987) noted that plant height increased significantly with N fertilization upto 60 Kg but plant height and number of branches were not affected by P fertilization. According to Belichki (1988) plant height and dry matter production increased with graded doses of NPK upto 320 Kg each. Damke et al. (1988) found that plant height was highest when P_2O_5 and K_2O were applied at the rate of 50 Kg each. Saji John (1989) reported that all the growth characters were increased with increased doses of N and P. K had no significant influence on these characters.

2.3.2. Effect on moisture characters

Mecs (1986) reported that increasing nutrient supply in chilli decreased the evapotranspiration co-efficient and water consumption co-efficient. Highest WUE in tomato ($\approx$6 lKg^{-1}) was obtained by plants fertilized with highest rate of nutrients.

2.3.3. Effect on yield and yield attributes

Subbiah et al. (1982) showed that N in combination with K tended to produce more yield in chillies. Dolkova et al. (1984) observed that increased NPK application increased fruit production in chilli. Highest yield was reported by the application of 360 Kg each. Highest dry fruit yield in chilli under rainfed condition was obtained by application of 112.5: 60:30 Kg NPK $hectare^{-1}$ (Joseph and Pillai, 1985). Green chilli yield increased with level of N upto 90 Kg and P upto 30 Kg (Prabhakar et al. 1987). Rao et al. (1988) reported that highest economic yield of dry chilli pods was obtained with 120 Kg N in combination with 50 Kg K_2O. According to Shin et al. (1988) optimum NPK rate for maximum yield was 23:20.2:18 Kg N:P:K ha^{-1}. Saji John (1989) noted that higher doses of N and P significantly increased number of flowers $plant^{-1}$, number of pods $plant^{-1}$ and percentage fruit set while K had no significant influence on these. Highest fruit yield of 2.6 tha^{-1} was obtained by the application of 120:90:90Kg NPK ha^{-1} (Shamima Nasreen and Islam, 1989). Increase in NPK rates increased the yield in chilli (Surlekov and Rankov, 1989). Similar results in chilli was reported by Subhani et al. (1990), Thiagarajan (1990), Jayaraman and Balasubramanian (1991), Kaminwar and Rajagopal (1993) and Subbiah (1994).

2.3.4. Effect on ascorbic acid content of fruits

Ascorbic acid content of chilli fruit decreased as the application of NPK increased (Belichki, 1988). Shibhila Mary and Balakrishnan (1990) reported that ascorbic acid content of green and red ripe chillies increased significantly with nitrogen upto 87.5 Kg and potassium 52.5 $Kgha^{-1}$. Uddin and Begum (1990) found that nitrogen alone or in combination had negative effect on ascorbic acid content in chilli while phosphorus had positive effect. According to Kaminwar and Rajagopal (1993) application of NPK at the rate of 100:75:100 $Kgha^{-1}$ recorded the highest ascorbic acid content in chilli.

2.4. Effect on the uptake of nitrogen, phosphorus and potassium

Joseph (1982) observed that, total uptake of nitrogen by chilli was significantly increased by increased levels of N,P and K. Similar trends were also noted in the uptake of P and K. Lakatos (1982) noted that, NPK uptake by chilli was more intensive at ripening. 96-98% of the optimum nutrient supply was taken up during fruit ripening. To produce an average chilli yield of 3.8 tha^{-1}, total uptake of NPK by plant was 205, 58 and 445 $Kgha^{-1}$ respectively (Roman, 1982). Rankov et al. (1983) found that NPK uptake of chilli was always greater on a light sandy soil. For producing 1000 Kg fruits, control chilli plants and plants receiving highest NPK removed from soil 6.91 and 6.37

$Kgha^{-1}$ N, 1.89 and 1.63 $Kgha^{-1}$ P_2O_5 and 7.3 and 6.13 $Kgha^{-1}$ K_2O respectively (Dolkova et al. 1984). Rankov and Todorov (1984) noticed that, on an average 4.79 Kg N, 1.74 Kg P_2O_5 and 5.47 Kg K_2O ha^{-1} were needed for producing 1 t market ripe chilli fruits of early cultivars and 6.08Kg N, 2.12 Kg K_2O_5 and 6.27 Kg K_2O with mid-early cultivars. 82% of total N, 53% P_2O_5 and 68% K_2O uptake in chilli occured after full fruit set (Tapia and Dabed, 1984). Locascio et al. (1985) observed that at the end of crop season, N accumulation in chilli was 16.5% in shoot, 2.2% in immature fruit and 15.8% in the harvested fruit. Greatest amount of nutrient uptake occured during the last third of the growing season and was in the order K>N>P (Santiago and Goyal, 1985).

Dolkova et al. (1986) found that, during ripening N content in chilli increased but nitrate content decreased. Fruit N content reached permissible level even at lower rates of NPK when applied with. Fruit nitrate content was below the permissible level. Chilli removed 47-67% of fertilizer N applied (Jinadasa et al. 1987). Crespo-ruiz et al. (1988) observed that there are five phases of nutrient uptake in chilli and uptake was significantly higher in last one third of growing season. According to Hegde (1988) in chilli, N fertilization upto 120 Kg ha^{-1} significantly increased the nutrient uptake by 128, 64 and 76% NPK respectively. Saji John (1989) reported that, uptake of N and K by chilli was significantly increased by higher doses of NPK.

Russo (1991) observed that the levels of nutrients in leaves and fruits did not respond to fertilizer application. To produce 1q of dry chilli pods, the nutrient requirement was found to be 1.94, 0.25 and 1.6Kg N P K respectively (Kaminwar and Rajagopal, 1993). Subbiah (1994) noted that at 100% of the recommended dose of N and P, chilli crop had recorded the highest N, P and K uptake.

2.5. Effect of Drip irrigation

2.5.1. Effect on growth characters

2.5.1.1. Height of plant

Horton et al. (1982) reported that plant height increased by drip irrigation. Increase in plant height with drip irrigation in chilli was noted by Narayanan (1991). Similar result was also reported by Pravin (1992) and Roshni (1993).

2.5.1.2. Number of branches plant^{-1}

Drip irrigation increased the number of branches plant^{-1} of chilli (Horton et al. 1982). Narayanan (1991) noted maximum number of branches plant^{-1} (7.39) due to drip irrigation. Similar result was noted by Roshni (1993).

2.5.1.3. **Dry matter production**

According to Bar-Yosef *et al*. (1980) dry matter production increased in chilli as drip irrigation frequency increased from one to three day^{-1}. Beese *et al*. (1982) working on sweet pepper under drip irrigation found linear response to water application rates at 0.8,1,1.2,1.4 times the control (applied at -25cbr) with maximum dry matter production at highest regime. Increasing drip irrigation frequency increased the dry matter production in chilli (Ramesh, 1986). Narayanan (1991) noted that drip irrigation recorded highest dry matter production in chilli.

2.5.1.4. **Shoot-root ratio**

Hassan *et al*. (1984) reported increased shoot-root ratio with increased quantity of water in drip. Similar result was observed by Pravin (1992) and Roshni (1993).

2.5.1.5. **Spread of canopy**

Drip irrigation increased the plant growth resulting in more spread of canopy (Horton *et al*. 1982). Pravin (1992) also reported similar result.

2.5.2. Effect on moisture characters

2.5.2.1. Moisture distribution pattern

Wierenga and Saddiq (1985) noted that optimum range of soil water tension in a clay loam soil in New Mexico was 150-250 cm water. Naik (1986) observed an uniform application of irrigation water in drip system. Root growth and distribution of roots were maximum at 5-10 cm depth. Spread of roots were upto 40-55 cm within the wetted zone. According to Ramesh (1986) availability of soil moisture is more constant with drip irrigation. Drip maintained soil moisture content of 28.23 mm at 0-15 cm and 29.07 mm at 15-30 cm depth. Goyal *et al*. (1988) stated that more than 80% roots were in 0-22 cm soil depth which corresponds to wetting zone under a dripper.

2.5.2.2. Water use efficiency

O'Dell (1983) reported that trickle irrigated capsicum plants increased WUE than unirrigated plants. Drip irrigation need 40% less water than sprinkler (Lechl and Frenz, 1985). Ramesh (1986) working on green chilli observed that irrigation at 0.6Ep with drip method gave significantly higher WUE (20.86 Kg ha^{-1} mm^{-1}). According to Goyal *et al*. (1987) drip irrigation had highest irrigation efficiency of 84%. Similar result was noted by Foster *et al*. (1989). Tekinel *et al*. (1989) fond highest WUE in drip compared to conventional methods. Drip irrigation resulted in greater water saving (Nandal et al. 1991). Narayanan (1991) reported that drip irrigation in chilli resulted in maximum WUE of 254 $Kgha^{-1}cm^{-1}$.

2.5.3.**Effect on yield attributes and yield**

2.5.3.1.**Time of 50% flowering**

Hassan et al. (1984) noticed a decrease in time of 50% flowering in chilli due to drip irrigation. Similar results were reported by Goyal et al. (1984) and Roshni (1993).

2.5.3.2.**Number of flowers plant^{-1}**

Haynes and Herring (1981) found an increase in number of flowers plant^{-1} with drip irrigation at 500 mb tension. Increase in number of flowers plant^{-1} was noticed with drip irrigation (Roshni, 1993).

2.5.3.3.**Number of fruits plant^{-1}**

Haynes and Herring (1981) reported an increase in number of fruits plant^{-1} with drip irrigation in chilli. Trickle irrigated capsicum yielded more fruits than unirrigated ones (O'Dell, 1983). Goyal et al. (1984) noted more number of defective fruits grown with drip irrigation in summer than in winter. Increasing water quantity in drip irrigation increased number of fruits plant^{-1} (Hassan et al. 1984). Increased number of fruits plant^{-1} with drip irrigation was also reported by Ramesh (1986), Narayanan (1991) and Roshni (1993)..pl61

2.5.3.4.**Setting percentage of fruit**

Haynes and Herring (1981) noted an increase in setting percentage of fruits with drip irrigation at 500 mb tension. Similar results were observed by Ramesh (1986), Narayanan (1991) and Roshni (1993).

2.5.3.5.**100 fruit weight**

Drip irrigation at 500 mb tension resulted in maximum 100 fruit weight in chilli (Haynes and Herring, 1981). Goyal et al. (1984) found that drip irrigation in winter resulted in maximum fruit weight. According to Hassan et al. (1984) drip irrigation in chilli increased 100 fruit weight. Similar results were reported by Ramesh (1986), Narayanan (1991) and Roshni (1993).

2.5.3.6.**Total yield of chillies**

Haynes and Herring (1981) observed an increase in yield with drip irrigation at 500 mb tension. Beese et al. (1982) working on sweet pepper under drip irrigation found highest yield at water application of 1-4 times the control (applied at -25cbr). Drip irrigation gave highest yield when amount of water applied was increased (Horton et al. 1982). According to Sirjacobs and Dada Ould Slama (1983) drip irrigation corresponding to 125% class A pan evaporation recorded highest yield of about 6.5 Kgm^{-2}. Hassan et al. (1984) reported an increase in yield of chilli when drip irrigated. Similar result was noted by Lechl and Frenz (1985); Ramesh (1986); Goyal *et al*. (1987); Palevitch *et al*. (1988); Dysko and Kaniszewski (1989); Tekinel *et al*. (1989); Gutal *et al*. (1990); Narayanan (1991) and Roshni (1993).

2.5.4. Effect on ascorbic acid content of fruit

Lechl and Frenz (1985) noted that drip irrigation gave better quality fruits. Highest crop quality was obtained when drip irrigated to conventional methods (Tekinel *et al*. 1989). Increase in ascorbic acid content of chilli fruit when drip irrigated was noticed by Ramesh (1986) and Narayanan (1991).

2.6. Effect of Furrow irrigation

2.6.1. Effect on growth characters

2.6.1.1. Height of plant

Abou-Hussein *et al*. (1984) reported that increase in field capacity from 9 to 90% increased plant height till 172 or 193 days from seed sowing.

2.6.1.2. Number of branches plant^{-1}

Narayanan (1991) found that furrow irrigation gave only 7.07 branches plant^{-1}.

2.6.1.3. **Dry matter production**

Hegde (1987) observed an increase in dry matter production when irrigated at 40% ASM. Similar result was reported by Narayanan (1991).

2.6.1.4. **Shoot-root ratio**

Irrigation at 40% ASM resulted in maximum shoot-root ratio (Hegde, 1987).

2.6.1.5. **Spread of canopy**

Hegde (1987) working on chilli found that irrigation at 40% ASM increased crop growth resulting in more canopy spread.

2.6.2. **Effect on moisture characters**

2.6.2.1. **Moisture distribution pattern**

Mecs (1986) reported that increased water supply decreased ET co-efficient. Ramesh (1986) found that furrow irrigation maintained soil moisture at 60-70% ASM at 0.6 Ep level. Narayanan (1991) noted that soil moisture content at 0-15 cm depth was 27.96 mm while at 15-30 cm it was 28.85 mm by furrow irrigation.

2.6.2.2. **Water use efficiency**

Goyal *et al*. (1987) noted that irrigation efficiency was 37% more for furrow when compared with control. Hegde (1988) observed that irrigation at 40% ASM resulted in maximum WUE (34.9 $Kgha^{-1}cm^{-1}$). Irrigation at 0.5 CPE resulted in maximum WUE (Palled *et al*. 1988). Hegde (1989) observed that alternate and widely spaced furrow irrigation with 20 mm water can result in substantial saving in irrigation water to the extend of about 40% without any adverse effect on productivity. Furrow irrigation resulted in WUE of 242 $Kgha^{-1}cm^{-1}$ (Narayanan, 1991).

2.6.3. **Effect on yield attributes and yield**

2.6.3.1. **Time of 50% flowering**

Abou-Hussein *et al*. (1984) reported that as field capacity decreased, flowering occured earlier. 54% field capacity is found to be optimum.

2.6.3.2. **Number of flowers plant^{-1}**

As field capacity decreased, number of flowers increased due to the effect of water supply on endogenous levels of different growth active materials (Abou-Hussein *et al*. 1984).

2.6.3.3. **Number of fruits plant^{-1}**

Abou-Hussein *et al*. (1984) found as field capacity decreased, number of fruits plant^{-1} increased. Hegde (1989) noted that furrow irrigation with 20 mm water depth resulted in increased number of fruits plant^{-1}.

2.6.3.4. **Setting percentage of fruit**

Setting percentage of fruit increased as percentage field capacity decreased (Abou-Hussein *et al*. 1984).

2.6.3.5. **100 fruit weight**

Furrow irrigation with 20 mm water resulted in increased fruit weight (Hegde, 1989).

2.6.3.6. **Total yield of chillies**

Goyal *et al*. (1987) found furrow irrigation increased commercial yield by 42% compared with control. Hegde (1988) reported irrigation at 40% ASM resulted in maximum yield of 15-39 tha^{-1}. Irrigation at 85% field water content gave highest yield compared with control (Leon and Portuondo, 1989). Narayanan (1991) found furrow irrigation gave maximum yield of 11.55 tha^{-1}. Manjunath *et al*. (1994) reported irrigation at 100% ASM decreased the yield (2.01 tha^{-1}) compared with that at 50% ASM (2.2 tha^{-1}). Gulati *et al*. (1995) observed irrigation at IW/CPE 1.0 gave highest dry chilli yield of 14.58 qha^{-1}.

2.6.4. Effect on ascorbic acid content of fruit

Shibhila Mary and Balakrishnan (1990) reported highest ascorbic acid content of green pod when irrigated at 0.75 IW/CPE due to availability of water for increased cell metabolism for ascorbic acid synthesis.

2.7. Effect of drip vs. furrow irrigation on growth, moisture characters, yield attributes, yield and quality

2.7.1. Effect on growth characters

Ramesh (1986) found that drip irrigation resulted in only marginal increase in branches plant^{-1} over furrow irrigation but there was significant increase in dry matter production by application of drip irrigation compared to furrow irrigation. Goyal et al. (1987) observed that growth characters increased under drip irrigation than furrow irrigation. Similar result was noted by Narayanan (1991) and Pravin (1992).

2.7.2. Effect on moisture characters

Ramesh (1986) working on green chilli reported that availability of soil moisture was more constant with drip irrigation than furrow irrigation. Drip irrigation maintained soil moisture close to field capacity whereas furrow irrigation maintained soil moisture at 60-70% ASM at 0.6 Ep level.

Goyal et al. (1987) reported that drip irrigation had highest irrigation efficiency of 84% compared to 37% with furrow irrigation. Drip irrigated plants do not get subjected to any stress during their growth period in contrast to furrow irrigation method where fluctuations in soil moisture during on irrigation cycle was observed (Thimmegowda, 1990). Narayanan (1991) found that, drip irrigation recorded highest WUE and less consumptive use compared to furrow irrigation. Soil moisture content at 15-30 cm depth was 29.07 mm in case of drip irrigation while it was only 28.85 mm in furrow irrigation.

2.7.3.**Effect on yield and yield attributes**

El-Gindy (1984) working on sweet pepper crop found that drip irrigation gave 64% increased yield over furrow irrigation. Lechl and Frenz (1985) reported that drip irrigation increased capsicum yield by 20% over other methods of irrigation. They also observed less weed growth in drip irrigated plots which was responsible for increased yield over furrow method of irrigation. According to Goyal et al. (1987) drip irrigation increased yield in sweet pepper significantly by 168% compared to furrow irrigation (52%) during winter. Tekinel et al. (1989) found increased yield with drip compared to furrow irrigation. Similar result was noted by Narayanan (1991) and Pravin (1992).

However, Ramesh (1986) working on green chilli observed no significant difference in yield between drip irrigation and furrow irrigation. Similar result was reported by Wivutvongvana et al. (1990).

2.7.4. Effect on ascorbic acid content of fruit

Sivanappan and Padmakumari (1980) reported that drip irrigation in chilli gave better quality fruits compared to furrow irrigation. Highest crop quality with drip compared to furrow irrigation as reported by Tekinel et al. (1989). Narayanan (1991) found that ascorbic acid content of fruits under drip irrigation was 99.15 mg per 100 g while in the case of furrow irrigation it was only 92.71 mg per 100 g. Increase in ascorbic acid content of fruits under drip irrigation was reported by Pravin (1992).

2.8. Effect of nutrient irrigation interaction on growth, moisture characters, yield and quality

2.8.1. Effect on growth characters

Haynes (1988) noted that vegetative growth in chilli was greatest when 75 Kg nitrogen hectare^{-1} was applied by fertigation. Growth was reduced at high nitrogen due to Aluminium toxicity induced by soil acidity below the emitters. He also found that growth was inferior in broadcast to that in fertigation treatment. Hegde (1988) observed that application of 120 $Kgha^{-1}$ nitrogen and irrigating at 40% ASM resulted in maximum dry matter production of 24.3 g $plant^{-1}$ in chilli which was 97% increase over control. Irrigating chilli at 40% ASM and applying 180 $Kgha^{-1}$ nitrogen increased dry matter production by partitioning the plant dry matter into leaves, stem and fruits (Hegde, 1989). Prabhakar and Naik (1993) reported that irrigating chilli at 60 mm CPE and applying nitrogen at the rate of 180 $Kgha^{-1}$ resulted in maximum vegetative growth and dry matter production of 89.2 g $plant^{-1}$.

2.8.2. **Effect on moisture characters**

Mecs (1986) reported that increased nutrient supply in chilli decreased the evapotranspiration co-efficient while increased moisture supply increased it. More than 80% of the roots were in 0-22 cm soil depth when chilli crop was fertigated with 6.9 g nitrogen $plant^{-1}$ and this depth corresponds to the wetting zone (Goyal et al. 1988). According to Hegde (1988) irrigating bell pepper at 40% ASM and applying nitrogen at 120 Kg ha^{-1} resulted in highest WUE of 34.9 $Kgha^{-1}mm^{-1}$. Hegde (1989) reported that scheduling irrigation when soil matric potential at 15 cm depth reached -65 KPa and applying 168 $Kgha^{-1}$ nitrogen resulted in maximum WUE in chilli. Palled et al. (1988) observed that maximum WUE in chilli was obtained with irrigation at 0.5 IW/CPE and applying 200 $Kgha^{-1}$ nitrogen. Prabhakar and Naik

(1993) found that application of 180 $Kgha^{-1}$ nitrogen and irrigating at 60 mm CPE resulted in maximum WUE of 23.3 $Kgha^{-1}$ mm^{-1} in capsicum.

2.8.3. **Effect on yield attributes and yield**

Batal and Smittle (1981) noted that yield of chilli increased by frequent irrigation only if additional nitrogen was applied to maintain a higher soil nitrate nitrogen. Fertigated chilli receiving 30 g urea $plant^{-1}$ outyielded plants receiving side-dressed urea (Goyal et al. 1985). Yield of dry chilli pods was highest on plots with CPE 0.6 and N and K_2O 100 and 50 Kg ha^{-1} respectively (Wankhade and Morey, 1986). Ferreyra et al. (1987a) reported that chilli yield was highest with 0.7 times CPE which resulted in NPK absorption rates of 138-150, 14-15.42 and 122-142 $Kgha^{-1}$ respectively. Hegde (1987) observed that irrigating chilli at 40% ASM and nitrogen application of 180 Kg ha^{-1} resulted in maximum yield. Crespo-ruiz et al. (1988) stated that fertigating chilli with 300 $Kgha^{-1}$ nitrogen produced higher commercial yield compared with fertilization and control. Yield of chilli was highest when 75 $Kgha^{-1}$ nitrogen was applied by fertigation (Haynes, 1988). Hegde (1988) observed that irrigating chilli at 40% ASM and application of 120 $Kgha^{-1}$ nitrogen resulted in maximum yield of 15.39 tha^{-1}. According to Hegde (1989) scheduling irrigation when soil matric potential at

15 cm depth reached -65 K Pa along with 168 $Kgha^{-1}$ nitrogen resulted in highest yield in chilli. Hartz *et al*. (1993) reported that fertigating chilli resulted in maximum fruit yield and mean fruit size. Prabhakar and Naik (1993) found that irrigating chilli at 60 mm CPE and applying 180 $Kgha^{-1}$ nitrogen increased the fruit size and fruit number and resulted in maximum yield of 13.04 tha^{-1}. Scheduling irrigation at 1.0 IW/CPE along with 100 Kg ha^{-1} nitrogen gave highest dry chilli yield of 14.58 qha^{-1} (Gulati *et al*. 1995).

2.8.4. Effect on ascorbic acid content of fruit

Shibhila Mary and Balakrishnan (1990) noted that ascorbic acid content of green and red ripe chillies increased significantly with the irrigation level at 0.75 IW/CPE ratio, nitrogen at 87.5 $Kgha^{-1}$ and potassium 52.5 $Kgha^{-1}$.

2.9. Economics of drip irrigation vs furrow irrigation

El-Gindy (1984) reported that drip irrigation was economically more efficient than furrow irrigation in chilli. Ramesh (1986) observed that a gross income of Rs.29,472/- per hectare can be realised by adopting drip in chilli which is Rs.7,468/- more than that obtained with furrow irrigation. Every additional rupee spend on drip brings back a net income of Rs.0.67. According to Narayanan (1991) drip irrigation in chilli at 0.6 CPE gave a low consumptive use (48 ha-cm) and high WUE of

269 $Kgha^{-1}cm^{-1}$ and with a gross return of Rs.39,760/- per hactare. The heavy investment on a high quality drip irrigation system is not only recovered in the very first season but there is also additional profit of 55% over furrow irrigated capsicum (Pravin, 1992).

MATERIALS AND METHODS

3. MATERIALS AND METHODS

A field experiment was conducted to study the effect of nitrogen, potassium, drip and furrow irrigation on the growth, yield, quality and soil moisture characters and nutrient uptake of vegetable chilli cv. Jwalasakhi, at the Instructional Farm attached to the College of Agriculture, Vellayani during Rabi 1994. The details of the materials used and methods followed are presented in this chapter.

3.1.Materials

3.1.1.Experimental site

The experiment was conducted in the garden land at the Instructional Farm attached to the College of Agriculture, Vellayani. The Farm is situated at $8^{o} 5'$ north latitude and $76^{o} 9'$ east longitude at an altitude of 29 m above mean sea level.

3.1.2.Soil

The soil of the experimental area was red loam, acidic in reaction, medium in available nitrogen and phosphorus and low in available potassium. The chemical properties of the soil are presented in Table 3.1.

Table 3.1. **Chemical properties of the soil**

Sl.No.	Parameter	Observation	Remarks
1.	Soil texture	Red loam	
2.	pH	5.3	Acidic
3.	Available N ($kgha^{-1}$)	310.3	Medium
4.	Available P_2O_5 ($kgha^{-1}$)	38.76	Medium
5.	Available K_2O ($kgha^{-1}$)	89.3	Low

3.1.3.**Cropping history of the field**

The experimental area was under bulk crop of banana before the experiment.

3.1.4.**Meteorological parameters**

The experimental area enjoys a humid tropical climate. The data on various weather parameters like rainfall, minimum and maximum temperature, relative humidity and evaporation during the cropping period are given in Appendix I and graphically presented in Figure 3.1a and Figure 3.1b.

In general, the weather conditions were favourable for the satisfactory growth of the crop.

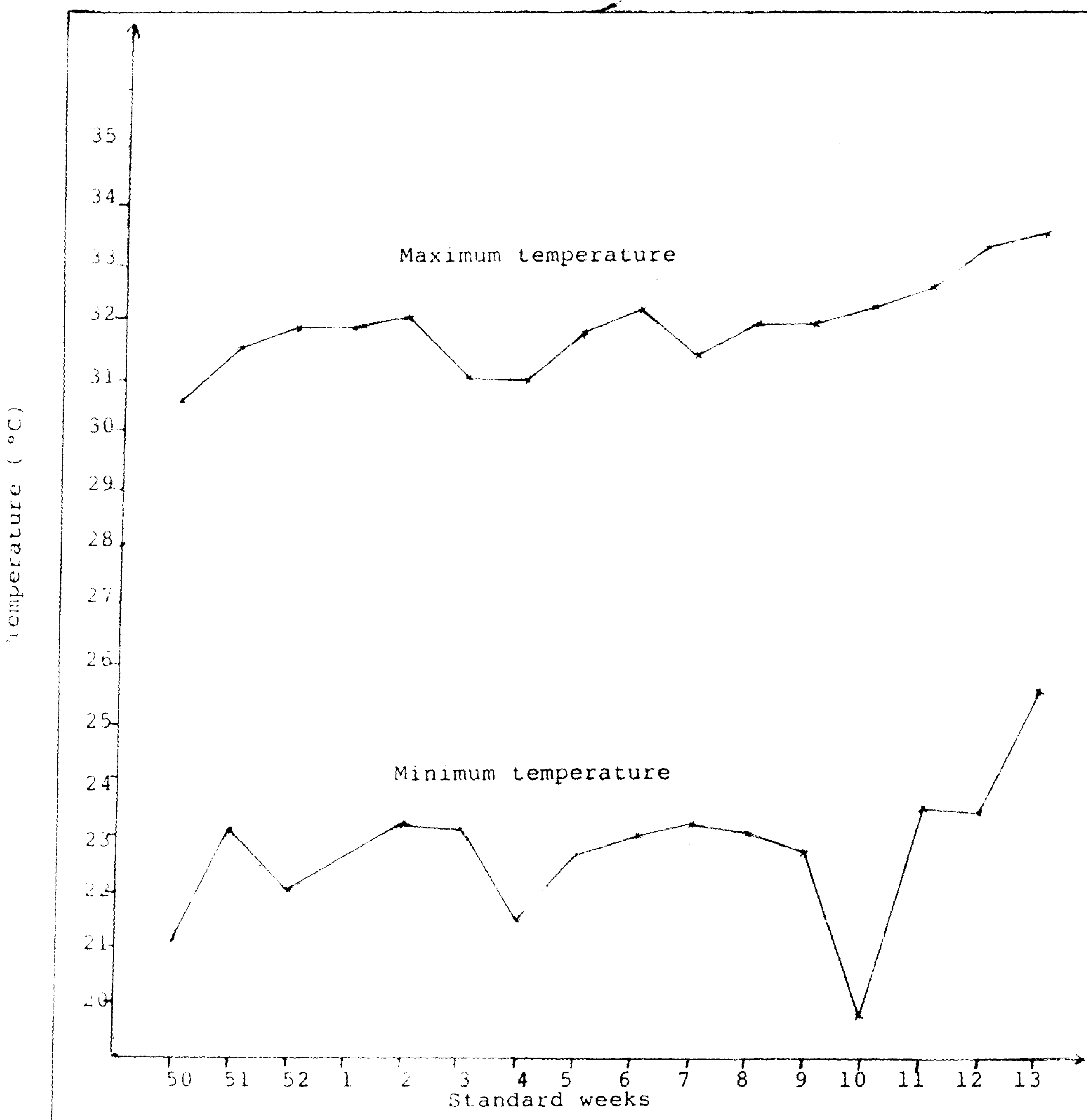
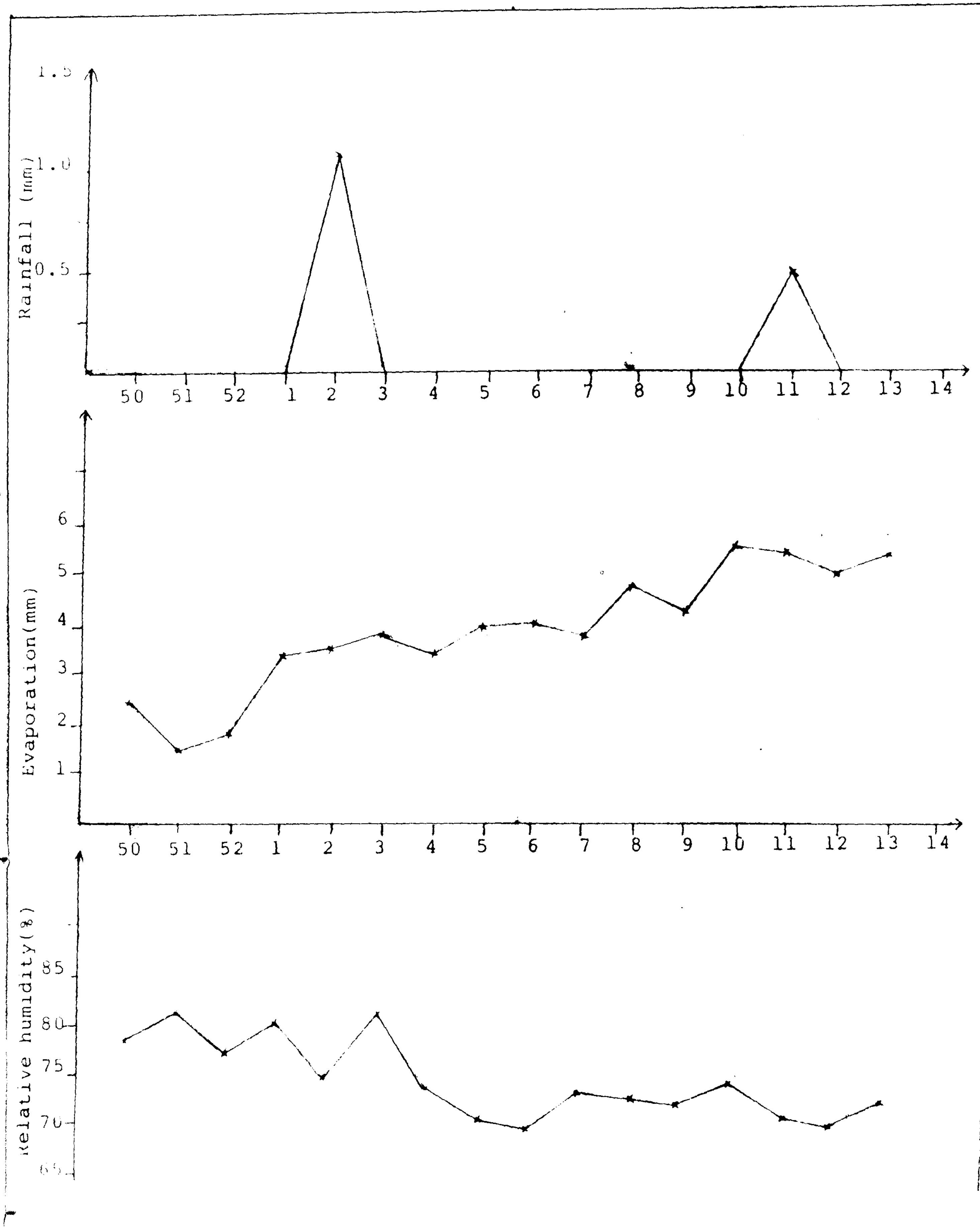


Fig.3.1a. Weather conditions during the cropping period



1.5
1.0
0.5
Rainfall (mm)
50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13 14
Evaporation(mm)
1 2 3 4 5 6
50 51 52 1 2 3 4 5 6 7 8 9 10 11 12 13 14
Relative humidity(%)
65 70 75 80 85

3.1.5. **Season**

The field experiment was conducted during the period from 12.12.1994 to 29.3.1995.

3.1.6. **Variety**

The variety used was Jwalasakhi, a newly released high yielding variety of vegetable chilli evolved by Kerala Agricultural University by crossing Vellanotchi, a popular local cultivar of South Kerala with Pusa Jwala. It has got high yield potential, ideal for culinary purpose and suited for high density planting.

The seed material was obtained from the Instructional Farm, College of Agriculture, Vellayani.

3.1.7. **Nursery**

200g seeds were sown in well prepared raised nursery beds of size 1.2 m wide and 15 cm high with channels around them to facilitate the drainage of excess water. A basal dressing of powdered cattle manure at the rate of 1 kgm^{-2} was applied in the nursery beds.

The seeds were sown on 29.10.1994. The seedlings were irrigated everyday. Hand weeding and plant protection measures were undertaken periodically as per KAU package of practices recommendations (KAU, 1993) The seedlings were ready for transplanting in 30-45 days.

3.1.8. Manures and fertilizers

A uniform dose of 20 t cattle manure hectare^{-1} was applied in the experimental area at the time of preparatory cultivation. The fertilizers used for the experiment were Urea (46% N); Super phosphate (16% P_2O_5) and Muriate of Potash (60% K_2O).

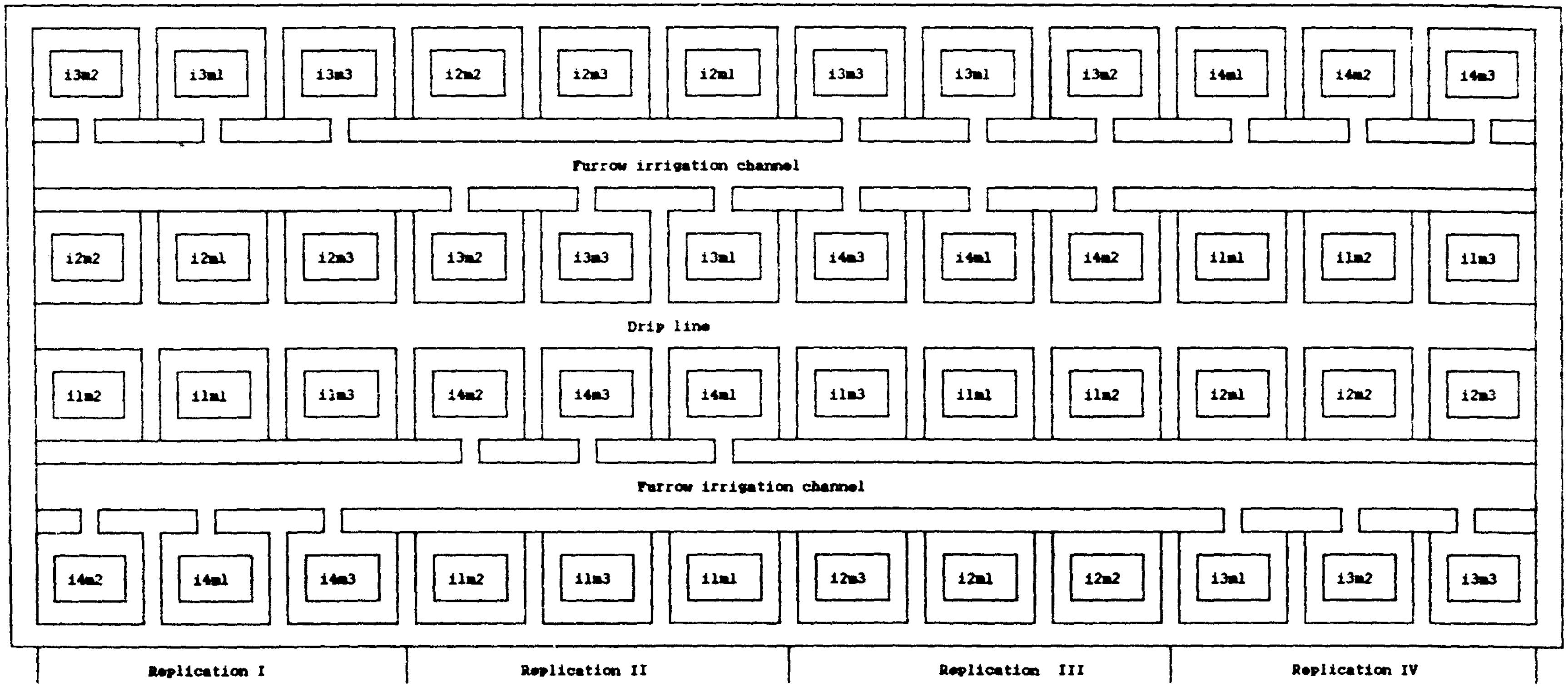
3.2. Methods

3.2.1. Design and layout

The experiment was laid out in Strip Plot Design with 4 replications. The layout of the experiment is given in Figure 3.2. The details of the layout are given below.

No. of treatments	- 12
No. of replications	- 4
Total no. of plots	- 48
Gross plot size	- 2.7 x 3.15 m
Net plot size	- 2.25 x 2.7 m
Spacing	- 45 x 45 cm
No. of plants in gross plot	- 42
No of plants in net plot	- 28

Fig.3.2. Layout plan of strip plot design



3.2.2. Treatments

The treatment consisted of three levels of nutrients and four levels of irrigation.

i) Levels of nutrients (kg ha^{-1})

m_1 - 50 : 40:16.7 N P K

m_2 - 75 : 40: 25 N P K

m_3 - 100; 40: 33.3 N P K

ii) Levels and methods of irrigation

i_1 - drip irrigation with one litre per plant per day

i_2 - drip irrigation with two litre per plant per day

i_3 - furrow irrigation at 10 mm CPE

i_4 - furrow irrigation at 20 mm CPE

(Depth of irrigation for i_3 and i_4 kept at 20 mm)

The different treatment combinations were as follows.

i_1 m_1	i_3 m_1
i_1 m_2	i_3 m_2
i_1 m_3	i_3 m_3
i_2 m_1	i_4 m_1
i_2 m_2	i_4 m_2
i_2 m_3	i_4 m_3

3.2.3. Details of cultivation

3.2.3.1. Land preparation

The main field was dug twice and plots of 2.7 x 3.15 m were laid out with bunds of 30 cm width all round. Buffer area were provided in between plots to avoid seepage of irrigation water. Individual plots were again dug and perfectly levelled. Ridges and furrows were formed 45 cm apart and 45 day old seedlings were planted on the ridges at 45 cm apart on 12.12.1994. Plants were given uniform irrigation. Necessary shade was also provided for the first seven days after planting.

3.2.3.2. Application of fertilizers

Fertilizers were applied as per the schedule of treatments. The entire dose of phosphorus and half of nitrogen and potash were given as basal. One fourth nitrogen and half potash were applied to the soil at 25 days after transplanting. The remaining quantity of nitrogen was applied one month after the first top dressing.

3.2.3.3. Installation of drip

Drip system was installed on the field for the respective plots before transplanting. Drippers were calibrated to deliver the required quantity of water.

3.2.3.4. Preparation of furrow

Furrows were taken at the time of transplanting and the required quantity of water was adjusted to flow through the furrows to the respective plots.

3.2.3.5. Maintanence of the crop

Gap filling was done on the seventh day after transplanting with seedlings of same age group. Crop was handweeded thrice at 25 day interval. The crop was given furrow irrigation based on the pan evaporimeter reading and drip irrigation was given daily for the respective plots. Rainfall occured was accounted for scheduling irrigation Bordeaux mixture at 1 percent was sprayed at 20 DAT as a prophylactic measure against diseases. Spraying with Quinaphos at 0.3 percent was also done to prevent the attack by aphid and shoot borer.

3.2.3.6. Harvest

The crop was ready for first harvest 71 days after transplanting and subsequent harvest were made at an interval of 7-10 days. 5 pickings were taken at equal intervals.

3.3. Observations

3.3.1. Growth characters

3.3.1.1. Height of plant

This observation was taken from 4 plants at random in each plot after eliminating border rows. The height of plants were measured from the base to the growing tip of the plants. Observations were recorded on the same plants at three growth stages viz. 35th day, 70th day after transplanting and at final harvest and the mean values were recorded.

3.3.1.2. No. of branches plant^{-1}

The total number of branches plant^{-1} at final harvest was recorded from 4 plants at random in each plot after eliminating border rows and mean values recorded.

3.3.1.3. Dry matter production (DMP)

The entire dry weights of shoots and fruits of 4 observational plants were recorded. The samples were dried to constant weight in a hot air oven at a temperature of 105^{o}C and the mean dry weight were taken.

3.3.1.4. Shoot - root ratio

After the final harvest, plants were pulled out without damaging the roots. The dry weights of shoots and roots of 4 plants were recorded after drying in sun. From this, shoot-root ratio was calculated.

3.3.1.5. Spread of canopy

The spread was measured as the maximum lateral diameter through the main stem of each plant and expressed in cm.

3.3.2. Moisture characters

3.3.2.1. Moisture distribution pattern at 10, 20 and 30 cm depth.

Soil moisture studies were done at planting and harvest. Soil moisture content was determined gravimetrically after oven drying the sample at 105°C for 24 hours and to a constant weight.

3.3.2.2. Water use efficiency (WUE)

Weight of marketable produce ie. green fruit yield of crop per unit volume water used was calculated.

$$\text{WUE}\ (\text{kgha}^{-1}\text{cm}^{-1}) = \frac{\text{yield}\ (\text{kgha}^{-1})}{\text{water applied (cm)}}$$

3.3.3. Time of 50% flowering, yield attributes and yield

3.3.3.1. Time of 50% flowering

The number of days taken for 50% of the plant population to flower in each plot was recorded by visual observation.

3.3.3.2. **No. of flowers produced plant^{-1}**

Flower production on the observational plants was recorded from the first flower opening till the flower production was ceased.

3.3.3.3. **No. of fruits plant^{-1}**

The total number of fruits on the four observational plants was recorded and the average worked out.

3.3.3.4. **Setting percentage of fruits**

This was calculated by dividing the total number of fruits formed on a plant with the total number of flowers produced in the same plant and it was worked out in selected observational plants in each plot.

3.3.3.5. **100 fruit weight**

From each plot, 100 fruits were drawn at random from each harvest and their fresh weight recorded.

3.3.4. **Ascorbic acid content of fruits**

Variation in the quality of fresh fruits as influenced by the incremental doses of N, K and irrigation was assessed by estimating the vitamin C content of fruits. It is expressed as mg per 100g of mature fresh fruits.

3.4. Chemical analysis

3.4.1. Plant analysis

The contents of total N, P and K in the stem and root, leaves and fruits of the plants in each plot were determined separately in order to assess the nutrient uptake by the crop.

The plant samples collected from the observational plants in each plot at the time of final harvest were separated into stem and root, fruits and leaves. They were dried to constant weight in an electric oven at 105°C, ground and passed through a 20 mesh sieve and subjected to acid extraction of total nutrients. Nitrogen, phosphorus and potassium were determined by the methods given in Table 3.2.

3.4.2.1. Uptake of nitrogen, phosphorus and potassium

The total uptake of nitrogen, phosphorus and potassium by the stem and root, leaves and fruits were calculated as the product of the percent content of these nutrients in the plant samples and the respective dry weights and expressed in $kgha^{-1}$.

3.4.2. Soil analysis

Before the commencement of the trial, composite soil sample from the experimental site was taken and subjected to analysis for chemical properties and fertility status in terms of available N, P, and K.

After the experiment, the effect of individual treatment on the residual soil fertility was determined. Soil from each experimental plot was analysed for available N,P and k. The methods followed for the assay of various soil parameters are given in Table 3.2.

Table 3.2. Analytical methods for plant and soil parameters.

SL.No.	Parameter	Method	Reference
1.	Soil analysis		
i.	Available N	Alkaline permangano-metric method	Subbiah and Asija, 1956
ii.	Available P_2O_5	Bray No. 1 extract	Bray and kurts, 1945
iii.	Available K_2O	Neutral normal ammonium acetate extract	Jackson, 1967
2.	Plant analysis		
i.	Total N	Modified Kjeldahl method	Jackson,1967
ii.	Total P	Vandomolybdate yellow colour method by spect-ronic 2000	Jackson, 1967
iii.	Total K	Atomic Absorption Spectrophotometry	Jackson, 1967
iv.	Vitamin C	Titrimetric method	Paul Gyorgy and Pearson, 1967

3.5. Economics of cultivation

The economics of chilli cultivation was worked out based on following factors.

	Rs.	Ps.
1. Cost of cultivation of chilli excluding the cost of treatments.		
2. Cost of 1 kg N		
3. Cost of 1 kg P_2O_5		
4. Cost of 1 kg K_2O		
5. Share of drip set installation for one crop of chilli.		
6. Extra labour for guiding water for furrow irrigation.		
7. Market price of 1 kg vegetable chilli.		

The net income and return per rupee invested were calculated as follows.

Net income (Rs ha^{-1}) = Gross income - Total expenditure

$$\text{Net return per rupee invested (Rs)} = \frac{\text{Net income}}{\text{Total expenditure}}$$

3.6. Economics of adopotion of drip irrigation

The economics of adoption of drip irrigation over furrow irrigation in the cultivation of chilli was worked out.

3.7. Statistical analysis

The data relating to each character were analysed using the analysis of variance technique as applied to strip plot design (Snedecor and Cochran, 1967). In case where the effects were found to be significant, critical difference were calculated for effecting multiple comparisons among the means.

RESULTS

4. RESULTS

The experimental data were subjected to statistical analysis to find out the soil moisture nutrient interaction for yield maximisation of vegetable chilli cv.Jwalasakhi and to work out the economics of different treatments. The results are presented under the following sections.

1. Growth characters
2. Moisture characters
3. Time of 50% flowering, yield components and yield
4. Ascorbic acid content of fruits
5. Plant uptake of nutrients
6. Post harvest soil nutrient status
7. Economics

4.1.Growth characters

4.1.1.Height of plant

The data on the effect of irrigation methods on plant height recorded at 35DAT,70DAT and at harvest is presented in Table 4.1. Drip irrigated plants were found to be superior than furrow irrigated plants. AT 35DAT, plants drip irrigated @ 2 litre day^{-1} produced taller plants than those drip irrigated @1 litre day^{-1}. Same result was observed till the harvest stage. In later stages of plant growth (70DAT and at harvest) even those drip

Table 4.1. Effect of irrigation methods on various growth characters

Character		Drip Irrigation			Furrow Irrigation			C.D.
		i_1	i_2	Mean	i_3	i_4	Mean	
Plant Height (cm)	35 DAT	28.99	33.28	31.14	27.47	25.65	26.56	0.058
	70 DAT	47.3[illegible]	50.95	49.13	44.93	39.77	42.35	0.236
	Harvest	54.63	59.97	57.30	52.53	48.24	50.39	0.183
No.of branches plant^{-1}		74.09	75.72	74.91	71.11	67.79	69.45	0.211
DMP plant^{-1} (g)		77.11	78.72	77.92	70.55	69.61	70.08	0.450
Shoot-root ratio		5.11	5.20	5.16	4.91	4.84	4.88	0.017
Spread of canopy (cm)		53.70	54.34	54.02	52.73	52.08	52.41	0.165

irrigated @ 1 litre plant^{-1} day^{-1} recorded significant increase in plant height.

An increase in nutrients resulted in significant increase in height of plant at all stages of observation (Table 4.2).

No significant difference in plant height was observed at initial two levels of nutrients when plants were drip irrigated @ 1 litre day^{-1} while even at medium level of nutrients, the growth in plant was observed when drip irrigated @ 2 litre plant^{-1} day^{-1} (Table 4.3). Maximum height was recorded by drip irrigation @ 2 litre plant^{-1} day^{-1} at highest level of nutrients at all growth stages.

4.1.2. **Number of branches plant^{-1}**

The data on the effect of irrigation methods on mean number of branches plant $^{-1}$ is presented in **Table 4.1. Drip** irrigated plants produced more branches than furrow irrigated plants. Those received drip irrigation @ 2 litre day^{-1} recorded more branches.

There was significant increase in mean number of branches plant^{-1} with increase in nutrient level (Table 4.2).

Significant interaction was observed between irrigation methods and nutrient levels (Table 4.3). Maximum branches was

Table 4.2. Effect of nutrient levels on various growth characters

Characters		m_1	m_2	m_3	CD
Plant Height (cm)	35 DAT	27.09	28.56	30.89	0.090
	70 DAT	40.78	45.75	50.69	0.429
	Harvest	47.42	53.65	60.46	0.197
No.of branches $plant^{-1}$		65.14	73.35	78.05	0.171
DMP $plant^{-1}$ (g)		72.47	73.81	75.72	0.400
Shoot-root ratio		4.92	5.03	5.10	0.041
Spread of canopy (cm)		48.79	54.33	56.52	0.336

Table 4.3. Interaction effect of irrigation methods and nutrient levels on growth characters.

Interaction	Plant height (cm)			No.of branches $plant^{-1}$	DMP $plant^{-1}$ (g)	Shoot root ratio	Spread of canopy (cm)
	35DAT	70DAT	Harvest				
i_1m_1	27.18	42.12	47.80	67.11	75.18	5.02	49.42
i_1m_2	27.61	46.47	54.34	76.16	77.21	5.11	54.66
i_1m_3	32.20	53.33	61.77	79.01	78.94	5.20	57.03
i_2m_1	31.10	46.08	53.16	68.91	77.41	5.09	50.33
i_2m_2	32.59	51.25	61.21	78.22	78.67	5.21	55.19
i_2m_3	36.16	55.51	65.55	80.55	80.09	5.31	57.49
i_3m_1	26.54	39.83	46.32	64.47	68.94	4.84	48.15
i_3m_2	27.50	46.04	53.06	70.79	70.39	4.92	53.92
i_3m_3	28.37	48.93	58.20	78.06	72.31	4.98	56.13
i_4m_1	23.53	35.08	42.41	60.06	68.34	4.74	47.25
i_4m_2	26.55	39.24	45.99	68.23	68.95	4.87	53.57
i_4m_3	26.86	44.50	56.33	75.09	71.57	4.91	55.43
CD	0.253	0.430	0.507	0.427	0.438	-	-
SE	0.085	0.145	0.171	0.144	0.147		

recorded by plants receiving drip irrigation @2 litre day^{-1} at higher level of nutrients.

4.1.3.**Dry matter production**

DMP plant $^{-1}$ was high for drip irrigated plants than furrow irrigated plants (Table 4.1). Also drip irrigation @ 2 litre $plant^{-1}$ day^{-1} was found to produce more dry matter than those with 1 litre $plant^{-1}$ day^{-1}.

There was a progressive increase in the DMP $plant^{-1}$ due to enhanced levels of nutrients (Table 4.2).

Significant interation was observed between irrigation methods and nutrient levels (Table 4.3).DMP under low nutrient level and drip irrigation @ 2 litre $plant^{-1}$ day^{-1} was on par with DMP under medium level of nutrients and drip irrigation @ 1 litre $plant^{-1}$ day^{-1}. Maximum DMP was recorded by plants receiving higher rate of nutrients and drip irrigation @ 2 litre $plant^{-1}$ day^{-1}.

4.1.4.**Shoot - root ratio**

The data on the effect of irrigation methods on shoot - root ratio is presented in Table 4.1. Shoot - root ratio was high for drip irrigated than furrow irrigated plants. Those plants which were drip irrigated @2 litre day^{-1} recorded high shoot - root ratio.

Regarding the nutrient levels, there was significant increase in shoot-root ratio (Table 4.2). Nutrients at higher level recorded high shoot - root ratio.

Significant interaction was not noticed between irrigation methods and nutrient levels (Table 4.3). Plants treated with lowest level of nutrients and drip irrigation @ 2 litre day^{-1} recorded comparable shoot-root ratio under medium level of nutrients and drip irrigation @ 1 litre day $^{-1}$. Similarly plants receiving higher level of nutrients and drip irrigation @ 1 litre day^{-1} was on par with plants receiving higher level of nutrients and drip irrigation @ 2 litre day $^{-1}$. Plants receiving higher level of nutrients and drip irrigation @ 2 litre day^{-1} recorded maximum shoot-root ratio.

4.1.5. **Spread of canopy**

Canopy spread was more in drip irrigated plants, maximum canopy spread being for plants receiving irrigation @ 2 litre day^{-1} (Table 4.1).

An increase in nutrient level resulted in significant increase in canopy spread (Table 4.2).

Drip irrigated plants with 1 or 2 litre day^{-1} did not respond differently at medium level of nutrients or at higher levels (Table 4.3). Al lower level of nutrients, plants drip irrigated @ 2 litre day^{-1} showed significant difference in canopy development compared to plants drip irrigated @ 1 litre day^{-}. An increase in the levels of drip irrigation produced no significant difference in canopy spread at higher doses of nutrients.

4.2. Moisture characters

4.2.1. Moisture distribution pattern at 10, 20 and 30 cm depth

The data on moisture distribution pattern at 10 cm, 20 cm and 30 cm depth are presented in Table 4.4. Moisture content was significantly higher in drip irrigated plots at all depths than furrow irrigated plots.

There was difference in moisture distribution pattern with nutrient levels at all depths (Table 4.5). But the difference was significant only in plots receiving medium level of nutrients.

In treatments where lower and higher levels of nutrients were applied, no significant difference in moisture content at 10 cm was seen with drip irrigation either @ 1 litre or 2 litre plant^{-1} day^{-1} but at increased depth, irrespective of the levels of nutrients, moisture content was high in plots drip irrigated @ 2 litre day^{-1} (Table 4.6).

Table 4.4. Effect of irrigation methods on various moisture characters

Character		Drip Irrigation			Furrow Irrigation			C.D.
		i_1	i_2	Mean	i_3	i_4	Mean	
Moisture distribution at	10 cm	27.65	28.16	27.90	27.60	26.78	27.19	0.189
(mm)	20 cm	28.00	28.34	28.17	27.95	27.22	27.58	0.019
	30 cm	28.35	28.69	28.52	28.30	27.57	27.93	-
WUE (Kgha^{-1} cm^{-1})		308.57	317.42	312.99	293.31	277.56	285.44	12.165

Table 4.5. Effect of nutrient levels on various moisture characters

Characters		m_1	m_2	m_3	CD
Moisture distribution at	10 cm	27.85	27.62	27.17	0.253
(mm)	20 cm	28.23	27.89	27.52	-
	30 cm	28.58	28.22	27.89	-
WUE ($Kgha^{-1}$ cm^{-1})		280.51	298.19	318.95	13.094

Table 4.6 Interaction effect of irrigation methods and nutrient levels on various moisture characters

Interaction	Moisture distribution			WUE kgha-1 cm-1	Water requirement cm
	10cm	20cm	30cm (mm)		
i_1m_1	27.30	27.65	28.00	283.93	36.61
i_1m_2	27.65	28.00	28.34	310.23	36.32
i_1m_3	28.01	28.36	28.71	331.55	35.88
i_2m_1	27.65	28.00	28.35	300.49	36.09
i_2m_2	28.50	28.35	28.70	317.67	35.90
i_2m_3	28.22	28.68	29.03	334.10	34.95
i_3m_1	27.25	27.60	27.95	268.27	38.27
i_3m_2	27.60	27.95	28.30	296.92	37.86
i_3m_3	27.96	28.31	28.66	314.75	37.27
i_4m_1	26.50	26.85	27.25	269.34	39.27
i_4m_2	26.75	27.25	27.55	267.96	38.29
i_4m_3	27.11	27.56	27.91	295.39	38.86
CD		-	-	-	-
SE					

4.2.2. Water use efficiency

WUE was more with drip irrigation than furrow irrigation (Table 4.4). But WUE was not significantly different with either 1 litre or 2 litre use of water for drip irrigation. Regarding furrow irrigation, irrigation at 10mm CPE recorded higher WUE than that at 20mm CPE

With respect to nutrient levels, WUE increased with incremental levels of nutrients (Table 4.5).

No interaction was observed between irrigation methods and nutrient levels with respect to WUE (Table 4.6). But highest WUE was recorded by plants drip irrigated @ 2 litre day^{-1} in combination with higher nutrient level.

4.3. Time of 50% flowering and yield components

4.3.1. Time of 50% flowering

Furrow irrigated plants took more number of days to produce 50% flowering than drip irrigated plants (Table 4.7). Plants drip irrigated @ 2 litre day^{-1} took less number of days (31.6) than plants drip irrigated @ 1 litre day^{-1} (32.02 days).

As nutrient levels increased, number of days taken for 50% flowering increased (Table 4.8). Plants supplied with lower level of nutrients recorded a duration of 32.19 days only for 50% flowering while those supplied with higher level of nutrients recorded a duration of 35.41 days for 50% flowering.

Table 4.7. Effect of irrigation methods on various yield characters

Character	Drip Irrigation			Furrow Irrigation			C.D.
	i_1	i_2	Mean	i_3	i_4	Mean	
Time of 50% flowering (days)	32.02	31.60	31.81	34.86	37.15	36.01	0.241
No.of flowers $plant^{-1}$	142.03	142.51	142.27	139.31	135.96	137.64	0.122
No.of fruits $plant^{-1}$	68.38	69.86	69.12	63.65	58.42	61.03	0.362
Setting percentage	48.14	49.01	48.58	45.67	42.94	44.31	0.247
100 fruit weight (g)	410.59	412.60	411.60	393.52	373.58	383.55	0.267

Table 4.8. **Effect of nutrient levels on various yield characters**

Characters	m_1	m_2	m_3	CD
Time of 50% flowering (days)	32.19	34.13	35.41	0.165
No.of flowers $plant^{-1}$	137.19	140.21	141.73	0.265
No.of fruits $plant^{-1}$	62.14	64.90	68.19	0.372
Setting percentage	44.99	46.25	48.08	0.212
100 fruit weight (g)	392.15	396.52	404.04	0.499

At lower and higher level of nutrients, there was no significant difference in the number of days to 50% flowering with drip irrigation at both levels (Table4.9). But at medium level of nutrients (package of practice recommemndation) plants drip irrigated @ 2 litre day^{-1} recorded less duration (32.04 days) than plants drip irrigated @ 1 litre day^{-1} (32.5 days).

4.3.2.**NUmber of flowers plant^{-1}**

Number of flowers produced plant^{-1} was significantly high in drip irrigated plants compared to furrow irrigated plants (Table 4.7). On an average, 4.63 flowers plant^{-1} were more produced by drip irrigation.

There was progressive increase in the number of flowers produced plant^{-1} with increase in nutrients (Table 4.8).

However, no significant difference in the number of flowers produced was seen in plants drip irrigated @ 2 litre and 1 litre day^{-1} at higher level of nutrients (Table 4.9). But at lower and medium levels of nutrients, plants drip irrigated @ 2 litre day^{-1} produced more flowers than plants drip irrigated @ 1 litre day^{-1}.

4.3.3.**Number of fruits plant^{-1}**

Number of fruits plant^{-1} was high in drip irrigated plants. Plants drip irrigated @ 2 litre day^{-1} produced more number of fruits than plants drip irrigated @ 1 litre day^{-1} (Table 4.7).

Table 4.9. Interaction effect of irrigation methods and nutrient levels on various yield characters

Interaction	Time of 50% flowering (days)	No. of flowers $plant^{-1}$	No. of fruits $plant^{-1}$	Setting percentage	100 fruit weight (g)
i_1m_1	30.41	139.98	65.89	47.07	404.95
i_1m_2	32.50	142.11	68.48	48.19	401.81
i_1m_3	33.17	144.00	70.78	49.16	417.00
i_2m_1	29.98	140.97	68.01	48.24	406.94
i_2m_2	32.04	142.73	69.64	48.79	411.74
i_2m_3	32.78	143.84	71.93	50.01	419.13
i_3m_1	33.17	137.15	60.14	43.85	387.91
i_3m_2	34.92	139.80	62.90	44.99	392.86
i_3m_3	36.50	140.99	67.91	48.17	399.79
i_4m_1	35.20	133.60	54.53	40.82	368.79
i_4m_2	37.06	136.19	58.59	43.02	371.69
i_4m_3	39.20	138.11	62.13	44.99	380.25
CD	0.436	0.567	1.003	0.582	0.429
SE	0.147	0.191	0.338	0.196	0.144

Higher level of nutrients recorded maximum number of fruits plant^{-1} (Table 4.8).

At higher level of nutrients, no significant difference in number of fruits plant^{-1} was recorded with drip irrigation @ 2 litre day^{-1} and 1 litre day^{-1} but, at lower level of nutrients, plants drip irrigated @ 2 litre day^{-1} recorded more number of fruits than plants drip irrigated @ 1 litre day^{-1} (Table 4.9).

4.3.4. **Setting percentage of fruit**

Drip irrigated plants recorded more setting percentage than furrow irrigated plants (Table 4.7). Drip irrigation @ 2 litre plant^{-1} day^{-1} recorded higher setting percentage than that @ 1 litre plant^{-1} day^{-1}.

There was significant increase in percentage fruit set with increase in nutrient levels (Table 4.8).

Interaction effect was found to be significant (Table 4.9). Irrespective of the levels of nutrients, plants drip irrigated @ 2 litre day^{-1} recorded more setting percentage than plants drip irrigated @ 1 litre day^{-1}.

4.3.5.100 **fruit weight**

100 fruit weight was markedly high for drip irrigated plants. Plants drip irrigated @ 2 litre day^{-1} recorded higher 100 fruit weight (Table 4.7).

With respect to nutrients, higher level of nutrients recorded maximum 100 fruit weight (Table 4.8).

Interaction was found to be significant (Table 4.9). At all levels of nutrients, plants drip irrigated @ 2 litre day^{-1} gave higher 100 fruit weight.

4.3.6.**Yield**

Fruit yield was significantly high in drip irrigated plants than furrow irrigated plants. Plants drip irrigated @ 2 litre day^{-1} recorded the highest yield (Table 4.10). However, furrow irrigation at 10mm CPE recorded more yield than furrow irrigation at 20mm CPE

There was significant increase in yield with increase in nutrient levels. Maximum yield was at higher level (Table 4.11).

However, marked difference was observed between plants drip irrigated @ 2 litre and 1 litre day^{-1} at lower level of nutrients (Table 4.12). At medium and higher levels, plants drip irrigated @ 1 litre and 2 litre day^{-1} recorded no significant difference in yield.

Table 4.10. Effect of irrgation methods on yield

Character	Drip Irrigation			Furrow Irrigation			C.D.
	i_1	i_2	Mean	i_3	i_4	Mean	
Yield (tha^{-1})	12.12	12.47	12.30	10.73	10.06	10.40	0.184

Table 4.11. Effect of nutrient levels on yield

Character	m_1	m_2	m_3	CD
Yield (tha^{-1})	10.77	11.71	12.53	[illegible]

Table 4.12 Interaction effect of irrigation methods and nutrient levels on yield

Interaction	Yield(tha^{-1})
i_1m_1	11.15
i_1m_2	12.18
i_1m_3	13.02
i_2m_1	11 .80
i_2m_2	12.48
i_2m_3	13.12
i_3m_1	10.54
i_3m_2	10.66
i_3m_3	11.00
i_4m_1	9.59
i_4m_2	10.00
i_4m_3	10.60
CD	-
SE	-

4.4. Ascorbic acid content of fruits

Vitamin C content of drip irrigated plants was significantly higher than furrow irrigated plants (Table 4.13). Drip irrigation @ 2 litre plant^{-1} day^{-1} recorded maximum ascorbic acid content of fresh fruit.

Among the nutrient levels, the difference in vitamin C content was not significant at low and medium levels, but was significant at higher level (Table 4.14).

The interaction was not significant (Table 4.15). But drip irrigation @ 2 litre plant day^{-1} at higher nutrient level recorded maximum ascorbic acid content.

4.5. Plant uptake of nutrients

4.5.1. Plant nitrogen

Nitrogen uptake by plant was high in drip irrigated plants than furrow irrigated plants, with 2 litre irrigated plants recording more nitrogen uptake (Table 4.16).

With increased levels of nutrients, significant increase in nitrogen uptake was observed (Table 4.17).

No significant interaction was observed between methods of irrigation and nutrient levels (Table 4.18). But plants drip irrigated @ 2 litre day^{-1} with higher nutrient level recorded maximum nitrogen uptake.

Table 4.13. **Effect of irrigation methods on ascorbic acid content of fruit**

Character	Drip Irrigation			Furrow Irrigation			C.D.
	i_1	i_2	Mean	i_3	i_4	Mean	
Fruit Vit.C.content (mg/100g)	98.11	98.46	98.28	96.36	93.50	94.93	0.176

Table 4.14. Effect of nutrient levels on ascorbic acid content o fruit

Character	m_1	m_2	m_3	CD
Fruit Vit.C.content (mg/100g)	96.54	96.67	97.61	[illegible]

Table 4.15 Interaction effect of irrigation methods and nutrient levels on ascorbic acid content of fruit

Interaction	Fruit vit.C content (mg/100g)
i_1m_1	97.00
i_1m_2	98.24
i_1m_3	99.09
i_2m_1	97.25
i_2m_2	98.60
i_2m_3	99.52
i_3m_1	95.44
i_3m_2	96.38
i_3m_3	97.26
i_4m_1	92.46
i_4m_2	93.46
i_4m_3	94.58
CD	-
SE	-

Table 4.16. Effect of irrigation methods on plant and soil nutrient status.

Character	Drip Irrigation			Furrow Irrigation			CD
	i_1	i_2	Mean	i_3	i_4	Mean	
Plant uptake							
(Kg ha^{-1}) N	56.59	59.79	58.19	55.30	51.89	53.60	0.566
P	10.16	10.21	10.19	9.34	8.77	9.06	-
K	75.47	75.64	75.56	70.98	63.84	67.41	0.187
Soil status							
(Kg ha^{-1}) N	281.97	282.40	282.18	281.93	281.49	281.713	0.218
P	48.69	48.72	48.71	48.67	48.66	48.67	-
K	105.10	105.21	106.16	105.06	104.88	104.97	-

Table 4.13. Effect of nutrient levels on plant and soil nutrient status.

Character		m_1	m_2	m_3	CD
Plant uptake					
(Kg ha^{-1})	N	50.64	56.10	60.94	0.748
	P	8.90	9.81	10.15	-
	K	65.43	72.42	76.60	0.257
Soil status					
(Kg ha^{-1})	N	281.44	282.09	282.32	0.395
	P	48.62	48.70	48.73	0.054
	K	104.83	104.08	105.28	-

Table 4.18. Interaction effect of irrigation methods and nutrient levels on plant and soil nutrient status.

Interaction	Plant uptake (Kg ha^{-1})			Soil status (Kg ha^{-1})		
	N	P	K	N	P	K
i_1m_1	51.71	9.44	69.37	281.45	48.63	104.86
i_1m_2	56.05	10.35	76.36	282.11	48.71	105.11
i_1m_3	62.01	10.69	80.67	282.34	48.75	105.33
i_2m_1	54.42	9.49	69.71	281.90	48.65	104.97
i_2m_2	60.26	10.40	76.70	282.54	48.74	105.22
i_2m_3	64.71	10.74	80.51	282.77	48.77	105.45
i_3m_1	49.93	8.62	64.88	281.43	48.61	104.85
i_3m_2	55.75	9.53	71.87	282.07	48.70	105.10
i_3m_3	60.22	9.87	76.18	282.30	48.72	105.22
i_4m_1	46.52	8.05	57.74	280.99	48.59	104.64
i_4m_2	52.36	8.96	64.73	281.63	48.68	104.89
i_4m_3	56.81	9.30	69.04	281.86	48.71	105.11
CD	-	-	-	-	-	-
SE	-	-	-	-	-	-

4.5.2. **Plant phosphorus**

Drip irrigated plants @ 2 litre day^{-1} recorded more phosphorus uptake than drip irrigated plants @ 1 litre day^{-1} and furrow irrigated plants eventhough no significant difference was noticed (Table 4.16).

There was no significant increase in plant phosphorus uptake with increase in nutrient level (Table 4.17). However, highest uptake was recorded at higher level of nutrients.

Between irrigation methods and nutrient levels, no interaction was noticed (Table 4.18). But drip irrigation @ 2 litre plant^{-1} day^{-1} with higher level of nutrients recorded maximum phosphorus uptake.

4.5.3. **Plant potassium**

Potassium uptake by plants was high in drip irrigated plants than furrow irrigated plants (Table 4.16). But, plant uptake of potassium was not influenced by levels of drip irrigation.

There was significant increase in the uptake of potassium by plants receiving incremental doses of nutrients (Table 4.17).

No interaction was noticed on potassium uptake by plants (Table 4.18). Uptake was highest with drip irrigation

@ 1 litre plant^{-1} day^{-1} in combination with higher nutrient level.

4.6. Post harvest soil nutrient status

4.6.1. **Soil nitrogen**

Soil nitrogen was high in 2 litre drip irrigated plots compared to furrow irrigated plots (Table 4.16). No significant difference was observed in 1 litre drip irrigated and furrow irrigated plots.

Available soil nitrogen increased progressively with increase in nutrient level (Table 4.17). However, no significant difference was noticed between medium and higher levels of nutrients.

No significant interaction was observed between irrigation methods and nutrient levels on available nitrogen status (Table 4.16).

4.6.2. **Soil phosphorus**

Soil phosphorus did not differ significantly among plots receiving different methods and levels of irrigation (Table 4.16).

Soil phosphorus was influenced by levels of nutrients (Table 4.17). Plots treated with medium and higher levels of nutrients recorded more soil phosphorus than those treated with lower level of nutrients (Table 4.17) but no significant difference was noticed between medium and higher level of nutrients.

No significant interaction was noticed between irrigation methods and nutrient levels on soil phosphorus status (Table 4.18).

4.6.3. Soil potassium

Soil potassium did not differ significantly in plots receiving different methods and levels of irrigation (Table 4.16).

Effect of nutrient levels on soil potassium is not significant (Table 4.17). Higher nutrient level recorded maximum soil potassium status.

No significant interaction is noticed on soil potassium status (Table 4.18). Drip irrigation @ 2 litre plant^{-1} day^{-1} in combination with higher nutrient level recorded maximum soil potassium status.

4.7. Economics

4.7.1. Economics of cultivation

The data on economics of cultivation is presented in Table 4.19. It was found that all interactions were able to give more profit. Drip irrigation @ 2 litre plant^{-1} day^{-1} at higher

Table 4.19. Economics of cultivation

Treatment	Cost of cultivation as per package (Rs.)	Cost of treatment (Rs.)	Total cost of cultivation y(Rs.)	Total yield (tha^{-1})	Gross Income x (Rs.)	Net Income Rs.(x-y)	B:C ratio
i_1m_1	46,015.00	3,468.50	49,483.50	11.15	1,33,800.00	84,316.50	2.70
i_1m_2	46,015.00	3,700.00	49,715.00	12.18	1,46,460.00	96,745.00	[illegible]
i_1m_3	46,015.00	3,931.50	49,946.50	13.02	1,56,240.00	1,06,293.50	[illegible]
i_2m_1	46,015.00	3,748.50	49,763.50	11.80	1,41,600.00	91,836.50	[illegible]
i_2m_2	46,015.00	3,980.00	49,995.00	12.48	1,49,760.00	99,765.00	3.00
i_2m_3	46,015.00	4,211.50	50,226.50	13.12	1,57,440.00	1,07,213.50	3.13
i_3m_1	46,015.00	4,318.50	50,333.50	10.54	1,26,480.00	76,146.50	[illegible]
i_3m_2	46,015.00	4,550.00	50,565.00	10.66	1,27,920.00	77,355.00	[illegible]
i_3m_3	46,015.00	4,781.50	50,796.50	11.00	1,32,000.00	81,203.50	[illegible]
i_4m_1	46,015.00	4,668.50	50,683.50	9.59	1,15,200.00	64,516.50	[illegible]
i_4m_2	46,015.00	4,900.00	50,915.00	10.00	1,20,000.00	69,085.00	[illegible]
i_4m_3	46,015.00	5,131.50	51,146.50	10.60	1,27,200.00	[illegible]	[illegible]

level of nutrients recorded higher net income of Rs.1,07,213.50 and B-C ratio of 3.13. This was followed by drip irrigation @ 1 litre plant^{-1} day^{-1} and at higher level of nutrient with a net income of Rs.1,06,293.50 and B-C ratio 3.12. Furrow irrigation at 20 mm CPE at lower level of nutrients registered the least income of Rs. 64,516.50 and B-C ratio 2.27. In general, drip irrigation was found to be better than furrow irrigation.

4.7.2.**Economics of adoption of drip irrigation**

Table 4.20 shows the economics of adoption of drip irrigation. At all levels of nutrients, furrow irrigation at 20 mm CPE recorded least net profit and maximum profit was obtained by drip irrigation @ 2 litre plant^{-1} day^{-1}. Regarding additional net profit realised on different methods of irrigation over furrow irrigation at 20 mm CPE, drip irrigation @ 2 litre plant^{-1} day^{-1} was found to be best. At higher level of nutrients, drip irrigation @2 litre plant^{-1} day^{-1} recorded maximum additional net profit of Rs.31,160.00 over furrow irrigation at 20 mm CPE.

Table 4.20. Economics of adoption of drip irrigation

Particulars	m_1				m_2				m_3			
	Drip		Furrow		Drip		Furrow		Drip		Furrow	
	i_1	i_2	i_3	i_4	i_1	i_2	i_3	i_4	i_1	i_2	i_3	i_4
Cost of cultivation ($Rsha^{-1}$)	49,483.50	49,763.50	50,333.50	50,683.50	49,715.00	49,995.00	50,565.00	50,915.00	49,946.50	50,226.50	50,796.50	51,146.50
Yield ($Kgha^{-1}$)	11150	11800	10540	9590	12180	12480	10660	10000	13020	13120	11000	10600
Gross income ($Rsha^{-1}$)	1,33,800.00	1,41,600.00	1,26,480.00	1,15,200.00	1,46,460.00	1,49,760.00	1,27,920.00	1,20,000.00	1,56,240.00	1,57,440.00	82,083.50	76,933.50
Net profit (Rs ha^{-1})	84,316.50	91,836.50	76,146.50	64,516.50	96,745.00	99,765.00	77,355.00	69,085.00	1,06,293.50	1,07,213.50	81,203.50	76,053.50
Additional net profit realised over i_4 (Rs ha^{-1})	+19,800.00	+27,320.00	+11,630.00	-	+27,660.00	+30,680.00	+8,270	-	+30,240.00	+31,160.00	+5,150.00	-
Gross return per rupee spent (Rs ha^{-1})	2.70	2.85	2.51	2.27	2.95	3.00	2.53	2.36	3.12	3.13	2.60	2.49

@ Market price : Rs.16.00 per Kg.of green chilli.

DISCUSSION

5. DISCUSSION

An experiment was conducted in strip plot design at the Instructional Farm, College of Agriculture, Vellayani during 1994 to study the effects of nitrogen, potassium, drip and furrow irrigation on growth, moisture characters, yield, quality and nutrient uptake of vegetable chilli cv. Jwalasakhi. The results of the experiment are discussed in this chapter.

5.1. Growth characters

5.1.1. Height of plant

Drip irrigated plants were found to be superior than furrow irrigated plants at all stages of observation. Drip irrigation @ 2 litre plant^{-1} day^{-1} was found to be superior. This was due to more availability of water in the effective root zone which positively influenced the uptake of nutrients resulting in increased plant growth. This is in conformity with the findings of Ramesh (1986), Narayanan (1991) and Pravin (1992).

The result indicates significant effect on increased levels of nutrients on plant height at all stages of growth. Influence of nitrogen in increasing the vegetative growth of plant is a universally accepted fact. Potassium increases the translocation of photosynthates. Increased nutrient level increase the plant height as reported by Prabhakar *et al*. (1987), Belichki (1988) and Saji John (1989).

Interaction effect was found to be significant. Drip irrigation @ 2 litre $plant^{-1}$ day^{-1} at higher level of nutrients recorded maximum height at all stages of observation. Nutrients when associated with efficient supply and distribution of irrigation by drip enhanced vegetative growth from the begining. Similar results have been reported by Haynes (1988) and Goyal *et al*. (1988).

5.1.2. Number of branches $plant^{-1}$

Maximum number of branches $plant^{-1}$ (75.72) was produced by drip irrigation @ 2 litre $plant^{-}$ day^{-1}. Drip irrigation resulted in better soil mositure condition to near field capacity throughout the crop growth period while in furrow irrigation, moisture stress caused due to lower level of irrigation resulted in less growth producing less number of branches $plant^{-1}$. Similar finding were observed by Locascio *et al*. (1981), Beese *et al*. (1982), Hegde (1987) and Narayanan (1991).

The total number of branches produced per plant was significantly influenced by varying levels of nutrients. Increase in nutrients increased photosynthetic surface area resulting in more production, translocation and assimilation of photosynthates which in turn increased the crop growth. Similar result of increased branching at higher level of nutrients have been reported by Joseph (1982), Zayed et al.(1985) and Saji John (1989).

Significant interaction was noticed between irrigation methods and nutrient levels on number of branches plant^{-1}. Drip irrigation @ 2 litre plant^{-1} day^{-1} at higher level of nutrients recorded maximum number of branches. Along with increased nutrients, continuous and greater availability of water within the vicinity of root zone by drip irrigation, plants might have better growth condition than furrow irrigated plants. This is in conformity with the result obtained by Haynes (1988).

5.1.3. **Dry matter production**

DMP was significantly higher for plants drip irrigated @ 2 litre day^{-1} than furrow irrigated plants. Higher DMP with drip irrigation might have been due to more uniform distribution of moisture and favourable moisture regime throughtout the grouth period. Vasanthakumar (1984) noted higher DMP with drip irrigation due to higher leaf area which represents more surface area available for photosynthesis, production, translocation and assimilation of photosynthates to growing points. Increase in DMP by drip irrigation was also noted by Ramesh (1986), Kataria and Michael (1990) and Singh et al.(1990).

There was significant increase in DMP due to increased levels of nutrients. Higher rate of DMP with nutrients was due to higher total dry matter availability through increased plant height, more number of branches and physiologically active green leaves which might have resulted in increased photosynthesis. Similar results have also ben reported by Pandev et al. (1980), Paraminder Singh et al. (1986) and Damke et al. (1988).

Interaction effect was found to be significant. Drip irrigation @2 litre plant^{-1} day^{-1} at higher level of nutrients recorded maximum DMP plant^{-1} (80.09). Increased availability of nutrients and continous supply of irrigation might have helped in better expression of growth characters which is turn helped in better trapping of solar radiation. All these might have resulted in a significant increase in DMP in drip irrigated plants. Haynes (1988) reported similar trend on total DMP.

5.1.4. **Shoot-root ratio**

Drip irrigation @ 2 litre plant^{-1} day^{-1} gave higher shoot-root ratio (5.20) over furrow irrigation (4.90). Uniform and steady supply of moisture maintained under drip irrigation prevented excessive water loss from the soil and increased the crop growth, while furrow irrigation causes quick moisture loss by way of evaporation and infiltration resulting in hastened senescence and quick drying of leaves. Similar finding on increased shoot - root ratio by drip irrigation was reported by Hassan et al (1984) and Pravin (1992).

Significant increase in shoot-root ratio was noted at higher level of nutrients. Increase in nutrients increased photosynthetically active surface area and in turn higher photosynthates for producing more shoot gorwth. Similar results were reported by Lakatos (1982) and Leskovar et al. (1989).

5.1.5. **Spread of canopy**

Canopy spread was maximum for plants drip irrigated @ 2 litre day^{-1} (54.34cm) while in furrow irrigation it was only 52.73cm. Adequate supply of moisture by drip irrigation would create high internal moisture content in plants, and may initiate cell elongation, carbohydrate synthesis and ultimately increased photosynthesis. Increase in canopy spread with drip irrigation was observed by Horton et al. (1982), Pravin (1992) and Roshni (1993).

There was significant increase in canopy spread with increase in nutrients. Nutrients at higher level recorded maximum canopy spread of 56.52 cm. Increase in nutrients enchanced cell division and elongation in chilli resulting in more spread of canopy as reported by Nazeer Ahmed and Tanki (1991).

No significant interaction in canopy spread between irrigation and nutrient was observed. But drip irrigation @ 2 litre $plant^{-1}$ day^{-1} at higher level of nutrients recorded maximum canopy spread of 57.49cm.

5.2.Moisture characters

5.2.1.Moisture distribution pattern

Drip irrigation recorded significant increase in soil moisture content at all depths than furrow irrigation. Drip irrigation @ 2 litre $plant^{-1}$ day^{-1} recorded a soil moisture content of 28.16 mm, 28.34 mm and 28.69 mm at 10, 20 and 30 cm depths while in furrow irrigation it was 27.60 mm, 27.95 mm 28.30 mm respectively. High soil moisture content under drip irrigation may be due to limited area of wetting and continous replenishment which help in maintaining high soil moisture potential and enabled plants to fare better compared to furrow method of irrigation. Similar results were obtained by Bucks et al. (1981), Howell et al. (1981), Vasanthakumar (1984) and Narayanan (1991).

There was no significant difference in soil mositure content with increased level of nutrients at all depths. Increase in nutrient supply resulted in decrease in soil moisture content at all depths. This can be due to increase in nutrient supply which in turn might have increased the root distribution causing increased soil moisture extraction from more depth. Similar result has been reported by Goyal et al. (1988).

Moisture distribution at 10,20 and 30cm depth recorded no significant interaction between irrigation methods and nutrient levels. However, maximum soil moisture content was recorded by drip irrigation @ 2 litre plant^{-1} day^{-1} at higher level of nutrients at all depths.

5.2.2.**Water use efficiency**

Siginificant increase in WUE by drip irrigation @ 2 litre plant^{-1} day^{-1} over furrow irrigation was observed (Fig.5.1). There was an efficiency of 96% increase in water use by drip irrigation over furrow irrigation. This increase in water gain is because, water is being given only at the root zone as drops and this minimise various types of losses. Moreover plants receiving drip irrigation do not get subjected to any stress during their growth period in contrast to furrow irrigation where fluctuation in soil moisture during an irrigation cycle was experienced. High WUE by drip irrigation over furrow irrigation was noted by Lin et al.(1983); Thimmegowda (1990); Wivutvongvana et al.(1990) and Narayanan (1991).

The result indicate significant increase in WUE by increase in nutrients (Fig.5.1.). Nutrients at higher level recorded

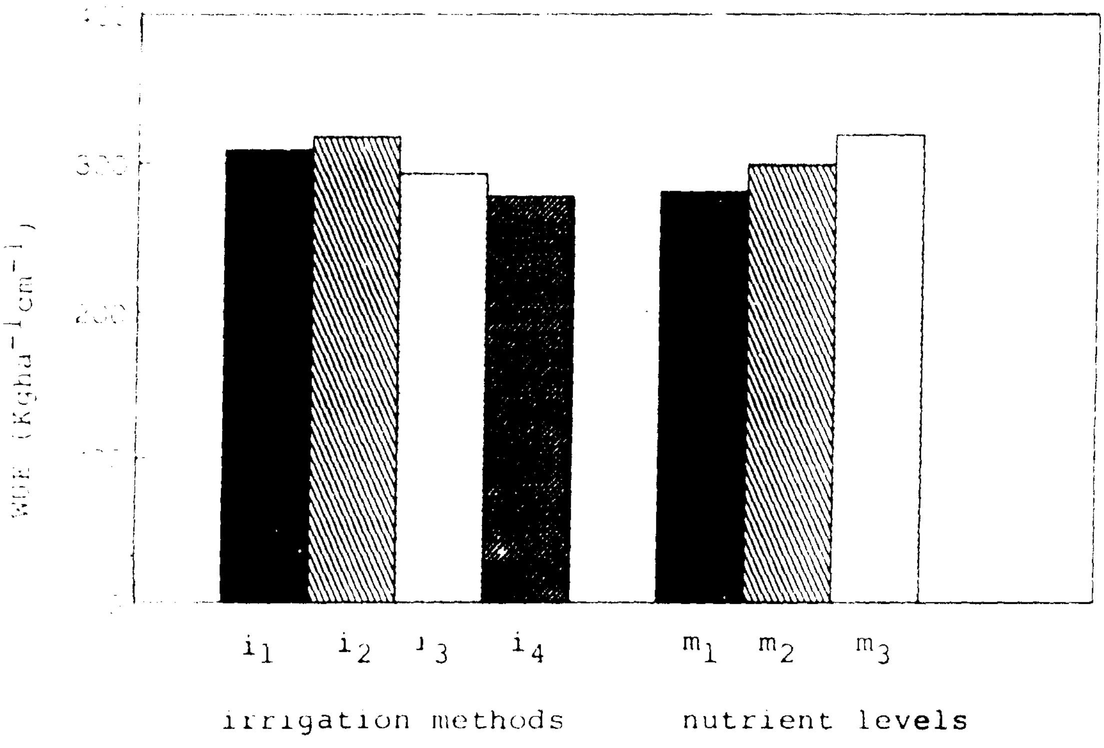


Fig.5.1. WUE due to irrigation methods and nutrient levels

maximum WUE of 318.95 Kg ha^{-1} cm^{-1}. Increased nutrient supply decreased evapotranspiration co-efficient and water consumption co-efficient resulting in more WUE (Mecs,1986). Similar result was noted by Prabhakar and Naik (1993).

Interaction between irrigation and nutrient levels on WUE was not found to be significant. But drip irrigation @ 2 litre $plant^{-1}$ day^{-1} at higher nutrient level recorded maximum WUE of 334.10 kg ha^{-1} cm^{-1}.

5.3.Time of 50% flowering, yield components and yield

5.3.1.**Time of 50% flowering**

Drip irrigation had significantly hastened the time for 50% flowering. Plants drip irrigated @ 2 litre day^{-1} had a duration of 31.6 days while furrow irrigated plants had a duration of 37.15 days for 50% flowering. Lesser duration for flowering under drip irrigation indicate that plants used water more efficiently when it was in limited quantity. Decrease in the time taken for 50% flowering by drip irrigation was reported by Goyal et al.(1984), Hassan et al. (1984) and Roshni (1993).

An increase in nutrients resulted in a significant increase in time taken for 50% flowering. Higher level of nutrients recorded maximum time of 35.41 days for 50% flowering. Increase in nutrients especially nitrogen might have prolonged the vegetative growth and delayed the maturity. Similar increase in time for 50% flowering with increase in nutrients was noted by Saji John (1989).

Time taken for 50% flowering showed a significant difference in the interaction of irrigation methods and nutrient levels. Drip irrigation @ 2 litre plant^{-1} day^{-1} at lower level of nutrients recorded minimum time for 50% flowering (29.98 days). Similar decrease in the time taken for 50% flowering in combination with nutrients was reported by Hartz et al. (1993).

5.3.2. **Number of flowers plant $^{-1}$**

Number of flowers produced per plant was significantly high in drip irrigated than furrow irrigated plants (Fig.5.2.). On an average, 4.63 flowers plant^{-1} were more produced by drip irrigated plants. Uniform and continous supply of moisture by drip irrigation might have increased nutrient uptake which in turn had a beneficial effect in stimulating plants to initiate more number of flowers plant^{-1}. Similar results on the increase in number of flowers plant^{-1} by drip irrigation was noted by Vasanthakumar (1984); Ferreyra et al. 1987 (a) and 1987 (b); Hegde (1987) and Narayanan (1991).

Number of flowers produced per plant increased significantly with increase in nutrients (Fig.5.2.). Nutrients at higher level recorded maximum number of flowers plant^{-1} (141.73). Increase in

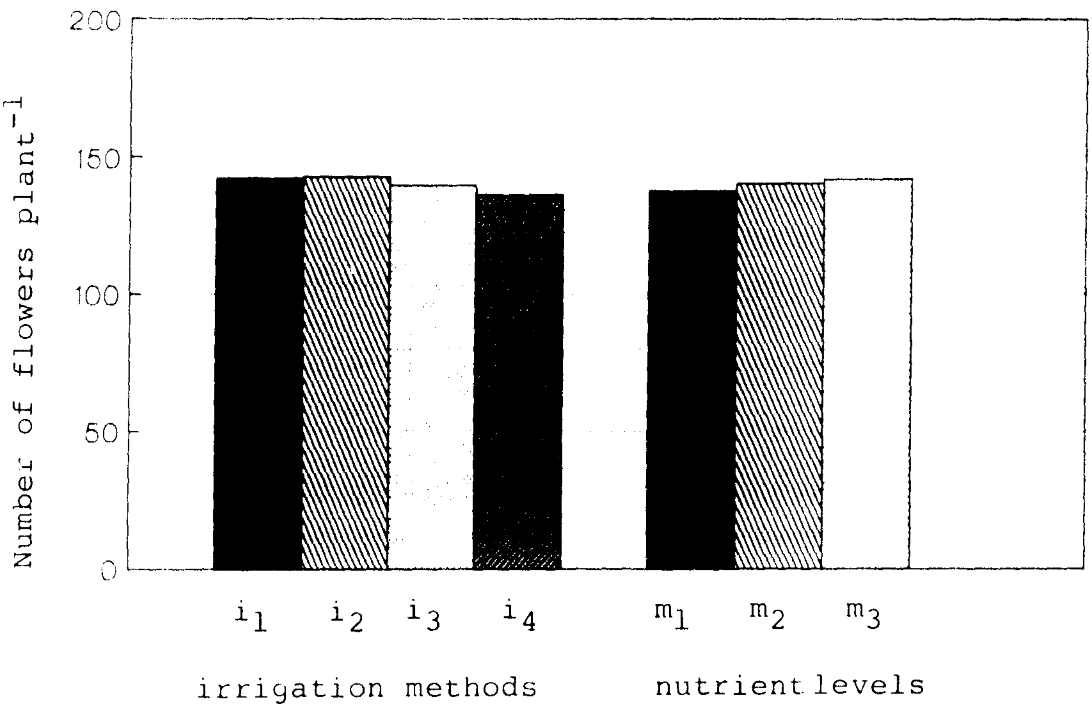


Fig.5.2. Number of flowers per plant due to irrigation methods and nutrient levels

nutrients increased photosynthetic surface area and more production, translocation and assimilation of photosynthates to growing points thereby initiating more number of flowers plant^{-1}. This is in conformity with the findings obtained by Shukla _et al_. (1987) and Jayaraman and Balasubramanian (1991).

Interaction effect on number of flowers produced per plant was found to be significant. Drip irrigation @ 2 litre plant^{-1} day^{-1} at higher level of nutrients recorded maximum number of flowers plant^{-1} (143.84). Drip irrigation along with higher level of nutrients gave higher growth rate and plant vigour resulting in flower primordial growing points thereby increasing the number of flowers plant^{-1}. Similar finding on the increase in number of flowers plant^{-1} by drip irrigation at increased nutrient level was noted by Goyal _et al_. (1989).

5.3.3. **Number of fruits plant^{-1}**

Drip irrigation increased number of fruits plant^{-1} over furrow irrigation (Fig.5.3). Plants drip irrigated @ 2 litre day^{-1} produced maximum number of fruits plant^{-1} (69.86) while furrow irrigation at 10 mm CPE produced only 63.65 fruits plant^{-1}. Increased plant height by drip irrigatioon increased number of branches which helped in assimilation and translocation of more photosynthates to growing points resulting in more number of fruits plant^{-1}. Similar findings were observed by Hassan

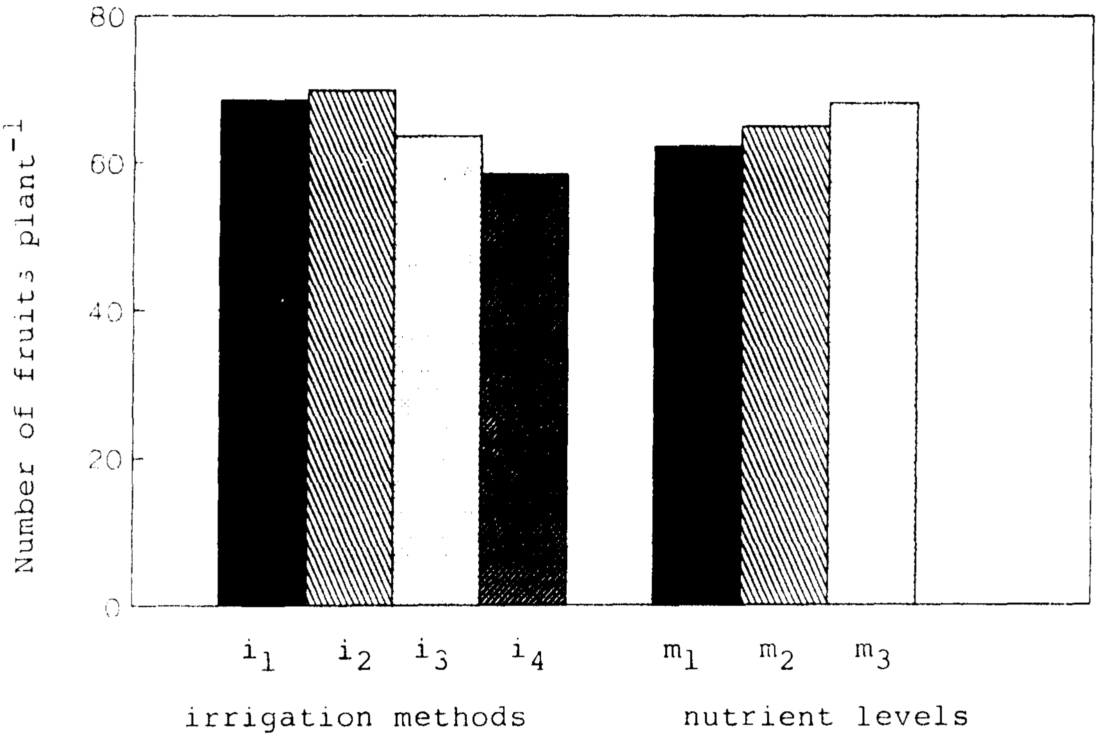


Fig.5.3. Number of fruits per plant due to irrigation methods & nutrient levels

et al. (1984), Vasanthakumar (1984), Ramesh (1986) and Narayanan (1991).

Application of nutrients significantly increased number of fruits plant^{-1} (Fig.5.3). Higher level of nutrients resulted in maximum number of fruits plant^{-1} (68.19). Increased nutrients in turn increased production, translocation and assimilation of photosynthates to growing points thereby stimulating plants to produce more number of flowers plant^{-1} and subsequently more fruits plant^{-1}. Similar results were reported by Dolkova *et al*.(1984) and Kaminwar and Rajagopal (1993).

Significant interaction was noticed between irrigation methods and nutrient levels on the production of number of fruits plant^{-1} (Fig.5.4). Drip irrigation @ 2 litre plant^{-1} day^{-1} with higher level of nutrients recorded highest number of fruits plant^{-1} (71.93). Continous and greater availability of water near the vicinity of root zone by drip irrigation along with nutrients resulted in vigorous growth there by increasing the number of flowers and fruits plant^{-1} than furrow irrigation. Similar findings on drip irrigation and nutrients was observed by Goyal *et al*. (1988) and Hartz *et al* (1993).

5.3.4. Setting percentage of fruit

Drip irrigation was found to be superior than furrow irrigation (Fig.5.5). Drip irrigation recorded 10.6% increase in

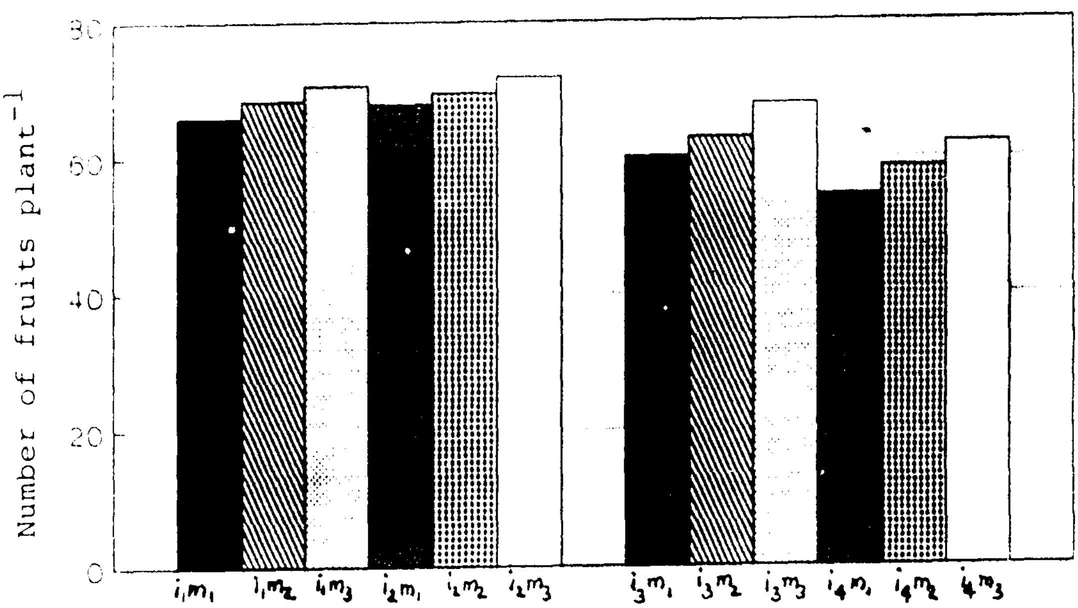


Fig.5.4. Number of fruits per plant due to interaction effect of irrigation methods and nutrient levels

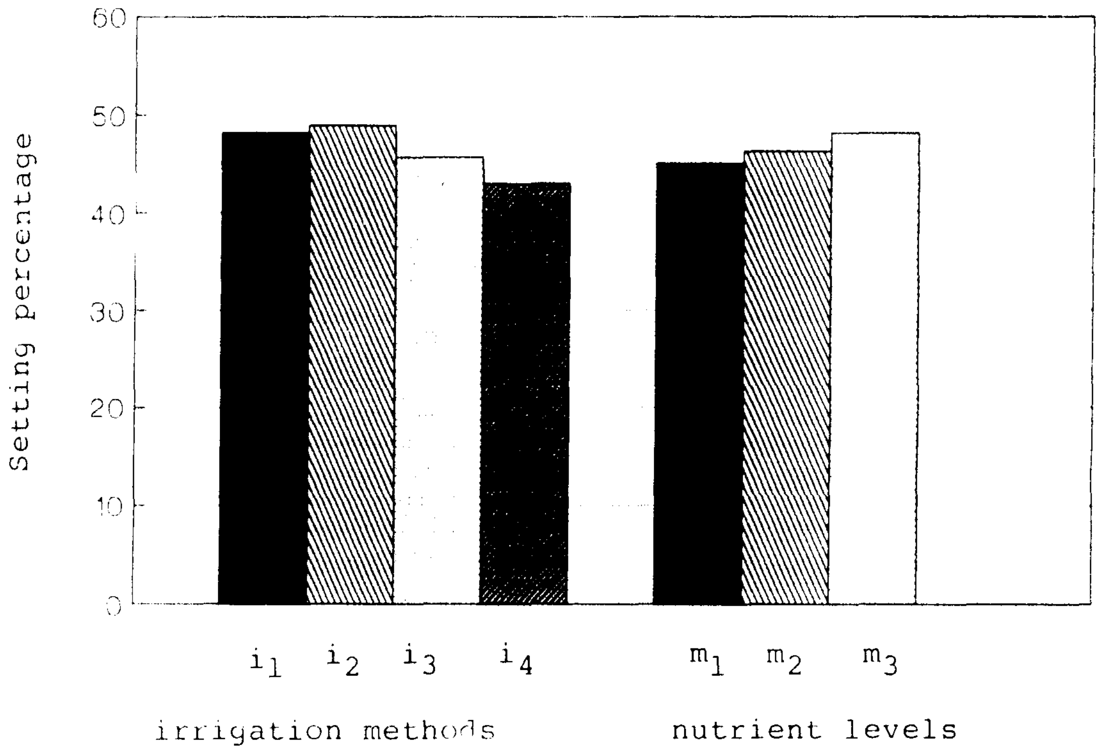


Fig.5.5. Setting percentage due to irrigation methods and nutrient levels

setting percentage over furrow irrigation. Under uniform and continous availability of water by drip irrigation, there is greater plant height, number of branches and leaf area and there by increased translocation of photosynthates and increased number of fruiting points. This resulted in increased number of flowers plant $^{-1}$ and setting percentage of fruit. Similar result was obtained by Narayanan (1991).

Graded levels of nutrients significantly increased the setting percentage of fruit (Fig.5.5). Nutrients at higher level resulted in maximum setting percentage of fruit (48.08). Increase in nutrients enhanced the production and translocation of photosynthates to growing points there by increasing the number of fruiting nodes resulting in more setting percentage. Similar findings on increased setting percentage with increased nutrient level was reported by Joseph (1982) and Jayaraman and Balasubramanian (1991).

Interaction effect on setting percentage was found to be significant (Fig.5.6). Plants drip irrigated @ 2 litre day^{-1} under higher level of nutrients recorded highest setting percentage of 50.01. Nutrients in association with efficient supply of water by drip irrigation had positive effect on yield components which in turn resulted in more number of flowers and fruits plant^{-1} resulting in more setting percentage. Similar result was noted by Goyal et al. (1989).

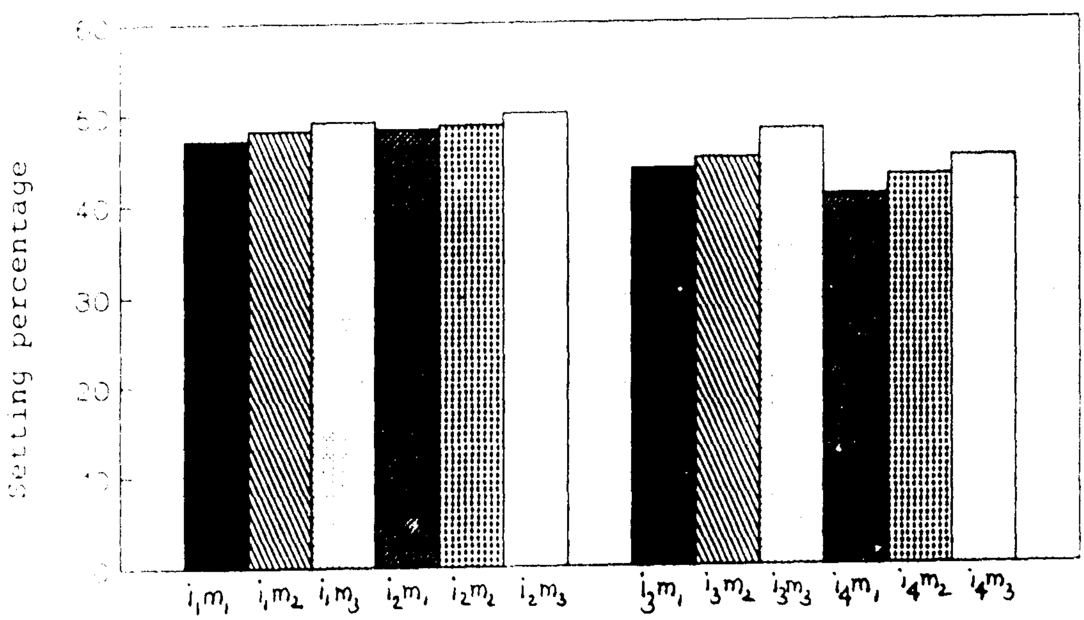


Fig.5.6. Setting percentage due to interaction effect of irrigation methods and nutrient levels

5.3.5.100 fruit weight

There was a significant increase in 100 fruit weight by drip irrigation (Fig.5.7). An increse of 7.3% in 100 fruit weight was noted due to drip irrigation. Increase in fruit weight could be attributed to higher rate of photosynthesis and increased translocation of photosynthates to fruit because of continous supply of water by drip irrigation. This result was in conformity with the findings of Hassan et al.(1984), Ramesh (1986), Narayanan (1991) and Roshni (1993).

Significant increase in 100 fruit weight was noticed with higher level of nutrients (Fig.5.7). Increase in nutrient supply resulted in increased absorption of nutrients and translocation of photosynthates resulting in more weight of fruits. Increase in 100 fruit weight with higher level of nutrients was reported by Joseph (1982) and Nazeer Ahmed and Tanki (1991).

The results showed significant interaction on 100 fruit weight (Fig.5.8). Maximum 100 fruit weight of 419.13 g was recorded by plants drip irrigated @ 2 litre day^{-1} at higher level of nutrients. Increased nutrient availability and continous supply of irrigation might have increased photosynthetically active surface area and in turn higher photosynthates for producing more fruit weight. Similar results were noted by Csizinszky et al. (1987) and Goyal et al. (1989).

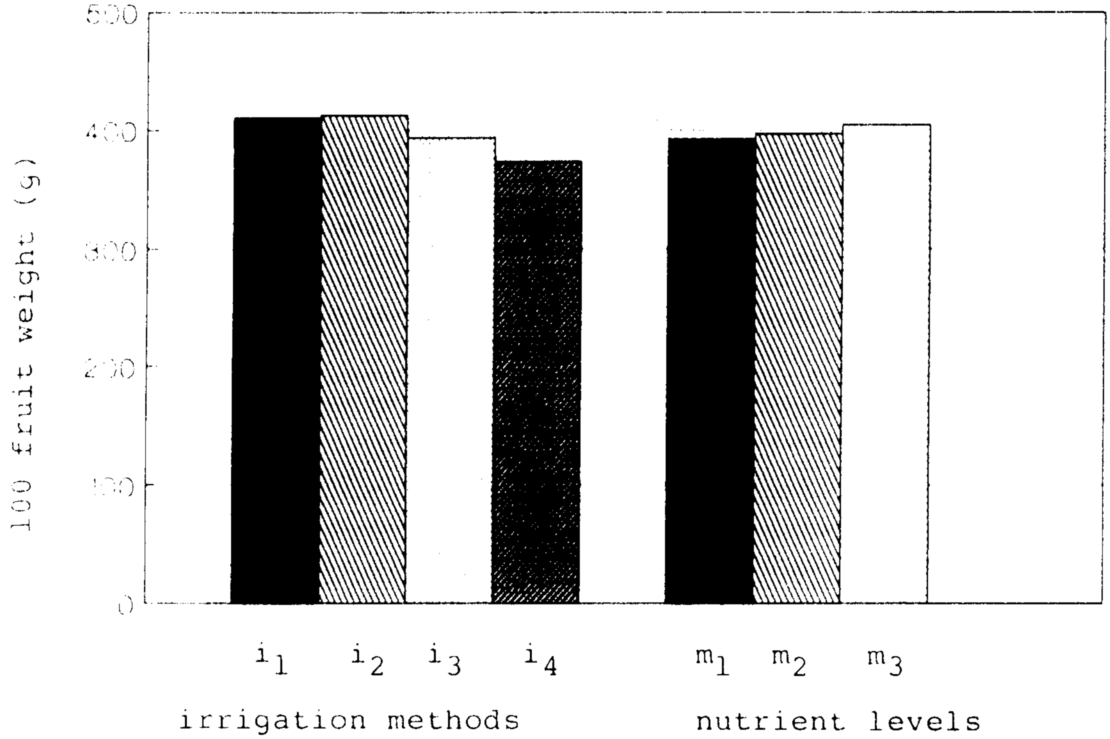


Fig.5.7. 100 fruit weight due to irrigation methods and nutrient levels

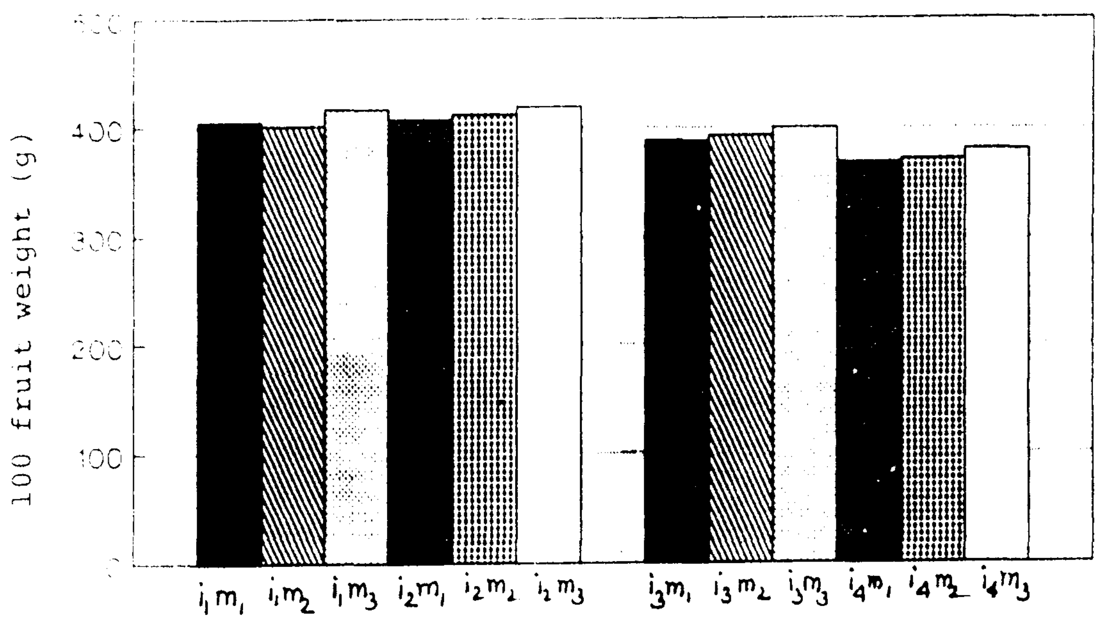


Fig.5.8. 100 fruit weight due to interaction effect of irrigation methods and nutrient levels

5.3.6. **Total yield of chillies**

Drip irrigated plants recorded an increase in yield over furrow irrigation (Fig.5.9). Continous and greater availability of water near the vicinity of root zone increased the canopy spread resulting in less weed growth and thereby offering no competition for soil moisture. Similar findings on the enhanced effect of drip irrigation was noted by Abdullah (1981), Bhorgonde (1982), Ananthakumar (1984), Lechl and Frenz (1985) and Thimmegowda (1990). Among the drip irrigation, plants drip irrigated @ 2 litre day^{-1} recorded more yield than plants drip irrigated @ 1 litre day^{-1}. As more quantity of water was applied, lateral spread of water from the point of application might have been more. So large wetted area in between two plants might have favoured movement of applied water to effective root zone and wet large soil and root mass. This is in agreement with the finding of Vasanthakumar (1984) and Ramesh (1986).

Application of higher levels of nutrients recorded significant increase in yield of chilli (Fig.5.9). Higher level of nutrients recorded maximum yield of 12.53 t ha^{-1}. Increase in nutrients increased number of fruits $plant^{-1}$ and setting percentage resulting in more yield. Similar findings on increased yield with higher nutrients was noted by Jayaraman and Balasubramanian (1991), Kaminwar and Rajagopal (1993) and Subbiah (1994).

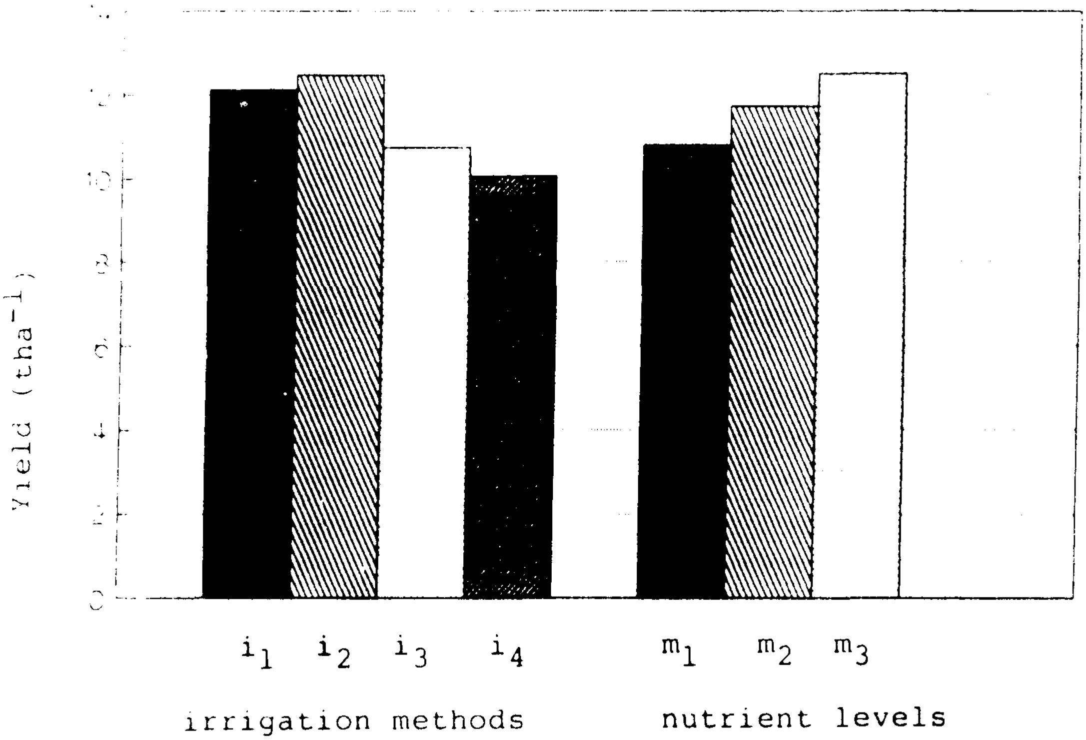


Fig.5.9. Yield of chilli due to irrigation methods and nutrient levels

Interaction effect on yield was not significant. However highest yield oof 13.12 t ha^{-1} was recorded by drip irrigation @ 2 litre $plant^{-1}$ day^{-1} under higher level of nutrients.

5.4.Ascorbic acid content of fruits

Drip irrigation showed a significant increase in ascorbic acid content over furrow irrigation (Fig.5.10). Maximum ascorbic acid content of 90.46 mg per 100 g was observed under treatment receiving drip irrigation @ 2 litre $plant^{-1}$ day^{-1}. Drip irrigation gave better quality fruits due to better absorption of nutrients. Insufficient moisture under furrow irrigation might have resulted in hampered plant growth which in turn resulted in poor quality fruits. High ascorbic acid content with drip irrigation was noted by Alvino _et al_. (1980), Tekinel _et al_. (1989), Narayanan (1991) and Pravin (1992).

Ascorbic acid content of fruits showed significant increase with increase in nutrients (Fig.5.10). Maximum ascorbic acid content of 97.61 mg per 100 g was noted at the higher level of nutrients. Increased ascorbic acid content might be due to increase in protein synthesis and enhancement of enzymatic activites for amino acid synthesis at higher level of nutrients which is instrumental in improving the quality (Shibhila Mary and Balakrishnan, 1990 and Kaminwar and Rajagopal, 1993).

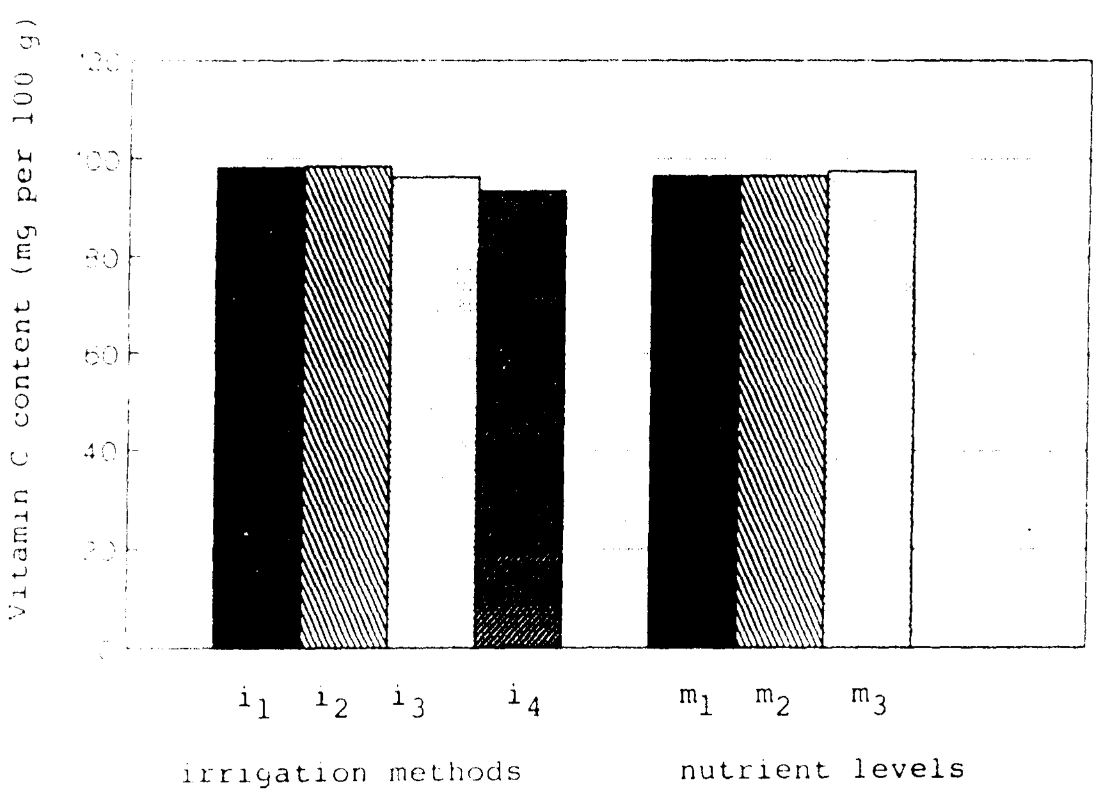


Fig.5.10. Fruit vitamin C content due to irrigation methods and nutrient levels

No significant interaction was noticed on ascorbic acid content of fruit. But drip irrigation @ 2 litre plant^{-1} day^{-1} at higher level of nutrients recorded highest ascorbic acid content of 99.52 mg per 100 g.

5.5.Plant uptake of nutrients

5.5.1.**Plant nitrogen**

Total uptake of nitrogen by plant was significantly increased by drip irrigation over furrow irrigation. Continous availability of water by drip irrigation helped in better nutrient uptake. Similar result was noted by Locascio et al. (1985).

Uptake of nitrogen increased significantly with higher level of nutrients. Nutrients at higher doses resulted in maximum nitrogen uptake by plant. The beneficial efects of higher levels of nutrients in increasing the uptake of nitrogen have been reported by Dolkova et al. (1986), Hegde (1988) and Saji John (1989).

Interaction effect was found to be not significant. However, drip irrigation @ 2 litre plant^{-1} day^{-1} at higher level of nutrients recorded maximum nitrogen uptake by plant (64.71 kg ha^{-1}).

5.5.2. **Plant phosphorus**

Application of drip irrigation did not significantly influenced phosphorus uptake over furrow irrigation. But drip irrigation @ 2 litre plant^{-1} day^{-1} recorded high phosphorus uptake (59.79 Kg ha^{-1}). Increased phosphorus uptake with drip irrigation was noted by Rankov et al. (1983).

Various nutrient levels had no significant effect in increasing phosphorus uptake.

No significant interactioon was noticed on phosphorus uptake by plant.

5.5.3. **Plant potassium**

Application of drip irrigation significantly increased the total uptake of potassium by plants over furrow irrigation. Plants drip irrigated @ 2 litre day^{-1} recorded maximum phosphorus uptake. Better nutrient uptake may be due to continuous supply of water by drip. Increased uptake of potassium by drip irrigation had been reported by Santiago and Goyal (1985).

Potassium uptake increased with increasing levels of nutrients. Nutrients at higher level recorded maximum potassium uptake. The beneficial effect of higher levels of nutrients in increasing the potassium uptake were reported by Tapia and Dabed (1984) and Subbiah (1994).

Interaction effect was found to be not significant.

5.6.Post harvest soil nutrient status

Soil phosphorus and potassium did not differ significantly in plots irrigated differently. But soil nitrogen was significantly high under drip irrigated plots. Phosphorus and potassium content was higher under drip irrigated plots than furrow irrigated plots. This is because, under drip irrigation, water is applied to the effective root zone and so leaching of nutrient along with water is less than under furrow irrigated plots.

Significant difference in soil nutrient status is noticed only upto nutrients applied at medium level. Similar result was noted by Saji John (1989).

Significant interaction was not noticed on nitrogen, phosphrous and potassium status of soil.

5.7.Economics of adoption of drip irrigation

The installation of drip irrigatiion for chilli ha^{-1} require an additional investment of Rs 30,000/- which when apportioned over ten years (approximate life span of a drip system) and two crops a year, work out to Rs.1,500/- per crop and interest on fixed cost amounting to Rs.1,500/- (Ramesh, 1986). Results

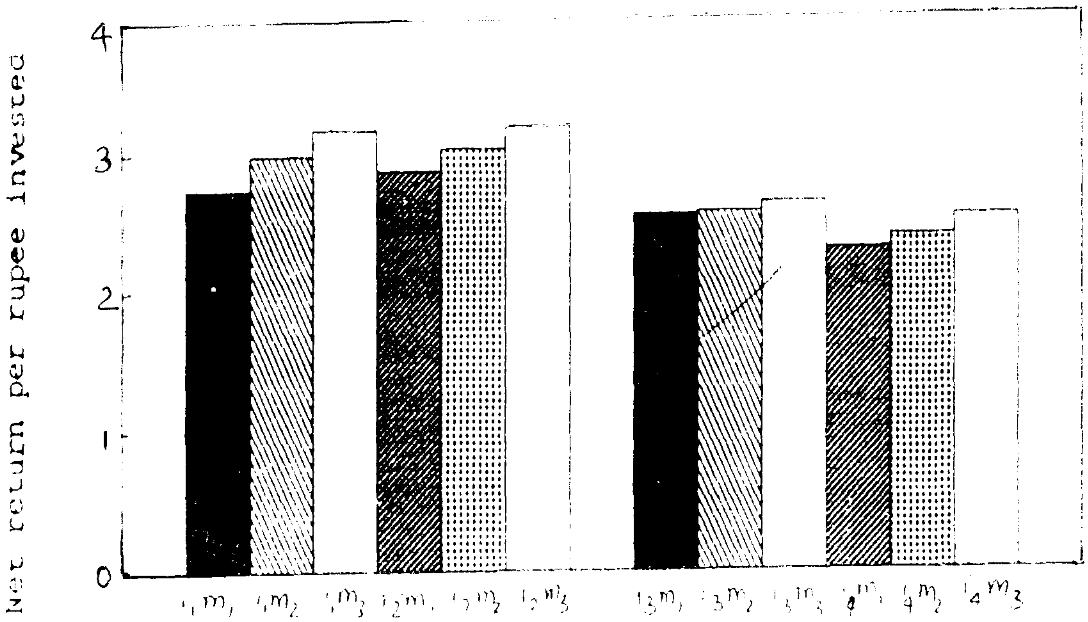


Fig.5.11. Net return per rupee invested due to interaction effect of irrigation methods and nutrient levels

indicate that a gross income of Rs.1,57,440/- ha^{-1} can be realised by adopting drip irrigation @ 2 litre $plant^{-1}$ day^{-1} at higher level of nutrients which is Rs. 80,506.50 more than that abtained with furrow irrigation at 20 mm CPE (Fig.5.11). Among the treatment combination, drip irrigation @ 2 litre $plant^{-1}$ day^{-1} at higher level of nutrients recorded highest net profit of Rs. 1,07,213.50 which is Rs.31,160/- more than that with furrow irrigatioon at 20 mm CPE. These figures were calculated using the average mean market price for vegetable chilli (Rs.16/- Kg^{-1}) that was prevailing.

SUMMARY

6. SUMMARY

A field experiment was conducted at the Instructional Farm of the College of Agriculture, Vellayani, during the period from December 1994 to March 1995, to study the effects of graded doses of nitrogen and potassium under different levels of drip and furrow irrigation on the growth, moisture characters, yield, quality and nutrient uptake of vegetable chilli, cv. Jwalasakhi. The soil of the experimental field was red loam, acidic in reaction, medium in available nitrogen and phosphorus and low in available potassium. The treatments consisted of three levels of nutrients (50;40;16.7., 75:40:25 and 100:40:33.3 $N:P_2O_5$: K_2O $kgha^{-1}$ respectively) under two levels of drip irrigation (1 litre $plant^{-1}$ day^{-1} and 2 litre $plant^{-1}$ day^{-1}) and two levels of furrow irrigation (at 10 mm CPE and 20 mm CPE at 20 mm depth). The experiment was laid out in strip plot design. The results of the investigation are summarised below.

1. Plant height differed significantly with methods of irrigation and levels of nutrients at all stages of growth. Plant height was maximum with drip irrigation @ 2 litre $plant^{-1}$ day^{-1} and at higher level of nutrients.

2. Number of branches produced per plant increased significantly with increased levels of nutrients. Plants drip irrigated @ 2 litre day^{-1} recorded maximum number of branches plant^{-1}.

3. Methods of irrigation and levels of nutrients had profound influence on DMP of plant. Maximum DMP was observed with drip irrigation @ 2 litre plant^{-1}day^{-1} and higher level of nutrients.

4. Shoot-root ratio differed significantly with treatments. Plants drip irrigated @ 2 litre day^{-1} recorded maximum shoot-root ratio. Graded doses of nutrients progressively increased it.

5. Higher doses of nutrients significantly increased the spread of canopy and it was highest with drip irrigation @ 2 litre plant^{-1} day^{-1}.

6. There was difference in moisture distribution pattern with increase in nutrient levels at 10 cm, 20 cm and 30 cm depths eventhough the difference was significant only with medium level of nutrients. Plants drip irrigated @ 2 litre day^{-1} recorded maximum soil moisture content at all depths.

7. WUE was significantly higher with drip irrigation. But no significant difference was noticed between drip irrigations @ 1 litre and 2 litre plant^{-1} day^{-1}. It was significantly increased with graded doses of nutrients.

8. Number of days taken for 50% flowering decreased with drip irrigation. Plant drip irrigated @ 2 litre day^{-1} recorded a duration of 31.6 days only for 50% flowering. With increase in levels of nutrients time taken for 50% flowering was increased.

9. Methods of irrigation and levels of nutrients significantly increased number of flowers $plant^{-1}$. It was highest with plants drip irrigated @ 2 litre day^{-1} and at higher level of nutrients.

10. Number of fruits $plant^{-1}$ significantly increased with methods of irrigation and levels of nutrients. Drip irrigation @ 2 litre $plant^{-1}$ day^{-1} and higher level of nutrients recorded maximum number of fruits $plant^{-1}$.

11. Significant influence was observed on setting percentage of fruit with treatments. Drip irrigation @ 2 litre $plant^{-1}$ day^{-1} and higher level of nutrients contributed to the highest setting percentage of fruit.

12. The maximum 100 fruit weight was obtained for plants drip irrigated @ 2 litre day^{-1} and higher level of nutrients.

13. Maximum yield was obtained for plants drip irrigated @ 2 litre day^{-1} and higher level of nutrients.

14. Plants drip irrigated @ 2 litre day^{-1} and higher level of nutrients recorded maximum ascorbic acid content of fruits.

15. The total uptake of nitrogen by plant was significantly increased by plants drip irrigated @ 2 litre day^{-1} and higher level of nutrients.

16. Drip irrigation @ 2 litre $plant^{-1}$ day^{-1} recorded maximum phosphorus uptake by plant but no significant difference was noted with 1 litre drip irrigatioon and furrow irrigation.

17. Potassium uptake by plants was higher under drip irrigated treatment. With respect to levels of nutrients, potassium uptake was maximum at higher level of nutrients applied.

18. Soil nitrogen and soil phosphorus did not differ significantly in plots irrigated differently. There was significant increase in soil nitrogen in plots receiving higher level of nutrients.

19. Methods of irrigation and levels of nutrients had no significance on soil potassium status.

20. For vegetable chilli cultivation maximum profit was received with drip irrigation at 2 litre $plant^{-1}$ day^{-1} and higher level of nutrients.

21. Interaction effect due to methods of irigation and levels of nutrients was significant on plant height at 35 DAT, 70DAT and at harvest, number of branches plant^{-1}, DMP, time of 50% flowering, number of flowers plant^{-1}, number of fruit plant^{-1}, setting percentage of fruit and 100 fruit weight. Drip irrigation @ 2 litre plant^{-1} day^{-1} in combination with higher level of nutrients recorded maximum value.

22. Interaction effect due to methods of irrigation and nutrient level on yield plant^{-1} was not significant. But yield was highest with drip irrigation @ 2 litre plant^{-1} day^{-1} at higher level of nutrients.

Future line of work:

1. Higher rates of application of irrigation should be studied.

2. Fertigation studies on the application of nutrients along with drip should be investigated.

REFERENCES

7. REFERENCES

Abdullah, S.1981. Drip irrigation system for application of fertilizer. M.Sc.(Ag.) thesis, Univ. Agric. Sci., Bangalore.

Abou-Hussein,M.R., El-Beltagy,A.S., El-Beltagy, Khalil,S., Maksound,M.A. and Abel-Halim,S.M.1984. Effect of soil water availability on growth, flowering and fruiting of pepper plants. Egyptian J. Hort., 11 : 113-126.

Ahmed,M.K. 1984. Optimum plant spacing and nitrogen fertilization of sweet pepper in Sudan Gezira. Acta Hortic., 143 : 305-310.

Ajay Kumar and Thakral, K.K. 1993. Effect of herbicides and nitrogen fertilization on growth and yield of chilli (Capsicum frutescens L.). Proc. Indian Soc. Weed Sci., Int. Sym., Hisar, India. Indian Soc. Weed Sci., 3 : 206-208.

Alvino,A., Frusciante, L. and Monti, L.M. 1980. Yield and quality traits of two new tomato varieties under different irrigation regimes. Acta Hortic., 160 : 173-180.

Amritalingam,S. 1988. Studies on the effect of Azospirillum, Nitrogen and NAA on growth and yield of chilli (Capsicum annum L.) cv.K-1. S. Indian Hort., 36 (4) : 218.

Ananthakumar, A.P. 1984. Studies on relative economy in the use of irrigation water in sweet orange (Citrus sinensis L.). M.Sc. (Ag.) thesis, Univ. Agric. Sci., Bangalore.

Bar-yosef,B., Stammers, C. and Sagev, B.1980. Growth of trickle irrigated tomato as related to rooting volume and uptake of nitrogen and water. Agron. J., 72 : 815-822.

Batal,K.M. and Smittle, D.A.1981. Response of bell pepper to irrigation, nitrogen and plant population. J. Amer. Soc. Hort. Sci., 106 (3) : 259-262.

Beese,F., Horton,R. and Wierenga,P.J.1982. Growth and yield response of chile pepper to trickle irrigation. Agron. J., 74 : 556-561.

*Belichki,I.1988. Mineral fertilization of Capsicum annum for early field production. Rasteniev "dni Nauki, 25 (6) : 56-61.

Bhorgonde,D.S.1982. Drip system of irrigation for the use of saline water for cabbage crop. M.Sc.(Ag.) thesis, Univ. Agric. Sci., Bangalore.

Bray,A.H. and Kurtz,L.O. 1945. Determination of total, organic and available forms of phosphorus in soils. Curr. Sci., 59 : 39-45.

*Bubicz,M., Korzen,A. and Perucka,I.1981. Effect of potassium fertilization on the content of L-ascorbic acid, ß carotene and capsaicin in capsicum fruits. Roczniki Nauk Rolniczych A, 104 (4) : 43-52.

Bucks,D.A., Nakayama, F.S. and Warrick,A.1981. Principles of Trickle (drip) irrigation - In advances in irrigation. Academic Press Inc., New York, pp.220-299.

Crespo-Ruiz,M., Goyal,M.R., Baez,C.C.De. and Rivera,L.E.1988. Nutrient uptake and growth characteristics of nitrogen fertigated sweet pepper under drip irrigation and plastic mulch. J. Amer. Univ. Puerto Rico, 72 (4) : 575-584.

Csizinszky,A.A., Stanely,C.D. and Overman, A.J. 1987. Response of two tomato cultivars to irrigation systems, fertilizer sources and plant spacings for three consecutive seasons. Proc. Soil Crop Sci. Soc. Fla., 46 : 1-4.

Damke,M.M., Kawarkhe,V.J. and Patil,C.V.1988. Effect of phosphorus and potassium on growth and yield of chilli. PKV Res. J., 12 (2) : 110-114.

*Demirovska,V., Trepeuski,V., Ognenovski,V., Stojanova,M., Agric,R. and Simonov,D. 1992. The effect of different nitrogen rates on yield and quality of some capsicum cultivars. Savremene Poljoprivreda, 40 (1-2) : 45-50.

Dharmatti,P.R. and Kulkarni,G.N. 1988. Effect of nutrition, spacing and pickings on seed yield and seed quality in bell pepper. Seed Res., 16 (2) : 148-151.

Dod,V.N., Joshi,A.T., Kale, P.B. and Kulwal,L.V.1983. Effect of different levels of nitrogen in split doses on yield and quality of red ripe chilli (Capsicum annum L.) cv. G-3. Proc. Nat. Sem. Prod. Tech. Chillies and Tomato, TNAU, Coimbatore, pp. 152-153.

*Dolkova,M., Petronv.K.H. and Rankov,V.1984. Nutrient uptake from fertilized soil by capsicum crop. Gradinarska i Lozarska Nauka, 21 (8) : 51-57.

*Dolkova,M., Ralkova,L. and Rankov,V. 1986. Effect of fertilization on the productivity and total nitrogen and nitrate content of capsicum. Rasteniev "dni Nauki, 23 (6) : 70-74.

*Dysko,J. and Kaniszewski,S. 1989. Effect of soil moisture level on capsicum yield. Biuletyn Warzywniczy Suppl1. 11 : 189-194.

El-Beheidi,M.A., El-Sherbeiny,A.A. and El-Sawah,M.H. 1994. Influence of different irrigation methods and potassium fertilizer on tomato plants in new reclaimed sandy soil. Egyptian J. Hort., 17 (1) : 37-45.

El-Gindy,A.G.M.1984. Optimization of water use for pepper crop. Amer. Agric. Sci., 29 : 539-556.

Everett,P.H. and Subramanya.R, 1984. Pepper production as influenced by plant spacing and nitrogen-potassium rates. Citrus Veg. Mag., 48 (4) : 42-47.

Ferreyra,E.R., Selles Van, S.G. and Gonzalez, P.M. 1987a. Effect of different water levels on pepper. III. Plant water relations and nitrogen, phosphorus and potassium absorption. Agricultura Tecnica, 45 : 235-249.

Ferreyra,E.R., Selles Van, S.G. and Gonzalez, P.M. 1987b. Effect of different water levels on pepper. III. Plant water relations and nitrogen, phosphorus and potassium absorption. Agricultura Tecnica, 47 : 304-307.

Foster,W.M., Batechelor,C.H., Bell,J.P. and Hodet.1989. Small scale irrigation in SriLanka - soil moisture status and crop response to drip irrigation. Irrigation - Theory and Practice, pp.602-615.

Goyal,M.R., Santiago,C.L. and Chao De Baez, C. 1984. How plastic mulches affect growth parameters of drip irrigated summer peppers. J. Agric. Univ. Puerto Rico, 68 : 365-373.

Goyal,M.R., Rivera,L.E. and Santiago, C.L. 1985. Nitrogen fertigation in drip irrigated peppers, tomato and egg plant. In drip/trickle irrigation in action. Vol I. Amer. Soc. Agric. Engg., pp.388-392.

*Goyal,M.R., Gonzalez, E.A., Rivera, L.E. and Chao De Baez, C.1987. Sweet pepper response to drip, micro-sprinkler and furrow irrigation. Hort. Abst., 58 : 1081.

Goyal, M.R., Crespo-Ruiz,M. and Rivera, L.E. 1988. Root distribution of nitrogen fertigated sweet pepper under drip irrigation. J. Agric. Univ., Puerto Rico, 72 (1) : 51-55.

Goyal,M.R., Guadalupe-Luna,R., Hernandez,E., R.DE., Cha Ude. and Baez, C.1989. Post harvest evaluation of nitrogen fertigated sweet pepper under drip irrigation and plastic mulch. J. Agric. Univ. Puerto Rico, 73 (2) : 109-114.

Gulati,J.M.L., Mishra,M.M., Paul, J.C. and Sahu, G.S. 1995. Production potential of chilli (Capsicum annum L.) under levels of irrigation and nitrogen. Indian J. Agron., 40 (1) : 145-146.

Gutal,G.B., Jadhav,S.S. and Takte,R.L. 1990. Response of chilli crop to drip irrigation. Proc. Int. Agric. Engg. Conf. Exhibition, Thailand, Dec. 3-6.

Hartz,T.K., Le Strange,M. and May,D.M. 1993. Nitrogen requirement of drip irrigated peppers. Hort. Sci., 28 (11) : 1097-1099.

Hassan,A.H., Agria, E.A., Saleh, M.M. and El-Wahba,H.1984. Effect of water regime on growth and chemical composition of Capsicum annum L. Annals Agric. Sci., 21 (3) : 1007-1016.

Haynes, R.J. 1988. Comparison of fertigation with broadcast application of urea-nitrogen on levels of available soil nutrients and on growth and yield of trickle irrigated peppers. Scientia Hortic., 35 (3-4) : 189-198.

Haynes, R.J. and Herring,S. 1981. Performance of drip irrigated bell peppers. Arakanas Farm Res., 30 : 12.

Hegde, D.M. 1987. Growth analysis of bell pepper (Capsicum annum L.) in relation to soil moisture and nitrogen fertilization. Scientia Hortic., 33 : 179-187.

Hedge, D.M.1988. Irrigation and nitrogen requirement of bell pepper. Indian J. Agric. Sci., **58** (9) : 669-672.

Hegde, D.M.1989. Effect of soil moisture and nitrogen on plant water relations, mineral composition and productivity of bell pepper (Capsicum annum L.). Indian J. Agron., **34** : 30-34.

Horton,R., Beese, F. and Wierenga, P.J. 1982. Physiological response of chile pepper to trickle irrigation. Agron. J., **74** : 551-555.

Howell, T.A., Bucks, D.A. and Chesness, J.L. 1981. Advances in trickle irrigation, In "Irrigation-Challenges of 80's". Proc. 2nd Nat. Irrig. Sym., Amer. Soc. Agric. Engg., pp. 67-94.

Jackson, M.L. 1967. Soil Chemical Analysis. Prentice Hall of Indian Ltd., New Delhi, 2nd Ed., pp. 1-498.

Jayaraman, S.and Balasubramanian,R. 1991. Effect of different levels of potassium and nitrogen on yield of irrigated chilli. Madras Agric. J., **78** (9-12) : 519-520.

Jinadasa. D.M., Eavis, B.W., Bolton, F.R. and Thenabadu, M.W. 1987. Nitrogen and water balance studies in relation to farmyard manure and nitrogen fertilizer applications to Sri Lankan Luvisols. Trop. Agric., **64** (1) : 49-54.

Joseph, P.A.1982. Effect of nitrogen, phosphorus and potassium on the growth and yield of chilli, var. Pant C-1. M.Sc. (Ag.) thesis, Kerala Agric. Univ., Trichur.

Joseph, P.A. and Pillai, P.B. 1985. Effect of nitrogen, phosphorus and potassium on the growth and yield of chilli, var. Pant C-1. Agric. Res. J. Kerala, 23 (1) : 75-82.

Kaminwar, S.P. and Rajagopal, V. 1993. Fertilizer response and nutrient requirements of rainfed chillies in Andhra Pradesh. Fert. News, 38 (7) : 21, 23-26.

Kataria, D.P. and Michael, A.M. 1990. Comparative study of drip and furrow irrigation methods. Proc. XI Int. Cong. Use Plastics Agric., New Delhi, pp.19-27.

KAU.1992. Research highlights on vegetables. Directorate of Research, Kerala Agric. Univ., Trichur

KAU. 1993. Package of Practices Recommendations - Crops. Directorate of Extension, Kerala Agric. Univ., Trichur, pp.176-177.

Kulvinder Singh. and Srivastava, B.K. 1988. Effect of various levels of nitrogen and phosphorus on growth and yield of chilli (Capsicum annum L.). Indian J. Hort., 45 (3-4) : 319-324.

*Lakatos, M.1982. Studies on drymatter accumulation and nutrient uptake by capsicum cv. Soroksai Hajtato in water culture experiements. Kerteszeti Egyetem Kozlemenyei, 45 (13) : 23-25.

Lata, S. and Singh, R.P. 1993. Effect of nitrogen level and growth regulators on growth, yield and quality of chilli (Capsicum annum L.). var. Pant C-1. Veg. Sci., 20 (1) : 40-43.

*Lechl, P. and Frenz, F.W. 1985. A comparison of drip irrigation and nozzle sprinkling for growing paprikas at Weihenstephan. Deutscher Gartenban, 39 : 655-656.

*Leon, M. and Portuondo, M.A. 1989. Irrigation regime for capsicum cultivar. Medalla de Oro. Agrotecnika de Cuba, 21 (2) : 29-34.

Leskovar, D.I., Cantiliffe, D.J. and Stoffella, P.J. 1989. Pepper (Capsicum annum L.) root growth and its relation to shoot growth in response to nitrogen. J. Hort. Sci., **64** (6) : 711-716.

Lin, S.S.M., Hubbel, J.N., Samson, S.C.S. and Splittstoesser, W.E. 1983. Drip irrigation and tomato yield under tropical conditions. Hort. Sci., **18** : 460-461.

Locascio. S.J., Mayers, J.M. and Kosteuriez, S.P. 1981. Quality and rate of water application for drip irrigated tomatoes. Proc. Fla. St. Hort. Soc., **94** : 163-166.

Locascio, S.J., Fiskell, J.G.A., Greatz, D.A. and Hauk, R.D. 1985. Nitrogen accumulation by pepper as influenced by mulch and time of fertilizer application. J. Amer. Soc. Hort. Sci., **110** (3) : 325-328.

Manchanda, A.K. and Bhopal Singh. 1987. Effect of plant density and nitrogen on yield and quality of bell pepper (Capsicum annum L.). Indian J. Hort., **44** (3-4) : 250-252.

Manjunath, B.L., Mishra, P.K., Rao, J.V. and Subba Reddy, G. 1994. Water requirement of vegetables in a dryland watershed. Indian J. Agric. Sci., **64** (12) : 845-846.

*Mecs. 1986. Investigation on the simultaneous effect of water and nutrient supply on direct-sown spice capsicum. Zoldsegtermesztesi Kutato Intezet Bulletinje, 19 : 91-95.

Naik, A.V. 1986. Study on the use of saline water through drip irrigation system. M.Sc. (Ag.) thesis, Univ. Agric. Sci., Bangalore.

Nandal, J.K., Banerjee,M.K. and Arora,S.K.1991. Drip Irrigation - A New Approach in Vegetable Farming. Farm Parl., 5 : 19,41.

Narasappa,K., Reddy, E.N. and Reddy, V.P. 1985. Effect of nitrogen fertilization on chilli (Capsicum annum L.). cv. Sindhur, S. Indian Hort., 33 (3) : 158-162.

Narasimhan,V. and Alagianagalingam, M.N. 1986. Potassium in the management of chilli mosaic disease. J. Potassium Res., 2 (2) : 59-64.

Narayanan, T.A. 1991. Studies on efficiency of drip irrigation in sweet peper (Capsicum annum L.). M.Sc. (Ag.) thesis, Univ. Agric. Sci., Bangalore.

Natarajan,S.1990. Standardisation of nitrogen application for chilli (Capsicum annum L.) grown under semi-dry condition. S. Indian Hort., 38 (6) : 315-318.

Nazeer Ahmed. and Tanki, M.I. 1991. Response of chilli (Capsicum annum L.) to nitrogen and phosphorus. Haryana J. Hort. Sci., 20 (1-2) : 114-118.

O'Dell, C. 1983. Trickle did the trick. Amer. Veg. grower, 31 (4) : 56.

*Palevitch, D. Gera, G., Shaked, M., Levy, A., Menagem, E. and Yehuda, M.B. 1988. Irrigation of paprika (Capsicum annum L.) plants. Hassadeh, 60 : 1535-1543.

Palled, Y.B., Chandrasekharaiah, A.M., Kachapur, M.D. and Khot, A.B. 1988. Yield and WUE of chilli as influenced by irrigation schedules and nitrogen levels in Malaprabha Command Area. Farming System, 4 (1-2) : 25-28.

*Pandev, S., Stanev, V. and K"Drev, T.1980. Effect of major element deficiency in the nutrient medium on the photosynthetic productivity of Capsicum annum. Fiziologiya na Rasteniyata, 6 (4) : 46-55.

Pandey, D.P., Singh, S.B. and Shashank Singh. 1992. Effect of nitrogen levels and row spacings on growth and yield of autumn - winter chilli (Capsicum annum L.). Narendra Deva J. Agric. Res., 7 (1) : 58-61.

Paraminder Singh, Sharma, P.P. and Arya, P.S. 1986. Studies on the effect of nitrogen and potassium on growth, fruit yield and quality of chilli. Indian Cocoa Arecanut Spices J., 9 (3) : 67-79.

Paul Gyorgy. and Pearson, W.N. 1967. The vitamins - Chemistry, Philosophy - method. Academic Press, New York, 2nd Ed. Vol. VII. pp. 235-238.

Prabhakar, B.S., Srinivas,K. and Vishnu Shukla. 1987. Growth and yield response of green chilli to nitrogen and phosphorus fertilizatioin. Indian Cocoa Arecanut Spices J., 10 (1) : 12-14.

Prabhakar, M. and Naik, L.B. 1993. Effect of irrigation and nitrogen fertilization on growth, yield, nitrogen uptake and water use of chilli (Capsicum annum L.) grown for green fruits. Golden Jubilee Sym. Hort. Res. - Changing Scenario, Bangalore, May 24-28, p.185.

Pravin, T.Gala.1992. Economics of tomato and capsicum production under drip versus furrow irrigation. Drip Irrigation, Oxford and IBH, pp.69-76.

Ramachandran, S. and Subbiah, K.K. 1981. Studies on the effect of plant density and graded levels of nitrogen on yield and yield components of chillies (Capsicum annum L.). S. Indian Hort., 29 (4) : 178-181.

Ramachandran,S. and Subbaiah, K.K. 1982. Effect of plant density and graded levels of nitrogen on growth attributes of chillies (Capsicum annum L.)cv. MDU-1. S. Indian Hort., 30 : 266-267.

Ramesh, S. 1986. A study on drip and furrow method of irrigation in green chilli (Capsicum annum L.) under different planting patterns and plant densities. M.Sc. (Ag.) thesis, Univ. Agric. Sci., Bangalore.

*Rankov, V., Oimitrov, G. and Stoyanova, I. 1983. Nitrogen, phosphorus and potassium uptake during early capsicum growth at different levels of mineral fertilization. Fiziologiya na Rasteniyata, 9 (1) : 22-31.

*Rankov, V. and Todorov, I.K. 1984. Nitrogen, phosphorus and potassium uptake from the soil in relation to the yield of capsicum cultivars. Gradinarska i Lozarska Nauka, 21 (1) : 57-62.

Rao, E.H. and Gulshanlal. 1986. Response of chilli (Capsicum annum L.) var. Pant C-1 to varying levels of nitrogen and spacing. Veg. Sci., 13 (1) : 17-21.

Rao, R.Y., Bhavaji, J.N. and Murthy, N.S.R. 1988. Studies on nitrogen nutrition of chilli in relation to potassium under rainfed condition. Indian Cocoa Arecanut Spices J., 11 (3) : 90-93.

*Roman,L. 1982. Studies on mineral nutrition with nitrogen, phosphorus and potassium of capsicum grown under high plastic tunnels. Anale, Institutul de Ceretari pentru Legumicultura Si Floricultura, Vidra, 6 : 191-196.

Roshni, C. 1993. Evaluation of low cost techniques in potted vegetables grown in roof gardens. M.Sc. (Ag.) thesis, Kerala Agric. Univ., Trichur.

Russo, V.M. 1991. Effects of fertilizer rate, application timing, plant spacing on yield and nutrient content of bell pepper. J. Plant Nut., **14** (10) : 1047-1056.

Saji John. 1989. Nutrient management in vegetable chilli (Capsicum annum L.) var. Jwalasakhi. M.Sc. (Ag.) thesis, Kerala Agric. Univ., Trichur.

Santiago, C.L. and Goyal, M.R. 1985. Nutrient uptake and solute movement in drip irrigated summer peppers. J. Agric. Univ., Puerto Rico, 69 (1) : 63-68.

Shamima Nasreen. and Islam, M.S. 1989. Response of chilli to nitrogen, phosphorus, potassium and and sulphur fertilization. Bangladesh Hort., **17** (2) : 5-9.

Shibhila Mary, S. and Balakrishnan, R.1990. Effect of irrigation, nitrogen and potassium on pod characters and quality in chilli (Capsicum annum L.) cv. K-2. S. Indian Hort., **38** (2) : 86-89.

Shin, C.W., Yoon, J.H., Rhee, K.M., Park, J.K. and Roh, T.H. 1988. Soil chemical properties of representative farmer's field for hot pepper and yield response to nitrogen, phosphorus and potassium fertilizers. Res. Report, Rural Development Administration, Soils Fert., Korea Republic, 30 (1) : 76-83.

Shukla, V., Srinivas, K. and Prabhakar, B.S. 1987. Response of bell pepper to nitrogen, phosphorus and potassium fertilization. Indian J. Hort., **44** (1&2) : 81-84.

Singh, P. Kumar, R., Agarwal, M.C. and Mandel, J.L. 1990. Performance of drip and surface irrigation for tomato (Lycopersicon esculentum L.) in heavy soils. Proc. XI Int. Cong. Use Plastics Agric., New Delhi, p.51.

*Sirjacobs, M. and Dada Ould Slama. 1983. Localised irrigation of a green pepper plant in a green house in an arid region - Practical approach to the management of the water supply. Agronomiques de Gem blours, 18 (2) : 137-148.

Sivanappan, R.K. and Padmakumari, O. 1980. Drip irrigation. College Agric. Engg., Coimbatore, p.58.

Snedecor, G.W. and Cochran, W.G. 1967. Statistical Methods. Oxford and IBH, Publishing Co., Calcutta.

Song, S.J. 1987. Studies on the time of applying nitrogen fertilizer to capsicums. Acta Hortic. Sinica, 14 (3) : 185-191.

Splittstoesser, W.E. and Gerber, J.M. 1986. Response of bell pepper to high rates of side dressed nitrogen. Proc. Inter American Soc. Trop. Hort., 30 : 171-176.

Srinivas, K. and Prabhakar, B.S. 1982. Response of capsicum to nitrogen fertilization. Veg. Sci., 9 (2) : 71-74.

Srinivas, K. 1983. Response of green chilli to nitrogen and phosphorus fertilization. S. Indian Hort., 31 (1) : 37-39.

Subbiah, B.V. and Asija, G.L. 1956. A rapid procedure for the determination of available nitrogen in soils. Soil Sci., 59 : 39-45.

Subbiah, K., Helkiah, J., Ravikumar, V. and Rajagopal, C.K. 1982. Effect of combined application of organic and inorganic fertilizer on yield and nutrient uptake of MDU-1 chilli. S. Indian Hort., 30 (1) : 45-47.

Subbiah, K. 1993. Effect of biofertilizer in the presence of nitrogen and potassium on yield in chilli and bellary onion. Golden Jubilee Sym. Hort. Res. - Changing Scenario, Bangalore, May 24-28, p.129.

Subbiah, K. 1994. Effect of nitrogen, potassium and biofertilizers on yield and nutrient uptake in chilli and bellary onion. Madras Agric J., 81(5) : 277-279.

Subhani, P.M., Ravisankar, C. and Narayana, N. 1990. Effect of graded levels and time of application of nitrogen and potassium on flowering, fruiting and yield of irrigated chilli. Indian Cocoa Arecanut Spices J., 14 (2) : 70-73.

Sundstrom, F.J., Thomas, C.H., Edwards, R.L. and Baskin, G.R. 1984. Influence of Nitrogen and plant spacing on mechanically harvested tabasco pepper. J. Amer. Soc. Hort., 109 (5) : 642-645.

*Surlekov, P. and Rankov, V. 1989. The effect of fertilization on capsicum productivity and soil agrochemical and biological properties in monoculture. Pochvoznanie i Agrokhimiya, 24 (2) : 17-23.

Tapia, M.L. and Dabed, R. 1984. Nutrient uptake by sweet pepper grown in quartz. Proc. IX Int. Cong. Soilless culture, Luntern, ISOSC, pp.683-696.

Tekinel, O., Kanber, R., Onder, S., Baytorun, N. and Bastug, R. 1989. The effect of trickle and conventional irrigation methods on some crops, yield and WUE under Cukurowa condition. Irrigation - theory and practice, Southampton, U.K.

Thiagarajan, C.P. 1990. Influence of nitrogen, phosphorus and potassium on the yield and quality of chilli seed. S. Indian Hort., 38 (3) : 159-160.

Thimmegowda, S. 1990. A brief review of drip irrigation in Karnataka. Proc. XI Int. Cong. Use Plastics Agric., New Delhi, pp. 131-135.

Thomas, M.B. and Leong, A.G.B. 1984. The effect of shade and nitrogen on production of container grown ornamental peppers (Capsicum annum L.) Annual J. Royal Newzealand Ins. Hort., 12 : 57-67.

Uddin, M.M. and Begum, S. 1990. Effect of fertilizer on Vitamin C content of green chilli (Capsicum sp.). Bangladesh J. Scientific Industrial Res., 25 : 1-4.

Vasanthakumar, G.K. 1984. Efficiency and adoption of drip irrigation in cultivation of tomato (Lycopersicon esculentum Mill.). Ph.D. (Ag.) thesis, Univ. Agric. Sci., Bangalore.

Wankhade, B.N. and Morey, D.K. 1986. Effect of levels of irrigation, nitrogen and potassium on growth and yield of chilli (Capsicum annum L.). PKV Res. J., 8 (2) : 22-25.

Wierenga, P.J. and Saddiq, M.H. 1985. Optimum soil water tension for trickle irrigated chilli peppers. In drip/trickle irrigation in action. Vol II. Amer. Soc. Agric. Engg., pp. 193-197.

Wivutvongvana, P., Methi Ekasingh, Paungmanee, J., Klodpeng, T., Nikornpun, M. and Lumyong, P. 1990. The use of fertilizers, mulching and irrigation for vegetable production. I. The Tropical Zone, Thailand. FFTC. Extension Bulletin No.245.

Zayed, E.A., Eh-Zawily, A.I. and Nofal, E.S. 1985. Studies on growth, productivity and some physiological aspects of hot pepper (Capsicum annum L.) var. Red Cherry. I. Effects of interaction between Morphactin, GA and nitrogen, phosphorus and potassium fertilization. J. Agric. Sci. Mansouria Univ., 10 (1) : 191-198.

* Originals not seen.

APPENDICES

APPENDIX - I

Meteorological data during the cropping period.

Standard weeks	period From	period To	Rainfall (mm)	Maximum temperature (^{o}c)	Minimum temperature (^{o}c)	Relative Humidity (%)	Evapouration (mm)
50	10-12-1994	16-12-1994	-	30.5	21.1	78.5	2.4
51	17-12-1994	23-12-1994	-	31.5	23.1	81.5	1.5
52	24-12-1994	31-12-1994	-	31.8	22.0	77.2	1.8
1	1-1-1995	7-1-1995	-	31.8	22.6	80.4	3.4
2	8-1-1995	14-1-1995	1.2	32.0	23.2	74.7	3.5
3	15-1-1995	21-1 1995	-	30.9	23.1	81.4	3.8
4	22-1-1995	28-1-1995	-	30.9	21.5	73.8	3.4
5	29-1-1995	4-2-1995	-	31.8	22.7	70.8	4.0
6	5-2-1995	11-2-1995	-	32.2	23.0	69.5	4.0
7	12-2-1995	18-2-1995	-	31.3	23.2	73.5	3.7
8	19-2-1995	25-2-1995	-	31.9	23.0	72.6	4.8
9	26-2-1995	4-3-1995	-	31.9	27.7	72.4	4.2
10	5-3-1995	11-3-1995	-	32.2	19.8	74.6	5.5
11	12-3-1995	18-3-1995	0.5	32.5	23.5	70.8	5.4
12	19-3-1995	25-3-1995	-	33.0	23.4	69.8	5.0
13	26-3-1995	1-4-1995	-	33.5	25.5	72.5	5.3

APPENDIX - II.

COST OF CULTIVATION OF VEGETABLE CHILLI ha^{-1}

Particulars	Tiller Rs.70 hr^{-1}		Labour		Total Amount Rs.
	Time	Cost	M Rs.70/-	W Rs.65/-	
I. Labour Cost					
A. Preparation of nursery					
1. Preparation of nursery by use of tiller	1/2 hr	35.00 5.25	1		110.25
2. Clod breaking, preparing seed bed and sowing			1		70.00
3. Providing thrash mulch				2	130.00
4. Irrigating nursery area (in case there is no rain)				3	195.00
B. Layout and preparation of main field					
1. Land preparation by use of tiller	5 hr	350.00 52.50	1		472.50
2. Light digging and clod breaking			34		2,380.00
3. Removing stubbles				20	1,300.00
4. Preparing bed and furrows for planting the crops			60		4,200.00

C. **Transplanting**			
Transplanting the seedlings, planting and gap filling		50	3,250.00
D. **Staking**		50	3,250.00
E. **Irrigation**		35	2,275.00
F. **Intercultural operations**			
1. First weeding and intercultivation		25	1,625.00
2. Second weeding and intercultivation		25	1,625.00
G. **Manuring**			
1. Transport,drying and application of farmyard manure	15	10	1,700.00
2. Transporting,mixing and application of fertilizers	20		1,400.00
3. Top dressing two times	10		700.00
H. **Plant protection**			
Application of PPC (need based)	30		2,100.00
I. **Harvesting**			
Harvesting matured fruits		100	6,500.00
Total	172	320	33,282.75

II. **Material Cost**

Particulars	Quantity needed	Amount Rs.
1. Farm yard manure (Rs.300/t)	25t	7,500.00
2. Seeds	1 Kg	600.00
3. Fertilizers		
a. Urea (Rs.3/Kg)	165 Kg	495.00
b. Super phosphate (Rs.2/Kg)	250 Kg	500.00
c. MOP (Rs.5/Kg)	40 Kg	200.00
4. Staking material		1,000.00
5. Plant protection chemicals		1,500.00
6. Irrigation energy		937.25
Total		12,732.25
Total cost of cultivation		46,015.00

ABSTRACT

Particulars	Tiller Rs.70 hr^{-1}		Labour		Total Amount Rs.
	Time	Cost	M Rs.70/-	W Rs.65/-	
I. Labour Cost					
A. Preparation of nursery	1/2 hr	**35.00** 5.25	2	5	505.25
B. Layout and preparation of main field	5 hr	350.00 52.50	95	20	8,352.50
C. Transplanting				50	3,250.00
D. Staking				50	3,250.00
E. Irrigation				35	2,275.00
F. Intercultural operations				50	3,250.00
G. Manuring			45	10	3,800.00
H. Plant protection			30		2,100.00
I. Harvesting				100	6,500.00
Total			172	320	33,282.75

II. **Material Cost**

Particulars	Amount needed	Cost Rs.	Amount Rs.
1. Farmyard manure	25t	300/t	7,500.00
2. Seeds	1 Kg		600.00
3. Fertilizers			1,195.00
4. Staking material			1,000.00
5. Plant protection chemicals			1,500.00
6. Irrigation energy			937.25
Total			12,732.25
Total cost of cultivation			46,015.00

ABSTRACT

A field experiment was conducted at the Instructional Farm of the College of Agriculture, Vellayani during the period December 1994 to March 1995 to study the effects of graded levels of nitrogen, potassium, drip and furrow irrigation on the growth, moisture characters, yield, quality and nutrient uptake of vegetable chilli cv.Jwalasakhi. The soil of the experimental field was red loam, acidic in reaction, medium in available nitrogen and phosphorus and low in available potassium. The treatments consisted of three levels of nutrients (50:40:16.7; 75:40:25 and 100:40:33.3 $N:P_2O_5$: K_2O Kg ha^{-1} respectively) under two levels of drip irigation (1 litre and 2 litre $plant^{-1}$ day^{-1}) and two levels of furrow irrigation (at 10 mm and 20 mm CPE at a depth of 20 mm). The experiment was laid out in strip plot design. An abstract of the result is given below.

Plant height, number of branches $plant^{-1}$, DMP,shoot-root ratio and spread of canopy differed significantly with methods of irrigation and levels of nutrients. All these parameters were on the increase under drip irrigation @ 2 litre $plant^{-1}$ day^{-1} and higher level of nutrients.

Moisture characters like moisture distribution pattern at 10,20 and 30 cm depth and WUE increased with drip irrigation and

higher level of nutrients. Drip irrigation @ 2 litre plant^{-1} day^{-1} recorded maximum soil moisture content at all depths while there was no significant difference with 1 litre or 2 litre water with regard to WUE. The effect on graded levels of nutrients on soil moisture content at varying depths was significant only upto medium level of nutrients.

All yield parameters like number of flowers plant^{-1}, setting percentage of fruit and 100 fruit weight vary significantly with methods of irrigation and levels of nutrients. These parameters were higher with drip irrigation @ 2 litre plant^{-1} day^{-1} and higher level of nutrients. With regard to the time taken for 50% flowering, plants drip irrigated @ 2 litre day^{-1} and higher level of nutrients hastened this phytophase.

Maximum yield plant^{-1} vary significantly with methods of irrigation and levels of nutrients. This was highest (13.12 t ha^{-1}) for drip irrigation @ 2 litre plant^{-1} day^{-1} and with 100:40:33.3 Kg NPK ha^{-1}.

Ascorbic acid content of fruit was maximum with drip irrigation @ 2 litre plant^{-1} day^{-1} and higher level of nutrients.

Uptake of nitrogen, phosphorus and potassium were maximum with drip irrigation @ 2 litre plant^{-1} day^{-1} and higher level of nutrients.

Soil nitrogen and phosphorus status was significant in plots receiving nutrients only upto the medium level. Plot receiving drip irrigation @ 2 litre plant^{-1} day^{-1} recorded highest soil nitrogen, phosphorus and potassium status.

Maximum profit was obtained (Rs.1,07,213.50 ha^{-1}) with drip irrigation @ 2 litre plant^{-1} day^{-1} with NPK @ 100:40:33.3 Kgha^{-1}.