

**RESPONSE OF WATERMELON  
(CITRULLUS LANATUS *Thunb. Musf.*) TO DRIP  
AND FURROW IRRIGATION UNDER DIFFERENT  
NITROGEN AND PLANT POPULATION LEVELS.**

**K SRINIVAS**

**DEPARTMENT OF AGRONOMY  
COLLEGE OF AGRICULTURE  
GANDHI KRISHI VIGNANA KENDRA  
UNIVERSITY OF AGRICULTURAL SCIENCES  
BANGALORE**

**1987**

**RESPONSE OF WATERMELON  
(CITRULLUS LANATUS *Thunb. Musf.*) TO DRIP  
AND FURROW IRRIGATION UNDER DIFFERENT  
NITROGEN AND PLANT POPULATION LEVELS.**

**K SRINIVAS**

Thesis Submitted to the  
**University of Agricultural Sciences, Bangalore**  
in partial fulfilment of the requirements  
for the Degree of

**Doctor of Philosophy**

in

**AGRONOMY**

**BANGALORE**

**APRIL 1987**

*Dedicated to my Wife*

**DEPARTMENT OF AGRONOMY**  
**UNIVERSITY OF AGRICULTURAL SCIENCES**  
**BANGALORE**  
**CERTIFICATE**

This is to certify that the thesis entitled "RESPONSE OF WATERMELON TO DRIP AND FURROW IRRIGATION UNDER DIFFERENT NITROGEN AND PLANT POPULATION LEVELS" submitted by Mr.K.SRINIVAS for the degree of **DOCTOR OF PHILOSOPHY IN AGRONOMY** of the University of Agricultural Sciences, Bangalore, is a record of research work done by him during the period of his study in this University under my guidance and supervision, and the thesis has not formed previously the basis for award of any degree, diploma, associateship, fellowship or other similar titles.

Bangalore

  
(G.V.HAVANAGI)

April, 27, 1987

PROFESSOR OF AGRONOMY AND CHAIRMAN

APPROVED BY

Chairman:

  
(G.V.HAVANAGI)

Co-Chairman:

  
(D.M.HEGDE)

Members:

1.

  
(B.S.BHARGAVA) 3.8.87

2.

  
(K.M.BOJAPPA) 3/8/87

3.

  
(N.SUNDER RAJ)

## ACKNOWLEDGEMENT

I am grateful to Dr.G.V.Havanagi, B.Sc. (Agri), M.S. (U.S.A), Ph.D. (I.A.R.I), Professor and Head of Agronomy, Agricultural College, G.K.V.K, Bangalore, who as the Chairman of my advisory committee, has guided me during the course of this investigation. I am thankful for his advice, critical comments and timely help during the preparation of this thesis.

I am ever indebted to Dr.D.M.Hegde, Scientist-S<sub>2</sub> (Agronomy), Indian Institute of Horticultural Research, Bangalore, who served as Co-Chairman of my advisory committee and helped me at each and every step both in the field and laboratory research work. I am sincerely thankful to Dr.D.M.Hegde for his substained encouragement, critical suggestions and guidance.

My sincere thanks are due to Dr.B.S.Bhargava, Head of Division, Soil Science, Indian Institute of Horticultural Research, Bangalore, who not only served as a member of my advisory committee, but also gave free access to the analytical facilities of the Leaf analysis laboratory, during the course of my investigation. I am thankful to him for his critical suggestions in the preparation of the thesis.

I take this opportunity to thank Dr.K.M.Bojappa, Professor of Horticulture, University of Agricultural Sciences, Bangalore and Dr.S.Sunderaj, Professor of Statistics, University of Agricultural Sciences, Bangalore, who served as members of my advisory committee and also for the keen interest and constructive suggestions during the course of my work. I owe my special thanks to Mr.V.R.Srinivasan,

Statistician, I.I.H.R., Bangalore for helping me in the statistical analysis. I also thank all the friends in the Department of Agronomy, U.A.S, Bangalore and at I.I.H.R, Hessaraghatta who one way or the other helped in the completion of this thesis.

Finally, I express my heartfelt gratitude to my wife, who was a constant source of inspiration throughout the period of this investigation and without whose help this could not have been completed.

Bangalore,  
April, 1987.



(K.SRINIVAS)

## CONTENTS

CHAPTER	TITLE	PAGE NO.
I.	INTRODUCTION	1
II.	REVIEW OF LITERATURE	5
III.	MATERIAL AND METHODS	32
IV.	RESULTS	59
4.1	Experiment I: Effect of nitrogen and spacing under drip and furrow irrigation in watermelon.	59
4.2	Experiment II: Studies on the comparative efficiency of drip and furrow irrigation systems in watermelon	139
V.	DISCUSSION	232
5.1	Influence of nitrogen on growth, yield and nutrient uptake in watermelon.	233
5.2	Influence of plant population on growth, yield and nutrient uptake in watermelon	240
5.3	Influence of drip and furrow methods of irrigation on growth, yield and nutrient uptake in watermelon.	243
5.4	Influence of pan evaporation ratios on growth, yield and nutrient uptake in watermelon.	253
5.5	Water use and water use efficiency in watermelon	258
VI.	SUMMARY	263
VII.	REFERENCES	269
VIII.	APPENDIX	293

## LIST OF TABLES

Sl. No.	Title	Page No.
3.1	Physical and chemical properties of soil at the experimental site, Hesaraghatta.	33,34
3.2	Normal (1954 - 83) and actual (1984 and 1985) monthly meteorological data.	36,37
3.3	Per cent moisture under drip irrigation (20 cm away from the emitter).	57
4.1	Vine length of watermelon as influenced by nitrogen, Spacing and method of irrigation.	60
4.2	Vine girth of watermelon as influenced by nitrogen, Spacing and method of irrigation.	62
4.3	Number of leaves per plant of watermelon as influenced by nitrogen, Spacing and method of irrigation.	64
4.4	Dry matter production in watermelon by as influenced nitrogen, spacing and method of irrigation	67
4.5	Number of male and female flowers, Primary branches and node of first female flower occurrence of watermelon as influenced by nitrogen, Spacing and method of irrigation.	70
4.6	Leaf area of watermelon as influenced by nitrogen, Spacing and method of irrigation.	73
4.7	Leaf area index of watermelon as influenced by nitrogen, Spacing and method of irrigation.	75
4.8	Leaf area duration of watermelon as influenced by nitrogen, Spacing and method of irrigation.	77
4.9	Relative growth rate of watermelon as influenced by nitrogen, Spacing and method of irrigation.	79
4.10	Net assimilation rate of watermelon as influenced by nitrogen, Spacing and method of irrigation.	82

4.11	Crop growth rate of watermelon as influenced by nitrogen, Spacing and method of irrigation.	85
4.12	Fruit yield and yield components of watermelon as influenced by nitrogen, spacing and method of irrigation.	88
4.13	A) Interaction effect of nitrogen and spacing on fruit yield (q/ha) of watermelon. B) Interaction effect of nitrogen and method of irrigation on fruit yield (q/ha) of watermelon.	89
4.14	Fruit and Seed characters of watermelon as influenced by nitrogen, spacing and method of irrigation.	93
4.15	Fruit quality of watermelon as influenced by nitrogen, spacing and method of irrigation.	97
4.16	Root length, maximum length of lateral root, number of secondary roots and root dry weight of watermelon as influenced by nitrogen, spacing and method of irrigation.	103
4.17	Nitrogen content of watermelon as influenced by nitrogen, spacing and method of irrigation.	108
4.18	Nitrogen uptake of watermelon as influenced by nitrogen, spacing and method of irrigation.	111
4.19	Phosphorus content of watermelon as influenced by nitrogen, spacing and method of irrigation.	114
4.20	Phosphorus uptake of watermelon as influenced by nitrogen spacing and method of irrigation.	117
4.21	Potassium content of watermelon as influenced by nitrogen, spacing and method of irrigation.	120
4.22	Potassium uptake of watermelon as influenced by nitrogen, spacing and method of irrigation.	122
4.23	Calcium content of watermelon as influenced by nitrogen, spacing and method of irrigation.	125

4.24	Calcium uptake of watermelon as influenced by nitrogen, spacing and method of irrigation.	127
4.25	Magnesium content of watermelon as influenced by nitrogen, spacing and method of irrigation.	130
4.26	Magnesium uptake of watermelon as influenced by nitrogen, spacing and method of irrigation.	132
4.27	Correlation between fruit yield of watermelon with other characters.	135
4.28	Details of the economics of drip irrigation for watermelon.	138
4.28a	Economics of drip and furrow irrigation under different levels of spacing.	137
4.29	Vine length of watermelon as influenced by IW/CPE ratio and method of irrigation.	140
4.30	Interaction effect of IW/CPE ratio and method of irrigation, on vine length of watermelon (80 DAE).	142
4.31	Vine girth of watermelon as influenced by IW/CPE ratio and method of irrigation.	144
4.32	Number of leaves per plant of watermelon as influenced by IW/CPE ratio and method of irrigation.	146
4.33	Number of male and female flowers, number of branches and node of first female flower occurrence of watermelon as influenced by IW/CPE ratio and method of irrigation.	149
4.34	Dry matter production of watermelon as influenced by IW/CPE ratio and method of irrigation.	152
4.35	Leaf area of watermelon as influenced by IW/CPE ratio and method of irrigation.	155
4.36	Leaf area index of watermelon as influenced by IW/CPE of ratio and method of irrigation.	158

4.37	Leaf area duration of watermelon as influenced by IW/CPE of ratio and method of irrigation.	161
4.38	Relative growth rate of watermelon as influenced by IW/CPE ratio and method of irrigation.	163
4.39	Net assimilation rate of watermelon as influenced by IW/CPE ratio and method of irrigation.	167
4.40	Crop growth rate of watermelon as influenced by IW/CPE ratio and method of irrigation.	169
4.41	Yield and Yield components of watermelon as influenced by IW/CPE ratio and method of irrigation.	173
4.42	Interaction effects of IW/CPE ratios and method of irrigation on fruit yield (q/ha) of watermelon, 1985.	175
4.43	Fruit and Seed characters of watermelon as influenced by IW/CPE ratio and method of irrigation.	177
4.44	Fruit quality of watermelon as influenced by IW/CPE ratio and method of irrigation.	181
4.45	Root length, secondary roots and dry weight of roots of watermelon as influenced by IW/CPE ratio and method of irrigation.	190
4.46	Nitrogen content of watermelon as influenced by IW/CPE ratio and method of irrigation.	193
4.47	Nitrogen uptake of watermelon as influenced by IW/CPE ratio and method of irrigation.	197
4.48	Phosphorus content of watermelon as influenced by IW/CPE ratio and method of irrigation.	199
4.49	Phosphorus uptake of watermelon as influenced by IW/CPE ratio and method of irrigation.	203
4.50	Potassium content of watermelon as influenced by IW/CPE ratio and method of irrigation.	206

4.51	Potassium uptake of watermelon as influenced by IW/CPE ratio and method of irrigation.	208
4.52	Calcium content of watermelon as influenced by IW/CPE ratio and method of irrigation.	212
4.53	Calcium uptake of watermelon as influenced by IW/CPE ratio and method of irrigation.	214
4.54	Magnesium content of watermelon as influenced by IW/CPE ratio and method of irrigation.	217
4.55	Magnesium uptake of watermelon as influenced by IW/CPE ratio and method of irrigation.	220
4.56	Correlation between yield and other parameter in watermelon.	223
4.57	Water use of watermelon under furrow irrigation.	225
4.58	Water use of watermelon under drip irrigation.	226
4.59	Water-use efficiency of watermelon as influenced by IW/CPE ratio and method of irrigation.	227
4.60	Interaction effects of IW/CPE ratio and method of irrigation on water-use efficiency.	229
4.61	Economics of drip and furrow irrigation.	231

## LIST OF FIGURES

Sl. No.	Title	Between Pages
3.1	Normal and actual monthly meteorological data.	37-38
3.2	Plan of layout of Experiment - I.	39-40
3.3	Plan of layout of Experiment -II.	40-41
3.4	Moisture percentage under furrow irrigation as influenced by IW/CPE ratio and method of irrigation.	56-57
4.1	Relative water content in watermelon as influenced by nitrogen, spacing and method of irrigation.	100-101
4.2	Changes in sap osmotic potential as influenced by nitrogen, spacing and method of irrigation.	101-102
4.3	Canopy temperature as influenced by nitrogen, spacing and method of irrigation.	101-102
4.4	Changes in relative water content as influenced by method of irrigation.	183-184
4.5	Changes in sap osmotic potential as influenced by method of irrigation.	185-186
4.6	Changes in canopy temperature under drip and furrow irrigation at different IW/CPE ratio.	187-188

# **INTRODUCTION**

## I. INTRODUCTION

Watermelon is an important summer crop, grown throughout the country for its juicy flesh. There has been a continuous increase in the area under this crop, in recent years, with the introduction of high yielding varieties. The data on area and production of watermelon in India and in the State of Karnataka are not available. However, the area under Cucurbitaceous crops in Karnataka including watermelon has increased from 4850 hectares in 1982-83 with a production of 1,21,245 tonnes, to 5646 hectares during 1984-85 with a production of 1,41,145 tonnes (Anon, 1985). It is said that this increase in area and production of Cucurbitaceous crops is largely due to watermelon.

The farmers in an attempt to produce higher yields go for frequent irrigations and invariably over-irrigate the crop. With the increase in energy costs and competing demand for water, there is always the need to maximise the water use efficiency, without sacrificing production. Since watermelon is raised under irrigated conditions, there is a need to apply the optimum quantity of water at the right time, as in other irrigated crops. To obtain maximum dry matter production and thereby, higher yields either per unit of water or per unit of land, it is generally desirable to avoid water stress by maintaining a uniformly high water potential in the soil root zone. One of the possibilities

for making effective use of water is by using high frequency low volume irrigations.

The last decade has seen major advances in a unique method of water application to crops through drip irrigation, which allows judicious use of water. Although, drip irrigation obviates the static water holding capacity requirement of the soil, its efficiency is crucially dependent upon the dynamic hydraulic flow properties of the soil. In many cases, the soil fulfils the latter requirement and drip irrigation has been used for effective and efficient watering of crops. The drip irrigation achieves a three dimensional differential spread of water maintaining low levels of soil water tension (Clothier et al., 1985). Under conventional system of furrow irrigation for watermelon, lot of water is being applied, especially in the early period of crop growth, since it is widely spaced. Excess water application is said to dilute the sugars, especially during the fruit development stage, thus making the fruits insipid. The fruits also get damaged, if they come in contact with water due to over irrigation. In this context, adaption of drip irrigation can be considered as a potential alternative, which would greatly aid in economising the water and maximising the productivity per unit area of land.

Under semi-arid regions of South India, information on the comparative effect of drip and furrow irrigation, in terms of growth, yield and quality of watermelon is not available. Information on the water requirement of

watermelon is also lacking.

In addition to water, other main factors affecting the productivity of watermelon are, the plant population and the quantity of fertilizer applied. Plant yield and density relationships have received considerable attention in recent years (Willey and Heath, 1969). Yield responses to plant density are basically the consequences of inter and intra-row plant competition largely for water and nutrients. Since watermelon is a widely spaced crop, with limited potential for fruiting, any adjustments in crop density resulting in increasing the number of plants per unit area, will have a direct bearing on the fruit yield.

Watermelon plants are generally spaced 3 m between rows for commercial cultivation with two plants per hill. Since, the average number of fruits per plant is only about 1.2, there is every possibility of increasing the fruit number and yield by accommodating more number of plants per hectare. Apart from this, row spacing has a definite bearing on fruit size and number (Halsey, 1959). In general, the fruit size was reported to increase with wider spacing, with concomitant decrease in fruit number and vice versa with closer spacing.

Judicious application of nitrogen has been a major constraint in realising the production potential of newly developed varieties of watermelon. Nitrogen is one of the important and major nutrients, which is basic to crop production, since all physiological and biochemical growth

processes are controlled by this element. The plant and soil must be nutritionally compatible, to achieve maximum production with greatest efficiency. Nitrogen is one of the major elements influencing the growth, sex ratio, fruit set and yield of watermelon (Brantley and Warren, 1960). Excess nitrogen induces profuse vegetative growth and increases male flower production, whereas, reduced application will limit the source itself, resulting in an imbalance, in the absence of nitrogen (Bradley and Fleming, 1959). Watermelon is generally applied with 100 kg N per hectare for its commercial cultivation (Anon, 1985). However, response beyond this level have also been reported (Yusifov, 1984 and Khristov, 1984).

Thus, the present investigation on the "Response of Watermelon (Citrullus lanatus, Thunb. Musf.) to drip and furrow irrigation, under different nitrogen and plant population levels" was framed with the following objectives:

1. To compare the efficiency of drip irrigation system with conventional method of furrow irrigation and to standardise the techniques of drip irrigation to watermelon. (cv. Arka manik).
2. To find out the effect of plant population/spacing and nitrogen fertilization on growth, yield and quality attributes in watermelon. (cv. Arka manik).
3. To work out the optimum requirement of irrigation, spacing and nitrogen for watermelon. (cv. Arka manik)

## **REVIEW OF LITERATURE**

## II REVIEW OF LITERATURE

The relevant literature pertaining to the effect of irrigation, plant population, spacing and nitrogen on growth, yield and quality of watermelon and other cucurbitaceous crops is reviewed in this chapter.

### 2.1 Effect of irrigation on growth, yield and quality of certain Cucurbitaceous crops:

Soil moisture is essential for every biological system. Vegetable crops which are generally succulent need large quantities of water during their crop growth and development. But farmers in their anxiety to get higher yields, apply irrigation water either heavily or more frequently. In either case, there is excess application of water and results in percolation of water and leaching losses of some nutrients, besides creating aeration problems. Contrary to this, when soil moisture content is not optimum, the crop suffers due to stress.

#### 2.1.1. Watermelon :

The research work done on water requirements of watermelon is very meagre. Doneen et al. (1939) working with watermelon at Davis, opined that watermelon is deep rooted crop and irrigation neither appreciably increased yield nor growing period, to any appreciable extent and in only one year did it affect average weight and percentage soluble solids. Rafiev (1969) studying the dynamics of fruit growth in watermelon observed that the weight increment of fruits mainly depended on the water supply to the roots. Some days the increase in fruit weight reached 100 g whereas, at high

temperature and low relative humidity, there were days when the fruit did not gain in weight. The fruit growth was more rapid during the night. He further observed that fruit weight increased most rapidly at the end of July and early August, when there was a reserve of available moisture in the soil. The period of marked weight increase in early-set fruit lasted on the average for 15 days and the fruit reached 4.2 kg, while in fruit set in the middle period, intensive growth lasted for 10 days and the fruit reached a weight of 3.7 kg. Malinina (1971) in U.S.S.R. observed that irrigation to watermelon every 10 days gave higher yields than 7 or 15 days and the irrigated plants carried 2 to 4 fruits as compared to 1 to 2 fruits in unirrigated plots. On forest soils in southern Bulgaria, Dimitrov (1973) reported that a moisture level of 70 to 80 percent field capacity maintained over the entire growing season, was the most economic treatment giving a total yield of 26 t/ha. While, studying the characteristics of growth and development of irrigated watermelon, Belik and Veselovskii (1975) found high mean diurnal water requirement, termination of leaf and root growth and increased leaf chlorophyll content in watermelon during fruit formation. Under irrigation the main root mass was found in the 8.5 to 17 cm soil layer. The leaf photosynthesis rose with plant growth, reaching a peak at the beginning of fruit formation.

Comparing the value of drip irrigation with conventional irrigation, under hot arid conditions of Jodhpur, India, Singh and Singh (1978) recorded increased yields of

✓watermelon by 10 to 22 per cent in case of drip method of irrigation over Sprinkler and furrow irrigation. The water use efficiency under drip was nearly twice as high, as compared to other methods of water application. They further concluded that on loamy sand soils in hot arid regions, daily irrigation is advantageous when water is applied by drip irrigation. However, Rudich et al. (1978) studying the optimal growth stages for the application of drip irrigation in Israel, did not observe any effect of drip irrigation on watermelon, during the stages of vegetative growth, flowering or fruit set. But drip irrigation in fruit development stage resulted in yield increases upto 48 per cent. In experiments at Florida, ✓Elmstrom et al. (1981) reporting on the response of watermelon to drip and sprinkler irrigation, concluded that the benefit of irrigation was greater on deep sands. Early yield was enhanced by drip irrigation, compared to overhead or no irrigation. Further, irrigation significantly increased total yield and about 40 per cent less water was used with drip system than with the overhead irrigation. Desai and Patil (1984) at Maharashtra, observed that the highest yields of watermelon were recorded with irrigation at 1.0 IW/CPE ratio and had consumptive use, water requirement and water use efficiency of 169.9 mm, 540 mm and 1.64 q/ha-mm, respectively. The total soluble solids were low in the fruits with irrigation at 1.2 IW/CPE ratio, but the total sugars were more in the fruits with 1.0 IW/CPE ratio. In a three year study on pitcher irrigation of watermelon grown in Jodhpur during winter season, Sahu (1984) reported 40 per

cent saving in the irrigation water by this method

#### 2.1.2 Muskmelon

McClatchie (1902) in Arizona reported that twelve irrigations totalling 3.3 feet of water was required for producing 27,000 lbs per acre of melons. However, Headley and Fulkerson (1913) in U.S.A. observed that too much water in ripening period tends to retard ripening and reduce the sweetness of the melon. The greatest number, both of melons and high grade melons was obtained by the application of 0.5 inch water per week (Fleming, 1936), and the sugar content was not affected by irrigation. While studying the effect of irrigation on the production of cantaloupes (muskmelon), MacGillivray (1951) observed that the yields were not greatly affected by different quantities (11.3 or 7.0 inches) of irrigation. The dry treatment without irrigation produced the smallest yield and maximum application of water gave the highest yield, but there were no differences in the soluble solids. They recorded the time from fruit set to maturity of the fruits to be 45 days in dry, 44.6 days in medium and 45.6 days in wet treatment. Gill and Ali (1964) recommended a maximum of 3 irrigations to avoid fruit deterioration and the sugar content of fruit was significantly increased by the reduction of irrigations from five to three.

Irrigation practices for melons vary widely. Flocker et al. (1965) studying the influence of scheduling irrigation on the yield, quality and size of muskmelon observed that

satisfactory yields could be obtained when soil moisture tensions at 18 inch soil depth reached 3.0 bar. The yield response to irrigation was mainly by increase in fruit size and heavier irrigation increased cull fruits associated with increased vine growth and succulence. However, higher soil moisture stress also increased culls associated with restrictions of vine growth such as sunburn and small fruits. They finally concluded that excellent yields of high quality melon can be produced with comparatively infrequent irrigation, if the soil profile is near field capacity at planting time. Reporting the results of three years trials on melon in Hungary, Molnar (1965) observed that irrigation of melon was successful only where sunshine is abundant and humidity is low during ripening. Irrigation increased the number of female flowers and advanced their flowering. However, the fruit set in general was not improved, but fruit drop was reduced, there by indicating the water requirement of melon to be high especially at the beginning of fruit growth. The dry matter content of fruit was not reduced. He concluded that furrow irrigation is preferable to sprinkler irrigation.

From a three year study at Israel, Goldberg and Shmueli (1970) reported that of equal water consumption, drip irrigation produced yields of melons twice as high as sprinkler irrigation. In a comparison of sprinkler, furrow and trickle irrigation applied during the growing season from August to December, Shmueli and Goldberg (1971) recorded more rapid vegetative growth, earlier and higher yields of

melons with trickle irrigation.

Studies carried out by Niel and Zumino (1972) on water requirement of melons revealed that the maximum evapotranspiration in irrigated plots at 10,000 plants per hectare was 60 per cent of the potential evapotranspiration. They further observed that between flowering and fruit formation the water uptake represented 55 per cent of potential evapotranspiration, which increased during fruit enlargement reaching 85 per cent at harvest. But, by mid harvest it had dropped to 55 per cent of potential evapotranspiration. In a similar study, Niel and Zumino (1972) further reported that irrigation upto 80 per cent maximum evapotranspiration was economically feasible. The water uptake in successive growth stages of the melon crop was  $650 \text{ m}^3/\text{ha}$  upto fruit enlargement,  $882 \text{ m}^3/\text{ha}$  upto prematuring and  $280 \text{ m}^3/\text{ha}$  upto harvest. Out of the water uptake of  $2730 \text{ m}^3/\text{ha}$ , the average irrigation requirement was  $2000 \text{ m}^3/\text{ha}$ . By raising the irrigation rate in melons from  $850$  to  $2600 \text{ m}^3/\text{ha}$ , melons produced were more and heavier with improved flavour and decreased firmness, without any change in the dry matter content. Muminov (1973) forecasting the times of irrigation to melon suggested the time and amount of irrigation should be determined by the leaf water content. At a leaf water content of 84 to 86 per cent, the yields were the highest. However, Konishi (1974) reporting on the amount and nature of water consumption by a fruit bearing plant with a final leaf area of about  $1100 \text{ cm}^2$  was 85 to 90 litres and

less water was consumed by plants without fruit. As the plants grew, the ratio of total water consumption per plant to pan evaporation increased to a maximum of about 4760 cm<sup>3</sup> per cm at the netting stage, and then declined with ageing. The rate of water absorption on a fine day was greatest from 12.00 to 13.00 hrs and the amount of water absorbed between 11.00 and 14.00 hrs was 36.4 per cent of the value for the day and that absorbed between 18.00 and 06.00 hrs was only 2.9 per cent of the day's total. The young leaves transpired faster than old leaves and most of the transpiration occurred when soil  $p^F$  was 1.6 to 2.0. While comparing the effect of different methods of irrigation under green house conditions, Borelli and Zerbi (1977) observed that trickle irrigation resulted in higher yields than furrow irrigation especially at low irrigation, whenever the accumulated maximum evapotranspiration reached 30 mm. The yield increment declined with increasing soil moisture levels. In trails comparing furrow irrigation applied at two soil water levels of 0.4 or 0.7 atmospheres, with drip irrigation using 1, 2 or 4 emitters per planting hole (2 plants) at the same soil water levels, Abreu et al. (1978) recorded highest yields of 13.8 t per hectare from drip irrigation with 2 emitters per planting hole of 0.7 atmosphere. While studying the effect of interval and method of irrigation for three years on some qualitative and quantitative characteristics in Iran, Kashi (1981) reported maximum yields and enhanced soluble solids content with irrigation intervals of 6 and 8 days. However,

the number of fruits per plant and fruit weight varied in different years. But the traditional furrow irrigation at 5 cm depth gave better results than modern shallow furrow irrigation. Chander and Mangal (1983) studying the response of muskmelon at Hissar, to various soil moisture regimes reported that the best growth, flowering and fruiting were obtained on plots irrigated at 0.9 pan evaporation coefficient (55.5 mm of irrigation water).

In Arizona, Pew and Gardner (1983) while working on the effects of irrigation practices on vine growth, yield and quality reported higher yields, larger fruit size and earlier maturity by irrigating when soil moisture tensions at 25 cm depth reached 50 and 75 kPa compared with tensions of 25 kPa. They also reported more culled fruits in the wet treatment due to decay, while the drier treatments produced more fruits with growth cracks. Apart from this, melons from the drier treatment were higher in soluble solids and a pre thinning irrigation caused restricted root development, vine growth, fruit size and yields.

Studying the effect of soil moisture for summer cropping of muskmelon, at the vegetative, fruit swelling and maturity growth stages in Japan, Yabe et al. (1981) observed that a small amount of water at the vegetative growth stage suppressed growth but increased fruit weight and improved fruit quality. However, a large amount of water at fruit swelling had no beneficial effects and in spring adversely affected quality. They also recommended soil PF values of 2.3 to 2.5 at the vegetative stage, 2.3 to 2.7 at the fruit

swelling stage and 2.5 to 2.7 at maturity stage.

Callebaut et al. (1985) studying the response of melons to irrigation observed maximum yield at a relative water supply of 47 per cent of PET and obtained an optimum yield within the range of 277 to 484 mm of water depth. While comparing the drip and furrow irrigation for muskmelon production, Bogle and Hartz (1986) reported that drip irrigation at 40 or 20 per cent available soil water depletion in the surface 30 cm required 25 and 42 per cent of the irrigation water volume needed by furrow irrigation at 40 per cent soil water depletion. The highest water-use efficiency of 181 kg marketable fruits per ha per mm total water, was recorded in the 40 per cent soil water depletion.

### 2.1.3 Cucumber :

In two experiments comparing trickle irrigation with hose watering of frame grown cucumbers, Van Den Ende (1959) reported that trickle irrigation increased the yields of cucumbers by 18 per cent and 22 per cent respectively. Investigating the pattern of soil wetting under drip irrigated cucumber fields, Varga and Nyujto (1974) observed that the water spread was very good upto a distance of 30 cm and to a depth of 40 cm, when interrupted drip irrigation was provided at 10 mm water per hectare in 5 hrs. In field and green house studies at Ohio under three moisture regimes corresponding to low, medium and high stress, Cummins and Kretchman (1975) reported that the leaf area and fruit yields were greatly reduced under high stress compared with the low

stressed plants. The first fruit set was 2 to 3 days earlier with the high stressed plants, but the time taken for these fruits to attain 2 inch diameter was 4 to 6 days longer.

Pavlov (1976) studying the irrigation regime, reported a highest yield of 26.6 kg per m<sup>2</sup>, when 70 to 100 litres per m<sup>2</sup> were applied during the plant growing phase, in 20 to 32 individual irrigations followed by 480 to 570 litres per m<sup>2</sup> during fruiting in 92 to 94 individual irrigations. Loomis and Crandall (1977) reported that the last irrigation schedule for cucumbers involved removal by plants between 48 to 64 per cent of the available water in the upper 90 cm of soil profile between irrigations. They further observed that the ratio of consumptive water use to evaporation pan loss reached a maximum of 1.5 during the early harvest. But moderate moisture stress had no significant effect on the grade or number of poorly developed fruit. However, the transpiration rate was higher and leaf area smaller for fruiting plants and the fruit production did not significantly affect total water consumption or the seasonal water use pattern.

In experiments on time of irrigation with ridge cucumbers, Chernoval (1979) recorded highest yields when irrigated during night times as compared with irrigation at mid-day or in the evening. In 4 year trials with cucumbers grown either without irrigation or irrigation when the water deficit reached 50,75 or 100 per cent of evaporation with drip irrigation or overhead watering. Henriksen (1980)

reported 60 per cent more fruits with irrigation at 75 to 100 per cent water deficits than without irrigation. Irrigation improved quality and reduced the tendency towards spongy fruits but failed to improve fruit uniformity. It was further observed that twice as many fruits per plant were obtained by irrigation, but there were no differences in yield and quality between irrigation methods.

Forced Cucumbers when watered at different soil suctions gave highest yields at  $p^F$  2.3 (Gato et al., 1981). But Mannini and Roncuzzi (1983) observed that neither the method (drip or perforated) nor the interval (3 or 6 days) of irrigation influenced the cucumber yields but the volume of water applied assumed much importance. By restoring 50, 100 and 150 per cent of evapotranspiration required 1380, 2760 and 4140 m<sup>3</sup> per hectare water and gave fruit yields of 985, 1248 and 1385 q per hectare. Likewise, Tan et al. (1983) reported that irrigation substantially increased the yield and improved the grades of multi-harvest and once-over harvest cucumbers. They obtained highest yields with irrigation at 60 per cent available soil moisture level and with once over harvest at 25 per cent available soil moisture level. Reporting the results of irrigation trials with different systems of localized irrigation, Restoy (1983) recorded similar yields with all systems and averaged 7.27 and 7.35 kg per m<sup>2</sup>. In summer irrigation requirement trials with cucumber at Puerto Rico, Goyal and Allison (1983) applied a total volume of 116.6, 90.3 and 71.30 litres per emitter for wet, moist and dry treatments during the growing

period and per plant water applications were 14.6, 11.3 and 8.91 litres for wet, moist and dry treatments, respectively. The moist treatment gave significant increase in crop yield compared with wet and dry treatments.

Evaluating the response of trickle irrigation conducted on loamy sand soils in South Western Indiana, Bhella and Kwolek (1984) recorded an increase in plant growth, early bloom and yield. The trickle irrigation reduced the percentage of culled fruits. However, plant growth was negatively correlated with days to bloom after planting and days to bloom were correlated negatively with yield. The early blooming plants yielded more than the late blooming plants.

#### 2.1.4 Gourds and Squash :

Smittle and Thereadgill (1983) at Georgia, reported highest marketable Squash yields from applying irrigation at 0.3 bar soil water tension.

In a comparative study at Tirupati with pitcher and basin irrigation in Bitter gourd every 4th or 8th day, Reddy and Rao (1983) observed highest yields of 21.6 kg per 25 m<sup>2</sup> with pitchers filled every 4th day and was lowest i.e. 15.9 kg per 25 m<sup>2</sup> on plots with basins filled every 8th day.

From the experiment conducted at Tirupati, Andhra Pradesh, to compare the pitcher and basin irrigation on Snakegourd, Reddy and Rao (1980) reported that for the same quantity of water applied, water-use efficiency was higher

in Pitcher irrigation than in basin irrigation. The yield at pitcher irrigation treatment at four days interval was higher than that with eight days interval. But the water use efficiency was higher in eight days interval. Studying different drip layouts and discharges on Squash yields Shatanawi (1983) reported similar yields when one emitter per one plant or two plants were used, but when one emitter per four plants was used, the yield produced was less.

It is seen from the foregoing review that the information on the method of irrigation and its scheduling to watermelon is meagre. Based on the research conducted on Cucurbitaceous crops, it is observed that rapid growth, early harvest and higher yields with increased water-use efficiency have been obtained under drip system of irrigation, as compared to other methods of irrigation.

Irrigation every 7 to 10 days resulted in higher yields and irrigated plants carried more number of fruits. A moisture level near to field capacity, maintained over the entire growing season, resulted in higher yields. A pan evaporation coefficient of 0.90 recorded best growth, flowering and fruiting of Cucurbitaceous crops.

## 2.2 Effect of plant population and spacing on growth, yield and quality of certain Cucurbitaceous crops

Plant density and yield relationships have received considerable attention in recent years (Donald, 1963; Willey and Heath, 1969). One of the primary reasons for the

interest in narrow-row, high population culture is its theoretical advantage for improving earliness and maturity by reducing field time of the crop without reducing yield (Fowler and Ray, 1977). Maintenance of optimum plant population assumes greater importance, since this accounts for manifold yield increase when other factors are non-limiting.

#### 2.2.1 Watermelon

Experiments conducted at Horticultural unit, Gainesville, Florida, by Halsey (1959) revealed that the number of marketable watermelons per acre increased as the inter-row spacing decreased from 12 ft. to 3 ft. and spaced 10 ft. apart, within the rows. However, the size of the fruits increased due to wider spacing. Locascio and Halsey (1960) observed that watermelon spaced at 2 ft. between plants compared with 4 ft. resulted in a 30 per cent increase in the number of fruits, 23 per cent decrease in weight of marketable fruits and a 5 per cent decrease in the average weight per fruit.

Peterson (1961) obtained an increase of 4 to 5 tons of fruits per acre when spaced at 4 ft. x 7 ft. spacing as compared with 12 ft x 7 ft. with only slight reduction in fruit size. In a later study, Peterson (1962) recorded highest yield with 2 ft. spacing in the rows spaced 7 ft. apart, but the fruit size decreased with closer spacing and was too small for most markets. Petkov (1970) reported highest watermelon yield, with greatest number of plants,

with negligible decrease in size, with a spacing of 2m x 1m with 2 plants per hill. In trials with 17,000 to 20,400 plants per hectare, leaf area, photosynthesis and total yield increased with increase in plant density but the greatest yields of marketable fruits were obtained with 5,000 to 10,000 plants per hectare (Belik and veselovskii, 1973). Studies carried out by Kononenko and Maksimova (1976) with non-irrigated watermelons, revealed that a decrease of soil surface area per plant from 2.94 to 0.74 m<sup>2</sup> (from 3.4 to 13.5 thousand plants per hectare) increased the total and commercial yields. But a further decrease to 0.49 m<sup>2</sup> (20.4 thousand plants per hectare) markedly reduced the commercial yield and increased the total yield. Nevertheless, watermelons planted one per planting hole, yielded 41 to 45 per cent more marketable fruits than when planted two per hole. Row spacing of 2.4 m proved wide for watermelon and resulted in very low yields of 12.7 t per ha (Patil and Bhosale, 1976). But, the yield increased significantly (19 t/ha) when spacing was reduced to 1.8 m x 1.8 m, with the highest yield (23.2 t/ha) at 1.2 m x 1.2 m. Similarly, Brinen et al. (1979) observed that watermelon grown on sandy soils, the fruit yield decreased, while yield per plant and fruit weight increased with an increase in plant spacing from 0.6 to 2.4 m and the row from 1.5 m to 4.5 m.

In pruning trials, Mangal et al. (1981) reported that pruning to leave 3 to 4 main shoots per plant and spacing the plants at 30 cm gave best results with respect to yield.

While comparing two plant spacings (2.5 ft. and 5.0 ft. apart in rows of 10 ft.), Elmstrom et al. (1981) at Gainesville, Florida, recorded higher total yield with closer spacing (2.5 ft by 10 ft.) as compared to wider spacing (5ft x 10ft).

#### 2.2.2 Muskmelon

Investigating the effect of certain agronomic factors on yield and quality, Gill and Ali (1964) concluded that although wider spacing produced the best plants, the maximum overall yield was obtained by sowing on ridges 5 ft. apart with 2 ft. between the plants. The sugar content was highest in fruits from the most widely spaced plants.

Lazin and Simonds (1981) at Florida, observed that increasing the within row plant spacing from 1 ft to 3 ft increased the number of fruits per plant and mean fruit size but decreased the total number and weight of fruits. Substantial yield increases in melon at Haryana were reported by Baljeet Singh et al. (1982) when the plants were spaced at 30 cm (334 q/ha), as compared to 60 cm (152 q/ha). Studying the effects of population density and plant spacing on the growth, flowering and yield, Nerson et al. (1984) at Israel observed that vegetative development, flower number, yield and quality were not affected significantly by growing one or two plants per hill, which justified the practice of sowing 2 seeds/hill without thinning. They further reported that with a population of 31,250 plants per ha, the vegetative growth per unit area was faster than with 13,500 plants per ha.

There were more leaves per  $m^2$ , a higher leaf area index and more dry matter accumulation per  $m^2$ . At higher density more flowers were produced per  $m^2$  (36% more male and 9% more perfect flowers), 21 per cent more fruits were set, the yield was 20 per cent higher and percentage of fully netted high quality fruits were greater.

### 2.2.3 Cucumber :

Spacing trials carried out at Ceylon, revealed that closest spacing of 4ft x 1ft was by far the most productive (Fernando 1943). However, Charlottetown (1954) at Dominion Experimental Station, recommended an optimum spacing of 6 feet between rows and one foot between plants for pickling cucumbers. In spacing trials Cehmistrenko et al. (1954) reported methods of spacing cucumbers at a distance of 1.5m x 1.5m. The advantages claimed for this type of spacing are easier mechanical cultivation and increased and earlier yields. While comparing the plant population of 29,000 to 1,16,000 per acre achieved by planting 2, 3 or 4 rows on 6 ft. bed with 2 or 4 plants per ft. row, Bradley et al. (1975) reported higher yields above population of 58,000 plants per acre. Similarly, Nerson et al. (1982) observed that planting cucumbers at 15,000 and 30,000 plants per ha. produced a higher proportion of smaller fruits (38 mm diameter) than wider placed plants. However, the best plant growth and development, higher photosynthesis and greatest yields were obtained when the Cucumbers were spaced at 1.5 plants per  $m^2$  (Karataev and Salnikova, 1982). In spacing

trial with Cucumber cultivars at Newzealand, Burgmans (1983) reported higher yields of first grade fruits (14-17 t/ha), as well as total yields of all cultivars in rows of 50 cm.

Thus, it could be seen that in cucurbitaceous crops the number of fruits per acre increased as the spacing decreased and the plant populations increased but the fruit size increased at wider spacing ie., low plant population. In general, closer spacing recorded nearly 30 per cent higher marketable yields, though it resulted in 5 per cent decrease in fruit weight. The vegetative development, flower number, yield and quality were not affected by growing one or two plants per hill.

### 2.3 Effect of fertilizers on growth, yield and quality of certain Cucurbitaceous crops

Inadequate fertilizer use forms a major constraint in increasing watermelon yields. Minieral nutrition is basic to crop production since all physilogical and biochemical growth process are controlled by nutrient elements. The plant and soil must be nutritionally compatible to achieve maximum production with greatest effeciency.

#### 2.3.1 Watermelon :

Studies carried out by Nettles et al. (1957) at different locations, revealed that at Gainsville, Florida, 500 lb. of 6-8-8 (N.P.K.) fertilizers per acre produced 780 watermelons weighing 18,330 lb. and with 1,000 lb per acre produced 1080 watermelon weighing 26,568 lb. However, at

Suwance Valley Station, 500 lb of 6-8-8 (N-P-K) fertilizer per acre produced 423 watermelon, weighing 10,025 lb. and with 1,000 lb. per acre 480 watermelon, weighing 11,684 lb. But at neither place were there any differences in yield with different sources of nitrogen. Abdel-Samie (1958) at Egypt, reported no significant effect on the height of plants and number of male and female flowers by varying the fertilizers, although, the ratio of male to female flowers was greatest with cotton - seed meal applied before planting. The highest yields were obtained with a pre-planting dressing of cotton - seed meal followed by pigeon manure during fruiting and pre - plant cotton-seed meal application followed by nitrate of soda during fruiting.

Halsey (1959) at Florida, obtained significant increase in the number of melons with increased rates of fertilizer upto 2000 lb. per acre of 6 - 8 - 28 (NPK) fertilizer. Experiments of Bradley and Fleming (1959) at Arkansas on watermelon fertilization, revealed that good yields were assured by 60 lb. N, 60 lb. P, and 30 to 60lb. K per acre. The main effect of adequate fertilizer was on the number and not on the size of fruits and the sugar content was slightly reduced by deficiency of any of the major nutrients. They also put forward a method of finding critical percentage of P and K, from foliar analysis which had given high rate of accuracy in predicting yields. However, Locascio and Halsey (1960) studying the fertilizer requirements at Florida Experimental Station, reported that different rates of

fertilizers had no effect on yields, but split application increased the number of melons by 20 per cent, weight of the marketable melons by 25 per cent, and average weight by 4 per cent and early yields by 70 per cent.

While studying the effect of nitrogen fertilization at Indiana, Brantley and Warren (1960) reported that application of nitrogen increased the number of pistillate flowers and the increase was slight when the rates were above 100 kg N per ha. But the per cent fruit set, early and total yields and fruit size were increased by nitrogen. A complete fertilizer with 30 per cent N derived from natural organics at Florida, resulted in significantly higher total yields and early higher yields (Everett, 1960), than when 3 inorganic nitrogen sources were used and Amonium sulphate gave the highest yields. Likewise, Kasceev (1969) observed that absence of nitrogen in the fertilizer mixture retarded growth in the early stages of watermelon production and the absence of nitrogen or high rates of nitrogen produced similar yields.

Watermelon yields were highest at Florida (43.7 t/ha) on plots receiving Sulphur coated urea at 140 kg/ha (Locascio and Fiskell, 1975). Studying the effect of mineral fertilizers on yields and quality of watermelon, Knysh and Vakulenko (1976) reported that N,  $P_2O_5$  and  $K_2O$  at 90, 135 and 90 kg per ha, incorporated to soil, improved the plant growth and increased yields upto 43 per cent, but the fertilizers had no appreciable effect on fruit sugar, dry

matter and Vitamin C content. Based on three year trials on watermelon, Bhosale et al. (1978) in Maharashtra reported highest yields (26t/ha) with nitrogen at 75 or 100 kg per ha.

Comparing the efficiency of Sulphur coated urea, Locascio et al. (1978) found that single application of various formulations of Sulphur coated urea, resulted in yields equal to or exceeding those obtained with three split applications of urea, at the same nitrogen rate. However, on sandy soils at Gainsville, Brinen et al. (1979) realised both higher yield and mean fruit weight with 1680 kg per ha, than 840 kg per ha, of 12-7-13, N P K fertilizer. Watermelon grown on a chernozem soil of Bulgaria, with a low nutrient content showed that increasing amounts of organic and mineral fertilizers, increased leaf area and consequently yields of watermelon (Yusifov, 1983). He obtained the highest yield (100% higher than that of control ) with 20 t per ha. of FYM and 140 N, 170  $P_2O_5$  and 115  $K_2O$  kg per ha. Yusifov (1984) continuing his studies on the photosynthetic activity of watermelon in relation to nutrition, recorded highest photosynthetic production during fruit ripening, on plots receiving 20 t per ha of FYM and N P K at 100 : 130 : 80 kg per ha. Similarly, Khristov (1984) in experiment at Bulgaria, on the relationship between the growth and productivity of watermelons and mineral fertilizers, reported an optimum economic rate of 140 N and 120 P kg per ha.

### 2.3.2 Muskmelon :

Enumerating the improved practices for getting higher yields at Iowa, Peterson (1957), reported that plots receiving animal manure produced greater yield increases than unmanured plots. In trials with nitrogen nutrition to muskmelon at Indiana, Brantley and Warren (1961) observed that, in season of heavy rainfall, 30, 60 and 90 lb. nitrogen per acre increased the number of perfect flowers, number of fruits and total yield, while higher rates caused depression. An application of 250 kg. per acre, reduced the number of days from anthesis to maturity. However, Padda et al. (1969) at Ludhiana, opined that application of 56 kg N per ha, is most profitable, although yields were greater when double the quantity was applied. Jassal et al. (1970) studying the effect of certain doses of nitrogen, phosphorus and potassium at Punjab, reported an increase in fruit weight and yield, by application of nitrogen upto 165 kg per ha.. While studying the response of muskmelon to foliar application of nitrogen and potassium on Loamy sand soils of Ludhiana, Randhawa and Kirti Singh (1971) reported that foliar application of 1.5 per cent of nitrogen, proved more efficacious in the early initiation of first hermaphroditic flower, at lower node on main axis, followed by potassium sprays. With increase in amount of doses from 0 to 1.5 per cent, there was positive responses in respect of yield, while negative response was obtained in plants treated with 2.0 per cent nitrogen. Jassal et al. (1972) reported an increase in the number of flowers with N P K application. However, Wilcox (1973)

studying the response of muskmelon to rates and sources of nitrogen, obtained increased vine growth and intensified leaf colour by nitrogen at 33 kg per ha. But optimum growth and yields were obtained with nitrogen applied pre-plant at 80 to 90 kg per ha. Gupta et al. (1975) reported an optimum fertilizer rate of 106 kg N and 122 kg  $P_2O_5$ , for getting 99 q per ha yield, under Bangalore conditions. Randhawa et al. (1981) observed that the best results with regard to growth, yield and quality could be obtained by applying N P K at 50 : 37.5 : 37.5 kg per ha.

Lazin and Simonds (1981) at Florida, concluded that fertilizer rates had no effect on marketable yield, but the percentage of cull fruits was decreased, with highest fertilizer rate of 2500 lb per acre of 6-8-8 (N-P-K) fertilizer. In pruning and fertilizer trials at Haryana, Baljeet Singh et al. (1982) failed to obtain any yield increase at 100 kg N and 60 kg  $P_2O_5$  per ha, as compared to half these rates. Studying the growth and uptake of nutrient elements on melons fertilized with 180 kg N, 120 kg  $P_2O_5$  and 180 kg  $K_2O$  per ha, Graifenberg and Petsas (1983) in Italy, observed vegetative development to be maximum between 30 and 45 days and fruit development between 45 and 60 days from transplanting. The amounts of N, P and K, Ca and Mg required to produce one quintal of fruits were 0.32, 0.053, 0.518, 0.495 and 0.52 kg respectively. From an experiment conducted in South Korea, on the nitrogen levels of muskmelon, Kim and Ito (1983) recorded the best fruit size and sugar content

with 80 kg nitrogen per acre.

### 2.3.3 Cucumber :

Mineral nutrition studies carried out by Afans'Ev (1940) indicated that mineral manures could replace organic manures and were sometimes more effective and quickly available at an early stage of crop growth. The trace elements were found to facilitate the intake of N, P and K, increase the sugar content of cucumbers and improve their quality. He further observed that, even though organic manures, notably poultry manure and night soil were less efficiently utilised, they improved the quality of the soil. For growing cucurbits in general, Zonn and Pavlova (1942) in Russia, found N and P fertilizers to be more effective than K fertilizers. In long term trials with different vegetables at Hamburg, Gericke (1948) observed that, in addition to complete mineral fertilizer, stable manure applied every 3 years increased the cucumber yields by 81.3 per cent. However, Wittwer and Tyson (1950) at Michigan, reported that on fairly productive soils, band application of upto 500 lb. per ac. of 3 - 12 - 12 fertilizer would prove profitable for pickling cucumbers and on a poorly drained soil, this amount may be increased to 800 lb. broadcast and 200 lb. ammonium nitrate added as side dressing. Likewise, Charlottetown (1954) observed that highest yields of good grade cucumber could be obtained by applying 10 t of manure broadcast and 10 t in the furrows. In top dressing trials with cucumbers, Peterson et al. (1954) observed applications of 3.33 kg calcium nitrate per 100 m<sup>2</sup>,

to favour earliness, while with organic manures highest yields were obtained. On leached chernozems of Ukraine, U.S.S.R., N P K applications to irrigated cucumbers increased yields by 35 to 70 per cent and improved dry matter and vitamin C content (Bolotskih, 1969). Jagoda et al. (1970) recommended an optimum nitrogen rate of 133 and 200 kg per ha for unirrigated and irrigated cucumbers. But under irrigation, high yields were obtained with FYM at 3 t per ha and nitrogen at 66 kg per ha. However, Jagoda and Koniszewski (1975) reported that, under irrigated conditions, 600 kg N, P, K per ha was more efficient than either 300 or 900 kg. On the contrary, Bradley et al. (1975) recommended an optimum nitrogen level of 60 lbs per acre. Likewise, Krynska (1975) observed good quality and increased market values for cucumbers, when fertilized with 600 kg N P K per ha. The best quality of sour cucumbers were obtained with 80 : 100 : 120 N,  $P_2O_5$  and  $K_2O$  kg per ha (Krynska et al., 1976). Studying the effect of fertilizer on cucumber yield in northern Moldavia, Talmach (1977) observed that highest yields could be obtained on chernozem soils by applying compost at 25 t per ha, with N :  $P_2O_5$  :  $K_2O$  at 90 : 60 : 60 kg per ha.

Studying the dry matter production and N, P, K uptake in greenhouse grown cucumbers, under drip irrigation with nutrient solution, Massrawa et al. (1984) recorded an yield of about 70 t per ha. and total dry matter production of 80 t per ha. Total N, P and K uptakes were 220, 50 and 290 per

ha. respectively.

The response of Cucumbitaceous crops to fertilizers have been well documented. significant increase in fruit set, early yields and marketable yields have been reported by several workers. The absence of nitrogen in the early stages retarded the growth of melons. Fertilizer application in the range of 100 to 140 kg nitrogen per ha, in split doses is recommended. Nitrogen application did not alter the fruit sugar, dry matter or Vitamin C content appreciably.

#### 2.4 Effect of plant population and fertilizers at different levels of irrigation:

Based on comparative studies of the agronomic factors affecting muskmelon yield in West Pakistan, Gill and Ali (1964) reported a spacing of 5 ft x 2 ft, with a maximum of three irrigations to avoid fruit deterioration. The sugar content was significantly increased by reducing the irrigation from five to three and with wide spacing.

Jassal et al. (1970) working on melons in Punjab, recorded higher yields and fruit weight, with increase in nitrogen from 0 to 165 kg per ha and bi-weekly irrigation, as compared to fortnightly irrigation. Krynska et al. (1976) obtained best quality cucumbers, with 80 : 100 : 120 kg N :  $P_2O_5$  :  $K_2O$  per ha with 120 mm irrigation. At Florida, drip irrigation with higher plant population (2.5' x 10') in watermelon, resulted in increased total yields with a 40 per cent saving in water (Elmstrom et al., 1981). Smittle and Threadgill (1982) at Tifton, U.S.A., observed highest

marketable yields of Squash with 22.5 kg nitrogen per ha, through irrigation system with 0.3 bar soil water tension at 2, 3, 4, 5 and 6 weeks after planting. From trials conducted in Haryana, Chander and Mangal (1983) reported best growth, flowering and cropping of melon with irrigation at 0.90 pan evaporation coefficient and 40 kg nitrogen per ha.

Sharma and Shukla (1972) studying response of pumpkin, at Bangalore reported an optimum level of 103 kg nitrogen and 160 kg phosphorus per ha. While Gupta and Srinivas (1979) at Bangalore, observed that application of 80 kg nitrogen and 65 kg phosphorus per ha was optimum in realising higher yields of pumpkin cv. Arkachandan. For obtaining maximum yields of Squash, Shukla and Gupta (1980) at Bangalore, recommended 100 kg nitrogen and 60 kg phosphorus per ha. Smittle and Threadgill (1982) at Tifton, U.S.A., recorded highest yield of Squash by applying 22.5 kg nitrogen per ha, at 2, 3, 4, 5 and 6 weeks after planting. While working on melons at Haryana, Baljeet Singh et al. (1982) observed fertilization with 100 kg nitrogen and 60 kg phosphores per ha to have little effect on yield, as compared to half these rates and the yield increased at 30 cm plant spacing, as compared to 60 cm spacing. Trials conducted at Bangalore, by Srinivas and Prabhakar (1984) in muskmelon, indicated an optimum spacing of 300 cm x 60 cm, with 60 kg nitrogen per ha for realising higher yields.

## **MATERIAL AND METHODS**

### III. MATERIAL AND METHODS

The details of the experimental techniques adapted and procedures followed are presented in this chapter.

#### 3.1 Experimental Site

The experiment was conducted at the Horticultural Experiment Station, Indian Institute of Horticultural Research, Hessaraghatta, Bangalore during the summer seasons (January to May) of 1984 and 1985. Hessaraghatta is situated at  $13^{\circ} 58'$  North latitude and  $78^{\circ}$  East longitude with an altitude of 890 metres.

##### 3.1.1. Soil Characters

Composite soil samples were drawn from the experimental site for the upper 0-15 cm soil layer and analysed for soil mechanical composition and chemical properties. The single value physical constants i.e. Field capacity, Permanent Wilting Point and Bulk Density were estimated for the soil depth of 120 cm at each 15 cm interval. The data are presented in Table 3.1.

The soil of the experimental site is red sandy clay loam (Udic Haplustalf) having low fertility. The soil is nearly neutral in reaction and free from excessive salts. It is low in organic matter, total nitrogen, available phosphorus and potash.

Table 3.1. Physical and Chemical properties of  
soil at the experimental site,  
Hessaraghatta

Character	Value	Method adopted
A. Mechanical composition (0 - 15 cm)		
1. Coarse sand (%)	41.3	International pipette method (Piper, 1950)
2. Fine sand (%)	23.0	
3. Silt (%)	3.7	
4. Clay (%)	32.0	
B. Chemical properties (0 - 15 cm)		
p <sup>H</sup>	6.70	Hesse (1972)
EC, $\mu$ Siemens / metre	114.00	Hesse (1972)
Organic Carbon (%)	0.45	Page <u>et al.</u> (1982)
Available N (kg/ha)	242.00	Page <u>et al.</u> (1982)
Available P <sub>2</sub> O <sub>5</sub> (kg/ha)	9.35	Page <u>et al.</u> (1982)
Available K <sub>2</sub> O (kg/ha)	135.50	Page <u>et al.</u> (1982)

Table 3.1 contd.

## C. Single value physical constants

	Soil depth, (cm)	Field capacity (0.33 bar)*	Permanent wilting point * , (15 bar)	Bulk density, (g/cc)
		(per cent)		
1.	0 - 15	14.45	6.52	1.62
2.	15 - 30	16.36	7.46	1.61
3.	30 - 45	17.22	8.24	1.60
4.	45 - 60	17.54	8.96	1.61
5.	60 - 75	23.28	12.68	1.60
6.	75 - 90	29.54	16.84	1.60
7.	90 -105	31.24	19.01	1.58
8.	105 -120	31.92	18.64	1.55

\* Field capacity and permanent wilting point were estimated by pressure membrane apparatus

+ Bulk density was estimated by Core sampler method as per Piper (1950).

The field capacity ranged from 14.45 percent in the upper 0- 15 cm to 31.92 percent in 105 - 120 cm soil depth. The permanent wilting point was low in the upper 0 - 15 cm (6.52%) and gradually increased with depth and was 18.64 per cent in the 105 - 120 cm depth. The bulk density was high (1.62 g/cc ) in the 0 - 15 cm depth soil and decreased in the lower depths and was lowest (1.55 g / cc ) in the 105-120 cm.

### 3.2. General Weather Conditions

The meteorological data for crop season (Jan- May) of 1984 and 1985 along with normal values (1954 - 1983) are presented in Table 3.2. and graphically presented in figure 3.1. The normal values are for G.K.V.K. Farm, U.A.S., Bangalore located 13.5 km away from Hessaraghatta.

The normal maximum temperature ranged from 26.9<sup>0</sup>C in January to 33.6<sup>0</sup>C in April for the crop growth period. During 1984, the maximum temperature was lower by 0.2<sup>0</sup>C in January and March, whereas, it was lower by 2.2<sup>0</sup>C in February. The maximum temperature was higher by 1.8<sup>0</sup>C in May. During 1985, it was higher throughout the crop period and ranged from 0.9<sup>0</sup>C in January to 2.8<sup>0</sup>C in March, The normal minimum temperatures ranged between 13.9<sup>0</sup>C in January to 20.7<sup>0</sup>C in May. The minimum temperatures were higher during both the years. During 1984, it was higher by 0.9<sup>0</sup>C in April to 2.8<sup>0</sup>C in January and in 1985, it was higher by 1.1<sup>0</sup>C in May and 2.5<sup>0</sup>C in January and February.

**Table 3.2 Normal (1954 - 83) and actual (1984 and 1985) monthly meteorological data.**

A. Temperature

Months	Maximum temperature (°C)			Minimum temperature (°C)						
	Normal	1984	d 1985	Normal	1984	d 1985				
January	26.9	26.7	- 0.2	27.8	0.9	13.9	16.7	2.8	16.4	2.5
February	29.5	27.3	- 2.2	31.1	1.6	15.1	17.7	2.6	17.6	2.5
March	31.0	30.8	- 0.2	33.8	2.8	17.6	18.7	1.1	19.7	2.1
April	33.6	33.0	- 0.6	34.2	0.6	20.5	21.4	0.9	22.1	1.6
May	32.6	34.4	1.8	33.9	1.3	20.7	22.1	1.4	21.8	1.1

B. Relative Humidity

Months	Maximum Relative Humidity (%)			Minimum Relative Humidity (%)						
	Normal	1984	d 1985	Normal	1984	d 1985				
January	88	84	- 4	84	- 4	38	50	12	39	1
February	82	81	- 1	68	-14	34	50	16	29	5
March	77	67	-10	67	-10	29	37	8	27	- 2
April	79	74	- 5	72	- 7	33	34	1	37	4
May	83	76	- 7	70	-13	41	41	0	39	- 2

d: deviation

Table 3.2 (contd.)

C. Rain fall and Evaporation

Months	Rainfall (mm)		Open pan evaporation (mm/day)	
	Normal	1984	Normal	1984
January	3.0	0.7	5.7	4.9
February	6.1	24.0	7.5	5.3
March	8.3	36.8	9.5	7.2
April	39.3	26.0	9.4	8.3
May	115.0	60.2	9.2	8.4
TOTAL	171.7	147.7	43.2	38.8

d: deviation

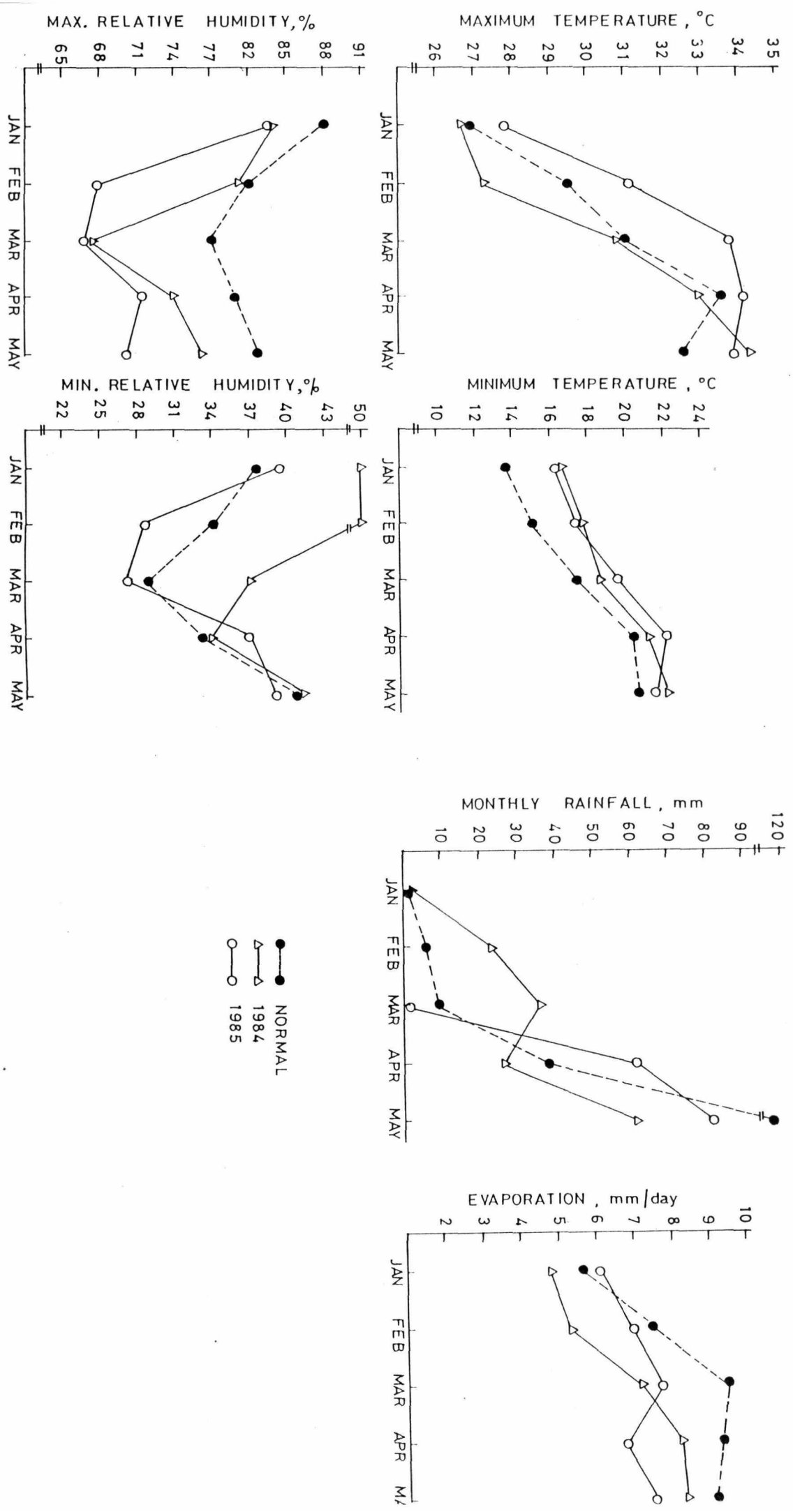


FIG. 3-1. NORMAL AND ACTUAL MONTHLY METEOROLOGICAL DATA

The maximum normal relative humidity ranged from 77 per cent in March to 88 per cent in January. During 1984, it was always less than the normal and was lower by 1 per cent in February to 10 per cent in March. Likewise, during 1985, the maximum relative humidity was lower by 4 per cent in January to 14 per cent during February. The normal minimum relative humidity between January and May ranged from 29 per cent in March to 41 per cent in May. During 1984, it was higher by 1 per cent in April to 16 per cent in February as compared to normal and in May the minimum relative humidity was the same. However, during 1985, it was higher by 2 per cent in January to 5 per cent in February and was lower during March and May by 2 per cent.

The average annual rainfall of G.K.V.K., Bangalore is 825 mm and that of Hesaraghatta, an average of 1980 to 1987 is 810 mm. The normal rainfall during the crop season (Jan-May) is 171.7 mm. The actual rainfall was lower by 24.0 mm during 1984 and by 28.4 mm in 1985. During January to May in 1984, the rainfall received was higher during February (17.9 mm), March (28.5 mm) and lower in April (13.3 mm) and May (54.8 mm), as compared to the normal rainfall. During 1985, it was lower than the normal rainfall in all the months (3.0 mm in January to 33.6 mm in May), except in April which received 22.3 mm higher rainfall than normal.

From January to May, the normal mean monthly evaporation rate varies from 5.7 mm per day in January to 9.5 mm per day in March. During 1984, the mean monthly evaporation rate for the above period was less than the normal by 0.8 mm per day in January to 2.3 mm per day in March. During 1985 also, it was lower by 0.5 mm per day in February to 2.6 mm per day in April, whereas, it was higher by 0.4 mm in the month of January.

### 3.3. Experimental details

The studies on "Response of watermelon to drip and furrow irrigation under different nitrogen and plant population levels" involved two field experiments, the details of which are as follows

Experiment I : Effect of nitrogen and spacing under drip and furrow irrigation in watermelon. (cv. Arka manik)

#### Treatment details

a) Nitrogen levels : Three

$N_1$  = 60 kg N / ha

$N_2$  = 120 kg N / ha

$N_3$  = 180 kg N / ha

b) Spacing : Two

$S_1$  = 300 cm x 60 cm (11,111 plants / ha)

$S_2$  = 200 cm x 60 cm (16,666 plants / ha)

PLAN OF LAYOUT OF THE EXPERIMENT

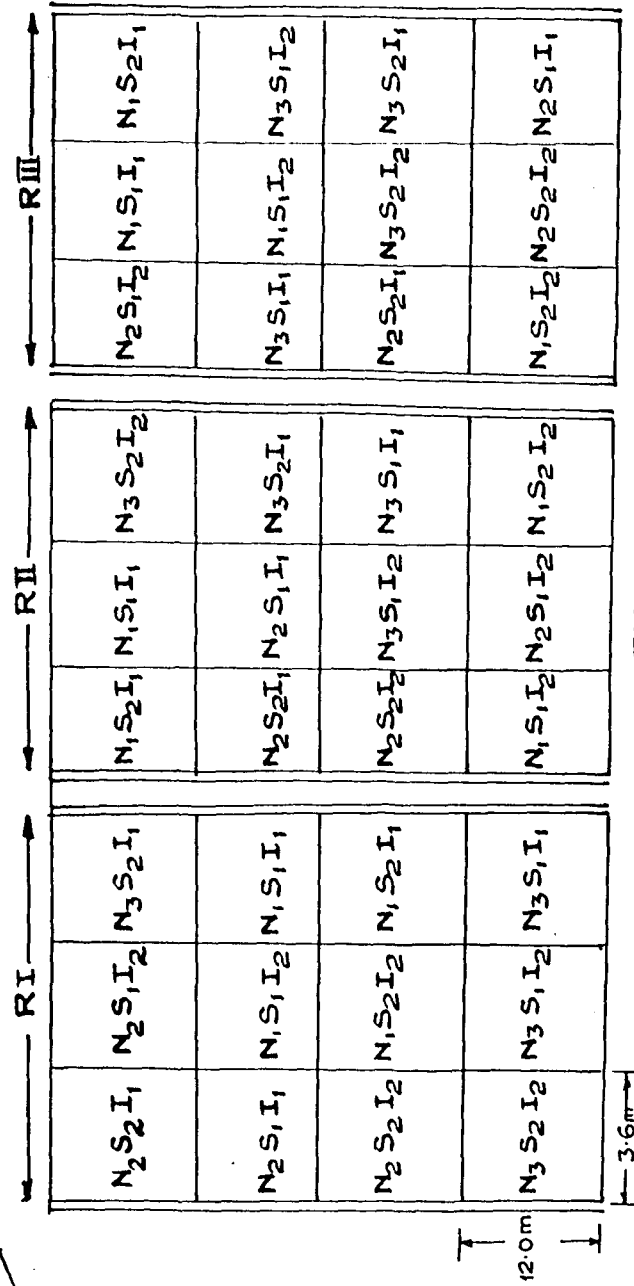


FIG.3.2

TREATMENTS

NITROGEN LEVELS:

- $N_1 = 60 \text{ kg/ha}$
- $N_2 = 120 \text{ kg/ha}$
- $N_3 = 180 \text{ kg/ha}$

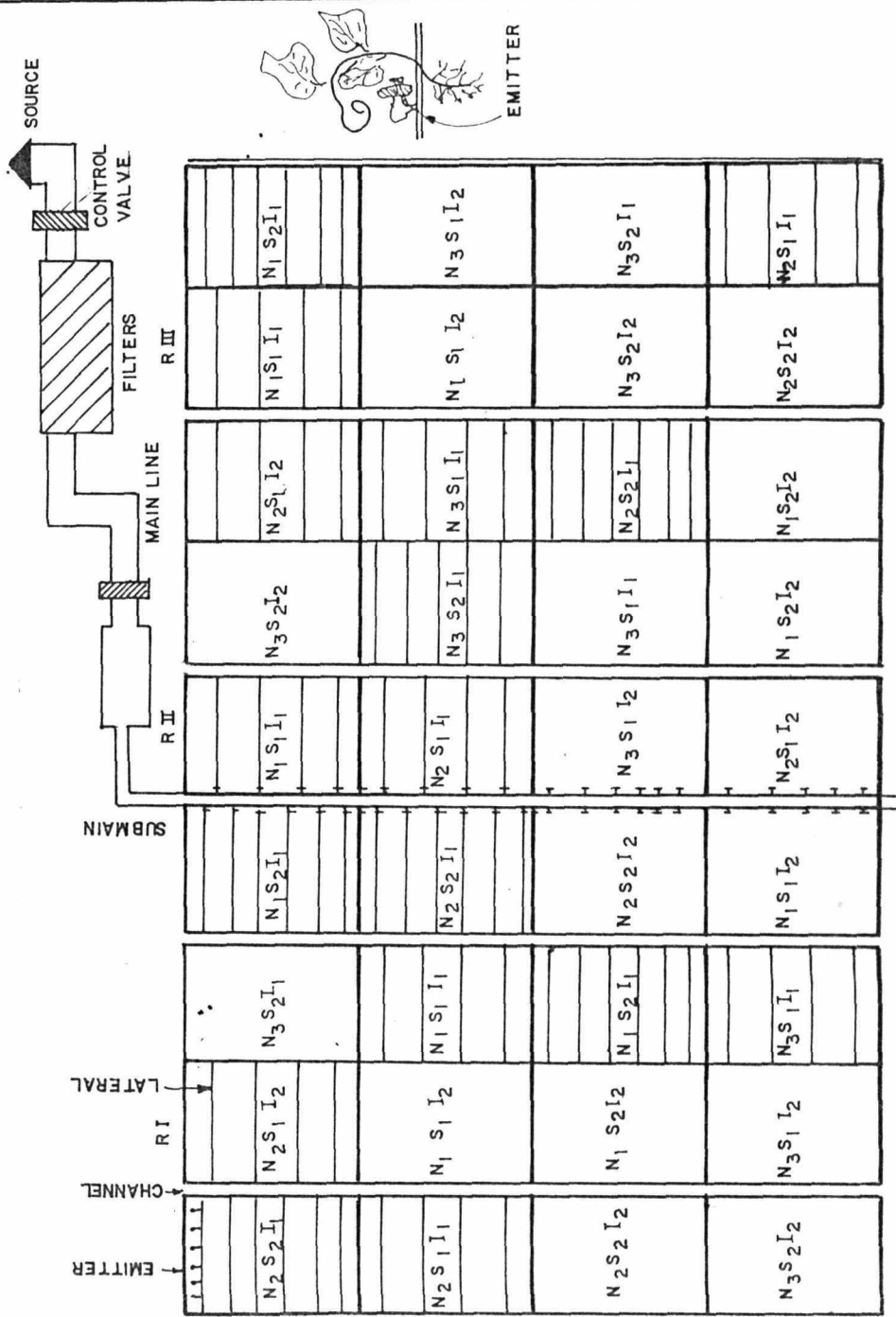
SPACING :

- $S_1 = 3.0 \text{ m} \times 0.6 \text{ m}$
- $S_2 = 2.0 \text{ m} \times 0.6 \text{ m}$

METHOD OF IRRIGATION :

- DRIP:  $I_1 = 0.5 \text{ PER}$
- FURROW:  $I_2 = 0.5 \text{ IW/CPE}$   
WITH 5.0 cm  
- DEPTH OF IRRIGATION WATER

# LAYOUT PLAN OF DRIP SYSTEM



## TREATMENTS

NITROGEN LEVELS : N<sub>1</sub> 60; N<sub>2</sub> 120; N<sub>3</sub> 180 Kg/ha  
 SPACING : S<sub>1</sub> 300cm x 60cm; S<sub>2</sub> 200cm x 60cm  
 METHOD OF IRRIGATION : I<sub>1</sub> 0.50 PER; I<sub>2</sub> 0.50 IW/CPE WITH 5.0cm DEPTH

c) Irrigation methods : Two

$I_1$  = Drip irrigation at 0.50 pan evaporation ratio (PER) calculated on the basis of whole area.

$I_2$  = Furrow irrigation at depth of irrigation water/cumulative pan evaporation (IW/CPE) ratio of 0.50 with 5.0 cm depth of irrigation water.

There were twelve treatment combinations. The factorial experiment was laid out in a Randomised Complete Block Design with three replications. The gross plot size was 12.0 m x 3.6 m with four rows in 300 cm row spacing and six rows in 200 cm row spacing, with a uniform plant spacing of 60 cm. The net plot sizes were 6.0 m x 3.6 m for 300 cm row spacing and 8.0 m x 3.6 m for 200 cm spacing, respectively. The plan and layout of the experiment is given in Fig.3.2.

Experiment II: Studies on the comparative efficiency of drip and furrow irrigation systems in watermelon.

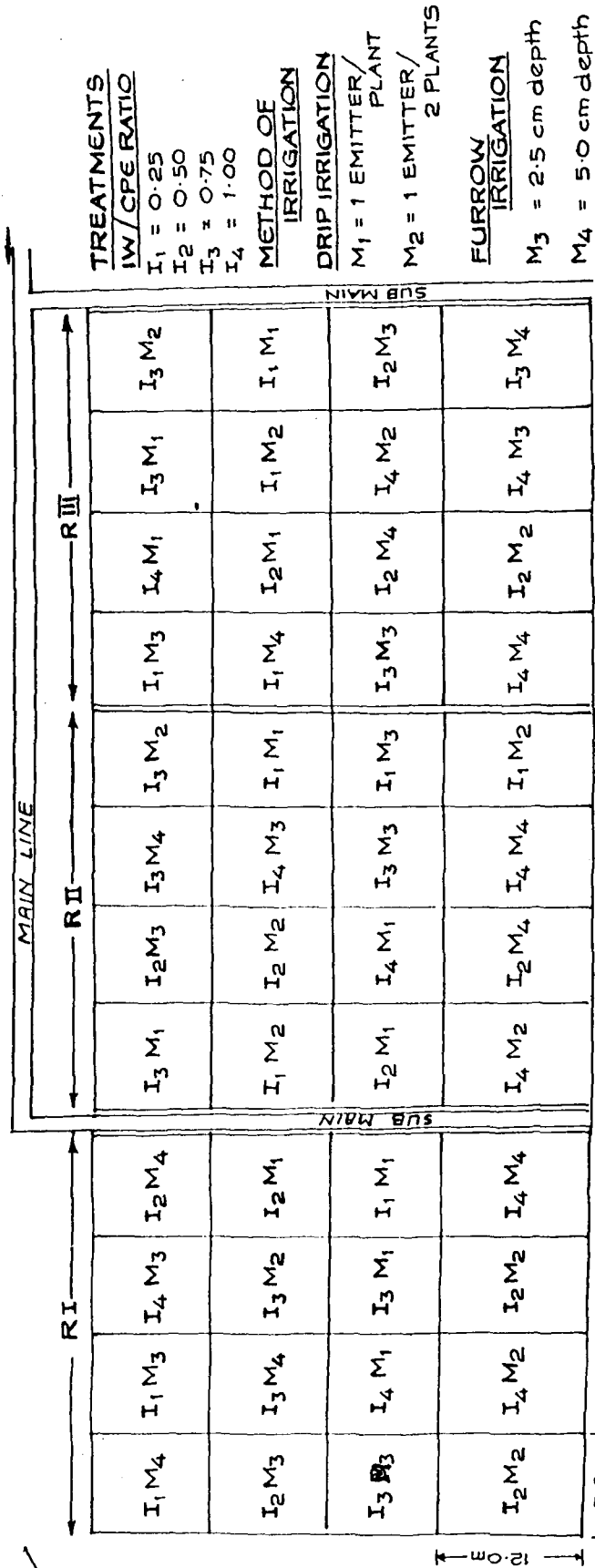
Treatment details

(cv. Arka manik).

a) Pan evaporation ratio (PER) calculated on the basis of whole area and IW/CPE ratios : Four

		<u>Drip irrigation</u>	<u>Furrow irrigation</u>
$I_1$	=	0.25 PER	0.25 IW / CPE
$I_2$	=	0.50 PER	0.50 IW / CPE
$I_3$	=	0.75 PER	0.75 IW / CPE
$I_4$	=	1.00 PER	1.00 IW / CPE

PLAN OF LAYOUT OF THE EXPERIMENT



TREATMENTS

IW/CPE RATIO

- I<sub>1</sub> = 0.25
- I<sub>2</sub> = 0.50
- I<sub>3</sub> = 0.75
- I<sub>4</sub> = 1.00

METHOD OF IRRIGATION

DRIP IRRIGATION

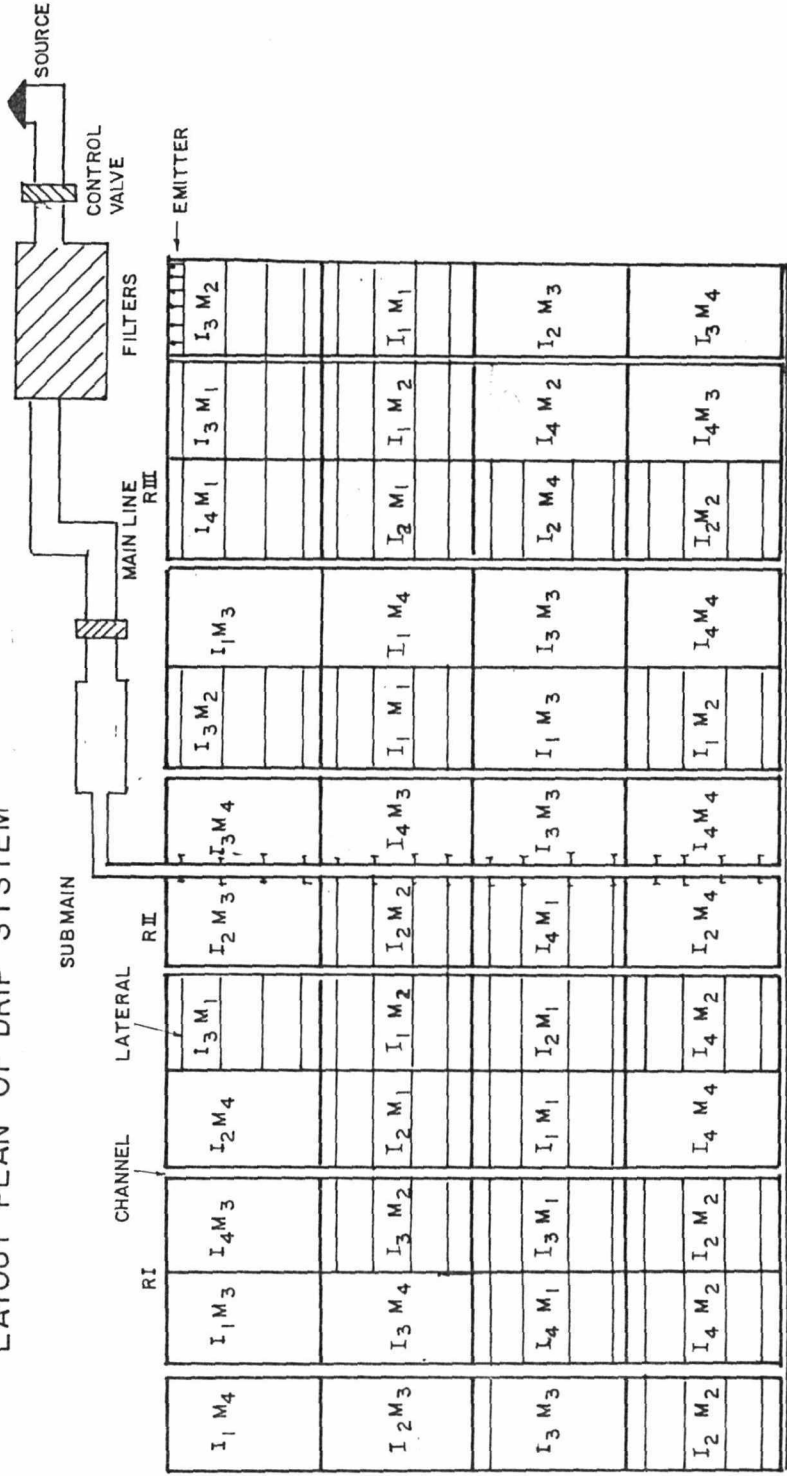
- M<sub>1</sub> = 1 EMITTER/  
PLANT
- M<sub>2</sub> = 1 EMITTER/  
2 PLANTS

FURROW IRRIGATION

- M<sub>3</sub> = 2.5 cm depth
- M<sub>4</sub> = 5.0 cm depth

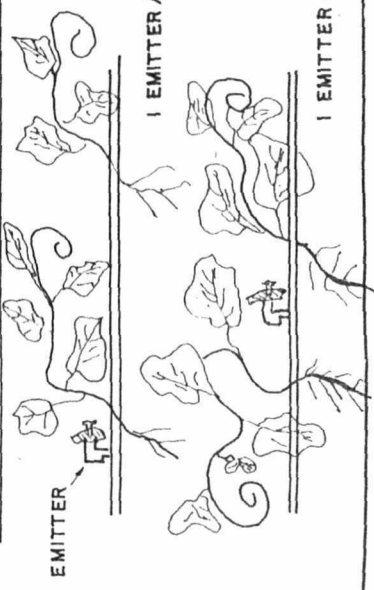
FIG. 3.3

# LAYOUT PLAN OF DRIP SYSTEM



TREATMENT  
 IW/CPE : I<sub>1</sub> 0.25 ; I<sub>2</sub> 0.50 ; I<sub>3</sub> 0.75 ; I<sub>4</sub> 1.00  
 RATIO

METHOD OF DRIP = M<sub>1</sub>: 1 EMITTER / PLANT  
 IRRIGATION: M<sub>2</sub>: 1 EMITTER / 2 PLANTS  
 FURROW = M<sub>3</sub>: 2.5 cm DEPTH  
 M<sub>4</sub>: 5.0cm DEPTH



b) Methods of irrigation : Four

- $M_1$  = drip irrigation with one emitter per plant  
 $M_2$  = drip irrigation with one emitter per two plants  
 $M_3$  = furrow irrigation with 2.5 cm depth of irrigation water.  
 $M_4$  = furrow irrigation with 5.0 cm depth of irrigation water.

There were sixteen treatment combinations and the factorial experiment was laid out in a Randomised Complete Block Design with three replications. The gross plot size was 12.0 m x 3.6 m with four rows of 300 cm and an uniform plant spacing of 60 cm. The net plot size was 6.0 m x 3.6 m. The plan and layout of the experiment is given in Fig. 3.3. The layout and randomisation were the same for both the experiments in 1984 and 1985.

### 3.3.1. Installation of drip irrigaton unit

The drip irrigation unit was installed in the experimental site measuring 100 m length and 50 m width as per treatments. The unit consisted of four stage filter system with a mesh of 100 and 80 microns, water meter, control valve, air-exhaust valve and pressure gauge attached in series to the main line of 5.0 cm diameter. The sub-mains (5.0 cm diameter), laterals (1.25 cm diameter) and point source adjustable emitters connected to the laterals were other components of the drip unit.

The entire pipe network was made of low density polyethylene (LDPE) material. The laterals were running parallel to the plant rows. The water source was from a bore well located at a distance of 150 m from the experimental site, to which the main pipe line was connected. The excess water was let out through two sub-mains located at a distance of 50 m. Thus, it was ensured that emitters located at different points on the laterals throughout the experimental area were letting out the required discharge uniformly. Four stage filter was connected to the main line just prior to the bifurcation, into sub-mains in order to ensure flow of clear water in the drip system. Since the water was directly drawn from the bore well into the drip system, the water was completely devoid of all sediments. The sub-mains started from the point where the filtering system out-let terminated. From this point, the sub-mains were laid at 25 m on either side, parallel to the main line and 50 m perpendicular to the main line. From these sub-mains, the lateral pipe lines were drawn on either side depending on the plant rows with the help of saddles fitted to the sub-mains. Emitters were fixed to these laterals at 60 cm distance uniformly for Experiment I and either at 60 cm (one emitter per plant) or at 120 cm (one emitter per two plants) in Experiment II. The lateral pipe lines were flushed with water repeatedly and closed with the help of end plugs after ensuring that there is continuous water flow in each of the lateral line.

#### 3.4. Land Preparation

A general crop of cowpea was sown during Kharif seasons of 1983 and 1984 in order to even out the fertility variations in the field. After the harvest of the crop, the land was thoroughly ploughed, harrowed, levelled and worked with a cultivator criss-cross. Then the plots were laid out as per the plan. Furrows of 60 cm width and 3.6 m length were opened at a distance of either 2 m or 3 m, as per the treatment in Experiment I, and uniformly at a row distance of 3 m in Experiment II.

Small basins were opened on one side of the furrow at a distance of 60 cm. All the field channels for the surface irrigation were lined with thick gauge polyethylene sheets to prevent percolation losses and convey the measured quantity of water to the experimental plot.

#### 3.5. Fertilizer application and sowing

Entire quantity of 100 kg  $P_2O_5$  (as Single Super Phosphate) and 40 kg  $K_2O$  (as Muriate of Potash) per ha, along with 50 per cent of N (as urea) were mixed and applied as per the treatments viz., 60, 120 and 180 kg N / ha in Experiment I and 100 kg N /ha in Experiment II. Furadon (3 % a.i.) at the rate of 30 kg per ha was also applied along with the fertilizers, for the control of pests in the early stages of crop growth.

Two days prior to planting, each plot (43.2 m<sup>2</sup>) was given 1080 litres of water (25 mm depth) to bring the top

soil to field capacity and to facilitate good germination. Irrigation water was measured using a Parshall flume of 7.62 cm (3 inches) throat width, before letting out the water into each plot. Since the ratio between  $H_b$  and  $H_a$  gauge points in the Parshall flume did not exceed 0.6, it was considered as "free flow". Depending on the head observed in converging section ( $H_a$ ) of the throat of Parshall flume, the time was adjusted to let in the desired quantity of water in each plot.

Two to four seeds of watermelon were sown in each of the basins on 27<sup>th</sup> and 20<sup>th</sup> January during 1984 and 1985, respectively. Two plants were retained later in each basin. The remaining 50 per cent N was top dressed 30 days after sowing. The vines were trained on one side of the furrow when they started running after 30 days of sowing.

### 3.6. Cultural operations after sowing

Two common irrigations of 25 mm depth (1080 l/plot) each were given to the plots after sowing and before the imposition of treatments. The crop was sprayed regularly with Nuvacron (1 to 1.25 ml/l) along with Sulphur (2g/l) or any other copper fungicide to control the pests and diseases. Fruits were harvested in two to three pickings starting from 95 days after sowing and was completed by 110 days. Care was taken to see that only the fruits which are fully ripe were harvested each time. The suitability of harvesting of fruits was judged by either the vine drying at the point of fruit

attachment or change in colour (green to yellow) or by tapping the fruit (a mature fruit will invariably produce a dull sound).

### 3.7 Scheduling of irrigation

The irrigation treatments were imposed after germination and complete establishment of the crop (10 - 15 days). The frequency of irrigation for drip and surface methods were as follows

#### Experiment I

- $I_1$  = Drip irrigation: Daily replenishment of 50 per cent of the evaporation losses from U.S.W.B. Class I open pan evaporimeter (0.50 PER).
- $I_2$  = Furrow irrigation : When the cumulative pan evaporation (CPE) reached 100 mm, irrigation water applied was 50 mm (0.50 IW/CPE ratio).

#### Experiment II

##### a) Drip irrigation:

- 0.25 PER : Daily replenishment of 25 per cent of the evaporation losses from U.S.W.B. class I open pan evaporimeter.
- 0.50 PER : Daily replenishment of 50 per cent of the evaporation losses from U.S.W.B class I open pan evaporimeter.
- 0.75 PER : Daily replenishment of 75 per cent of the evaporation losses from U.S.W.B class I open pan evaporimeter.
- 1.00 PER : Daily replenishment of 100 per cent of the evaporation losses from U.S.W.B class I open pan evaporimeter.

b) Furrow irrigation:

i) 2.5 cm depth of irrigation water

0.25 IW/CPE : After 100 mm of cumulative pan evaporation.

0.50 IW/CPE : After 50 mm of cumulative pan evaporation.

0.75 IW/CPE : After 33 mm of cumulative pan evaporation.

1.00 IW/CPE : After 25 mm of cumulative pan evaporation.

ii) 5.0 cm depth of irrigation water

0.25 IW/CPE : After 200 mm of cumulative pan evaporation.

0.50 IW/CPE : After 100 mm of cumulative pan evaporation.

0.75 IW/CPE : After 66 mm of cumulative pan evaporation.

1.00 IW/CPE : After 50 mm of cumulative pan evaporation.

For drip irrigation treatments also, a notation IW/CPE is used in results and discussion, but it refers to pan evaporation ratio (PER). The discharge rate in case of drip irrigation was adjusted to 4 litres per hour uniformly throughout the experiment. The amount of water to be given through each emitter under different PER ratios was calculated daily and the time of operation of drip system was regulated accordingly. Daily evaporation and rainfall data are presented in Appendix I and II.

### 3.8. Crop observations

Five plants were labelled in the net plot at random in each treatment, for periodical observations. The observations on vine length, vine girth, number of leaves per plant, number of male and female flowers produced and number of branches were obtained from these plants. For dry matter studies, leaf area measurements and for partitioning the plant and fruit separately in the final stage, another set of five plants in the gross plot was randomly cut at the base near the ground level and washed thoroughly to remove the soil adhering to it. The plants were washed in dilute acid, teepol, distilled water and double distilled water and air dried for few days before drying it in the oven at 65<sup>0</sup>C till constant weight. Fruits were also separated from the plant in later stages of sampling and the fresh weights were recorded. From the total, a representative sample of 500 g was taken in a large petri-dish, treatmentwise and oven dried separately. The plants were sampled at 20,40,60,and 80 days after the emergence(DAE) of seeds (10 - 15 days).Plant and fruit samples collected at first picking of fruits(80 DAE) were considered as the final sampling.The leaf area of the plants were recorded using a leaf area meter LICOR 3000 at each of the samplings.The dried plant and fruit samples were powdered in a multiplex grinder and the powdered samples were used for estimation of N, P, K, Ca and Mg.

### 3.8.1 Growth and Growth components

Vine length : The vine length was measured from the base of the vine to tip of the vine and the average vine length was worked out.

Vine girth : The vine girth was recorded at the middle of the vine using a Vernier Callipers and the average vine girth was calculated.

Number of leaves : Total number of fully opened leaves both on the main axis and those arising on the branches were counted. From this, the average number of leaves per plant was worked out.

Number of branches: The total number of branches arising out of the main stem were counted and the average number of branches per plant was calculated.

Flowering and Fruiting : The flowers produced on each plant was tagged daily, from the date of flowering till the flowering ceased. Finally, the total number of male and female flowers were counted along with the number of fruits set in each plant. The node at which the first female flower occurred was also recorded.

Leaf area (LA) : The leaf area was determined at each sampling using a LICOR Model - 3000 leaf area meter and the leaf area per plant ( $\text{cm}^2$ ) was worked out.

From the basic observations on leaf area and total dry matter production per plant, other growth parameters viz. Leaf Area index (LAI), Leaf Area Duration (LAD), Relative Growth Rate (RGR), Net Assimilation Rate (NAR) and crop Growth Rate (CGR) were computed.

Leaf area index (LAI) : Leaf area index is the ratio of the leaf area of total plant cover to the ground area. From leaf area per plant, leaf area index was worked out as suggested by Hunt (1978).

Leaf area duration (LAD): Leaf area duration is the integral of the LA over the growing period. LAD was calculated from LA as per the formula suggested by Hunt (1978) and expressed in  $\text{dm}^2$  days.

$$\text{LAD} = \frac{(L_1 + L_2) (T_2 - T_1)}{2}$$

Where  $L_1$  and  $L_2$  are leaf area at  $T_1$  and  $T_2$ .

Relative growth rate (RGR) : The RGR represents the rate of increase in dry matter per unit of dry weight and expressed in g per g per day. It was calculated using the formula of Hunt (1978).

$$\text{RGR} = \frac{\text{Log}_e W_2 - \text{Log}_e W_1}{t_2 - t_1}$$

where  $W_1$  and  $W_2$  are the dry matter production per plant at time  $t_1$  and  $t_2$  respectively.

Net assimilation rate (NAR) : NAR is the rate of increase in dry matter per unit leaf area and expressed as g per  $\text{dm}^2$  (leaf) per day. NAR was calculated as per Hunt (1978).

$$\text{NAR} = \frac{(\text{Log}_e L_2 - \text{Log}_e L_1) (W_2 - W_1)}{(L_2 - L_1) (t_2 - t_1)}$$

where  $L_1$  and  $L_2$  are leaf area in  $\text{dm}^2$  per plant and  $W_1$  and  $W_2$  are dry matter production per plant at time  $t_1$  and  $t_2$  respectively.

Crop growth rate (CGR): CGR is the growth rate per unit area of ground expressed as g per  $\text{dm}^2$  (land) per day. It was worked out by adapting,  $\text{CGR} = \text{NAR} \times \text{LAI}$  as suggested by Hunt (1978).

### 3.8.2. Yield and yield components

Fruit yield : Completely matured fruits were harvested judging by the available maturity standards such as (a) drying of tendrils opposite to the leaf, (b) yellowing on the surface of the fruit, and (c) dull sound when tapped. The fruits were harvested treatment wise from each net plot, counted and weighed. Totally, there were two to three pickings for complete harvest. The yield of individual pickings were totalled to obtain the total yield per plot.

Number of fruits : The fruits harvested from each plot were counted and the total number of fruits per hectare was worked out. Five fruits were picked at random from each plot at harvest, for recording individual fruit observations.

Average fruit weight: The average fruit weight was calculated by dividing the weight of the fruits by number of fruits per plot.

Fruit shape index : For obtaining the fruit shape index, the polar and equatorial diameters of the fruits were recorded. The ratio of longitudinal (polar) diameter by equatorial (cross) diameter gives the fruit shape index (Davis et al., 1964). A fruit shape index of 1.0 means nearly spherical, 1.0 to 1.2 means slightly oblong and 1.2 means very oblong shape.

Flesh thickness : Flesh thickness was obtained by following the formula of Davis et al. (1964).

$$\text{Flesh thickness} = \frac{\text{Melon cross diameter with out rind} - \text{Cavity diameter}}{2}$$

2

Rind thickness: Rind thickness was obtained by deducting the flesh thickness from the equatorial diameter.

Number of seeds per fruit : The seeds from each of the five randomly collected fruits was extracted , cleaned and washed thoroughly and air dried. These seeds were counted treatmentwise and the number of seeds per fruit was recorded.

Weight of seeds : The weights of the counted seeds of fruits were recorded and the seed weight per fruit was determined. Hundred seeds were taken separately from each treatment and weighed.

### 3.9. Quality studies

Total Soluble Solids (TSS) : It was determined in five randomly picked fruits from each treatment, using a Hand

Refractometer. A small central portion of the flesh was squeezed to get a few drops, of juice which was placed on the refractometer and the readings were read on percentage basis. The necessary temperature corrections were made (Ranganna, 1977).

Nitrate-Nitrogen : A portion of the flesh from each cut open fruit was placed in a muslin cloth and squeezed into a bottle to obtain about 100 ml juice. This juice was used directly for estimating  $\text{NO}_3\text{-N}$ , using nitrate electrode in a digital ion activity meter. A standard curve was drawn by different standard solutions and the necessary calibrations were done.

Sugar estimations : The sugar estimations were done as described by Ranganna (1977). The procedure followed was as per Lane and Eynon method . Both the reducing and total sugars were determined in the juice.

a) Estimation of Reducing sugars: A sample of 10 ml of Watermelon fruit juice was pipetted out into a conical flask to which 50 ml of distilled water was added and neutralised with 1 N NaOH. To this, 2 ml of lead acetate was added and stirred well and allowed to stand for 10 minutes. Potassium oxalate was added to remove the excess lead acetate. The solution was then filtered and the volume made upto 100 ml. One ml each of Fehling's A and B solutions were taken in a conical flask and 5 ml of water was added. This was boiled on a hot plate after adding 2 - 3 drops of methylene blue indicator. The sugar solution was slowly added from the

burette to the Fehling's solution mixture at the time of boiling, till the brick red colour appears. The volume of sugar solution run down was noted. The per cent reducing sugars was calculated as follows:

$$\text{Reducing sugars} = \frac{\text{mg. of invert sugar} \times \text{dilution} \times 100}{\text{Titre value} \times \text{volume of the sample} \times 100}$$

b) Estimation of Total Sugars: A sample of 50 ml. of sugar solution prepared was taken in a conical flask and 10 ml of HCL (1:1) was added. It was allowed to stand at room temperature for 24 hours. This was neutralised with concentrated NaOH and the volume was made upto 100 ml.

One ml. of Fehling's A and B solution was taken in a conical flask and a small quantity of water (5 ml) was added and boiled, adding a few drops of methylene blue indicator. To this, the sugar solution was added till the brick red colour appeared. The volume of sugar solution added was noted down. The per cent total sugars was calculated as:

$$\text{Total sugars} = \frac{\text{mg. invert sugar} \times \text{dilution} \times 100}{\text{Titre value} \times \text{volume of sample} \times 100}$$

### 3.10. Plant water Studies

Relative water content (RWC): For estimating the relative water content, leaf samples were collected from each treatment around mid day. The samples were obtained by cutting the leaf to the base of the petiole and transferred immediately to a polyethylene bag and secured tightly. Fully expanded

leaf devoid of any diseases were chosen for the sampling. The leaves were brought to the laboratory and weighed. Leaf samples were placed in petridishes containing distilled water and covered with the lid. Enough care was taken to see that the leaves were completely immersed in the water. After allowing the leaves to stand in water for 3 - 4 hours, they were taken out and wiped with a blotting paper to remove excess water sticking to the surface and its turgid weights were recorded. The leaf samples were then oven dried at 65°C till constant weight and the dry weights were recorded. The RWC was determined for two irrigation cycles. The relative water content was calculated as

$$\text{RWC} = \frac{\text{Fresh weight} - \text{Dry weight}}{\text{Turgid weight} - \text{Dry weight}} \times 100$$

Osmotic potential: For determining the osmotic potential of the leaf, samples were collected around mid day and wrapped in an aluminium foil and transferred to a butter paper bag and kept for thawing over night. To measure the inter-cellular osmotic pressure, a disc of tissue that had been blotted was frozen and thawed once to fracture the cell membranes. After thawing, the leaf disc was placed in a Wescor 5100 C Vapour pressure Osmometer and osmolality was measured after vapour pressure equilibrium was attained.

The above method assumes that a matrix potential arising from surface tension in cell and capillaries is equivalent to the matrix potential of the standard paper disc saturated with standard solution used to calibrate the Osmometer.

The Osmotic potential was determined for two irrigation cycles.

### 3.11. Water use and soil moisture studies

Water use: The quantity of irrigation water applied was as per the treatments based on cumulative pan readings.

In case of drip irrigation, the quantity of water applied through drip system was based on the pan evaporation ratio. Whenever the rainfall occurred, the drip system was not operated and effective rainfall was assumed to be equal to the quantity of water to be applied through the drip. In case of furrow irrigation, whenever the rainfall occurred, irrigation water application was postponed, till the cumulative pan evaporation values reached the required IW/CPE ratios including rainfall. The soil moisture content for 0 - 90 cm depth of the soil was also noted, at sowing and at harvest and the contribution of soil moisture for the crop use was calculated. Thus, the water use of the crop was arrived at, as follows ;

Water use = Irrigation water applied + Effective rainfall + soil moisture contribution.

Pre-sowing irrigations were given and the soil moisture upto 90 cm depth was brought to field capacity.

Soil moisture studies: The per cent soil moisture under drip irrigation with a discharge rate of 4 l per hr was recorded 20 cm away from the emitter to a depth of 90 cm at 30, 60 and 90 days after emergence to observe the soil

moisture status under drip system and are presented in Table 3.3. The moisture per cent varied from 15.02 at 0 - 15 cm depth to 29.27 per cent at 75 - 90 cm depth and the variations at different depths during 1984 and 1985 were less.

To observe the soil moisture status under furrow irrigation with different IW/CPE ratios, soil samples were collected before and after irrigation for four irrigation cycles to a depth of 90 cm and the mean soil moisture per cent are graphically presented in Fig.3.4. The moisture per cent varied from 14.0 per cent at 0 - 15 cm depth to 28.95 per cent at 75 - 90 cm with 0.25 IW/CPE ratio, before irrigation to 14.68 per cent at 0 - 15 cm depth to 29.11 per cent at 75 - 90 cm depth with 1.00 IW/CPE ratio, after irrigation.

### 3.12. Canopy temperature and Root studies

Canopy temperature : Canopy temperature was recorded between 12 noon and 1 pm by using an Instatherm (Model 14 - 220 D - 1,7). The instrument was calibrated to the calibration temperature and held 90 cm above the canopy, until a constant temperature was noticed. This stable temperature was recorded in each treatment, daily, for 2 irrigation cycles.

Root studies : For root measurement studies, the soil near and around the roots was slowly excavated after the complete harvest of the crop. Care was taken to see that the entire root system to a depth of 90 cm, along with lateral

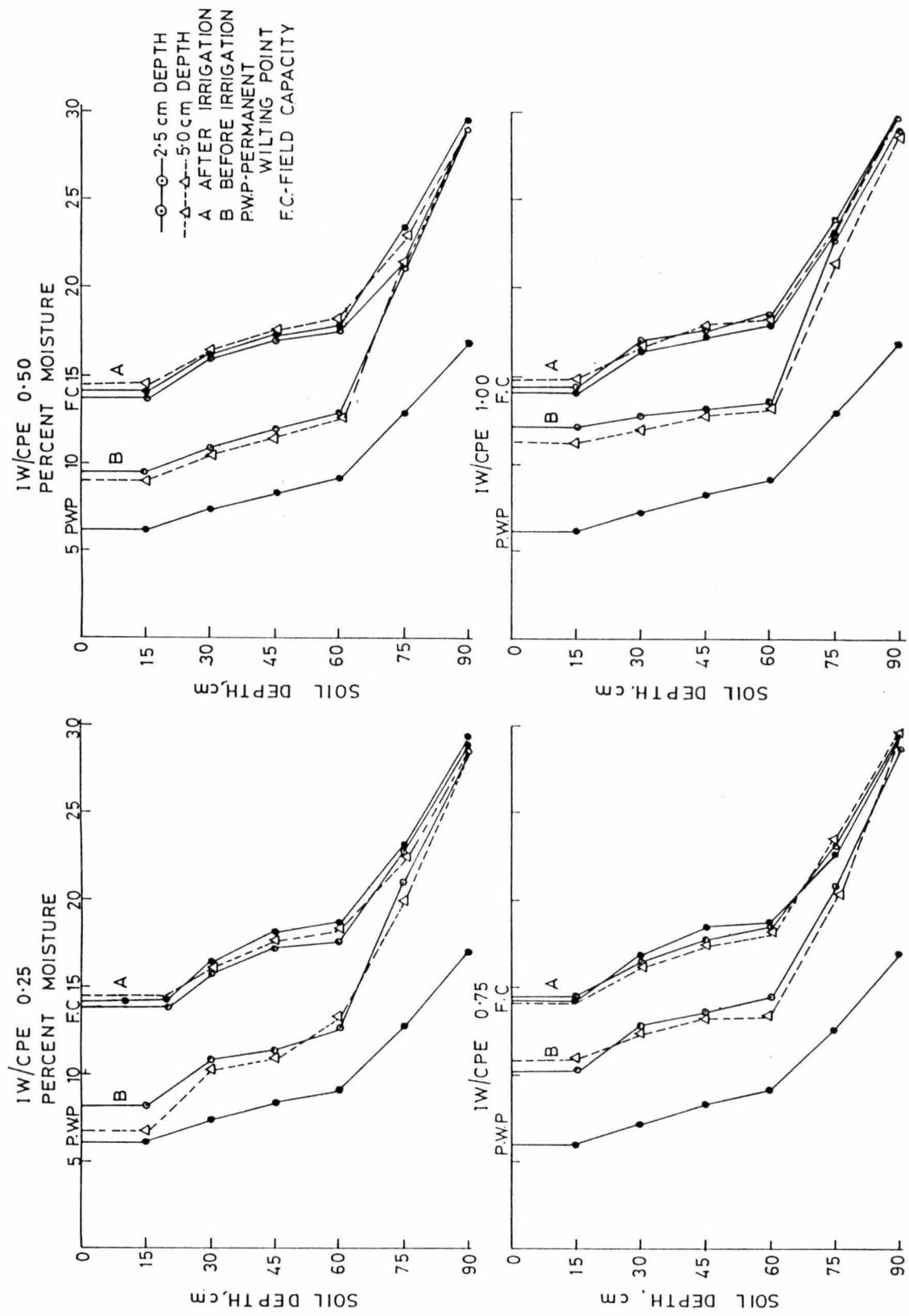


FIG. 3.4 MOISTURE PERCENTAGE UNDER FURROW IRRIGATION AS INFLUENCED BY IW/CPE RATIOS AND METHOD OF IRRIGATION.

**Table 3.3** Per cent moisture under drip irrigation (20 cm away from the emitter)

Treatment		Soil depth, cm					
		0-15	15-30	30-45	45-60	60-75	75-90
<b>A. <u>30 DAE</u></b>							
1. One emitter per plant	1984	15.72	16.41	17.32	17.64	23.21	29.25
	1985	15.62	16.28	17.40	17.56	23.08	28.96
2. One emitter per 2 plants	1984	15.06	16.27	17.30	17.51	23.11	29.18
	1985	15.21	16.32	17.25	17.44	23.06	29.12
<b>B. <u>60 DAE</u></b>							
1. One emitter per plant	1984	15.48	16.32	17.26	17.66	23.19	29.19
	1985	15.52	16.29	17.35	17.58	23.10	28.80
2. One emitter per 2 plants	1984	15.05	16.28	17.21	17.49	23.08	29.02
	1985	15.42	16.35	17.12	17.37	23.11	29.25
<b>C. <u>90 DAE</u></b>							
1. One emitter per plant	1984	15.33	16.11	17.31	17.40	23.20	29.11
	1985	15.41	16.08	17.20	17.32	23.14	29.27
2. One emitter per 2 plants	1984	15.28	16.30	17.18	17.52	23.17	29.27
	1895	15.21	16.22	17.31	17.48	23.02	29.51

roots were extracted. The entire root system was carefully washed to remove the adhering soil. The tap root length was measured and the lateral roots were counted. The entire root mass was oven dried at 65<sup>0</sup>C and the dry weights were recorded.

### 3.13. Chemical Analysis

A sample of five plants harvested at random for dry matter studies at 40, 60 and 80 days after emergence was used for determining nitrogen content, according to method described by Jackson (1967), Phosphorus and potassium by using Technicon Auto Analyser II and calcium and Magnesium by using Perkin-Elmer 5000 Atomic Absorption Spectrophotometer. At harvest, the plants were partitioned into shoot and fruit and the nutrient contents were determined separately.

### 3.14. Statistical analysis and interpretation of data

Fisher's method of Analysis of variance was adapted for analysis of the data and interpretation of results. The levels of significance used in 'F' test and calculation of C. D. values were at  $P = 0.05$ . Interaction effects are also presented, where ever these were found to be statistically significant.

## **EXPERIMENTAL RESULTS**

#### IV. RESULTS

The results of the studies on the "Response of watermelon to drip and furrow irrigation under different nitrogen and plant population levels" which involved two field experiments are presented in this Chapter.

##### 4.1 Experiment I : Effect of nitrogen and spacing under drip and furrow irrigation in watermelon.

###### 4.1.1 Growth and growth components :

###### 4.1.1.1 Vine length :

The data on vine length of watermelon as influenced by nitrogen, spacing and method of irrigation at different stages are presented in Table 4.1.

Effect of nitrogen : Vine length increased with the increase in the levels of nitrogen, at all the growth stages (20, 40, 60 and 80 DAE) during both the years, although the differences were statistically significant only at 20 DAE during both the years and at 40 DAE during 1985.

During 1984 at 20 DAE, vine length increased significantly from 12.3 cm with 60 kg nitrogen per ha to 13.3 cm and 21.0 cm with the application of 120 kg and 180 kg nitrogen per ha, respectively.

During 1985 at 20 DAE, it increased significantly with the application of 180 kg nitrogen per ha (18.1 cm) as compared to 60 kg (9.7 cm) and 120 kg (10.5 cm) nitrogen per ha. At 40 DAE, the vine length increased significantly from 86.7 cm with 60 kg nitrogen per ha to 105.1 cm with 120 kg

**Table 4.1** Vine length of watermelon as influenced by nitrogen, Spacing and method of irrigation.

Treatments	Vine length (cm)							
	20 DAE		40 DAE		60 DAE		80 DAE	
	1984	1985	1984	1985	1984	1985	1984	1985
<u>Nitrogen, kg/ha</u>								
60	12.3	9.7	137.0	86.7	291.3	228.6	304.2	243.5
120	13.3	10.5	155.6	105.1	254.9	237.5	306.2	272.7
180	21.0	18.1	157.4	110.0	268.2	258.2	316.7	283.7
'F'test	Sig	Sig	NS	Sig	NS	NS	NS	NS
S.E.m±	0.20	0.58	8.76	5.11	12.7	10.3	13.3	13.5
C.D. at 5%	0.58	1.69	-	14.90	-	-	-	-
<u>Spacing, cm</u>								
300 x 60	15.4	12.3	140.9	95.0	284.9	237.8	307.9	271.7
200 x 60	15.8	13.2	159.1	106.2	257.9	245.1	310.2	261.6
'F' Test	NS	NS	NS	NS	NS	NS	NS	NS
<u>Method of Irrigation</u>								
Drip	15.6	13.0	150.5	102.2	288.5	254.6	324.2	271.2
Furrow	15.6	12.5	149.5	99.0	245.4	228.3	293.8	262.1
'F'test	NS	NS	NS	NS	Sig	Sig	NS	NS
S.E.m±	0.16	0.47	7.16	4.17	10.37	8.41	10.86	11.01
C.D. at 5%	-	-	-	-	30.42	24.55	-	-

Sig : Significant

NS : Not Significant

nitrogen per ha and there was no significant increase in vine length, with further increase in nitrogen level to 180 kg nitrogen per ha (110.0 cm).

Effect of spacing : There was no significant difference in vine length between row spacings, at any of the growth stages during both the years.

Method of irrigation : Vine length under drip irrigation was generally higher than that under furrow irrigation at all the stages, but the differences were statistically significant only at 60 DAE during both the years. At this stage during 1984, the vine length was 288.5 cm with drip irrigation and 254.4 cm with furrow irrigation. During 1985, these values were 254.6 cm with drip irrigation and 228.3 cm with furrow irrigation.

#### 4.1.1.2 Vine girth :

The data on vine girth of watermelon as influenced by nitrogen, spacing and method of irrigation are presented in Table 4.2.

Effect of nitrogen : Vine girth generally increased with the increase in nitrogen application upto 180 kg per ha, but the differences were statistically significant only at 40 DAE during 1985. At this stage, it increased significantly from 0.86 cm with 60 kg nitrogen per ha to 1.11 cm with 120 kg nitrogen per ha. The difference in vine girth between 120 kg and 180 kg nitrogen per ha was not statistically significant.

Effect of spacing : The difference in vine girth

**Table 4.2** Vine girth of watermelon as influenced by nitrogen, Spacing and method of irrigation.

Treatments	Vine girth (cm)					
	40 DAE		60 DAE		80 DAE	
	1984	1985	1984	1985	1984	1985
<u>Nitrogen, kg/ha</u>						
60	1.26	0.86	2.13	2.01	1.96	1.91
120	1.39	1.11	2.14	2.05	2.11	1.92
180	1.46	1.18	2.24	2.10	2.14	1.96
'F' test	NS	Sig	NS	NS	NS	NS
S.E.m+	0.06	0.05	0.04	0.04	0.06	0.06
C.D. at 5%	-	0.15	-	-	-	-
<u>Spacing, cm</u>						
300 x 60	1.37	1.09	2.18	2.08	2.07	1.95
200 x 60	1.36	1.01	2.16	2.03	2.07	1.91
'F' Test	NS	NS	NS	NS	NS	NS
<u>Method of Irrigation</u>						
Drip	2.46	1.07	2.18	2.06	2.11	1.93
Furrow	2.36	1.03	2.16	2.04	2.04	1.93
'F' test	NS	NS	NS	NS	NS	NS
S.E.m+	0.05	0.04	0.03	0.03	0.05	0.05

between the two row spacings was not statistically significant at any of the growth stages during both the years. However, vines had slightly higher girth under wider row spacing of 300 cm than under narrow row spacing of 200cm.

Method of irrigation : Vines under drip irrigation recorded slightly higher girth at all the growth stages during both the years, as compared to furrow irrigation but the differences were not statistically significant.

#### 4.1.1.3 Number of leaves per plant :

The data on the number of leaves per plant of watermelon at all the growth stages as influenced by nitrogen, spacing and method of irrigation are presented in Table 4.3.

Effect of nitrogen : The number of leaves per plant increased with increase, in the level of nitrogen application at all the stages, but the variations were statistically significant at 20 DAE during 1985, at 40 and 80 DAE during both the years.

During 1984, at 40 DAE, the number of leaves increased significantly from 33.1 with 60 kg nitrogen per ha to 43.3 leaves with 180 kg nitrogen per ha and the difference between 60 kg and 120 kg nitrogen was not statistically significant. At 80 DAE, it was significantly higher (80.9) with 180 kg nitrogen per ha, as compared to 60 kg nitrogen per ha (42.1) and the differences between 60 kg and 120 kg as well as between 120 kg and 180 kg nitrogen per ha were not statistically significant.

**Table 4.3** Number of leaves per plant of watermelon as influenced by nitrogen, Spacing and method of irrigation.

Treatments	Number of leaves/plnat							
	20 DAE		40 DAE		60 DAE		80 DAE	
	1984	1985	1984	1985	1984	1985	1984	1985
<u>Nitrogen, kg/ha</u>								
60	3.9	2.6	33.1	26.7	77.9	69.0	42.1	58.6
120	4.4	2.9	32.6	27.5	97.7	87.6	65.0	75.5
180	4.4	3.4	43.3	32.6	105.0	90.7	80.9	79.9
'F' test	NS	Sig	Sig	Sig	NS	NS	Sig	Sig
S.E.m+	0.3	0.2	0.8	0.8	9.0	6.4	11.4	4.3
C.D. at 5%	-	0.6	2.5	2.3	-	-	33.5	12.5
<u>Spacing, cm</u>								
300 x 60	4.2	2.9	35.7	28.3	87.8	78.2	74.1	71.0
200 x 60	4.3	3.0	36.9	29.6	95.8	86.7	81.2	71.7
'F' Test	NS	NS	NS	NS	NS	NS	NS	NS
<u>Method of Irrigation</u>								
Drip	4.6	3.0	37.6	30.2	101.1	85.4	71.1	76.4
Furrow	3.9	2.9	35.0	27.7	82.5	79.4	54.2	66.3
'F' test	NS	NS	Sig	Sig	NS	NS	NS	NS
S.E.m+	0.2	0.2	0.7	0.6	7.4	5.2	9.3	3.5
C.D. at 5%	-	-	2.0	1.8	-	-	-	-

During 1985, at 20 DAE, the number of leaves was significantly higher (3.4) with 180 kg nitrogen per ha as compared to that at 60 kg nitrogen per ha (2.6) and the difference between 60 kg and 120 kg nitrogen was not significant. At 40 DAE the number of leaves was significantly higher (32.6) with 180 kg nitrogen per ha, as compared to 60 kg nitrogen per ha (26.7) and the difference between 60 kg and 120 kg nitrogen per ha was not statistically significant. At 80 DAE, it increased significantly with 120 kg nitrogen per ha (75.5) as compared to 60 kg nitrogen per ha (58.6) but the difference between 120 kg and 180 kg nitrogen per ha was not statistically significant.

Effect of spacing : Closer row spacing of 200 cm resulted in slightly higher number of leaves per plant at all the growth stages during both the years, as compared to 300 cm row spacing. The differences, however, were not statistically significant.

Method of irrigation : Plants under drip irrigation had higher number of leaves, as compared to that under furrow irrigation at all the stages during both the years, although the differences were statistically significant only at 40 DAE. At this stage during 1984, drip irrigation recorded significantly higher leaf number (37.6), as compared to furrow irrigation (35.0). The trend was similar during 1985.

#### 4.1.1.4 Dry matter production:

The data on dry matter production in watermelon at different stages as influenced by nitrogen, spacing and method of irrigation are presented in Table 4.4.

Effect of nitrogen : Statistically significant differences in dry matter production were observed, due to nitrogen levels, during both the years except at 20 DAE in both the years, at 40 DAE during 1984 and at 80 DAE in fruit during both the years.

During 1984, at 60 DAE, dry matter production was significantly higher (80.42 g/plant) with 180 kg nitrogen per ha, as compared to 60 kg nitrogen per ha (59.10 g/plant). However, the differences between successive levels of nitrogen application were not significant. At 80 DAE, there was significant increase in total dry matter, when nitrogen application increased from 60 kg (356.27 g/plant) to 120 kg nitrogen per ha (412.56 g/plant). The variation in dry matter with 120 kg and 180 kg nitrogen per ha was not statistically significant. Similar trend was noticed with respect to shoot dry matter at this stage.

During 1985 at 40 DAE, 120 kg nitrogen per ha (19.56 g/plant) increased the dry matter production significantly as compared to 60 kg nitrogen per ha (14.69 g/plant) and the difference between 120 kg and 180 kg nitrogen per ha was not statistically significant. At 60 DAE, it increased significantly from 53.58 g per plant with 60 kg nitrogen per ha to 71.93 g per plant with 180 kg nitrogen per ha and the

**Table 4.4 Dry matter production in watermelon by as influenced nitrogen, spacing and method of irrigation**

Treatments	20 DAE		40 DAE		60 DAE		80 DAE								
	Dry matter (g/plant)		Dry matter (g/plant)		Dry matter (g/plant)		1984		1985		Total	Shoot	FRUIT	Total	
	1984	1985	1984	1985	1984	1985	Shoot	Fruit	Shoot	FRUIT					
<u>Nitrogen, kg/ha</u>															
60	1.00	0.71	17.76	14.69	59.10	53.58	197.66	158.61	356.27	186.38	131.94	318.22			
120	1.09	0.72	22.08	19.56	68.91	58.48	239.50	173.02	412.56	191.83	141.64	333.47			
180	1.12	0.74	22.62	19.87	80.42	71.93	242.91	179.14	422.05	234.33	157.10	391.43			
'F' test	NS	NS	NS	Sig	Sig	Sig	NS	NS	Sig	Sig	NS	Sig	NS	Sig	Sig
S.E.m+	0.077	0.029	2.59	1.40	5.25	4.74	9.01	9.18	16.57	13.31	13.11	17.97			
C.D. at 5%	-	-	-	4.09	14.20	13.83	26.43	-	48.60	39.03	-	52.70			
<u>Spacing, cm</u>															
300 x 60	1.11	0.74	22.96	18.96	73.74	66.14	257.93	184.33	442.26	205.83	148.55	354.38			
200 x 60	1.03	0.70	18.69	17.78	65.20	56.52	195.44	156.15	351.60	202.53	142.57	345.10			
'F' Test	NS	NS	NS	NS	NS	NS	Sig	Sig	Sig	NS	NS	NS	NS	NS	NS
<u>Method of Irrigation</u>															
Drip	1.15	0.74	21.96	18.30	81.30	66.79	243.87	173.16	417.03	209.07	145.78	354.85			
Furrow	0.99	0.71	19.70	17.78	57.66	55.87	209.51	167.40	376.91	199.29	145.34	344.63			
'F' test	NS	NS	NS	NS	Sig	NS	Sig	NS	Sig	NS	NS	NS	NS	NS	NS
S.E.m+	0.063	0.024	2.11	1.14	4.29	5.21	7.35	7.49	13.53	10.87	10.70	14.67			
C.D. at 5%	-	-	-	-	12.58	-	21.58	21.97	39.69	-	-	-	-		

difference between successive levels of nitrogen were also not statistically significant. At 80 DAE, application of 180 kg nitrogen per ha (391.43 g/plant) resulted in significantly highest total dry matter, as compared to 60 kg nitrogen per ha (318.22 g/plant) and 120 kg nitrogen per ha (333.47 g/plant) which were on par. Shoot dry matter production also followed a trend similar to that of total dry matter.

Effect of spacing : Wider row spacing of 300 cm resulted in higher dry matter per plant, as compared to 200 cm row spacing. The differences, however, were statistically significant only at 80 DAE during 1984. At this stage, the variations in the dry matter of shoot (257.93 and 195.44 g/plant at 300 cm and 200 cm respectively), fruit (184.33 and 156.15 g/plant at 300 cm and 200 cm respectively) and their dry matter (442.26 and 351.60 g/plant at 300 cm and 200 cm respectively) were significantly different.

Method of irrigation: Drip irrigation resulted in higher dry matter at all the stages during both the years, as compared to furrow irrigation. However, the variations were statistically significant only at 60 DAE and at 80 DAE in the shoot and total dry matter, during 1984. At 60 DAE during 1984, drip irrigation recorded significantly higher dry matter (81.30 g/plant), as compared to furrow irrigation (57.66 g/plant). Similarly at 80 DAE, the total dry matter was significantly higher (417.03 g/plant) under drip irrigation, as compared to furrow irrigation (376.91 g/plant). At this stage, the shoot dry matter was also significantly higher (243.87 g/plant) with drip irrigation, as compared to furrow irrigation

(209.51 g/plant).

4.1.1.5 Number of male and female flowers, primary branches and node of first female flower occurrence.

The data on number of male and female flowers, primary branches and first female flower occurrence in watermelon are presented in Table 4.5.

Number of male flowers :

Effect of nitrogen : During 1984, the number of male flowers were significantly higher (60.5) with 60 kg nitrogen per ha, as compared to both at 120 kg (47.8) and 180 kg (48.2) nitrogen per ha, which were on par. Similar trend was observed during 1985.

Effect of spacing : During 1984, wider row spacing of 300 cm produced significantly higher number of male flowers (59.4) as compared to closer row spacing of 200 cm (54.6). Similar trend was observed during 1985, but the difference was not statistically significant.

Method of irrigation : The differences in the number of male flowers produced was not statistically significant due to method of irrigation, in both the years. However, drip irrigation had more number of male flowers, as compared to furrow irrigation.

Number of female flowers:

Effect of nitrogen : During 1984, the number of female flowers was significantly higher (4.7) with 120 kg nitrogen per ha, as compared to both 60 kg (3.2) and 180 kg (3.7) nitrogen per ha. Similar trend was noticed during 1985.

**Table 4.5** Number of male and female flowers, Primary branches and node of first female flower occurrence of watermelon as influenced by nitrogen, Spacing and method of irrigation.

Treatments	Number of male flowers/plant		Number of female flowers/plant		Number of primary branches		Node of first female flower occurrence	
	1984	1985	1984	1985	1984	1985	1984	1985
<u>Nitrogen, kg/ha</u>								
60	60.5	56.1	3.2	3.4	2.28	2.15	4.3	4.4
120	47.8	42.7	4.7	4.9	2.46	2.39	3.3	3.1
180	48.2	45.3	3.7	4.0	2.53	2.42	3.8	3.3
'F' test	Sig	Sig	Sig	Sig	NS	NS	Sig	Sig
S.E.m+	1.56	1.41	0.13	0.14	0.16	0.14	0.22	0.20
C.D. at 5%	4.58	4.09	0.40	0.41	-	-	0.65	0.62
<u>Spacing, cm</u>								
300 x 60	59.4	60.5	3.9	4.0	2.32	2.30	4.0	3.9
200 x 60	54.6	57.8	3.7	3.8	2.52	2.49	3.7	3.7
'F' Test	Sig	NS	NS	NS	NS	NS	NS	NS
<u>Method of Irrigation</u>								
Drip	53.3	56.7	4.1	4.3	2.46	2.51	3.9	3.8
Furrow	54.0	54.3	3.6	3.8	2.38	2.43	3.8	3.8
'F' test	NS	NS	Sig	Sig	NS	NS	NS	NS
S.E.m+	1.27	1.18	0.11	0.12	0.13	0.13	0.18	0.17
C.D. at 5%	3.74	-	0.32	0.35	-	-	-	-

Effect of spacing : Wider row spacing recorded slightly higher number of female flowers, as compared to closer row spacing, but the differences were not statistically significant during both the years.

Method of irrigation : The differences in number of female flowers produced, due to the method of irrigation were statistically significant in both the years. Drip irrigation recorded significantly higher number of female flowers (4.1 in 1984 and 4.3 in 1985) as compared to, furrow irrigation (3.6 in 1984 and 3.8 in 1985).

Number of primary branches:

Effect of nitrogen : The number of branches increased with the nitrogen levels from 60 kg to 180 kg per ha, during both the years. However, the variations were not statistically significant.

Effect of spacing : Closer row spacing of 200 cm recorded higher number of branches, during both the years, as compared to the wider row spacing of 300 cm, but the differences were not statistically significant.

Method of irrigation: Drip irrigation had higher number of branches, as compared to, furrow irrigation during both the years. However, the differences were not statistically significant.

Node of first female flower occurrence :

Effect of nitrogen : During 1984, female flowers appeared at significantly higher node (4.3), with 60 kg nitrogen per ha, as compared to 120 kg nitrogen per ha (3.3). The difference

between 120 kg and 180 kg nitrogen per ha, was not statistically significant. Similar trend was observed during 1985.

Effect of spacing : Closer row spacing produced the female flowers at lower nodes, as compared to wider row spacing. However, the differences were not statistically significant.

Method of irrigation : Significant differences were not observed in female flower occurrence due to method of irrigation during both the years.

#### 4.1.1.6 Leaf area per plant :

The data on the leaf area per plant in watermelon at different stages as influenced by nitrogen, spacing and method of irrigation are presented in Table 4.6.

Effect of nitrogen : Leaf area increased with the increase in nitrogen application at all the growth stages, during both the years. The differences, however, were statistically significant only at 80 DAE, during 1984. At this stage, leaf area increased significantly from 2530 cm<sup>2</sup> per plant with 60 kg nitrogen per ha to 3591 cm<sup>2</sup> per plant with 180 kg nitrogen per ha. The difference between 60 kg and 120 kg nitrogen per ha was not statistically significant.

Effect of spacing : Wider row spacing of 300 cm resulted in higher leaf area per plant, as compared to closer row spacing of 200 cm, at all the, stages during both the years, but the variation was statistically significant only at 80 DAE during 1984. At this stage, closer row spacing of 200 cm recorded

**Table 4.6** Leaf area of watermelon as influenced by nitrogen, Spacing and method of irrigation.

Treatments	Leaf area (cm <sup>2</sup> /plant)							
	20 DAE 1984	20 DAE 1985	40 DAE 1984	40 DAE 1985	60 DAE 1984	60 DAE 1985	80 DAE 1984	80 DAE 1985
<u>Nitrogen, kg/ha</u>								
60	189	128	1702	1348	4309	3843	2530	2467
120	211	138	2114	1731	4885	4047	2649	2718
180	216	139	2171	1755	5433	4566	3591	2862
'F' test	NS	NS	NS	NS	NS	NS	Sig	NS
S.E.m <sub>±</sub>	14	12	248	171	385	266	204	196
C.D. at 5%	-	-	-	-	-	-	600	-
<u>Spacing, cm</u>								
300 x 60	213	149	2200	1730	5001	4468	3618	2726
200 x 60	197	129	1791	1493	4751	3836	2329	2638
'F' Test	NS	NS	NS	NS	NS	NS	Sig	NS
<u>Method of Irrigation</u>								
Drip	220	136	2105	1708	5690	4558	3477	2840
Furrow	190	134	1887	1515	4061	3746	2369	2524
'F' test	NS	NS	NS	NS	Sig	NS	Sig	NS
S.E.m <sub>±</sub>	12	10	202	140	315	217	167	160
C.D. at 5%	-	-	-	-	923	-	490	-

lower leaf area ( $2329 \text{ cm}^2/\text{plant}$ .) as compared to wider row spacing of 300 cm ( $3518 \text{ cm}^2/\text{plant}$ ).

Method of irrigation : Drip irrigation produced higher leaf area, at all the growth stages of the crop, during both the years than those grown under furrow irrigation. However, statistically significant differences were recorded only at 60 and 80 DAE during 1984. At 60 DAE, drip irrigation had significantly higher leaf area ( $5691 \text{ cm}^2/\text{plant}$ ), as compared to furrow irrigation ( $4062 \text{ cm}^2/\text{plant}$ ). Likewise, at 80 DAE drip irrigation had significantly higher leaf area ( $3477 \text{ cm}^2/\text{plant}$ ), as compared to furrow irrigation ( $2369 \text{ cm}^2/\text{plant}$ ).

#### 4.1.1.7 Leaf area index :

The data on leaf area index of watermelon as influenced by nitrogen, spacing and method of irrigation are presented in Table 4.7.

Effect of nitrogen : Increase in nitrogen levels increased the leaf area index, at most of the growth stages, during both the years. The differences, however, were statistically significant only at 80 DAE, during 1984. At this stage, leaf area index increased from 0.338 with 60 kg nitrogen per ha to 0.471 with 180 kg nitrogen ha. The difference between application rates of 60 kg and 120 kg nitrogen per ha was not statistically significant.

Effect of spacing : Significant differences in leaf area index, were observed at all the stages, during both the years

**Table 4.7** Leaf area index of watermelon as influenced by nitrogen, Spacing and method of irrigation.

Treatments	Leaf area index											
	20 DAE		40 DAE		60 DAE		80 DAE		1984		1985	
	1984	1985	1984	1985	1984	1985	1984	1985	1984	1985	1984	1985
<u>Nitrogen, kg/ha</u>												
60	0.026	0.017	0.233	0.183	0.593	0.536	0.338	0.344				
120	0.029	0.019	0.309	0.250	0.705	0.557	0.359	0.393				
180	0.030	0.019	0.306	0.262	0.742	0.698	0.471	0.395				
'F' test	NS	NS	NS	NS	NS	NS	Sig	NS	Sig	NS		
S.E.m <sub>+</sub>	0.002	0.002	0.038	0.025	0.059	0.048	0.025	0.030				
C.D. at 5%	-	-	-	-	-	-	0.073	-				
<u>Spacing, cm</u>												
300 x 60	0.014	0.024	0.199	0.164	0.527	0.449	0.388	0.298				
200 x 60	0.023	0.033	0.367	0.300	0.833	0.745	0.391	0.456				
'F' Test	Sig	Sig	Sig	Sig	Sig	Sig	NS	Sig	NS	Sig		
<u>Method of Irrigation</u>												
Drip	0.031	0.019	0.300	0.243	0.788	0.641	0.460	0.399				
Furrow	0.028	0.018	0.266	0.220	0.473	0.553	0.319	0.355				
'F' test	NS	NS	NS	NS	Sig	NS	Sig	NS	Sig	NS		
S.E.m <sub>+</sub>	0.001	0.002	0.031	0.021	0.058	0.040	0.020	0.024				
C.D. at 5%	0.004	0.005	0.087	0.059	0.141	0.115	0.059	0.067				

except at 80 DAE during 1984. During 1984 at 20 DAE, closer row spacing of 200 cm recorded significantly higher leaf area index (0.023), as compared to wider row spacing of 300 cm (0.014). At 40 DAE, leaf area index was significantly higher (0.367) with closer row spacing, as compared to wider row spacing (0.199). Again at 60 DAE, significantly higher leaf area index was recorded (0.833) with 200 cm row spacing, as compared to 300 cm row spacing (0.527). Similar trend was observed at all the stages during 1985.

Method of irrigation : Variation in the leaf area index due to method of irrigation was statistically significant only at 60 and 80 DAE during 1984. At 60 DAE, the leaf area index was significantly higher (0.788) under drip irrigation, as compared to furrow irrigation (0.273). Even at 80 DAE, the leaf area index was significantly higher with drip irrigation (0.460), as compared to furrow irrigation (0.319).

#### 4.1.1.8 Leaf area duration :

The data on leaf area duration at different stages, as influenced by nitrogen, spacing and method of irrigation are presented in Table 4.8.

Effect of nitrogen : Leaf area duration increased with the increase in nitrogen levels upto 180 kg nitrogen per ha, at all the stages. However, statistically significant differences, in leaf area duration, among nitrogen levels were observed only during 1985 between 41 to 60 DAE. Leaf area duration with 180 kg nitrogen per ha ( $669.8 \text{ dm}^2$  days) was

**Table 4.8** Leaf area duration of watermelon as influenced by nitrogen, Spacing and method of irrigation.

Treatments	Leaf area duration (dm <sup>2</sup> days)					
	21-40 DAE 1984	21-40 DAE 1985	41 - 60 DAE 1984	41 - 60 DAE 1985	61 - 80 DAE 1984	61 - 80 DAE 1985
<u>Nitrogen, kg/ha</u>						
60	191.8	148.7	647.3	539.7	747.3	631.0
120	230.3	185.9	713.5	557.4	792.2	690.6
180	238.6	196.0	716.2	669.8	796.1	767.7
'F' test	NS	NS	NS	Sig	NS	NS
S.E.m <sub>±</sub>	25.2	17.2	37.1	34.8	45.0	49.5
C.D. at 5%	-	-	-	102.1	-	-
<u>Spacing, cm</u>						
300 x 60	240.0	193.4	720.3	626.1	732.7	720.4
200 x 60	200.5	160.4	653.7	551.8	826.3	672.5
'F' Test	NS	NS	NS	NS	NS	NS
<u>Method of Irrigation</u>						
Drip	232.6	184.5	779.0	626.7	916.0	739.7
Furrow	207.9	169.3	594.9	551.2	643.1	653.3
'F' test	NS	NS	Sig	NS	Sig	NS
S.E.m <sub>±</sub>	20.6	14.0	30.3	28.4	36.7	40.4
C.D. at 5%	-	-	88.8	-	107.8	-

significantly highest, as compared to 60 kg (539.7 dm<sup>2</sup> days) and 120 kg (557.4 dm<sup>2</sup> days) nitrogen per ha, which were on par.

Effect of spacing : Wider row spacing of 300 cm recorded comparatively higher leaf area duration at all the stages, in both years except, between 61 to 80 DAE during 1984. However, these differences were not statistically significant at any of the crop growth stages.

Method of irrigation : The variation in leaf area duration between 41 to 60 DAE and 61 to 80 DAE during 1984, due to method of irrigation were statistically significant. Between 41 to 60 DAE, drip irrigation recorded significantly higher leaf area duration (779.0 dm<sup>2</sup> days), as compared to furrow irrigation (594.9 dm<sup>2</sup> days). Similarly, between 61 to 80 DAE drip irrigation recorded significantly higher leaf area duration (916.0 dm<sup>2</sup> days), as compared to furrow irrigation (643.1 dm<sup>2</sup> days).

#### 4.1.1.9 Relative growth rate :

The data on relative growth rate of watermelon at different stages of growth, as influenced by nitrogen, spacing and method of irrigation are presented in Table 4.9.

Effect of nitrogen : Nitrogen fertilization had significant influence on relative growth rate, at all the stages, except between 21 to 40 DAE during 1984 and between 41 to 60 DAE during both the years.

**Table 4.9** Relative growth rate of watermelon as influenced by nitrogen, Spacing and method of irrigation.

Treatments	Relative growth rate (g/g/day)					
	21-40 DAE 1984	21-40 DAE 1985	41-60 DAE 1984	41-60 DAE 1985	61-80 DAE 1984	61-80 DAE 1985
<u>Nitrogen, kg/ha</u>						
60	0.1322	0.1478	0.0493	0.0490	0.0461	0.0594
120	0.1469	0.1641	0.0593	0.0563	0.0629	0.0820
180	0.1530	0.1642	0.0795	0.0797	0.0734	0.0824
'F' test	NS	Sig	Sig	Sig	Sig	Sig
S.E.m+	0.0068	0.0049	0.0081	0.0063	0.0043	0.0039
C.D. at 5%	-	0.0144	0.0239	0.0186	0.0104	0.0113
<u>Spacing, cm</u>						
300 x 60	0.1368	0.1552	0.0571	0.0583	0.0549	0.0701
200 x 60	0.1513	0.1622	0.0655	0.0650	0.0667	0.0791
'F' Test	NS	NS	NS	NS	Sig	NS
<u>Method of Irrigation</u>						
Drip	0.1465	0.1608	0.0709	0.0674	0.0670	0.0799
Furrow	0.1416	0.1566	0.0544	0.0560	0.0541	0.0693
'F' test	NS	NS	NS	NS	Sig	Sig
S.E.m+	0.0056	0.0040	0.0067	0.0052	0.0035	0.0031
C.D. at 5%	-	-	-	-	0.0104	0.0092

During 1984, between 41 to 60 DAE, relative growth rate was significantly higher with 180 kg nitrogen per ha (0.0795 g/g/day), as compared to 60 kg nitrogen per ha (0.0493 g/g/day). The difference between 120 kg and 180 kg nitrogen was not statistically significant. Between 61 to 80 DAE, there was statistically significant increase in relative growth rate, with the application of 180 kg nitrogen per ha (0.0734 g/g/day), as compared to 60 kg nitrogen per ha (0.0461 g/g/day). The difference between 120 kg and 180 kg nitrogen per ha was not statistically significant.

During 1985, between 21 to 40 DAE, the relative growth rate increased significantly from 0.1478 g per g per day with the application of 60 kg nitrogen per ha to 0.1641 g/g/day with 120 kg nitrogen per ha. The difference between 120 kg and 180 kg (0.1642 g/g/day) nitrogen per ha was not statistically significant. Between 41 to 60 DAE, relative growth rate was significantly higher with 180 kg nitrogen per ha (0.0797 g/g/day) as compared to 60 kg nitrogen per ha (0.0490 g/g/day). The difference between 120 kg (0.0563 g/g/day) and 180 kg nitrogen per ha was also statistically significant. Between 61 to 80 DAE, the relative growth rate was significantly higher (0.0824 g/g/day) with 180 kg nitrogen per ha, as compared to 60 kg nitrogen per ha (0.0594 g/g/day) but was on par with 120 kg nitrogen per ha (0.0820 g/g/day).

Effect of spacing : Relative growth rate was higher with closer row spacing of 200 cm, at all the growth stages

during both the years, as compared to 300 cm row spacing, but the differences were statistically significant only between 61 to 80 DAE, during 1984. At this stage, the relative growth rate was significantly higher (0.0667 g/g/day) with closer row spacing, as compared to wider row spacing (0.0549 g/g/day).

Method of irrigation : Relative growth rate of watermelon was higher under drip irrigation than under furrow irrigation at all the stages in both the years. However, statistically significant differences were observed between 61 to 80 DAE during both the years. Drip irrigation recorded significantly higher relative growth rate (0.0670 g/g/day during 1984 and 0.0799 g/g/day during 1985), as compared to furrow irrigation (0.0541 g/g/day in 1984 and 0.0693 g/g/day in 1985).

#### 4.1.1.10 Net assimilation rate :

The data on net assimilation rate of watermelon as influenced by nitrogen, spacing and method of irrigation are presented in Table 4.10.

Effect of nitrogen : Nitrogen fertilization had significant effect on net assimilation rate at different stages, during both the years, except between 21 to 40 DAE.

During 1984, between 41 to 60 DAE, there was statistically significant increase in net assimilation with the application of nitrogen upto 180 kg per ha (0.1038 g/dm<sup>2</sup>/day), as compared to 60 kg nitrogen per ha (0.0608 g/dm<sup>2</sup>/day). The

**Table 4.10** Net assimilation rate of watermelon as influenced by nitrogen, Spacing and method of irrigation.

Treatments	Net assimilation rate (g/dm <sup>2</sup> /day)					
	21-40 DAE 1984	41-60 DAE 1985	41-60 DAE 1984	61-80 DAE 1985	61-80 DAE 1984	61-80 DAE 1985
<u>Nitrogen, kg/ha</u>						
60	0.1104	0.1338	0.0608	0.0678	0.1606	0.2317
120	0.1242	0.1506	0.0766	0.0706	0.2462	0.3521
180	0.1301	0.1671	0.1038	0.1223	0.2491	0.3629
'F' test	NS	NS	Sig	Sig	Sig	Sig
S.E.m+	0.0064	0.0158	0.0106	0.0120	0.0209	0.0298
C.D. at 5%	-	-	0.0312	0.0352	0.0613	0.0874
<u>Spacing, cm</u>						
300 x 60	0.1147	0.1442	0.0671	0.0708	0.2287	0.3145
200 x 60	0.1285	0.1569	0.0938	0.1029	0.2386	0.3166
'F' Test	NS	NS	Sig	Sig	NS	NS
<u>Method of Irrigation</u>						
Drip	0.1240	0.1607	0.0907	0.0925	0.2554	0.3562
Furrow	0.1192	0.1404	0.0702	0.0813	0.2019	0.2750
'F' test	NS	NS	NS	NS	Sig	Sig
S.E.m+	0.0052	0.0129	0.0087	0.0098	0.0171	0.0243
C.D. at 5%	-	-	0.0254	0.0288	0.0500	0.0713

differences between 60 kg and 120 kg, as well as that between 120 kg and 180 kg nitrogen per ha were on par. Between 61 to 80 DAE, net assimilation rate increased significantly from 0.1606 g per  $\text{dm}^2$  per day with 60 kg nitrogen per ha to 0.2462 g per  $\text{dm}^2$  per day with 120 kg nitrogen per ha. The difference between 120 kg and 180 kg nitrogen per ha was not statistically significant.

During 1985, between 41 to 60 DAE, application of 180 kg nitrogen per ha resulted in significantly higher net assimilation rate (0.1223 g/ $\text{dm}^2$ /day), as compared to both 60 kg (0.0678 g/ $\text{dm}^2$ /day) and 120 kg nitrogen per ha (0.0706 g/ $\text{dm}^2$ /day). Between 61 to 80 DAE, it was significantly higher with 180 kg nitrogen per ha (0.3629 g/ $\text{dm}^2$ /day), as compared to 60 kg nitrogen per ha (0.2317 g/ $\text{dm}^2$ /day), but was on par with 120 kg nitrogen per ha (0.3521 g/ $\text{dm}^2$ /day).

Effect of spacing: Closer row spacing of 200 cm recorded higher net assimilation rate at all the growth stages, during both the years, although the difference was statistically significant only between 41 to 60 DAE. At the stage closer row spacing recorded significantly higher net assimilation rate (0.0938 g/ $\text{dm}^2$ /day during 1984 and 0.1029 g/ $\text{dm}^2$ /day during 1985), as compared to wider row spacing (0.0671 g/ $\text{dm}^2$ /day in 1984 and 0.0708 g/ $\text{dm}^2$ /day in 1985).

Method of irrigation: Net assimilation rate of watermelon was higher under drip irrigation than under furrow irrigation. The variations were statistically significant only between 61 to 80 DAE. At this stage, drip irrigation recorded

significantly higher net assimilation rate ( $0.2554 \text{ g/dm}^2/\text{day}$  in 1984 and  $0.3562 \text{ g/dm}^2/\text{day}$  in 1985), as compared to furrow irrigation ( $0.3562 \text{ g/dm}^2/\text{day}$  during 1984 and  $0.2750 \text{ g/dm}^2/\text{day}$  during 1985).

#### 4.1.1.11 Crop growth rate :

The data on crop growth rate of watermelon, at different growth stages, during both the years, as influenced by nitrogen, spacing and method of irrigation are presented in Table 4.11.

Effect of nitrogen : Significant differences in crop growth rate were observed due to the influence of nitrogen, during both the years, except between 21 to 40 DAE during 1984.

During 1984, between 41 to 60 DAE, the crop growth rate was significantly higher ( $0.0425 \text{ g/dm}^2/\text{day}$ ) as compared to 60 kg nitrogen per ha ( $0.0244 \text{ g/dm}^2/\text{day}$ ). The difference between 120 kg and 180 kg nitrogen per ha was not statistically significant. Between 61 to 80 DAE, the crop growth rate increased significantly from  $0.0781 \text{ g per dm}^2 \text{ per day}$  with 60 kg nitrogen per ha to  $0.1153 \text{ g per dm}^2 \text{ per day}$  with 120 kg nitrogen per ha. The difference between 120 kg and 180 kg nitrogen per ha was not statistically significant.

During 1985, between 21 to 40 DAE, 120 kg nitrogen per ha recorded significantly higher crop growth rate ( $0.0137 \text{ g/dm}^2/\text{day}$ ), as compared to 60 kg nitrogen per ha ( $0.0094 \text{ g/dm}^2/\text{day}$ ). The difference between 120 kg and 180 kg nitrogen per ha, was not much. Between 41 to 60 DAE, crop growth rate was significantly higher ( $0.0382 \text{ g/dm}^2/\text{day}$ ) with

**Table 4.11** Crop growth rate of watermelon as influenced by nitrogen, Spacing and method of irrigation.

Treatments	Crop growth rate (g/dm <sup>2</sup> /day)					
	21-40 DAE 1984	21-40 DAE 1985	41-60 DAE 1984	41-60 DAE 1985	61-80 DAE 1984	61-80 DAE 1985
<u>Nitrogen, kg/ha</u>						
60	0.0114	0.0094	0.0244	0.0222	0.0781	0.1080
120	0.0154	0.0137	0.0317	0.0288	0.1153	0.1404
180	0.0153	0.0134	0.0425	0.0382	0.1215	0.1757
'F' test	NS	Sig	Sig	Sig	Sig	Sig
S.E.m <sub>+</sub>	0.0020	0.0010	0.0051	0.0038	0.0068	0.0061
C.D. at 5%	-	0.0029	0.0149	0.0112	0.0199	0.0178
<u>Spacing, cm</u>						
300 x 60	0.0098	0.0091	0.0306	0.0282	0.1014	0.1089
200 x 60	0.0183	0.0152	0.0352	0.0313	0.1083	0.1739
'F' Test	Sig	Sig	NS	NS	NS	Sig
<u>Method of Irrigation</u>						
Drip	0.0148	0.0123	0.0397	0.0326	0.1077	0.1477
Furrow	0.0132	0.0120	0.0261	0.0268	0.1022	0.1351
'F' test	NS	NS	Sig	NS	NS	NS
S.E.m <sub>+</sub>	0.0019	0.0008	0.0041	0.0031	0.0055	0.0050
C.D. at 5%	0.0067	0.0023	0.0121	-	-	0.0145

180 kg per ha, as compared to 60 kg nitrogen per ha (0.0222 g/dm<sup>2</sup>/day). The differences between 60 kg and 120 kg as well as 120 kg and 180 kg nitrogen per ha were not statistically significant. Between 61 to 80 DAE, it increased significantly from 0.1080 g per dm<sup>2</sup> per day with 60 kg nitrogen to 0.1404 g per dm<sup>2</sup> per day with 180 kg nitrogen per ha.

Effect of spacing : Wider row spacing of 300 cm had lower crop growth rate at all the growth stages during both the years but the differences were statistically significant only between 21 to 40 DAE during both the years and between 61 to 80 DAE during 1985.

During 1984, between 21 to 40 DAE, it was 0.0183 g per dm<sup>2</sup> per day with closer row spacing of 200 cm, as compared to 0.0098 g per dm<sup>2</sup> per day with wider row spacing of 300 cm.

During 1985, between 21 to 40 days, 200cm row spacing recorded significantly higher crop growth rate (0.0152 g/dm<sup>2</sup>/day). Similar trend was observed between 61 to 80 DAE.

Method of irrigation : Crop growth rate was higher under drip irrigation, as compared to furrow irrigation at all the stages during both the years. But the difference was statistically significant only between 41 to 60 DAE during 1984. At this stage, the crop growth rate was significantly higher under drip irrigation (0.0397 g/dm<sup>2</sup>/day) as compared to furrow irrigation (0.0261 g/dm<sup>2</sup>/day).

#### 4.1.2 Yield and Yield components :

The data on fruit yield and yield components of watermelon as influenced by nitrogen, spacing and method of irrigation are presented in Table 4.12 and the data on fruit and seed characters are presented in Table 4.14.

##### 4.1.2.1 Fruit yield :

Effect of nitrogen : During 1984, the fruit yield increased from 348.60 q per ha with 60 kg nitrogen per ha to 378.60 q per ha with 120 kg nitrogen per ha and to 360.81 q per ha with 180 kg nitrogen per ha. However, the difference in fruit yield due to nitrogen levels were not statistically significant. During 1985, the fruit yield increased significantly (344.90 q/ha) with 120 kg nitrogen per ha, as compared to 60 kg nitrogen per ha (308.28 q/ha). The difference between 120 kg and 180 kg nitrogen per ha (345.51 q/ha) was not statistically significant.

Effect of spacing : During 1984, closer row spacing of 200 cm recorded significantly higher fruit yield (389.25 q/ha), as compared to wider row spacing of 300 cm (336.12 q/ha). Likewise, during 1985, the fruit yield with closer row spacing was significantly higher (362.36 q/ha), as compared to wider row spacing (303.42 q/ha).

Method of irrigation : During 1984, drip irrigation recorded significantly higher yield (418.00q/ha), as compared to furrow irrigation (307.37 q/ha). During 1985 also drip irrigation resulted in significantly higher fruit yield

**Table 4.12** Fruit yield and yield components of watermelon as influenced by nitrogen, spacing and method of irrigation.

Treatments	Fruit yield q/ha		Number of fruits/ha		Fruit weight,kg	
	1984	1985	1984	1985	1984	1985
<u>Nitrogen, kg/ha</u>						
60	348.60	308.28	12,229	9,050	2.6	2.3
120	378.66	344.90	14,333	10,514	3.0	2.8
180	360.81	345.51	13,792	10,954	2.8	3.0
'F' test	NS	Sig	Sig	Sig	Sig	Sig
S.E.m <sub>±</sub>	14.46	8.33	637	509	0.11	0.07
C.D. at 5%	-	24.42	1,868	1,476	0.32	0.20
<u>Spacing, cm</u>						
300 x 60	336.12	303.42	11,066	10,873	3.0	3.1
200 x 60	389.25	362.36	15,842	13,470	2.5	2.7
'F' Test	Sig	Sig	Sig	Sig	Sig	Sig
<u>Method of Irrigation</u>						
Drip	418.00	379.00	14,930	13,840	3.0	2.9
Furrow	307.37	286.78	11,972	10,502	2.6	2.6
'F' test	Sig	Sig	Sig	Sig	Sig	Sig
S.E.m <sub>±</sub>	11.80	6.78	521	484	0.09	0.06
C.D. at 5%	34.62	19.93	1,525	1,428	0.26	0.17

Table 4.13

A) Interaction effect of nitrogen and spacing on fruit yield (q/ha) of watermelon, 1985

Nitrogen levels, kg/ha	300 x 60	Spacing, cm 200 x 60
60	273.33	343.24
120	336.11	353.70
180	308.88	390.11
'F' test	Sig	
S.E.m <sub>±</sub>	11.78	
C.D. at 5%	34.51	

B) Interaction effect of nitrogen and method of irrigation on fruit yield (q/ha) of watermelon.

Nitrogen levels, kg/ha	300 x 60	Spacing, cm 200 x 60
60	327.52	289.05
120	394.97	294.84
180	414.51	276.46
'F' test	Sig	
S.E.m <sub>±</sub>	11.78	
C.D. at 5%	34.51	

(379.00 q/ha) as compared to furrow irrigation (286.78 q/ha).

The interaction effects of nitrogen and spacing, nitrogen and method of irrigation were statistically significant during 1985 and are presented in Table 4.13.

Interaction effect of nitrogen and spacing indicated statistically significant fruit yield differences. Closer row spacing of 200 cm with 180 kg nitrogen per ha resulted in the highest yields (390.11 q/ha) as compared to all other treatment combinations. This was followed by closer row spacing and 120 kg nitrogen per ha (353.70 q/ha). The differences between 200 cm row spacing with 60 kg nitrogen, and 300 cm row spacing either with 120 kg or 180 kg nitrogen were not statistically significant. The fruit yield was significantly lowest (273.33 q/ha) with 300 cm row spacing and 60 kg nitrogen per ha.

Interaction effect of nitrogen and method of irrigation indicated significantly higher fruit yield under drip irrigation with 180 kg nitrogen per ha which was on par with 120 kg nitrogen under drip irrigation. The fruit yield was lowest under furrow irrigation with 180 kg nitrogen per ha which was significantly on par with other furrow irrigation treatments, but lower than the drip irrigation treatments.

#### 4.1.2.2 Number of fruits per ha :

Effect of nitrogen : During 1984, the number of fruits per ha increased significantly from 12,229 fruits per ha with 60 kg nitrogen per ha to 14,333 fruits per ha with 120 kg nitrogen per ha. The difference between 120 kg and 180 kg

nitrogen per ha was not statistically significant.

During 1985, it increased from 9,050 fruits per ha with 60 kg nitrogen per ha to 10,514 fruits per ha with 120 kg nitrogen per ha. The difference between 120 kg and 180 kg nitrogen per ha was not statistically significant.

Effects of spacing : During 1984, closer row spacing of 200 cm recorded significantly higher (15,842 fruits/ha) number of fruits as compared to wider row spacing (11,066 fruits/ha) of 300 cm. Likewise, during 1985, the number of fruits were significantly higher (13,470 fruits/ha) with closer row spacing, as compared to wider row spacing (10,873 fruits/ha).

Method of irrigation : Drip irrigation recorded significantly higher number of fruits per ha during both the years (14,930 fruits/ha during 1984 and 13,840 during 1985), as compared to furrow irrigation (11,972 during 1984 and 10,502 during 1985).

#### 4.1.2.3. Fruit weight:

Effect of nitrogen : During 1984, fruit weight increased significantly from 2.6 kg with 60 kg nitrogen per ha to 3.0 kg with 120 kg nitrogen per ha and was on par with 180 kg nitrogen per ha. During 1985, the fruit weight increased significantly with successive levels of nitrogen from 2.3 kg with 60 kg nitrogen to 2.8 kg with 120 kg nitrogen and 3.0 kg with 180 kg nitrogen per ha.

Effect of spacing : Wider row spacing of 300 cm resulted in significantly higher fruit weight (3.0 kg in 1984 and 3.1 kg

in 1985) as compared to closer row spacing (2.5 kg in 1984 and 2.7 kg in 1985).

Method of irrigation : Drip irrigation recorded significantly higher fruit weight during both the years (3.0 kg in 1984 and 2.9 kg in 1985) as compared to furrow irrigation (2.6 kg during 1984 and 1985).

#### 4.1.2.4 Flesh thickness :

Effect of nitrogen : Statistically significant differences in flesh thickness were recorded only during 1985. It was 7.1 cm with 60 kg nitrogen per ha, which was significantly lower as compared to 180 kg nitrogen per ha ( 7.8 cm ). The difference between 60 kg and 120 kg nitrogen per ha was not statistically significant.

Effect of spacing : Row spacing failed to bring about any significant variations in flesh thickness during both the years.

Method of irrigation : Flesh thickness was significantly influenced by method of irrigation only during 1984. It was significantly higher (8.7 cm) with drip irrigation as compared to furrow irrigation ( 8.1 cm ).

#### 4.1.2.5 Rind thickness :

Effect of nitrogen : Statistically significant differences in rind thickness were observed due to nitrogen levels only during 1985. It increased significantly from 2.4 cm with 60 kg nitrogen per ha to 3.0 cm with 180 kg nitrogen per ha. The difference between 60 kg and 120 kg nitrogen per ha was not statistically significant.

**Table 4.14** Fruit and Seed characters of watermelon as influenced by nitrogen, spacing and method of irrigation.

Treatments	Flesh thick- ness, cm		Rind thick- ness, cm		Fruit shape index		Seed number/ fruit		Seed weight/ fruit		Hundred seed weight, g	
	1984	1985	1984	1985	1984	1985	1984	1985	1984	1985	1984	1985
<u>Nitrogen, kg/ha</u>												
60	8.2	7.1	3.2	2.4	1.03	0.90	216	212	9.0	8.9	4.1	4.1
120	8.4	7.2	3.5	2.6	1.01	0.94	226	222	10.1	10.0	4.2	4.2
180	8.6	7.8	3.3	3.0	1.01	0.96	304	298	12.4	11.1	4.5	4.4
'F' test	NS	Sig	NS	Sig	NS	Sig	Sig	Sig	NS	NS	NS	NS
S.E.m <sub>t</sub>	0.02	0.12	0.26	0.13	0.02	0.02	25	20	1.15	1.23	0.14	0.16
C.D. at 5%	-	0.35	-	0.37	-	0.05	74	59	-	-	-	-
<u>Spacing, cm</u>												
300 x 60	8.4	7.2	3.6	2.7	1.02	0.93	262	251	11.1	10.9	4.2	4.1
200 x 60	8.4	7.5	3.1	2.7	1.01	0.94	235	228	10.0	8.9	4.2	4.2
'F' Test	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
<u>Method of Irrigation</u>												
Drip	8.7	7.4	3.4	2.7	1.02	0.93	254	240	10.6	10.4	4.3	4.2
Furrow	8.1	7.3	3.2	2.7	1.02	0.94	244	221	10.4	10.0	4.1	4.1
'F' test	Sig	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
S.E.m <sub>t</sub>	0.12	0.13	0.22	0.10	0.01	0.01	21	19	0.94	0.87	0.12	0.11
C.D. at 5%	0.35	-	-	-	-	-	-	-	-	-	-	-

Effect of spacing : The difference in rind thickness was not statistically significant due to the influence of row spacing during both the years.

Method of irrigation : Rind thickness did not vary significantly due to method of irrigation during both the years.

#### 4.1.2.6 Fruit shape index :

Effect of nitrogen : Statistically significant differences in fruit shape index was recorded only during 1985. It was significantly higher ( 0.96 ) with 180 kg nitrogen per ha, as compared to 60 kg nitrogen per ha ( 0.90 ). However, the difference between 60 kg and 120 kg, as well as 120 kg and 180 kg nitrogen per ha, were not statistically significant.

Effect of spacing : The variation in fruit shape index as influenced by row spacings were not statistically significant during both the years.

Method of irrigation :

Method of irrigation did not influence the fruit shape index significantly during both the years.

#### 4.1.2.7 Seed characters :

The data on seed characters of watermelon as influenced by nitrogen, spacing and method of irrigation are presented in Table 4.14.

Effect of nitrogen : Seed number per fruit increased significantly due to nitrogen levels during both the years.

During 1984, it was 304 with 180 kg nitrogen per ha, which was significantly higher as compared to 216 with 60 kg nitrogen per ha. The difference between 60 kg and 120 kg nitrogen per ha was not statistically significant. Similar trend was observed during 1985.

Effect of spacing : Seed number was not significantly influenced by row spacing during both the years. However, wider row spacing of 300 cm recorded higher seed number during both the years, as compared to closer row spacing of 200 cm.

Method of irrigation : Method of irrigation did not influence markedly the seed number during both the years. However, drip irrigation recorded more number of seeds per fruit as compared to furrow irrigation.

Seed weight per fruit :

Effect of nitrogen : Seed weight per fruit increased with nitrogen levels during both the years, but the differences were not statistically significant.

Effect of spacing : Seed weight did not vary significantly due to row spacings during both the years. However, wider row spacing recorded higher seed weight as compared to closer row spacing.

Method of irrigation : Drip irrigation had higher seed weight as compared to furrow irrigation. However, the differences were not statistically significant.

#### Hundred seed weight :

Effect of nitrogen : The hundred seed weight differences due to nitrogen levels were not statistically significant during both the years, although it increased with increase in nitrogen levels.

Effect of spacing : Statistically significant differences in hundred seed weight were not observed due to row spacing during both the years.

Method of irrigation : The differences in hundred seed weight were not statistically significant due to method of irrigation. However, drip irrigation had slightly higher hundred seed weight, as compared to furrow irrigation.

#### 4.1.3 Fruit Quality

The data on fruit quality of watermelon as influenced by nitrogen, spacing and method of irrigation are presented in Table 4.15.

##### 4.1.3.1. Total soluble solids :

Effect of nitrogen : There was a gradual increase in the total soluble solids due to increase in nitrogen levels during both the years. The differences were statistically significant during 1985, when it increased significantly with successive levels of nitrogen. These values were 8.1, 8.9 and 9.6 per cent with 60 kg, 120 kg and 180 kg nitrogen per ha, respectively.

Effect of spacing : Wider row spacing of 300 cm recorded higher total soluble solids than closer row spacing of 200 cm

**Table 4.15** Fruit quality of watermelon as influenced by nitrogen, spacing and method of irrigation

Treatments	Total soluble solids, %		Reducing sugars, %		Total sugars, %		Fruit Juice NO <sub>3</sub> -N, PPM	
	1984	1985	1984	1985	1984	1985	1984	1985
<u>Nitrogen, kg/ha</u>								
60	9.2	8.1	2.0	1.9	3.9	3.2	13.37	12.88
120	9.7	8.9	2.7	2.6	4.3	3.3	16.40	16.02
180	9.4	9.6	3.1	2.7	4.6	3.5	18.28	19.21
'F' test	NS	Sig	Sig	Sig	NS	Sig	Sig	Sig
S.E.m <sub>t</sub>	0.15	0.12	0.22	0.10	0.47	0.16	1.21	1.34
C.D. at 5%	-	0.37	0.64	0.31	-	-	3.54	3.93
<u>Spacing, cm</u>								
300 x 60	9.5	9.0	2.4	2.3	3.9	3.3	15.47	14.86
200 x 60	9.3	8.8	2.7	2.4	4.0	3.4	16.57	16.08
'F' Test	NS	NS	NS	NS	NS	NS	NS	NS
<u>Method of Irrigation</u>								
Drip	9.6	9.0	2.5	2.4	4.6	3.4	15.55	15.01
Furrow	9.3	8.8	2.7	2.4	4.0	3.2	16.48	17.12
'F' test	NS	NS	NS	NS	NS	NS	NS	NS
S.E.m <sub>t</sub>	0.12	0.10	0.18	0.09	0.38	0.13	0.99	1.60
C.D. at 5%	-	-	-	-	-	-	-	-

during both the years. The differences, however, were not statistically significant.

Method of irrigation : Method of irrigation did not provide any statistically significant variations in total soluble solids during both the years. In general, drip irrigation recorded higher total soluble solids, as compared to furrow irrigation.

#### 4.1.3.2 Reducing sugars :

Effect of nitrogen : During 1984, the reducing sugars increased significantly from 2.0 per cent with 60 kg nitrogen per ha to 2.7 per cent with 120 kg nitrogen per ha. The difference between 120 kg and 180 kg nitrogen per ha was not statistically significant. Similar trend was observed during 1985.

Effect of spacing : The differences in reducing sugars were not statistically significant due to row spacing during both the years. However, closer row spacing recorded higher reducing sugars as compared to wider row spacing.

Method of irrigation : Method of irrigation did not influence significantly the reducing sugars in watermelon during both the years.

#### 4.1.3.3 Total sugars :

Effect of nitrogen : The differences in total sugars as influenced by nitrogen levels were not statistically significant during both the years, although, it increased marginally with increase in nitrogen levels.

Effect of spacing : Closer row spacing of 200 cm recorded higher total sugars, as compared to wider row spacing of 300 cm in both the years. The differences, however, were not statistically significant.

Method of irrigation : The variations in total sugars as influenced by method of irrigation were not statistically significant during both the years. However, drip irrigation recorded higher total sugars as compared to furrow irrigation.

#### 4.1.3.4 Nitrate-nitrogen :

Effect of nitrogen : Nitrate-nitrogen increased significantly during both the years.

During 1984, it increased significantly from 13.37 ppm with 60 kg nitrogen per ha to 18.28 ppm with 180 kg nitrogen per ha. The differences between 60 kg and 120 kg as well as between 120 kg and 180 kg nitrogen per ha were not statistically significant. Similar trend was observed during 1985.

Effect of spacing : Closer row spacing of 200 cm recorded higher nitrate - nitrogen, as compared to wider row spacing of 300 cm. However, the differences were not statistically significant.

Method of irrigation : Furrow irrigation had higher nitrate - nitrogen as compared to drip irrigation during both the years, but the differences were not statistically significant.

#### 4.1.4 Plant water studies

##### 4.1.4.1 Relative water content :

The data on relative water content of watermelon as influenced by nitrogen, spacing and method of irrigation for two irrigation cycles are presented in Fig.4.1

Effect of nitrogen : Relative water content gradually decreased from 92.6 per cent to 86.0 per cent with 180 kg nitrogen, from 93.2 per cent to 84.1 per cent with 120 kg nitrogen and from 92.3 per cent to 80.1 per cent with 60 kg nitrogen per ha from 1 to 15 days after irrigation. Thus 60 kg nitrogen per ha, recorded lower ( 2.3 % at 7 days and 3.1 % at 15 days ) relative water content as compared to 120 kg ( 2.8 % at 7 days and 3.0 % at 15 days ) and 180 kg nitrogen per ha ( 3.2 % at 7 days and 5.1 % at 15 days ).

Effect of spacing : In closer row spacing of 200 cm, the relative water content decreased from 94.7 per cent to 80.7 per cent and in wider row spacing of 300 cm, it decreased from 92.5 per cent to 79.5 per cent, from 1 to 15 days after irrigation. Thus, closer row spacing had higher ( 4.4 % at 7 days and 2.8 % at 15 days ) relative water content, as compared to wider row spacing.

Method of irrigation : The relative water content under drip irrigation ranged from 95.2 to 93.6 per cent, from 1 to 15 days after irrigation. Under furrow irrigation, it decreased from 91.7 per cent to 80.8 per cent from 1 to 15 days after irrigation. Thus, the variation in relative water content under furrow irrigation was more ( 3.8 % at 7 days and 12.6 % at 15 days ) as compared to drip irrigation.

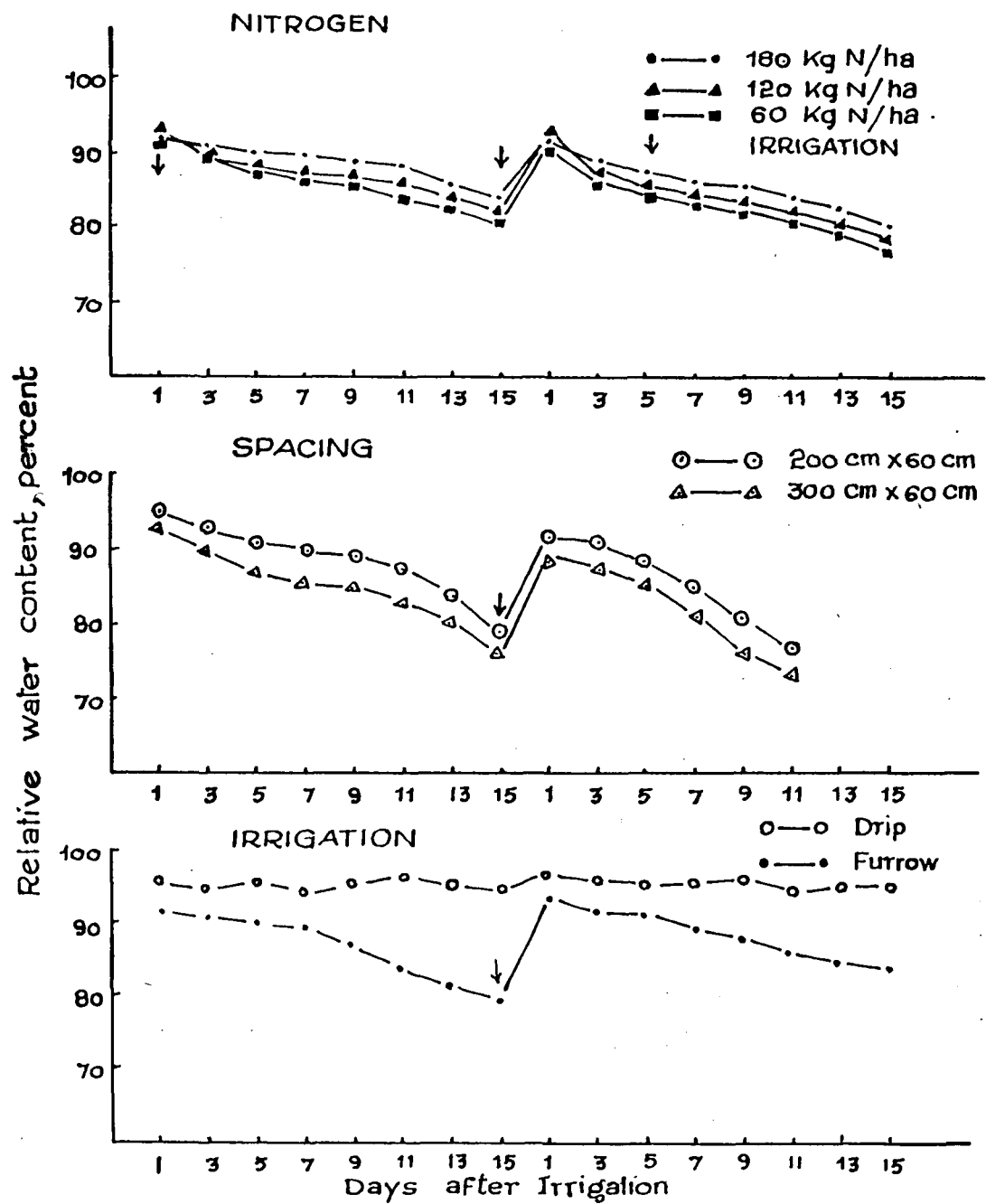


FIG. 4.1. RELATIVE WATER CONTENT IN WATER-MELON AS INFLUENCED BY NITROGEN, SPACING AND METHOD OF IRRIGATION.

#### 4.1.4.2 Osmotic Potential :

The data on osmotic potential as influenced by nitrogen, spacing and method of irrigation are presented in Fig. 4.2.

Effect of nitrogen: Osmotic potential values increased from -2.1 bar to -12.4 bar with 180 kg nitrogen, from -3.0 bar to -14.2 bar with 120 kg nitrogen and from -3.2 bar to -16.3 bar with 60 kg nitrogen per ha, from 1 to 15 days after irrigation. Thus, 60 kg nitrogen per ha recorded lower osmotic potential, as compared to 120 kg and 180 kg nitrogen per ha.

Effect of spacing : Osmotic potential values increased from -3.0 bar to -14.8 bar with closer row spacing, as compared to bar wider row spacing (-3.2 bar to -16.8) from 1 to 15 days after irrigation. Thus, closer spacing recorded lower osmotic potential, as compared to wider row spacing.

Method of irrigation : Osmotic potential values under drip irrigation varied from -3.2 bar to -5.8 bar and under furrow irrigation, it ranged from -5.8 bar to -17.1 bar, from 1 to 15 days after irrigation. Drip irrigation recorded lower osmotic potential, as compared to furrow irrigation and it maintained higher leaf water readings altogether.

#### 4.1.5 Canopy temperature and Root studies

4.1.5.1 Canopy temperature : The data on canopy temperature, as influenced by nitrogen, spacing and method of irrigation are presented in Fig.4.3.

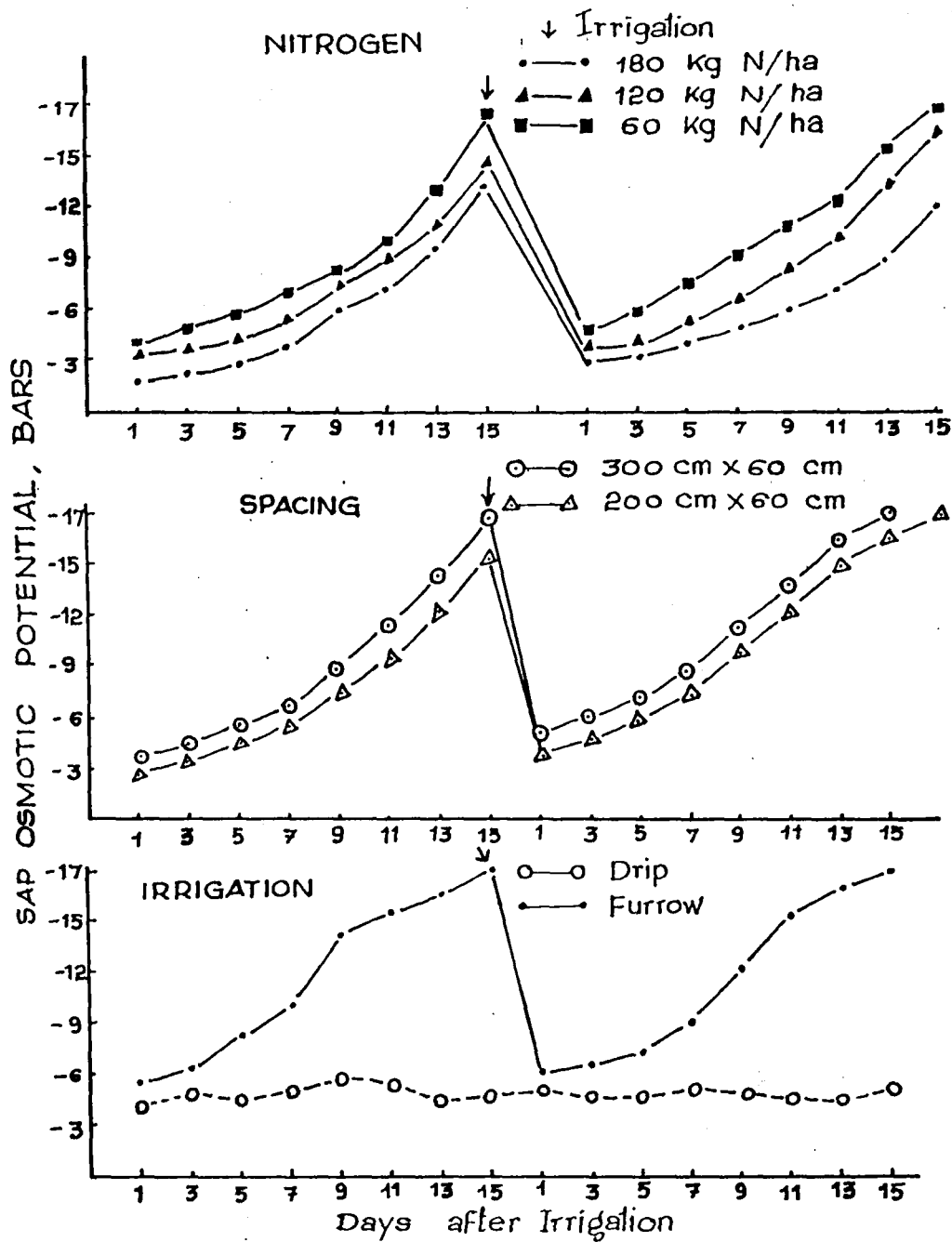


FIG. 4.2. Changes in Sap osmotic Potential as influenced by Nitrogen, Spacing and method of Irrigation.

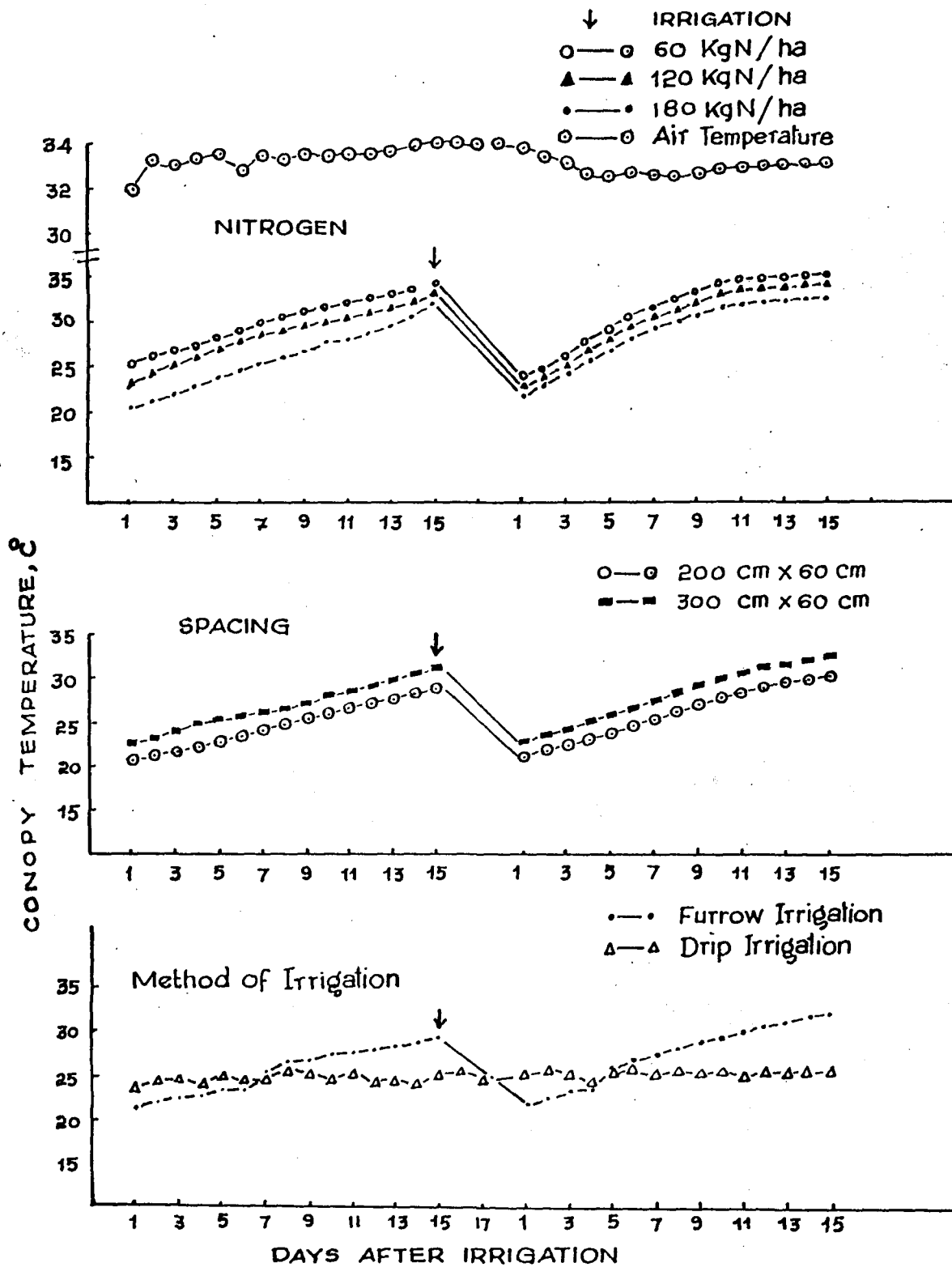


FIG. 4.3. CONOPY TEMPERATURE AS INFLUENCED BY NITROGEN, SPACING AND METHODS OF IRRIGATION.

Effect of nitrogen : Canopy temperature increased from 20.8<sup>o</sup>C to 32.8<sup>o</sup>C with 180 kg nitrogen, from 23.1<sup>o</sup>C to 33.9<sup>o</sup>C with 120 kg nitrogen and from 25.2<sup>o</sup>C to 34.5<sup>o</sup>C with 60 kg nitrogen per ha, from 1 to 15 days after irrigation. Thus, canopy temperatures were higher with 60 kg nitrogen (3.8<sup>o</sup>C at 7 days to 2.1<sup>o</sup>C at 15 days), as compared to 120 kg and (1.8<sup>o</sup>C at 7 days to 0.7<sup>o</sup>C at 15 days) and 180 kg nitrogen per ha.

Effect of spacing : Canopy temperatures with closer row spacing increased from 21.1<sup>o</sup>C to 31.3<sup>o</sup>C and from 22.7<sup>o</sup>C to 32.8<sup>o</sup>C, with wider row spacing from 1 to 15 days after irrigation. Closer row spacing recorded low (2.2<sup>o</sup>C at 7 days to 2.9<sup>o</sup>C at 15 days) canopy temperatures, as compared to wider row spacing.

Method of irrigation : Canopy temperature under drip irrigation, varied from 23.2<sup>o</sup>C to 25.8<sup>o</sup>C. Whereas, it varied from 23.8<sup>o</sup>C to 30.5<sup>o</sup>C, under furrow irrigation from 1 to 15 days after irrigation. Thus, drip irrigation recorded lower (2.3<sup>o</sup>C at 12 days to 3.7<sup>o</sup>C at 15 days) canopy temperatures as compared to furrow irrigation.

4.1.5.2 Root studies : The data pertaining to root length, number of secondary roots and dry weight of roots in watermelon, as influenced by nitrogen, spacing and method of irrigation are presented in Table 4.16.

**Table 4.16** Root length, maximum length of lateral root, number of secondary roots and root dry weight of watermelon as influenced by nitrogen, spacing and method of irrigation.

Treatments	Tap root length, (cm)		Maximum length of lateral root, (cm)	Number of secondary roots		Dry weight of root (g/plant)		
	1984	1985		1984	1985	1984	1985	
<u>Nitrogen, kg/ha</u>								
60	40.5	38.6	73.0	68.7	5.5	5.0	4.29	3.84
120	37.7	37.8	66.4	50.5	7.3	7.1	4.88	4.10
180	35.3	37.1	68.6	48.6	9.4	9.8	4.91	4.24
'F' test	NS	NS	Sig	Sig	Sig	Sig	Sig	Sig
S.E.m <sub>±</sub>	1.16	1.01	2.27	2.07	0.35	0.41	0.08	0.06
C.D. at 5%	-	-	6.64	6.14	1.03	1.32	0.25	0.19
<u>Spacing, cm</u>								
300 x 60	30.2	28.6	67.1	60.2	6.2	5.8	4.90	4.78
200 x 60	45.5	38.5	58.3	53.5	8.6	7.9	4.49	4.12
'F' Test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
<u>Method of Irrigation</u>								
Drip	30.5	31.1	60.7	56.8	7.9	8.0	4.26	4.07
Furrow	45.2	43.6	64.7	59.0	6.9	6.6	5.14	4.88
S.E.m <sub>±</sub>	1.32	1.10	1.85	1.53	0.28	0.34	0.07	0.05
C.D. at 5%	3.86	3.34	5.43	4.81	0.84	0.98	0.20	0.16

Root length :

Effect of nitrogen : Root length was highest with 60 kg nitrogen per ha and decreased with the application of nitrogen, during both the years. The differences, however, were not statistically significant.

Effect of spacing : Row spacing had significant influence on root length, during both the years. It was highest (45.5 cm in 1984 and 38.5 in 1985) with 200 cm row spacing, as compared to 300 cm row spacing (30.2 and 28.6 cm during 1984 and 1985, respectively).

Method of irrigation : Drip irrigation recorded significantly lower root length during both the years (30.5 cm during 1984 and 31.1 cm during 1985) as compare to furrow irrigation (45.2 cm in 1984 and 43.6 cm in 1985).

Lateral root length :

Effect of nitrogen : During 1984, significantly higher lateral root length was recorded with 60 kg nitrogen per ha (73.0 cm), as compared to 120 kg nitrogen per ha (66.4 cm) but, the differences between 120 and 180 kg nitrogen per ha (68.6 cm) were not statistically significant. During 1985, the lateral root length was significantly higher (68.7 cm) with 60 kg nitrogen per ha, as compared to, both 120 and 180 kg nitrogen per ha.

Effect of spacing : Closer row spacing of 200 cm recorded significantly lower lateral root length, during both the years, as compared to wider row spacing of 300 cm. It was

58.3 cm during 1984 and 53.3 cm during 1985, with 200 cm row spacing, as compared to 67.1 cm and 60.2 cm, with 300 cm row spacing, during 1984 and 1985, respectively.

Method of irrigation : Furrow irrigation had more lateral root length, during both the years, as compared to drip irrigation, although, the differences were not statistically significant.

Number of secondary roots :

Effect of nitrogen : The number of secondary roots increased significantly with nitrogen fertilization, during both the years. During 1984, it increased from 5.5 to 7.3 and to 9.4 with the increase in nitrogen levels from 60, 120 and 180 kg per ha respectively. During 1985 also, it increased from 5.0 to 7.1 and to 9.8 with 60, 120 and 180 kg nitrogen per ha, respectively.

Effect of spacing : Closer row spacing of 200 cm had significantly higher number of secondary roots, during both the years (8.6 in 1984 and 7.9 in 1985), as compared to 300 cm row spacing (6.2 and 5.8 during 1984 and 1985, respectively).

Method of irrigation : Drip irrigation recorded significantly higher number of secondary roots (7.9 and 8.0 during 1984 and 1985 respectively), as compared to furrow irrigation (6.9 and 6.6 during 1984 and 1985 respectively).

Dry weight of roots :

Effect of nitrogen : During 1984, root dry weight increased significantly with 120 kg nitrogen per ha (4.88 g/plant), as compared to 60 kg nitrogen per ha (4.29 g/plant) and the difference between 120 kg and 180 kg nitrogen per ha (4.91 g/plant), were not statistically significant. Likewise, during 1985, it was 3.84 g per plant with 60 kg nitrogen per ha, which increased significantly to 4.10 g per plant with 120 kg nitrogen per ha and finally to 4.24 g per plant with 180 kg nitrogen per ha, but, the difference between 120 and 180 kg nitrogen per ha, was not statistically significant.

Effect of spacing : Wider row spacing of 300 cm recorded significantly higher dry weight (4.90 and 4.78 g/plant during 1984 and 1985 respectively), as compared to closer row spacing of 200 cm (4.49 and 4.12 g/plant during 1984 and 1985, respectively).

Method of irrigation : Furrow irrigation recorded significantly higher dry weight of roots (5.14 and 4.88 g/plant, during 1984 and 1985 respectively), as compared to drip irrigation (4.26 and 4.07 g/plant, during 1984 and 1985, respectively).

#### 4.1.6 Nutrient Content and Uptake Studies :

##### 4.1.6.1 Nitrogen content :

The data on nitrogen content in watermelon, as influenced by nitrogen, spacing and method of irrigation at different stages of crop growth are presented in Table 4.17.

Effect of nitrogen : There was statistically significant increase in the nitrogen content, due to increase in nitrogen levels at all the growth stages, during both the years, except at 60 DAE, during 1985.

During 1984, at 40 DAE in plant, it increased significantly from 3.96 per cent with 60 kg nitrogen per ha to 4.36 per cent with 120 kg nitrogen per ha and was highest (4.96%) with 180 kg nitrogen per ha. At 60 DAE in plant, it was significantly higher (4.35%) with 180 kg nitrogen per ha, as compared to 60 kg nitrogen per ha (3.67%) and the differences between 60 and 120 kg, as also between 120 and 180 kg nitrogen per ha, were not statistically significant. At 80 DAE in shoot, 120 kg nitrogen per ha resulted in significantly higher nitrogen content (2.09%), as compared to 60 kg nitrogen per ha (1.77%) and the difference between 120 and 180 kg nitrogen per ha was not statistically significant. Nitrogen content in fruit was significantly highest with 180 kg nitrogen per ha (2.02%), as compared to that at 60 (1.71%) and 120 kg (1.80/5) nitrogen per ha, which were on par.

During 1985 at 40 DAE, nitrogen content in plant increased significantly with successive increment in nitrogen levels. The values were 3.56, 4.09 and 4.63 per cent at 60,

**Table 4.17** Nitrogen content of watermelon as influenced by nitrogen, spacing and method of irrigation

Treatments	40 DAE		Nitrogen content (percent)			
	1984	1985	60 DAE		80 DAE	
			1984	1985	1984	1985
			Shoot	Fruit	Shoot	Fruit
Nitrogen, kg/ha						
60	3.96	3.56	3.67	3.53	1.77	1.47
120	4.36	4.09	4.01	3.77	1.80	1.57
180	4.96	4.63	4.35	3.90	2.11	1.79
'F' test	Sig	Sig	Sig	NS	Sig	Sig
S.E.m <sub>t</sub>	0.09	0.09	0.15	0.14	0.09	0.05
C.D. at 5%	0.27	0.26	0.45	-	0.26	0.16
Spacing, cm						
300 x 60	4.46	4.13	4.09	3.80	2.07	1.69
200 x 60	4.39	4.06	3.94	3.66	1.91	1.53
'F' Test	NS	NS	NS	NS	NS	Sig
Method of Irrigation						
Drip	4.46	4.15	4.06	3.74	2.02	1.79
Furrow	4.39	4.06	3.97	3.73	1.96	1.43
'F' test	NS	NS	NS	NS	NS	Sig
S.E.m <sub>t</sub>	0.08	0.07	0.13	0.11	0.07	0.04
C.D. at 5%	-	-	-	-	-	0.13

120 and 180 kg nitrogen per ha, respectively. At 80 DAE, nitrogen content in shoot increased from 1.40 per cent with 60 kg nitrogen per ha to 1.62 per cent with 120 kg nitrogen per ha. The difference between 120 kg and 180 kg nitrogen per ha was not statistically significant. The nitrogen content in fruit was significantly higher (1.79%) with 180 kg nitrogen per ha, as compared to 60 kg nitrogen per ha. The difference between 120 and 180 kg nitrogen was also statistically significant but, the variation between 60 kg and 120 kg nitrogen per ha was not statistically significant.

Effect of spacing : Spacing had statistically significant influence on nitrogen content in fruit, only at 80 DAE during both the years. Closer row spacing of 200 cm recorded significantly reduced nitrogen content in fruit (1.74 and 1.53% during 1984 and 1985, respectively) as compared to that under wider row spacing of 300 cm (1.95 and 1.69% during 1984 and 1985, respectively).

Method of irrigation : Method of irrigation had statistically significant influence on nitrogen content in fruit during both the years. Drip irrigation (2.16 and 1.79% during 1984 and 1985, respectively) resulted in higher nitrogen content in fruits, as compared to that under furrow irrigation (1.53 and 1.43% during 1984 and 1985, respectively). Similar trend was noticed in nitrogen content in plant, at all the stages, although, the differences were not statistically significant.

#### 4.1.6.2 Nitrogen uptake :

The data on nitrogen uptake of watermelon, as influenced by nitrogen, spacing and method of irrigation are presented in Table 4.18.

Effect of nitrogen : Nitrogen fertilization had statistically significant influence on its uptake, at all the stages of growth, during both the years, except at 80 DAE in fruit during 1984. During 1984, at 40 DAE, nitrogen uptake in plant was significantly higher, with 120 kg nitrogen per ha (14.17 kg/ha), as compared to that at 60 kg nitrogen per ha (9.50 kg/ha), and the difference between 120 and 180 (15.13 kg/ha) kg nitrogen per ha, was not statistically significant. At 60 DAE in plant, 180 kg nitrogen per ha recorded significantly higher nitrogen uptake (47.41 kg/ha), as compared to that at 60 kg nitrogen per ha (32.60 kg/ha) and the difference between successive levels of nitrogen were not statistically significant. At 80 DAE, nitrogen uptake in shoot increased significantly from 46.64 kg per ha with 60 kg nitrogen per ha to 66.14 kg per ha with 120 kg nitrogen per ha and the difference between 120 kg and 180 kg (67.33 kg/ha) nitrogen per ha was not statistically significant. The total nitrogen uptake was significantly highest (117.41 kg/ha) with 180 kg nitrogen per ha, as compared to 60 kg nitrogen per ha (85.77 kg/ha) and the differences between 60kg and 120 kg (105.73 kg/ha), as also between 120 kg and 180 kg nitrogen per ha, were not statistically significant.

**Table 4.18** Nitrogen uptake of watermelon as influenced by nitrogen, spacing and method of irrigation

Treatments	Nitrogen uptake (kg/ha)											
	40 DAE			60 DAE			80 DAE					
	1984	1985	1984	1985	1984	1985	Shoot	Fruit	Total uptake	Shoot	Fruit	Total uptake
Nitrogen, kg/ha												
60	9.50	7.10	32.60	27.40	46.64	39.13	85.77	36.00	27.04	63.04		
120	14.17	11.75	35.60	29.11	66.14	39.59	105.73	42.06	31.05	73.11		
180	15.13	12.83	47.41	38.12	67.33	50.08	117.41	56.69	39.86	96.55		
'F' test	Sig	Sig	Sig	Sig	Sig	NS	Sig	Sig	Sig	Sig	Sig	Sig
S.E.m <sub>+</sub>	1.54	0.83	4.08	3.36	3.02	3.39	8.71	3.44	3.53	7.67		
C.D. at 5%	4.53	2.42	11.98	9.08	8.86	-	25.52	10.08	10.36	22.25		
Spacing, cm												
300 x 60	9.15	7.86	33.40	28.06	58.05	39.44	97.49	37.19	28.32	65.51		
200 x 60	16.65	13.20	43.67	35.04	62.02	40.43	108.45	52.65	36.98	89.03		
'F' test	Sig	Sig	Sig	NS	NS	NS	NS	Sig	Sig	Sig	Sig	Sig
Method of Irrigation												
Drip	14.61	10.64	44.81	33.83	63.12	50.03	113.15	46.93	36.34	83.27		
Furrow	11.19	10.42	32.27	29.26	56.95	35.84	92.79	42.90	28.96	71.86		
'F' test	NS	NS	Sig	NS	NS	Sig	NS	NS	NS	NS	NS	NS
S.E.m <sub>+</sub>	1.26	0.67	3.33	2.74	2.47	2.77	7.87	2.81	2.88	6.82		
C.D. at 5%	3.70	1.98	9.78	-	7.23	8.11	-	8.23	8.44	19.78		

During 1985, at 40 DAE, nitrogen uptake in plant significantly increased from 7.01 kg per ha, with 60 kg nitrogen per ha to 11.75 kg per ha, with 120 kg nitrogen per ha. The difference between 120 kg and 180 kg nitrogen per ha, was not statistically significant.

At 60 DAE, nitrogen uptake in plant was significantly higher (38.12 kg/ha) with 180 kg nitrogen per ha, as compared to 60 kg (27.40 kg/ha) nitrogen per ha. However, the difference between 60 and 120 kg (29.11 kg/ha), as well as 120 and 180 kg nitrogen per ha, were not statistically significant. At 80 DAE, nitrogen uptake in shoot was significantly highest (56.69 kg/ha) with 180 kg nitrogen per ha, as compared to both 60 and 120 kg nitrogen per ha. The difference between application rates of 60 (36.00 kg/ha) and 120 kg (42.06 kg/ha) nitrogen per ha, was not statistically significant. The nitrogen uptake in fruit was significantly higher (39.86 kg/ha) with 180 kg nitrogen per ha, as compared to 60 kg nitrogen per ha (27.04 kg/ha). The differences between 60 kg and 120 kg, as well as that of 120 kg and 180 kg nitrogen per ha, were not statistically significant. Similar trend was observed in total nitrogen uptake.

Effect of spacing : Closer row spacing of 200 cm resulted in significantly higher nitrogen uptake in watermelon, at all the stages, except at 80 DAE, during 1984 and at 60 DAE, during 1985.

During 1984, at 40 DAE, nitrogen uptake in plant was significantly higher (16.65 hg/ha) with closer row spacing of 200 cm, as compared to wider row spacing of 300 cm (9.15 kg/ha). At 60 DAE in plant, closer row spacing recorded significantly higher nitrogen uptake (43.67 kg/ha), as compared to wider row spacing (33.40 kg/ha).

During 1985, at 40 DAE in plant, wider row spacing recorded significantly lower (7.86 kg/ha) nitrogen uptake, as compared to closer row spacing (13.20 kg/ha). Similar trend was observed at 80 DAE in shoot, fruit and total nitrogen uptake.

Method of irrigation : Method of irrigation had statistically significant influence on nitrogen uptake, only at 60 DAE and in fruit at 80 DAE, during 1984. During 1984, at 60 DAE in plant, drip irrigation recorded significantly higher nitrogen uptake (44.81 kg/ha), as compared to furrow irrigation (32.27 kg/ha). AT 80 DAE, also, the nitrogen uptake in fruit was significantly higher (50.03 kg/ha), under drip irrigation, as compared to furrow irrigation (35.84 kg/ha).

#### 4.1.6.3 Phosphorus content :

The data on phosphorus content in watermelon, as influenced by nitrogen, spacing and method of irrigation are presented in Table 4.19.

Effect of nitrogen : Nitrogen fertilization had statistically significant influence on phosphorus content in shoot, at 80 DAE, during 1984. At this stage, phosphorus content

**Table 4.19** Phosphorus content of watermelon as influenced by nitrogen, spacing and method of irrigation

Treatments	Phosphorus content (per cent)												
	40 DAE			60 DAE			80 DAE						
	1984	1985	1984	1985	1984	1985	Shoot	Fruit	Shoot		Fruit		
<u>Nitrogen, kg/ha</u>													
60	0.57	0.54	0.24	0.21	0.16	0.32	0.15	0.28					
120	0.58	0.54	0.25	0.22	0.20	0.34	0.18	0.30					
180	0.60	0.55	0.26	0.23	0.21	0.36	0.19	0.32					
'F'test	NS	NS	NS	NS	Sig	NS	NS	NS					
S.E.m±	0.022	0.021	0.014	0.015	0.014	0.012	0.015	0.018					
C.D. at 5%	-	-	-	-	0.041	-	-	-					
<u>Spacing, cm</u>													
300 x 60	0.58	0.55	0.25	0.22	0.22	0.37	0.20	0.32					
200 x 60	0.57	0.53	0.24	0.21	0.16	0.31	0.15	0.28					
'F'test	NS	NS	NS	NS	Sig	Sig	Sig	Sig					
<u>Method of Irrigation</u>													
Drip	0.59	0.56	0.31	0.27	0.23	0.37	0.21	0.32					
Furrow	0.56	0.52	0.12	0.16	0.15	0.31	0.14	0.29					
'F'test	NS	NS	Sig	Sig	Sig	Sig	Sig	Sig					
S.E.m±	0.012	0.018	0.007	0.008	0.009	0.011	0.008	0.009					
C.D. at 5%	-	-	0.020	0.023	0.026	0.032	0.023	0.026					

significantly increased from 0.16 per cent with 60 kg nitrogen per ha to 0.20 per cent with 120 kg nitrogen per ha and the difference between 120 kg and 180 kg nitrogen per ha was not statistically significant.

Effect of spacing : Row spacing had statistically significant influence on phosphorus content, only at 80 DAE during both the years, although, it was higher at wider row spacing of 300 cm, as compared to closer row spacing of 200 cm, at all the stages.

During 1984, at 80 DAE, the phosphorus content in shoot was significantly higher (0.22%) with 300 cm row spacing, as compared to 0.16 per cent with 200 cm row spacing. Similarly, in fruit, it was 0.37 and 0.31 per cent with 300 cm and 200 cm row spacing, respectively. During 1985, also similar trend was observed.

Method of irrigation : Statistically significant differences in phosphorus content were recorded, due to method of irrigation, during both the years, except at 40 DAE, during 1984 and 1985.

During 1984, at 60 DAE in plant, drip irrigation had significantly higher phosphorus content (0.31%), as compared to furrow irrigation (0.12%). At 80 DAE, phosphorus content in shoot was significantly higher (0.23), under drip irrigation, as compared to furrow irrigation (0.15%).

During 1985, at 60 DAE in plant, drip irrigation recorded significantly higher phosphorus content (0.27%) as compared to furrow irrigation (0.16%). Similar trend was observed at 80 DAE also both in shoot and fruit.

#### 4.1.6.4 Phosphorus uptake :

Phosphorus uptake of watermelon as influenced by nitrogen, spacing and method of irrigation are presented in Table 4.20.

Effect of nitrogen : Nitrogen fertilization had statistically significant influence on phosphorus uptake only, at 40 DAE in plant, during 1985 and at 80 DAE in shoot, during both the years. However, it increased with the application of nitrogen at all the stages, during both the years. During 1984, at 80 DAE, the phosphorus uptake in shoot increased significantly from 4.04 kg per ha with 60 kg nitrogen per ha to 6.62 kg per ha with 120 kg nitrogen per ha. The difference was not statistically significant between 120 and 180 kg nitrogen per ha.

During 1985, at 40 DAE in plant, it was significantly higher (1.46 kg/ha), with 120 kg nitrogen per ha, as compared to 60 kg nitrogen per ha (1.06 kg/ha) and the difference between 120 kg and 180 kg nitrogen per ha, was not statistically significant. AT 80 DAE, total phosphorus uptake was significantly higher (9.23 kg/ha), with 180 kg nitrogen per ha, as compared to 60 kg nitrogen per ha (11.36 kg/ha). The differences between 60 kg and 120 kg as well as between 120 kg and 160 kg nitrogen per ha were not statistically significant.

Effect of spacing : Phosphorus uptake was significantly influenced by row spacing during both the years, except at 80 DAE in plant, during both the years.

Table 4.20 Phosphorus uptake of watermelon as influenced by nitrogen spacing and method of irrigation

Treatments	Phosphorus uptake (kg/ha)											
	40 DAE		60 DAE		80 DAE		1984		1985		Total uptake	
	1984	1985	1984	1985	1984	1985	Shoot	Fruit	Shoot	Fruit		
Nitrogen, kg/ha												
50	1.42	1.06	2.10	1.62	4.04	7.12	11.16	3.71	5.52	9.23		
120	1.77	1.46	2.55	1.90	6.62	8.23	14.85	4.77	6.59	11.36		
180	2.04	1.51	2.95	2.13	6.77	8.87	15.64	6.14	6.74	12.88		
'F'test	NS	Sig	NS	NS	Sig	NS	Sig	Sig	NS	Sig		
S.E.m <sub>+</sub>	0.24	0.11	0.25	0.18	0.56	0.56	1.31	0.50	0.72	1.08		
C.D. at 5%	-	0.32	-	-	1.64	-	3.80	1.46	-	3.14		
Spacing, cm												
300 x 60	1.33	1.02	2.09	1.64	5.50	6.39	11.89	4.58	4.73	9.31		
200 x 60	2.15	1.66	2.97	2.12	6.12	9.76	15.88	5.17	7.84	13.01		
'F'test	Sig	Sig	Sig	Sig	NS	Sig	Sig	NS	Sig	Sig		
Method of Irrigation												
Drip	1.88	1.40	3.24	2.52	6.77	8.94	15.71	6.08	6.69	12.77		
Furrow	1.60	1.29	1.82	1.25	4.85	7.21	12.06	3.67	5.88	9.55		
'F'test	NS	NS	Sig	Sig	Sig	Sig	Sig	Sig	NS	NS		
S.E.m <sub>+</sub>	0.20	0.09	0.20	0.15	0.56	0.46	1.24	0.41	0.60	1.15		
C.D. at 5%	0.59	0.26	0.60	0.43	1.63	1.34	3.60	1.20	1.72	3.33		

During 1984, at 40 DAE in plant, closer row spacing of 200 cm, recorded significantly higher phosphorus uptake (2.15 kg/ha), as compared to wider row spacing of 300 cm (1.33 kg/ha). Similar trend was observed at 60 and 80 DAE in fruit and total phosphorus uptake.

During 1985, at 40 DAE in plant, phosphorus uptake was significantly higher (1.66 kg/ha), with closer row spacing, as compared to wider row spacing (1.02 kg/ha). Similar trend was observed at 60 and 80 DAE in fruit and total phosphorus uptake.

Method of irrigation : Plants raised under drip irrigation recorded higher phosphorus uptake, than those raised under furrow irrigation. Method of irrigation had statistically significant influence on phosphorus uptake at 60 and 80 DAE during 1984 in shoot, fruit and total uptake and at 60 DAE and 80 DAE in shoot during 1985.

During 1984, at 60 DAE in plant, drip irrigation recorded significantly higher phosphorus uptake (3.24 kg/ha), as compared to furrow irrigation (1.82 kg/ha). At 80 DAE, the phosphorus uptake in shoot, was significantly higher under drip irrigation (6.77 kg/ha), as compared to furrow irrigation (4.85 kg/ha). Likewise in fruit, the phosphorus uptake was 8.94 and 7.21 kg per ha, under drip and furrow irrigations, respectively.

During 1985, at 60 DAE in plant, the phosphorus uptake was significantly higher (2.52 kg/ha) under drip irrigation, as compared to furrow irrigation (1.25 kg/ha). At 80 DAE in

shoot, furrow irrigation recorded significantly lower (3.67 kg/ha) phosphorus uptake, as compared to drip irrigation (6.08 kg/ha).

#### 4.1.6.5 Potassium content :

The data on potassium content of watermelon, as influenced by nitrogen, spacing and method of irrigation are presented in Table 4.21.

Effect of nitrogen : Nitrogen fertilization had significant influence on potassium content, only at 60 DAE in plant during 1984 and at 80 DAE in fruit, during both the years, although potassium content increased with the increase in nitrogen levels, during both the years.

During 1984, at 60 DAE, potassium content in plant significantly increased from 1.87 per cent with 60 kg nitrogen per ha to 2.05 per cent with 120 kg nitrogen per ha and the difference between 120 kg and 180 kg nitrogen per ha was not statistically significant. Similar trend was observed in fruit at 80 DAE.

During 1985, at 80 DAE, it increased significantly in fruit, from 2.62 per cent with 60 kg nitrogen per ha to 3.46 per cent with 180 kg nitrogen per ha and the variations between 60 and 120, as well as between 120 and 180 kg nitrogen per ha, were not statistically significant.

Effect of spacing : Statistically significant differences in potassium content, due to row spacing were recorded at 60 DAE during 1984 and at 40 DAE during 1985.

**Table 4.21** Potassium content of watermelon as influenced by nitrogen, spacing and method of irrigation

Treatments	Potassium content (Per cent)								
	40 DAE		60 DAE		80 DAE		1985		
	1984	1985	1984	1985	1984	1985	Shoot	Fruit	
<u>Nitrogen, kg/ha</u>									
60	3.31	3.22	1.87	1.76	0.61	2.79	0.52	2.62	
120	3.70	3.52	2.05	1.88	0.63	3.13	0.52	2.97	
180	3.76	3.62	2.06	1.93	0.64	3.61	0.54	3.46	
'F'test	NS	NS	Sig	NS	NS	Sig	NS	Sig	
S.E.m+	0.17	0.15	0.05	0.06	0.08	0.17	0.07	0.17	
C.D. at 5%	-	-	0.14	-	-	0.49	-	0.51	
<u>Spacing, cm</u>									
300 x 60	3.81	3.68	2.08	1.90	0.65	3.25	0.54	3.04	
200 x 60	3.43	3.24	1.94	1.81	0.62	3.27	0.50	3.00	
'F'test	NS	Sig	Sig	NS	NS	NS	NS	NS	
<u>Method of Irrigation</u>									
Drip	3.82	3.65	2.12	1.99	0.69	3.42	0.56	3.26	
Furrow	3.42	3.27	1.87	1.72	0.56	2.94	0.48	2.78	
'F'test	NS	Sig	Sig	Sig	NS	Sig	NS	Sig	
S.E.m+	0.14	0.12	0.04	0.04	0.09	0.14	0.05	0.14	
C.D. at 5%	-	0.35	0.11	0.13	-	0.40	-	0.42	

During 1984, at 40 DAE, the potassium content in plant was significantly lower (3.24%) with closer row spacing of 200 cm, as compared to wider row spacing of 300 cm (3.68%).

During 1985, at 60 DAE in plant, closer row spacing had significantly lower (3.24%) potassium content, as compared to wider row spacing (3.68%).

Method of irrigation : Method of irrigation had significant influence on potassium content, during both the years except, at 40 DAE during 1984 and 80 DAE in shoot, during both the years.

During 1984, at 60 DAE in plant, drip irrigation recorded significantly higher potassium content (2.12%), as compared to furrow irrigation (1.87%). At 80 DAE, in fruit, the potassium content was significantly higher (3.42%) under drip irrigation, as compared to furrow irrigation (2.94%).

During 1985, at 40 DAE in plant, drip irrigation recorded significantly higher potassium content (3.65%), as compared to furrow irrigation (3.27%). Similar trend was observed at 60 DAE and at 80 DAE in fruit.

#### 4.1.6.6 Potassium uptake :

The data on potassium uptake of watermelon, as influenced by nitrogen, spacing and method of irrigation are presented in Table 4.22.

Effect of nitrogen : Nitrogen had statistically significant influence on the potassium uptake, only at 40 DAE in plant, during 1985 and 80 DAE in fruit, during both the years. It increased with the nitrogen levels during both the years.

**Table 4.22** Potassium uptake of watermelon as influenced by nitrogen, spacing and method of irrigation

Treatments	40 DAE			60 DAE			80 DAE			
	1984	1985	1984	1985	1984	1985	1984	1985	Total uptake	
<u>Nitrogen, kg/ha</u>										
60	9.10	7.04	15.95	13.19	16.61	63.20	79.81	13.34	53.34	66.68
120	11.30	9.43	19.56	16.06	20.75	63.59	84.34	13.49	53.47	66.96
180	12.23	10.26	22.42	18.22	20.93	87.35	108.28	18.68	76.51	95.19
'F' test	NS	Sig	NS	NS	NS	Sig	NS	NS	Sig	Sig
S.E.m <sub>±</sub>	1.56	0.78	1.72	1.61	2.84	6.61	9.91	2.31	5.98	9.17
C.D. at 5%	-	2.30	-	-	-	19.38	-	-	17.52	26.59
<u>Spacing, cm</u>										
300 x 60	7.14	6.21	15.90	13.45	17.84	61.83	79.67	12.04	49.52	61.56
200 x 60	14.62	11.61	22.72	18.20	21.01	84.27	105.28	18.30	72.69	90.99
'F' test	Sig	Sig	Sig	Sig	NS	Sig	NS	Sig	Sig	Sig
<u>Method of Irrigation</u>										
Drip	12.14	9.24	23.18	17.74	19.55	77.50	97.05	16.66	65.72	82.38
Furrow	9.62	8.58	15.45	13.91	19.31	68.60	87.91	13.68	56.49	70.17
'F' test	NS	NS	Sig	Sig	NS	NS	NS	NS	NS	NS
S.E.m <sub>±</sub>	1.27	0.64	1.40	1.31	2.32	5.39	8.90	1.89	4.88	8.86
C.D. at 5%	3.73	1.88	4.11	3.85	-	15.82	-	5.48	14.31	25.69

During 1984, at 80 DAE, the fruit potassium uptake was significantly higher (87.35 kg/ha) with 180 kg nitrogen per ha, as compared to 60 kg (63.20 kg/ha) and 120 kg nitrogen per ha (63.59 kg/ha), which were on par.

During 1985, at 40 DAE in plant, it was significantly higher (10.26 kg/ha) with 180 kg nitrogen per ha, as compared to 60 kg nitrogen per ha (7.04 kg/ha). The difference between 120 (9.43 kg/ha) and 180 kg nitrogen per ha was not statistically significant. At 80 DAE, the potassium uptake in fruit was significantly highest (76.51 kg/ha) with 180 kg nitrogen per ha, as compared to 60 kg (53.34 kg/ha) and 120 kg nitrogen per ha (53.47 kg/ha).

Effect of spacing : Closer row spacing of 200 cm recorded higher potassium uptake, as compared to wider row spacing of 300 cm, at all the stages during both the years. Row spacing had statistically significant influence on potassium uptake during both the years, except at 80 DAE, during 1984, in shoot and fruit.

During 1984, at 40 DAE, potassium uptake in plant was significantly higher (14.62 kg/ha), with closer row spacing, as compared to wider row spacing (7.14 kg/ha). At 60 DAE in plant, closer row spacing recorded significantly higher (22.72) potassium uptake, as compared to wider row spacing (15.90 kg/ha). Similar trend was observed at 80 DAE in fruit.

During 1985, at 40 DAE in plant, it was significantly higher (11.61 kg/ha), with closer row spacing of 200 cm, as compared to wider row spacing of 300 cm (6.21 kg/ha). Similar trend was observed at 60 DAE and 80 DAE.

Method of irrigation : Method of irrigation had significant influence on potassium uptake in plant, only at 60 DAE. At this stage, drip irrigation recorded significantly higher (23.18 and 17.74 kg/ha during 1984 and 1985 respectively) potassium uptake, than furrow irrigation (15.45 and 13.91 kg/ha during 1984 and 1985, respectively).

#### 4.1.6.7 Calcium content :

The data on calcium content of watermelon, as influenced by nitrogen, spacing and method of irrigation are presented in Table 4.23.

Effect of nitrogen : Calcium content did not increase significantly, due to nitrogen levels, during both the years. However, calcium content increased with increase in the levels of nitrogen, at all the stages, during both the years.

Effect of spacing : Closer row spacing of 200 cm recorded lower content of calcium, at all the growth stages during both the years. Statistically significant influence of row spacing on calcium content was observed, at 80 DAE in shoot, during both the years. During 1984, calcium content in shoot was 4.65 per cent with 300 cm row spacing and 4.02 per cent with 200 cm row spacing. During 1985, it was 4.34 per cent in shoot, with 300 cm row spacing and 3.78 per cent with 200 cm row spacing.

Method of irrigation : Method of irrigation had statistically significant influence on calcium content in plant, only at 40 DAE, during both the years and at 80 DAE in shoot, during

**Table 4.23** Calcium content of watermelon as influenced by nitrogen, spacing and method of irrigation

Treatments	Calcium content (Per cent)					
	40 DAE		60 DAE		80 DAE	
	1984	1985	1984	1985	1984	1985
			Shoot	Fruit	Shoot	Fruit
<u>Nitrogen, kg/ha</u>						
60	3.10	3.00	3.89	3.62	4.11	0.29
						3.95
120	3.29	3.15	3.98	3.68	4.29	0.30
						4.07
180	3.49	3.24	4.12	3.93	4.60	0.32
						4.15
'F' test	NS	NS	NS	NS	NS	NS
S.E.m <sub>t</sub>	0.20	0.16	0.15	0.13	0.19	0.01
C.D. at 5%	-	-	-	-	-	-
<u>Spacing, cm</u>						
300 x 60	3.35	3.14	4.03	3.80	4.65	0.31
						4.34
200 x 60	3.24	3.12	3.97	3.69	4.02	0.30
						3.78
'F' test	NS	NS	NS	NS	Sig	NS
<u>Method of Irrigation</u>						
Drip	3.54	3.35	4.03	3.82	4.52	0.31
						4.23
Furrow	3.05	2.91	3.96	3.67	4.14	0.30
						3.88
'F' test	Sig	Sig	NS	NS	NS	NS
S.E.m <sub>t</sub>	0.16	0.13	0.12	0.11	0.16	0.01
C.D. at 5%	0.47	0.38	-	-	0.46	-
						0.33

1984. During 1984, at 40 DAE, the calcium content in plant was 3.54 per cent in 1984 and 3.35 per cent in 1985 under drip irrigation, as compared to 3.05 per cent in 1984 and 2.91 per cent in 1985, under furrow irrigation, respectively.

#### 4.1.6.8 Calcium uptake :

The data on calcium uptake of watermelon, as influenced by nitrogen, spacing and method of irrigation are presented in Table 4.24.

Effect of nitrogen : Calcium uptake increased with the increase in nitrogen, at all the growth stages, during both the years. Statistically - significant influence on calcium uptake due to nitrogen was observed, only at 80 DAE in shoot and total uptake, during both the years.

During 1984, at 80 DAE, total calcium uptake was significantly highest (158.57 kg/ha) with 180 kg nitrogen per ha, as compared to 60 (114.40 kg/ha) kg nitrogen per ha and the difference between 120 (142.36 kg/ha) and 180 kg nitrogen per ha was not statistically significant. Similar trend was observed in calcium uptake of shoot.

During 1985, it increased significantly from 105.54 kg per ha with 60 kg nitrogen to 141.26 kg per ha with 180 kg nitrogen per ha and the differences between 60 kg and 120 kg, as well as 120 kg and 180 kg nitrogen per ha, were not statistically significant. The calcium uptake in shoot was significantly highest (134.69 kg/ha), with 180 kg nitrogen per ha, as compared to 60 kg nitrogen per ha (100.54 kg/ha)

**Table 4.24** Calcium uptake of watermelon as influenced by nitrogen, spacing and method of irrigation

Treatments	Calcium uptake (kg/ha)						80 DAE		Total uptake
	40 DAE		60 DAE		1984		1985		
	1984	1985	1984	1985	Shoot	Fruit	Shoot	Fruit	Total uptake
<u>Nitrogen, kg/ha</u>									
60	7.85	6.28	33.03	30.43	107.78	6.62	100.54	5.00	105.54
120	9.81	8.18	44.80	34.03	135.63	6.73	107.74	5.79	113.53
180	10.62	8.44	40.07	37.60	150.51	8.06	134.69	6.57	141.26
'F' test	NS	NS	NS	NS	Sig	NS	Sig	NS	Sig
S.E.m <sub>±</sub>	1.28	0.67	3.83	4.61	7.54	0.62	9.47	0.64	10.08
C.D. at 5%	-	-	-	-	22.12	-	27.76	-	29.23
<u>Spacing, cm</u>									
300 x 60	6.61	6.00	38.01	32.70	130.65	6.34	100.12	4.60	104.72
200 x 60	12.24	9.28	43.93	35.33	131.97	7.94	128.62	6.98	135.60
'F' test	Sig	Sig	NS	NS	NS	Sig	Sig	Sig	Sig
<u>Method of Irrigation</u>									
Drip	9.44	8.28	46.72	34.43	136.38	7.21	121.91	5.83	127.74
Furrow	9.41	7.00	35.21	33.60	126.24	7.07	106.73	5.74	112.47
'F' test	NS	NS	Sig	NS	NS	NS	NS	NS	NS
S.E.m <sub>±</sub>	1.04	0.55	3.13	3.76	6.16	0.51	7.73	0.52	7.85
C.D. at 5%	3.06	1.62	9.17	-	-	1.50	22.67	1.54	22.76

and the difference between 60 kg and 120 kg (107.74 kg/ha) as well as 120 kg and 180 kg nitrogen per ha were not statistically significant.

Effect of spacing : Closer row spacing of 200 cm recorded higher calcium uptake, at all the stages, during both the years. Row spacing had statistically significant influence on calcium uptake, during both the years, except at 60 DAE in plant, during both the years and at 80 DAE in total uptake and shoot during 1984.

During 1984, at 40 DAE, the calcium uptake in plant with closer row spacing of 200 cm was 12.24 kg per ha, as compared to 6.61 kg per ha with wider row spacing of 300 cm. At 80 DAE in fruit, similar trend was observed.

During 1985, at 40 DAE, calcium uptake in plant was significantly higher (9.28 kg/ha) with 200 cm row spacing, as compared to 300 cm row spacing (6.00 kg/ha). At 80 DAE, the total calcium uptake was significantly higher (135.60 kg/ha) with closer row spacing, as compared to wider row spacing (104.72 kg/ha). Similar trend was observed in shoot and calcium uptake in fruit.

Method of irrigation : In general, drip irrigation recorded higher calcium uptake, as compared to furrow irrigation, during both the years. Method of irrigation had significant influence on calcium uptake, only at 60 DAE in plant, during 1984. At this stage, drip irrigation recorded significantly higher (46.72 kg/ha) calcium uptake, as compared to furrow irrigation (35.21 kg/ha).

#### 4.1.6.9 Magnesium content :

The data on magnesium content in watermelon, as influenced by nitrogen, spacing and method of irrigation are presented in Table 4.25.

Effect of nitrogen : Increase in nitrogen levels did not result in significant increase in magnesium content, during both the years. However, slight increase in magnesium content was observed, due to nitrogen application.

Effect of spacing : Row spacing did not influence the magnesium content, during both the years, except at 80 DAE in shoot during 1984. At this stage, wider row spacing of 300 cm, recorded higher (10.09 %) magnesium content than closer row spacing of 200 cm (0.99%).

Method of irrigation : Magnesium content was not influenced by method of irrigation, at any of the growth stages, during both the years, except at 60 DAE in plant, during 1984. At this stage, it was significantly higher with drip irrigation (1.06%), as compared to furrow irrigation (0.39%).

#### 4.1.6.10 Magnesium uptake :

The data on magnesium uptake of watermelon, as influenced by nitrogen, spacing and method of irrigation are presented in Table 4.26.

Effect of nitrogen : Magnesium uptake increased with the application of nitrogen, at all the stages, during both the years. Nitrogen fertilization had statistically significant

**Table 4.25** Magnesium content of watermelon as influenced by nitrogen, spacing and method of irrigation

Treatments	Magnesium content (Per cent)								
	40 DAE		60 DAE		80 DAE		1985		
	1984	1985	1984	1985	1984	1985	Shoot	Fruit	
<u>Nitrogen, kg/ha</u>									
60	0.91	0.82	0.98	0.89	1.02	0.43	0.95	0.41	
120	0.93	0.84	0.98	0.89	1.03	0.46	0.96	0.42	
180	0.94	0.87	1.01	0.95	1.08	0.47	1.00	0.43	
'F'test	NS	NS	NS	NS	NS	NS	NS	NS	NS
S.E.m <sub>+</sub>	0.035	0.036	0.019	0.031	0.022	0.019	0.028	0.019	0.019
C.D. at 5%	-	-	-	-	-	-	-	-	-
<u>Spacing, cm</u>									
300 x 60	0.94	0.84	1.02	0.93	1.09	0.47	0.99	0.43	
200 x 60	0.91	0.85	0.98	0.88	0.99	0.44	0.96	0.42	
'F'test	NS	NS	NS	NS	Sig	NS	NS	NS	NS
<u>Method of Irrigation</u>									
Drip	0.93	0.85	1.06	0.94	1.06	0.47	0.97	0.43	
Furrow	0.92	0.84	0.93	0.88	1.02	0.44	0.97	0.42	
'F'test	NS	NS	Sig	NS	NS	NS	NS	NS	NS
S.E.m <sub>+</sub>	0.028	0.029	0.023	0.025	0.018	0.023	0.015	0.019	0.019
C.D. at 5%	-	-	0.067	-	0.052	-	-	-	-

influence on magnesium uptake, only at 60 DAE in plant, during 1984 and at 80 DAE in shoot, during both the years and at 40 DAE, during 1985.

During 1984, at 60 DAE in plant, it increased significantly (10.77 kg/ha) with 180 kg nitrogen per ha, as compared to 60 kg nitrogen per ha (8.22 kg/ha) and the differences between 60 kg and 120 kg, as well as 120 kg and 180 kg nitrogen per ha were not statistically significant. At 80 DAE, the total magnesium uptake was significantly highest (45.95 kg/ha), with 180 kg nitrogen per ha, as compared to 60 kg nitrogen per ha (37.20 kg/ha), but was on par with 120 kg nitrogen per ha (43.82 kg/ha). The difference between 60 kg and 120 kg nitrogen per ha, was also statistically significant. The shoot calcium uptake followed a trend similar to that of total calcium uptake.

During 1985, at 40 DAE, magnesium uptake in plant increased significantly from 1.62 kg per ha, with 60 kg nitrogen per ha to 2.34 kg per ha, with 120 kg nitrogen per ha and the difference between 120 and 180 kg (2.44 kg/ha) nitrogen per ha, was not statistically significant. At 80 DAE, the total magnesium uptake was significantly highest (42.91 kg/ha), as compared to both 60 kg (32.14 kg/ha) and 120 kg nitrogen per ha (33.53 kg/ha). The difference between 60 kg and 120 kg nitrogen per ha, was not statistically significant. The magnesium uptake in shoot followed a similar trend.

**Table 4.26 Magnesium uptake of watermelon as influenced by nitrogen, spacing and method of irrigation**

Treatments	Magnesium uptake (kg/ha)										Total uptake										
	40 DAE			60 DAE			80 DAE														
	1984	1985	1984	1985	1984	1985	Shoot	Fruit	Total	Shoot		Fruit									
<u>Nitrogen, kg/ha</u>																					
60	2.19	1.62	8.22	6.79	27.48	9.72	37.20	24.37	7.77	32.14											
120	2.98	2.34	8.99	7.17	33.34	10.49	43.82	24.99	8.54	33.53											
180	2.99	2.44	10.77	8.58	34.59	11.36	45.95	33.52	9.39	42.91											
'F'test	NS	Sig	Sig	NS	Sig	NS	Sig	Sig	NS	Sig	NS	Sig	Sig	NS	Sig						
S.E.m+	0.37	0.18	0.68	0.65	1.43	0.80	2.35	2.11	0.92	2.97											
C.D. at 5%	-	0.52	1.97	-	4.19	-	6.80	6.18	-	8.61											
<u>Spacing, cm</u>																					
300 x 60	1.93	1.60	8.34	6.80	30.80	9.68	40.48	22.79	7.23	30.02											
200 x 60	3.50	2.67	10.32	8.23	32.81	11.36	44.17	32.46	9.90	42.36											
'F'test	Sig	Sig	Sig	NS	NS	NS	NS	Sig	Sig	Sig	NS	Sig	Sig	Sig							
<u>Method of Irrigation</u>																					
Drip	2.84	2.15	10.17	7.93	33.62	10.81	44.33	28.36	8.36	36.72											
Furrow	2.59	2.12	8.48	7.10	29.99	10.24	40.23	26.90	8.77	35.67											
'F'test	NS	NS	Sig	NS	Sig	NS	NS	NS	NS	NS	NS	NS	NS	NS							
S.E.m+	0.30	0.14	0.55	0.55	1.17	0.65	1.98	1.72	0.75	2.10											
C.D. at 5%	0.89	0.42	1.62	1.55	3.42	-	-	5.05	2.19	6.09											

Effect of spacing : Significant differences in magnesium uptake, were recorded, due to the influence of row spacing during both the years, except at 80 DAE, during 1984 and at 60 DAE in plant, during 1985. During 1984, at 40 DAE in plant, closer row spacing of 200 cm recorded significantly higher uptake of magnesium (3.50 kg/ha), as compared to wider row spacing of 300 cm (1.93 kg/ha). Similar trend was observed at other stages also.

During 1985, closer row spacing of 200 cm recorded significantly higher (2.67 kg/ha) magnesium uptake, as compared to, wider row spacing of 300 cm (1.60 kg/ha). Similar trend was observed at 80 DAE.

Method of irrigation : Method of irrigation had significant influence on magnesium uptake in plant, only at 60 DAE and at 80 DAE in shoot, during 1984, though drip irrigation recorded higher uptake of magnesium, at all the stages, during both the years.

At 60 DAE in plant, drip irrigation recorded significantly higher magnesium uptake (10.17 kg/ha), as compared to furrow irrigation (8.48 kg/ha). Likewise, at 80 DAE, drip irrigation resulted in significantly higher magnesium uptake (33.62 kg/ha), as compared to furrow irrigation (29.99 kg/ha).

#### 4.1.7 Correlation studies :

The data on correlations between yield and other characters are presented in Table 4.27.

During 1984, significant and positive correlations were obtained, between yield and rind thickness and calcium content.

During 1985, significant and positive correlations were obtained, between yield and vine length, leaf area index and number of fruits per ha.

#### Response equations :

Response equations fitted to the yield data indicated a quadratic response which are presented in the following table.A (page 136).

From the response equations, the optimum nitrogen requirement was found to be 121 kg nitrogen per ha, in 1984 and 141 kg nitrogen per ha, in 1985 and the corresponding optimum yields at these levels were 379.4 q per ha and 349.3 q per ha respectively. The nitrogen use efficiency was 313.9 and 247.9 kg fruit per kg nitrogen, during 1984 and 1985 respectively.

#### 4.1.8 Water-use :

The data on water-use in watermelon under drip and furrow irrigation are presented below.

Method of irrigation	Total water used including rainfall, mm	
	1984	1985
Drip : 0.50 PER	352.25	377.30
Furrow : 0.50 IW/CPE with 5.0 cm depth of irrigation	408.78	408.90

**Table 4.27** Correlation between fruit yield of watermelon with other characters.

Parameters	'r' Values	
	1984	1985
Fruit yield with		
1. Vine length	0.5263	0.6134*
2. Leaf area index	0.3969	0.7330*
3. Number of fruits per ha	0.5708	0.7790*
4. Average fruit weight	0.4779	0.3992
5. Flesh thickness	0.3105	0.2006
6. Rind thickness	0.6171*	0.4867
7. Total soluble solids	0.0129	0.0747
8. Nitrogen content in plant	0.4327	0.2043
9. Phosphorus content in plant	0.5619	0.5106
10. Potassium content in plant	0.1154	0.0650
11. Calcium content in plant	0.6379*	0.5582
12. Magnesium content in plant	0.1649	0.0103

\* Significant at 5% level

**Table. A. Fitted response functions of watermelon to nitrogen**

Year	Response equation	R <sup>2</sup>	Optimum nitrogen kg/ha.	Yield at optimum nitrogen, q/ha	Nitrogen use efficiency, kg fruits/kg N
1984	Y = 270.63 + 1.698 N - 0.0066 N <sup>2</sup>	1.00	120.89	379.44	313.90
1985	Y = 235.65 + 1.511 N - 0.005 N <sup>2</sup>	1.00	140.88	349.28	247.90

Cost of unit fertilizer (Urea) : Rs. 5.11

Cost of produce (Watermelon) : Rs. 50 per quintal.

Thus, the water use under furrow irrigation was higher by 16 per cent in 1984 and 8 per in 1985.

#### 4.1.9 Economics of drip irrigation :

The details of the cost of laying out the drip irrigation system along with the cost and returns of drip and furrow irrigation are presented in Table 4.28. and 4.28a.

The cost of drip irrigation unit per hectare worked out to be Rs.22,960/-. The total cost under drip irrigation includes, the cost of cultivation, interest on capital invested at 12 per cent per annum and depreciation.

The economics of drip and furrow irrigation under different levels of spacing are presented in table 4.28 a.

**Table 4.28a** Economics of drip and furrow irrigation under different levels of spacing.

Particulars	Drip irrigation		Furrow irrigation	
	200 cm	300 cm	200 cm	300 cm
1. Yield, q/ha	390.07	362.83	336.36	303.42
2. Gross returns, Rs/ha	19,503	18,141	16,818	15,171
3. Cost of cultivation, Rs/ha	3201	3125	3354	3278
4. * Total costs, Rs/ha	5506	4808	3354	3278
5. Gross profit Rs/ha	13,997	13,333	13,464	11,893
6. Benefit cost ratio	2.54	2.77	4.01	3.63

price of the produce : Rs.50/

\* Total cost includes depreciation charges and interest on capital invested at 12%.

**Table 4.28** Details of the economics of drip irrigation for watermelon

Cost of layout of drip irrigation per ha of watermelon				
Materials	Quantity	Cost/Unit Rs.	Total cost Rs.	
1. Main line (50 mm)	150 m	12/m	1,800	
2. Sub main (25 mm)	200 m	8/m	1,600	
3. Laterals (12 mm)	3,600 m	1.6/m	5,760	
4. Filter	one	1000/00	1,000	
5. Emitters (Numbers)	11,300	1.0/emitter	11,300	
6. T's, Saddles and other accessories			1,500	
			-----	
			22,960	
			-----	

The total cost under drip irrigation with 200 cm row spacing was Rs.5506 and with 300 cm spacing, it was Rs.4808, as compared to Rs.3354 and Rs.3278 with 200 cm and 300 cm row spacing respectively, under furrow irrigation. The gross profit with 200 cm row spacing was higher, under both the drip (Rs.13,997) and furrow (13,464) irrigation, as compared to 300 cm row spacing (Rs.13,333 under drip and Rs.11,893 under furrow irrigation). The benefit-cost ratio was higher under furrow irrigation (4.01 with 200 cm row spacing and 3.63 with 300 cm row spacing), as compared to drip irrigation (2.54 with 200 cm row spacing and 2.77 with 300 cm row spacing). The benefit cost ratio was low under drip irrigation, mainly due to higher initial cost involved.

#### 4.2. Experiment II : Studies on comparative efficiency of drip and furrow irrigation systems in watermelon.

##### 4.2.1. Growth and growth components :

##### 4.2.1.1 Vine length :

The data on vine length of watermelon, as influenced by IW/CPE ratio and method of irrigation are presented in Table 4.29.

IW/CPE ratio : Statistically significant differences in vine length due to IW/CPE ratio were observed at all the growth stages, except at 20 DAE during both the years.

**Table 4.29** Vine length of watermelon as influenced by IW/CPE ratio and method of irrigation

Treatments	20 DAE		40 DAE		60 DAE		80 DAE	
	1984	1985	1984	1985	1984	1985	1984	1985
0.25	11.9	11.0	150.5	137.0	258.3	232.5	297.7	277.3
0.50	12.1	11.3	175.6	139.6	275.5	267.9	301.4	280.9
0.75	12.4	11.6	178.4	166.6	286.2	268.4	330.6	316.8
1.00	12.8	12.3	189.3	170.8	317.5	292.8	335.2	323.0
'F' test	NS	NS	Sig	Sig	Sig	Sig	Sig	Sig
<u>Method of irrigation</u>								
Drip :								
1 emitter/plant	12.3	11.6	163.3	150.7	298.7	270.3	314.8	289.5
1 emitter/2 plants	12.6	11.7	180.2	171.7	308.9	282.7	353.9	327.5
Furrow :								
2.5 cm depth	12.3	11.6	170.0	151.7	296.4	281.2	309.6	296.4
5.0 cm depth	12.1	11.4	151.6	134.0	242.5	227.3	286.4	284.7
'F' test	NS	NS	Sig	Sig	Sig	Sig	Sig	Sig
S.E.m ±	0.42	0.39	5.23	5.16	14.7	15.9	12.6	11.1
C.D. at 5%	-	-	15.12	14.90	42.6	45.8	36.3	32.1
Sig. Significant. NS. Not Significant.								

During 1984, at 40 DAE, vine length was significantly higher with irrigation at 1.00 IW/CPE ratio (189.3 cm), as compared to irrigation at 0.25 IW/CPE ratio (150.5cm). The differences between 0.50 and 0.75, as well as between 0.75 and 1.00 IW//CPE ratios were not statistically significant. At 60 and 80 DAE, similar trend was observed.

During 1985, at 40 DAE, the vine length variations between irrigation at 0.25 and 0.50 and between 0.75 and 1.00 IW/CPE ratios were not statistically significant. However, irrigation at 0.25 and 0.50 IW/CPE ratios recorded significantly lower vine length, as compared to irrigation at 0.75 and 1.00 IW/CPE ratios. At 60 DAE, vine length was significantly higher with irrigation at 1.00 IW/CPE ratio (292.8cm), as compared to irrigation at 0.25 IW/CPE ratio (232.5 cm). The differences among 0.25, 0.50 and 0.75 IW/CPE ratios were not statistically significant. At 80 DAE, irrigation at 1.00 IW/CPE ratio recorded significantly higher (323.0 cm ) vine length, as compared to 0.25 (277.3 cm) and 0.50 (280.9 cm) IW/CPE ratios. The vine length at 0.75 (316.8 cm) and 1.00 IW/CPE ratios were on par.

Method of irrigation : Statistically significant differences in vine length were recorded, due to method of irrigation, at all the growth stages, during both the years, except at 20 DAE in both the years.

During 1984 at 40 DAE, drip irrigation with one emitter per two plants recorded significantly higher vine

**Table 4.30** Interaction effect of IW/CPE ratio and method of irrigation, on vine length of watermelon (80 DAE)

IW/CPE ratio	Vine length (cm)		
	Drip irrigation one emitter per plant	2.5 cm depth one emitter per two plant	Furrow irrigation 5.0 cm depth
0.25	272.3	351.3	331.3
0.50	309.6	372.3	285.7
0.75	325.0	372.0	348.0
1.00	360.2	348.1	344.0

'F' test Sig

S.E.m ± 25.2

C.Dat 5% 72.7

length (180.2 cm), as compared to 5.0 cm depth under furrow irrigation (151.6 cm), but was on par with one emitter per plant under drip irrigation (163.3 cm) and 2.5 cm depth under furrow irrigation (170.0 cm). At 60 DAE, furrow irrigation with 5.0 cm depth recorded significantly lowest (242.5 cm), vine length as compared to all other treatments which were on par. At 80 DAE, similar trend was observed.

During 1985 at 40 DAE, drip irrigation with one emitter per two plants recorded significantly higher vine length (171.7 cm) as compared to 5.0 cm depth under furrow irrigation (134.0 cm). The differences within two drip and within two furrow irrigations were also statistically significant.

The interaction effect of IW/CPE ratio and method of irrigation was statistically significant during 1984, at 80 DAE (Table 4.30). The vine length was highest (372.3 cm) with irrigation at 0.50 IW/CPE ratio, under drip irrigation, with one emitter per two plants and was lowest (223.3 cm) with irrigation at 0.50 IW/CPE ratio under furrow irrigation, with 5.0 cm depth. This was on par with irrigation at 0.25 IW/CPE ratio (249.3 cm) and 1.00 IW/CPE (270.0 cm) ratio with 5.0 cm depth under furrow irrigation and 0.25 IW/CPE ratio (272.3 cm) with one emitter per plant under drip irrigation.

#### 4.2.1.2 Vine girth :

The data on vine girth of watermelon as influenced by IW/CPE ratio and method of irrigation are presented in Table 4.31

**Table 4.31** Vine girth of watermelon as influenced by IW/CPE ratio and method of irrigation

Treatments	40 DAE		Vine girth (cm)		80 DAE		
	1984	1985	60 DAE	1984	1985	1984	1985
<u>IW/CPE ratio</u>							
0.25	1.42	1.41	1.99	1.86	2.15	2.07	
0.50	1.45	1.43	2.12	2.03	2.19	2.08	
0.75	1.51	2.02	2.21	2.07	2.22	2.19	
1.00	1.60	2.04	2.24	2.20	2.28	2.23	
'F' test	NS	Sig	Sig	Sig	NS	Sig	Sig
<u>Method of irrigation</u>							
Drip :							
1 emitter/plant	1.49	1.40	2.16	2.07	2.22	2.04	
1 emitter/2 plants	1.52	1.45	2.20	2.14	2.35	2.23	
Furrow :							
2.5 cm depth	1.51	1.45	2.15	2.00	2.16	2.10	
5.0 cm depth	1.45	1.40	2.10	2.10	2.12	2.06	
'F' test	NS	NS	NS	NS	Sig	Sig	Sig
S.E.m ±	0.06	0.07	0.06	0.07	0.05	0.04	
C.D. at 5%	-	0.21	0.17	0.20	0.14	0.11	

IW/CPE ratio : Statistically significant variations in vine girth were recorded at 60 DAE in both the years and at 40 and at 80 DAE during 1985.

During 1984 at 60 DAE, vine girth was significantly higher (2.24 cm) with irrigation at 1.00 IW/CPE ratio, as compared to irrigation at 0.25 IW/CPE ratio (1.99 cm), but was on par with irrigation at 0.50 (2.12 cm) and 0.75 (2.21 cm), IW/CPE ratios.

During 1985 at 40 DAE, the vine girth was significantly lower (1.86 cm) with irrigation at 0.25 IW/CPE ratio, as compared to irrigation at 0.75 (2.07 cm) and 1.00 (2.20 cm) IW/CPE ratios, but was on par with irrigation at 0.50 IW/CPE ratio (2.03 cm). Similar trend was observed at 60 and at 80 DAE.

Method of irrigation : Vine girth was more under drip irrigation, as compared to furrow irrigation, at all the stages. However, the variations were statistically significant only at 80 DAE during both the years. At this stage, during 1984, furrow irrigation with 5.0 cm depth recorded significantly lower (2.12 cm) vine girth, as compared to one emitter per two plants under drip irrigation (2.35 cm), but was on par with 2.5 cm depth (2.16 cm), under drip irrigation. Similar trend was observed during 1985.

#### 4.2.1.3 Number of leaves per plant :

The data on the number of leaves in watermelon, as influenced by IW/CPE ratio and method of irrigation are presented in Table 4.32.

**Table 4.32** Number of leaves per plant of watermelon as influenced by IW/CPE ratio and method of irrigation

Treatments	20 DAE		40 DAE		60 DAE		80 DAE	
	1984	1985	1984	1985	1984	1985	1984	1985
0.25	3.7	3.6	32.5	29.7	97.5	89.2	44.6	38.1
0.50	4.1	3.8	34.8	30.6	117.9	104.2	54.3	44.9
0.75	4.4	3.8	42.1	35.7	120.5	112.3	78.6	62.3
1.00	5.1	4.2	45.5	39.2	130.0	119.8	80.3	64.8
'F' test	Sig	NS	Sig	Sig	NS	Sig	Sig	Sig
<u>Method of irrigation</u>								
Drip :								
1 emitter/plant	4.3	3.9	41.5	36.4	123.7	112.7	65.8	51.0
1 emitter/2 plants	4.6	4.0	42.9	37.3	126.7	114.9	75.9	65.2
Furrow :								
2.5 cm depth	4.5	3.7	37.0	31.8	121.7	109.6	58.8	47.8
5.0 cm depth	3.9	3.8	33.0	29.7	94.7	88.6	57.4	46.1
'F' test	NS	NS	Sig	Sig	NS	Sig	NS	NS
S.E.m ±	0.31	0.27	1.66	1.27	10.06	7.98	6.35	5.26
C.D. at 5%	0.89	-	4.80	3.68	-	23.04	18.33	15.19

IW/CPE ratio : Statistically significant differences in number of leaves, as influenced by IW/CPE ratios were observed at all the stages, except 60 DAE during 1985.

During 1984 at 20 DAE, the number of leaves was significantly lower (3.7) with irrigation at 0.25 IW/CPE ratio, as compared to irrigation at 1.00 IW/CPE ratio (5.1), but was on par with irrigation at 0.50 (4.1) and 0.75 (4.4) IW/CPE ratios . At 40 DAE, the number of leaves was significantly lower (32.5) with irrigation at 0.25 IW/CPE ratio, as compared to irrigation at 0.75 (42.1) and 1.00 (45.5) IW/CPE ratio, but was on par with irrigation at 0.50 (34.8) IW/CPE ratio. At 80 DAE, similar trend was observed.

During 1985 at 40 DAE, number of leaves was significantly lower (29.7) with irrigation at 0.25 IW/CPE ratio, as compared to irrigation at 0.75 (35.7) and 1.00 (39.2) IW/CPE ratio, but was on par with irrigation at 0.50 (30.6) IW/CPE ratio. At 60 DAE and 80 DAE, similar trend was observed.

Method of irrigation : During 1984 at 40 DAE, the number of leaves was significantly higher (42.9) with one emitter per two plants under drip irrigation, as compared to 2.5 cm (37.0) and 5.0 cm (33.0) depths under furrow irrigation, but was on par with one emitter per plant (41.5) under drip irrigation.

During 1985 at 40 DAE, 5.0 cm depth under furrow irrigation recorded significantly lower number of leaves (29.7), as compared to one emitter per plant (36.4) and one

emitter per two plants (37.3) under drip irrigation, but was on par with 2.5 cm depth, under furrow irrigation (31.8). Similar trend was observed at 60 DAE.

#### 4.2.1.4 Number of male and female flowers, primary branches and node of first female flower occurrence.

The data on number of male and female flowers, primary branches and node of first female flower occurrence are presented in Table 4.33.

##### Number of male flowers

IW/CPE ratio : During 1984, the number of male flowers was significantly higher (59) with irrigation at 1.00 IW/CPE ratio as compared to irrigation at 0.25 IW/CPE ratio (49). The differences among 0.50, 0.75 and 1.00 IW/CPE ratios were not statistically significant.

During 1985, the number of male flowers was significantly lower (45) with irrigation at 0.25 IW/CPE ratio, as compared to irrigation at 0.50 (52), 0.75 (55) and 1.00 (58) IW/CPE ratios.

Method of irrigation : During 1984, the number of male flowers produced was significantly higher (58) with 5.0 cm depth under furrow irrigation, as compared to 2.5 cm depth (48) under furrow irrigation, but was on par with one emitter per plant (53) and one emitter per two plants (57), under drip irrigation. During 1985, similar trend was observed.

##### Number of female flowers:

IW/CPE ratio : During 1984, the number of female flowers

**Table 4.33** Number of male and female flowers, number of branches and node of first female flower occurrence of watermelon as influenced by IW/CPE ratio and method of irrigation

Treatments	Number of male flowers/plant 1984	Number of male flowers/plant 1985	Number of female flowers/plant 1984	Number of female flowers/plant 1985	Number of branches /plant 1984	Number of branches /plant 1985	Node of first female flower occurrence 1984	Node of first female flower occurrence 1985
<u>IW/CPE ratio</u>								
0.25	49	45	18	16	2.4	2.3	4.2	4.1
0.50	54	52	19	18	2.5	2.3	4.0	3.7
0.75	57	55	21	22	2.7	2.5	3.7	3.6
1.00	59	58	23	24	2.9	2.6	3.5	3.5
'F' test	Sig	Sig	Sig	Sig	Sig	NS	NS	NS
<u>Method of irrigation</u>								
Drip :								
1 emitter/plant	53	54	20	19	2.6	2.5	3.8	3.6
1 emitter/2 plants	57	55	21	22	2.8	2.6	3.6	3.4
Furrow :								
2.5 cm depth	48	49	21	22	2.4	2.4	3.9	3.7
5.0 cm depth	58	56	19	19	2.3	2.3	4.2	4.1
'F' test	Sig	Sig	NS	NS	Sig	NS	NS	Sig
S.E.m ±	2.08	2.05	1.18	1.16	0.11	0.12	0.17	0.15
C.D. at 5%	6.02	5.94	3.40	3.35	0.32	-	-	0.44

produced ratio, was significantly higher (23) with irrigation at 1.00 IW/CPE ratio, as compared to irrigation at 0.25 (18) and 0.50 IW/CPE ratio (19). The difference between irrigation at 0.75 (21) and 1.00 IW/CPE ratios were not statistically significant. Similar trend was observed during 1985.

Method of irrigation : The number of female flowers produced, as influenced by method of irrigation was not statistically significant, during both the years.

Number of branches:

IW/CPE ratio : During 1984, the number of branches were significantly higher (2.9) with irrigation at 1.00 IW/CPE ratio, as compared to irrigation at 0.25 (2.4) and 0.50 (2.5) IW/CPE ratio. The differences between irrigation at 0.75 and 1.00 IW/CPE was not statistically significant.

The variations in number of branches produced during 1985 were not statistically significant.

Method of irrigation : During 1984, the number of branches was significantly higher with one emitter per plant under drip irrigation (2.8), as compared to 5.0 cm depth under furrow irrigation (2.3). The differences among other treatments were not statistically significant. The differences in number of branches during 1985 were not statistically significant.

Node of first female flower occurrence :

IW/CPE ratio : Statistically significant differences were not

recorded, due to the influence of IW/CPE ratio on the node of first female flower occurrence, during both the years. However, the node at which the first female flower occurred, were reduced during both the years, with increase in the IW/CPE ratios.

Method of irrigation : Statistically significant differences in node of first female flower occurrence were recorded only during 1985. The node at which the first female flower occurred was significantly higher (4.1) with 5.0 cm depth, under furrow irrigation as compared to all other treatments.

#### 4.2.1.5 Dry matter production :

The data on dry matter production of watermelon, as influenced by IW/CPE ratio and method of irrigation are presented in Table 4.34.

IW/CPE ratio : Statistically significant differences in dry matter production, as influenced by IW/CPE ratio, were recorded only at 40 DAE in both the years, at 80 DAE in fruit and total dry matter during 1984 and 1985.

During 1984 at 40 DAE, the dry matter was significantly higher with irrigation at 0.75 (27.27 g/plant) and 1.00 (29.00 g/plant) IW/CPE ratio, as compared to irrigation at 0.25 (20.67 g/plant) and 0.50 IW/CPE ratio (20.68 g/plant). The differences between irrigation at 0.25 and 0.50 as well as that between 0.75 and 1.00 IW/CPE ratio, were not statistically significant. At 80 DAE, the total dry

TABLE 4.34 Dry matter production of watermelon as influenced by IW/CPE ratio and method of irrigation

Treatments	Dry matter production (g/plant)											
	20 DAE			40 DAE			60 DAE			80 DAE		
	1984	1985	1984	1985	1984	1985	1984	1985	1984	1985	Total	Total
0.25	0.95	0.84	20.67	18.41	99.77	82.19	235.84	176.76	412.60	206.66	136.51	343.17
0.50	1.04	0.93	20.68	19.79	104.22	85.00	235.85	185.99	421.84	222.19	144.32	366.51
0.75	1.06	0.96	27.27	24.13	105.88	85.43	244.34	191.54	435.88	231.60	155.78	387.38
1.00	1.09	0.97	29.00	25.15	119.51	87.73	257.68	209.88	467.56	232.33	163.57	395.90
'F' test	NS	NS	Sig	Sig	NS	NS	NS	Sig	Sig	NS	Sig	Sig
<u>Method of irrigation</u>												
Drip :												
1 emitter/plant	0.95	0.89	26.00	23.40	126.54	83.76	246.03	196.33	442.36	223.67	145.74	369.41
1 emitter/2 plants	1.44	0.95	28.26	26.60	128.38	98.37	275.58	210.50	486.08	252.47	169.16	421.63
Furrow :												
2.5 cm depth	1.07	0.96	22.85	19.30	125.05	83.76	239.92	180.97	420.89	230.49	143.26	373.75
5.0 cm depth	0.97	0.91	20.45	16.20	90.40	74.88	227.83	176.37	404.20	185.61	142.03	327.64
'F' test	Sig	NS	Sig	Sig	Sig	NS	Sig	Sig	Sig	Sig	Sig	Sig
S.E.m ±	0.09	0.06	1.12	0.82	9.71	7.78	10.49	8.78	18.10	10.07	7.58	14.79
C.D. at 5%	0.26	-	3.24	2.37	28.30	-	30.30	25.35	52.26	29.07	21.89	42.71

matter was significantly higher with irrigation at 1.00 IW/CPE ratio (467.56 g/plant) as compared to irrigation at 0.25 IW/CPE ratio (412.60 g/plant). The differences among 0.25, 0.50 and 0.75 IW/CPE ratios were not statistically significant. Similar trend was observed in fruit dry matter.

During 1985 at 40 DAE, the dry matter production was significantly higher with irrigation at 0.75 (24.13 g/plant) and 1.00 (25.15 g/plant) IW/CPE ratio, as compared to irrigation at 0.25 (18.41g/plant) and 0.50 (19.79 g/plant) IW/CPE ratio. The differences in dry matter production between irrigations at 0.25 and 0.50, as well as that between 0.75 and 1.00 IW/CPE ratios, were not statistically significant. At 80 DAE, the total dry matter production with irrigation at 1.00 IW/CPE ratio (395.90 g/plant) was on par with irrigation at 0.75 (387.38 g/plant) and 0.50 (366.51 g/plant) IW/CPE ratio, but significantly higher than irrigation at 0.25 IW/CPE ratio (343.17 g/plant). Similar trend was observed in fruit dry matter.

Method of irrigation : Method of irrigation resulted in statistically significant variations in dry matter, at all the growth stages, except at 20 DAE and 60 DAE during 1985.

During 1984 at 20 DAE, dry matter production was significantly higher (1.44 g/plant) with one emitter per two plants under drip irrigation, as compared to all other treatments. At 40 and 80 DAE, the trend was similar in total and fruit dry matter. At 80 DAE, the dry matter production in shoot was significantly higher (252.47 g/plant) with one

emitter per plant under drip irrigation, as compared to 5.0 cm depth, under furrow irrigation (185.61 g/plant). The differences within two drip irrigation and within two furrow irrigation treatments were not statistically significant.

#### 4.2.1.6 Leaf area per plant :

The data on leaf area per plant of watermelon as influenced by IW/CPE ratio and method of irrigation are presented in Table 4.35

IW/CPE ratio : Leaf area of watermelon increased with increase in the IW/CPE ratio, at all the growth stages, during both the years, but the differences were statistically significant only at 40 DAE during both the years and at 60 DAE during 1985.

During 1984 at 40 DAE, leaf area was significantly higher with irrigation at 0.75 (2615 cm<sup>2</sup>/plant) and 1.00 (2779 cm<sup>2</sup>/plant) IW/CPE ratios, as compared to irrigation at 0.25 (1981 cm<sup>2</sup>/plant) and 0.50 (1982 cm<sup>2</sup>/plant) IW/CPE ratios.

During 1985 at 40DAE, the leaf area with irrigation at 0.75 (2485 cm<sup>2</sup>/plant) and 1.00 (2692 cm<sup>2</sup>/plant) IW/CPE ratios were on par, but significantly higher, as compared to irrigation at 0.25 (1856 cm<sup>2</sup>/plant) and 0.50 (1937 cm<sup>2</sup>/plant) IW/CPE ratios. At 60 DAE, it was significantly higher with irrigations at 0.75 (5795 cm<sup>2</sup>/plant) and 1.00 (6064 cm<sup>2</sup>/plant) IW/CPE ratio as compared to irrigation at 0.25 IW/CPE ratio (4456 cm<sup>2</sup>/plant), but was on par with 0.50

Table 4.35 Leaf area of watermelon as influenced by IW/CPE ratio and method of irrigation

Treatments	Leaf area (cm <sup>2</sup> /plant)							
	20 DAE		40 DAE		60 DAE		80 DAE	
	1984	1985	1984	1985	1984	1985	1984	1985
<u>IW/CPE ratio</u>								
0.25	177	152	1981	1856	4813	4456	2122	1777
0.50	182	169	1982	1937	5807	5477	2235	1993
0.75	200	170	2615	2485	6460	5795	2257	2026
1.00	211	178	2779	2692	6618	6064	2623	2253
'F' test	NS	NS	Sig	Sig	NS	Sig	NS	NS
<u>Method of irrigation</u>								
Drip :								
1 emitter/plant	184	158	2535	2420	6640	5952	2556	2187
1 emitter/2 plants	220	177	2766	2674	6903	6259	2618	2247
Furrow :								
2.5 cm depth	186	172	2134	2020	5191	4904	2206	2022
5.0 cm depth	180	162	1921	1856	4964	4678	1857	1592
'F' test	NS	NS	Sig	Sig	Sig	Sig	Sig	Sig
S.E.m ±	20	13	107	105	626	453	208	191
C.D. at 5%	-	-	312	304	1878	1309	624	573

IW/CPE ratio (5477 cm<sup>2</sup>/plant).

Method of irrigation : Statistically significant variations were recorded due to method of irrigation, at all the stages, except at 20 DAE in both the years.

During 1984 at 40 DAE, drip irrigation with one emitter per two plants (2766 cm<sup>2</sup>/plant) and one emitter per plant (2535 cm<sup>2</sup>/plant) recorded significantly higher leaf area, as compared to 2.5 cm (2134 cm<sup>2</sup>/plant) and 5.0 cm (1921 cm<sup>2</sup>/plant) depth under furrow irrigation. At 60 DAE, the leaf area was significantly higher (6903 cm<sup>2</sup>/plant) with one emitter per two plants under drip irrigation, as compared to 5.0 cm depth under furrow irrigation (4964 cm<sup>2</sup>/plant) but was on par with one emitter per plant under drip irrigation (6640 cm<sup>2</sup>/plant) and 2.5 cm depth under furrow irrigation (5191 cm<sup>2</sup>/plant). At 80 DAE, similar trend was observed.

During 1985 at 40 DAE, one emitter per plant under drip irrigation recorded significantly higher leaf area (2674 cm<sup>2</sup>/plant), as compared to 2.5 cm (2020 cm<sup>2</sup>/plant) and 5.0 cm (1856 cm<sup>2</sup>/plant) depths, under furrow irrigation, but was on par with one emitter per plant under drip irrigation (2420 cm<sup>2</sup>/plant.). At 60 DAE, one emitter per plant under drip irrigation resulted in significantly higher leaf area (6259 cm<sup>2</sup>/plant), as compared to 5.0 cm depth under furrow irrigation (4678 cm<sup>2</sup>/plant). The difference between 2.5 cm depth under furrow irrigation (4904 cm<sup>2</sup>/plant) and one emitter per plant (5952 cm<sup>2</sup>/plant) or one emitter per two

plants was not statistically significant. At 80 DAE, similar trend was observed.

#### 4.2.1.7 Leaf area index :

The data on leaf area index of watermelon at different growth stages as influenced by IW/CPE ratio and method of irrigation are presented in Table 4.36.

IW/CPE ratio : Leaf area index increased with increasing IW/CPE ratio at all the growth stages, during both the years. The variations however, were statistically significant only at 40 and 80 DAE during both the years.

During 1984, at 40 DAE, leaf area index was significantly higher (0.309) with irrigation at 1.00 IW/CPE ratio, as compare to irrigation at 0.25 (0.220) and 0.50 (0.220) IW/CPE ratios, but was on par with irrigation at 0.75 (0.290) IW/CPE ratio. Similar trend was observed at 60 DAE.

During 1985, at 40 DAE, leaf area index was significantly higher with irrigation at 0.75 (0.276) and 1.00 (0.299) IW/CPE ratios, as compared to irrigation at 0.25 (0.206) and 0.50 (0.215) IW/CPE ratio . The difference between 0.25 and 0.50 IW/CPE ratios, as well as that between 0.75 and 1.00 IW/CPE ratios were not statistically significant. But the difference between 0.50 and 0.75 IW/CPE ratios was statistically significant. At 60 DAE, leaf area index was significantly higher with irrigation at 0.75 (0.644) and 1.00 (0.674) IW/CPE ratios, as compared to irrigation at 0.25 (0.495) IW/CPE ratio, but was on par with irrigation at 0.50 (0.608) IW/CPE ratio .

**Table 4.36** Leaf area index of watermelon as influenced by IW/CPE of ratio and method of irrigation

Treatments	20 DAE		40 DAE		60 DAE		80 DAE	
	1984	1985	1984	1985	1984	1985	1984	1985
<u>IW/CPE ratio</u>								
0.25	0.020	0.017	0.220	0.206	0.535	0.495	0.236	0.197
0.50	0.022	0.019	0.220	0.215	0.645	0.608	0.248	0.221
0.75	0.023	0.019	0.290	0.276	0.718	0.644	0.251	0.225
1.00	0.023	0.020	0.309	0.299	0.735	0.674	0.291	0.250
'F' test	NS	NS	Sig	Sig	Sig	Sig	NS	NS
<u>Method of irrigation</u>								
Drip :								
1 emitter/plant	0.020	0.018	0.283	0.268	0.737	0.661	0.281	0.243
1 emitter/ 2plants	0.024	0.020	0.307	0.296	0.768	0.695	0.294	0.250
Furrow :								
2.5 cm depth	0.023	0.019	0.237	0.224	0.557	0.545	0.245	0.225
5.0 cm depth	0.021	0.018	0.213	0.209	0.552	0.519	0.206	0.177
'F' test	NS	NS	Sig	Sig	Sig	Sig	Sig	Sig
S.E.m +	0.002	0.001	0.012	0.012	0.069	0.050	0.023	0.021
C.D. at 5%	-	-	0.034	0.034	0.159	0.145	0.067	0.061

Method of irrigation : Method of irrigation recorded statistically significant differences in leaf area index, at all the growth stages, except at 20 DAE during both the years.

During 1984, at 40 DAE, one emitter per two plants under drip irrigation recorded significantly higher leaf area index (0.307), as compared to 2.5 cm (0.237) and 5.0 cm depth (0.213) under furrow irrigation, but was on par with one emitter per plant under drip irrigation (0.283). Similar trend was observed at 60 DAE. At 80 DAE, one emitter per two plants under drip irrigation recorded significantly higher (0.294) leaf area index, as compared to 5.0 cm depth under furrow irrigation (0.206), but was on par with one emitter per plant under drip irrigation (0.281) and 2.5 cm depth under furrow irrigation (0.245).

During 1985, at 40 DAE, drip irrigation with one emitter per two plants recorded significantly higher leaf area index (0.296), as compared to 2.5 cm (0.224) and 5.0 cm depth (0.209) under furrow irrigation, but was on par with one emitter per plant under drip irrigation (0.268). Similar trend was observed at 60 DAE. At 80 DAE also, leaf area index was significantly higher (0.250) with one emitter per two plants, as compared to 5.0 cm depth (0.177) under furrow irrigation, but was on par with 2.5 cm depth (0.255) under furrow irrigation and one emitter per plant under drip irrigation (0.243).

#### 4.2.1.8 Leaf area duration :

The data on leaf area duration of watermelon as influenced by IW/CPE ratio and methods of irrigation are presented in Table 4.37.

IW/CPE ratio : Leaf area duration increased with increase in IW/CPE ratio at all the growth stages, during both the years. However, the differences were statistically significant only between 21 to 40 DAE during both the years.

During 1984 at this stage, leaf area duration was significantly higher with irrigation at 0.75 (282 dm<sup>2</sup> days) and 1.00 (298 dm<sup>2</sup> days) IW/CPE ratios, as compared to irrigation at 0.25 (216 dm<sup>2</sup> days) and 0.50 (218 dm<sup>2</sup> days) IW/CPE ratio. The differences between irrigation at 0.25 and 0.50, as well as that between 0.75 and 1.00 IW/CPE ratios, were not statistically significant. Similar trend was observed during 1985.

Method of irrigation : Statistically significant differences were recorded in leaf area duration, as influenced by method of irrigation, at all the stages except between 41 to 60 DAE in 1985.

During 1984 between 21 to 40 DAE, drip irrigation with one emitter per two plants recorded significantly higher leaf area duration (295 dm<sup>2</sup> days), as compared to 2.5 cm (235 dm<sup>2</sup> days) and 5.0 cm depth (210 dm<sup>2</sup> days) under furrow irrigation, but was on par with one emitter per plant (276 dm<sup>2</sup> days) under drip irrigation. Between 41 to 60 DAE, drip irrigation with one emitter per two plants, recorded

**Table 4.37** Leaf area duration of watermelon as influenced by IW/CPE of ratio and method of irrigation

Treatments	Leaf area duration (dm <sup>2</sup> days)					
	21 - 40 1984	DAE 1985	41 - 60 1984	DAE 1985	61 - 80 1984	DAE 1985
0.25	216	205	743	694	707	648
0.50	218	209	844	765	842	773
0.75	282	266	858	800	869	778
1.00	298	286	860	817	874	784
'F' test	Sig	Sig	NS	NS	NS	NS
<u>Method of irrigation</u>						
Drip :						
1 emitter/plant	276	260	853	811	852	815
1 emitter/2 plants	295	280	946	837	952	828
Furrow :						
2.5 cm depth	235	223	773	807	775	714
5.0 cm depth	210	207	733	735	682	627
'F' test	Sig	Sig	Sig	NS	Sig	Sig
S.E.m +	11	11	63	46	65	48
C.D. at 5%	32	31	181	-	187	139

significantly higher leaf area duration ( $946 \text{ dm}^2 \text{ days}$ ), as compared to 5.0 cm depth under furrow irrigation ( $733 \text{ dm}^2 \text{ days}$ ), but was on par with 2.5 cm depth ( $773 \text{ dm}^2 \text{ days}$ ) under furrow irrigation and one emitter per plant ( $853 \text{ dm}^2 \text{ days}$ ), under drip irrigation. Similar trend was observed between 61 to 80 DAE.

During 1985, between 21 to 40 DAE, leaf area duration was significantly higher ( $280 \text{ dm}^2 \text{ days}$ ) with one emitter per two plants under drip irrigation, as compared to 2.5 cm ( $223 \text{ dm}^2 \text{ days}$ ) and 5.0 cm depth ( $207 \text{ dm}^2 \text{ days}$ ) under furrow irrigation, but was on par with one emitter per plant ( $260 \text{ dm}^2 \text{ days}$ ) under drip irrigation. Between 61 to 80 DAE, drip irrigation with one emitter per two plants ( $828 \text{ dm}^2 \text{ days}$ ) resulted in significantly higher leaf area duration, as compared to 2.5 cm depth under furrow irrigation ( $627 \text{ dm}^2 \text{ days}$ ), but was on par with 2.5 cm depth ( $714 \text{ dm}^2 \text{ days}$ ) under furrow irrigation and one emitter per plant under drip irrigation ( $815 \text{ dm}^2 \text{ days}$ ).

#### 4.2.1.9 Relative growth rate :

The data on relative growth rate of watermelon as influenced by IW/CPE ratio and method of irrigation are presented in Table 4.38.

IW/CPE ratio : Statistically significant variations in relative growth rate, as influenced by IW/CPE ratio were recorded during all stages, except between 61 to 80 DAE, in both the years.

**Table 4.38** Relative growth rate of watermelon as influenced by IW/CPE ratio and method of irrigation

Treatments	Relative growth rate (g/g/day)					
	21 - 40 DAE 1984	41 - 60 DAE 1984	61 - 80 DAE 1984	81 - 90 DAE 1985	91 - 100 DAE 1985	101 - 110 DAE 1985
<u>IW/CPE ratio</u>						
0.25	0.1486	0.1475	0.0636	0.0570	0.0688	0.0714
0.50	0.1548	0.1593	0.0655	0.0611	0.0709	0.0733
0.75	0.1608	0.1593	0.0813	0.0721	0.0722	0.0775
1.00	0.1685	0.1651	0.0849	0.0759	0.0732	0.0815
'F' test	Sig	Sig	Sig	Sig	NS	NS
<u>Method of irrigation</u>						
Drip :						
1 emitter/plant	0.1613	0.1617	0.741	0.0710	0.0679	0.0815
1 emitter/2plants	0.1694	0.1688	0.0881	0.0852	0.0857	0.0833
Furrow :						
2.5 cm depth	0.1531	0.1511	0.0698	0.0588	0.0677	0.0710
5.0 cm depth	0.1490	0.1450	0.0633	0.0512	0.0639	0.0679
'F' test	Sig	Sig	Sig	Sig	Sig	Sig
S.E.m ±	0.0051	0.0042	0.0047	0.0051	0.0039	0.0050
C.D. at 5%	0.0148	0.0120	0.0136	0.0148	0.0113	0.0147

During 1984 between 21 to 40 DAE, relative growth rate was significantly higher (0.1685 g/g/day) with irrigation at 1.00 IW/CPE ratio as compared to irrigation at 0.25 IW/CPE ratio (0.1486 g/g/day). The differences among 0.25, 0.50 and 0.75 IW/CPE ratio were not statistically significant. Similar trend was observed between 41 to 60 DAE.

During 1985 between 21 to 40 DAE, the variations in relative growth rate, with irrigation at 0.25, 0.50 and 0.75 IW/CPE ratios were not statistically significant. But significantly higher relative growth rate was recorded with irrigation at 1.00 IW/CPE ratio (0.1651 g/g/day) as compared to irrigation at 0.25 IW/CPE (0.1475 g/g/day). Between 41 to 60 DAE, it was significantly higher (0.0759 g/g/day) with irrigation at 1.00 IW/CPE as compared to 0.25 (0.0570 g/g/day) and 0.50 (0.0611 g/g/day) IW/CPE ratio, but was on par with irrigation at 0.75 (0.0721 g/g/day) IW/CPE ratio.

Method of irrigation : Statistically significant variations in relative growth rate, as influenced by method of irrigation were recorded at all stages, during both the years.

During 1984, between 21 to 40 DAE, relative growth rate was significantly higher (0.1694 g/g/day) with one emitter per two plants under drip irrigation, as compared to 5.0 cm depth under furrow irrigation (0.1490 g/g/day), but was on par with 2.5 cm depth under furrow irrigation (0.1531 g/g/day) and one emitter per plant under drip irrigation (0.1613 g/g/day). Between 41 to 60 DAE, it was significantly higher

(0.0881 g/g/day) with one emitter per two plants under drip irrigation, as compared to 2.5 cm (0.0698 g/g/day) and 5.0 cm (0.0633 g/g/day) depth, under furrow irrigation. The difference between one emitter per plant and one emitter per two plants under drip irrigation was not statistically significant. Similar trend was observed between 61 to 80 DAE.

During 1985, between 21 to 40 DAE, the relative growth rate was significantly higher (0.1688 g/g/day) with one emitter per two plants under drip irrigation, as compared to 2.5 cm (0.1511 g/g/day) and 5.0 cm depth (0.1450 g/g/day) under furrow irrigation. The differences between one emitter per plant and one emitter per two plants under drip irrigation, as well as that between one emitter per plant under drip irrigation and 2.5 cm depth under furrow irrigation were not statistically significant. Between 41 to 60 DAE, similar trend was observed. Between 61 to 80 DAE, relative growth rate was significantly higher (0.0833 g/g/day) with one emitter per two plants under drip irrigation, as compared to 5.0 cm depth (0.0679 g/g/day) under furrow irrigation, but was on par with one emitter per plant (0.0815 g/g/day) under drip irrigation and 2.5 cm depth (0.0710 g/g/day) under furrow irrigation. The differences among one emitter per plant under drip irrigation and 2.5 cm as well as 5.0 cm depth under furrow irrigation, were not statistically significant.

#### 4.2.1.10 Net assimilation rate :

The data on net assimilation rate of watermelon as influenced by IW/CPE ratio and method of irrigation are presented in Table 4.39.

**IW/CPE ratio** : Net assimilation rate increased with increase in IW/CPE ratio at all growth stages, during both the years. Statistically significant variations in net assimilation rate, as influenced by IW/CPE ratio were recorded only between 21 to 40 DAE and 41 to 60 DAE During 1984.

During 1984, between 21 to 40 DAE, net assimilation rate was significantly higher ( $0.1447 \text{ g/dm}^2/\text{day}$ ) with irrigation at 1.00 IW/CPE ratio, as compared to irrigation at 0.25 IW/CPE ratio ( $0.1256 \text{ g/dm}^2/\text{day}$ ). The differences among other treatments were not statistically significant.

During 1985, between 41 to 60 DAE, net assimilation rate was significantly higher ( $0.1281 \text{ g/dm}^2/\text{day}$ ) with irrigation at 1.00 IW/CPE ratio, as compared to irrigation at 0.25 ( $0.0948 \text{ g/dm}^2/\text{day}$ ), but was on par with 0.50 ( $0.1075 \text{ g/dm}^2/\text{day}$ ) and 0.75 ( $0.1135 \text{ g/g/day}$ ) IW/CPE ratio .

**Method of irrigation** : Statistically significant variations in net assimilation rate were recorded, at all the growth stages, during both the years.

During 1984, between 21 to 40 DAE, it was significantly higher ( $0.1457 \text{ g/dm}^2/\text{day}$ ) with one emitter per two plants under drip irrigation, as compared to 2.5 cm depth ( $0.1301 \text{ g/dm}^2/\text{day}$ ) and 5.0 cm depth under furrow irrigation ( $0.1260$

**Table 4.39** Net assimilation rate of watermelon as influenced by IW/CPE ratio and method of irrigation

Treatments	Net assimilation rate (g/dm <sup>2</sup> /day)					
	21 - 40 DAE 1984	41 - 60 DAE 1984	61 - 80 DAE 1985	81 - 90 DAE 1985	91 - 100 DAE 1984	101 - 110 DAE 1985
<u>IW/CPE ratio</u>						
0.25	0.1256	0.1265	0.0948	0.0799	0.4113	0.4000
0.50	0.1319	0.1321	0.1075	0.0855	0.4510	0.4522
0.75	0.1374	0.1337	0.1135	0.0968	0.4843	0.4771
1.00	0.1447	0.1391	0.1281	0.0969	0.5197	0.5382
'F' test	Sig	NS	Sig	NS	NS	NS
<u>Method of irrigation</u>						
Drip :						
1 emitter/plant	0.1378	0.1394	0.1103	0.1007	0.4834	0.5279
1 emitter/2 plants	0.1457	0.1456	0.1329	0.1125	0.5632	0.5685
Furrow :						
2.5 cm depth	0.1301	0.1235	0.1005	0.0745	0.4330	0.3952
5.0 cm depth	0.1260	0.1230	0.1002	0.0713	0.3867	0.3775
'F' test	Sig	Sig	Sig	Sig	Sig	Sig
S.E.m +	0.0049	0.0058	0.0092	0.0102	0.0373	0.0431
C.D. at 5%	0.0142	0.0168	0.0266	0.0296	0.1077	0.1244

g/dm<sup>2</sup>/day), but was on par with one emitter per plant under drip irrigation (0.1378 g/dm<sup>2</sup>/day). Similar trend was observed between 41 to 60 DAE and 61 to 80 DAE.

During 1985, between 21 to 40 DAE, net assimilation rate was significantly higher (0.1456 g/dm<sup>2</sup>/day) with one emitter per two plants under drip irrigation, as compared to 2.5 cm depth (0.1235 g/dm<sup>2</sup>/day) and 5.0 cm depth under furrow irrigation (0.1230 g/dm<sup>2</sup>/day), but was on par with one emitter per plant under drip irrigation (0.1394 g/dm<sup>2</sup>/day). Similar trend was observed between 41 to 60 DAE. Between 61 to 80 DAE, drip irrigation with one emitter per two plants recorded significantly higher (0.5685 g/dm<sup>2</sup>/day) net assimilation rate, as compared to 2.5 cm depth (0.3952 g/dm<sup>2</sup>/day) and 5.0 cm depth (0.3755 g/dm<sup>2</sup>/day) under furrow irrigation, but was on par with one emitter per plant under drip irrigation (0.5279 g/dm<sup>2</sup>/day). The differences between one emitter per plant under drip irrigation and 2.5 cm depth under furrow irrigation was also statistically significant.

#### 4.2.1.11 Crop growth rate :

The data on crop growth rate of watermelon, as influenced by IW/CPE ratio and method of irrigation at different stages, are presented in Table 4.40.

IW/CPE ratio : Crop growth rate increased with increase in IW/CPE ratio at all the growth stages, during both the years. However, the variations were statistically significant only between 21 to 40 DAE during both the years.

**Table 4.40** Crop growth rate of watermelon as influenced by IW/CPE ratio and method of irrigation

Treatments	Crop growth rate (g/dm <sup>2</sup> /day)					
	21 - 40 1984	DAE 1985	41 - 60 1984	DAE 1985	61 - 80 1984	DAE 1985
<u>IW/CPE ratio</u>						
0.25	0.0109	0.0097	0.0418	0.0322	0.1713	0.1505
0.50	0.0145	0.0105	0.0428	0.0347	0.1803	0.1541
0.75	0.0155	0.0129	0.0475	0.0362	0.1811	0.1636
1.00	0.0155	0.0134	0.0549	0.0370	0.1934	0.1707
'F' test	Sig	Sig	NS	NS	NS	NS
<u>Method of irrigation</u>						
Drip :						
1 emitter/plant	0.0146	0.0130	0.0546	0.0355	0.1800	0.1648
1 emitter/2 plants	0.0155	0.0142	0.0548	0.0446	0.2216	0.1880
Furrow :						
2.5 cm depth	0.0117	0.0104	0.0395	0.0330	0.1643	0.1508
5.0 cm depth	0.0106	0.0093	0.0376	0.0270	0.1603	0.1355
'F' test	Sig	Sig	Sig	Sig	Sig	Sig
S.E.m ±	0.0060	0.0005	0.0049	0.0041	0.0101	0.0088
C.D. at 5%	0.0018	0.0013	0.0142	0.0117	0.0288	0.0255

During 1984, between 21 to 40 DAE, the crop growth rate increased significantly from 0.0109 g per dm<sup>2</sup> per day with irrigation at 0.25 IW/CPE ratio to 0.0145 g per dm<sup>2</sup> per day with irrigation at 0.50 IW/CPE ratio. The differences among 0.50, 0.75 and 1.00 IW/CPE ratios were not statistically significant.

During 1985, between 21 to 40 DAE, crop growth rate was significantly higher with irrigation at 0.75 (0.0129 g/dm<sup>2</sup>/day) and 1.00 (0.0134 g/dm<sup>2</sup>/day) IW/CPE ratios, as compared to irrigation at 0.25 (0.0097 g/dm<sup>2</sup>/day) and 0.50 (0.0105 g/dm<sup>2</sup>/day). The differences between irrigation at 0.25 and 0.50, as well as that between 0.75 and 1.00 IW/CPE ratios were not statistically significant.

Method of irrigation : Statistically significant variations in crop growth rate, were recorded at all the growth stages during both the years.

During 1984, drip irrigation with one emitter per plant (0.0146 g/dm<sup>2</sup>/day) and one emitter per two plants (0.0155 g/dm<sup>2</sup>/day) resulted in significantly higher crop growth rate, as compared to 2.5 cm (0.0117 g/dm<sup>2</sup>/day) and 5.0 cm depth (0.0106 g/dm<sup>2</sup>/day) under furrow irrigation. Similar trend was observed between 41 to 60 DAE. Between 61 to 80

DAE, the crop growth rate was significantly higher ( $0.2216 \text{ g/dm}^2/\text{day}$ ) with one emitter per two plants under drip irrigation, as compared to 2.5 cm ( $0.1643 \text{ g/dm}^2/\text{day}$ ) and 5.0 cm ( $0.1603 \text{ g/dm}^2/\text{day}$ ), depth under furrow irrigation and also with one emitter per plant under drip irrigation ( $0.1800 \text{ g/dm}^2/\text{day}$ ).

During 1985, between 21 to 40 DAE, the crop growth rate was significantly higher under drip irrigation with one emitter per plant ( $0.0130 \text{ g/dm}^2/\text{day}$ ) and one emitter per two plants ( $0.0142 \text{ g/dm}^2/\text{day}$ ), as compared to 2.5 cm ( $0.0104 \text{ g/dm}^2/\text{day}$ ) and 5.0 cm ( $0.0093 \text{ g/dm}^2/\text{day}$ ) depth, under furrow irrigation. The variations between two drip irrigation or two furrow irrigation treatments were not statistically significant. Between 41 to 60 DAE, the crop growth rate was significantly higher with one emitter per two plants ( $0.0446 \text{ g/dm}^2/\text{day}$ ) under drip irrigation, as compared to 5.0 cm depth ( $0.0270 \text{ g/dm}^2/\text{day}$ ) under furrow irrigation. The difference between one emitter per plant ( $0.0355 \text{ g/dm}^2/\text{day}$ ) and one emitter per two plants under drip irrigation were not statistically significant. Between 61 to 80 DAE, similar trend was observed.

#### 4.2.2 Yield and yield components :

The data on fruit yield, fruit number per ha and fruit weight, as influenced by IW/CPE ratio and method of irrigation are presented in Table 4.41.

#### 4.2.2.1 Fruit yield :

IW/CPE ratio : Irrigation at higher IW/CPE ratios increased the fruit yield of watermelon during both the years. However, the differences were statistically significant only during 1985.

During 1984, the fruit yield increased from 290.8 q per ha with irrigation at 0.25 IW/CPE ratio to 327.4, 333.65 and 337.68 q per ha with irrigation at 0.50, 0.75 and 1.00 IW/CPE ratios, respectively.

During 1985, the fruit yield was significantly higher (310.14 q/ha) with irrigation at 1.00 IW/CPE ratio, as compared to irrigation at 0.25 IW/CPE ratio (252.29 q/ha), but was on par with irrigation at 0.50 (281.94 q/ha) and 0.75 (295.15 q/ha) IW/CPE ratios.

Method of irrigation : Drip irrigation with one emitter per plant and one emitter per two plants recorded higher yields, as compared to 2.5 cm and 5.0 cm depth under furrow irrigation, in both the years.

During 1984, fruit yield under drip irrigation with one emitter per two plants was significantly higher (367.54 q/ha), as compared to 2.5 cm (300.32 q/ha) and 5.0 cm (268.98 q/ha) depth, under furrow irrigation, but was on par with one emitter per plant under drip irrigation (352.73 q/ha).

**Table 4.41** Yield and Yield components of watermelon as influenced by IW/CPE ratio and method of irrigation

Treatments	Yield, q/ha 1984	Yield, q/ha 1985	Fruit number/ha 1984	Fruit number/ha 1985	Fruit weight, kg 1984	Fruit weight, kg 1985
<u>IW/CPE ratio</u>						
0.25	290.80	252.29	10,745	9,038	2.79	2.56
0.50	327.40	281.94	10,803	9,062	2.99	2.76
0.75	333.65	295.15	10,907	9,082	3.05	3.00
1.00	337.68	310.14	10,956	9,105	3.14	3.15
'F' test	NS	Sig	NS	NS	NS	NS
<u>Method of irrigation</u>						
Drip :						
1 emitter/plant	352.73	309.73	11,169	10,248	3.10	3.02
1 emitter/2 plants	367.54	313.96	11,979	10,874	3.19	3.11
Furrow :						
2.5 cm depth	300.32	282.31	10,514	10,125	3.01	2.86
5.0 cm depth	268.98	227.08	9,750	9,879	2.78	2.66
'F' test	Sig	Sig	Sig	NS	NS	NS
S.E.m ±	19.88	12.63	664	512	0.105	0.103
C.D. at 5%	57.43	36.47	1,926	-	-	-

During 1985, fruit yield was significantly lower (227.08 q/ha) with 5.0 cm depth under furrow irrigation, as compared to 2.5 cm depth under furrow irrigation (282.31 q/ha), one emitter per plant (309.73 q/ha) and one emitter per two plants under drip irrigation (313.96 q/ha), which were on par.

The interaction effect of IW/CPE ratio and method of irrigation were statistically significant during 1985 (Table 4.42)

Fruit yield was significantly higher, with one emitter per two plants under drip irrigation, at 0.25 IW/CPE ratio as compared to 5.0 cm depth under furrow irrigation, at all the IW/CPE ratios and 2.5 cm depth under furrow irrigation with 0.25 IW/CPE ratio as well as 0.75 IW/CPE ratio under furrow irrigation with one emitter per two plants.

#### 4.2.2.2 Number of fruits per ha :

IW/CPE ratio : Number of fruits per ha increased with the increase in IW/CPE ratio and was highest with irrigation at 1.00 IW/CPE ratio. However, the differences were not statistically significant.

Method of irrigation : Statistically significant variations in number of fruits were recorded due to method of irrigation only during 1984. Number of fruits per ha was significantly higher (11,979) with one emitter per two plants under drip irrigation, as compared to 5.0 cm depth under furrow irrigation (9,750), but was on par with 2.5 cm depth

**Table 4.42** Interaction effects of IW/CPE ratios and method of irrigation on fruit yield (q/ha) of watermelon, 1985

Treatments	Method of irrigation			
	Drip		Furrow	
IW/CPE ratio	1 emitter/ plant	2 emitter/ plants	2.5 cm depth	5.0 cm depth
0.25	286.11	354.33	198.22	170.53
0.50	313.96	327.61	272.75	213.42
0.75	303.40	265.74	339.97	243.52
1.00	333.17	308.13	318.31	280.85

'F' test                      Sig

S.E.m +                      25.25

C.D. at 5%                      72.94

(10,514) under furrow irrigation and with one emitter per plant under drip irrigation (11,169).

#### 4.2.2.3 Fruit weight :

IW/CPE ratio : The fruit weight gradually increased with increase in IW/CPE ratio, during both the years. However, the differences were not statistically significant.

Method of irrigation : Fruit weight was more under drip irrigation, as compared to furrow irrigation. However, the differences were not statistically significant.

#### 4.2.3 Fruit and Seed characters :

The data on flesh thickness, rind thickness, fruit shape index, seed number per fruit, seed weight per fruit and hundred seed weight are presented in Table 4.43.

##### 4.2.3.1 Flesh Thickness :

IW/CPE ratio : Flesh thickness increased with the increase in IW/CPE ratio. However, the variations were statistically significant only during 1985. Flesh thickness was significantly higher (8.83 cm) with irrigation at 1.00 IW/CPE ratio, as compared to irrigation at 0.25 IW/CPE ratio (7.9 cm), but was on par with irrigation at 0.50 (7.93 cm) and 0.75 (8.19 cm) IW/CPE ratios.

Method of irrigation : Flesh thickness was more under drip irrigation, as compared to furrow irrigation. However, the differences were not statistically significant.

**Table 4.43** Fruit and Seed characters of watermelon as influenced by IW/CPE ratio and method of irrigation.

Treatments	Flesh thick- ness, cm		Rind thick- ness, cm		Fruit shape index		Seed number/ fruit		Seed weight/ fruit, g		Hundred seed weight, g	
	1984	1985	1984	1985	1984	1985	1984	1985	1984	1985	1984	1985
<u>IW/CPE ratio</u>												
0.25	8.76	7.92	3.65	3.12	1.02	1.00	259	238	11.2	8.9	4.3	3.9
0.50	8.84	7.93	3.08	2.87	1.03	1.01	285	250	12.1	9.3	4.4	3.9
0.75	9.03	8.19	3.03	2.83	1.04	1.01	376	341	15.8	12.5	4.8	4.1
1.00	9.11	8.53	2.99	2.72	1.11	1.02	383	343	19.1	15.0	5.1	4.4
'F' test	NS	Sig	NS	NS	NS	NS	NS	NS	Sig	Sig	Sig	NS
<u>Method of irrigation</u>												
Drip :												
1 emitter/plant	9.06	8.14	2.98	2.71	1.06	1.02	429	372	18.9	14.4	4.7	4.1
1 emitter/2 plants	9.07	8.16	2.97	2.76	1.10	1.01	409	364	17.6	12.7	4.6	4.2
Furrow :												
2.5 cm depth	8.93	8.13	3.07	2.77	1.02	1.00	239	220	11.1	9.5	4.7	4.0
5.0 cm depth	8.68	8.01	3.17	3.31	1.02	1.01	230	217	10.7	9.1	4.5	3.8
'F' test	NS	NS	NS	NS	NS	NS	Sig	Sig	Sig	Sig	NS	NS
S.E.m ±	0.16	0.16	0.21	0.17	0.04	0.03	45	38	1.8	1.2	0.21	0.17
C.D. at 5%	-	0.46	-	-	-	-	129	109	5.2	3.5	0.61	-

#### 4.2.3.2 Rind Thickness :

IW/CPE ratio : Rind thickness decreased with the increase in IW/CPE ratio. However, the variations were not statistically significant.

Method of irrigation : The differences in rind thickness due to method of irrigation were not statistically significant during both the years.

#### 4.2.3.3 Fruit Shape index :

IW/CPE ratio : Fruit shape index was higher under higher IW/CPE ratio, as compared to lower IW/CPE ratio, but the variations were not statistically significant.

Method of irrigation : Statistically significant differences due to method of irrigation were not recorded in both the years.

#### 4.2.3.4 Seed number per fruit :

IW/CPE ratio: Seed number per fruit increased with the increase in IW/CPE ratio, but the variations were not statistically significant in both the years.

Method of irrigation : Statistically significant differences due to method of irrigation were recorded during both the years.

During 1984, drip irrigation with one emitter per plant recorded significantly higher (429) seed number, as compared to 2.5 cm (239) and 5.0 cm (230) depths, under furrow irrigation, but was on par with one emitter per two plants (409), under drip irrigation. Similar trend was observed during 1985.

#### 4.2.3.5 Seed weight per fruit :

IW/CPE ratio: Seed weight per fruit increased significantly, with increase in IW/CPE ratio during both the years.

During 1984, seed weight was significantly higher (19.1 g) with irrigation at 1.00 IW/CPE ratio, as compared to irrigation at 0.25 (11.2 g) and 0.50 (12.1 g) IW/CPE ratios, but was on par with 0.75 (15.8 g) IW/CPE ratio. Similar trend was observed during 1985.

Method of irrigation : Seed weight was statistically significant due to method of irrigation. Drip irrigation recorded higher seed weight during both the years.

During 1984, drip irrigation with one emitter per plant recorded significantly higher (18.9 g) seed weight, as compared to 2.5 cm (11.1 g) and 5.0 cm (10.7 g) depths, under furrow irrigation, but was on par with one emitter per two plants under drip irrigation (17.6 g).

During 1985, drip irrigation with one emitter per plant recorded significantly higher seed weight (14.4 g) as compared to 2.5 cm (9.1 g) and 5.0 cm depth (9.5 g) under furrow irrigation, but was on par with one emitter per two plants, under drip irrigation (12.7 g). The variation in seed weight between one emitter per two plants under drip irrigation and 2.5 cm depth under furrow irrigation was not statistically significant.

#### 4.2.3.6 Hundred seed weight :

IW/CPE ratio : Hundred seed weight increased with increase in IW/CPE ratio, but the differences were statistically significant during 1984. Hundred seed weight was significantly lower (4.3) with irrigation at 0.25 IW/CPE ratio as compared to irrigation at 1.00 IW/CPE ratio (5.1), but was on par with irrigation at 0.50 (4.4) and 0.75 (4.8) IW/CPE ratios.

Method of irrigation : The variations in hundred seed weight, as influenced by method of irrigation were not statistically significant during both the years.

#### 4.2.4 Fruit quality :

The data on total soluble solids, reducing sugars, total sugars and nitrate-nitrogen in fruit juice, as influenced by IW/CPE ratio and method of irrigation are presented in Table 4.44.

##### 4.2.4.1 Total soluble solids :

IW/CPE ratio : The total soluble solids increased marginally with increase in the IW/CPE ratio, during both the years. However, the variations were not statistically significant.

Method of irrigation : The variations in total soluble solids, as influenced by method of irrigation were not statistically significant, during both the years.

Table 4.44 Fruit quality of watermelon as influenced by IW/CPE ratio and method of irrigation.

Treatments	Total soluble solids, per cent		Reducing sugars, per cent		Total sugars, per cent		NO <sub>3</sub> - N, ppm	
	1984	1985	1984	1985	1984	1985	1984	1985
IW/CPE ratio								
0.25	9.0	9.1	1.59	1.58	2.27	2.10	13.42	13.21
0.50	9.1	9.3	1.79	1.70	2.67	2.48	13.52	13.60
0.75	9.3	9.3	1.98	1.80	2.85	2.94	13.67	13.72
1.00	9.6	9.7	2.30	2.00	3.69	3.25	13.75	13.81
'F' test	NS	NS	Sig	NS	Sig	Sig	NS	NS
Method of irrigation								
Drip :								
1 emitter/plant	9.3	9.2	1.89	1.75	2.95	2.82	13.40	13.32
1 emitter/2 plants	9.4	9.8	2.60	2.45	2.84	2.80	13.32	13.36
Furrow :								
2.5 cm depth	9.1	9.2	1.70	1.55	2.90	2.84	13.43	13.41
5.0 cm depth	9.0	9.1	1.47	1.34	2.79	2.61	14.17	14.54
'F' test	NS	NS	Sig	Sig	NS	NS	NS	NS
S.E.m ±	0.20	0.21	0.15	0.12	0.21	0.17	2.19	2.21
C.D. at 5%	-	-	0.44	0.35	0.60	0.48	-	-

#### 4.2.4.2 Reducing sugars :

IW/CPE ratio: Reducing sugar percentage increased, with the increase in IW/CPE ratio, in both years. However, the differences were statistically significant only during 1984. Reducing sugar was significantly higher (2.30%) with irrigation at 1.00 IW/CPE ratio as compared to irrigation at 0.25 IW/CPE ratio (1.59%), but was on par with 0.50 (1.79%) and 0.75 (1.98%) IW/CPE ratios.

#### 4.2.4.3 Total sugars :

IW/CPE ratio : Statistically significant variations in total sugars were recorded during both the years.

During 1984, the total sugar was significantly higher (3.69%) with irrigation at 1.00 IW/CPE ratio as compared to irrigation at 0.25 (2.27%) and 0.50 (2.67%) IW/CPE ratios, but was on par with irrigation at 0.75 (2.85%) IW/CPE ratio.

During 1985, the total sugar was significantly higher with irrigation at 1.00 IW/CPE ratio (3.25%), as compared to irrigation at 0.25 (2.10%) and 0.50 (2.48%) IW/CPE ratios. The variation between irrigation at 0.50 and 0.75 IW/CPE ratios, was also statistically significant.

Method of irrigation : Statistically significant differences were not recorded due to method of irrigation, during both the years.

#### 4.2.4.4 Nitrate - nitrogen :

IW/CPE ratio: Nitrate - nitrogen content increased with increase in IW/CPE ratio. However, the differences were not statistically significant.

Method of irrigation : Statistically significant differences in nitrate - nitrogen were recorded due to method of irrigation, during both the years.

#### 4.2.5 Plant Water Studies :

##### 4.2.5.1 Relative Water Content :

The data on relative water content of watermelon as influenced by IW/CPE ratio and method of irrigation are presented in Fig.4.4.

At 0.25 IW/CPE ratio: The fluctuations in relative water content under drip irrigation was less and it varied from 94.7 per cent to 94.1 per cent with one emitter per plant and from 94.6 per cent to 94.3 per cent with one emitter per two plants, throughout the growth of the crop. In case of furrow irrigation with 2.5 cm depth, it decreased from 94.2 per cent to 87.8 per cent, from 1 to 17 days after irrigation and with 5.0 cm depth, from 94.7 per cent to 86.8 per cent, from 1 to 34 days after irrigation. Thus, the relative water content under drip irrigation was higher by 4.7 per cent at 8 days and 6.8 per cent at 17 days after irrigation with 2.5 cm depth and by 4.3 per cent at 8 days and 7.8 per cent at 34 days after irrigation with 5.0 cm depth, under furrow irrigation.

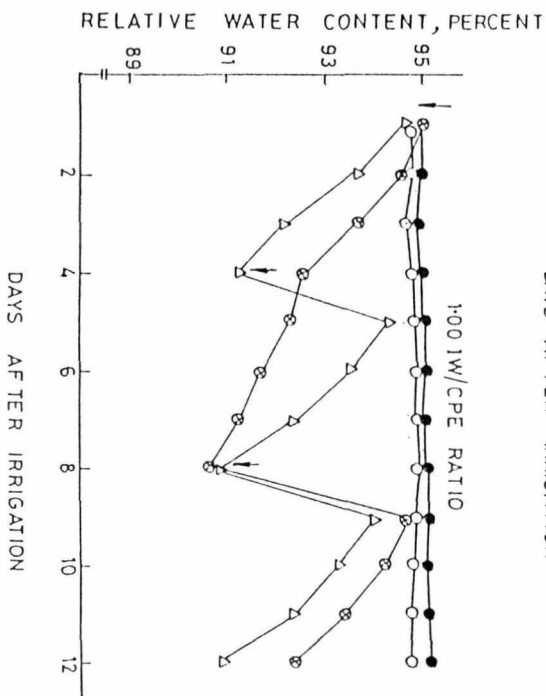
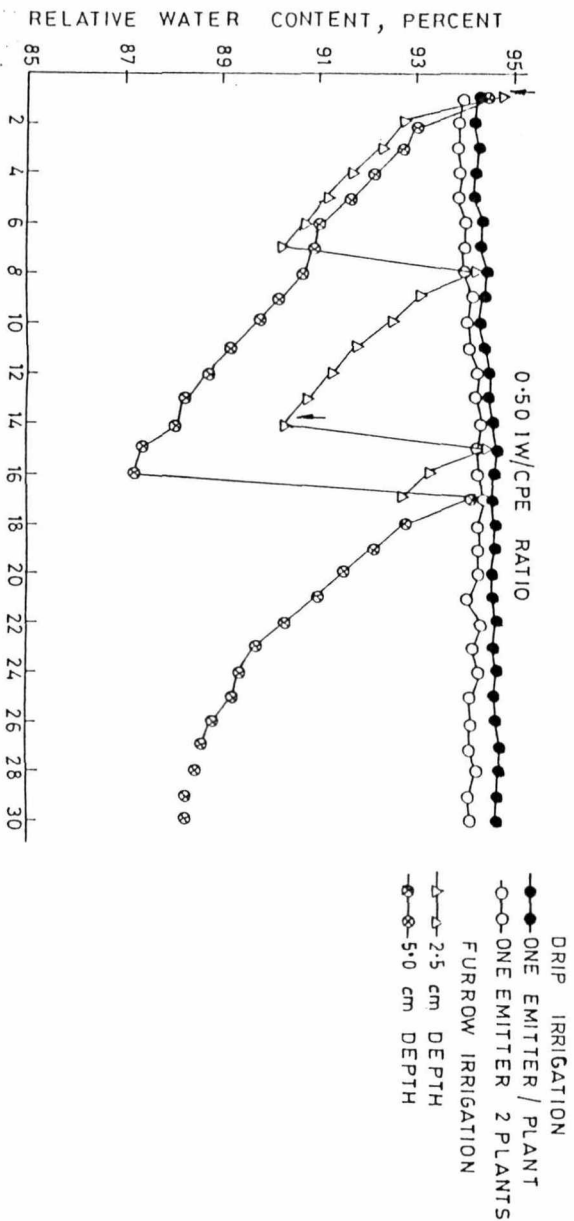
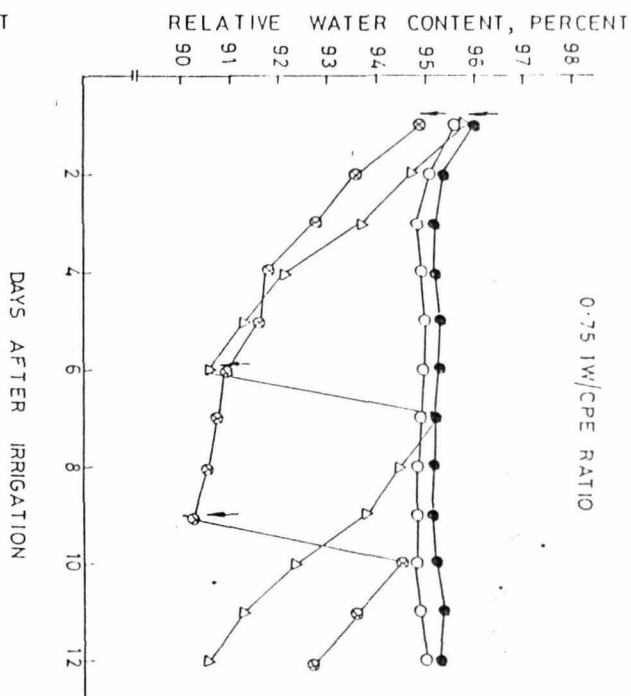
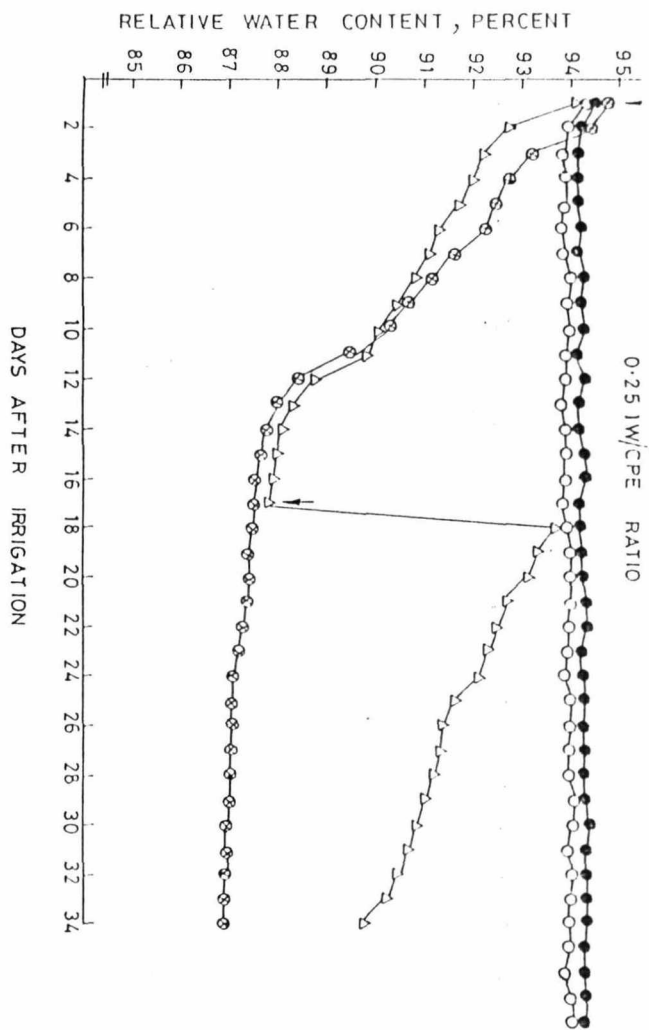


FIG. 4.4. CHANGES IN RELATIVE WATER CONTENT AS INFLUENCED BY METHOD OF IRRIGATION

At 0.50 IW/CPE ratio: The relative water content under drip irrigation with one emitter per plant, varied from 94.2 per cent to 94.8 per cent and it varied from 94.0 per cent to 94.6 per cent with one emitter per two plants. Under furrow irrigation with 2.5 cm depth, the relative water content decreased from 94.6 per cent to 90.3 per cent, from 1 to 7 days after irrigation and from 94.8 per cent to 87.3 per cent, from 1 to 16 days after irrigation with 5.0 cm depth. Thus, furrow irrigation with 2.5 cm depth recorded 2.4 per cent to 4.2 per cent lower relative water content at 4 and 7 days after irrigation, as compared to drip irrigation. In case of 5.0 cm depth relative water content was lower by 2.3 per cent to 7.5 per cent at 4 days and 16 days after irrigation, as compared to drip irrigation.

At 0.75 IW/CPE ratio: The relative water content under drip irrigation with one emitter per plant, varied from 95.9 per cent to 95.1 per cent and it varied from 94.8 per cent to 95.4 per cent with one emitter per two plants. Under furrow irrigation, with 2.5 cm depth, the relative water content decreased from 95.6 per cent to 90.3 per cent from 1 to 6 days after irrigation and from 94.8 per cent to 90.1 per cent from 1 to 9 days after irrigation. Thus, furrow irrigation with 2.5 cm recorded 2.7 per cent to 4.1 per cent lower relative water content at 3 and 6 days after irrigation, as compared to drip irrigation and from 2.9 per cent to 5.6 per cent, from 3 to 9 days after irrigation with 5.0 cm depth, as compared to drip irrigation.

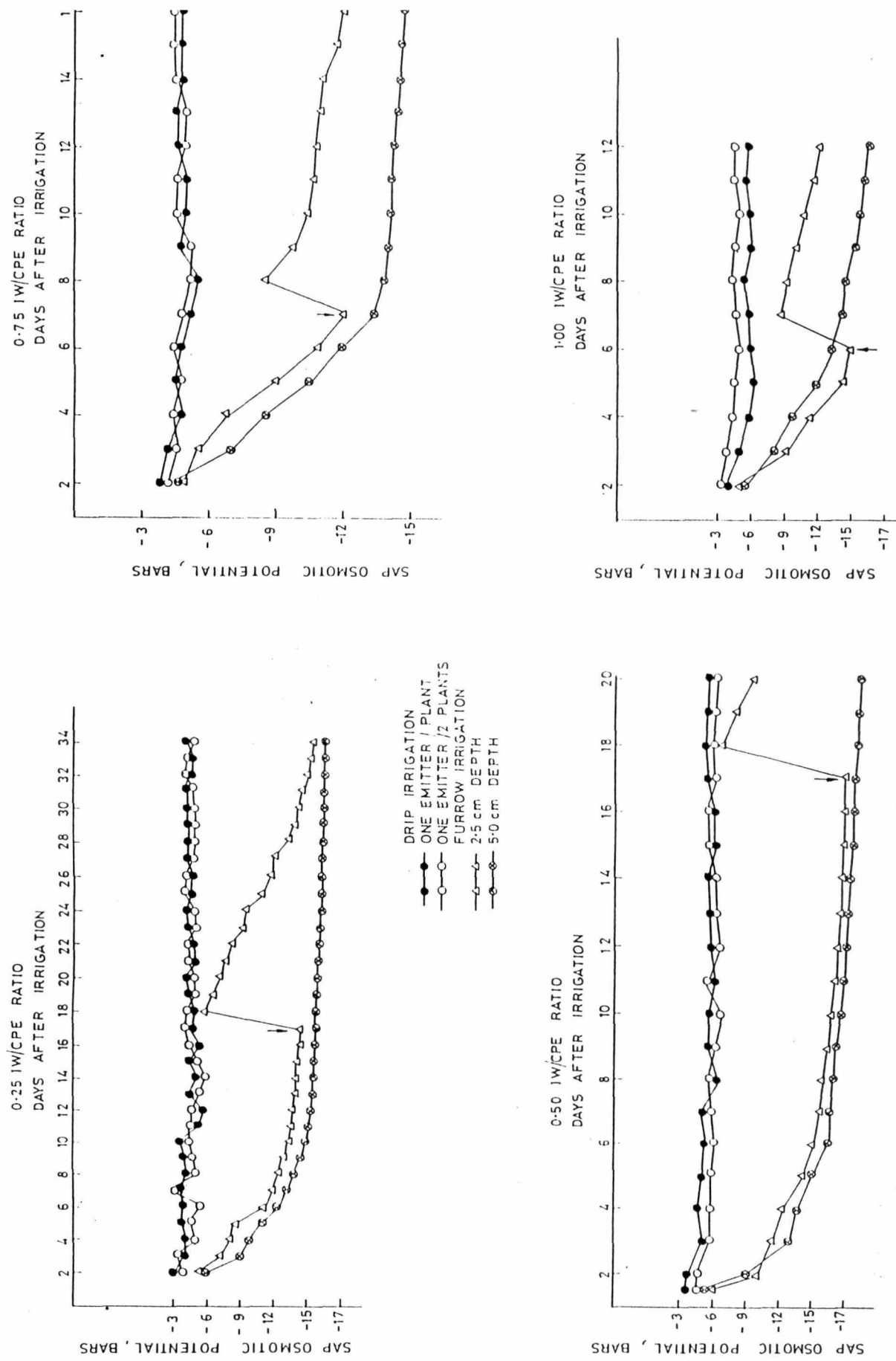


FIG.4.5. CHANGES IN OSMOTIC POTENTIAL AS INFLUENCED BY METHOD OF IRRIGATION

At 1.00 IW/CPE ratio : The relative water content under drip irrigation with one emitter per plant, varied from 94.8 per cent to 95.3 per cent and it varied from 94.6 per cent to 94.1 per cent, with one emitter per two plants. In case of furrow irrigation with 2.5 cm depth, the relative water content decreased from 94.6 per cent to 91.4 per cent, from 1 to 4 days after irrigation and from 94.8 per cent to 90.2 per cent, from 1 to 8 days after irrigation with 5.0 cm depth. Thus, furrow irrigation with 2.5 cm depth recorded 2.6 per cent to 3.8 per cent lower relative water content at 3 and 4 days after irrigation, as compared to drip irrigation and from 1.8 per cent to 5.2 per cent lower relative water content at 3 and 8 days after irrigation, as compared to drip irrigation.

#### 4.2.5.2 Osmotic potential :

The data on Osmotic potential of watermelon, as influenced by IW/CPE ratio and method of irrigation are presented in Fig 4.5

At 0.25 IW/CPE ratio: The osmotic potential under drip irrigation with one emitter per plant, varied from -4.2 bar to -2.9 bar and from -4.6 bar to -3.1 bar with one emitter per two plants. In case of furrow irrigation with 2.5 cm depth, the osmotic potential increased from -4.6 bar to -14.2 bar, from 1 to 17 days after irrigation and in case of 5.0 cm depth, it increased from -4.8 bar to -15.4 bar from 1 to 34 days after furrow irrigation. Thus, the osmotic potential

increased by -6.2 bar at 8 days to -9.6 bar at 17 days with 2.5 cm depth and from -8.5 bar to -11.4 bar with 5.0 cm depth under furrow irrigation, as compared to drip irrigation.

At 0.50 IW/CPE ratio: The osmotic potential under drip irrigation varied from -4.2 bar to -2.8 bar with one emitter per plant and from -5.1 to -2.2 bar with one emitter per two plants. In case of furrow irrigation with 2.5 cm depth osmotic potential increased from -4.6 bar to -17.1 bar from 1 to 17 days after irrigation with 5.0 cm depth, from -5.4 bar to -18.6 bar from 1 to 20 days after irrigation. Thus, the osmotic potential was higher by -7.8 bar at 6 days to -11.5 bar at 17 days after irrigation with 2.5 cm depth and by -8.2 bar at 6 days to -12.3 bar at 20 days after irrigation, as compared to drip irrigation.

At 0.75 IW/CPE ratio: The osmotic potential under drip irrigation with one emitter per plant varied from -4.1 bar to -3.8 bar and from -3.8 bar to -4.1 bar, with one emitter per two plants. In case of furrow irrigation with 2.5 cm depth, the osmotic potential increased from -4.1 to -12.1 bar from 1 to 7 days after irrigation and with 5.0 cm depth, osmotic potential increased from -4.5 bar to -15.2 bar from 1 to 16 days after irrigation. Thus, the osmotic potential with 2.5 cm depth increased by -3.6 bar at 4 days to -8.3 bar at 8 days after irrigation and from -4.6 bar at 4 days to -10.1 bar at 16 days after irrigation with 5.0 cm depth, under furrow irrigation, as compared to drip irrigation.

At 1.00 IW/CPE ratio: The Osmotic potential under drip irrigation with one emitter per plant, varied from -3.2 bar to 4.2 bar and from -2.7 bar to -6.1 bar with one emitter per two plants. In case of furrow irrigation with 2.5 cm depth, the osmotic potential increased from -4.6 bar at 2 days to -15.0 bar at 8 days and from -5.1 bar at 2 days to -15.8 bar at 12 days after irrigation. Thus, the osmotic potential with 2.5 cm depth under furrow irrigation, increased from -5.6 bar at 5 days to -10.2 bar at 6 days after irrigation and from -6.2 bar at 5 days to -11.6 bar at 12 days after irrigation.

#### 4.2.6 Canopy temperature and root studies:

4.2.6.1 Canopy temperature : The data on canopy temperature as influenced by IW/CPE ratio and method of irrigation are presented in Fig. 4.6.

At 0.25 IW/CPE ratio: The variation in canopy temperature was less under drip irrigation which varied from 23.1<sup>0</sup>c to 24.7<sup>0</sup>c with one emitter per plant and from 24.8<sup>0</sup>c to 25.3<sup>0</sup>c with one emitter per two plants. Whereas, the canopy temperature increased from 22.3<sup>0</sup>c to 30.2<sup>0</sup>c from 1 to 15 days after irrigation under furrow irrigation with 2.5 cm depth and from 22.7<sup>0</sup>c to 32.6<sup>0</sup>c from 1 to 27 days after irrigation with 5.0 cm depth. Thus, the canopy temperature was lower under drip irrigation with one emitter per plant by 2.3<sup>0</sup>c at 7 days to 4.8<sup>0</sup>c at 15 days after irrigation as compared to 2.5 cm depth under furrow irrigation and by 2.6<sup>0</sup>c at 7 days

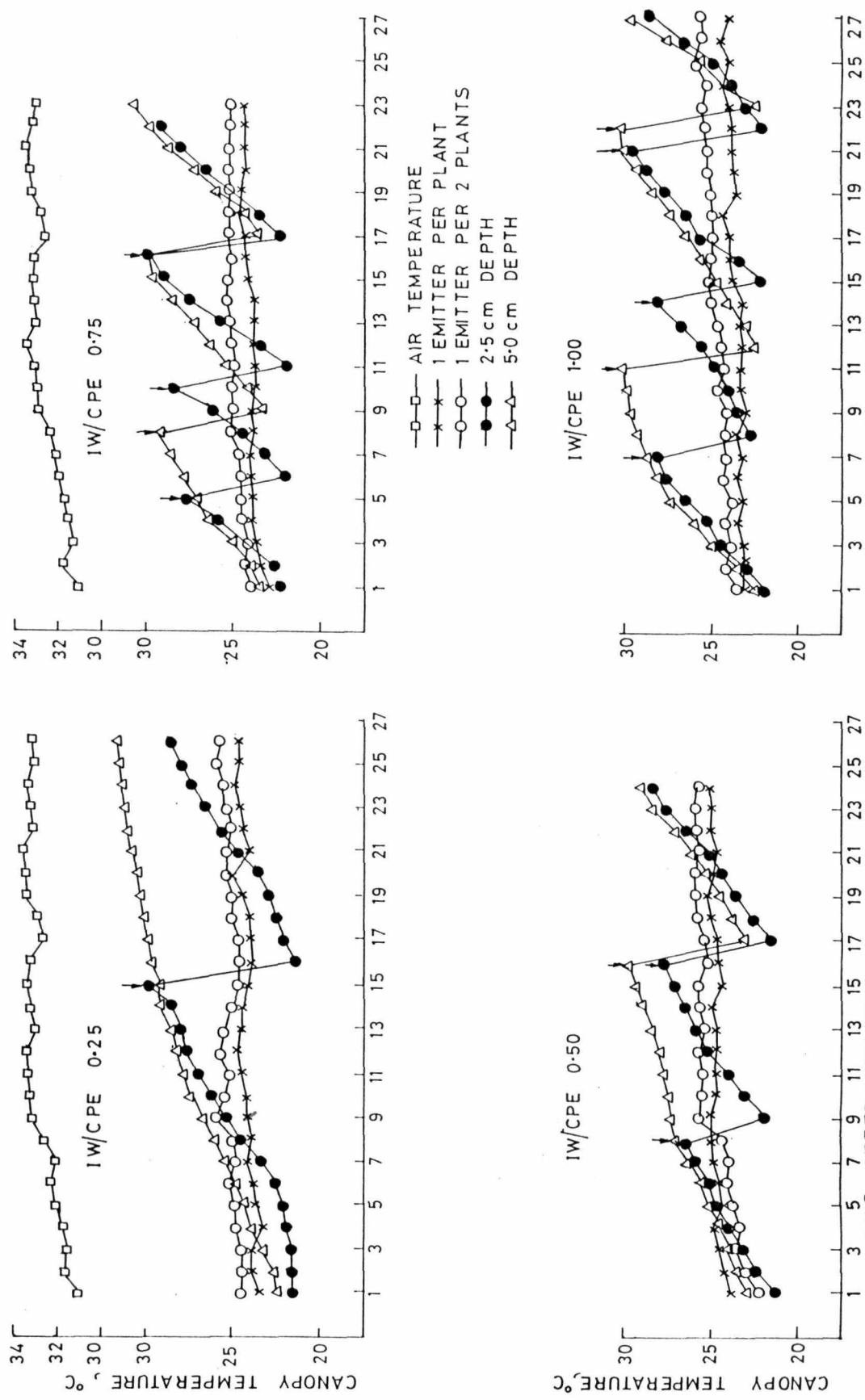


FIG.4.6 CHANGES IN CANOPY TEMPERATURE UNDER DRIP AND FURROW IRRIGATION AT DIFFERENT IW/CPE RATIO

to  $5.9^{\circ}\text{C}$  at 25 days, as compared to 5.0 cm depth under furrow irrigation.

At 0.50 IW/CPE ratio: The canopy temperature variation under drip irrigation with one emitter per plant was from  $22.3^{\circ}\text{C}$  to  $25.0^{\circ}\text{C}$  and with one emitter per two plants was from  $22.5^{\circ}\text{C}$  to  $25.2^{\circ}\text{C}$ . The canopy temperature increased under furrow irrigation with 2.5 cm depth from  $21.7^{\circ}\text{C}$  to  $26.8^{\circ}\text{C}$  from 1 to 8 days after irrigation and from  $22.7^{\circ}\text{C}$  to  $29.8^{\circ}\text{C}$  from 1 to 16 days after irrigation with 5.0 cm depth under furrow irrigation. Thus, furrow irrigation with 5.0 cm depth recorded  $2.1^{\circ}\text{C}$  and  $4.8^{\circ}\text{C}$  higher canopy temperature at 8 and 16 days after irrigation, as compared to drip irrigation with one emitter per plant.

At 0.75 IW/CPE ratio: The variations in temperature under drip irrigation with one emitter per plant, were from  $23.8^{\circ}\text{C}$  to  $25.1^{\circ}\text{C}$ . Furrow irrigation with 2.5 cm recorded higher canopy temperature ( $22.6^{\circ}\text{C}$  to  $27.5^{\circ}\text{C}$  from 1 to 5 days after irrigation) and with 5.0 cm depth, the canopy temperature increased from  $22.5^{\circ}\text{C}$  to  $28.8^{\circ}\text{C}$  from 1 to 8 days after irrigation. Thus, canopy temperature with 5.0 cm depth under furrow irrigation resulted in  $2.1^{\circ}\text{C}$  to  $4.6^{\circ}\text{C}$  higher canopy temperatures as compared to irrigation with one emitter per plant.

At 1.00 IW/CPE ratio: The canopy temperature under drip irrigation with one emitter per plant varied from  $22.0^{\circ}\text{C}$  to  $24.2^{\circ}\text{C}$  and from  $23.6^{\circ}\text{C}$  to  $24.3^{\circ}\text{C}$  with one emitter per two

plants. The canopy temperature under furrow irrigation with 2.5 cm depth increased from 22.3<sup>0</sup>c to 27.2<sup>0</sup>c from 1 to 7 days after irrigation and from 22.6<sup>0</sup>c to 30.1<sup>0</sup>c from 1 to 11 days after irrigation, with 5.0 cm depth. Thus, furrow irrigation with 2.5 cm depth recorded 1.3<sup>0</sup>c to 3.8<sup>0</sup>c higher canopy temperature at 3 and 7 days after irrigation, as compared to drip irrigation with one emitter per plant and with 5.0 cm depth under drip irrigation, the canopy temperature was higher by 3.8<sup>0</sup>c to 5.8<sup>0</sup>c at 5 and 11 days after irrigation, as compared to drip irrigation with one emitter per plant.

Root studies : The data on tap root length, number of secondary roots and dry weight of roots are presented in Table 4.45.

#### 4.2.6.2 Tap root length:

IW/CPE ratio : Root length increased significantly with increase in IW/CPE ratio, during both the years.

During 1984, the root length was significantly higher (57.1 cm) with irrigation at 1.00 IW/CPE ratio, as compared to irrigation at 0.25 (45.1 cm) and 0.50 (50.9 cm) IW/CPE ratios, but was on par with irrigation at 0.75 IW/CPE ratio (56.4 cm). During 1985, the root length was significantly higher (46.8 cm) as compared to irrigation at 0.25 (32.8 cm) and 0.50 (34.4 cm) IW/CPE ratios, but was on par with irrigation at 0.75 IW/CPE ratio (42.7 cm).

Method of irrigation : Root length was more under furrow

**Table 4.45** Root length, secondary roots and dry weight of roots of watermelon as influenced by IW/CPE ratio and method of irrigation

Treatments	Tap root length, (cm) 1984	1985	Number of Sec- ondary roots 1984	1985	Dry weight of roots (g/plant) 1984	1985
<u>IW/CPE ratio</u>						
0.25	45.1	32.8	6.4	6.5	3.49	3.26
0.50	50.9	34.4	6.7	6.6	3.54	4.02
0.75	56.4	42.7	7.8	7.2	4.23	4.18
1.00	57.1	46.8	8.2	7.7	5.09	4.86
'F' test	Sig	Sig	Sig	Sig	Sig	Sig
<u>Method of irrigation</u>						
Drip :						
1 emitter/plant	45.8	35.2	7.0	6.6	3.83	3.81
1 emitter/2 plants	45.5	36.8	6.8	6.4	3.82	3.78
Furrow :						
2.5 cm depth	58.5	48.8	7.8	7.6	4.46	4.52
5.0 cm depth	59.6	49.7	9.9	8.9	4.25	4.43
'F' test	Sig	Sig	Sig	Sig	Sig	Sig
S.E.m ±	1.66	1.48	0.42	0.31	0.089	0.072
C.D. at 5%	4.49	4.29	1.22	0.89	0.259	0.209

irrigation, as compared to drip irrigation. During 1984, tap root length was significantly higher with 2.5 cm (58.5 cm) and 5.0 cm (59.6 cm) depths, under furrow irrigation as compared to one emitter per plant (45.8 cm) and one emitter per two plants (45.5 cm) under drip irrigation. The variations within drip and within furrow irrigation treatments were not statistically significant. Similar trend was observed during 1985.

IW/CPE ratio : The number of secondary roots was more under furrow irrigation, as compared to drip irrigation. During 1984, the number of secondary roots was significantly higher (8.2) with irrigation at 1.00 IW/CPE ratio, as compared to irrigation at 0.25 (6.4) and 0.50 (6.7) IW/CPE ratios, but was on par with irrigation at 0.75 (7.80 IW/CPE ratio. During 1985, number of secondary roots was significantly lower (6.5) with irrigation at 0.25 IW/CPE ratio, as compared to irrigation at 1.00 IW/CPE ratio (7.7) but was on par with irrigation at 0.50 (6.6) and 0.75 (7.2) IW/CPE ratios.

Method of irrigation : During 1984, the number of secondary roots was significantly higher (9.9) with 5.0 cm depth under furrow irrigation, as compared to one emitter per plant (7.0), one emitter per two plants (6.8) under drip irrigation and 2.5 cm depth (7.8) under furrow irrigation which were on par. During 1985, the number of secondary roots was significantly lower (6.4) with one emitter per two plants under drip irrigation, as compared to 2.5 cm (7.6) and 5.0 cm (8.9) depths under furrow irrigation, but was on par with one emitter per plant (6.6) under drip irrigation.

Dry weight of roots:

IW/CPE ratio : During 1984, dry weight of roots was significantly lower (3.49 g/plant ) with irrigation at 0.25 IW/CPE ratio, as compared to irrigation at 0.75 (3.23 g/plant) and 1.00 (5.09 g/plant) IW/CPE ratio, but was on par with irrigation at 0.25 (3.54 g/plant ) IW/CPE ratio. During 1985, dry weight of roots was significantly higher (4.86 g/plant) with irrigation at 1.00 IW/CPE ratio, as compared to irrigation at 0.25 (3.26 g/plant), 0.50 (4.02 g/plant) and 0.75 (4.18 g/plant ) IW/CPE ratios. The differences in dry weight of roots with irrigation at 0.25 and 0.50 IW/CPE ratio were statistically significant. Irrigation at 0.50 and 0.75 IW/CPE ratios were on par.

Method of irrigation : During 1984, furrow irrigation with 2.5 cm depth recorded significantly higher dry weight (4.46 g/plant), as compared to one emitter per plant (3.83 g/plant) and one emitter per two plants (3.82 g/plant) under drip irrigation, but was on par with 5.0 cm depth under furrow irrigation (4.25 g/plant). Similar trend was observed during 1985.

4.2.7 Nutrient content and uptake studies :

4.2.7.1 Nitrogen content :

The data on nitrogen content at different stages of growth, as influenced by IW/CPE ratio and method of irrigation are presented in Table 4.46.

**Table 4.46** Nitrogen content of watermelon as influenced by IW/CPE ratio and method of irrigation

Treatments	Nitrogen content (per cent)								
	40 DAE		60 DAE		80 DAE		1985		
	1984	1985	1984	1985	1984	1985	Shoot	Fruit	
0.25	3.45	3.33	2.87	2.67	1.45	1.57	1.36	1.35	
0.50	4.00	3.82	2.84	2.62	1.51	1.68	1.38	1.38	
0.75	4.29	3.99	2.90	2.68	1.60	1.76	1.40	1.50	
1.00	4.63	4.25	2.93	2.75	1.61	2.04	1.42	1.78	
'F' test	Sig	Sig	NS	NS	NS	Sig	NS	Sig	
<u>Method of irrigation</u>									
Drip :									
1 emitter/plant	4.16	3.94	2.95	2.74	1.66	1.72	1.47	1.61	
1 emitter/2 plants	4.36	4.04	2.97	2.84	1.69	2.01	1.51	1.75	
Furrow :									
2.5 cm depth	4.01	3.73	2.82	2.55	1.46	1.88	1.38	1.45	
5.0 cm depth	3.84	3.71	2.80	2.53	1.36	1.45	1.19	1.20	
'F' test	Sig	Sig	NS	Sig	Sig	Sig	NS	Sig	
S.E.m ±	0.05	0.09	0.06	0.05	0.06	0.08	0.09	0.07	
C.D. at 5%	0.15	0.27	-	0.15	0.18	0.24	0.36	0.22	

IW/CPE ratio : Nitrogen content increased with increase in IW/CPE ratios at all the stages during both the years. However, the differences were statistically significant only at 40 and at 80 DAE, in fruit, during both the years.

During 1984, at 40 DAE, nitrogen content in plant was significantly higher (4.63 %) with irrigation at 1.00 IW/CPE ratio, as compared to irrigation at 0.25 (3.45 %), 0.50 (4.00 %) and 0.75 (4.29%) IW/CPE ratios. At 80 DAE, the nitrogen content in fruit was significantly lower (1.57 %), with irrigation at 0.25 IW/CPE ratio, as compared to irrigation at 1.00 (2.04 %) IW/CPE ratio, but was on par with 0.50 (1.68 %) and 0.75 (1.76%) IW/CPE ratio .

During 1985, at 40 DAE, nitrogen content in plant was significantly higher (4.25%) with irrigation at 1.00 IW/CPE ratio, as compared to irrigation at 0.25 (3.33%), 0.50 (3.82%) and 0.75 (3.99%) IW/CPE ratios. At 80 DAE, in fruit the nitrogen content was significantly lower (1.35%) with irrigation at 0.25 IW/CPE ratio, as compared to irrigation at 1.00 (1.78%) IW/CPE ratio, but was on par with irrigation at 0.25 (1.38%) and 0.75 (1.50%) IW/CPE ratios.

Method of irrigation : Statistically significant variations in nitrogen content were recorded at all the stages, except at 60 DAE in 1984 and 80 DAE in shoot in 1985.

During 1984, at 40 DAE, the nitrogen content in plant was significantly lower (3.84%) with 5.0 cm depth under furrow irrigation, as compared to 2.5 cm depth (4.01%) under furrow irrigation, one emitter per plant (4.16%) and one

emitter per two plants (4.36%) under drip irrigation. At 80 DAE, the nitrogen content in shoot was significantly lower (1.36%) with 5.0 cm depth under furrow irrigation, as compared to one emitter per plant (1.66%) and one emitter per two plants (1.69 %) under drip irrigation, but was on par with 2.5 cm depth (1.46 %) under furrow irrigation. The nitrogen content in fruit was significantly lower (1.45 %) with 5.0 cm depth under furrow irrigation, as compared to 2.5 cm depth (1.88 %) under furrow irrigation and one emitter per plant (1.72 %) and one emitter per two plants (2.01 %) under drip irrigation.

During 1985, at 40 DAE in plant, furrow irrigation with 5.0 cm depth recorded significantly lower (3.71 %) nitrogen content, as compared to drip irrigation with one emitter per plant (4.04 %), but was on par with one emitter per two plants (3.94 %) and 2.5 cm depth under furrow irrigation (3.73 %). At 60 DAE in plant, furrow irrigation with 5.0 cm depth recorded significantly lower (2.53 %) nitrogen content, as compared to one emitter per plant (2.74 %) and one emitter per two plants (2.84 %) under drip irrigation, but was on par with 2.5 cm depth (2.55 %) under furrow irrigation. At 80 DAE, nitrogen content in fruit was significantly lower (1.20%) with 5.0 cm depth under furrow irrigation, as compared to 2.5 cm depth (1.45 %) under furrow irrigation, one emitter per plant (1.61%) and one emitter per two plants (1.75 %) under drip irrigation.

#### 4.2.7.2 Nitrogen uptake :

The data on nitrogen uptake, as influenced by IW/CPE ratio and method of irrigation are presented in Table 4.47.

IW/CPE ratio : Nitrogen uptake increased with the increase in IW/CPE ratio, at all the stages, however, the variations were statistically significant at 40 DAE in both the years, at 80 DAE, in fruit in both the years and at 60 DAE in 1985.

During 1984, at 40 DAE, nitrogen uptake in plant was significantly lower (9.18 kg/ha) with irrigation at 0.25 IW/CPE ratio, as compared to irrigation at 1.00 IW/CPE ratio (13.75 kg/ha), but was on par with irrigation at 0.50 (10.24 kg/ha) and 0.75 (10.65 kg/ha) IW/CPE ratios. At 80 DAE the uptake in fruit was significantly lower (31.55 kg/ha), as compared to irrigation at 0.75 (38.84 kg/ha) and 1.00 (43.84 kg/ha) IW/CPE ratios, but was on par with irrigation at 0.50 (33.51 kg/ha) IW/CPE ratio.

During 1985, at 40 DAE, nitrogen uptake in plant was significantly lower (7.80 kg/ha) with irrigation at 0.25 IW/CPE ratio, as compared to irrigation at 1.00 (11.04 kg/ha) IW/CPE ratio, but, was on par with irrigation at 0.50 (8.77 kg/ha) and 0.75 (8.96 kg/ha) IW/CPE ratios. At 60 DAE in plant and at 80 DAE in fruit, similar trend was observed.

Method of irrigation : Statistically significant variations in nitrogen uptake were observed at all the stages, except at 80 DAE in shoot and total in both the years and at 60 DAE in plant, during 1985.



During 1984, at 40 DAE in plant, furrow irrigation with 2.5 cm depth recorded significantly lower (9.51 kg/ha) nitrogen uptake, as compared to one emitter per plant (12.37 kg/ha) and one emitter per two plants (12.60 kg/ha) under drip irrigation, but was on par with 5.0 cm depth under furrow irrigation (9.53 kg/ha). At 60 DAE in plant, furrow irrigation with 5.0 cm depth recorded significantly lower (28.56 kg/ha) nitrogen uptake, as compared to one emitter per two plants under drip irrigation (40.70 kg/ha), but was on par with one emitter per plant (36.79 kg/ha) under drip irrigation and 2.5 cm depth (35.22 kg/ha) under furrow irrigation. At 80 DAE, the nitrogen uptake in fruit was significantly lower (31.11 kg/ha) with 5.0 cm depth under furrow irrigation, as compared to one emitter per plant (39.57 kg/ha) and one emitter per two plants (44.84 kg/ha) under drip irrigation, but was on par with 2.5 cm depth (33.43 kg/ha) under furrow irrigation.

During 1985, at 40 DAE in plant, furrow irrigation with 5.0 cm depth recorded significantly lower (7.68 kg/ha) nitrogen uptake, as compared to one emitter per plant (10.15 kg/ha) and one emitter per two plants (10.77 kg/ha) under drip irrigation, but was on par with 2.5 cm depth under furrow irrigation (7.96 kg/ha). At 80 DAE in fruit, similar trend was observed.

#### 4.2.7.3 Phosphorus content :

The data on phosphorus content, as influenced by IW/CPE ratio and method of irrigation are presented in Table 4.48.

**Table 4.48 Phosphorus content of watermelon as influenced by IW/CPE ratio and method of irrigation**

Treatments	Phosphorus content (per cent)								
	40 DAE		60 DAE		80 DAE		1985		
	1984	1985	1984	1985	1984	1985	Shoot	Fruit	
0.25	0.58	0.52	0.32	0.28	0.13	0.37	0.11	0.32	
0.50	0.59	0.52	0.39	0.31	0.15	0.42	0.13	0.33	
0.75	0.61	0.55	0.40	0.31	0.16	0.47	0.14	0.36	
1.00	0.64	0.58	0.40	0.32	0.17	0.49	0.15	0.39	
'F' test	Sig	Sig	NS	NS	Sig	Sig	Sig	NS	
<u>Method of irrigation</u>									
Drip :									
1 emitter/plant	0.64	0.56	0.37	0.31	0.17	0.44	0.14	0.40	
1 emitter/2 plants	0.66	0.59	0.42	0.32	0.17	0.52	0.16	0.41	
Furrow :									
2.5 cm depth	0.60	0.53	0.38	0.31	0.13	0.41	0.12	0.30	
5.0 cm depth	0.53	0.48	0.35	0.28	0.13	0.38	0.11	0.29	
'F' test	Sig	Sig	NS	NS	Sig	Sig	Sig	Sig	
S.E.m +	0.013	0.012	0.024	0.015	0.011	0.029	0.010	0.020	
C.D. at 5%	0.038	0.035	-	-	0.032	0.084	0.029	0.058	

IW/CPE ratio : Statistically significant variations in phosphorus content were observed at all the stages, as influenced by IW/CPE ratio, except at 60 DAE, in both the years and at 80 DAE in fruit, during 1985.

During 1984, at 40 DAE, phosphorus content in plant was significantly lower (0.58%) with irrigation at 0.25 IW/CPE ratio, as compared to irrigation at 1.00 (0.64%) IW/CPE ratio, but was on par with irrigation at 0.50 (0.59%) and 0.75 (0.61%) IW/CPE ratios. At 80 DAE in shoot, similar trend was observed. At this stage, in fruit, the phosphorus content was significantly lower (0.37%) with irrigation at 0.25 IW/CPE ratio, as compared to irrigation at 0.75 (0.47%) and 1.00 (0.49%) IW/CPE ratios, but was on par with irrigation at 0.50 (0.42%) IW/CPE ratio.

During 1985, at 40 DAE, phosphorus content in plant was significantly lower (0.52%) with irrigation at 0.25 and 0.50 IW/CPE ratios, as compared to irrigation at 1.00 (0.58%) IW/CPE ratio, but was on par with irrigation at 0.75 (0.55%) IW/CPE ratio. At 80 DAE, the phosphorus content in shoot was significantly lower (0.11%), with irrigation at 0.25 IW/CPE ratio, as compared to irrigation at 1.00 (0.15%) IW/CPE ratio but was on par with irrigation at 0.50 (0.13%) and 0.75 (0.14%) IW/CPE ratios. Similar trend was observed in fruit.

Method of irrigation : Statistically significant variations were observed, as influenced by method of irrigation at all the stages, except at 60 DAE, in both the years.

During 1984, at 40 DAE in plant, furrow irrigation with 5.0 cm depth recorded significantly lower (0.53%) phosphorus content, as compared to 2.5 cm depth (0.60%) under furrow irrigation, one emitter per plant (0.64) and one emitter per two plants (0.66%) under furrow irrigation.

At 80 DAE, the phosphorus content in shoot was significantly lower with 2.5 cm (0.13%) and 5.0 cm (0.13%) depths under furrow irrigation, as compared to one emitter per plant (0.17%) and one emitter per two plants (0.17%) under drip irrigation. At this stage, the phosphorus content in fruit was significantly lower (0.38%) with 5.0 cm depth under furrow irrigation, as compared to one emitter per two plants (0.52%) under drip irrigation, but was on par with one emitter per plant (0.44%) and 2.5 cm depth (0.41%) under furrow irrigation.

During 1985, at 40 DAE, phosphorus content in plant was significantly lower (0.48%) with 5.0 cm depth under furrow irrigation, as compared to 2.5 cm depth (0.53%) under furrow irrigation, one emitter per plant (0.56%) and one emitter per two plants (0.59%) under drip irrigation. At 80 DAE in shoot, the phosphorus content was significantly lower (0.11%) with 5.0 cm depth under furrow irrigation, as compared to one emitter per plant (0.14%) and one emitter per two plants (0.16%) under drip irrigation, but was on par with 2.5 cm depth (0.12%) under furrow irrigation. Similar trend was observed in fruit phosphorus content.

#### 4.2.7.4 Phosphorus uptake :

The data on phosphorus uptake, as influenced by IW/CPE ratio and method of irrigation are presented in Table 4.49.

IW/CPE ratio : Statistically significant differences in phosphorus uptake, as influenced by IW/CPE ratios were recorded at all the stages, except at 60 DAE, in both the years and at 80 DAE in shoot in 1984 and in shoot and total uptake at 80 DAE during 1985.

During 1984, at 40 DAE, phosphorus uptake in plant was significantly lower (1.39 kg/ha) with irrigation at 0.25 IW/CPE ratio, as compared to irrigation at 0.75 (1.73 kg/ha) and 1.00 (1.88 kg/ha) IW/CPE ratios, but was on par with irrigation at 0.50 (1.48 kg/ha) IW/CPE ratio. At 80 DAE, the total phosphorus uptake was significantly lower (11.24 kg/ha) with irrigation at 0.25 IW/CPE ratio as compared to irrigation at 1.00 (15.69 kg/ha) IW/CPE ratio, but was on par with irrigation at 0.50 (12.12 kg/ha) and 0.75 (14.19 kg/ha) IW/CPE ratios. Similar trend was observed in fruit.

During 1985, at 40 DAE, phosphorus uptake in plant was significantly lower (1.12 kg/ha) with irrigation at 0.25 IW/CPE ratio, as compared to irrigation at 0.75 (1.35 kg/ha) and 1.00 (1.44 kg/ha) IW/CPE ratios, but was on par with irrigation at 0.50 (1.19 kg/ha) IW/CPE ratio. At 80 DAE, the phosphorus uptake in fruit was significantly lower (4.89 kg/ha) with irrigation at 0.25 IW/CPE ratio, as compared to irrigation at 1.00 (7.13 kg/ha) IW/CPE ratio, but was on par



with irrigation at 0.50 (5.07 kg/ha) and 0.75 (6.05 kg/ha) IW/CPE ratios.

Method of irrigation : Statistically significant variations in phosphorus uptake, as influenced by method of irrigation were recorded only at 40 DAE, in both the years, in fruit and total uptake in 1985.

During 1984, at 40 DAE, the phosphorus uptake in plant was significantly lower (1.46 kg/ha) with 5.0 cm depth under furrow irrigation, as compared to one emitter per plant (1.70 kg/ha) and one emitter per two plants (1.74 kg/ha) under drip irrigation, but was on par with 2.5 cm depth (1.59 kg/ha) under furrow irrigation.

During 1985, at 40 DAE, in plant, furrow irrigation with 5.0 cm depth recorded significantly lower (1.14 kg/ha) phosphorus uptake, as compared to one emitter per plant (1.33 kg/ha) and one emitter per two plants (1.43 kg/ha) under drip irrigation, but, was on par with 2.5 cm depth (1.21 kg/ha), under furrow irrigation. At 80 DAE, the total phosphorus was significantly lower (7.68 kg/ha) with 5.0 cm depth under furrow irrigation, as compared to one emitter per plant (12.99 kg/ha) under drip irrigation, but was on par with one emitter per two plants (10.20 kg/ha), under drip irrigation and 2.5 cm depth (8.57 kg/ha) under furrow irrigation. At this stage, the shoot phosphorus uptake was significantly lower (4.69 kg/ha), with 5.0 cm depth under furrow irrigation, as compared to one emitter per plant (6.46 kg/ha) and one emitter per two plants (6.53 kg/ha) under

drip irrigation, but was on par with 2.5 cm depth under furrow irrigation (5.46 kg/ha).

#### 4.2.7.5 Potassium content :

The data on potassium content of watermelon, as influenced by IW/CPE ratio, and method of irrigation at different stages of growth, are presented in Table 4.50.

**IW/CPE ratio :** Potassium content increased with increase in IW/CPE ratio, however, the variations were statistically significant only at 80 DAE in 1984. At this stage, the shoot potassium content was significantly lower (0.69%) with irrigation at 0.25 IW/CPE ratio, as compared to irrigation at 1.00 IW/CPE ratio (1.00%) but, was on par with irrigation at 0.50 (0.71%) and 0.75 (0.83%) IW/CPE ratios. Similar trend was observed in fruit potassium content.

**Method of irrigation :** Statistically significant differences in potassium content were observed at all the stages, except at 40 DAE in both the years.

During 1984, at 60 DAE, the potassium content in plant was significantly lower (1.99%) with 5.0 cm depth, under furrow irrigation, as compared to 2.5 cm depth (2.42%) under furrow irrigation and one emitter per plant (2.58%) and one emitter per two plants (2.65%) under drip irrigation. At 80 DAE, the potassium content in shoot was significantly lower (0.53%) with 5.0 cm depth under furrow irrigation, as compared to 2.5 cm depth (0.66%) under furrow irrigation and one emitter per plant (0.91%) and one emitter per two



plants (1.13%), under drip irrigation. In case of fruit, the potassium content was significantly lower (2.84%), with 5.0 cm depth, under furrow irrigation, as compared to one emitter per two plants (3.49%), under drip irrigation, but was on par with one emitter per plant (3.24%) under drip irrigation and 2.5 cm depth (3.11%), under furrow irrigation.

During 1985, at 60 DAE in plant, furrow irrigation with 5.0 cm depth, recorded significantly lower potassium content (1.99%) as compared to 2.5 cm depth (2.45%), under furrow irrigation and one emitter per plant (2.32%) and one emitter per two plants (2.52%), under drip irrigation. At 80 DAE, the potassium content in shoot was significantly lower (0.52%), with 5.0 cm depth, under furrow irrigation, as compared to one emitter per plant (0.80%) and one emitter per two plants (0.87%), under furrow irrigation. Similar trend was observed in fruit potassium content.

#### 4.2.7.6 Potassium uptake :

The data on potassium uptake of watermelon, as influenced by IW/CPE ratio and method of irrigation at different stages are presented in Table 4.51.

IW/CPE ratio : Potassium uptake increased with the increase in IW/CPE ratio. Statistically significant variations were observed at all the stages, except at 80 DAE in 1984 and in fruit and total uptake in 1985.

During 1984, at 40 DAE, the potassium uptake in plant was significantly lower (5.63 kg/ha) with irrigation at 0.25

**Table 4.51** Potassium uptake of watermelon as influenced by IW/CPE ratio and method of irrigation

Treatments	Potassium uptake (kg/ha)												
	40 DAE		60 DAE				80 DAE						
	1984	1985	1984	1985	1984	1985	Shoot	Fruit	Total uptake	Shoot	Fruit	Total uptake	
<u>IW/CPE ratio</u>													
0.25	5.63	5.55	21.98	18.66	18.44	60.10	78.64	14.03	45.10	59.13			
0.50	6.21	6.82	28.20	20.36	20.36	64.82	85.18	16.04	47.24	63.28			
0.75	8.18	7.15	29.71	23.18	20.96	65.89	86.85	17.58	47.97	65.55			
1.00	9.25	7.44	34.35	28.22	21.62	71.12	92.74	19.22	54.59	73.81			
'F' test	Sig	Sig	Sig	Sig	NS	NS	NS	Sig	NS	NS			
<u>Method of irrigation</u>													
Drip :													
1 emitter/plant	7.36	7.36	27.99	26.60	21.55	67.28	88.83	18.43	48.68	67.11			
1 emitter/2 plants	7.36	7.77	38.04	27.04	26.06	74.87	100.93	20.42	59.86	80.28			
Furrow :													
2.5 cm depth	6.68	6.30	26.03	20.60	18.23	67.00	85.23	15.25	44.64	59.89			
5.0 cm depth	5.85	5.53	22.19	16.18	15.63	52.79	68.42	12.76	41.72	54.48			
'F' test	NS	NS	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig			
S.E.m +	0.69	0.37	3.26	2.59	2.69	5.29	6.58	1.45	3.40	6.15			
C.D. at 5%	2.00	1.07	9.40	7.48	7.77	15.26	19.08	4.07	9.82	18.50			

IW/CPE ratio, as compared to irrigation at 0.75 (8.18 kg/ha) and 1.00 (9.25 kg/ha) IW/CPE ratios, but was on par with irrigation at 0.50 (6.21 kg/ha) IW/CPE ratio. At 60 DAE, potassium uptake in plant was significantly lower (21.98 kg/ha) with irrigation at 0.25 IW/CPE ratio, as compared to irrigation at 1.00 IW/CPE ratio (34.35 kg/ha), but was on par with irrigation at 0.50 (28.20 kg/ha) and 0.75 (29.71 kg/ha) IW/CPE ratios.

During 1985, at 40 DAE, the potassium uptake in plant was significantly lower (5.55 kg/ha) with irrigation at 0.25 IW/CPE ratio, as compared to irrigations at 0.50 (6.82 kg/ha), 0.75 (7.15 kg/ha) and 1.00 (7.44 kg/ha) IW/CPE ratios. At 60 DAE, irrigation at 0.25 IW/CPE ratio, recorded significantly lower (18.66 kg/ha) potassium uptake in plant, as compared to irrigation at 0.50 (20.36 kg/ha), 0.75 (23.18 kg/ha) and 1.00 (28.22 kg/ha) IW/CPE ratios. Similarly at 80 DAE, the potassium uptake in shoot was significantly lower (14.03 kg/ha) with irrigation at 0.25 IW/CPE ratio, as compared to irrigation at 0.50 (16.04 kg/ha), 0.75 (17.58 kg/ha) and 1.00 (19.22 kg/ha) IW/CPE ratios.

Method of irrigation : Statistically significant variations in potassium uptake were recorded at all the stages, except at 40 DAE in 1984.

During 1984, at 60 DAE, furrow irrigation with 5.0 cm depth, recorded significantly lower (22.19 kg/ha) potassium uptake as compared to one emitter per two plants (38.04 kg/ha) under drip irrigation, but was on par with one emitter

per plant (27.99 kg/ha) under drip irrigation and 2.5 cm depth (26.03 kg/ha) under furrow irrigation. At 80 DAE, the total potassium uptake was significantly lower (68.42 kg/ha) with 5.0 cm depth under furrow irrigation, as compared to one emitter per plant (88.83 kg/ha) and one emitter per two plants (100.93 kg/ha) under drip irrigation, but, was on par with 2.5 cm depth (85.23 kg/ha) under furrow irrigation. At this stage in shoot, the potassium uptake was significantly lower (15.63 kg/ha) with 5.0 cm depth under furrow irrigation, as compared to one emitter per two plants (26.06 kg/ha) under drip irrigation, but, was on par with 2.5 cm depth (18.23 kg/ha) under furrow irrigation and one emitter per plant (21.55 kg/ha) under drip irrigation. Similar trend was observed in fruit potassium uptake.

During 1985, at 40 DAE in plant, furrow irrigation with 5.0 cm depth recorded significantly lower (5.53 kg/ha) potassium uptake, as compared to, one emitter per plant (7.36 kg/ha) and one emitter per two plants (7.77 kg/ha), under drip irrigation, but, was on par with 2.5 cm depth (6.30 kg/ha) under furrow irrigation. At 60 DAE in plant, the potassium uptake was significantly lower (16.18 kg/ha), with 5.0 cm depth under furrow irrigation, as compared to, one emitter per plant (26.60 kg/ha), one emitter per two plants (27.04 kg/ha) under drip irrigation, but, was on par with 2.5 cm depth (20.60 kg/ha) under furrow irrigation. At 80 DAE, the total potassium uptake was significantly lower (54.48 kg/ha), with 5.0 cm depth under furrow irrigation, as

compared to, one emitter per two plants under drip irrigation (80.28 kg/ha), but, was on par with one emitter per plant (67.11 kg/ha) under drip irrigation and 2.5 cm depth (59.89 kg/ha) under furrow irrigation. Similar trend was observed in fruit. In shoot, the potassium uptake was significantly lower (12.76 kg/ha), with 5.0 cm depth under furrow irrigation, as compared, to one emitter per plant (18.43 kg/ha) and one emitter per two plants (20.42 kg/ha) under drip irrigation, but, was on par with 2.5 cm depth (15.25 kg/ha) under furrow irrigation.

#### 4.2.7.7. Calcium content :

The data on calcium content of watermelon, as influenced by IW/CPE ratio and method of irrigation are presented in Table 4.52.

IW/CPE ratio : Calcium content increased with the increase in IW/CPE ratio, although, the variations were statistically significant only at 60 DAE, in both the years and at 80 DAE in shoot, during both the years.

During 1984, at 60 DAE, calcium content in plant was significantly lower (4.10%), with irrigation at 0.25 IW/CPE ratio, as compared to irrigation at 0.50 (5.38%), 0.75 (5.55%) and 1.00 (5.59%) IW/CPE ratios. At 80 DAE, the calcium content in shoot was significantly lower (4.48%) with irrigation at 0.25 IW/CPE ratio, as compared to irrigation at 0.75 (5.14%) and 1.00 (5.24%) IW/CPE ratios, but, was on par with irrigation at 0.50 (4.86%) IW/CPE ratio.

**Table 4.52** Calcium content of watermelon as influenced by IW/CPE ratio and method of irrigation

Treatments	Calcium content (per cent)					
	40 DAE		60 DAE		80 DAE	
	1984	1985	1984	1985	1984	1985
	Shoot	Fruit	Shoot	Fruit	Shoot	Fruit
<u>IW/CPE ratio</u>						
0.25	3.75	3.10	4.10	4.01	4.48	0.28
					3.66	0.27
0.50	4.09	3.39	5.38	4.86	4.94	0.28
					4.39	0.27
0.75	4.12	3.41	5.55	5.02	5.14	0.29
					4.46	0.28
1.00	4.44	3.66	5.59	5.12	5.24	0.29
					4.63	0.29
'F' test	NS	NS	Sig	Sig	Sig	NS
<u>Method of irrigation</u>						
Drip :						
1 emitter/plant	4.23	3.48	5.23	4.71	5.35	0.28
					4.19	0.28
1 emitter/2 plants	4.23	3.89	5.39	4.85	5.68	0.29
					4.96	0.29
Furrow :						
2.5 cm depth	3.96	3.47	5.05	4.77	4.52	0.29
					4.12	0.28
5.0 cm depth	3.66	3.31	4.94	4.67	4.25	0.27
					3.88	0.27
'F' test	NS	NS	NS	NS	Sig	NS
S.E.m ±	0.27	0.14	0.14	0.11	0.17	0.01
C.D. at 5%	-	-	0.39	0.31	0.50	-
					0.43	-

During 1985, at 60 DAE, calcium content in plant was significantly lower (4.10%), with irrigation at 0.25 IW/CPE ratio, as compared to irrigation at 0.50 (4.86%), 0.75 (5.02%) and 1.00 (5.12%) IW/CPE ratios. At 80 DAE, the calcium content in fruit was significantly lower (3.66%) with irrigation at 0.25 IW/CPE ratio, as compared to irrigation at 0.50 (4.39%), and 0.75 (4.46%) and 1.00 (4.63%) IW/CPE ratios.

Method of irrigation : Statistically significant variations were recorded only at 80 DAE in shoot, during both the years.

During 1984, the calcium content was significantly lower (4.25%) with 5.0 cm depth under furrow irrigation, as compared to, one emitter per plant (5.35%) and one emitter per two plants (5.68%) under drip irrigation, but, was on par with 2.5 cm depth (4.52%), under furrow irrigation.

During 1985, furrow irrigation with 5.0 cm depth recorded significantly lower (3.88%) calcium content, as compared to, one emitter per two plants (4.96%) under drip irrigation, but was on par with one emitter per plant (4.19%) under drip irrigation and 2.5 cm depth (4.12%) under furrow irrigation.

#### 4.2.7.8 Calcium uptake :

The data on calcium uptake of watermelon, as influenced by IW/CPE ratio and method of irrigation are presented in Table 4.53.

**Table 4.53** Calcium uptake of watermelon as influenced by IW/CPE ratio and method of irrigation

Treatments	Calcium uptake (kg/ha)											
	40 DAE		60 DAE		80 DAE		1984		1985		Total uptake	
	1984	1985	1984	1985	1984	1985	Shoot	Fruit	Shoot	Fruit		
<u>IW/CPE ratio</u>												
0.25	9.60	6.94	39.45	32.85	100.84	4.89	105.73	95.60	4.11	99.71		
0.50	12.01	8.11	62.89	46.30	124.92	5.01	129.93	102.89	4.75	107.64		
0.75	12.88	8.54	67.56	48.01	133.78	5.23	139.01	111.92	4.86	116.78		
1.00	24.86	9.50	71.16	48.82	158.08	5.36	163.44	115.10	4.92	120.02		
'F' test	Sig	Sig	Sig	Sig	Sig	NS	Sig	NS	NS	NS	NS	NS
<u>Method of irrigation</u>												
Drip :												
1 emitter/plant	12.00	9.32	57.84	46.46	134.18	5.02	140.00	102.68	4.56	107.24		
1 emitter/2 plants	26.54	9.59	79.50	50.93	147.20	5.90	153.10	110.79	5.13	115.92		
Furrow :												
2.5 cm depth	10.96	7.37	55.30	39.48	110.43	5.18	123.61	102.78	4.63	107.41		
5.0 cm depth	9.84	6.83	48.38	39.13	112.60	4.86	117.46	101.88	4.31	106.19		
'F' test	Sig	Sig	Sig	Sig	NS	NS	NS	NS	NS	NS	NS	NS
S.E.m ±	3.94	0.54	5.88	3.85	13.28	0.33	14.56	7.29	0.30	11.86		
C.D. at 5%	11.37	1.58	16.98	11.13	39.88	-	42.24					

IW/CPE ratio : Calcium uptake increased with increase in IW/CPE ratios at all the stages. However, the variations were statistically significant only at 40 and 60 DAE, in both the years and at 80 DAE in shoot and total uptake during 1984.

During 1984, at 40 DAE, the calcium uptake in plant was significantly lower (9.60 kg/ha), with irrigation at 0.25 IW/CPE ratio, as compared to, irrigation at 1.00 (24.86 kg/ha) IW/CPE ratio, but, was on par with irrigation at 0.50 (12.01 kg/ha) and 0.75 (12.88 kg/ha) IW/CPE ratios. At 60 DAE, calcium uptake in plant was significantly lower (39.45 kg/ha), with irrigation at 0.25 IW/CPE ratio, as compared to, irrigation at 0.50 (62.89 kg/ha), 0.75 (67.56 kg/ha) and 1.00 (71.16 kg/ha) IW/CPE ratios. At 80 DAE, the total calcium uptake was significantly lower (105.73 kg/ha), with irrigation at 0.25 IW/CPE ratio, as compared to, irrigation at 1.00 (163.44 kg/ha) IW/CPE ratio, but, was on par with irrigation at 0.50 (129.93 kg/ha) and 0.75 (139.01 kg/ha) IW/CPE ratios. Similar trend was observed in calcium uptake in shoot.

Method of irrigation : Statistically significant variations in calcium uptake, as influenced by method of irrigation were recorded at 40 and 60 DAE, in both the years.

During 1984, at 40 DAE in plant, furrow irrigation with 5.0 cm depth (9.84 kg/ha) recorded significantly lower calcium uptake, as compared to, one emitter per two plants (26.54 kg/ha) under drip irrigation, but, was on par with one emitter per plant (12.00 kg/ha) under drip irrigation and 2.5

cm depth (10.96 kg/ha) under furrow irrigation. At 60 DAE, the calcium uptake in plant was significantly lower (48.38 kg/ha), with 5.0 cm depth under furrow irrigation, as compared to one emitter per two plants (79.50 kg/ha) under drip irrigation, but, was on par with one emitter per plant (57.84 kg/ha) under drip irrigation and 2.5 cm depth (55.30 kg/ha) under furrow irrigation.

During 1985, at 40 DAE, the calcium uptake in plant was significantly lower (6.83 kg/ha) with irrigation at 5.0 cm depth under furrow irrigation, as compared to, one emitter per plant (9.32 kg/ha) and one emitter per two plants (9.59 kg/ha), under drip irrigation, but, was on par with and 2.5 cm depth (7.37 kg/ha) under furrow irrigation. At 60 DAE in plant, furrow irrigation with 5.0 cm depth recorded significantly lower calcium uptake (39.13 kg/ha), as compared to, one emitter per two plants (50.93 kg/ha) under drip irrigation, but, was on par with 2.5 cm depth (39.48 kg/ha) under furrow irrigation and one emitter per plant (46.46 kg/ha) under drip irrigation.

#### 4.2.7.9 Magnesium content :

The data on magnesium content of watermelon, as influenced by IW/CPE ratio and method of irrigation are presented in Table 4.54.

IW/CPE ratio : Statistically significant variations in magnesium content were recorded only at 60 DAE, in both years and at 80 DAE in shoot, in both the years.

Table 4.54 Magnesium content of watermelon as influenced by IW/CPE ratio and method of irrigation

Treatments	Magnesium content (per cent)								
	40 DAE		60 DAE		80 DAE		1985		
	1984	1985	1984	1985	1984	1985	Shoot	Fruit	
IW/CPE ratio									
0.25	0.85	0.81	1.07	1.01	1.05	0.43	1.00	0.42	
0.50	0.90	0.82	1.11	1.05	1.17	0.44	1.06	0.43	
0.75	0.93	0.83	1.14	1.07	1.22	0.46	1.11	0.45	
1.00	0.94	0.86	1.22	1.20	1.25	0.45	1.16	0.45	
'F' test	NS	NS	Sig	Sig	Sig	NS	Sig	NS	NS
<u>Method of irrigation</u>									
Drip :									
1 emitter/plant	0.88	0.82	1.17	1.13	1.17	0.44	1.10	0.45	
1 emitter/2 plants	0.94	0.90	1.21	1.18	1.22	0.45	1.11	0.45	
Furrow :									
2.5 cm depth	0.91	0.80	1.12	1.06	1.16	0.44	1.07	0.43	
5.0 cm depth	0.89	0.80	1.04	0.96	1.13	0.44	1.06	0.42	
'F' test	NS	NS	Sig	Sig	NS	NS	NS	NS	NS
S.E.m ±	0.03	0.03	0.04	0.04	0.05	0.02	0.03	0.02	0.02
C.D. at 5%	-	-	0.12	0.11	0.13	-	0.09	-	-

During 1984, at 60 DAE, the magnesium content in plant was significantly lower (1.07%) with irrigation at 0.25 IW/CPE ratio, as compared to irrigation at 1.00 (1.22%) IW/CPE ratio, but, was on the par with irrigation at 0.50 (1.11%) and 0.75 (1.14%) IW/CPE ratios. At 80 DAE in shoot, the magnesium content was significantly lower (1.05%), with irrigation at 0.25 IW/CPE ratio, as compared to, irrigation at 0.75 (1.22%) and 1.00 (1.25%) IW/CPE ratios, but, was on par with irrigation at 0.50 (1.17%) IW/CPE ratio.

During 1985, at 60 DAE, the magnesium content in plant was significantly lower (1.01%), with irrigation at 0.25 IW/CPE ratio, as compared to, irrigation at 1.00 (1.20%) IW/CPE ratio, but was on par with irrigation at 0.50 (1.05%) and 0.75 (1.07%) IW/CPE ratios. At 80 DAE, the shoot magnesium content was significantly lower (1.00%), with irrigation at 0.25 IW/CPE ratio, as compared to, irrigation at 0.75 (1.11%) and 1.00 (1.16%) IW/CPE ratios, but, was on par with irrigation at 0.50 (1.06%) IW/CPE ratio.

Method of irrigation : Statistically significant variations in magnesium content, as influenced by method of irrigation were recorded only at 60 DAE in plant, during both the years.

During 1984, the magnesium content was significantly lower (1.04%) with 5.0 cm depth under furrow irrigation, as compared to, one emitter per plant (1.17%) and one emitter per two plants (1.21%) under drip irrigation, but, was on par with 2.5 cm (1.12%) under furrow irrigation.

During 1985, furrow irrigation with 5.0 cm depth recorded significantly lower (0.96%) magnesium content as compared to, one emitter per plant (1.13%) and one emitter per two plants (1.18%) under drip irrigation, but, was on par with 2.5 cm depth (1.06%) under furrow irrigation.

#### 4.2.7.10 Magnesium uptake :

The data on magnesium uptake of watermelon as influenced by IW/CPE ratio and method of irrigation are presented in Table 4.55.

IW/CPE ratio : Magnesium uptake increased with increase in IW/CPE ratio, but, the variations were statistically significant at 40 DAE in both the years, at 60 DAE in 1985 and at 80 DAE in shoot and total uptake in 1985.

During 1984, at 40 DAE, the magnesium uptake in plant was significantly lower (1.98 kg/ha) with irrigation at 0.25 IW/CPE ratio, as compared to, irrigation at 0.75 (2.66 kg/ha) and 1.00 (3.03 kg/ha) IW/CPE ratios, but, was on par with irrigation at 0.50 (2.11 kg/ha) IW/CPE ratio .

During 1985, at 40 DAE, the magnesium uptake in plant was significantly lower (1.64 kg/ha), with irrigation at 0.25 IW/CPE ratio, as compared to, irrigation at 0.75 (2.17 kg/ha) and 1.00 (2.24 kg/ha) IW/CPE ratios, but, was on par with irrigation at 0.50 (1.95 kg/ha) IW/CPE ratio. At 80 DAE, the total magnesium uptake was significantly lower (31.79 kg/ha), with irrigation at 0.25 IW/CPE ratio, as compared to, irrigation at 1.00 (38.49 kg/ha) IW/CPE ratio, but, was on par with irrigation at 0.50 (31.91 kg/ha) and 0.75 (34.84

**Table 4.55** Magnesium uptake of watermelon as influenced by IW/CPE ratio and method of irrigation

Treatments	Magnesium uptake (kg/ha)									
	40 DAE		60 DAE				80 DAE			
	1984	1985	1984	1985	1984	1985	Shoot	Fruit	Total uptake	Total uptake
0.25	1.98	1.64	11.07	7.65	27.61	6.82	25.01	6.78	34.43	31.79
0.50	2.11	1.95	12.24	9.74	29.39	6.88	25.11	6.80	36.77	31.91
0.75	2.66	2.17	14.58	10.02	30.21	6.84	27.59	7.25	37.15	34.84
1.00	3.03	2.24	14.71	11.07	33.56	7.11	30.35	8.14	40.67	38.49
'F' test	Sig	Sig	NS	Sig	NS	NS	Sig	NS	NS	Sig
<u>Method of irrigation</u>										
Drip :										
1 emitter/plant	2.64	2.15	17.70	10.65	32.60	6.96	28.04	6.86	39.56	34.90
1 emitter/2 plants	2.85	2.29	16.11	12.46	33.58	7.12	30.25	7.25	40.90	37.50
Furrow :										
2.5 cm depth	2.19	1.79	12.19	8.05	30.58	7.00	27.19	6.98	37.58	34.17
5.0 cm depth	2.10	1.77	10.60	7.32	23.70	6.93	22.58	6.78	30.63	29.36
'F' test	Sig	Sig	Sig	Sig	Sig	NS	Sig	NS	Sig	Sig
S.E.m +	0.16	0.13	1.46	0.97	2.40	0.36	1.51	0.39	3.01	2.11
C.D. at 5%	0.45	0.37	4.22	2.81	6.94	-	4.36	6.12	8.73	6.12

kg/ha) IW/CPE ratios. Similar trend was observed in shoot.

Method of irrigation : Method of irrigation had statistically significant influence on magnesium uptake, at all the stages except, in fruit at 80 DAE during both the years.

During 1984, at 40 DAE, the magnesium uptake in plant was significantly lower (2.10 kg/ha) with 5.0 depth under furrow irrigation, as compared to, one emitter per plant (2.64 kg/ha) and one emitter per two plants (2.85 kg/ha) under drip irrigation, but, was on par with 2.5 cm depth (2.19 kg/ha) under furrow irrigation. At 60 DAE, in plant, furrow irrigation with 5.0 cm depth recorded significantly lower (10.60 kg/ha) magnesium uptake, as compared to, one emitter per plant (17.70 kg/ha) and one emitter per two plants (16.11 kg/ha) under drip irrigation, but, was on par with 2.5 cm depth (12.19 kg/ha) under furrow irrigation. At 80 DAE, the total magnesium uptake was significantly lower (30.63 kg/ha) with 5.0 cm depth under furrow irrigation, as compared to, one emitter per plant (39.56 kg/ha) and one emitter per two plants (40.90 kg/ha) under drip irrigation, but, was on par with 2.5 cm depth (37.58 kg/ha) under furrow irrigation. Similar trend was observed in shoot magnesium uptake.

During 1985, at 40 DAE, the magnesium uptake in plant was significantly lower (1.77 kg/ha) with 5.0 cm depth under furrow irrigation, as compared to, one emitter per plant (2.15 kg/ha) and one emitter per two plants (2.29 kg/ha) under drip irrigation, but, was on par with 2.5 cm depth

(1.79 kg/ha) under furrow irrigation. At 60 DAE, the magnesium uptake in plant was significantly lower (7.32 kg/ha) with 5.0 cm depth under furrow irrigation, as compared to, one emitter per plant (10.65 kg/ha) and one emitter per two plants (12.46 kg/ha) under drip irrigation, but, was on par with 2.5 cm depth (8.05 kg/ha) under furrow irrigation. At 80 DAE, the total magnesium uptake was significantly lower (29.36 kg/ha) with 5.0 cm depth under furrow irrigation, as compared to, one emitter per two plants (37.50 kg/ha) under drip irrigation, but, was on par with one emitter per plant (34.90 kg/ha) under drip irrigation and 2.5 cm depth (34.17 kg/ha) under furrow irrigation. The magnesium uptake in shoot, at this stage, was significantly lower (22.58 kg/ha) with 5.0 cm depth under furrow irrigation, as compared to, 2.5 cm depth (27.19 kg/ha) under furrow irrigation, one emitter per plant (28.04 kg/ha) and one emitter per two plants (30.25 kg/ha) under drip irrigation.

#### 4.2.8 Correlation Studies :

The data on correlations between fruit yield and other growth and yield parameters are presented in Table 4.56.

During 1984, significant and positive correlations were obtained in respect of vine length, dry matter, hundred seed weight, reducing and total sugars and phosphorus content in plants. However, during 1985, the correlations with yield were significant and positive only with vine length, dry matter in fruit and number of seeds per fruit.

**Table 4.56** Correlation between yield and other attributes, as affected by IW/CPE ratio and method of irrigation

Parameters	'r' value	
	1984	1985
1. Vine length	0.6815**	0.5688*
2. Dry matter per plant	0.8632**	0.1751
3. Dry matter per fruit	0.3281	0.5133*
4. Leaf area index	0.3793	0.3489
5. Number of fruits per ha	0.0283	0.4276
6. Average fruit weight	0.2813	0.3012
7. Number of seeds per fruit	0.1512	0.4949*
8. Hundred seed weight	0.4808*	0.3778
9. Flesh thickness	0.2864	0.3143
10. Rind thickness	0.3962	0.3221
11. Reducing sugars	0.7968**	0.4371
12. Total sugars	0.7395**	0.3187
13. Nitrogen (% in plant)	0.2946	0.3156
14. Phosphorus (% in plant)	0.1009	0.0215
15. Potassium (% in plant)	0.3694	0.0719
16. Calcium (% in plant)	0.4750	0.1781
17. Magnesium (% in plant)	0.1335	0.1579

\* Significant at 5% level

\*\* Significant at 1% level

#### 4.2.9 Water use and water use efficiency :

Water use : The data on water use of watermelon crop are presented in Tables 4.57 and 4.58. The total water use under furrow irrigation ranged from 288 mm with irrigation at 0.25 IW/CPE ratio, with two to five irrigations, to 672 mm with irrigation at 1.00 IW/CPE ratio and the number of irrigations varied from ten to twenty three. Thus, it could be seen that nearly 384 mm more water was used with irrigation at 0.25 IW/CPE ratio.

The total water use under drip irrigation with one emitter per plant and one emitter per two plants was the same, in both the years. The water use varied from 207 mm with irrigation at 0.25 PER to 680 mm with irrigation at 1.00 PER ratio. Drip irrigation with 1.00 PER resulted in nearly 473 mm more water use, as compared to, irrigation at 1.00 PER.

Table 4.57 Water use of watermelon crop under furrow irrigation

IW/CPE ratio	IW, cm	* Quantity of irrigation water applied, mm		Effective rainfall, mm		** Soil moisture depletion, mm		Total water use mm	
		1984	1985	1984	1985	1984	1985	1984	1985
0.25	2.5	175 (5)	175 (5)	68.8	65.4	44.77	48.93	288.57	289.33
	5.0	150 (2)	150 (2)	87.4	65.9	66.77	53.78	304.17	269.68
0.50	2.5	300 (10)	325 (11)	67.7	51.9	32.39	36.92	400.09	413.82
	5.0	300 (5)	300 (5)	68.8	65.4	39.98	33.50	408.78	408.90
0.75	2.5	425 (15)	475 (17)	50.8	58.7	23.25	22.46	499.05	556.16
	5.0	400 (7)	450 (8)	87.4	65.0	43.40	42.72	530.80	557.72
1.00	2.5	550 (20)	625 (23)	63.8	53.4	20.42	30.83	634.22	709.23
	5.0	550 (10)	600 (11)	67.7	51.9	34.38	38.75	652.08	690.65

\* Includes the two common irrigations of 25 mm each

The figure in the parenthesis show the total number of irrigations excluding the common irrigations

\*\* The contribution of crop water use from the stored soil moisture at sowing and harvest.

**Table 4.58** Water use of watermelon under drip irrigation.

PER ratios	Water use, mm	
	1984	1985
0.25	201.12	213.67
0.50	352.25	377.30
0.75	503.37	541.02
1.00	654.50	704.70

Water use efficiency : The data on water use efficiency of watermelon, as influenced by IW/CPE ratio and method of irrigation are presented in Table 4.59.

IW/CPE ratio : Water use efficiency decreased significantly with higher IW/CPE ratio, in both the years.

During 1984, water use efficiency was significantly lower (0.52 q/ha-mm) with irrigation at 1.00 IW/CPE ratio, as compared to, irrigation at 0.50 (0.88 q/ha-mm) and 0.25 (1.26 q/ha-mm) IW/CPE ratios, but, was on par with irrigation at 0.75 (0.66 q/ha-mm) IW/CPE ratio. Similar trend was observed in 1985.

Method of irrigation : Statistically significant variations in water use efficiency, as influenced by method of irrigation, were observed in both the years.

During 1984, water-use efficiency was significantly lower (0.60 q/ha-mm) with 5.0 cm depth under furrow

**Table 4.59** Water-use efficiency of watermelon, as influenced by IW/CPE ratio and method of irrigation

Treatment	Water-use efficiency, q/ha-mm	
	1984	1985
<u>IW/CPE ratio</u>		
0.25	1.26	1.08
0.50	0.88	0.72
0.75	0.66	0.52
1.00	0.52	0.44
'F' test	Sig	Sig
<u>Method of irrigation</u>		
Drip :		
one emitter/plant	0.96	0.80
one emitter/two plants	1.07	0.86
Furrow :		
2.5 cm depth	0.69	0.60
5.0 cm depth	0.60	0.50
'F' test	Sig	Sig
S.E.m <u>+</u>	0.05	0.03
C.D at 5%	0.15	0.08

irrigation, as compared to, one emitter per plant (0.96 q/ha-mm) and one emitter per two plants (1.07 q/ha-mm), under drip irrigation, but, was on par with 2.5 cm depth (0.69 q/ha-mm) under furrow irrigation.

During 1985, furrow irrigation with 5.0 cm depth (0.50 q/ha-mm) recorded significantly lower water-use efficiency, as compared to, 2.5 cm depth, under furrow irrigation (0.60 q/ha-mm), one emitter per plant (0.80 q/ha-mm) and one emitter per two plants (0.86 q/ha-mm) under drip irrigation.

**Table 4.60** Interaction effects of IW/CPE ratio and method of irrigation, on water-use efficiency

IW/CPE ratio	Method of irrigation							
	Drip				Furrow			
	one emitter/ plant		one emitter/ two plants		2.5 cm depth		5.0 cm depth	
	1984	1985	1984	1985	1984	1985	1984	1985
0.25	1.52	1.34	1.99	1.66	0.78	0.68	0.76	0.63
0.50	1.03	0.83	1.10	0.87	0.73	0.66	0.66	0.52
0.75	0.72	0.56	0.64	0.49	0.76	0.61	0.52	0.44
1.00	0.58	0.47	0.55	0.44	0.48	0.45	0.48	0.41
'F' test	Sig	Sig						
S.E.m $\pm$	0.10	0.05						
C.D at 5%	0.30	0.16						

The interaction effect of IW/CPE ratio and method of irrigation was statistically significant, during both the years and are presented in Table 4.60.

During 1984, furrow irrigation with 2.5 cm depth (0.48 q/ha-mm) and 5.0 cm depth (0.48 q/ha-mm), recorded significantly lower water-use efficiency, as compared to, irrigation at 0.25 IW/CPE ratio with one emitter per plant (1.52 q/ha-mm) and one emitter per two plants (1.99 q/ha-mm), as well as, 0.50 IW/CPE ratio with one emitter per plant (1.03 q/ha-mm) and one emitter per two plants (1.10 q/ha-mm) under drip irrigation, but, was on par with other treatments.

During 1985, furrow irrigation at 1.00 IW/CPE ratio with 5.0 cm depth recorded significantly lower (0.41 q/ha-mm),

water use efficiency, as compared to, drip irrigation at 0.25 IW/CPE ratio with one emitter per plant (1.34 q/ha-mm) and one emitter per two plants (1.66 q/ha-mm) and 0.50 IW/CPE ratio with one emitter per plant (0.83 q/ha-mm) and one emitter per two plants (0.87 q/ha-mm). This was on par with furrow irrigation at 0.25 IW/CPE ratio with 2.5 cm (0.68 q/ha-mm) and 5.0 cm depth (0.63 q/ha-mm) and 0.50 IW/CPE ratio with 2.5 cm depth (0.66 q/ha-mm), as well as 0.75 IW/CPE ratio with 2.5 cm depth (0.61 q/ha-mm).

#### 4.2.10. Economics of drip and furrow irrigation :

The details of the cost of laying out the drip irrigation system are presented in Table 4.28. The cost and returns for drip and furrow methods of irrigation, for watermelon, per cropping season are presented in Table 4.61.

The total cost under drip irrigation with one emitter per plant was Rs.4119=00 and with one emitter per two plants was Rs.4101=00, as compared to, Rs.3278=00 under furrow irrigation. The gross returns under drip irrigation with one emitter per two plants was higher by Rs 3824=00. However, the benefit-cost ratio was more (3.44) under furrow irrigation with 2.5 cm depth, as compared to drip irrigation (3.02 with one emitter per plant and 3.16 with one emitter per two plants, respectively). The benefit-cost ratio was lowest (2.78), under furrow irrigation with 5.0 cm depth of irrigation .

Thus, it is evident that the benefit realised in terms of drip irrigation seems to be marginal, as compared to, furrow irrigation with 2.5 cm depth, but for the substantial saving in water. The saving in water under drip irrigation is nearly to the extent of 50 percent.

**Table 4.61**

Economics of drip and furrow irrigation

Particulars	Drip irrigation		Furrow irrigation	
	One emitter/ plant	One emitter/ 2 plants	2.5 cm depth	5.0 cm depth
1. Yield, q/ha	330.95	340.95	291.34	248.03
2. Gross returns, Rs/ha	16,547	17,048	14,567	12,401
3. Cost of cultivation, Rs/ha	3,125	3,125	3,278	3,278
4. Total cost, Rs/ha	4,119	4,101	3,278	3,278
5. Gross profit, Rs/ha	12,428	12,947	11,289	9,123
6. Benefit-cost ratio	3.02	3.16	3.44	2.78

*Discussion* **DISCUSSION**

## V. DISCUSSION

The studies on "Response of watermelon to drip and furrow irrigation, under different nitrogen and plant population levels" were taken up at Hossaraghatta, Bangalore during the summer seasons of 1984 and 1985.

The weather conditions during the crop growth season of both the years were favourable for watermelon. The mean temperatures ranged between 24.9<sup>0</sup>C in 1984 and 25.8<sup>0</sup>C in 1985 which were higher than the normal, which is 24.1<sup>0</sup>C. Yamaguchi (1983) has stated that watermelon is a warm season crop requiring a relatively long growing season and high temperature i.e., mean temperatures higher than 21<sup>0</sup> for its best development.

During the crop season (January - May), a rainfall of 147.7 mm and 143.3 mm, during 1984 and 1985 respectively, were received as against, 171.7 mm normal for the period. During 1984, a rainfall of 24.0 to 36.8 mm was received during each of the months of February, March and April, which affected the irrigation treatments. However, this rainfall has been considered while working out the effective rainfall. During 1985, a rainfall of 61.6 mm was received during April. A rainfall of 60.2 mm in 1984 and 81.4 mm in 1985 was received in May. This did not affect the irrigation treatments, since most of it occurred after the harvest of the crop. The relative humidity which ranged from 67 to 84 per cent during 1985, was also favourable for the crop

growth. The yield levels obtained in watermelon, to the various treatments tried in the present investigation, can be considered as normal yields, based on the expected yields, when the improved practices are followed (Anon, 1985).

The findings of this investigation, covering the following aspects are discussed in this chapter.

1. Influence of nitrogen on growth, yield and nutrient uptake in watermelon.
2. Influence of plant population on growth, yield and nutrient uptake in watermelon.
3. Influence of drip and furrow methods of irrigation on growth, yield and nutrient uptake in watermelon.
4. Influence of Pan Evaporation ratio and irrigation water/cumulative pan evaporation ratio, on growth, yield and nutrient uptake in watermelon.
5. Water use and water use efficiency in watermelon.

5.1 Influence of nitrogen on growth, yield and nutrient uptake in watermelon

Nitrogen fertilization has profound influence on growth and yield of watermelon. Some of the growth parameters like vine length, number of leaves and dry matter increased with increase in nitrogen levels, from 60 kg to 180 kg nitrogen per ha. The vine length increased significantly at 20 DAE, with increase in nitrogen from 60 kg to 180 kg nitrogen per ha. The number of leaves increased significantly with nitrogen levels upto 120 kg per ha, at 20 DAE in 1985, upto

180 kg per ha, at 40 DAE in both the years and upto 120 kg per ha, at 80 DAE in both the years. The dry matter production was also significantly higher with 180 kg nitrogen, at 60 DAE in both the years and upto 120 kg nitrogen per ha, at 40 DAE in 1985 and at 80 DAE in both the years. Leaf area also increased with increase in nitrogen levels, although the variations were significant only at 80 DAE in 1984. The increase in leaf area with nitrogen fertilization may be due to better availability of nutrients at higher levels, which might have probably triggered off vigorous cell division, cell elongation and cell expansion processes, resulting in enlarged leaf area. Leaf area index also increased with increase in nitrogen levels, however, the variations were significant only at 80 DAE in 1984.

This resulted in significant increase in net assimilation rate at all the stages, except between 21 to 40 DAE, indicating higher photosynthetic efficiency of the plant with increase in levels of nitrogen. Similar results have been obtained by Yusifov (1983) and Khris̆tov (1984) while studying the relationship of growth and productivity of watermelons.

Higher leaf area with improved photosynthetic efficiency due to increase in nitrogen application resulted in higher dry matter production. Leaf area at 80 DAE in 1984 was significantly higher with 180 kg nitrogen per ha, as compared to 60 kg nitrogen per ha. Dry matter production was significantly higher with 180 kg nitrogen per ha, as compared

to 60 kg nitrogen per ha at 60 DAE in both the years, in shoot and total uptake in both the years, at 80 DAE and at 40 DAE in 1985. Both total dry matter production and its distribution into the sink increased with increase in supply of nitrogen. Leaf area duration also increased with increase in nitrogen levels, although the variations were significant only at 80 DAE in 1984. This indicated the persistence of leaf cover, which was efficient in photosynthetic production for longer period. Reynolds and Stark (1953) reported that variations in nitrogen levels produced the greatest effect on vegetative growth in cucumbers. Similarly, Roychaudhury et al. (1984) observed reduced length of vines, size of the leaves and number of flowers with nitrogen deficiency in cucumbers.

Variations in nitrogen supply also had significant influence on sex expression of watermelon. Number of male flowers was significantly higher with 180 kg nitrogen per ha, as compared to 60 kg nitrogen per ha, whereas, the number of female flowers was significantly higher with 120 kg nitrogen per ha, as compared to 60 kg and 180 kg nitrogen per ha. The number of female flowers at 180 kg nitrogen per ha decreased significantly, as compared to 120 kg nitrogen per ha. As a result of more number of female flowers at 120 kg nitrogen per ha, the fruit set was also higher, as compared to 60 kg nitrogen per ha. This optimum nitrogen application of 120 kg nitrogen per ha, led to higher sink strength in the form of increased fruit set. Increase in perfect flowers and more

fruit set with nitrogen application has been reported in muskmelon by Srinivas and Doijode (1984).

Fruit yield of watermelon increased with the application of nitrogen in both the years, although it was statistically significant only in 1985. During 1984, the yield increased from 348.6 q per ha with 60 kg nitrogen per ha, to 378.66 q per ha with 120 kg nitrogen per ha, an increase of nearly 9 per cent. During 1985, the yield increased significantly from 308.28 q per ha with 60 kg nitrogen per ha to 344.9 q per ha with 120 kg nitrogen per ha, an increase of nearly 12 per cent and further increase in nitrogen level to 180 kg per ha, had no additional benefit (345.51 q ha). There was slight decrease in yield with 180 kg nitrogen per ha during 1984. Deswal and Patil (1984) also observed yield reductions in watermelon, with the application of 100 kg nitrogen per ha. Reynolds and Stark (1953) reported greatest number of fruits on plants receiving medium supply of nitrogen, as compared to high or low nitrogen in cucumbers. Bradley and Fleming (1959) reported higher yields of watermelon with 60 kg nitrogen per ha. Brantley and Warren (1960) observed nitrogen levels of either 100 kg or 150 kg per ha to be better for higher yields in watermelon. Knysh and Vakulenku (1976) recorded yield increase of watermelon upto 90 kg nitrogen per ha. Similarly Bhosale et al., (1976) recommended 75 kg or 100 kg nitrogen per ha, for realising higher yields of watermelon.

Plants supplied with low amounts of nitrogen grew slowly and produced smaller fruits than plants receiving high rate of nitrogen in cucumbers (Dearborn, 1936). Likewise Cantliffe (1977) reported higher yields of cucumbers with the application rates of 67 to 134 kg nitrogen per ha.

In the present studies, also the yields decreased with 180 kg nitrogen per ha in 1984. This might be largely due to higher vegetative growth, more number of male flowers and lower female flowers, which resulted in decreased fruit number per ha and reduced fruit set and size.

The difference in fruit yield among nitrogen levels could be attributed to yield components like, the number of fruits per ha and fruit weight. Both the number of fruits per .ha and fruit weight increased markedly with increase in nitrogen level upto 120 kg per ha. This was mainly as a consequence of increase in the number of female flowers and fruit set, which ultimately resulted in higher fruit number. Higher photosynthetic efficiency coupled with enlarged source enabled more dry matter production. The increased photosynthates were diverted more to the sink leading to higher fruit set.

The importance of fruit size as the main yield attributing factor in watermelon has been well recognised (Karchi et al ., 1977). Brantley and Warren (1960) and Flocker et al ., (1965) have reported increased fruit size of watermelon with the application of nitrogen.

From the response equations presented, the optimum nitrogen requirement was found to be 121 kg nitrogen per ha

during 1984 and 141 kg nitrogen per ha during 1985. The optimum yields at these levels were 379.4 q per ha in 1984, 349.3 q per ha in 1985.

Nitrogen fertilisation significantly increased the nitrogen content in plant, at all the growth stages during both the years, except at 60 DAE in 1985. Increases in nitrogen content with nitrogen fertilisation have been reported by Roychaudhury et al ., (1984) in round gourd. It is quite logical to expect increase in nitrogen content with nitrogen application in soils of low fertility status (Henrikson, 1984).

The uptake of nitrogen also increased significantly with nitrogen fertilisation, at all the stages, during both the years, except at 80 DAE in fruit during 1984. Increase in nitrogen uptake was mainly due to the combined effect of increase in both nitrogen content and dry matter production.

Phosphorus content increased with increase in nitrogen levels, although the differences were statistically significant only at 80 DAE in shoot in 1984 and at 60 DAE in 1985. Roychaudhury et al ., (1984) reported increase in phosphorus content with higher doses of nitrogen, in roundgourd, at flowering and a gradual decline at early and late flowering. The phosphorus uptake also increased with increase in nitrogen levels.

Statistically significant increase in potassium content in plant, with increase in nitrogen level were recorded at 60 DAE in 1984 and at 80 DAE in fruit, in both the years. The

magnitude of increase was more between 60 kg and 120 kg nitrogen per ha. Thus, it can be seen that nitrogen fertilisation induced better vegetative growth and root penetration, which might have helped in absorbing more potassium from soil. Barker et al., (1983) also observed increased potassium content in plant tissue of radish with nitrogen fertilisation.

The potassium uptake also increased with nitrogen fertilisation, although the variations were statistically significant at 80 DAE in fruit during 1984, at 40 DAE in 1985 and at 80 DAE in fruit and total uptake in 1985.

Nitrogen fertilisation practices have been known to influence directly, the mineral nutrient composition of the leaf tissue in cucumbers and the concentrations of nitrogen, potassium, magnesium and calcium were higher, in tissues receiving fertiliser nitrogen rates from 67 kg to 201 kg per ha (Cantliffe, 1977). Generally nitrogen fertilisation influences cation and anion composition of the tissue. The increase in concentration of other elements in the tissue, might have been due to more active root growth or slight changes in soil availability of these nutrients, due to the addition of nitrogen fertilizers to the soil (Cantliffe, 1977). Likewise, Bishop et al., (1969) observed that increasing the nitrogen rates from 50 kg to 100 kg per ha, increased the percentage of nitrogen, calcium and magnesium in cucumbers. In the present studies the calcium and magnesium contents and their uptake in watermelon increased with higher nitrogen levels.

The root dry weight also increased with increase in nitrogen levels.

#### 5.2 Influence of plant population on growth, yield and nutrient uptake in watermelon:

The two spacings tried viz., 300 cm x 60 cm and 200 cm x 60 cm, in this study resulted in plant-populations of 11,111 plants and 16,666 plants per ha, respectively, when two plants per hill were maintained. The intra-row spacing of 60 cm being common to both the spacings, the variations in terms of growth, yield and nutrient uptake are due to inter-row effects which are discussed.

In the present studies, plant populations of 11,111 plants and 16,666 plants per ha, had marked influence on growth and yield of watermelon, during both the years. The results of spacing and yield have been quantified by Holliday (1960), who described the relationship as parabolic in fruiting crops.

The dry matter production per plant and its distribution into fruit was less in case of closer row spacing of 200 cm, as compared to wider row spacing of 300 cm. The leaf area per plant was more with 300 cm row spacing, although the variation was statistically significant only at 80 DAE in 1984. But the leaf area index was significantly higher, with closer row spacing of 200 cm at all the stages, except at 80 DAE in 1984. Leaf area index had significant and positive correlation with yield during 1985. The photo-synthetic efficiency of the plant, in terms

of net assimilation rate was higher with 200 cm, although the differences were statistically significant only between 41 to 60 DAE. As a consequence of this increase in leaf area index and net assimilation rate, the crop growth rate was significantly higher between 21 to 40 DAE, in both the years and between 61 to 80 DAE in 1985. These growth improvements were mainly due to better utilisation of light and nutrients at closer spacing. Nerson et al., (1984) reported faster vegetative growth per unit area, higher leaf area index and more dry matter accumulation in muskmelon, with increase in plant population from 13,500 to 31,250 plants per ha. Apart from this, there was improved fruit set and higher yields of melons.

Fruit yield of watermelon increased significantly, with decrease in row spacing, in both the years. The yield increased from 336.12 q per ha with 300 cm row spacing to 389.25 q per ha with 200 cm row spacing, during 1984 i.e. an increase of nearly 16 per cent. Whereas, during 1985, the yield increased from 303.42 q per ha with 300 cm row spacing to 362.36 q per ha with 200 cm row spacing, an increase of nearly 19 per cent. Locascio and Halsey (1966) also have reported higher yields of watermelon with a spacing of 9' x 2', Peterson (1961) with 4' x 2' and Patil and Bhosale (1976) with 1.2 m x 1.2 m.

The main yield attributing characters were the fruit number per ha and fruit weight. The fruit number was significantly higher with 200 cm row spacing, during both the

years (43% higher in 1984 and 24% in 1985, respectively). Whereas, the fruit weight was significantly higher by 0.50 kg during 1984 and 0.40 kg during 1985, with wider row spacing of 300 cm. Eventhough, the fruit weight was higher with 300 cm row spacing, the fruit yield per ha increased at 200 cm row spacing. This was mainly due to increase in fruit number per ha, as a consequence of higher plant population, which more than compensated for the reduced fruit weight. Significant and positive correlation was observed with yield and number of fruits per ha, during 1985. Similar increase in fruit number with closer spacing has been reported by Peterson (1961) in watermelon. Increase in yield with closer spacings in melons has also been reported by Baljeet Singh et al., (1982) and Srinivas and Prabhakar (1984), who attributed the yield increases to more number of plants per unit area.

Fruits must develop uniformly for optimum yields. Plant population densities govern uniformity, as well as number of fruits produced in cucumbers (Cantliffe and Pathak, 1975). Halsey (1959) also reported an increase in marketable watermelon fruits, as the intra row spacing decreased from 12 feet to 3 feet. Patil and Bhosale (1976) also recorded higher yields of watermelon, with a spacing of 1.2 m x 1.2 m (13,888 plant/ha).

The nitrogen content was higher with wider row spacing of 300 cm, at all the stages, although the variations were significant only in fruit, at 80 DAE, during both the years. Whereas, the nitrogen uptake was significantly higher with closer row spacing of 200 cm, at all the stages, except at 80

DAE in 1984 and at 60 DAE in 1985. The phosphorus content was higher at 300 cm row spacing at all the stages however, the differences were statistically significant only at 80 DAE in both the years. The phosphorus uptake was significantly higher with 200 cm row spacing, at all the stages, except at 80 DAE in shoot during both the years. The potassium, calcium and magnesium contents were higher at 300 cm row spacing, at all the stages. Thus, the contents of nitrogen, phosphorus, potassium, calcium and magnesium were higher by 0.14, 0.01 and 0.08 and 0.03 per cent respectively, at 60 DAE, with wider row spacing of 300 cm. Eventhough, the nutrient contents were higher with 300 cm row spacing, the growth and development of the crop was not curtailed at 200 cm, as could be clearly seen from higher biomass production per ha, which ultimately resulted in higher nutrient uptake at all the stages. The increase in nutrient contents at wider row spacing of 300 cm could be due to better availability and utilisation of nutrients and light. On the contrary, the uptake of all the elements studied were higher at closer row spacing of 200 cm, largely due to increased biomass production per ha.

### 5.3 Influence of drip and furrow methods of irrigation on growth, yield and nutrient uptake of watermelon:

The growth parameters i.e., vine length and number of leaves were higher under drip irrigation, as compared to furrow irrigation (Experiment I). The vine length was more at all the stages under drip irrigation, although the

variations were statistically significant, only at 60 DAE in both the years. Number of leaves was also higher under drip irrigation, at all the stages though, the differences were statistically significant only at 40 DAE. This increase in number of leaves culminated in higher dry matter production under drip irrigation. The leaf area and leaf area index under drip irrigation was also higher, at all the stages, although, the differences were statistically significant only at 60 DAE and 80 DAE in 1984. Leaf area duration was also higher under drip irrigation. The photosynthetic efficiency in terms of net assimilation rate was higher in case of drip irrigation, at all the stages and the variations were statistically significant between 61 to 80 DAE. Since, both the leaf area index and net assimilation rates were higher under drip irrigation, the total canopy photosynthesis in terms of crop growth rate was also higher. Improved growth of several crops by drip irrigation have been reported by Howell et al. (1981). Mitchell and Black (1971) and Middleton et al. (1979) reported improved growth and early productivity of Peach and Apple trees, when drip irrigated. Reduced growth and productivity under conventional irrigation has been attributed to, rapid depletion of readily available soil water from the limited rootzone (Proebsting et al 1977). Under such circumstances frequent irrigations would permit available water to be consistently maintained in the rootzone.

Apart from, this the canopy temperature was lower by  $2.8^{\circ}\text{C}$ , osmotic potential increased by 8.7 bars and the relative water content was higher by 4.8 per cent, at 15 days after irrigation, under drip irrigation, as compared to furrow irrigation. Denmead and Shaw (1962) showed that actual evapo-transpiration is a complex function of both soil water content and evaporative demand. Reduction in evapo-transpiration with reduced soil water potential has been associated with reduced photosynthesis.

The number of female flowers were significantly higher under drip irrigation, in both the years, which resulted in higher fruit set. Drip irrigation recorded significantly higher yields (418.0 q/ha and 379.0 q/ha during 1984 and 1985 respectively), as compared to furrow irrigation (307.37 q/ha in 1984 and 286.78 q/ha in 1985, respectively, Experiment I. Thus, the yield increase under drip irrigation was nearly 36 per cent in 1984 and 32 per cent during 1985. The significant yield increase was mainly the consequence of improved yield components like, number of fruits per ha and fruit weight. The fruit number per ha increased by 25 per cent in 1984 and 32 per cent in 1985, under drip irrigation. The fruit weight under drip irrigation increased by 0.40 kg in 1984 and 0.30 kg in 1985, as compared to furrow irrigation. Singh and Singh (1978) recorded increased watermelon yields by 10 to 22 per cent under drip irrigation. Such yield increase under drip irrigation have been reported

by several workers (Malinina, 1971 in cucurbits; Elmstrom et al. 1981 in watermelon; and Rudich et al. 1978 in melons).

The root length as well as the root dry weight was significantly lower under drip irrigation, as compared to furrow irrigation. The root concentration has been found to be very high in top layers of several vegetable crops, under drip irrigation, by Bernstein and Francois (1973).

Drip irrigation is uniquely suited for maintenance of steady high soil water potential, because frequent water applications can be made without interference with cultural practices. Conversion of formerly furrow irrigated Orange trees to trickle irrigation was accompanied by a significant reduction in soil water potential fluctuations (Alijubury et al. 1974).

The concentration of nitrogen, phosphorus, potassium, calcium and magnesium were higher by 0.06, 0.15, 0.26, 0.11 and 0.09 per cent respectively, at 60 DAE under drip irrigation, as compared to furrow irrigation. Nye and Tinker (1977) observed that the movement of ions to plant roots in dry soils is restricted by low rates of mass flow and diffusion.

The nutrient uptake was higher under drip irrigation because of higher nutrient content and increased dry matter production. Similar results have been recorded by Massarawa et al. (1984) with drip irrigated cucumbers. Much of the water saving has been achieved, by restricting the water

supply to the extent of the most efficient rootzone (Dasberg and Steinhardt, 1974). By not wetting the entire row particularly in the young stages of the crop, direct evaporation from the soil surface and uptake of water by weeds are drastically reduced (Lemon, 1956).

The results of Experiment II indicated significant variations in growth and yield components, under drip irrigation with one emitter per two plants, as compared to 5.0 cm depth under furrow irrigation. The growth parameters viz., vine length and number of leaves were significantly higher, under drip irrigation with one emitter per two plants, as compared to 5.0 cm depth under furrow irrigation. This increase in number of leaves resulted in higher leaf area and leaf area index, which led to increased photosynthetic production and its distribution into fruit. Apart from this, the photosynthetic activity reflected in terms of leaf area duration, was also higher. As a consequence of these improvements in growth, the relative growth rate, net assimilation rate and crop growth rate were higher with one emitter per two plants under drip irrigation, which resulted in higher photosynthetic efficiency, as compared to 5.0 cm depth under furrow irrigation.

Most of the growth and growth components under furrow irrigation with 2.5 cm depth and one emitter per plant under drip irrigation were on par.

Daily replenishment of water under drip irrigation did not allow any deficit to remain longer and thus maintained a

high soil water potential. This enabled the plants to perform better, as compared to those under furrow irrigation with 5.0 cm depth. Similar results have been obtained in vegetables by Bernstein and Francois (1973). The superiority of drip irrigation to maintain favourable soil water potentials continuously, without creating aeration problems has been well documented (Bresler, 1977; Bucks et al. 1981; and Howell et al. 1981).

Between two drip irrigation treatments, drip irrigation with one emitter per two plants, resulted in slightly improved growth attributes, probably due to better aeration and optimum moisture in the rootzone. It is quite possible that the root growth and development might have been curtailed, as a result of ponding of the water near the plant, under one emitter per plant.

With regard to furrow irrigation, 2.5 cm depth of water resulted in higher growth and development of the plants, in terms of increased leaf area and leaf area index. Most of the growth parameters studied were higher with 2.5 cm depth, as compared to 5.0 cm depth, probably due to more frequent irrigation and reduced stress. Although, the total quantity of water applied was same in both the cases, because of lower frequency under 5.0 cm depth the plants were subjected to greater degree of stress all along, leading to poor growth.

The number of female flowers produced was also higher in drip irrigated plants, which accounted for increased fruit set, as compared to furrow irrigated plants.

The fluctuations in canopy temperature were very little under drip irrigation. The relative water content was more with drip irrigated plants, with the result the tissue maintained higher turgidity. This probably enabled the plants to maintain higher cell division and elongation and increased photosynthesis. Thus, the plant growth and development was higher under drip irrigation. The osmotic potential values also remained more or less the same, because of daily replenishment of water under drip irrigation which eliminated stress and higher accumulation of solutes in the tissues.

Method of irrigation had significant influence on the yield of watermelon during both the years. Drip irrigation was far superior (367.54 q/ha in 1984 and 313.96 q/ha in 1985, with one emitter /2plants and 353.73 q/ha in 1984 and 309.73 q/ha in 1985, with one emitter per plant) to furrow irrigation (300.32 q/ha in 1984 and 282.31 q/ha in 1985 with 2.5 cm depth and 268.98 q/ha in 1984 and 227.08 q/ha in 1985 with 5.0 cm depth), in realising higher yields of the order of 22 to 26 per cent. Furrow irrigation with 2.5 cm depth came close to drip irrigation treatments. The fruit yield did not vary markedly between two drip irrigation treatments. However, drip irrigation with one emitter per two plants (367.5 and 313.9 q/ha during 1984 and 1985 respectively) recorded slightly higher yields as compared to one emitter per plant (352.7 and 309.7 q/ha during 1984 and 1985 respectively). Similarly, Shatanawi (1983) did not observe

any differences in squash yields, when one emitter per plant or per two plants were used. Lower yields with one emitter per plant could be attributed to more concentration of water at a single point, which might have created imbalance in the soil-water inter phase, leading to aeration problems. Furrow irrigation with 5.0 cm depth recorded the lowest fruit yields of watermelon (268.9 and 227.12/ha during 1984 and 1985 respectively) as compared to 2.5 cm depth (300.3 and 282.3 q/ha during 1984 and 1985 respectively). This may be due to decrease in the frequency of irrigation, that might have led to large scale fluctuations in soil water potential (Goldberg et al. 1971) under furrow irrigation unlike in drip irrigation, wherein the fluctuations were reduced to a minimum.

The main yield contributing characters for higher fruit yields under drip irrigation were the fruit number per ha and fruit weight. The increase in fruit number with higher irrigation frequency has been reported as early as 1936, by Fleming in melon and in recent years by Malinina (1971) and Desai and Patil (1984). Likewise, Mac Gillivray (1951) obtained smallest melon fruits under dry treatments. There were no marked differences in fruit number and weight between two drip irrigation treatments. However, under furrow irrigation, both the fruit number and weight were less with 5.0 cm depth, as compared to that with 2.5 cm depth of irrigation. This may probably be due to decrease in

frequency of irrigation, leading to severe soil moisture stress.

The  $\text{NO}_3\text{-N}$  concentration in the fruits was also significantly influenced by method of irrigation. Both nitrate reductase activity and photosynthesis decreases have been reported with lower water potentials, resulting in reduced  $\text{NO}_3\text{-N}$  (Huffaker et al. 1970).

Drip irrigation recorded higher nitrogen content and uptake during both the years. The nitrogen content and uptake were lowest under furrow irrigation with 5.0 cm depth, as compared to drip irrigation with one emitter per two plants. Increased nitrogen uptake was the consequence of higher content and dry matter production. Soil moisture status affects nitrification of soil organic matter and a decline in nitrogen uptake could be expected under increased moisture stress (Colman and Lazenby, 1975). Phosphorus content at 60 DAE was higher under drip irrigation with one emitter per two plants, by 0.07 per cent, than under furrow irrigation with 5.0 cm depth. Gates (1957) observed that water-stressed tomato plants in soil have low phosphorus concentrations. This could be due to reduced phosphorus mobility in drier soils or to reduced uptake. The uptake of phosphorus was also reduced under furrow irrigation. Even small decreases in water potential reduced phosphorus uptake by tomato plants (Greenway et al. ., 1969). The potassium content was also higher, under drip irrigation with one emitter per two plants, by 0.55 per cent, as compared to

furrow irrigation with 5.0 cm depth.

The potassium uptake was higher under drip irrigation with one emitter per two plants, by 13.35 kg per ha. This may be mainly due to the fact that potassium moves towards roots by diffusion and mass flow (Barber, 1966), and its uptake is naturally governed by soil moisture status. Such a movement was affected to a great extent under furrow irrigation with 5.0 cm depth.

Calcium content increased under drip irrigation with one emitter per two plants, by 3.15 per cent, as compared to furrow irrigation with 5.0 cm depth. This may be possibly due to increased oxygen concentration in the root zone, which was reported to favour accumulation of calcium in the plant tissues (Lebanauskas et al. 1972). The calcium uptake pattern was similar to that of its content.

Likewise, magnesium content and uptake were higher under drip irrigation with one emitter per two plants, than under furrow irrigation with 5.0 cm depth. It may also be due to increased availability of oxygen, which must have had profound effect on respiration activity of the plant roots, leading to higher accumulation of magnesium (Jarrell and Beverly, 1981).

The content and uptake of nitrogen, phosphorus, potassium, calcium and magnesium under drip irrigation with one emitter per plant and furrow irrigation with 2.5 cm depth, did not vary much, mainly because of more frequent

irrigations, which aided in better uptake of these nutrients.

5.4 Influence of pan evaporation ratio and irrigation water / cumulative pan evaporation ratio on growth, yield and nutrient uptake in watermelon:

As the pan evaporation ratios increased there was progressive increase, in the growth parameters. The vine length was significantly lower at lower, IW/CPE ratios at all the stages, except at 20 DAE, as compared to higher IW/CPE ratios. The number of leaves was significantly lower with irrigation at lower IW/CPE ratio, as compared to higher IW/CPE ratio at all the stages, except at 60 DAE in 1984 and 20 DAE in 1985. Dry matter production and distribution to fruit was also more at higher IW/CPE ratios. Leaf area and leaf area index increased with higher IW/CPE ratios, however, the differences were statistically significant at 40 DAE and 60 DAE in both the years (except, leaf area at 60 DAE in 1984). Although, the leaf area duration increased at higher IW/CPE ratios, the variations were significant only between 21 to 40 DAE.

The importance of canopy development in light interception, growth and yield has been well documented.

Apart from the size of the photosynthetic surface, its sustenance, as measured by leaf area duration was also higher at higher IW/CPE ratios. The relative growth rate increased significantly at all the stages, except between 61 and 80 DAE, with higher IW/CPE ratios. Net assimilation rate was also higher. As a consequence of

higher leaf area index and net assimilation rate at higher IW/CPE ratios, the crop growth rate also increased with higher IW/CPE ratios. In the ultimate analysis, the dry matter synthesis is a function of higher photosynthetic surface, its longevity and photosynthetic efficiency. Increased leaf drop and senescence resulted in reduced photosynthetic activity and reduced dry matter production at lower IW/CPE ratios.

Physiological studies on the effect of soil moisture deficit on growth, by several workers, quoted earlier have indicated that poor cell elongation, low photosynthesis and carbohydrate synthesis resulted in poor growth with decrease in the frequency of irrigations. Severity of effects vary depending on the degree of stress, its longevity and stage of growth (Salter and Goode, 1967; Hsico, 1973; Begg and Turner, 1976). Soil moisture deficit below 25 to 50 per cent is detrimental to growth and yield of vegetables (Kaliappa et al . 1971; and Doss et al .1975).

The number of female flowers and fruit set significantly increased with higher IW/CPE ratios, which ultimately resulted in higher number of fruits per ha. Since the average fruit set in watermelon is 1.2 per plant, the alternative left to increase the fruit yield is, either by increasing the fruit size or by harvesting more number of average sized fruits. In the present study, higher yields were achieved by both fruit size increase and more number of harvested fruits per ha, with higher IW/CPE ratios.

The yield of watermelon increased with higher IW/CPE ratios, during both the years, although the differences were statistically significant only during 1985. The yield was highest with irrigation at 1.00 IW/CPE ratio (337.68 q/ha in 1984 and 310.14 q/ha in 1985), an increase of 16 per cent during 1984 and 23 per cent during 1985, as compared to irrigation at 0.25 IW/CPE ratio. The yield differences were not statistically significant during 1984, probably due to unusually heavy rainfall received during the months of February and March, which largely masked the treatment effects of irrigation. Eventhough, the irrigation schedules were adjusted to take care of the rainfall, the intended level of stress was not experienced by the crop during critical periods, which resulted in better performance of the crop, even at lower IW/CPE ratios. Desai and Patil (1984) obtained highest yields of watermelon with an IW/CPE ratio of 1.00. Better performance of the crop with increase in IW/CPE ratios, was also due to the fact that favourable soil moisture status was maintained in the rootzone, which in turn helped the plants to maintain higher turgor and increased utilisation of moisture and nutrients (Shmueli and Goldberg, 1971; Phene and Beale, 1976). Similar results have also been reported by Yadav and Mangal (1984), who obtained significantly improved yields with 0.90 cumulative pan evaporation ratio.

The differences in yield of watermelon, among irrigation levels, could be traced to yield components like fruit number per ha and fruit weight, which increased with

higher IW/CPE ratios, although the variations were not statistically significant in both the years. The total soluble solids and the sugars were not influenced by higher IW/CPE ratios. Similar results have been obtained by Desai and Patil (1984). The canopy temperatures increased with the decrease in IW/CPE ratio, probably due to reduced leaf area index which exposed the soil surface. On the contrary, relative water content increased with increase in IW/CPE ratio, due to more availability and uptake of water, by which the cells remained turgid for a longer period. This, consequently resulted in stomatal opening for a longer period, with increased influx of carbon dioxide leading to higher photosynthetic production. Osmotic potentials also decreased with decrease in IW/CPE ratio. This can be expected since, the solute concentrations increase under stress and plants try to adjust to drought conditions, by osmotic adjustment by decreasing osmotic potential.

The nutrient content, as well as the uptake in the plant increased with increase in IW/CPE ratios. This was mainly due to higher moisture availability in the root zone which resulted in better absorption and higher utilisation of nutrients by the plant.

Decreasing the IW/CPE ratio (under low water potentials) reduces both nitrate-reductase activity and photosynthesis, leading to nitrate-nitrogen accumulation in the tissue (Huffaker et al. 1970). Increase in nitrogen concentration with water stress is well documented (Greenway et al. 1969).

Total nitrogen uptake decreased with decrease in the IW/CPE ratios. Soil moisture status affects nitrification of soil organic matter, and a decline in nitrogen uptake could be expected under increased moisture stress (Colman and Lazenby, 1975).

Both the phosphorus content and uptake decreased with decreasing IW/CPE ratios. Decreased phosphorus uptake was the consequence of reduced phosphorus content and lower dry matter production. Since phosphorus moves towards root surface by diffusion, its uptake is largely governed by soil moisture status (Karien et al. 1985). Soil moisture affects both phosphorus uptake (Mederski and Wilson, 1960; Olsen et al. 1961) and root growth (Gingrich and Russell, 1957; Mirreh and Ketcherson, 1973). Lower moisture reduces phosphorus diffusion through the soil to the root surface (Olsen et al. 1965; Mahtab et al. 1971; Hira and Singh, 1977). Olsen et al. (1965) measured an eightfold decrease in phosphorus diffusion, the principal mechanism for phosphorus movement through the soil to the root surface, with a two fold decrease in soil moisture (Barber et al. 1963). As soil phosphorus level increases, the effect of soil moisture on phosphorus diffusion rate decreases (Mahtab et al. 1971). Similarly, potassium uptake also reduced, with decrease in IW/CPE ratios. As potassium moves towards roots by both diffusion and massflow (Barber, 1966), its uptake is naturally governed by soil moisture status. The calcium and magnesium uptake also increased with the increase in IW/CPE

ratios, largely due to higher biomass production and higher content of calcium and magnesium.

#### 5.5 Water use and water use efficiency in watermelon:

The water use in Experiment I, under drip irrigation with 0.50 PER, was 352 mm in 1984 and 377 mm in 1985. Whereas, under furrow irrigation of 0.50 IW/CPE ratio with 5.0 cm depth, the water use was 408 mm during both the years. The water use efficiency was higher under drip irrigation (1.19 q/ha mm in 1984 and 1.00 q/ha-mm in 1985) as compared to furrow irrigation (0.75 q/ha-mm in 1984 and 0.70 q/ha-mm in 1985).

Increased water-use efficiency under drip irrigation was mainly due to higher yields and lesser water used. Thus, the water-use efficiency was higher under drip irrigation by 58 per cent and 43 per cent in 1984 and 1985 respectively, as compared to furrow irrigation. Singh and Singh (1978) reported increased water use efficiency under drip irrigation in water melon. The higher water-use efficiency was also due to reduced water losses from the irrigation system and more efficient plant water use (Goldberg et al. 1971). Russo (1983) has shown that yield is linearly related to the variance of soil water potential.

The water-use in Experiment II, under drip irrigation with one emitter per plant and one emitter per two plants were the same and ranged from 201 mm in 1984 to 214 mm in 1985 with 0.25 PER, to 654 mm in 1984 to 705 mm in 1985 with 1.00 PER. In case of furrow irrigation, the water use as a

mean of two years was 288 mm with 0.25 IW/CPE ratio, as compared to 672 mm with 1.00 IW/CPE ratio. Thus, nearly 384 mm water use was higher with irrigation at 1.00 IW/CPE ratio, as compared to irrigation at 0.25 IW/CPE ratio (an increase of nearly 132 per cent).

Water use efficiency under drip irrigation with one emitter per plant (0.96 q/ha-mm in 1984 and 0.80 q/ha-mm in 1985) and one emitter per two plants (1.07 q/ha-mm in 1984 and 0.86 q/ha-mm in 1985) was significantly higher during both the years, as compared to 2.5 cm depth (0.69 q/ha-mm in 1984 and 0.60 q/ha-mm in 1985) and 5.0 cm depth (0.60 q/ha-mm in 1984 and 0.50 q/ha-mm in 1985). This is in conformity with views of several workers, who favoured drip irrigation mainly due to higher yield and water economy (Goldberg et al. 1976 and Doss et al. 1980). Much water saving may be achieved by restricting the water supply to the extent of most efficient rootzone (Dasberg and Steinhardt, 1974). Water use efficiency was significantly higher with irrigation at 0.25 IW/CPE ratio (1.26 q/ha-mm in 1984 and 1.08 q/ha-mm in 1985), as compared to irrigation at 0.50, 0.75 and 1.00 IW/CPE ratios. This was mainly due to less water use, as compared to higher IW/CPE ratios. Lin et al. (1983) also observed higher water-use efficiency under low water regime, as the degree of stress created was relatively low and decrease in yield was to a lesser extent, compared to reduction in water-use. Apart from this, at lower levels of irrigation, plants probably used water more economically, when it was limited

(Viets, 1962; and Lin et al. 1983).

The present investigations clearly brought out the fact that, even with irrigation at 0.50 IW/CPE ratio, it is possible to realise higher watermelon yields. Although, both the growth and yield parameters improved with further increase in the IW/CPE ratio, resulting in higher yields, the differences were not significant beyond 0.50 IW/CPE ratio.

Interaction effect of cumulative pan evaporation ratios and method of irrigation, on the fruit yield was significant only during 1985. There was significant increase in yield with increase in IW/CPE ratios, under both 2.5 cm and 5.0 cm depth, under furrow irrigation. Whereas, there was no such increase under drip irrigation. This clearly indicated that even with reduced quantity of water, plants will be able to perform better under drip irrigation, as compared to furrow irrigation. It was further observed that under furrow irrigation with 2.5 cm depth, the yield differences were not significant beyond 0.50 IW/CPE ratio. On the contrary, with 5.0 cm depth, the yield increased significantly upto 0.75 IW/CPE ratio. The yield with 2.5 cm depth and 0.50 IW/CPE ratio, was almost similar to that with 5.0 cm depth of irrigation, applied at 0.75 CPE ratio. Thus, it is evident that under drip system, replenishment of 25 per cent evaporation losses, resulted in near optimum yields. This could be obtained with 50 and 75 per cent replenishment of evaporation losses under furrow irrigation with 2.5 cm and 5.0 cm depth of irrigation, respectively. With the result, there is substantial saving in irrigation water to the extent

of 50 per cent under drip irrigation, as compared to 2.5 cm and 5.0 cm depth of furrow irrigation. The interval of irrigation ranged from 18-20 days, with irrigation at 0.25 IW/CPE ratio and 2.5 cm depth, and 35-36 days with 5.0 cm depth, as compared to irrigation at 1.00 IW/CPE ratio (4-5 days with 2.5 cm depth and 7-8 days with 5.0 cm depth).

Results of practical application:

1. A nitrogen level of 120 to 140 kg per ha, with a plant population of 16,666 plants per ha (200 cm x 60 cm) is optimum for watermelon to realise higher yields.
2. Drip irrigation with one emitter per two plants and daily application of water, at the rate of 25 per cent of pan evaporation, gives higher watermelon yields. This also results in the reduction of water use and increased water-use efficiency, as compared to drip irrigation, at the rate of 100 per cent of pan evaporation. Drip irrigation can be adapted, in case of scarcity of irrigation water.
3. Furrow irrigation with 2.5 cm depth of irrigation water, with IW/CPE ratios of 0.50 and 0.75 gives higher yields of watermelon. Eight to ten irrigations at an interval of 8 to 12 days are needed, during the crop growth period.

Future line of work:

1. A wider range of nitrogen and plant population levels should be tried, to exploit their interaction effects.

2. Critical stages of crop for soil moisture, needs to be identified, to make better use of limited water resources.
3. There is a need to find out the optimum soil water status, at different vertical and horizontal distances from the base of the plant, for maximisation of yield and water-use efficiency in watermelon.
4. Studies on use of mulches in conjunction with method of irrigation, is needed to reduce irrigation water requirements of water melon.

## **SUMMARY**

## VI. SUMMARY

The studies on "Response of watermelon to drip and furrow irrigation under different nitrogen and plant population levels" involved two field experiments. These field experiments were carried out at the Experimental Farm, Hesaraghatta, Bangalore on sandy clay loam soils, in factorial randomised block design, replicated thrice, during the summer seasons (January - May) of 1984 and 1985. The summary of these experiments are presented in this chapter.

Experiment I : Effect of nitrogen and spacing under drip and furrow irrigation in watermelon.

### Effect of nitrogen

1. The vine length, vine girth, number of leaves and dry matter production increased, with the increase in nitrogen levels upto 180 kg per ha.
2. Leaf area index, leaf area duration, relative growth rate, net assimilation rate and crop growth rate increased, with nitrogen levels upto 180 kg per ha. However, the increase was marginal beyond 120 kg nitrogen per ha.
3. The number of male flowers increased with nitrogen levels upto 180 kg per ha and the number of female flowers increased only upto 120 kg nitrogen per ha.
4. Watermelon yields increased with nitrogen levels upto 120 kg per ha (370 q/ha in 1984 and 345 q/ha in 1985, respectively), as compared to 60 kg nitrogen per ha (349 q/ha in 1984 and 308 q/ha in 1985), an increase of

nearly 9 per cent in 1984 and 12 per cent in 1985. However, during 1984, the yield (361 q/ha) decreased marginally with 180 kg nitrogen per ha, as compared to 120 kg nitrogen per ha.

5. During 1984, the number of fruits per ha increased from 12,229 with 60 kg nitrogen to 14,333 with 120 kg nitrogen per ha. During 1985, it increased from 9050 fruits per ha with 60 kg nitrogen per ha to 10,514 fruits per ha with 120 kg nitrogen per ha. The increase in number of fruits between 120 kg and 180 kg nitrogen per ha, was marginal.
6. The fruit weight also increased, with the application of nitrogen (2.6 kg with 60 kg and 3.0 kg with 120 kg nitrogen/ha, during 1984 and 2.3 kg with 60 kg and 2.8 with 120 kg nitrogen/ha, during 1985). The increase in fruit weight was less, beyond 120 kg nitrogen per ha.
7. The soluble solids, reducing and total sugars and nitrate-nitrogen in watermelon juice increased, with increase in nitrogen levels.
8. The content and uptake of nitrogen, phosphorus, potassium, calcium and magnesium of watermelon increased, with increase in nitrogen levels, upto 180 kg per ha.

#### Effect of spacing

9. The vine length and number of leaves were higher with 200 cm row spacing, whereas, the dry matter production and leaf area were more, with 300 cm row spacing, with

the same intra-row spacing of 60 cm. However, leaf area index, relative growth rate, net assimilation rate and crop growth rates were higher, with 200 cm row spacing.

10. Reducing the row spacing from 300 cm to 200 cm, increased the fruit yield to an extent of 16 to 19 per cent (389 q/ha in 1984 and 362 q/ha in 1985 with 200 cm row spacing and 336 q/ha in 1984 and 303 q/ha in 1985 with 300 cm row spacing).
11. Although, nitrogen, phosphorus, potassium, calcium and magnesium contents were slightly higher with 300 cm row spacing, the uptake of these nutrients per ha were invariably higher, with 200 cm row spacing.

#### Method of irrigation

12. Drip irrigation recorded higher vine length, number of leaves, leaf area index, relative growth rate, net assimilation rate and crop growth rates, as compared to furrow irrigation.
13. Fruit yield increased by 36 and 32 per cent under drip irrigation during 1984 and 1985 respectively, (418 q/ha in 1984 and 379 q/ha in 1985) as compared to furrow irrigation (307 q/ha in 1984 and 287 q/ha in 1985).
14. Fruit number per ha increased from 11,972 with furrow irrigation to 14,930 with drip irrigation, during 1984 and from 10,502 with furrow irrigation to 13,840 with drip irrigation, during 1985. The fruit weight was also higher under drip irrigation (3.0 kg in 1984 and 2.9 kg in 1985), as compared to furrow irrigation (2.6 kg during both 1984 and 1985).

15. The water use under drip irrigation was less (352 mm in 1984 and 377 mm in 1985), as compared to furrow irrigation (409 mm during both 1984 and 1985).
16. Nitrogen, phosphorus, potassium, calcium and magnesium contents and their uptake was higher under drip irrigation, as compared to furrow irrigation.

Experiment II : Studies on the comparative efficiency of drip and furrow irrigation systems in water-melon.

#### IW/CPE ratio

1. The growth parameters viz., vine length, number of leaves, dry matter, leaf area index, relative growth rate, net assimilation rate and crop growth rates were higher with higher, IW/CPE ratio.
2. The yield was highest with irrigation at 1.00 IW/CPE ratio (338 q/ha in 1984 and 310 q/ha in 1985), as compared to the lowest with irrigation at 0.25 IW/CPE ratio (327 q/ha in 1984 and 252 q/ha in 1985).
3. The number of fruits per ha and fruit weight increased with higher IW/CPE ratio.
4. Nitrogen, phosphorus, potassium, calcium and magnesium contents and their uptake increased, with higher IW/CPE ratio.

#### Method of irrigation

5. Drip irrigation with one emitter per two plants recorded higher vine length, number of leaves, leaf area index, relative growth rate, net assimilation rate and crop

growth rate, as compared to 5.0 cm depth, under furrow irrigation. These parameters did not differ markedly under drip irrigation, with one emitter per plant and 2.5 cm depth, under furrow irrigation.

6. Fruit yields were higher under drip irrigation with one emitter per two plants (367 q/ha 1984 and 314 q/ha in 1985), as compared to 5.0 cm depth (269 q/ha in 1984 and 227 q/ha in 1985), under furrow irrigation. However, the yields were on par with 2.5 cm depth, under furrow irrigation and one emitter per plant, under drip irrigation.
7. The yields were higher (nearly by 4% in 1984 and by 2% in 1985) with one emitter per two plants, as compared to one emitter per plant, under drip irrigation. Furrow irrigation with 2.5 cm depth resulted in higher yields, than 5.0 cm depth of irrigation (an increase of nearly 12% in 1984 and 24% in 1985).
8. The interaction effects indicated that, with daily drip irrigation at 25 per cent of pan evaporation, it is possible to obtain higher yields of watermelon. Whereas, under furrow irrigation, at least 0.50 and 0.75 IW/CPE ratios with 2.5 cm depth, were needed to maintain optimum yield levels. Thus, nearly 50 per cent saving in water was possible under drip irrigation, as compared to furrow irrigation.
9. The water use efficiency was higher with 0.25 IW/CPE ratio (1.26 q/ha-mm in 1984 and 1.08 q/ha-mm in 1985, as

compared to 0.52 q/ha-mm in 1984 and 0.44 q/ha-mm in 1985 with 1.00 IW/CPE ratio).

10. Drip irrigation with one emitter per two plants recorded higher nitrogen, phosphorus, potassium, calcium and magnesium content and uptake, as compared to 5.0 cm depth, under furrow irrigation. The variations in nutrient content and uptake, between drip irrigation with one emitter per plant and 2.5 cm depth under furrow irrigation, were less. Drip irrigation with one emitter per plant and one emitter per two plants recorded higher water-use efficiency, as compared to 2.5 cm and 5.0 cm depth, under furrow irrigation.

Based on the results obtained in these field experiments, the following recommendations can be made.

A nitrogen level of 120 to 140 kg per ha, is optimum for obtaining higher yields of watermelon. A plant population of 16,666 plants per ha (200 cm x 60 cm) is better for yield maximisation.

Drip irrigation is highly advantageous from the point of water economy, higher yields and increased water-use efficiency, as compared to furrow irrigation and is very well suited to areas of water scarcity. Drip irrigation with daily application of water, at the rate of 25 per cent pan evaporation, is suitable for realising higher yields. Furrow irrigation at 0.50 or 0.75 IW/CPE ratio, with 2.5 cm depth of water can also be adapted for watermelon for higher yields.

## REFERENCES

## VII. REFERENCES

- Abdel-Samie, A.S. 1958. Effect of organic and inorganic fertilizers on the growth and yield of watermelons. Agric. Res. Rev. 36: 436-79.
- \*Abreu, T.A. DE., Dutta, A.F.L and Marehetti, D.A.B. 1978. Comparison of two irrigation methods on melons in the Sao Francisco valley. Pesquisa Agropecuria Brasileira 13(3): 35-45.
- \*Afans' EV, L.I. 1940. The mineral nutrition of Klin cucumbers grown in glass houses. Vestnik Ovoscevodstvo ikartofel. No. 5: 26-46.
- Alijbury, F.K., Gerilts, M., Lange, A., Huntamer, J. and Levitt, G. 1974. Performance of plants with drip irrigation. Proc. 2nd Int. drip. Irrig. Congr. 497-499.
- Anonymous, 1985. Cultivation practices for vegetables. pub. Director of Extension. U.A.S. Bangalore.
- Anonymous. 1985. Annual Report of Department of Agriculture, Karnataka. 16-20.
- Baljeet Singh., Mangal, J.L. and Pandita, M.L. 1982. Effect of pruning, spacing and fertilizer levels on flowering, fruiting and quality of muskmelon. Haryana. Agric. Univ. Res. 12(1): 64-68.

- Barber, S.A., Walker, J.M. and Vasey, E.H. 1963. Mechanisms for the measurement of plant nutrients from the soil and fertilizer to the plant root. J. Agric. Food, Chem. 11: 204-207.
- Barber, S.A. 1966. International atomic energy agency, technical report series. No. 65, 39, Vienna.
- Barker, A.V., Laplante, J.F. and Daman, R.A. 1983. Growth and composition of radish under various regimes of nitrogen fertilization. J. Amer. Soc. Hort. Sci. 108: 1035-1040.
- Begg, J.E. and Turner, N.C. 1976. Crop water deficits. Adv. Agron., 28: 161-217.
- \*Belik, V.F. and Veselovskii, M. Ya. 1973. The effect of plant density on photosynthesis in irrigated watermelons. Refraktivrifi Zhournal, 3: 55:567
- \*Belik, V.F. and Veselovskii, M.Ya. 1975. The characteristics of growth and development of irrigated watermelons. Nauchnye Treedy NIL Ovoshch-Kh-Va, 5: 254-257.
- Bernstein, L. and Francois, L.E. 1973. Comparison of drip, furrow and sprinkler irrigation. Soil. Sci. 115: 73-76.
- Bhella, H.S and Kwolek, W.F. 1984. The effect of trickle irrigation and plastic mulch on Zucchini. Hort. Sci. 19(3): 410-411.

- Bhosale, R.J., Kanvilkar, S.A. and Andhale, R.K. 1978. Yield performance of watermelon under graded levels of N,P and K. J. Maharashtra Agric. Univ. 3(2): 93-95.
- Bishop, E.W. Chapman, E.W. and Mac Eachern. 1969. Effect of nitrogen, Phosphorus and Potassium on yields and nutrient levels in laminae and petioles of pickling cucumbers. Canadian J. Soil. Sci. 49:297-304.
- Bogle, C.R. and Hartz, T.K. 1986. Comparison of drip and furrow irrigation for muskmelon production Hort. Sci. 21(2): 242-244.
- \*Bolotskih, A.S. 1969. The effectiveness of mineral fertilizers in growing cucumbers under irrigated conditions. Himiya Sel' Hoz., 7(2): 19-20.
- Borelli, A. and Zerbi, G. 1977. Effect of different irrigation methods and levels on green house muskmelon. Acta. Hort. 58:129-135.
- \*Bradley, G.A. and Fleming, J.W. 1959. Fertilization and foliar analysis studies on watermelons. Bull. Arkan. Agric. Expt. Sta. 610:32.
- \*Bradley, G.A, Baker, E.C. and Motes, D.R. 1975. Cucumber spacing and fertilization studies, Proc. 96th Ann. Meet. Arkansas.
- Brantley, B.B and Warren, G.F. 1960. Effect of nitrogen on flowering, fruiting and quality in the watermelon. Proc. Amer. Soc. Hort. Sci. 75: 644-649.

- Brantley, B.B and Warren, G.F, 1961. Effect of nitrogen nutrition on flowering, fruiting and quality in the watermelon. Proc. Amer. Soc. Hort. Sci. 75: 644-649.
- Bresler, E. 1977. Trickle-drip irrigation principles and applications to soil water management. Adv. Agron., 29: 343-393.
- Brinen, G.H., Locascio, S.J. and Elmstrom, G.W. 1979. Plant and row spacing, mulch and fertilizer rate effects on watermelon production. J. Amer. Soc. Hort. Sci. 104(6): 724-726.
- Bucks, D.A., Nakayana, F.S. and Warriek, A, 1981. Principles of trickle irrigation. "In Advances in irrigation". Acad. Press. Inc. N.Y.220 -229.
- Burgmans, J.L. 1983. Spacing effects of zucchinis in Hauker Bay, New Zealand. Commercial Grower. 38(9): 34-35.
- Callebaut, M., Badji, M and Feyen, J. 1985. Response of Horticultural crops to irrigation in semi-arid regions of Tunisia. Sci. Hort. 26(4):279-291.
- Cantliffe, D.J. 1977. Nitrogen fertilizer requirements of pickling cucumbers grown for once-over harvest. I. Effect on yield and fresh quality. J. Amer. Soc. Hort. Sci. 102(2): 112-114.

- Cantliffe, D.J., 1977. Nitrogen fertilizer requirements of pickling cucumbers grown for once-over harvest. II. Effect on plant tissue mineral nutrient-concentration. J. Amer. Soc. Hort. Sci. 102(2): 115-119.
- Cantliffe, D.J., and Pathak, S.C. 1975. Plant population studies with pickling cucumbers grown for once-over harvest, J. Amer. Soc. Hort. Sci. 100(5): 464-466.
- \*Cehmistrenko, V.F., Usiki, G.E. and Noviko, N.M. 1954. Group spacing of cucumbers, tomatoes and vegetable marrows. Sod iogorod, No. 2:18-21.
- Chander, A. and Mangal, J.L. 1983. Studies on nitrogen fertilization under various soil moisture regimes on growth, flowering and fruiting behaviour of muskmelon. Punjab, Hort, J. 23(1/2): 105-110.
- \*Charlottetown, 1954, Pickling cucumbers. Prog. Rep. Dominion. Exp. Sta. P.E.I.:57.
- \*Chernovol, A.E. 1979. Cucumber Yields in relation to the time of irrigation. Nauch-Tekhen, Byul Ukr. N. II. Ovoschovod. i. Bakchevod. No. 10:8-10. Referativneji. Zhurnal. 5..55.393.
- Clothier, B., Scotter, D. and Harper, E. 1985. Three dimensional infiltration and trickle irrigation. Trans. Am. Soc. Agric. Engrs. 28(2): 497-501.

- Colman, R.L. and Lazenby, A. 1975. Effect of moisture on growth and nitrogen response of Lolium Perenne. Plant. Soil. 42:1.
- Cummins, T.L. and Kretchman, D.W. 1975. Moisture stress relations to growth and development of pickling cucumber. Ohio. Agric. Res. Rev. Cen. No. 81, 23-24.
- Dasberg, S. and Steinhardt, R. 1974. In "Isotopes and Radiation techniques in soil physics and irrigation studies". Proc. Series. 467-474, I.A.E.A., Vienna.
- Davis, R.M., Baker, G.A. and Kasmire, R.P. 1964. Muskmelon quality characteristics, their variability and inter-relationships. Hilgardia, 38: 165-180.
- \*Dearborn, R.B. 1936. Nitrogen nutrition and chemical composition in relation to growth and fruiting of the cucumber plant. Cornell, Univ. Agric. Exp. Sta. Manl. 192.
- Denmead, O.T. and Shaw, A.H. 1962. Availability of soil water to plants as affected by soil moisture content and meteorological conditions. Agron. J. 54: 385-390.
- Deswal, I.S. and Patil, V.K. 1984. Effects of N,P and K on the fruit yield of watermelon. J. Maharashtra. Agri. Univ. 9(3): 308-309.
- Desai, J.B. and Patil, V.K. 1984. Effects of sowing dates and irrigation on growth, yield and quality of watermelon. J. Maharashtra. Agric. Univ. 9(1): 34-37.

- Donald, C.M. 1963. Competition among crop and pasture plants. Adv. Agron. 15:1.
- Donald, C.M, 1962. In search of yeild. J. Aust. Inst. Agric. Sci. 28: 171-178.
- \*Dimitrov, Z. 1973. Seasonal irrigation pattern of watermelon. Gradinarstvo. 15(11): 31-34.
- Doneen, L.D. Porter, D.R. and Mac Gillivray, J. H. 1939. Irrigation studies with watermelons. Proc. Amer. Soc. Hort. Soc. 37: 821-824.
- Doss, B.E., Evans, C.E. and Johnson, W.A. 1975. Rates of nitrogen and irrigation for tomatoes. J. Amer. Soc. Hort. Sci. 100: 435-437.
- Edelstein, M., Karchi, Z., Nerson, H., Paris, H.S., Lozner, D., Pourger, Y., Roter, Y and Govers, A. 1983. What is the upper limit of spaghetti squash response to fertilization. Hassadels, 63(6), 1160-1162.
- Elmstrom. G.W., LoCascio, B.J. and Myers, J.M. 1981. Watermelon response to drip and sprinkler irrigation. Proc. Flo. St. Hort. Soc. 94: 161-163.
- Everett, P.H. 1960. The influence of nitrogen source and fertilizer rte on watermelon yields. Proc. Flo. St. Hort. Soc. 73: 107-111.
- Fernando, M. 1943. Spacing experiment with vegetable. Trop. Agri. St. 99: 69-77.

- Fleming, W.H. 1936. Irrigation of cantaloupes. Sci. Hort. 16: 634-643.
- Flocker, W.J. Lingle, J.C., Davis, R.M. and Miller, R.J. 1965. Influence of irrigation and nitrogen fertilization of yield, quality and size of Cantoloupes, Proc. Amer. Soc. Hort. Sci. 86: 424-432.
- Fowler, J.L. and Ray. L.L. 1977. Response of two cotton genotypes to fire equidistant spacing pattern. Agron. J. 69(5): 733-738.
- Gato, Y., Ichikawa, H., Araki, Y. and Shibata, A. 1981. Studies on variation of soil water suction at the beginning of irrigation and irrigation requirement of some vegetables under green house conditions. I. An experiment with cucumbers under forcing conditions. Bull. Veg. Orn. Cr. Res. Sta. A (Ano. Mic) 9: 133-141.
- Gates, C.T. 1957. The response of the young tomato plant to a brief period of water shortage.III. Drifts in nitrogen and Phosphorus. Australian. J. Biol. Sci. 10: 125-146.
- \*Gericke, S. 1948. The application of stable manure in vegetable growing. Ceres. Hamburg. 1: 11-13.
- Gill, M.S and Ali, M.N. 1964. Investigations into the effect of some of the agronomic factors on the yield and quality of muskmalon crop. West Pakistan. J. Agric. Res. 2(3): 1-5.

- Gingrich, J.R. and Russel, M.B. 1957. A comparison of effects of soil moisture tension and osmotic stress on root growth. Soil Sci. 84: 185-194.
- Goldberg, D. and shmueli, M. 1970. Irrigation trials on vegetables in Arva. Hossadeh. 50(9): 1103-1106.
- Goldberg, D., Rinot, M. and Koru, N. 1971. Effect of trickle irrigation intervals on distribution and utilization of soil moisture in a vineyard. Soil Sci. Soc. Amer. Proc. 35: 125-130.
- Goyal, M.R. and Allison, W.F. 1983. Summer drip irrigation requirements for cucumber. J. Agric. Univ. PuertoRico. 67(3): 328-334.
- Graifenberg, A. and Petsas, S. 1983. Growth and uptake of nutrient elements in melons. Informatore di. Ortofloro-frutti. Coltura. 24(7/8) : 5-10.
- Greenway, J., Hughes, P.G. and Klepper, B. 1969. Effect of water deficit on phosphorus nutrition of tomato plants. Physiol. Plant. 22: 144.
- Gupta, A., Sharma, C.B. and Shukla, V. 1975. Yield response of muskmelon to nitrogen and phosphorus fertilization. Indian. J. Hort. 32 (3 & 4): 171.
- Gupta, A. and Srinivas, K. 1979. Reasponse of pumpkin to nitrogen and phosphorus fertilization. Indian. J. Hort. 36(3): 289 - 293.

- Gupta, J.P. and Singh, S.D. 1983. Hydrothermal environment of soil and vegetable production with drip and furrow irrigations. Indian. J. Agri. Sci. 53(2): 138 - 142.
- Halsey, I.H. 1959. Watermelon spacing and fertilization. Proc. Flo. St. Hort. Sco. 72: 131 - 135.
- Headley, F.B. and Fulkerson, V. 1913. Commercial truck crops on the truckeearson Project, U.S.D.A. Bur. PI. Ind. Cir. 113: 15 - 22.
- Hesse, P.R. 1972. A test book of soil chemical analysis. Pub. John Murray, London.
- \*Henrikson, K. 1980. Irrigation of ridge cucumbers. Tidsskriff Planteavl. 84(6): 479 - 490.
- \*Henrikson, K. 1984. Nitrogen fertilizing in seed onions at high soil moisture content. Tidsskriff fur plantenval. 88: 621 - 31.
- Hira, G.G. and Singh, N.T. 1977. Observed and predicted rates of phosphorus diffusion soils of varying bulk density and water content. Soil. Sci. Soc. Amer. J. 41: 537-540.
- Holliday, R. 1960. Plant population and crop yield. Nature. 186: 22 - 24.
- Howell, T.A., Bucks, D.A. and Chesness, J.L., 1981. Advances in trickle irrigation. In "Irrigation, challenges of the 80'2". Proc. 2nd. Nat. Irrig. Symp., Am. Soc. agric. Engrs. 67 - 94.

- Hsico, T.C., 1973. Plant response to water stress. Ann. Rev. Plant Physiol., 24: 519 - 570.
- Huffaker, R.C., Radin, J., Kleinkopf, G.E. and Cox, E.L. 1970. Effect of mild water stress on enzymes of nitrate assimilation and of the carboxylative phase of photosynthesis in barley. Crop. Sci., 10: 471.
- Hunt, R. 1978. Plant growth analysis. Studies in Biology No.96. Edward Arnold publishers, Great Britain.
- Jackson, M.L. 1967. Soil chemical analysis. prentice Hall of India, New Delhi.
- Jagoda, J., Grajewska, H., Charzewska, W., Spaski, H. and Viseardi, K. 1970. The effect of irrigation and mineral and organic fertilization on cucumber yield. Biuletyn Warzywniczy. 11: 109 - 126.
- Jagoda, J. and Koniszewski, S. 1975. Effect of irrigation and mineral fertilizers on two cucumber cultivars. Biuletyn Warzywniczy. 18: 47 - 61.
- Jarrell, W.M. and Beverly, R.B. 1981. The dilution effects in plant nutrition studies. Adv. Agron. 34: 197 - 224.
- Jassal, N.S., Nandapuri, K.S. and Randhawa, K.S. 1970. A study on the effect of irrigation and certain doses of nitrogen, phosphorus and potassium on the weight of fruit and yield of muskmelon. Punjab. Hort. J. 10: 143-149.

- Jassal, N.S., Nandapuri., and Randhawa, K.S., 1972. Studies on the influence of irrigation and difference doses of nitrogen phosphorous and potassium on the flowering behaviour and absorption of nutrient elements in muskmelon. J. Res. 9(2): 242 - 247.
- Kaliappa, R., Venkatachalam, K.M., Nachappan, K.M. and Selvaraj, K.V., 1974. Water requirement of tomato. Madras agric. J., 61: 867.
- \*Karataev, E.S., and Salnikova, M.B. 1982. Effect of planting density on the growth and development of parthenocarpic cucumbers. In. Intensifik. Vozdelyvaniya Ovashch. Plod. i. Yagod. Kultur Leningard. U.S.S.R. 27 - 29.
- \*Karchi, Z., Growers, A. and Neubeuer, Y. 1977. Comparative effect of organic manure and NP fertilizers and yield parameters of the Honey Dew melon. Cv. Noy. Amid. J. Hassadesh. 57(9): 1671 - 1675.
- Karien, D.L., Camp, C.R., and Robbions, M.L. 1985. Fresh-market tomato response to N and K fertilization and water management practices. Plant. Soil 16(i): 71 - 81.
- Kashi, A. 1981. Effect of interval and method of irrigation on some quantitative and qualitative characteristics of semsuri Cantaloupe of Varmin. Iranian J. Agri. Sci. 12(1/4) 1 - 12.

- \*Khrystov, B. 1984. The relationship between the growth and productivity of watermelons and minerals fertilizers. Pochroznanie i Agrokimiya. 19(2): 94 - 99.
- \*Kim, H.T and Ito, T. 1983. Effect of nitrogen and potassium levels on yield and quality of melon. Reports of Rural dev., S. Korea, Hort. 25(10): 1 - 12.
- \*Knysh, A.N and Vakulenko, R.I. 1976. The effect of mineral fertilizers on watermelon yield and quality. Agro-khimiya 2. 100 - 101.
- Ko. B.R., Lee, K.B., La, J.S., Nho, S.P. and Lee, D.K. 1978. Studies on the effect of planting density and manurial rate of growth of Luffa Cyclindrica. Res. Rep. Ru. Dev. Hort. Ag. Engg. 20: 47 - 50.
- \*Konishi, K. 1974. The amount and nature of water consumption in muskmelon plants. Sci. Rep. Okayama. Univ. 43:27-37.
- \*Kononenko, A.G. and Maksimova, M.O 1976. Yield of watermelon cultivar Ogonek in relation to spacing and number of plants per planting hole. Ovochinivitetvoi Bashtannitstov. Resp. Mizhvid. Temat. Nauk. Zhovnik. 21. 26 - 31.
- \*Krynska, W. 1975. Effects of sprinkling irrigation and mineral fertilization on cucumber yields. Biuletyn. Warzywrieczy. 18: 63 - 78.

- \*Krynska, Eawocki, Z. and piotrowski, L. 1976. The effect of fertilization, irrigation and cultivar on the quality of fresh, sour and pickled cucumbers. Rolnietwo. 15: 109-123.
- Lazin, M.B. and Simonds, S.C. 1981. Influence of planting method, fertilizer rate and within row plant spacing on production of two cultivars of honey-dew melons. Proc. Fla. St. Hort. Soc. 94: 180-182.
- Locascio, S.J. and Halsey, L.H. 1960. Fertilizer requirements of watermelons. L.H. Fla. Agric. Wxpt. Sta. 194.
- Locascio, S.J., and Fiskell, J.G.A. 1975. Sulphur coated urea as slow release N-source for pepper and watermelon. Amer. Soc. Hort. Sci. 19: 171-180.
- Locascio, S.J., Fiskell J.G.A. and Elmstrom, G.W. 1978. Comparison of sulphur-coated urea and uncoated for watermelons. Soil.Crop.Sci.Soc.Fla.Proc. 37: 197-200.
- Locascio, S.J., Fiskell, J.G.A. and Enerett, P.E. 1970. Advances in watermelon fertility. Proc. Trop. Reg. Amer. Host. Sci. 14: 223-231.
- Lebanauskas, C.K., Stolzy, L.H. and Handy, M.F., 1972. Concentrations and total amounts of nutrients in citrusseedlings and in soil as influenced by differential soil oxygen treatments. Proc. Soil. Sci. Amer. 36: 454-457.

- Lemon, E.R. 1956. The potentialities for decreasing soil moisture evaporation loss. Soil. Sci. Soc. Amer. Proc. 20: 120-125.
- Lin, S.S.M., Hubbel J.N., Samson, Tsou, S.C.S. and splittstoesser, W.E., 1983. Drip irrigation and tomato yield under tropical conditions. Hort. Sci., 18(4): 460-461.
- Loomis, E.L. and Grandall, P.C. 1977. Water consumption of cucumbers during vegetative and reproductive stages of growth. J. Amer. Soc. Hort. Sci. 102(2): 124-127.
- MacGillivray, J.H. 1951. Effect of irrigation on the production of cantalopes. Proc. Amer. Soc. Hort. Sci. 57: 266-271.
- Mahtab, S.K. Godfrey, C.L., Swoboda, A.R., and Thomas, G.W. 1971. Phosphorus diffusion in soils. I. The effect of applied P, Clay Content, and water content of soil. Soil. Sci. Soc. Amer. Proc. 35: 393-397.
- \*Malinina, M.I. 1971. Source material and methods of growing cucurbit crops. Trudy Po Priladnoi Botaniks Genetike i Selektoskii 44(2): 113-120.
- Mangal, J.L. Pandita, M.L., and Gajraj Singh, 1981. Effect of pruning and spacing on watermelon. Haryana J. Hort. Sci. 10(3/4): 210-219.

- \*Mannini, P. and Roncuzzi, M. 1983. The yield response of cucumbers to different intervals, volume and systems of irrigation in the Untreated glass house. Culture Portettee 12(4): 29-30.
- Mannini, P., Abori, A. and Gallina, D. 1985. yield response of melons to different intervals, volumes and systems of irrigation in an untreated greenhouse. Informatore Agrario. 41(33): 47-53.
- Massarawa, M., Feigin, A. and Zeidan, O. 1984. Dry matter production and N,P,K uptake by cucumbers growing in a lipillituff bed in the greenhouse. Hassadeh. 64(5):908-911.
- McClatchie, A.J. 1902. Irrigation at station farm. Ariz. Agric. Expt. Sta. Bull. 41: 20-23.
- Mederski, M.J., and Wilson, J.M. 1960. Relation of soil moisture to ion absorption by corn plants. Soil. Sci. Soc. Amer. Proc. 24: 149-152.
- Middleton, J.E., Proebsting, E.L. and Roberts, S. 1979. Apple orchard irrigation by trickle and sprinkler. Trans. Amer. Soc. Agric. Eng. 22: 592-584.
- Mirreh, M.F., and Ketcherson, J.W. 1973. Influence of soil water matrix potential and resistance to penetration on corn root elongation. Canadian J. Soil. Sci. 53: 383-388.

- Mitchell, P.D. and Black, J.D.F. 1971. The response of preplant peach trees to Weedicide, daily irrigation, nitrogen and phosphorus. Australian. J. Expt. Agri. Anim. Husb. 11 : 699-704.
- \*Molnar, B. 1965. Irrigation of melons. Novenytermeles, 14: 203-214.
- \*Muminov, T.G. 1973. Forecasting the times of melon irrigation by means of leaf water content. Nanchney Trudy N II Oroshche Bakhchevykh Kuthur i Kartofelya. 10: 62-74.
- Nerson, H., Govers, A., Paris, H.S., Karchi, Z., Edelstein, M. and Freudentberg, D. 1982. Interactions between population density and plant growth regulators in the cultivation of pickling cucumbers in a simulated once-over mechanical harvest. Hassadesh. 62(7): 1192-1195.
- Nerson, H., Edelstein, M., Paris, H.S., Karchi, Z. and Govers, A. 1984. Effects of population density and plant spacing on the vegetative growth, flowering and yield of muskmelons, cv. Galia. Hassadesh. 64(4): 698-702.
- Nettles, V.F., Halsey, L.H. and Lundy, H.W. 1957. Fertilizer requirements of watermelons. A.R. Florida. agric. Expt. Stat. : 172-173 and 374.

- \*Niel, P. and Zumino, J.P. 1972. Water requirements of melons and methods of irrigation. Pepinoristes. Horticulteurs Marichers. 123 : 43-54.
- Nye, P.H. and Tinker, P.B. 1977. Solute movement in the soil root system. Univ. of California Press, Berkely.
- Olsen, S.R., Watanabe, F.S., and Danielson, R.E. 1961. Phosphorus absorption by corn roots as affected by moisture and phosphorus concentration. Soil Sci. Soc. Amer. Proc. 25 289-294.
- Olsen, S.R., Kemper, W.D., and Van Schaik, J.C. 1965. Self diffusion coefficients of phosphorus in soil measured by transient and steady methods. Soil Sci. Soc. Amer. Proc. 29: 154-158.
- Padda, D.S., Malik, B.S. and Kumar, J.C. 1969. Response of muskmelon to nitrogen, phosphate and potash fertilization. Indian J. Hort. 26: 172-175.
- Page, A.L., Miller, R.H. and Keeney, D.R. 1982. Methods of soil analysis. Part 2 - Chemical and microbiological properties. Amer. Soc. Agron. Proc.
- Patil, C.B. and Bhosale, R.J. 1976. Effect of nitrogen fertilization and spacings on the yield of watermelons. Indian. J. Agron. 21: 300-301.
- \*Pavlov, F.I. 1976. Irrigation regime for cucumbers under heated plastic green houses. Referativnyl. Zhurnal. 10.55.638.

- Pelaez, R.J., Calero De La Para, C. and Jarmillo, V.J. 1984. Response of squash to fertilization with nitrogen, phosphorus, potassium and organic matter. Acta Agronomica. 34(3): 86-95.
- \*Peterson, L. 1957. Improved practices to raise melon yields. Iowa. Fm. Sci. 12(3):10.
- \*Peterson, L. 1961. Get more watermelons with smaller spacing. Iowa. Fm. Sci. 15 : 631.
- \*Peterson, L.E. 1962. Space close for watermelon yields. Iowa. Rm. Sci. 16: 202.
- \*Peterson, V.J., Nielsen, H. and Peterson, A.W. 1954. Top dressing trials with cucumber. Arbog Gartneri. 35: 127-39.
- \*Petkov, N. 1970. The effect of area of nutrition on yield and quality in watermelon production., Gradinarstvo. 12(1): 18-20.
- Pew, W.D. and Gardner, B.R. 1983. Effects of irrigation practices on vine growth, yield and quality of muskmelon. J. Amer. Soc., Hort. Sci. 108 (1) : 134-137.
- Phene, C.J. and Beale, O.W., 1976. High frequency irrigation of water and nutrient management in humid regions. Proc. 2nd Int. Drip. irrig. Congr., P. 116-171.

- Piper, C.S. 1950. Soil and plant analysis. Acad. Press. New York.
- Proebsting, E.L., Middleton, J.E. and Roberts, S. 1977. Altered fruiting and growth characteristics of apple associated with irrigation methods. Hort. Sci. 12: 349-350.
- \*Rafiev, M.R. 1969. Dynamics of fruit growth in unirrigated watermelons. Uzb. Biol. Zhurnal. 2 :44-6.
- Rajendran, P.C., Gopalakrishnan, P.K., Gopalakrishnan, T.R. and Peter, K.V. 1893. Effect of graded doses of nitrogen, phosphorus, and potassium on yield of pumpkin. Agric. Res. J. Kerala. 21 (1): 51-54.
- Randhawa, K.S., Cheema, D.S. and Sandhu, K.S. 1981. The effects of nitrogen, phosphorus and potassium on growth, yield and quality of new muskmelon varieties. Harayana. J. Hort. Sci. 10(1/2): 88-94.
- Randhawa, K.S., and Kirti Singh, 1971. Response of muskmelon to foliar applications of nitrogen, potassium and Asafoetida Indian. J. Agron. 16(3): 351-354.
- Ranganna, 1977. Manual of analysis of fruits and vegetable products. CFTRI. Tata McGraw Hill Pub. New Delhi.
- Roy Chaudhury, A. Mitra, S.K. and Bose, T.K. 1984. Effect of different doses of nitrogen, phosphorus, potassium, magnesium, calcium and iron for growth and yield of gourd. Indian J. Hort. 41(3/4): 265-267.

- Reddy, S.E. and S.N. Rao. 1980. A comparative study of pitcher and surface irrigation methods on snake gourd. Indian. J. Hort. 37: 77-81.
- Reddy, S.E. and Rao, S.N. 1983. Response of bitter gourd to pitcher and basin system of irrigation. South. Ind. Hort. 31(2/3): 117-120.
- Restoy, J.E. 1983. Results of cucumber cultivation in the green house and sand culture with different systems of localized irrigation. Investigacion Scobre Cultivols. 5: 21-32.
- Reynolds, R.B. and Stark, F.C. 1953. Growth and fruiting respons of cucumbers to varying of Ca, Mg, K and N in sand culture. Assoc. Southern Agric. Workers. 50 : 133.
- Rudich, J., Elassar, G. and Shaji, Y. 1978. Optimal growth stage for the application of drip irrigation to muskmelon and watermelon. J. Hort. Sci. 53(1): 11-15.
- Russo, D. 1983. Crop yield - irrigation relationships in a gypsiferous sodic soil. Agron. J. 72: 253-257.
- Sahu, R.K. 1984, Pitcher irrigation of watermelon grown in winter in coastal saline soils. Indian. J. Agric.Sci. 54: 979-983.
- \*Salis, F.A.M., Haag, H.P. and Minami, K. 1895. Mineral nutrition of vegetable crops. LIV. Accumlation of nutrients in the cucumber under field conditions. Anais da Escola Superior de Agricultura. 39(2): 679-737.

- Salter, P.J. and Goode, J.E., 1967. Crop response to water at different stages of growth. Res. Rev. 2. Comm. Ag. Bur. Farnham Roy, Bucks, England, 246.
- Sharma, C.B. and Shukla, V. 1972. Response of pumpkin to nitrogen and phosphorus application and their optimum levels. Indian. J. Hort. 29(2): 179.
- \*Shatanawi, M.R. 1983. Squash yield, root salinity under drip irrigation. Paper, Amer. Soc. Agri. Eng. No. 83-2031, 13 PP.
- Shmueli, M. and Goldberg, D. 1971. Sprinkle, Furrow and trickle irrigation of muskmelon in an arid zone. Hort. Sci. 6(6) : 557-559.
- Shukla, V. and Gupta, A. 1980. Note on the effect of levels of nitrogen and phosphorus fertilization on growth and yield of squash. Indian. J. Hort. 37(2): 161.
- Singh, S.D. and Punjab Singh, 1978. Value of drip irrigation compared with conventional irrigation for vegetable production in hot arid climate. Agron. J. 70: 945-951.
- Smittle, D.A. and Threadgill, E.D. 1982. Response of squash to irrigation, nitrogen fertilization and tillage systems. J. Amer. Soc. Hort. Sci. 107(3): 437-440.
- Srinivas, K. and Doijode, S.D., 1984. Effect of major nutrients on the sex expression in muskmelon. Prog. Hort. 16(1-2): 113-115.

- Srinivas, K. and Prabhakar, B.S. 1984. Response of muskmelon to varying levels of spacing and fertilizers. Singapore. J. Prim. Ind. 12(1): 56-61.
- \*Talmach, F.S. 1977. The effect of fertilizer on Cucumber yield in northern Moldvia. Referativnyi Zhurnal. 5.55.655.
- Tan, C.S., Fulton, J.M. and Nuttall, V.W. 1983. The influence of soil moisture stress and plant populations on the yield of pickling cucumbers. Sci. Hort. 21(3): 217-224.
- \*Van Den Ende, J. 1959. Trickle irrigation of frame grown cucumbers. Stikstof. 2 430-441.
- \*Varga, S. and Nyujto, S. 1974. Investigations on the pattern of soil wetting in drip irrigated cucumber fields. Agrartudo Manyi. Egyetem. Kozlemenyei. 117-125.
- Viets, E.G. 1962. Fertilizers and effecient use of water. Adv. Agron. 14: 223-161.
- Wilcox, G.E. 1973. Muskmelon response to rates and sources of nitrogen. Agron. J. 65(5): 694-697.
- Willey, R.W. and Heath, S.B. 1969. The quantitative relationship between plant population and corp yield. Adv. Agron. 21: 281.

Wittwer, S.H. and Tyson, J. 1950. Yields of pickling Cucumbers as influenced by rates of fertilizer application, fertilizer placement and nitrogen side dressing. Quart.Bull. Mich. Agric. Exp. Stat. 32: 535-9.

\*Yabe, K., Sakurai, Y. and Osuga, M. 1981. Studies on the soil management of muskmelons growing on non-isolated soil beds. I. Effect of soil moisture at various growth stages on growth, yield and fruit quality. Res. Bull. Aichi-Ken, Agric. Res. Cen. 13: 157-164.

Yadav, A.C. and Mangal, J.L. 1984. Effect of irrigation and nitrogen fertilization on yield and quality of muskmelon. Haryana. J. Hort. Sci. 13(3/4): 156-160.

Yamaguchi, M. 1983. World vegetables. Principles, production and nutritive values. AVI Pub. Comp. Inc., W. Port., Canner. 327.

\*Yusifov, M.A. 1983. Photosynthetic activity in watermelons in relation to nutrition. Sel'skokhozyaistennaya Biologiya No.1: 36-39.

\*Zonn, S.V. and Pavlova, E.A. 1942. The cultivation of cucurbitacea on desert shell-sands Sovetskaja. Botanika. 4-5: 43-55.

## **APPENDICES**

## VIII. APPENDIX - I

Daily Evaporation and rainfall data during the crop growth period, 1984.

Date	Evaporation, mm/day	Rainfall, mm
27.01.1984	5.7	-
28.01.1984	6.0	-
29.01.1984	6.7	-
30.01.1984	5.6	-
31.01.1984	5.8	-
1.02.1984	5.4	-
2.02.1984	5.8	-
3.02.1984	5.6	-
4.02.1984	6.0	-
5.02.1984	5.9	-
6.02.1984	6.1	-
7.02.1984	4.9	-
8.02.1984	4.1	-
9.02.1984	4.2	-
10.02.1984	5.5	-
11.02.1984	5.7	-
12.02.1984	5.7	-
13.02.1984	5.8	-
14.02.1984	2.9	24.0
15.02.1984	1.9	-
16.02.1984	1.6	-
17.02.1984	3.3	-
18.02.1984	4.6	-

---

Date	Evaporation, mm/day	Rainfall, mm
19.02.1984	5.7	-
20.02.1984	6.0	-
21.02.1984	6.3	-
22.02.1984	6.3	-
23.02.1984	6.8	-
24.02.1984	6.5	-
25.02.1984	7.2	-
26.02.1984	6.1	-
27.02.1984	6.4	-
28.02.1984	7.4	-
29.02.1984	9.2	-
1.03.1984	8.8	-
2.03.1984	8.2	-
3.03.1984	8.0	-
4.03.1984	5.4	10.8
5.03.1984	5.4	26.6
6.03.1984	3.9	-
7.03.1984	4.5	-
8.03.1984	4.5	-
9.03.1984	2.8	-
10.03.1984	6.0	-
11.03.1984	5.6	-
12.03.1984	5.8	-
13.03.1984	4.2	-

---

Date	Evaporation, mm/day	Rainfall, mm
14.03.1984	2.0	-
15.03.1984	4.6	-
16.03.1984	6.6	-
17.03.1984	8.5	-
18.03.1984	5.2	-
19.03.1984	5.2	-
20.03.1984	9.9	-
21.03.1984	8.0	-
22.03.1984	8.0	-
23.03.1984	8.0	-
24.03.1984	7.0	-
25.03.1984	7.3	-
26.03.1984	7.3	-
27.03.1984	7.0	-
28.03.1984	5.0	-
29.03.1984	6.8	-
30.03.1984	4.8	-
31.03.1984	6.0	-
1.04.1984	6.5	-
2.04.1984	5.2	-
3.04.1984	5.2	-
4.04.1984	8.0	26.0
5.04.1984	6.0	-
6.04.1984	5.8	-
7.04.1984	6.0	-

Date	Evaporation, mm/day	Rainfall, mm
8.04.1984	5.4	-
9.04.1984	5.4	-
10.04.1984	4.2	-
11.04.1984	5.6	-
12.04.1984	6.5	-
13.04.1984	7.6	-
14.04.1984	7.4	-
15.04.1984	7.6	-
16.04.1984	7.6	-
17.04.1984	7.2	-
18.04.1984	7.0	-
19.04.1984	6.0	-
20.04.1984	6.8	-
21.04.1984	5.6	-
22.04.1984	7.6	-
23.04.1984	9.0	-
24.04.1984	7.8	-
25.04.1984	7.3	-
26.04.1984	7.4	-
27.04.1984	8.2	-
28.04.1984	8.2	-
29.04.1984	8.0	-
30.04.1984	8.0	-

---

Date	Evaporation, mm/day	Rainfall, mm
1.05.1984	7.3	-
2.05.1984	6.0	-
3.05.1984	7.3	-
4.05.1984	8.4	-
5.05.1984	8.4	-
6.05.1984	7.0	-
7.05.1984	7.0	-
8.05.1984	6.0	-
9.05.1984	7.7	-
10.05.1984	7.7	-
11.05.1984	6.0	-
12.05.1984	6.0	-
13.05.1984	7.2	14.4
14.05.1984	7.2	-

---

## APPENDIX - II

Daily Evaporation and rainfall data during the crop growth period, 1985.

Date	Evaporation, mm/day	Rainfall, mm
20.01.1985	5.1	-
21.01.1985	5.3	-
22.01.1985	4.6	-
23.01.1985	5.4	-
24.01.1985	6.0	-
25.01.1985	6.0	-
26.01.1985	6.0	-
27.01.1985	6.0	-
28.01.1985	5.4	-
29.01.1985	5.5	-
30.01.1985	5.6	-
31.01.1985	5.8	-
1.02.1985	5.6	-
2.02.1985	6.0	-
3.02.1985	6.0	-
4.02.1985	6.0	-
5.02.1985	5.8	-
6.02.1985	5.0	-
7.02.1985	4.0	-
8.02.1985	5.2	-
9.02.1985	3.0	-

---

Date	Evaporation, mm/day	Rainfall, mm
10.02.1985	3.4	-
11.02.1985	3.6	-
12.02.1985	4.6	-
13.02.1985	4.7	-
14.02.1985	4.9	-
15.02.1985	6.0	-
16.02.1985	6.2	-
17.02.1985	5.2	-
18.02.1985	5.6	-
19.02.1985	5.0	-
20.02.1985	4.0	-
21.02.1985	6.0	-
22.02.1985	6.0	-
23.02.1985	6.8	-
24.02.1985	6.8	-
25.02.1985	7.2	-
26.02.1985	6.0	-
27.02.1985	7.4	-
28.02.1985	7.0	-
1.03.1985	8.0	-
2.03.1985	6.0	-
3.03.1985	6.4	-
4.03.1985	6.0	-
5.03.1985	7.8	-

---

---

Date	Evaporation, mm/day	Rainfall, mm
6.03.1985	7.2	-
7.03.1985	8.0	-
8.03.1985	8.0	-
9.03.1985	8.0	-
10.03.1985	8.0	-
11.03.1985	8.0	-
12.03.1985	8.0	-
13.03.1985	8.0	-
14.03.1985	8.0	-
15.03.1985	8.0	-
16.03.1985	8.0	-
17.03.1985	6.5	-
18.03.1985	6.9	-
19.03.1985	8.0	-
20.03.1985	6.4	-
21.03.1985	8.0	-
22.03.1985	8.0	-
23.03.1985	8.4	-
24.03.1985	4.0	0.3
25.03.1985	4.0	-
26.03.1985	6.0	-
27.03.1985	6.0	-
28.03.1985	6.4	-

---

Date	Evaporation, mm/day	Rainfall, mm
29.03.1985	8.0	-
30.03.1985	6.8	-
31.03.1985	7.6	-
1.04.1985	7.0	-
2.04.1985	6.0	19.2
3.04.1985	7.8	23.0
4.04.1985	7.2	-
5.04.1985	6.2	-
6.04.1985	5.4	-
7.04.1985	5.0	-
8.04.1985	5.6	-
9.04.1985	6.0	-
10.04.1985	5.4	-
11.04.1985	5.4	-
12.04.1985	5.8	11.6
13.04.1985	5.9	-
14.04.1985	5.9	-
15.04.1985	10.4	-
16.04.1985	4.8	0.8
17.04.1985	8.0	-
18.04.1985	6.9	2.2
19.04.1985	7.0	-
20.04.1985	8.4	-
21.04.1985	8.5	-

---

Date	Evaporation, mm/day	Rainfall, mm
22.04.1985	4.6	-
23.04.1985	8.6	-
24.04.1985	6.7	-
25.04.1985	5.8	4.8
26.04.1985	6.0	-
27.04.1985	9.0	-
28.04.1985	9.0	-
29.04.1985	10.0	-
30.04.1985	8.4	-
1.05.1985	9.4	-
2.05.1985	8.0	-
3.05.1985	8.5	-
4.05.1985	8.6	-
5.05.1985	8.5	-
6.05.1985	8.8	3.8
7.05.1985	6.3	-
8.05.1985	8.0	-
9.05.1985	8.8	-
10.05.1985	9.3	-

---

ಕೃಷಿ ವಿಶ್ವವಿದ್ಯಾನಿಲಯ  
ವಿಶ್ವವಿದ್ಯಾನಿಲಯ ಗ್ರಂಥಾಲಯ  
ಗ. ಕೃ. ವಿ. ಕೆ, ಬೆಂಗಳೂರು ೨೨.  
11 AUG 1987  
ಅನುಸ್ಥಾನ ಸಂ. **Thi** 2069  
ಪುಸ್ತಕ: .....

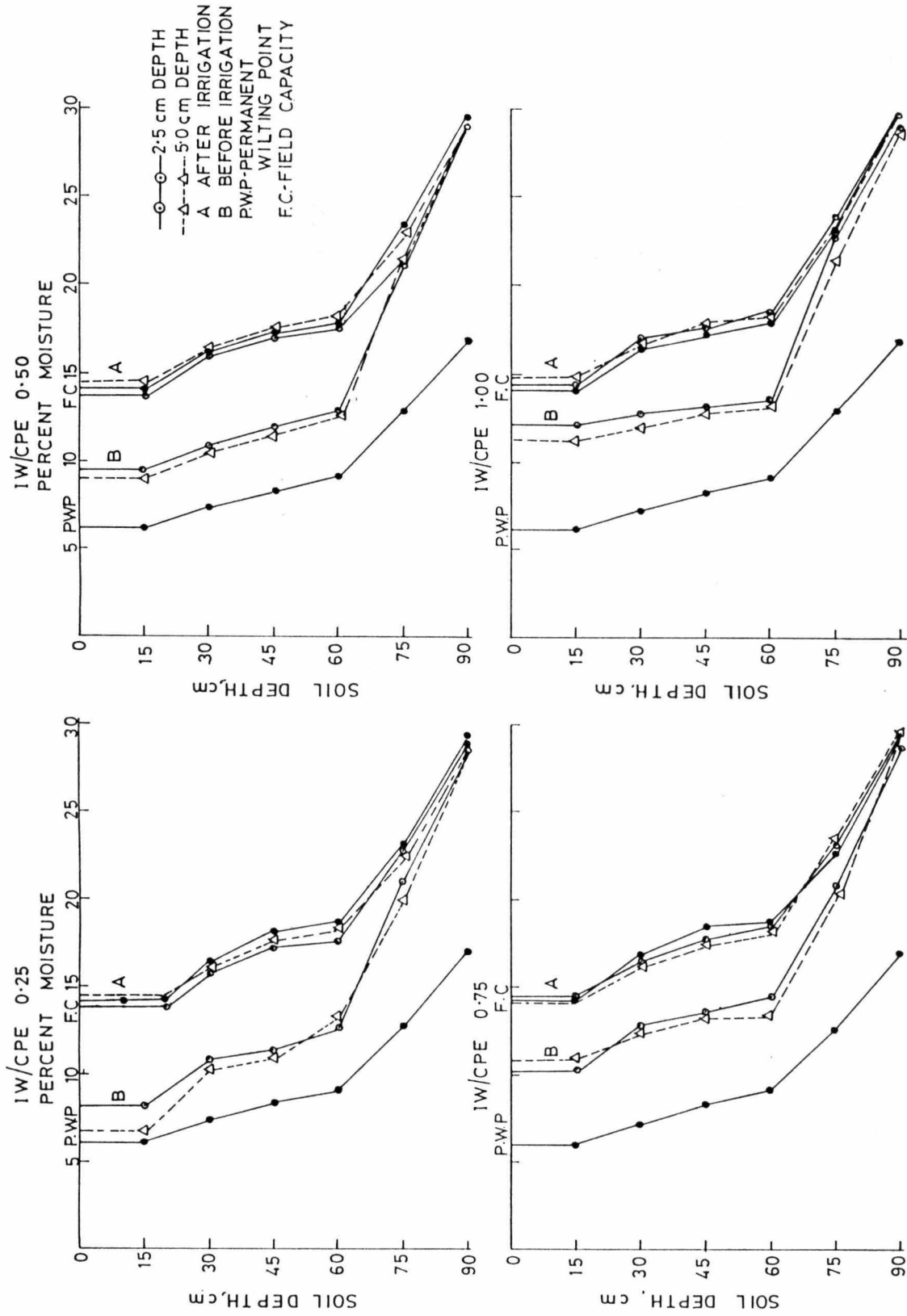


FIG. 3.4 MOISTURE PERCENTAGE UNDER FURROW IRRIGATION AS INFLUENCED BY IW/CPE RATIOS AND METHOD OF IRRIGATION.

**Table 4.5** Number of male and female flowers, Primary branches and node of first female flower occurrence of watermelon as influenced by nitrogen, Spacing and method of irrigation.

Treatments	Number of male flowers/plant		Number of female flowers/plant		Number of primary branches		Node of first female flower occurrence	
	1984	1985	1984	1985	1984	1985	1984	1985
<u>Nitrogen, kg/ha</u>								
60	60.5	56.1	3.2	3.4	2.28	2.15	4.3	4.4
120	47.8	42.7	4.7	4.9	2.46	2.39	3.3	3.1
180	48.2	45.3	3.7	4.0	2.53	2.42	3.8	3.3
'F' test	Sig	Sig	Sig	Sig	NS	NS	Sig	Sig
S.E.m+	1.56	1.41	0.13	0.14	0.16	0.14	0.22	0.20
C.D. at 5%	4.58	4.09	0.40	0.41	-	-	0.65	0.62
<u>Spacing, cm</u>								
300 x 60	59.4	60.5	3.9	4.0	2.32	2.30	4.0	3.9
200 x 60	54.6	57.8	3.7	3.8	2.52	2.49	3.7	3.7
'F' Test	Sig	NS	NS	NS	NS	NS	NS	NS
<u>Method of Irrigation</u>								
Drip	53.3	56.7	4.1	4.3	2.46	2.51	3.9	3.8
Furrow	54.0	54.3	3.6	3.8	2.38	2.43	3.8	3.8
'F' test	NS	NS	Sig	Sig	NS	NS	NS	NS
S.E.m+	1.27	1.18	0.11	0.12	0.13	0.13	0.18	0.17
C.D. at 5%	3.74	-	0.32	0.35	-	-	-	-