EFFECT OF DIFFERENT DATES OF PLANTING ON GROWTH AND YIELD OF DIFFERENT VEGETABLE CROPS UNDER RAINFED CONDITIONS

BY

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M.Sc. (Agri.)

Dissertation

Submitted To The Marathwada Agricultural University

In Partial Fulfilment Of The Requirement

For The Degree of

MASTER OF SCIENCE

(Agriculture)

IN

HORTICULTURE

DEPARTMENT OF HORTICULTURE

MARATHWADA AGRICULTURAL UNIVERSITY

PARBHANI [Maharashtra] INDIA

1989

AFFECTIONATELY DEDICATED

TO

BELOVED Dr. D.A.CHAVAN

AND

MY PARENTS

CANDIDATE'S DECLARATION

I hereby declare that the dissertation

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This is to certify that Shri Shivaji Shankarrao Hajare has satisfactorily prosecuted his course of research for a period of not less than four semesters and that the disseration entitled " EFFECT OF DIFFERENT DATES OF PLANTING ON GROWTH AND YIELD OF DIFFERENT VEGETABLE CROPS UNDER RAINFED CONDITIONS" submitted by him is the result of original work and is of sufficiently high standard to warrant its presentation to the examination. I also certify that the dissertation or part thereof has not been previously submitted by him for a degree of any University.

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DATED: 7th AUGUST, 1989

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Guide

CERTIFICATE II

This is to certify that the dissertation entitled "EFFECT OF DIFFERENT DATES OF PLANTING ON GROWTH AND YIELD OF DIFFERENT VEGETABLE CROPS UNDER RAINFED CONDITIONS" submitted by Shri Shivaji Shankarrao Hajare to the Marathwada Agricultural University, in partial fulfilment of the requirement for the degree of MASTER OF SCIENCE (Agriculture) in the subject of Horticulture has been approved by the student's advisory committee after oral examination in collaboration with the external examiner.

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ACKNOWLEDGEMENT

I have immence pleasure to express my deep sense of gratitude to Dr. N.N.Shinde, Senior Research Officer (Olericulture), Horticulture Research Station (Sub-Campus), Marathwada Agricultural University, Parbhani. for inspiration, suggesting the research project, valuable guidance and constructive crticism during the course of investigation and finalising manuscript.

My sincere thanks are also due to Dr. V.K.Patil, Dean, Faculty of Agriculture, Dr. K.R.Pawar, Director of Research, and Dr. C.P.Ghonsikar, Assiciate Dean and Principal, College of Agriculture, M.A.U., Parbhani for providing necessary facilities to conduct the investigations and my higher education.

My thanks are also due to the members of the advisory committee, Dr. V.R.Chakrawar, Head, Department of Horticulture, Dr. M.B.Sontakke, Senior Research Officer (Vegetable crops) Horticultural Research Scheme and Dr. M.V.Dhoble, Agronomist, Dryland Agricultural Research Centre, for their being in constant touch during the entire period of investigation.

Heartful gratitude is extented to Dr. K.W.Anserwadekar, Prof. of Horticulture, Prof. S.G.Rajput, Prof. S.N.Gunjkar and all staff members of the Horticulture Department for

their kind co-operation during this investigation.

My thanks are also due to Chavan A.K., Jadhav A.S., Gole M.D., Nimbalkar S.S., Jadhav B.S., Pinaki Datta, Ghorpade D.M., Karhale V.G. and my other M.Sc. colleagues for their encouragement during the studies.

My sincere thanks are also due to Phute M.G. for his excellent typing.

Lastly, my warm acknowledgement and honour is bestowed to my parents, Prof. Dr. D.A.Chavan and B.M.Sabne for their continuous inspiration and co-operation in building up my educational career.

Last but not least, my loving thanks are also due to my wife Mrs. Chaaya and loving daughter Snehlata for their sacrifice and everlasting love during the period of study.

PARBHANI

DATED: 7th AUGUST, 1989.

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INTRODUCTION

INTRODUCTION

Vegetable cultivation is one of the important source of farm income and their cultivation occupies an important place in the agricultural development and in the economy of the country.

In recent years, the importance of consuming vegetables for the maintenance of normal health is being realized in all parts of the country. A conciousness for its importance is also being gradually realized because they are the only cheaper natural sources of vitamins and minerals which are lacking in cereals. Consumption of vegetables in sufficient quantities also provides fair amount of fibres.

In this region it is seen that vegetable crops are grown on very small scale and in scattered manner. Wherever, assured irrigation facilities are available, vegetables are grown in very small scale just to meet out self requirement that too, for a particular period and not as a commercial crop. The present consumption of vegetables is just 100 gm./day/adult and which is far less than recommended by dietecian.

(Shinde and Sontakke, 1988).

Most important factor involved is paucity of irrigation facilities. Present irrigation potential in Marathwada region is only 12% and in 2001 A.D. it will be around 30 per cent (Dhoble, 1987).

Due to this, it is difficult to bring additional area under vegetable crops. Considering non-availability of irrigation facilities, development of technology for rainfed vegetable crops along with suitable varities having drought resistence is necessary.

There is variation in rainfall with respect to its onset, dryspell, excess or shortage in this region. Therefore, a vegetable grower will have to adjust a suitable date of planting of vegetable crops to get atleast some income from vegetable farming rather than its complete failure. Not only this but also growing of vegetable crops under rainfed conditions will provide food to rural people where it is badly needed.

For this purpose we have to develop technology for rainfed vegetable cultivation like identification of varieties, standerdization of package of practices so that vegetable crops like chilli, tomato, brinjal, cowpea, culsterbean and okra can be grown sucessfully under rainfed conditions.

As the dates of planting are not standerdized, an investigation on "Effect of dates of planting on growth and yield of different vegetable crops under rainfed conditions". was under taken with the following objectives-

1) To find out suitable date of planting for different vegetable crops under rainfed conditions.

2) To study effects of dates of planting on moisture use efficiency of different vegetable crops under rainfed conditions.

Results of these studies not only will help in standerdizing the dates of planting but it will also help to increase the vegetable production under rainfed conditions. Thus rural population will get needed vegetables for their consumption in daily diet.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

Scientific investigation of the problems on vegetable crops has increased markedly in recent years, particularly under irrigated conditions. But still the rainfed cultural practices on scientific basis have not much studied for almost all vegetable crops.

A scientific efforts have been made by research workers to judge the dates of planting and suitable variety of the chilli, tomato, brinjal cowpea, clusterbean and okra under rainfed conditions and to see the effect on growth and yield of these vegetable crops.

Literature on these aspects is reviewed under suitable headings.

2.1 Effect of dates of planting on growth

2.1.1 Chilli

Elangovan and Suthanthirapandian (1980) observed in chilli that even distribution of rainfall particularly during rapid growth are critical.

Kempe Gowda and Muddappa Gowda (1980) found that the chilli plants set out in August produced taller plants and number of branches were maximum.

Rao and Suranarayana (1983) obtained the best growth of chilli planted in August.

2.1.2 Tomato

Klapwijk (1981) observed that growth of tomato plant increased in the growing period between 21st September to 21st December.

Patil (1986) observed that tomato planted on 16th July showed significant growth of the plant.

2.1.3 Brinjal

Singh (1977) reported that Azad Kranti a new brinjal variety suitable for early and late growing in the North, especially in Kharif. It flowers earlier than other varieties under rainfed conditions.

Arora and Sidhy (1983) found that the Cv. Pusa Anmol shows significant growth than other varieties under rainfed conditions.

Narandrasingh and Yadav (1984) reported that egg plant (Cv. P_{H-4}) transplanted in late July on the North side of ridges running East-West shows significant growth.

Sharma and Arora (1985) revealed that the brinjal sown in June and transplanted in July gave the maximum growth than other seasons.

Carter and Jonson (1988) from two years studies reported that brinjal Cv. Black Beauty showed significant growth with limited rainfall in the first year while in the second year with abundant rainfall the growth was unaffected.

Golani (1988) reported that egg plant (Cv. Vaishali) recorded the height of 70 cm under rainfed conditions.

2.1.4 Cowpea

Kamara (1981) at sierra leone observed that plant height of cowpea sown in September was significantly greater than other dates.

Rana et al. (1986) reported that Pusa Dofasli variety of cowpea is suitable for rainy season and grows satisfactorily.

Singh and Singh (1986) reported that in cowpea Cv. Pusa Barsati grows faster in early rainy season than later dates.

Golani (1988) reported that the cowpea Cv. S-288 recorded the height of 44.81 cm under rainfed conditions.

2.1.5 Clusterbean

Gunjkar (1972) reported that amongst dates of planting, planting on 10th July was better for growth in Sem (Dolichus lablab).

Kukshal et al. (1973) reported maximum growth and branching of beans on 16th May sowing.

Rana et al. (1986) observed that guar Cv. Pusa Sadabahar grows satisfactorily under rainfed conditions.

Singh and Singh (1986) observed that the guar Cv. Pusa Navbahar sown in rainy season has good growing habit of Pusa Sadabahar.

Golani (1988) reported that clusterbean variety Pusa Navbahar recorded 113.57 cm height under rainfed conditions.

2.1.6 Okra

Bisaria and Shamshery (1979) found that growth characters, were directly influenced by day length and temperature in okra.

Iremiren and Okiy (1986) reported that the okra plants sown on 1st April during the main rainy season shows vigorous growth than plants sown on 1st June.

2.2 Effect of dates of planting on yield

2.2.1 Chilli

Somas (1962) found that Capsicum plants planted in Autumn resulted in pronounced flowering than spring season.

Elangovan and Suthanthirapandian (1980) observed in chilli that even distribution of rainfall particularly during early flowering and fruiting stage are crtical, and influenced the crop yield.

Kempe Gowda and Muddappa Gowda (1980) reported that chilli planted in August gave the highest yield than those planted in other months.

Rao and Surayanarayana (1983) reported that chilli Cvs. NP-46A and Jwala planted in August yielded (68-109 q/ha).

Patil (1986) reported that chilli Cv. Pusa Jwala planted on 16th July produced significant yield (46.17 q/ha) under rainfed conditions.

Golani (1988) reported that chilli Cv. Parbhani Tall planted on 24th July recorded 52.61 q/ha yield of green chillies under rainfed conditions.

2.2.2 Tomato

Arora et al.(1969) reported that planting of tomato shows significant differences in yield with different dates of planting under rainfed conditions.

Adelana (1977) observed that tomato plant in late May gave the higher yield, number of fruits per plant and greater average weight than later dates of planting.

Gray et al.(1979) reported that tomato planted in late May and early June gave good yields in cool condition of rainy seasons.

Patil (1986) revealed that tomato planted on 16th July produced 188.99 q/ha under rainfed conditions.

Golani (1988) reported that tomato transplanted on 24th July recorded the yield of 97.77 q/ha under rainfed conditions.

2.2.3 Brinjal

Kalda (1976) reported that the brinjal transplanted during June to middle of July gave the maximum yield upto 250 to 300 q/ha.

Nandpuri et al. (1976) reported that from Autumn (July to December) planted egg plants yields were highest.

Narendra Singh and Yadav (1984) concluded that brinjal Cv. P_{H-4} transplanted in late July on the North side of ridges running East-West recorded the highest yield under rainfed conditions.

Sharma and Arora (1985) reported that the brinjal sown in June and transplanted in July gave the maximum yield than other seasons.

Patil (1986) reported that brinjal Cv. Vaishali planted on 16th July produced the significant yield of 89.45 q/ha.under rainfed conditions.

Carter and Johnson (1988) reported that brinjal Cv. Black Beauty planted in early June gave the significant yield.

Golani (1988) revealed that the brinjal variety Vaishali planted on 24th July yielded 132 q/ha.

2.2.4 Cowpea

Kamara (1981) observed that seed yield of cowpea sown in September were significantly greater than other dates.

Ezveh (1982) reported that seed yield of cowpea was higher in early season sowing under rainfed conditions.

Patil (1986) observed that cowpea planted on 16th July recorded the satisfactory yield (43.49 q/ha) under rainfed conditions.

Singh and Singh (1986) reported that Pusa Barsati variety of cowpea produced 85 q/ha in early rainy season than other dates.

Golani (1988) reported that S-288 variety of cowpea recorded the satisfactory yield under rainfed conditions.

2.2.5 Clusterbean

Gunjkar (1972) reported that incase of Sem, amongst dates of sowing 16th July was better for production as well as income per hectare.

Kukaal et al. (1973) reported that highest vegetable and seed yield of clusterbean was obtained by planting on 16th May and 1st June.

Bains and Dhillon (1977) in two years studies with clusterbean observed that plants sown on 6th July produced significantly higher yields than plants sown on 20th July and 3rd August.

Kanwar Singh (1979) in two years trial with Guar reported that clusterbean sown on 15th July gave optimum yield.

Singh and Singh (1982) reported that Guar planted in early Kharif season resulted in significantly higher yield.

Sharma and Taneja (1984) found that the seed yield of clusterbean obtained was highest when sown on 5th July as compared to other dates of planting.

Patil (1986) reported that clusterbean Cv. local planted on 16th July produced the yield of 56.94 q/ha under rainfed conditions.

Golani (1988) observed that Pusa Navbahar variety of clusterbean recorded satisfactory yields when sown on 24th July under rainfed conditions.

2.2.6 Okra

Grewal et al.(1973) observed that okra Cv. Pusa Sawani sown on 20th June recorded highest yield as compared to other dates of planting.

Grewal et al. (1974) reported that mature pod number and total fruit number/plant were highest with early sowing in rainy season.

Bisaria and Shamshery (1979) reported that okra sown in July to September produces highest yield than other of planting.

Gupta et al.(1981) found that in okra earliest sowing (25th May) gave the highest average yield.

Iremiren and Okiy (1986) in two years studies reported that okra sown in early June resulted in early flowering, had longer harvesting duration which inturn increased the number of pods per plant, weight of fruits/plant and yield than later sowing dates.

2.3 Selection of crops and its variety

Selection of crop and its variety suitable to the rainfed conditions leads to increased and stabilized production.

2.3.1 Crops

Experiments were conducted at Hissar to identify efficient Kharif crop during 1971-75. Pearl millet (hybrid), clusterbean, green gram and cowpea were tested. It was reported that during the year of adequate and well distributed rainfall condition (1975), cowpea performed better than all other legumes. In dry years (1972 to 1974) leguminous crops; clusterbean and green gram tended to give more yield than pearl millet on account of extentive root system and lesser growth in comparison with pearl millet (Anonymous, 1976).

Pandita (1984) observed in three years trial that brinjal, guar, cowpea, Sem, Smooth gourd and bottle gourd can be grown successfully under rainfed conditions; whereas, tomato, bitter gourd, pumpkin and water melon wilted completely at the flowering stage and no fruit could be harvested.

2.3.2 Varieties

2.3.2.1 Chilli

In chilli varieties, Jwala, Japani, Laungi and Suvarnrekha were found to be suitable for Kharif and rabi season in South-Eastern Madhya Pradesh (Singh and Kashyap, 1987).

2.3.2.2 Tomato

In tomato Russian 700 is the most suitable due to its short ripening period of 65.2 days as reported by Verma and Sharma (1981).

Arora et al.(1982) evaluated tomato varieties during late spring, summer season and early autumn. HS-102 was found to give the early fruit set along with the highest, early and total yield during all three season, June planted tomato performed best and the highest yielding Cvs. were TAMU-Saladette, HS-102, Pant-1 and HS-10.

2.3.2.3 Brinjal

In brinjal sixteen varieties were evaluated by Pandita (1984), in which R-3 gave the highest yield followed by Pusa Purple Long under dry farming conditions.

According to Satyanarayana (1985), Bhagymati (APAU) and Nurki was the most Promising varieties for rainfed crops under the agroclimatic conditions of agency tract in Andhra Pradesh.

2.3.2.4 Cowpea

Marappan et al.(1980) reported that in cowpea, Co-3 variety yielded 20 per cent more yield than Co-2 under rainfed conditions.

Pandita et al.(1982) observed a wide range of variation for yield per plant, days to flowering and plant weight. Genotype C-49 and Pusa Dofasali were found superior regarding their mean yield per plant under dry farming conditions.

2.3.2.5 Clusterbean

Vashistha et al.(1981) reported that in guar, under dry farming conditions, yield per plant and number of pods per cluster were found to have comparatively high genetic coefficients of variation than other characters. The number of pod per cluster and length of pod have positive but weak association with yield. HG-351 gave maximum yield whereas, Pusa Navbahar and HG-363 were rated best types on the basis of pod length.

Dahiya et al.(1986) observed in three years trial that variety HG-75 was significantly better than HG-182 and FS-277 under dry farming conditions.

2.3.2.6 Okra

Vashistha et al.(1982) noted that Pusa Sawani was highest yielder amongst okra cultivars.

Golani (1988) reported that Parbhani Kranti variety of okra produced 94.44 q/ha under rainfed conditions.

2.5 Drought and water stress

According to Behboudian (1977[a]), in egg plant releative water content (RWC) remained higher as compared to other vegetable crops under drought conditions.

Behboudian (1977[b]) found that leaf potential declined, transpiration and photosynthesis decreased due to stomatal closure in egg plants under drought conditions.

Goncharova et al.(1981) found that in tomato, water uptake by old leaves was lower than by young leaves.

Chiarandu et al.(1982) observed in tomato that when water was with-held for a few days until the matric water potential fell to - 1.0 flower development was arrested, flower at all stages dropped and fruit growth almost ceased. When water stress was relieved, small fruit grew to size but partially developed fruit didnot recover fully.

Somogyi (1982) reported that in chilli crop, total water uptake per plant decreased proportionately with increase in plant numbers per container.

Yasui and Honda (1982) concluded that water uptake and fruit yield of tomatoes were suppressed by high moisture suction under natural day length, but under sheding and high moisture suction, a good growth balance was maintained.

Vaid et al.(1983) found that with-holding water supply induced measurable reduction in relative water content (RWC) in the leaves of clusterbean.

Venkateswarlu (1983) reported that in Guar, stress did not affect the nodule number but significantly reduce nodule fresh weight.

Acevedo and Massardo (1984) observed that when tomato seedlings were subjected to moderate water deficits at 28 days and 60 days, both treatments resulted in lower fruit weight and size.

Rhoden (1985) found in field and growth chamber studies that nitrate reductase levels decreased gradually from seedling to maturity under drought stress in cowpea.

Abou Hadid et al.(1986) studied the effect of water stress on tomato at different stage of development. They found that if the plants were stressed in early stage of development there was substantial recovery after rewatering. When stress was imposed in later stages the recovery was much less.

Kuhad and Sheoran (1986) studied moisture stress with five Cvs. of Guar and found that with-holding of water at flower initial stage decreased the relative water content in leaves of all cultivars. It was

concluded that Cymposis tetragonoloba has a capacity to recover from moisture stress.

Udovenko et al.(1986) reported in tomato that drought or high air temperature during fruit setting, dropped fruit prematurely.

Hulugalle and Willatt (1987) reported that chilli peppers plants can extract sub-soil moisture under drought conditions due to its root distrbution and water uptake patterns.

2.6 Soil moisture studies

Oswal et al.(1984) reported that water use efficiency was improved by ridge and furrow system in pearl millet and no much difference was observed in leguminous cropsi in the ridges and furrow system.

According to Viswambharan and Susidhar (1984), surface soil moisture was lowest under uncultivated and highest under ridges accross the slope in tapioca.

Wankhede and Morey (1985) recorded 1.94 kg/ha-mm water use efficiency in dry chilli under irrigated conditions.

Dhoble (1987) found that long duration crop cotton and castor utilized highest moisture use of 501.1 mm and 500.0 mm, respectively as compared to short duration crop (Seasamum) which consumed 394.1 mm moisture.

Golani (1988) recorted 9.41 kg/ha-mm water use efficiency in green chilli under rainfed conditions.

MATERIALS & METHODS

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3. MATERIALS AND METHODS

The details of the materials used and methods adopted during the course of investigation are given in this chapter.

3.1 Experimental site

The present investigation was carried out during Kharif season of 1988-89. The experiment was laid out at Horticultural Research Station, Parbhani. The field was fairly levelled. The soil was medium black clayey having one metre depth with good drainage.

3.2 Cropping History

In the previous year (1987) the crops taken in the experimental plots were mandarin and onion.

3.3 Climate and Weather

Parbhani is situated in Sub-tropical region at 409 M altitude above mean sea leval, 19° 16' North latitude and 76°47' east longitude. The average precipitaion received during the Kharif season of 1988-89 was 1542.2mm in 76 rainy days as against 804.49mm of last 33 years average in 57 rainy days.

The maximum and minimum temperature did not show any substantial deviation from the average of last 33 years. But there was considerable difference in relative humidity percentage of 1988, as against

last 33 years' average. The data are tabulated in Table 1

Table 1:- Meteorological data for the Kharif season of 1988-89 (June to January)

Month	Mean monthly temperature (°C) Max	Mini	Mean monthly rainfall (mm)	No. of rainy days	Mean relative humidity A.M.	P.M.
June	35.42	24.10	238.5	14	78.85	46.30
July	30.70	22.40	475.3	24	88.58	66.72
August	30.47	22.88	431.5	18	91.30	70.10
September	31.20	22.55	388.3	16	90.82	66.37
October	32.42	17.92	10.0	3	76.78	33.02
November	31.82	11.70	1.6	1	76.25	23.50
December	29.15	11.10	- -	--	79.25	27.50
January	30.80	12.32	- -	--	70.40	26.20

3.4 Experimental details

3.4.1 Design and treatments

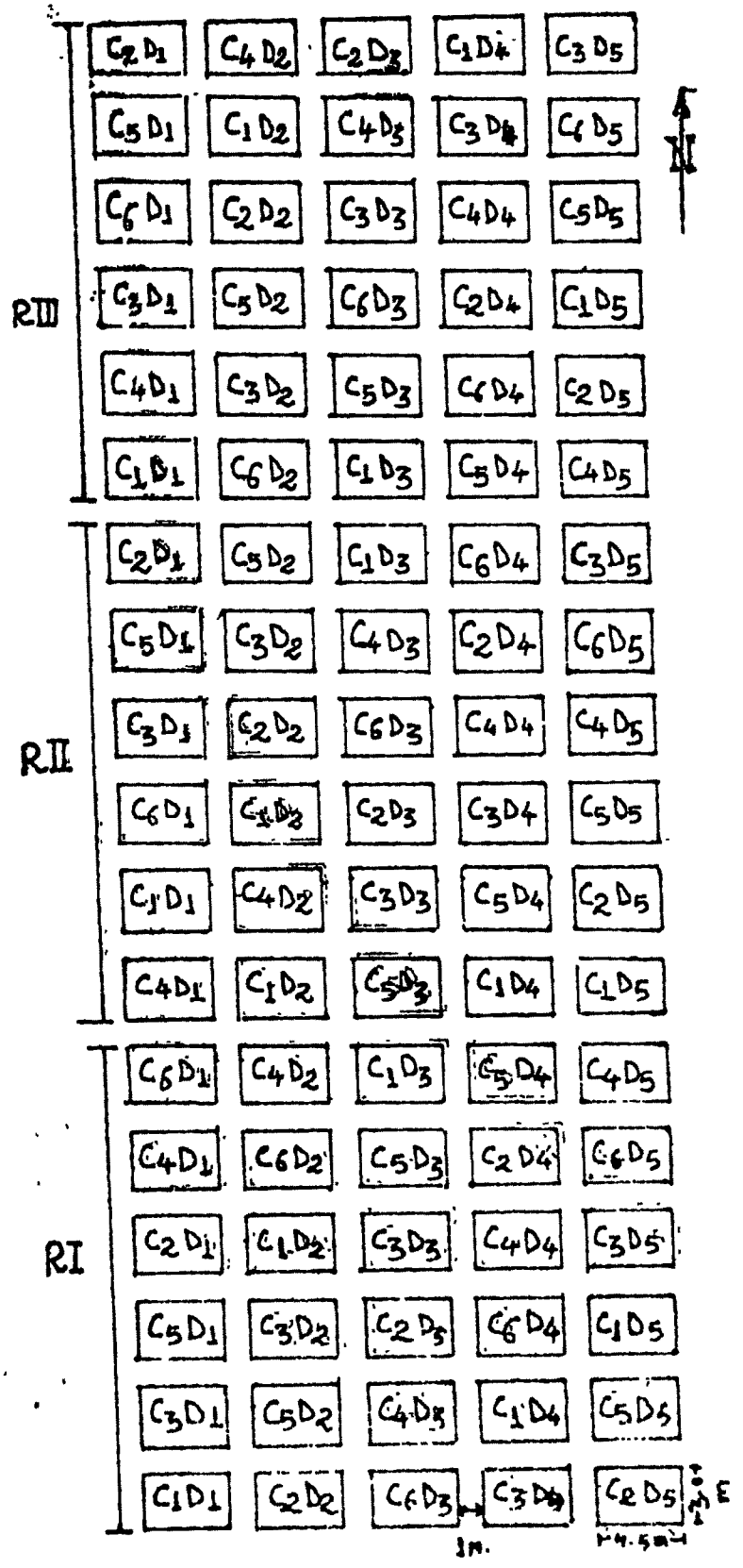
In the present investigation 30 treatment combinations of five planting dates at 10 days interval (Main-Plot) and six important vegetable crops (Sub-Plot) were tested. The experiment was laid out in split plot design with three replications. The details of the treatments along with symbol used are given below.

Date of planting (D)	Main plot
D_1	2nd July, 1988.
D_2	12th July, 1988.
D_3	22nd July, 1988.
D_4	1st August, 1988.
D_5	12th August, 1988.

Crops (C)	Sub-Plot	Variety
C_1	Chilli	Parbhani Tall
C_2	Tomato	Pusa Ruby
C_3	Brinjal	Vaishali
C_4	Cowpea	S-288
C_5	Clusterbean	Pusa Navbhar
C_6	Okra	Parbhani Kranti

3.4.2 Other details and layout

Design		: Spoit plot Technique
Replications		: Three
Plot size	Gross	: 4.50 M X 3.00M
	Net	: 3.60 M X 1.80M
Spacing	Chilli	: 60cm X 45 cm
	Tomato	: 60cm X 45 cm
	Brinjal	: 60cm X 45 cm
	Cowpea	: 60cm X 22.5 cm
	Clusterbean	: 60cm X 22.5 cm
	Okra	: 60cm X 22.5 cm



PLAN OF LAY OUT

3.5 Fertilizers application

Half of the recommended dose of irrigated crops was applied to all the crops except cowpea and clusterbean through urea, single superphosphate and murate of potash (Table 2).

Table 2: Fertilizers dose for different vegetable crops.

Sr. No.	Crops	Fertilizer Dose (kg/ha)		
		N	P_2O_5	K_2O
1.	Chilli	60	40	25
2.	Tomato	50	25	25
3.	Brinjal	50	25	25
4.	Cowpea	25	50	50
5.	Clusterbean	25	50	50
6.	Okra	50	25	25

Complete dose of P_2O_5 and K_2O was given as a basal dose to each plot of all crops at the time of planting. Nitrogen was applied in two split doses. First half, after 30 days of planting and remaining half after 45 days of planing.

3.6 Planting time

Thirty seven days old, vigorous and healthy seedlings of chilli, tomato and brinjal were planted on different dates of planting at 10 days interval.

Before planting the seedlings were deeped in a solution prepared by mixing 10 milliliters of rogar and 15 grammes of Bavistin in 10 liters of water. Two seedlings per hill were planted. Three seeds of cowpea, clusterbean and okra per hill were sown on different dates of planting at 10 days interval.

3.7 Gap filling

Gap filling was carried out 5 to 6 days after each date of planting.

3.8 Cultural operations

The cultural operations like land preparation, planting of vegetable crops, weeding, fertilizers applications, spraying etc. were carried out as and when necessary.

3.9 Harvesting

3.9.1 Chilli: Fruits of chilli were harvested when change in colour from dark green to faint green and when boldness of seed were obtained.

3.9.2 Tomato: Tomato fruits were harvested at breaker stage.

3.9.2 Brinjal: Brinjal fruits were harvested before the glossy appearance becoming dull.

3.9.4 Cowpea, Clusterbean and Okra

Harvesting of tender pods were carried out before the development of fibreness in outer skin and also before becoming tough as well as leathery.

3.10 Biometric observations

3.10.1 Final plant stand at harvest

The number of plants available in each net plot were counted seperatly.

3.10.2 Sampling technique

Five plants of each crop from five planting dates were randomly selected from each net plot. Each selected plant was labelled for easy identification. Biometric observations were recorded at 30 days interval. The same five plants were harvested seperately for post harvest studies. The mean of five observational plants was taken for statistical analysis.

3.10.3 Growth studies

The schedule of various biometric observations recorded during the course of present investigation are presented below.

3.10.3.1 Days to 50 per cent flowering

Number of days from the date of planting to the date of appearance of flowers in 50 per cent plants were recorded.

3.10.3.2 Days to fruit/pod setting

Number of days from the date of planting to date of fruit/pod set were recorded.

3.10.3.3 Height of the plant

Height of the plant from ground level to the tip of the main stem was recorded in centimetres. The height of the plant of all crops were recorded at an interval of 30 days during crop growth upto uprooting of plant.

3.10.3.4 Number of branches

Number of branches produced on plant were recorded by taking count at an interval of 30 days upto the date of uprooting of plant.

3.10.3.5 Number of leaves

Total number of fully opended green leaves per plant were counted and recorded at an interval of 30 days upto the uprooting of plant.

3.10.3.6 Plant spread

North-South and East-West spread was measured in centimeters at an interval of 30 days upto uprooting of plant and calculated by following formala -

$$\text{Plant spread (cm)} = \frac{(\text{North-South}) + (\text{East-West})}{2}$$

3.10.3.7 Diameter of stem

Diameter of stem was measured with the help of vernier

caliper in centimetre at an interval of 30 days upto uprooting of the plant.

3.11 Yield studies

3.11.1 Number of fruits per plant

Number of fruits per plant of five plants in each net plot was counted at each picking and recorded.

3.11.2 Average fruit weight per plant (g)

Fruit weight of five observational plants from each net plot was recorded and average of them was worked out.

3.11.3 Yield of fruits per net plot

Harvesting of fruits from net plot and gross plot was carried out seperately and the weight of the same were recorded seperately in kg. It was converted in quintals per hectare.

3.12 Physical analysis

3.12.1 Moisture percentage of fruits

A known weight of sample of ten fruits from each net plot were kept in oven for drying at $60^{o}C$ to constant dry weight. The moisture percentage was calculated by following formula (Ranganna, 1977).

$$\text{Moisture percentage in fruits} = \frac{\text{Fresh weight of sample} - \text{Dry weight of sample}}{\text{Fresh weight of sample}} \times 100$$

3.13 Post harvest studies

3.13.1 Length of root

Root length of main root of five plants were measured and recorded in centimetres.

3.13.2 Root spread

North-South and East-West spread of root was measured in centimetre and calculated by following formula.

$$\text{Root spread in (cm)} = \frac{(\text{North} - \text{South}) + (\text{East-West})}{2}$$

3.13.4 Number of secondary roots per plant

Number of secondary roots of five plants from each net plot was recorded by taking count.

3.13.4 Moisture of percentage of root

Weight of fresh roots of five plants was taken and roots were kept in oven at $60^{\circ}C$ and constant dry weight was taken. Moisture precentage was caculated by following formula (Ranganna, 1977).

$$\text{Moisture percentage of root} = \frac{\text{Weight of fresh root} - \text{weight of dry root}}{\text{weight of fresh root}} \times 100$$

3.13.5 Moisture percentage of shoot

Fresh weight of five shoots of each net plot was

taken and shoots were kept in oven for drying at 60°C and constant dry weight was taken. Moisture percentage was calculated as per the formula given by Ranganna (1977).

$$\text{Moisture percentage of shoot} = \frac{\text{Weight of fresh shoot} - \text{weight of dry shoot}}{\text{weight of fresh shoot}} \times 100$$

3.14 Soil moisture studies

Soil moisture studies was under taken right from planting and at the time of harvesting in each treatment.

3.14.1 Sampling technique

Soil sample for moisture studies were taken at randomly selected one spot in all treatments with the help of screw augur at 30, 60 and 90 cm. soil layer depth at the time of planting and later on continued up to the time of uprooting of the vegetable crops. The samples were transferred immediately to aluminium soil moisture boxes and covered with polythene sheet and wet gunny bags to avoid moisture loss in the field due to heat. The soil moisture boxes were transferred to the laboratory for weighing and drying.

3.14.2 Weighing and drying

The soil samples from the respective depths were weighed immediately (W_1) and dried in an oven at

temperature of 105 °C ± 5°C for 48 hours till constant weight was obtained (W_2). The soil moisture precentage was calculated by using the following formula -

$$\text{Soil moisture percentage in the soil} = \frac{W_1 - W_2}{W_1} \times 100$$

3.14.3 Consumptive water use efficiency (WUE)

Consumptive water use efficiency i.e. cost of economic yield per mm of water per hectare in each treatment was worked out with following formula -

$$WUE = \frac{Y}{CU}$$

Where,

WUE = Consumptive water use efficiency of economic produce per hectare per mm of water used.

Y = Cost of produce per hectare.

CU = Total seasonal consumptive use of water (mm)

Formula for calculating consumptive use (mm)

$$\text{Consumptive use} = \frac{\text{Initial soil water content (\%)} - \text{Final soil water content (\%)} \times \text{depth} \times \text{bulk density} + \text{effective rainfall}}{100}$$

Effective rainfall was calculated as described by Rao et al. (1978).

3.15 Economic returns

3.15.1 Gross monetary returns

The gross monetary returns for all treatments were worked out with prevailing market prices and subjected to statistical analysis.

3.15.2 Net monetary returns

The net monetary returns were calculated by deducting the cost of cultivation per treatment.

3.15.3 Cost benefit ratio

It is ratio of total annual project benefit to the total annual project cost or it is the ratio of net returns to the cost of cultivation and was worked out by the following formula -

$$\text{Cost benefit ratio} = \frac{\text{Net returns}}{\text{Cost of cultivation}}$$

3.16 Energy value

It is calculated by multiplying the calorie value of each vegetable with the yield of each net plot and subjected to statistical analysis.

The calorie values of each vegetable were taken as described by Kale *et al*. (1985).

3.17 General statistical analysis

Data obtained on various aspects were subjected to analysis of variance as proposed by Panse and Sukhatme (1985).

EXPERIMENTAL RESULTS

4. EXPERIMENTAL RESULTS

The results of investigation are presented in this chapter.

4.1 Growth studies

4.1.1 Final plant stand

4.1.1.1 Dates of planting

The data presented in Table 3 clearly indicated that there was gradual decrease in per cent final plant stand as dates of planting were delayed. The planting on 1st date (D_1) gave significantly higher plant stand over other dates except D_2 and D_4. The treatments D_3 and D_5 were at par with each other.

4.1.1.2 Crops

Amongst different crops it was observed that there were significant differences in per cent final stand. Okra recorded significantly higher plant stand except chilli, brinjal, cowpea and clusterbean. The crop tomato recorded significantly lower plant stand.

4.1.1.3 Interaction

Interaction effect between dates of planting and crops were found to be absent.

4.1.2 Number of days to 50 per cent flowering

Table 3. Final plant stand at harvest in percentage as affected by different treatments.

Treatments	Final per cent plant stand
Dates of planting	
D_1 2nd July,88	94.06
D_2 12th July,88	93.43
D_3 22nd July,88	90.24
D_4 1st August,88	90.65
D_5 12th August,88	87.32
S.E. ±	1.13
C.D. at 5%	3.68
Crops	
C_1 Chilli	96.23
C_2 Tomato	63.63
C_3 Brinjal	96.76
C_4 Cowpea	95.73
C_5 Clusterbean	97.20
C_6 Okra	97.48
S.E. ±	1.02
C.D. at 5%	2.90
Interaction	
Dates of planting X crops	
S.E. ±	2.28
C.D. at 5%	N.S.

4.1.2.1 Dates of planting

It is clear from the data presented in Table 4 that there was no consistency in the observations. The date of planting D_2 i.e. planting on 12th July received significantly less number of days for flowering over all other dates of planting except planting on (D_1). The third date (D_3) was next early to the treatments D_2 and D_1 which was significantly earlier than the treatment D_3 and D_4.

4.1.2.2 Crops

Incase of crops there were significant differences in number of days to 50 per cent flowering. This difference was due to independent crop behaviour. Significantly earlisest flowering was recorded in clusterbean over all other crops. It was followed by cowpea and chilli which were at par amongst themselves and also significantly earlier than tomato and brinjal. Significantly late flowering was observed in okra.

4.1.2.3 Interaction

Interaction effects of dates of planting and crops were non-significant.

Table 4 : Number of days to 50 per cent flowering and fruiting as affected by different treatments.

Treatments	Number of days 50% flowering	Number of days to fruiting
Dates of sowing		
D_1 2nd July,88	40.79	57.28
D_2 12th July,88	40.16	59.18
D_3 22nd July,88	42.61	60.55
D_4 1st August,88	41.09	58.43
D_5 12th August,88	42.30	59.66
S.E. ±	0.20	0.23
C.D. at 5%	0.67	0.75
Crops		
C_1 Chilli	37.98	72.20
C_2 Tomato	45.90	70.05
C_3 Brinjal	48.47	62.45
C_4 Cowpea	37.26	42.57
C_5 Clusterbean	29.33	48.52
C_6 Okra	51.78	57.84
S.E. ±	0.32	0.20
C.D. at 5%	0.92	0.58
Interaction		
Dates of planting X crops		
S.E. ±	0.72	0.45
C.D. at 5%	N.S.	N.S.

4.1.3 Number of days to fruiting

4.1.3.1 Dates of planting

Perusal of data presented in Table 4 clearly indicated that significantly earliest fruiting was done on 12th July over all other dates of planting. The next early fruiting was recorded in the tratments D_2, D_4 and D_5 which were statiscally similar amongst each other and significantly earlier than the planting on 22nd July (D_3).

4.1.3.2 Crops

It is clear from the Table 4 that the crop cowpea took significantly less number of days for harvesting over all other crops. It was followed in sequence by clusterbean, okra, brinjal, tomato and chilli. Preceding crop being significant over succeding crop.

4.1.3.3 Interaction

Interaction effects of dates of planting and crops were non-significant.

4.1.4 Plant height

4.1.4.1 Dates of planting

It is clear from data presented in Table 5 that there is gradual decrease in the height per plant as dates of planting were delayed. The planting on 1st

Table 5 : Plant height in cm as affected by different treatments

Treatments	plant height (cm)
Dates of planting	
D_1 2nd July,88	100.28
D_2 12th July, 88	95.83
D_3 22nd July,88	94.88
D_4 1st August,88	96.36
D_5 12th August,88	93.11
S.E. ±	0.70
C.D. at 5%	2.30
Crops	
C_1 Chilli	86.52
C_2 Tomato	97.12
C_3 Brinjal	81.35
C_4 Cowpea	48.44
C_5 Clusterbean	127.00
C_6 Okra	136.11
S.E. ±	0.78
C.D. at 5%	2.23
Interaction	
Dates of planting x crops	
S.E. ±	1.75
C.D. at 5%	N.S.

date (D_1) recorded significantly more height than all other dates of planting. Planting dates D_2, D_3 and D_5 were at par with each other except D_4.

4.1.4.2 Crops

Data presented in Table 5 clearly indicated that there was significant variation amongst the crops in respect of height. The crop okra found to be significantly taller over all other crops. It was followed by cluster-bean which was also significantly taller than chilli, brinjal and tomato.

4.1.4.3 Interaction

Interaction effects between planting dates and crops were found to be absent.

4.1.5 Number of branches per plant

4.1.5.1 Dates of planting

Perusal of the data presented in Table-6 clearly indicated that significantly highest branches were observed when planting was done on 2nd July (D_1) over all other dates of planting.

4.1.5.2 Crops

It is evident from the data presented in Table 6 that chilli recorded significantly higher number of

1. Chilli growth Planted on 2nd July, 88.

2. Tomato growth Planted on 2nd July, 88.

Table 6: Number of branches and leaves per plant as affected different treatments.

Treatments	Number of branches per plant	Number of leaves per plant
Dates of sowing		
D_1 2nd July,88	15.22	100.87
D_2 12th July,88	14.12	93.58
D_3 22nd July,88	13.56	97.46
D_4 1st August,88	14.47	104.80
D_5 12th August,88	13.97	104.73
S.E. ±	0.13	2.06
C.D. at 5%	0.44	6.73
Crops		
C_1 Chilli	27.69	304.36
C_2 Tomato	11.62	116.05
C_3 Brinjal	15.14	100.01
C_4 Cowpea	11.48	21.73
C_5 Clusterbean	5.37	36.45
C_6 Okra	0.00	23.10
S.E. ±	0.35	1.24
C.D. at 5%	1.00	3.52
Interaction		
Dates of plamting X crops		
S.E. ±	0.78	2.77
C.D. at 5%	2.24	7.88

branches per plant over all other crops. Tomato and cowpea recorded the similar number of branches per plant. The lowest number of branches per plant was recorded by clusterbean. There was no branching in okra crop.

4.1.5.3 Interaction

Interaction effects between dates of planting and crops were significant. It is seen that in general, chilli crop planted on D_5, D_4 and D_1 recorded significantly more number of branches per plant than all other treatment compinations (Table 7).

Table 7: Interaction effects of dates of planting X crops on number of branches per plant

Dates of planting	Crops						
	C_1	C_2	C_3	C_4	C_5	C_6	Mean
D_1	28.6	13.60	16.99	11.59	5.36	--	15.22
D_2	26.36	12.06	15.59	10.83	5.78	--	14.12
D_3	25.22	11.25	15.26	10.32	5.56	--	13.56
D_4	28.50	11.18	14.66	12.26	5.76	--	14.47
D_5	29.77	10.05	13.21	12.43	4.43	--	13.97
Mean	27.69	11.62	15.14	11.48	5.37	--	

S.E. ± 0.78 C.D. at 5% 2.24

3. Brinjal growth Planted on 2nd July, 88.

4. Cowpea growth planted on 2nd July, 88.

4.1.6 Number of leaves per plant

4.1.6.1 Dates of planting

It can be seen from the data presented in Table 6 that significantly higher number of leaves per plant were produced when planting was done on D_4, D_5 and D_1 over the treatments D_2 and D_3.

4.1.6.2 Crops

Amongst different crops significantly higher number of leaves per plant were produced by the crop chilli. It was followed by tomato, brinjal, clusterbean, okra and cowpea.

4.1.6.3 Interaction

Interaction effects between dates of planting and crops on number of leaves per plant was found to be significant and data are presented in Table 8. It is clear from the data the crop chilli produced significantly higher number of leaves when planted on D_1 i.e. 2nd July over all other treatment combinations.

Table 8: Interaction effects of dates of planting X crops on number of leaves per plant.

Planting dates	Crops						Mean
	C_1	C_2	C_3	C_4	C_5	C_6	
D_1	271.06	135.76	119.16	20.00	31.60	27.66	100.87
D_2	263.83	113.97	102.43	22.23	35.33	23.83	93.58
D_3	289.43	118.80	98.13	15.46	40.43	22.56	97.46
D_4	333.36	108.87	95.76	24.36	44.80	21.66	104.80
D_5	364.13	103.13	84.60	26.60	30.10	19.83	104.73
Mean	304.36	116.05	100.01	21.73	36.45	23.10	

S.E. ± 2.77 C.D. at 5% 7.88

4.1.7 Plant spread

4.1.7.1 Dates of planting

The data presented in Table 9 inrespect of plant spread in cm clearly showed significant difference in planting dates. The crop planted on 1st date (D_1) recorded significantly maximum plant spread over all other dates except 2nd date (D_2) which was statistically similar to D_1. It was followed in order of significance by dates D_3, D_5 and D_4.

Table 9: Plant spread and stem diameter (cm) as affected by different treatments.

Treatments	Plant spread (cm)	Stem diameter (cm)
Dates of planting		
D_1 2nd July,88	58.81	1.44
D_2 12th July,88	58.01	1.41
D_3 22nd July,88	54.08	1.44
D_4 1st August,88	45.09	1.43
D_5 12th August,88	52.53	1.40
S.E. ±	0.49	0.03
C.D. at 5%	1.60	N.S.
Crops		
C_1 Chilli	57.10	1.09
C_2 Tomato	85.29	1.63
C_3 Brinjal	64.81	1.61
C_4 Cowpea	27.60	1.11
C_5 Clusterbean	47.27	1.33
C_6 Okra	43.28	1.85
S.E. ±	0.66	0.05
C.D. at 5%	1.87	0.14
Interaction		
Dates of planting X crops		
S.E. ±	0.11	0.32
C.D. at 5%	N.S.	N.S.

5. Clusterbean growth planted on 2nd JULY, 88.

6. Okra growth Planted on 2nd JULY, 88.

4.1.7.2 Crops

It is clear from the Table 9 that there were significant differences in plant spread amongst crops. The tomato crop recorded significantly more plant spread over all other crops. It was followed by brinjal and chilli; former being significant over later.

4.1.7.3 Interaction

Interaction effects between dates of planting and crops were found to be non-significant.

4.1.8 Stem diameter

Data regarding stem diameter of plant in cm as affected by various treatments are tabulated in Table 9.

4.1.8.1. Dates of planting

It is clear from data presented in Table 9 that there was no significant difference in stem diameter of crops planted on different dates of planting.

4.1.8.2 Crops

Perusal of the data presented in Table 9 clearly showed that significantly thicker stem girth was recorded by the crop okra over all other crops. Statistically similar stem girth was recorded by tomato and brinjal and which was significant over chilli, cowpea and clusterbean.

4.1.8.3 Interaction

Interaction effect of dates of planting and crops on stem girth was non-significant.

4.2 Yield studies

4.2.1 Number of fruits per plant

Data on number of fruits per plant as affected by various treatments are recorded in Table 10.

4.2.1.1 Dates of planting

Perusal of the data presented in Table 10 clearly revealed that the crop planted on D_4, D_5 and D_1 produced significantly more number of fruits per plant over the treatments D_2 and D_3. Former three treatments were at par with each other while latter two were at par with each other.

4.2.1.2 Crops

It is evident from the data presented in Table 10 that significantly more number of fruits per plant were produced by the crop chilli followed by clusterbean which was also significantly more than other crops.

4.2.1.3 Interaction

Interaction effects between dates of planting and crops were non-significant.

Table 10: Number of fruits per plant as affected by different treatments.

Treatments	Number of fruits per plant
Planting dates	
D_1 2nd July,88	42.76
D_2 12th July,88	40.56
D_3 22th July,88	38.98
D_4 1st August,88	44.19
D_5 12th August,88	42.97
S.E. ±	0.92
C.D. at 5%	3.02
Crops	
C_1 Chilli	111.57
C_2 Tomato	17.56
C_3 Brinjal	15.32
C_4 Cowpea	17.20
C_5 Clusterbean	66.59
C_6 Okra	23.10
S.E. ±	0.66
C.D. at 5%	1.49
Interaction	
Dates of planting X crops S.E. ±	1.49
C.D. at 5%	N.S.

4.2.2 Fruit yield in g per plant

Data on average fruit yield in g per plant as influenced by different treatments, are presented in Table 11.

4.2.2.1 Dates of planting

It can be seen from the data presented in Table 11 that significantly higher yield of fruit per plant was observed when the crops were planted on 2nd July (D_1) than all other dates of planting. Next best date of planting was D_4 i.e. planting on 1st August which also produced significantly more yield than other dates of planting except the date 12th July (D_2). Significantly lowest yield was recorded when planting was done on 12th August,88.

4.2.2.2 Crops

Perusal of the data presented in Table 11 clearly indicated that the crop tomato yielded significantly more than the other crops. In order of sequence it was followed by okra, brinjal, chilli, cowpea and clusterbean. It is obvious since these are crop differences.

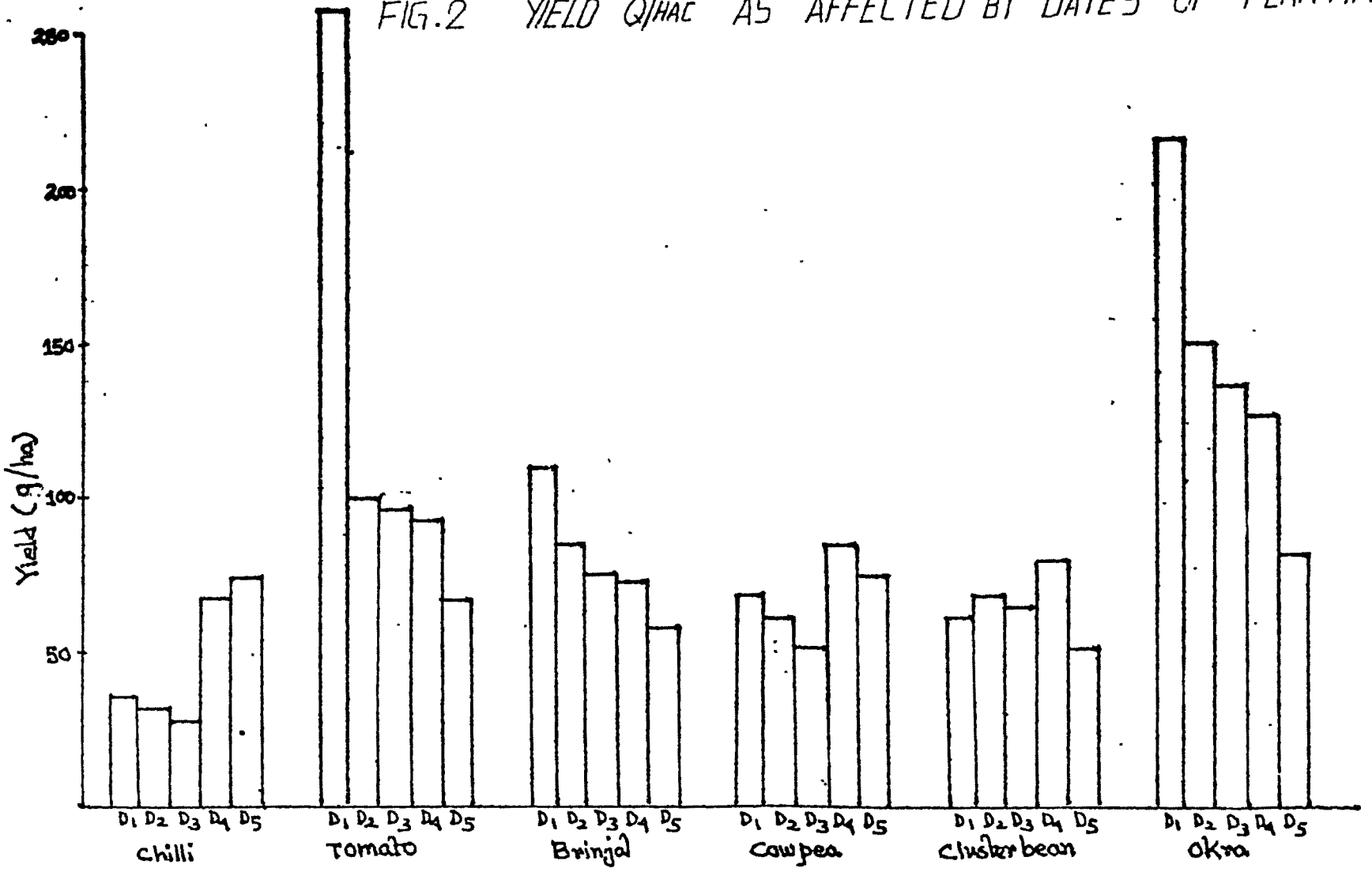
4.2.2.3 Interaction

Interaction effects between dates of planting and crops were non-significant.

Table 11: Fruit yield in of per plant and quintal per hectare as affected by different treatments.

Treatments	Fruit yield g/plant	Fruit yield q/ha
Dates of planting		
D_1 2nd July,88	227	123.17
D_2 12th July,88	155	82.30
D_3 22nd July,88	145	74.39
D_4 1st August,88	160	86.07
D_5 12th August,88	128	67.89
S.E. ±	2.83	7.41
C.D. at 5%	8.62	24.07
Crops		
C_1 Chilli	122	41.45
C_2 Tomato	343	80.32
C_3 Brinjal	170	61.25
C_4 Cowpea	98	67.37
C_5 Clusterbean	90	64.86
C_6 Okra	195	141.03
S.E. ±	2.61	5.84
C.D. at 5%	7.41	16.62
Interaction		
Dates of planting X crops		
S.E. ±	5.89	13.08
C.D. at 5%	N.S.	37.16

FIG.2 YIELD Q/HAC AS AFFECTED BY DATES OF PLANTING.



4.2.3 Fruit yield (q/ha) quintal per hectare

The yield of fruits per hectare as affected by various treatments are presented in Table 11 and graphically depicted in fig-2.

4.2.3.1 Dates of planting

It is evident from the data presented in Table 11 that yield of different crops was influenced significantly due to different dates of planting. Significantly higher yield (123.17 q/ha) was obtained when the crops were planted on 2nd July (D_1) over all other dates of planting. Latter dates of planting which were statistically similar with each other.

4.3.2.2 Crops

Perusal of the data presented in Table 11 clearly showed that the crop okra produced significantly higher yield (141.03 q/ha) over all other crops. The next higher yielding crop was tomato which produced significantly higher yield (80.32 q/ha) over brinjal and chilli. It was statistically similar to cowpea and clusterbean. Significantly least yield was produced by the crop chilli. Difference in yield of various vegetable crops are obvious.

Table 12: Interaction effects of dates of planting and crops on yield (q/ha) of different vegetable crops grown under rainfed conditions.

Dates of planting	Crops						Mean
	C_1	C_2	C_3	C_4	C_5	C_6	
D_1	30.31	257.90	109.43	64.36	61.72	215.58	123.17
D_2	29.84	99.08	84.41	62.19	68.74	149.57	82.30
D_3	23.07	97.22	74.40	51.32	64.05	136.33	74.39
D_4	58.79	96.27	73.76	84.46	79.53	124.84	86.07
D_5	65.27	81.17	57.25	74.53	50.30	78.85	67.89
Mean	41.45	80.32	61.25	67.37	64.86	141.03	

S.E. ± 13.08 C.D. at 5% 37.16

4.2.3.3 Interaction

There were significant differences due to dates of planting and crops.

It is evident from the data presented in Table 12 that interaction between D_1 X C_2 i.e. planting of tomato on 2nd July produced significantly higher yield (257.90 q/ha) over all other treatment combinations. The next best treatment combination was D_1 X C_6 i.e. okra sown on 2nd July,88 produced significantly highest yield (215.58 q/ha) over other treatment combinations.

4.3 Economic returns

4.3.1 Gross monetary returns

The data on gross monetary returns in rupees per hectare as obtained in different treatments are presented in Table 13 and graphically depicted in Fig-3.

4.3.1.1 Dates of planting

It is clearly observed from the data presented in Table 13 that gross monetary returns were significantly influenced due to dates of planting. Significantly highest gross monetary returns of Rs. 23,937 per hectare was obtained on 2nd July (D_1) over all other dates of planting. Latter dates of planting were on par with each other.

4.3.1.2 Crops

Perusal of data presented in Table 13 clearly indicated that the crop tomato gave significantly higher gross monetary returns over all other crops which was at par with okra. Statistically similar gross returns were recorded by chilli, brinjal and clusterbean. Significantly lowest gross returns was recorded by the crop cowpea.

4.3.1.3 Interaction

Interaction effects between dates of planting and crops on gross monetary returns were found to be non-significant.

Table 13: Gross monetary returns, net monetary returns and cost benefit ratio as affected by different treatments.

Treatments	Gross monetary returns (Rs/ha)	Net monetary returns (Rs/ha)	Cost benefit ratio
Dates of planting			
D_1 2nd July,88	23937	17823	2.86
D_2 12th July,88	15864	9810	1.59
D_3 22nd July,88	14230	8248	1.34
D_4 1st August,88	17390	11403	1.87
D_5 12th August,88	14447	8521	1.40
S.E. ±	2199.46	227.79	0.15
C.D. at 5%	7171.75	742.76	0.50
Crops			
C_1 Chilli	16583	9478	1.52
C_2 Tomato	25266	19316	3.23
C_3 Brinjal	17966	10862	1.52
C_4 Cowpea	9544	4855	1.02
C_5 Clusterbean	9745	3953	0.67
C_6 Okra	23976	17951	2.91
S.E. ±	2450.07	180.77	0.17
C.D. at 5%	6963.44	513.79	0.51
Interaction			
Dates of planting X crops			
S.E. ±	5478.53	404.23	0.40
C.D. at 5%	N.S.	N.S.	N.S.

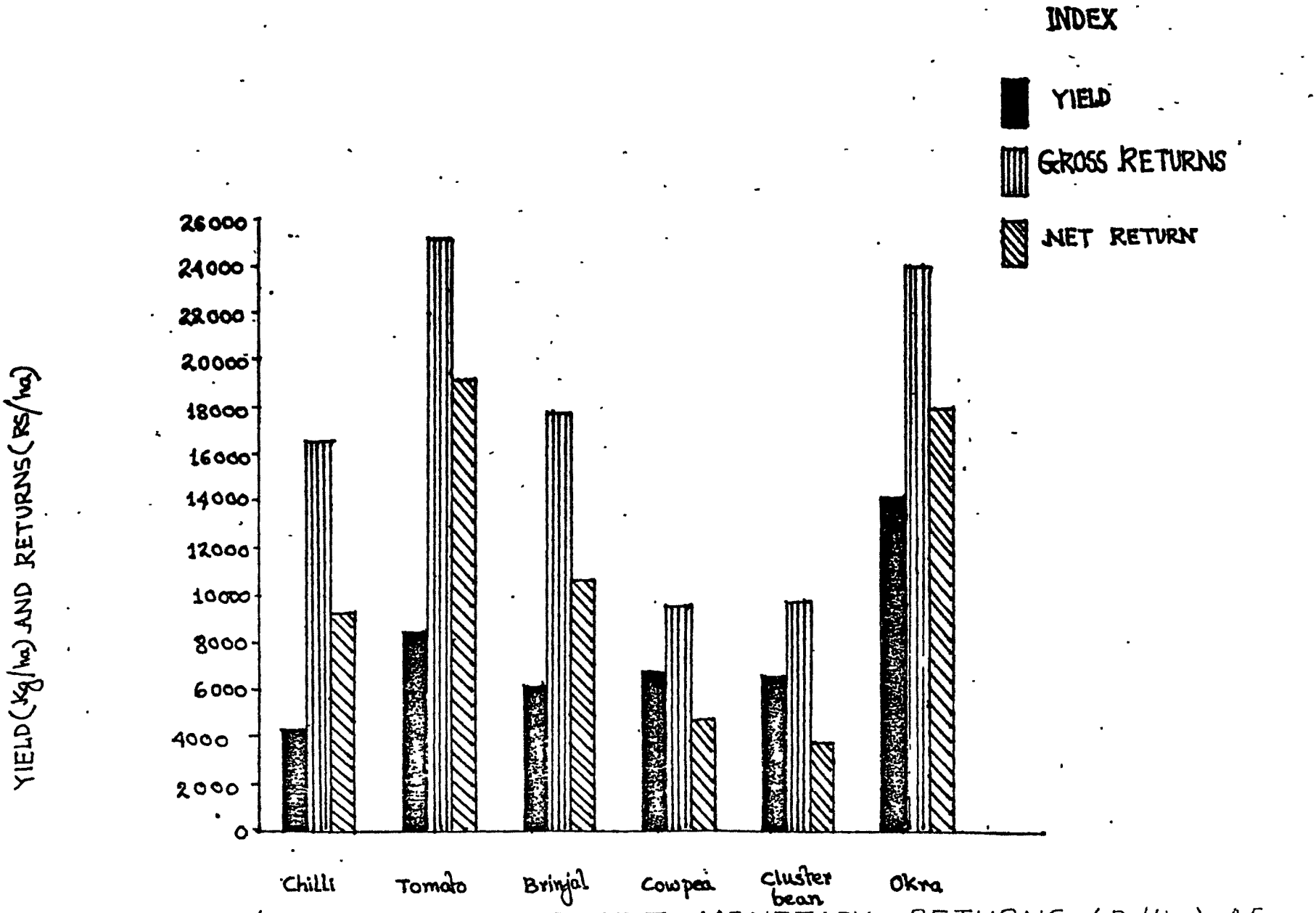


FIG.3. YIELD (KG/HAC.) GROSS AND NET MONETARY RETURNS (R_S/H_{AC}) AS AFFECTED BY DIFFERENT DATES OF PLANTING UNDER RAINFED CONDITIONS.

4.3.2 Net monetary returns

Data in respect of net menetary returns in rupees per hectare as affected by various treatments are recorded in Table 13 and graphically depicted in Fig-3.

4.3.2.1 Dates of planting

The data presented in Table 13 showed that the significantly highest net monerary returns was obtained from the produce harvested from the crops planted on 2nd July,88 (D_1). The second best treatment in respect of net monetary returns was the planting date D_4 i.e. planting on 1st August,88 (D_5) which was significantl over D_2, D_3 and D_5 followed by the treatment D_2which was significant over the treatments D_3 and D_5.

4.3.2.2 Crops

Perusal of the data presented in Table 13 indicated that significantly higher net monetary returns was obtained by the crop tomato over all other crops. The next best crop in respect of net monetary returns was okra which was significant over chilli, brinjal, cowpea and clusterbean. Significantly lowest monetary returns were obtained from the crop clusterbean.

4.3.2.3 Interaction

Interaction effect of dates of planting and crops on net monetary returns were found to be non-significant.

4.3.3 Cost benefit ratio

Data on cost benefit ratio as affected by different treatments are reported in Table 13.

4.3.3.1 Dates of planting

It is evident from the data presented in Table 13 that there was gradual decrease in cost benefit ratio as dates of planting were delayed except D_4. Significantly highest cost benefit ratio was observed when crops were planted on D_1 over all other dates of planting. The treatment D_4 was significant over the treatment D_3. Latter planting dates D_2 , D_3 and D_5 remained statistically similar with each other.

4.3.3.2 Crops

Perusal of the data presented in Table 13 clearly indicated that tomato recorded significantly higher cost benefit ratio over all other crops which was on par with okra. Statistically chilli and brinjal recorded similar cost benefit ratio which were significant over cowpea and clusterbean.

4.3.3.3 Interaction

Interaction effedts between dates of planting and crops on cost benefit ratio were found to be non-significant.

4.4 Physical analysis

4.4.1 Moisture content in fruits

Data in respect of moisture content of fruits as influenced by various treatments are presented in Table 14.

4.4.1.1 Dates of planting

The data presented in Table 14 revealed that there was significant difference in moisture percentage of fruits when different crops were planted on different planting dates. It is significantly higher in fruits harvested from crops planted on 2nd July (D_1) over all other dates of planting. Statistically similar moisture percentage was recorded when crops were planted on 12th July (D_2) and it was significantly more than the crops planted on 1st and 12th August,88. Significantly lower moisture content was observed in fruits harvested from the crops planted on 12th August, 88 (D_4).

4.4.1.2 Crops

It can be observed from Table 14 that per cent

Table 14:- Moisture content of fruits (%) as affected by various treatment.

Treatments	Moisture content of fruits (%)
Dates of planting	
D_1 2nd July,88	88.50
D_2 12th July,88	87.88
D_3 22nd July,88	87.12
D_4 1st August,88	86.22
D_5 12th August,88	85.31
S.E. ±	0.26
C.D. at 5%	0.85
Crops	
C_1 Chilli	82.13
C_2 Tomato	92.82
C_3 Brinjal	89.08
C_4 Cowpea	89.84
C_5 Clusterbean	81.93
C_6 Okra	86.22
S.E. ±	0.54
C.D. at 5%	1.55
Interaction	
Dates of planting X crops	
S.E. ±	1.22
C.D. at 5%	N.S.

moisture content in fruits of different crops was significantly highest in tomato (92.82%) over all other crops. It was followed by cowpea and brinjal which were statistically similar to each other and significantly more than rest of the crops. Significantly lowest moisture percentage 81.93 was recorded in chilli and clusterbean which were at par with each other.

4.4.1.3 Interaction

Interaction effects between dates of planting and crops in respect of per cent moisture of fruits were non-significant.

4.5 Post harvest studies

4.5.1 Length of root

Data pertaining to the length of root (cm) as influenced by various treatments are presented in Table 15 and graphically depicted in Fig. 4.

4.5.1.1 Dates of planting

Data presented in Table 15 revealed that the root length was significantly more when the crops were planted on 12th August (D_5) over all other dates of planting.

Table 15 : Root length and number of secondary roots as affected by different treatments.

Treatments	Root length (cm)	Number of secondary roots
Date of planting		
D_1 2nd July,88	18.13	16.31
D_2 12th July,88	19.83	15.11
D_3 22nd July,88	16.17	13.92
D_4 1st August,88	22.13	13.08
D_5 12th August,88	24.21	12.61
S.E. ±	0.12	0.06
S.D. at 5%	0.40	0.22
Crops		
C_1 Chilli	11.17	10.84
C_2 Tomato	24.44	13.50
C_3 Brinjal	20.60	19.26
C_4 Cowpea	17.57	13.08
C_5 Clusterbean	21.65	7.55
C_6 Okra	30.71	21.01
S.E.±	0.11	0.14
C.D. at 5%	0.32	0.41
Interaction		
Dates of planting X crops		
S.E. ±	0.25	0.32
C.D. at 5%	N.S.	N.S.

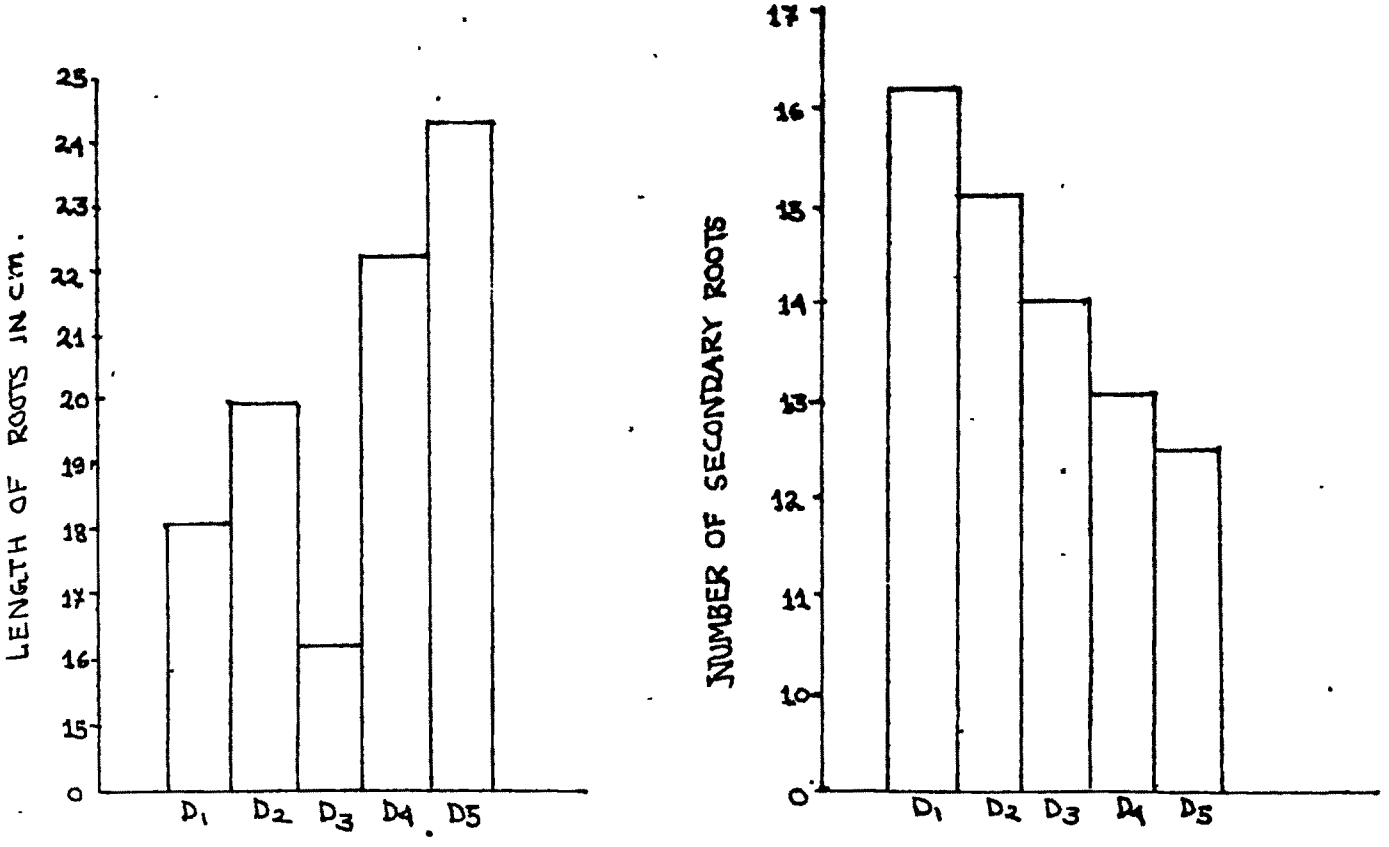


FIG. 4. ROOT LENGTH AND NUMBER OF SECONDARY ROOTS AS AFFECTED BY DATES OF PLANTING.

The crops planted on 1st August (D_4) produced significantly higher root length than earlier three dates of planting. Significantly lowest root length was recorded from the crops planted on 22nd July (D_3).

4.5.1.2 Crops

It is seen from the data presented in Table 15 that significantly highest root length (30.71 cm) was observed in okra followed by tomato (24.44 cm) which was significantly more than rest of the crops. Significantly lower length of root was observed in the crop chilli.

4.5.1.3 Interaction

Interaction effects between dates of planting and crops on root length was found to be non-significant.

4.5.2 Number of secondery roots per plant

The data on number of secondery roots per plant as affected by various treatments are presented in Table 15 and graphically depicted in fig-4.

4.5.2.1 Dates of planting

It is clear from the data presented in Table 15 that there were significant effects of dates of planting on number of secondery roots per plant. Significantly

higher number of secondery roots per plant were observed in the plants planted on 2nd July,88 over all other dates of planting. In sequence it was followed by planting on D_2, D_3, D_4, and D_5. Significantly lowest number of secondery roots were observed when planting was done on 12th August (D_4).

4.5.2.2 Crops

It dan be observed from the data presented in Table 15 that amongst different crops, there was significant variation in number of secondery roots per plant. The okra crop produced significantly higher number of secondery roots per plant over all other crops. It was followed by brinjal which produced significantly more number of secondery roots than tomato, cowpea and clusterbean. Significantly least number of secondery roots were produced by the crop clusterbean.

4.5.2.3 Interaction

Interaction effects between dates of planting and crops on number of secondery roots were found to be non-significant.

4.5.3 Shoot moisture percentage

Data on shoot moisture percentage as affected by different treatments are presented in Table 16.

Table 16: Shoot and root moisture percentage as affected by different treatments.

Treatments	Shoot moisture percentage	Root moisture percentage
Dates of planting		
D_1 2nd July,88	80.73	74.29
D_2 12th July,88	79.47	73.07
D_3 22nd July,88	79.24	71.86
D_4 1st August,88	76.84	70.15
D_5 12th August,88	76.14	69.38
S.E. ±	0.23	0.27
C.D. at 5%	0.77	0.89
Crops		
C_1 Chilli	71.76	68.15
C_2 Tomato	84.38	78.63
C_3 Brinjal	78.65	72.80
C_4 Cowpea	78.34	67.79
C_5 Clusterbean	76.63	71.82
C_6 Okra	81.66	71.52
S.E. ±	0.22	0.22
C.D. at 5%	0.64	0.65
Interaction		
Dates of planting X crops		
S.E. ±	0.50	0.51
C.D. at 5%	N.S.	N.S.

4.5.3.1 Dates of planting

It is seen from the data presented in Table 16 that significant differences in shoot moisture percentage due to dates of planting. Significantly highest moisture percentage was observed in crops when planted on 2nd July,88 (D_1) over all other dates of planting. Statistically planting dates D_2 and D_3 recorded similar per cent moisture in shoot and it was followed in sequence by D_3 and D_4. Singificantly lowest per cent moisture was recorded when planting was done on 12th August,88 (D_5).

4.5.3.2 Crops

It is clear from the data recorded in Table 16 that moisture percentage in shoot of tomato was significantly highest (84.38%) over shoots of all other crops. Significa ntly higher per cent moisture was recorded by shoots of okra than brinjal, cowpea, clusterbean and chilli. Statistically similar per cent moisture was recorded by brinjal and cowpea. Significantly lowest moisture percentage was recorded by the crop chilli.

4.5.3.3 Interaction

It is evident from the data presented in Table 16 interaction effects between dates of planting and crops were found to be non-significant.

4.5.4 Root moisture percentage

Data on root moisture percentage as affected by various treatments are presented in Table 16.

4.5.4.1 Dates of planting

The data presented in Table 16 revealed that significant variation in root moisture percentage was due to dates of planting. Planting on 2nd July (D_1) recorded significantly highest root moisture percentage than other dates of planting which was statistically similar to D_2. The next significant highest per cent moisture was on D_3 than D_4 and D_5. Statistically the planting dates D_4 and D_5 recorded the similar per cent moisture. Significantly lowest root moisture percentage was recorded when planting was done on 12th August,88 (D_5).

4.5.4.2 Crops

It was evident from the data presented in Table 16 that there were significantly wide differences in root moisture percentage. It was significantly highest in tomato over all other crops. It was followed by brinjal which recorded significantly higher moisture percentage than clusterbean, okra, chilli and cowpea. Statistically clusterbean and okra recorded similar moisture percentage in roots. Significantly lowest moisture percentage was recorded by the crop cowpea.

Table 17: Mean soil moisture use in mm as influenced by various treatments.

Treatments	Soil moisture use (mm)
Dates of planting	
D_1 2nd July,88	399.04
D_2 12th July,88	399.65
D_3 22nd July,88	387.47
D_4 1st August,88	337.97
D_5 12th August,88	305.39
S.E. ±	0.33
C.D. at 5%	1.08
Crops	
C_1 Chilli	368.41
C_2 Tomato	367.79
C_3 Brinjal	366.53
C_4 Cowpea	361.10
C_5 Clusterbean	363.57
C_6 Okra	368.02
S.E. ±	0.34
C.D. at 5%	0.97
Interaction	
Dates of planting X crops	
S.E. ±	0.93
C.D. at 5%	N.S.

4.5.4.3 Interaction

Interaction effects between dates of planting and crops on root moisture percentage were found to be non-significant.

4.6 Soil moisture studies

4.6.1 Soil moisture use in mm

Data on soil moisture use in mm as affected by different treatments are presented in Table 17.

4.6.1.1 Dates of planting

Data presented in Table 17 revealed that moisture use was significantly influenced due to dates of planting. Significantly highest moisture use (399.65 mm) had recorded by different vegetable crops when planted on 12th July (D_2) over all other dates of planting except 2nd July D_1 which was statistically similar to D_2. Second best treatment in respect of moisture use was 2nd July (D_1) followed by D_4. The lowest moisture use was recorded on 12th August,88 (D_5).

4.6.1.2 Crops

It is clear from the data presented in Table 17 that amongst different vegetable crops, chilli recorded significantly higher soil moisture use

(368.41 mm) than all other vegetable crops which was on par with tomato and okra. The lowest soil moisture use was recorded by the crop cowpea.

4.6.1.3 Interaction

Interaction effects between dates of planting and crops on soil moisture use were found to tbe non-significant.

4.6.2 Soil moisture use efficiency in kg/ha-mm

The data on on soil moisture use efficiency as influenced by various treatments are presented in Table 18 and graphically depicted in fig-5.

4.6.2.1 Dates of planting

Perusal of the data presented in Table 18 indicated that highest moisture use efficiency was recorded when planting was done on 2nd July (D_1). It was significantly superior over all other dates of planting. The next best treatment is D_4 which is significantly superior over D_2, D_3 and D_5. Significantly lowest moisture use efficiency was observed when planting was done on 22nd July,88 (D_3). It is evident from the data presented in Table 18 that no specific trend was observed in soil moisture use efficiency.

Table 18: Moisture use efficiency in kg/ha-mm and Rs/ha-mm as affected by different treatments.

Treatments	Moisture use efficiency	
	Kg/ha-mm	Rs/ha-mm
Dates of planting		
D_1 2nd July,88	31.03	60.05
D_2 12th July,88	20.59	39.67
D_3 22nd July,88	19.18	36.65
D_4 1st August,88	25.52	51.32
D_5 12th August,88	22.26	47.17
S.E. ±	0.33	0.47
C.D. at 5%	1.09	1.55
Crops		
C_1 Chilli	11.85	47.43
C_2 Tomato	33.76	67.52
C_3 Brinjal	21.62	48.65
C_4 Cowpea	19.43	27.21
C_5 Clusterbean	17.96	26.94
C_6 Okra	37.66	64.03
S.E. ±	0.66	0.54
C.D. at 5%	1.88	1.54
Interaction		
Dates of planting X crops		
S.E. ±	1.48	1.21
C.D. at 5%	N.S.	N.S.

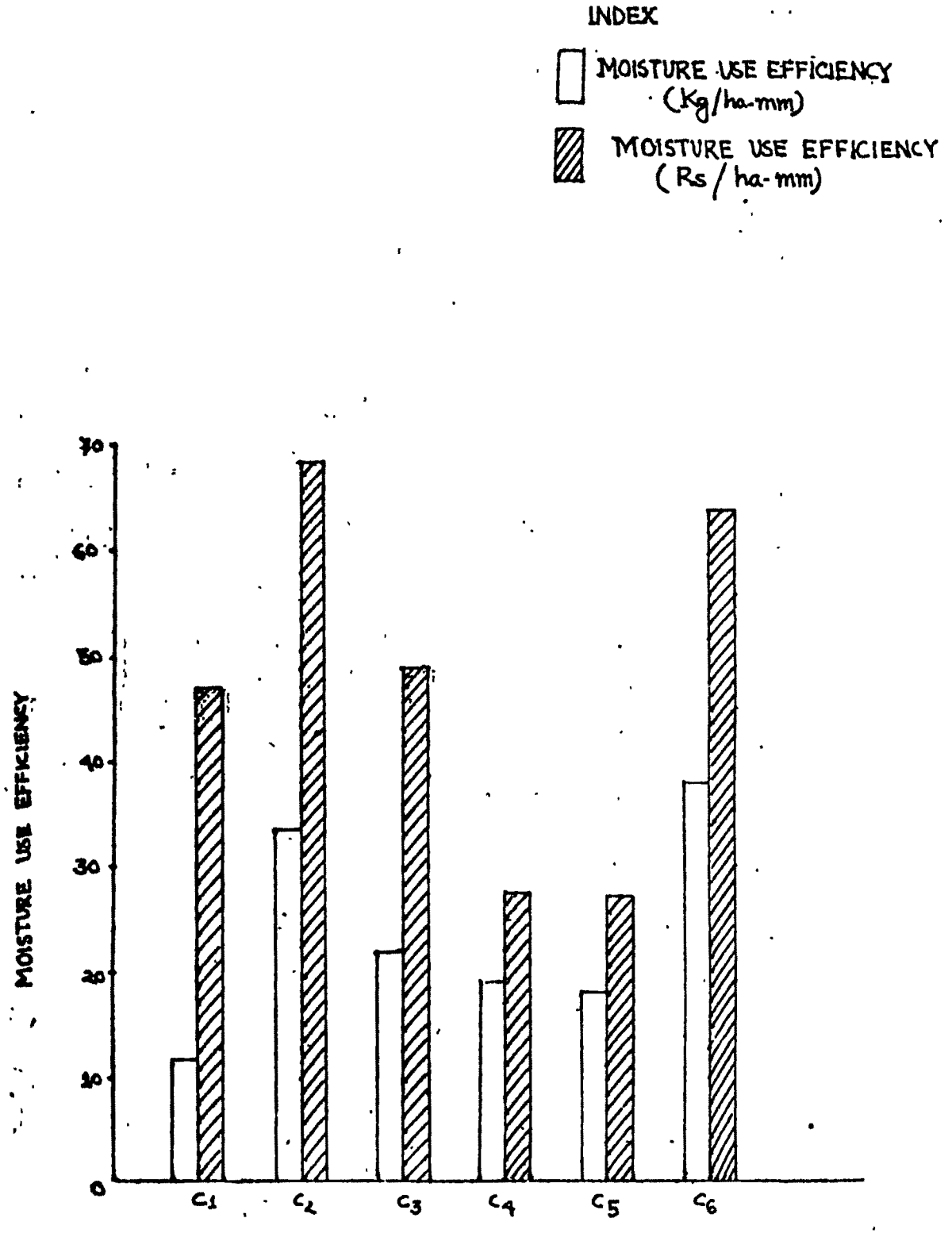


FIG.5. MOISTURE USE EFFICIENCY (KG/HAC-MM) AND (RS/HAC-MM) AS AFFECTED BY DIFFERENT DATES OF PLANTING.

4.6.2.2 Crops

Data presented in Table 18 clearly revealed that amongst different vegetable crops, okra had recorded significantly highest moisture use efficiency than other crops. The next position was acquired by tomato which had recorded 33.76 kg/ha-mm moisture use efficiency and which was significantly superior over chilli, brinjal, cowpea and clusterbean. Significantly lowest moisture use efficiency 11.85 kg/ha-mm was recorded by the crop chilli.

4.6.2.3 Interaction

Interaction effects of dates of planting and crops on moisture use efficiency were found to be non- significant.

4.6.3 Soil moisture use efficiency in Rs/ha-mm

Data on soil moisture use efficiency in Rs/ha-mm as influenced by various treatments are presented in Table 18 and graphically depicted in Fig-5.

4.6.3.1 Dates of planting

Data presented on mean soil moisture use effeciency in Table 18 revealed that there were significant variation due to dates of planting. Significantly

highest moisture use efficiency (60.65 Rs/ha-mm) was observed when crops were planted on 2nd July (D_1) over all other dates of planting. The next best treatment in respect of moisture use efficiency was D_4 which was significantly superior over D_2, D_3 and D_5. Significantly lowest moisture use efficiency was found when planting was done on 22nd July (D_3).

4.6.3.2 Crops

It was clear from Table 18 that mean moisture use efficiency was significantly influenced by different vegetable crops. Tomato was found to be most efficient crop in utilising soil moisture, recording the highest moisture use efficiency over all other crop. The next best crop was okra which was superior than chilli, brinjal, cowpea snd clusterbean. Statistically chilli and brinjal recorded similar moisture use efficiency which were significantly superior over cowpea and clusterbean.

4.6.3.3 Interaction

Interaction effects between dates of planting and crops were found to be non-significant.

Table 19: Energy value (Kilo calorie) as affected by different treatments.

Treatments		Energy value (Kilo calorie)
Dates of planting		
D_1	2nd July,88	3539
D_2	12th July,88	2327
D_3	22nd July,88	2172
D_4	1st August,88	2400
D_5	12th August,88	1909
S.E. ±		242.87
C.D. at 5%		791.94
Crops		
C_1	Chilli	1226
C_2	Tomato	2929
C_3	Brinjal	1975
C_4	Cowpea	2676
C_5	Clusterbean	1044
C_6	Okra	4967
S.E. ±		184.13
C.D. at 5%		523.33
Interaction		
Dates of planting X crops		
S.E. ±		411.73
C.D. at 5%		N.S.

4.7 Energy value

Data on energy value of different vegetable crops as affected by different treatment was converted into kilo calorie per hectare and are presented in Table 19.

4.7.1 Dates of planting

Data presented in Table 19 revealed that significantly highest energy value was obtained from the produce harvested from the crops planted on D_1 i.e. 2nd July,88. The next best treatment was D_2 followed by D_4 which was significant over the treatments D_3 and D_5.

4.7.2 Crops

Perusal of the data presented in Table 19 revealed that the crop okra recorded significantly highest energy value over other crops. The next best crop was tomato followed by cowpea which was significant over chilli and clusterbean.

4.7.3 Interaction

The interaction effects between dates of planting and crops were absent.

DISCUSSION

5. DISCUSSION

The distribution of vegetation over the surface of the earth is controlled more by the availability of water than by any other single factor. During rainy season in Marathwada region particularly Parbhani site is under assured rainfall zone. Hence the advantage of the situation for taking the rainfed vegetable crops is of great importance by adjusting their dates of planting.

The experimental results of the present investigation are discussed in this chapter under appropriate headings.

Soil, Climate and plant count

The mechanical and chemical analysis of the soil revealed that the soil of the experimental plot was clayey in texture, poor in nitrogen and moderate in phosphorus. The gravimetric moisture content at 1/3 and 1/15 bar tensions was 33.12 and 12.86 per cent, respectively. The bulk density was 1.30 kg/cubic metre.

Total precipitation of 1545.20 mm was received during the crop growth season. Effective rainfall was 463.56 mm. The rainfall was distributed over 76 rainy days. The maximum and minimum temperature ranged over

35.42 and 11.76 °C, respectively. The morning and evening humidity varied from 47.50 to 91.30&12.50 to 70.10 per cent, respectively.

The prevailing weater conditions during experimental period was matched with ecological requirement except continuous rains from July to September end. Except few light showers, whole of October was completely dry. On account of this exceptionally long term rains during the period of growth, all crops were more or less affected by these prevailing conditions.

Growth studies

The final plant stand in percentage of all vegetable crops except tomato was satisfactory. It was due to sufficient soil moisture. The low plants stand in tomato crop was due to early blight and spotted wilt virus. Similar results were obtained by Golani (1988).

The growth and vigour of the plant is an indication of power and forcefulness of the plant which ultimately results in better production.

The contributing characters of growth are plant height, number of branches, number of leaves, spread

and stem diameter which were crtically studied.

With regard to the height of plant (Table 5), it was observed that the height of the plant was significantly more when planting was done on 2nd July. Results were similar to those reported by Singh et al. (1982), where planting of brinjal was done in paired rows of 45 cm apart with 90 cm wide ridge between them. Vashistha et al. (1989), also reported the similar results in okra. Patil (1986) and Golani (1988), under rainfed conditions obtained similar results.

The data presented in Table 6 clearly indicated that the highest number of branches per plant were observed when planting was done on 2nd July. Interaction effect was also found to be significant. The crop chilli planted on D_5, D_4 and D_1 recorded significantly more number of branches per plant over other treatment combinations. The results are supported by the findings reported by Patil (1986), Lawand (1987) and Golani (1988) under rainfed conditions.

The variety of okra and clusterbean are Parbhani Kranti and Pusa Navbahar, respectively. These varieties are single stemed and hence branching was not observed.

Neverthless, Golani (1988) reported branching in okra. He reasoned that branching was due to water stress in Kharif. This year due to sufficient rains there was no moisture stress, hence no branching.

The data presented in Table 6 clearly showed that number of leaves per plant were significantly highest when planting was done on 1st August,88. This may be due to different vegetable crops having different growth nature, hence the variation. It may also be due to the prevailing weather conditions. Similar results were obtained by Kempe Gowda and Muddappa Gowda (1980), in chilli planted on 1st August.

Interaction effect was also found to be significant. It is clear from the data presented in Table 8 that the crop chilli produced significantly higher number of leaves per plant when planted on D_5 i.e. 12th August over all other treatment combinations.

The data in Table 9 revealed that significantly highest plant spread was observed in crops when planting was done on 2nd July over all other dates of planting which may be due to presence of sufficient available moisture in the soil at the time of vegetative growth

of the crops. This was supported by the findings of Patil (1986) and Lawand (1987). Similar results were also obtained by Golani (1988) under rainfed conditions.

Thus in general, crop planted earlier i.e. 2nd July produced significantly superior vegetative growth over latter dates of planting. This is due to sufficient soil moisture available to the crop through out its growth period.

Yield studies

Yield of different crops depends upon the vetegative growth which helps in supporting more flowers and higher fruit set and proper development of fruits and thus finally resulting in more yield.

On close scrutinity of the data presented in Table 10 revealed that crops planted on 1st August recorded that highest number of fruits per plant. The lowest being of crops planted on 22nd July. It is average of all crops and since the crop chilli produced significantly highest number of plants and therefore plants planted on 1st August gave significantly more fruits per plant. Other crops did not produced more number of fruits when planted on 1st August.

The rssults are in agreement with the results reported by Kempe Gowda and Muddappa Gowda (1980), in chilli crop.

It is evident from the Table 11 that amongst different dates of planting, planting on 2nd July produced significantly highest yield per plant and fruit yield per hectare than all other dates of planting. Interaction effects between dates of planting and crops on fruit yield per hectare was also found to be significant. From the data presented in Table 12 it is clear that interaction between D_1 X C_2 i.e. planting of tomato on 2nd July produced significantly highest yield over other treatment combinations. The next best treatment combination D_1 X C_6 i.e. okra sown on 2nd July,88 produced significantly highest yield over other treatment combinations.

Thus it is clear that fruit yield per plant and fruit yield per hectare were significantly highest when planting of various crop was done on 2nd July over all other dates of planting. However fruit yield of all latter dates were on par with each other.

It is clear from the results that yield of

almost all vegetable crops was significantly higher when aplanted earlier i.e. on 2nd July. There is gradual decrease in the yield as dates of planting were delayed. This is obvious since earlier planted crops received favourable weather conditions particularly to these crops till its completion of life cycle obtained sufficient soil moisture for its growth, fruiting and fruit development.

The yield of crops planted on all other dates was on par with each other. It may be due to non-significant differences in availability of soil moisture. Since this year rains received were above normal and rainy days also more. All the crops even planted on 12th August i.e. last date of planting received rains upto 3rd October. The duration of the crops like cowpea, clusterbean and okra is just 75-90 days. Thus there was sufficient moisture available for growth of the crop. Therefore there is no statistical difference. Eventhen there is gradual decline in the yield as dates of planting was delayed. This is on account of unfavourable weather for the crop growth. Moreover crop planted latter particularly okra was severely affected by powdery mildew and

therefore there is decrease in yield as dates were delayed.

These observations clearly indicated that crops like clusterbean and cowpea can be planted in July to obtain higher yield. However, the crop okra yielded significantly more when planting was done at early dates. There is gradual decline in the yield incase of brinjal too. In okra and brinjal earlier sown crop were vigorous and crop received sufficient moisture throughout its life period had early flowering and longer fruiting period than latter dates of planting. In respect of tomato only first date produced significantly higher yield than other dates. This is on account of more mortality due to high rainfall, incidence of early blight and spotted wilt virus.

Chilli produced significantly higher yield when planted in August except the treatment D_3. In case of chilli it was observed that latest planted crop was not seriously affected by diseases and hence more yield.

In case of cowpea and clusterbean there was not constant trend in yield in dates of planting.

It shows that cowpea and clusterbean were not sensitive to soil moisture availabily or it received sufficient moisture in all dates of planting.

Chilli recorded 41.45 q/ha fruit yield which was 55.26 per cent as against normal yield of 75 q/ha under irrigated conditions in Kharif season. Similar results were obtained by Patil (1986), Lawand (1987) and Golani (1988) under rainfed conditions.

Direct seeded vegetable crops recorded optimum yield under rainfed conditions. However, under irrigated conditions, the normal yield per hectare of clusterbean is 75 q/ha but clusterbean recorded 64.86 q/ha which was 86.48 per cent of normal yield. Cowpea and okra recorded the more yields than normal under irrigation which comes to be 103.65 and 141.03 per cent respectively. These results are in confirmity with the results of Grewal (1973) in okra, Sharma and Taneja (1984) in clusterbean and Kamara(1981) in cowpea.

The optimum yield obtained of these crops may not be due to sufficient rainfall harvested in beds but also due to distribution of rainfall during the growth stages of crops. In the months of July to

September end there was more rainfall and its distribution was comparatively more through out the growth stage druing this period.

Thus sufficient and well distrubuted rainfall during growth stage of crops was beneficial for obtaining more yield under rainfed conditions.

Economic returns

Gross monetary returns

From data presented in Table 18 it is evident that gross monetary returns were found to be significantly influcenced by dates of planting. Significantly highest gross monetary returns (23968 Rs/ha) were found in crops planted on 2nd July over all other dates of planting. The remaining dates were on par with each other. This may be attributed to the yield of vegetable crops and market prices.

Amongst the different crops, significantly highest gross monetary returns were obtained from tomato followed by okra which was at par with tomato. However, chilli recorded low yield, but due to higher price in market as compared to other vegetable crops it was statistically similar to brinjal. The crops cowpea and clusterbean yielded less compared to other

vegetable crops and fetched less price hence gross monetary returns obtained were also lower as compared to other vegetable crops.

Net monetary returns

It is clear from Table 18 that significantly higher net monetary returns in rupees per hectare were obtained when different vegetable crops were planted on 2nd July over all other dates of planting.

Amongst different vegetable crops, tomato had obtained significantly higher net monetary returns followed by okra than other vegetable crops. It is due to high yield obtained from these crops. The crop chilli recorded significantly higher net monetary returns than cowpea and clusterbean due to high price fetched in market. The lowest net monetary returns were obtained from cowpea and clusterbean. It is due to low price fetched in the market.

Cost benefit ratio

It is clear from the data presented in Table 18 that significantly highest cost benefit ratio was recorded when crops were planted on 2nd July over all other dates of planting. Latter dates were found to be at par with each other.

Amongst the different vegetable crops, tomato and okra being on par with each other recorded significantly higher cost benefit ratio than all other crops. Similar cost benefit ratio was observed in chilli and brinjal due to high cost of cultivation in brinjal crop. Clusterbean recorded significantly lowest cost benefit ratio (0.67) due to low price fetched in the markets for these vegetables.

From the economic studies it can be said that monetary returns and cost benefit ratio depends not only on yield obtained but also on the price fetched in the market. As it is known fact that depending upon supply of vegetables in market, prices also fluctuate, This may change the order of significance of a particular vegetable crop in a given situation.

Physical analysis

It is evident from the data presented in Table 13 that crops planted on 2nd July,88 recorded significantly more moisture percentage in fruits than remaining dates of planting. The crop tomato recorded significantly highest moisture percentage in fruits than all other crops. It was followed by cowpea and brinjal which were significant over chilli and clusterbean. Lowest

moisture percentage was recorded by chilli and clusterbean which were at par with each other. It is obivious due to crop difference. Similar results were obtained by Patil (1986), Lawand (1987) and Golani (1988).

Post harvest studies

The observations were recorded on length of root and number of secondary roots, moisture percentage in shoots and moisture percentage in roots.

Data presented in Table 14 inrespect of length of root and number of secondary roots indicated that significantly higher root length was recorded in crops planted on 12th August. This may be due to water stress observed on latter dates of planting resulting in penetration of roots deeper in soil in search of water. The number of secondary roots were significantly higher in the drops planted on 2nd July. This may be due to sufficient available moisture in the root zone of the crops as sufficient rains were received till 3rd October. Thus plants were grown under favourable conditions resulting into better crop growth which synthesized more food material in the leaves which was translocated towards the root

growth and development. These results are in agreement with the results of Goncharaova et al. (1979), Patil (1986), Lawand (1987) and Golani (1988).

The observation recorded on moisture percentage of shoots and moisture percentage of roots (Table 15) revealed that the crops planted on 2nd July recorded the higher moisture percentage than all other dates of planting. Delay in planting also decreased the moisture percentage. These results are similar to those reported by Patil (1986), Lawand (1987) and Golani (1988).

Soil moisture studies

Mean soil moisture use

From Table 16. It is clear that planting of different vegetable crops on 2nd July recorded the highest soil moisture use (mm) over all other dates of planting.

Chilli recorded significantly higher moisture use amongst all vegetable crops and it was followed by tomato and okra. This may be attributed to higher efficiency of these crops in utilising the available soil moisture and comparatively longer maturity period of these crop. Similar results were obtained

by Dhoble et al. (1987), where they found that long duration crop (Cotton and Castor) utilised highest moisture use of 501.1 mm and 500.9 mm, respectively as compared to short duration crops (Sesamum)which consumed 394.1 mm moisture. Similar advantage of moisture was observed by Viswambharam (1984) over uncultivated land where tapioca was grown.

Moisture use efficiency

It was evident from the Table 17 that moisture efficiency kg/ha-mm was highest in crops planted on 2nd July followed by 1st August. This may be attributed to the efficient use of moisture by different crops for their growth and yield in these dates of planting under rainfed conditions.

Amongst different vegetable studied, okra was found to be most efficient crop in utilising the soil moisture use for its growth and yield followed by tomato. Thereafter, the crops cowpea and clusterbean showed more or less similar moisture use efficiency. The results are in confirmity with those reported by Oswal et al. (1984), where they concluded that leguminous crops have low water use efficiency. The crop chilli showed lowest moisture use efficiency.

This may be due to low yields obtained by this crop, since the soil moisture use efficiency is related to yield of the crops. The results were also supported by Wankhede and More (1985) in chilli, where, this crop had recorded 1.94 kg/ha-mm water use efficiency under irrigated conditions.

Moisture use efficiency Rs/ha-mm was found to be highest in crops planted on 2nd July followed by 1st August over all other dates. This may be attributed to the efficient moisture use by different vegetable crops in these dates of planting.

In case of different vegetable crops, water use efficiency in Rs/ha-mm was found to be different. Significantly highest moisture use efficiency 67.52 Rs/ha-mm was obtained in tomato followed by okra (64.03 Rs/ha-mm) over all other crops. Chilli and brinjal, though they are on par with each other were also found to be significant in utilising soil moisture over cowpea and clusterbean which showed lower efficiency in utilising soil moisture for their growth and yield which may be due to their low yield potential.

Energy value

Considering the energy value (Table 19), it is seen that significantly higher energy value was recorded when crop were planted on 2nd July over all other dates of planting. Second position was acquired by the planting of crop on 1st August.

Energy value was influenced significantly due to different vegetable crops. The crops okra and tomato recorded significantly higher energy value than all other crops and it was 4968 and 2929 kilo calorie/ha, respectively. The crop cowpea recorded the energy value of 2675 kilo calorie/ha and it was significantly superior over chilli, brinjal and clusterbean. Due to less yield and low calorie value clusterbean recorded the lowest energy value (1044 kilo calorie/ha).

Summing up, the results obtained in the present investigation, clearly showed that planting of different vegetable crops on 2nd July and 1st August resulted in higher yield under rainfed conditions. It is on account of combined effect of better availability of soil moisture and aeration which resulted in absorption of more nutrients from soil. This helped in better vegetative growth and finally which supported more number of heavier fruits.

Thus in rainfed conditions we can successfully grow the vegetable crops by adjusting the dates of planting in order to harvest the more rain water for the proper growth of the crops. Thus earliest planting after onset of monsoon gave better results.

With regards to crop studies it was revealed that in general, all six vegetable crops yielded satisfactorily under rainfed conditions of high rainfall.

Comparative studies indicated that, okra produced highest yield over other crops, the net monetary returns of tomato were more. The cowpea and clusterbean though gave less monetary returns but yields were satisfactory.

Thus cultivation of rainfed vegetable crops will serve the following purpose -

i) Suceessful growing of vegetable crops in rainfed conditions as irrigation facilities are meagre,
ii) To increase the availability of vegetables at resonable price to rural population where consumption is far below than recommended by dietecian.

SUMMARY & CONCLUSION

6. SUMMARY AND CONCLUSION

An experiment was under taken at Horticultural Research Station, Sub-Campus, Marathwada Agricultural University, Parbhani to study the "Effect of different dates of planting on growth and yield of different vegetable crops grown under rainfed conditions" during the year 1988 in Kharif season.

The experiment was laid out in split-plot technique consisting of 30 treatment combinations of five dates of planting (Main plot) and six crops (Sub plot) with three replications. The dates of planting were 2nd July (D_1), 12thJuly (D_2), 22nd July (D_3), 1st August (D_4) and 12th August,88 (D_5) with six crops viz. Chilli (C_1), tomato(C_2), Brinjal (C_3), Cowpea (C_4), clusterbean (C_5) and okra (C_6),

The experimental site was fairly uniform in topography, clayey in texture, alkaline in chemical reaction and medium in soil fertility.

Data of biometric characters viz. plant height, number of branches, number of leaves, plant spread and stem diameter were recorded periodically at 30 days interval. The data inrespect of physical analysis of fruits, length of root, number of

secondary roots, moisture content of shoot and root was recorded at harvest. The data in respect of number of fruits per plant and yield per plant were recorded at each picking.

Data on soil moisture perdentage were recorded right from planting and continued up to harvesting at an interval of 30 days in each treatment from 0-30, 30-60 and 60-90 cm soil layer depth.

The data were subjected to statistical analysis and results were tested by adopting 'F' test at 5% probability level.

1) Statisfactory final plant stand was observed in all crops except tomato.
2) Significantly higher plant height was observed when crops were planted on 2nd July. The number of branches and number of leaves per plant were significantly highest on 2nd July and 1st August, respectively over all other dates of planting. Interaction effects between dates of planting and crops were also found to be significant.

In general, similar trend was observed in plant height, number of branches and plant spread except that stem diameter was on par on all dates

of planting. Number of leaves were significantly more on 1st August than all other dates of planting.

3) Significantly highest number of fruits per plant were recorded on 1st August over all other dates. Latter dates were found to be at par with each other except third date (22nd July) on which number of fruits per plant were lowest (38.98 fruits per plant). Where as, incase of fruit yield per plant and fruit yield per hectare was significantly highest on 2nd July over all other dates of planting.

4) There was significant effect of dates of planting on quality aspect of fruits. Significantly highest moisture percentage was recorded on 2nd July over all other dates of planting.

5) There was significant effect of dates of planting on length of root, number of secondary roots, moisture percentage in shoot and moisture percentage in root.

Significantly more length of root was observed on 12th August than all other dates of planting. Number of secondary roots were significantly more on 2nd July than all other dates of planting.

Shoot and root moisture presentage was significantly higher on 2nd July than all other dates of planting.

6) Significantly highest moisture use (mm) was recorded on 2nd July over all other dates of planting. It was lowest on 12th August (305.39 mm).

Amongst crops, shilli recorded significantly highest mean moisture use (368.41 mm).

The moisture use efficiency was significantly highest (31.03 kg/ha-mm) on 2nd July followed by 1st August (D_4) over all other planting dates.

Incase of crops, okra was found to be the most efficient vegetable crop by recording 37.66 kg/ha-mm moisture use efficiency over all other vegetable crops.

Water use efficiency in respect of Rs/ha-mm under different dates of planting was found to be similar to the water use efficiency in kg/ha-mm.

Whereas, amongst vegetable crops, significantly highest moisture use efficiency 67.52 Rs/ha-mm was recorded by tomato over all other vegetable crops. Next best crop in utilising higher moisture use efficiency 64.03 Rs/ha-mm was okra.

7) Significant effect of dates of planting on gross

monetary returns were recorded. The highest gross monetary returns were recorded on 2nd July over all other dates of planting.

Amongst various vegegetable crops, significantly higher gross monetary returns were recorded by tomato followed by okra than all other vegetable crops.

8) Significantly highest net monetary returns were obtained on 2nd July over all other dates of planting.

Incase of different vegetable crops, tomato recorded significantly higher net monetary returns followed by okra over all other crops. Chilli and brinjal recorded significantly higher net monetary returns than cowpea and clusterbean.

9) Significantly highest cost benefit ratio was obtained on 2nd July over all other dates of planting.

Significantly higher cost benefit ratio was obtained by the crop tomato followed by okra than all other crops which was on par with tomato. The lowest cost benefit ratio (0.67) was recorded by clusterbean.

Incase of different vegetable crops, okra produced significantly higher energy value than all other crops. Chilli and clusterbean as well as tomato and cowpea more or less recorded similar energy value and the lowest was recorded by the crop clusterbean.

CONCLUSION

On the basis of results obtained in the present investigation, it can be said that the dates of planting had remarkable effects on growth and yield of different vegetable crops planted under rainfed conditions.

The maximum vegetative growth was recorded when plants were planted on 2nd July. Significantly highest number of fruits, were recorded on 1st August whereas, yield per plant and yield per hectare was significantly highest on 2nd July.

Regarding the crops, tomato was found to be most efficient crop by recording higher moisture use efficiency of 33.76 kg/ha-mm and 67.52 Rs/ha-mm.

Significantly highest net monetary returns i.e. profit per hectare was also found in tomato over all other vegetable crops except okra under rainfed conditions.

The best dates of planting were 2nd July and 1st August for higher moisture use efficiency in Rs/ha-mm and obtained higher net monetary returns (Rs/ha) over all other dates of planting under rainfed

conditions. Cost benefit ratio was highest on 2nd July over all other dates of planting .

Thus it is possible to grow vegetable crops under rainfed conditions. This will facilitate growing of vegetable crops under rainfed condtions which will increase vegetable production. This increased vegetable production is essential for making available vegetables in rural area where its consumption is far below than recommended by dietician.

The results are based on one year trial hence for confirmation of the results experiment may be repeated.

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* Originals not seen.

APPENDICES

APPENDIX A

Meteorological data for the period of June 1988 to January 1989 as recorded at Agricultural Meteorological Observatory, Parbhani

Month	Met. week No.	Rain-fall (mm)	Rainy days	Temperature (^{O}C)		Relative humidity	
				Max.	Min	Mor.	Even.
1	2	3	4	5	6	7	8
June	23	39.8	3	39.0	25.5	68.8	33.1
	24	34.5	4	36.6	24.1	77.0	50.0
	25	23.17	6	32.11	22.7	90.8	60.4
	26	2.0	1	34.07	24.15	78.4	41.7
July	27	7.50	3	34.6	24.0	79.5	46.8
	28	34.0	5	30.9	20.5	89.4	66.1
	29	167.4	7	30.4	22.8	90.4	73.1
	30	103.3	5	29.2	22.2	91.5	70.8
	31	163.1		28.4	22.5	92.1	76.8
August	32	4.1	.3	32.5	23.0	87.0	52.0
	33	94.2	5	31.6	23.6	90.0	65.0
	34	162.0	5	28.9	22.5	95.0	76.0
	35	171.2	5	28.9	22.4	93.2	87.4

Continued

APPENDIX A (continued)

1	2	3	4	5	6	7	8
Sept.	36	134.5	4	30.6	22.9	92.0	66.2
	37	32.2	4	32.0	22.5	88.5	63.2
	38	116.9	5	30.4	22.6	91.4	70.1
	39	104.7	4	31.8	22.2	91.4	66.0
October	40	10.0	3	30.8	21.7	88.8	54.1
	41	--	-	31.9	17.8	79.1	32.0
	42	--	-	34.0	16.7	75.0	26.0
	43	--	-	33.3	15.0	70.0	22.0
	44	--	-	32.1	18.4	71.0	31.0
November	45	1.6	1	30.6	13.5	79.0	25.0
	46	--	-	30.4	10.0	74.0	20.0
	74	--	-	36.7	12.9	77.0	26.0
	48	--	-	29.0	10.4	75.0	25.0
December	49	--	-	29.6	11.1	78.0	24.0
	50	--	-	28.2	11.7	83.0	32.0
	51	--	-	29.3	9.5	78.0	25.0
	52	--	-	29.5	12.1	78.0	29.0
January	1	--	-	29.8	10.7	75.0	23.0
	2	--	-	29.1	12.9	70.0	34.0
	3	--	-	31.1	11.7	67.0	25.0
	4	--	-	31.5	14.5	72.0	31.0
	5	--	-	32.5	11.8	68.0	18.0

APPENDIX B

COST OF CULTIVATION (RS/ha)

Treat-ments	Raising of seed-lings	Prepa-ratory opera-tions	Cost of F.Y.M.	Appli-cation of ferti-lizers	Prepa-ration of ridgs and furrows	Cost of seeds	Plant-ing	Inter-culture opera-tions/ weeding	Appli-cation of insecti-cides & fungi cides	Har-vest-ting of fruits	Misce-llane-ous	Tital expen-diture	Yield (kg/ha)	Gross income	Net profit
1	2	3	4	5	6	7	8	9	10	11	12.	13	14	15	16
Chilli															
D_1	523=00	356=25	2000	654=03	43=75	100	96	1020	891	960	25	6669=03	3031	12124	5455
D_2	523=00	356=25	2000	654=03	43=75	100	96	1020	891	768	25	6477=03	2984	11936	5459
D_3	523=00	356=25	2000	654=03	43=75	100	96	1020	891	768	25	6477=03	2307	9228	2751
D_4	523=00	356=25	2000	654=03	43=75	100	96	1020	891	768	25	6477=03	5879	23516	17039
D_5	523=00	356=25	2000	654=03	43=75	100	96	1020	891	960	25	6669=03	6527	26108	19439
Tomato															
D_1	523=00	356=25	2000	506=55	43=75	100	96	877=50	685	768	25	5981=05	2579	51580	45599
D_2	523=00	356=25	2000	506=25	43=75	100	96	877=50	685	640	25	5853=05	9908	19816	13993
D_3	523=00	356=25	2000	506=25	43=75	100	96	877=50	685	896	25	6109=05	9722	19444	13335
D_4	523=00	356=55	2000	506=25	43=75	100	96	877=50	685	768	25	5981=05	9627	19254	13273
D_5	523=00	356=55	2000	506=25	43=75	100	96	877=50	685	640	25	5853=05	8117	16234	10381
Brinjal															
D_1	523=00	356=55	2000	506=25	43=75	112=50	96	937=50	1467	1120	25	7187=55	10083	24621	17434
D_2	523=00	356=55	2000	506=25	43=75	112=50	96	937=50	1467	896	25	6993=55	8441	18882	11888
D_3	523=00	356=55	2000	506=25	43=75	112=50	96	937=50	1467	1008	25	7075=55	7440	16740	9664
D_4	523=00	356=55	2000	506=25	43=75	112=50	96	937=50	1467	1008	25	7075=55	7376	16596	9520
D_5	523=00	356=55	2000	506=25	43=25	112=50	96	967=50	1467	1120	25	7187=55	5725	12881	5693

Continued

Appendix - B (continued)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Cowpea															
D_1		356-25	2000	604	43-75	375	72	390	362-50	576	25	4884-55	6836	9570	4765
D_2		356-25	2000	604	43-75	375	72	390	362-50	512	25	4740-55	6219	8706	3066
D_3	- -	356-28	2000	604	43-25	375	72	390	362-50	256	25	4484-55	5132	7184	2700
D_4	- -	356-25	2000	604	43-25	375	72	390	362-50	512	25	4740-55	8446	11824	7083
D_5	- -	356-25	2000	604	43-25	375	72	390	362-50	448	25	4676-55	7453	10434	5757
Clusterbean	--														
D_1	- -	356-25	2000	604	43-25	600	72	485	473-50	1248	25	5907-05	6172	9258	3351
D_2	- -	356-25	2000	604	43-25	600	72	485	473-50	1440	25	6099-05	6874	10311	4212
D_3	- -	356-25	2000	604	43-75	600	72	485	473-50	1056	25	5715-05	6405	9607	3882
D_4	- -	356-25	2000	604	43-75	600	72	485	473-50	1056	25	5715-05	7953	11929	6214
D_5	- -	356-25	2000	604	43-75	600	72	485	473-50	864	25	5523-05	5080	7620	2097
Okra															
D_1	- -	356-25	2000	506	43-75	200	72	520	1059-00	1536	25	6318-55	21558	36648	30330
D_2	- -	356-25	2000	506	43-75	200	72	520	1059-00	1440	25	6222-55	14957	25426	19203
D_3	- -	356-25	2000	506	43-75	200	72	520	1059-00	1248	25	6030-55	13633	23176	17145
D4	- -	356-25	2000	506	43-75	200	72	520	1059-00	1152	25	5934-55	12484	21222	15288
D_5	- -	356-25	2000	506	43-75	200	72	520	1059-00	864	25	5646-55	7855	13404	7757

Note:- 1. Daily paid labour either male or female considered Rs. 16-00 per day

2. The wages of bullock pair considered as Rs. 25-00 per day

3. F. Y.M. was applied at the rate of 20 metric tonnes per hectare

4. Cost of fertilizers considered as

Urea	2.30 Rs/kg
Single superphophate	1.04 Rs/kg
Murate of potash	1.44 Rs/kg

5. Cost of seeing (average)

1. Tomato (breaker stage)	Rs. 2/kg
2. Chilli (green)	4 Rs/kg.
3) Brinjal	2.25 Rs/kg.
4) Cowpea	1.40 Rs/kg.
5) Clusterbean	1.50 Rs/kg.
6) Okra	1.70 Rs/kg.

APPENDIX -C

Table 1: Reduction in yield as affected by dates of planting and crops under rainfed conditions. (per cent)

Crops	Dates of planting (2nd July to 12th August,88)				
	D_1 (2nd July)	D_2 (12th July)	D_3 (22nd July)	D_4 (1st Aug.)	D_5 (12th Aug)
Chilli	53.26	54.28	64.65	9.93	*
Tomato	*	61.58	62.30	62.67	68.52
Brinjal	*	22.86	32.01	32.59	47.68
Cowpea	23.79	26.38	39.23	*	11.75
Cluster-bean	22.29	13.56	19.46	*	36.75
Okra	*	30.61	36.76	42.08	63.42

*The highest yield obtained at a particular date was considered as normal yield (which is higher in this experiment) and the per cent reduction was calculated on this basis.

It was observed from Table 1 that the crops tomato, brinjal and okra recorded the highest yield when planted on 2nd July. The yield of these vegetable crops decreased as the planting dates were delayed upto 12th August.

The crop tomato may be recommended for planting in the 1st week of July only as there was very high reduction (more than 50%) on the latter dates of planting upto August.

Brinjal and okra may be recommended for planting from 1st week of July to 1st week of August as the reduction in yield during latter dates upto 1st week of August was less (less than 50%).

The crops cowpea and clusterbean produced the highest yield when they were planted on 1st August and the yield decreased in early as well as latter dates of planting. However, both the crops may be recommended for planting from first fortnight of July to 1st fortnight of August as the reduction in yield was less than 50% for the recommended period.

The crops chilli produced the highest yield when it was planted on 12th August and the yield was reduced in all the early plantings. However, the reduction in yield was very less (less than 10%) when it was planted on 1st August and hence planting of chilli may be recommended in the month of August and not earlier than this because the reduction in yield due to early plantings in the month of July was more than 50%.