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A STUDY OF INTERCROPPING IN BRINJAL (Solanum melongena L.)

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BY

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Dissertation

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1990

AFFECTIONALY DEDICATED

TO MY

BELOVED PARENTS

CANDIDATE'S DECLARATION

I hereby declare that the dissertation or part thereof has not been previously submitted by me for a degree of any University.

PARBHANI

DATED : 7-7-90

(A.R. SISODE)

CERTIFICATE - I

Shri Arun Raosaheb Sisode has satisfactorily prosecuted his course of research for a period of not less than four semesters and that the dissertation entitled " A STUDY OF INTERCROPPING IN BRINJAL (Solanum melongena L.) " 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.

(S.N. GUNJKAR)

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CERTIFICATE - II

This is to certify that the dissertation entitled " A STUDY OF INTERCROPPING IN BRINJAL (Solanum melongena L.) " submitted by Shri Arun Raosaheb Sisode 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 external examiner.

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CONTENT

CHAPTER - I

INTRODUCTION

Vegetables belongs to about thirteen plant families and have organised from widely different parts of the earth. They are so common in human diet that a meal without a vegetable is supposed to be incomplete in any part of the world. As vegetables are the protective food and are rich source of proteins, carbohydrates, minerals, salts and vitamins. They are energetic and have appetizing value because of there organic acid content. Vegetables also prevent constipation. Looking to this dietary importance the demand for vegetables is increasing tremendously. In India also consumption of vegetables is increasing steadily.

An improved diet is supposed to have about 350 gms of vegetables per day per capita. But in India, average per day per capita consumption of vegetables is reported to be less than 45 gms (Premnath et al. 1977).

In India vegetable crops occupy only about 1.2 per cent of the total cultivated area and the total production is about 16 million tonnes per year which is extremely low. However, various research workers have conducted scientific studies to increase the vegetable production by adaptation of F_1 hybrid varieties, improved varieties, timely sowing,

maintaining adequate plant spacing, giving optimum doses of fertilizer, using of plant protection measures etc.

These aspects in case of brinjal crop were also critically studied, the findings of the same have significantly increased the production of brinjal vegetable, which is a most common and popular in rural as well as urban areas. Looking to the studies the consumption of vegetables is more in urban areas as compared to rural areas, specially kinds of vegetables.

Brinjal being common and popularly grown in all most all villages of the country at the spacing of 60 x 60 cm. The duration of brinjal crop is about 150 to 180 days, which requires 55 to 70 days for flowering and covering the given space. The interspace of these crop can be utilized in better way by taking the intercrops of either of short duration like radish, coriander, and Palak or having straight growth like onion. Patil (1988) reported that the intercropping of coriender in brinjal gave the highest net profit followed by radish in tomato and palak with chilli in the respective solanaceous vegetables. Gorkhe (1989) indicated that the intercropping of radish, onion and coriender is highly profitable in cabbage crop.

In this way intercropping of vegetables in vegetables may be practised successfully to increase the production of vegetables of various kinds in the same piece of land, particularly for rural people to have balanced diet.

Thompson and Kelly (1959) opinioned that the intercropping in vegetables is advantageous from the point of view of economy of space, saving tillage, complete utilization of surplus nutrients, better utilization of soil moisture and increased gross returns from land unit area. Ramkrishna Nayar (1976) reported that intercropping besides providing variety of food, it gives ample employment opportunity for small growers.

While adopting intercropping practices it would be necessary to apply additional doses of fertilizers to have proper growth and high yield of main crop as well as intercrop. Avtar Singh and Srivastava (1987) reported that cauliflower yield was highest in monoculture, however profitability/ha was greatest when it was intercropped with spinach, especially of the higher N level.

Keeping the above objectives in view an experiment of intercropping of onion, radish, palak and coriender

with additional 1/3rd and 2/3rd doses of fertilizers of the intercrops were studied to standardize the best intercrop with optimum additional dose of fertilizers in brinjal crop. The experiment was laid out at Department of Horticulture, Marathwada Agricultural University, Parbhani during rabi/winter season 1989-90.

CHAPTER - II

REVIEW OF LITERATURE

Intercropping system means growing two or more crops together on the same piece of land. It is an important agricultural practice and regards as a key strategy for increasing food production, rural employment and income in a country facing irrigation shortage and labour surplus.

In India intercropping is generally followed in agronomical crops, but it is rarely practised in the vegetables. Though much work has not been done on intercropping in vegetables, the available literature on the intercropping system in vegetables and other crops is presented under the following headings.

I) Intercropping as an important agricultural practice :

Thompson and Kelly (1959) gave the advantages of intercropping as follows.

1. Economy of space, which is important with high price land.
2. Saving of tillage as the same ploughing and tilling of land serve for two or more crops.

3. Complete utilisation of the nutrients and any surplus applied to one crop being available for another.

4. Increased gross returns from the area under cultivation.

Mehrotra and Ali (1970) revealed that mixed cropping is an ancient agricultural practice in India to meet the vagaries of weather as insurance against total failure of crops, better utilization of space, manures, water and labour as well as it is advantageous to small and fragmented holdings to grow different varieties of crops for home consumption and for a balanced diet.

Kaith (1980) reported that pea and bean crops were found most suitable combiner as intercrop with kalazira because :

1. These crops are leguminous and fix the atmospheric nitrogen in to the soil.

2. It improves the soil fertility.

3. Both these crops do not exhaust the available nutrients from soil but add more of humus and atmospheric N inavailable form.

4. Less number of irrigations are needed in their life span as water requirement is less with no effect on kalazira.

At Central Tuber Crop Research Institute, Trivendrum, Prabhakar and Pillai (1984) recorded the advantages of multiple cropping system with tuber crops as it increased net returns, suppressed weed growth, minimized soil loss and an inclusion of grain legume and vegetables provide calorie protein and calorie-mineral-vitamin in diet.

II) Effect of inter cropping on growth of main crop :

Thompson and Kelly (1959) stated that snap bean, early cabbage, lettuce or any other small growing crop may be planted between the rows of asparagus. Tall growing or long season crops should not be grown with asparagus on account of shading and competition for moisture and nutrients.

They further mentioned that radish and lettuce are often planted as intercrops with cabbage or other similar crops. Cabbage and tomatoes may be grown together, the cabbage plants being set early in the season and tomatoes set between the rows. The early cabbage will be ready to harvest before the tomato plants need the space.

While working on intercropping in sugarcane Kar et al. (1972) reported that sugarcane germination was not affected by intercropping onions.

Mendal (1973) reported that intercropping cowpea, groundnut, black gram, green gram, sunhemp etc. can be taken as an intercrop succesfully in cassava at normal spacing of 1m x 1m without affecting the growth of main crop.

In banana at least two field crops like radish, mung (Phaseolus aureus) can safely be taken as intercrop without affecting the growth of main crop, given by Randhawa and Sharma,(1973).

No adverse effect on growth of maize crop was observed by Meenakshi et al. (1974) due to growing of bhendi, cowpea, radish, clusterbean, lablab, beatroot, knol-khol and carrot as intercrops.

Gallash (1975) observed an improved growth and production of coconut palm by taking as an intercrops of sweet potato, maize, groundnut and ginger.

Nagre (1979) indicated that though intercropping of mung, cowpea, tur, sesamum and sunflower in cotton was advantages, but sunflower and sesamum suppressed the growth of cotton.

Itulya (1980) observed that root and shoot dry weight of french bean, mung beans or pinto beans were significantly reduced by the intercropping with summer squash, but in summer squash root and shoot dry weight as well as leaf area was not significantly affected.

III) Effect of intercropping on yield of main crop :

Singh and Singh (1973) observed that sugarcane intercropped with potato gave slightly higher cane yield than pure autumn crops.

In Maharashtra, Zende and Patil (1973) reported that, growing of onion, berseem, sweet clove, methi and peas showed slight depressing effect on cane yield. The effect was particularly marked in case of onion. Growing of radish as intercrop had an adverse effect on cane yield.

Sharma et al. (1983) reported that intercropping of wheat, potatoes, onions and sunflower in sugarcane was better for production per unit land area. They observed that potatoes gave additional yield without much reduction in sugarcane yield followed by onions.

Studies on coconut based multistorey cropping, Margete and Magat (1983) observed that planting of

piper + nigrum + cocoa + pineapple markedly improved nut and copra production per palm compared with their monoculture.

Umrani et al. (1984) revealed that maize and french bean adversely affect the yield of turmeric particularly when maize was grown for grain as an intercrop.

Bengazo (1985) reported beans as one of the best crop for growing in young coffee plantation. He also stated that when beans were grown with cassava, the highest yield was obtained when one row of beans was grown between cassava rows.

Itulya and Obeker (1985) studied effects of inter-cropping and reported that intercropping with cucurbita pepo did not significantly affect fruit yield/unit area.

Qian (1986) observed the yield benefit of adopting intercropping and interplanting various cropping systems by wheat intercropped with rape, melons, rice or soyabeans and rice and potato with various horticultural crops.

IV) Effect of intercrops :

The best intercropping system for tomato was planting tomato on the eastern side of the ridge and cabbage on the other side of the same ridge. This gives 53.32 tonnes

tomato per hectare and 11.04 tonnes cabbage per hectare was reported by Liao and Montas (1978).

Intercropping of Corn with cowpea and soyabean planting legumes either in the rows with corn or alternate to the corn row. Monoculture yield ranged from 46 to 90 per cent. They stated that seed yield of intercropped cowpea ranged from 42 to 56 per cent of monoculture and intercropped soyabean yield ranged from 48 to 60 per cent of monoculture stated by Allen and Obura (1983).

Prabhakar and Pillai (1984) reported the yield of intercrops grown with cassava as follows :

1. Intercropping grain legumes in cassava yielded 800 kg per hectare of cowpea grains and 700 kg per hectare of pigeon pea grains.

2. Intercropping oilseeds in cassava like groundnut yielded 1200 kg dry pods from one hectare.

3. Among various vegetable crops grown as intercrop with cassava, french bean was found to be the most economical with a yield of 1,500 kg per hectare.

4. Growing of maize with cassava yielded 1,200 kg of grain from one hectare.

Chavan et al. (1985) studied the intercropping in cole crops and reported that head weights of cabbages intercropped with radish, palak, chakwat and kholrabi and curd weight of cauliflowers intercropped with beet roots, radishes, lettuces, onions, chakwat, palak were reduced particularly with cabbages + kholrabi and cauliflower + beet roots. Total yields were increased by intercropping cabbages and cauliflowers with radishes or palak, but they were reduced due to all other crop combinations.

Itulya and Obeker (1985) reported that there was no effect of mung bean or summer squash. However yields of summer squash were significantly reduced when intercropped with mung bean possibly due to shading.

Halepyati et al. (1987) studied with comprising four rows of sorghum and seven rows of garlic and these two crops were maintained at 100 and 50 per cent respectively of their normal plant population in monoculture. Sorghum grains and yields were significantly higher on intercropped plots.

V) Effect of fertilizer application in intercropping on growth and yield :

While working on intercropping in sugarcane Kar et al. (1972) reported that sugarcane germination was not affected by intercropping onions but it needs additional dose of nitrogen.

Itulya and Oebker (1985) studied the effect of intercropping nitrogen and phosphorus fertility levels on yield of mungbean and summer squash. Pure stands of mung bean, summer squash or summer squash intercropped with mung bean were given 0,17.5, 35 or 70 kg N/ha combined with 0, 21.5, 43 or 86 kg P/ha. N had no effect on any of test plots, whereas with P only summer squash intercropped with mung bean showed any effect.

Average bean seed yields and cane and pod yields were highest (0.316, 128.24 and 19.56 t/ha respectively) with bean sown in double rows receiving N fertilization (Perez et al., 1986).

Qian (1986) observed the fertilizer needs and reported that an application of additional fertilizer are essential for higher yields of horticultural crops, when intercropped with rape, melons, rice or soyabeans.

Yadav et al. (1987) observed that sugarcane in pure stands and intercropped with black gram (Vigna mungo) was given 0-150 kg N and 0-60 kg P_2O_5/ha. Application of 150 kg N/ha gave the highest cane yield, P had no significant effect. The cane yields in pure and intercropped stands were similar. Vigna mungo gave additional seed yields in the intercropped stands.

Verma and Yadav (1988) studied to find the optimum N rates, they reported that the optimum N rates for sugar--cane were 152, 175, 186 and 231 kg/ha when intercropped with potato, coriender, mustard and wheat respectively. At optimum N rate, the highest sugarcane yield was obtained when sugarcane was intercropped with Potato (79.11 t/ha) and the lowest yield when it was intercropped with wheat (68.84 t/ha).

Obiefuna (1989) studied productivity of nitrogen fertilized plantain in intercropping systems. He reported that in plantain + cassava intercrop receiving 480 kg N/ha, plantain intercropped with yam and fertilized with 320 kg N/ha matured early and produced better bunches than other treatments. Plantain + yam or cocoyam inter--cropping systems fertilized with 320 kg N/ha were recommended because of improved plantain establishment and increased combined crop yields.

VI) Economics of intercropping :

Kar et al. (1972) obtained a net profit of Rs. 1,659 per hectare, which was Rs. 216 more than that obtained from pure spring planted cane.

Studies conducted on intercropping Meenakshi et al. (1974) reported that cultivation of bhendi along with maize gave an additional return of Rs. 934 per hectare during summer and Rs. 2,632 per hectare during monsoon season. The intercropping of cowpea with maize gave an additional return of Rs. 700 per hectare in summer and Rs. 1,934 per hectare in the monsoon season.

Ramkrishna Nayar (1976) reported that intercropping of ginger, turmeric, elephant foot (yam) in young robusta coffee gave highest returns from a unit area per unit time. Further, he reported that, intercrops raising all the three crops was profitable but turmeric giving maximum return per rupee.

Jain (1978) observed that potato, barley is the most succesful and profitable system of intercropping with an average additional net profit of Rs. 2,730.

While working on intercropping in sugarcane Tiwari et al. (1983) reported that, economically the

most viable combination was sugarcane + okra followed by sugarcane + mung and sugarcane + blackgram. They also observed that sugarcane + onion gave very poor returns due to the high cost of cultivation of onions.

Rajshekharan et al. (1983) noted that the maize intercropped with onion gave higher return followed by cowpea during kharif season, whereas in rabi season maize intercropped with black gram followed by cow pea gave higher returns.

Studies conducted at Indore and Akola, Maheshwari et al. (1985) reported that the net returns were highest when Ranvolfia Serpentine was intercropped with soyabeans in kharif and onion and garlic in rabi giving an extra income of Rs. 8,352 and Rs. 11,770 per hectare respectively.

The highest net income was obtained in the intercropping of cabbage with tomatoes when grown on 5-10 hectare farm by Brown et al. (1985).

Patra and Chatterjee (1986) reported soyabean intercropped with maize 48 to 50 per cent more yield and Rs. 4,300 to Rs. 5,800 per hectare net returns over the sole cropping.

From a field study Singh and Singh (1986) reported that wild turnip intercropped in taramira and chickpea in paired rows (2:2) gave 11.1 per cent more total productivity than sole cropped taramira and 81.9 per cent more productivity than sole cropped chick pea.

Bastine et al. (1986) studied cost benefit analysis of intercropping of cocoa in coconut gardens. According to them intercropping with cocoa had no adverse effects on coconut yields, and the returns from double cocoa rows were more than double those from single cocoa rows.

In the studies on intercropping in turmeric with maize, chilli, castor and okra the mean gross income was highest when two rows of turmeric werealternated with one row of maize (Shankaiah et al., 1987).

Choudhary (1988) studied intercropping short duration summer crops with ginger in darjeeling hills and observed that although ginger yield in monoculture was higher (93.4 - 103.4 q/ha) than in the intercrop variants (75.8 - 98.7 q/ha) the net returns, except for intercropping with sunflowers were higher (Rs.13,225-17,322/ha) from the intercropped plots than from the monoculture (Rs. 11,873/ha). Ginger + lady's finger gave the highest net returns, followed by ginger + maize (Rs.15,156/ha).

Patil (1988) concluded that intercropping of coriender in brinjal gave highest net profit followed by radish in tomato and palak with chilli in the respective solanaceous vegetables.

Gorkhe (1989) observed that intercropping of radish, onion and coriender was highly profitable in cabbage crop and gave an additional income of Rs. 6,448, Rs. 6,250 and Rs. 5,679 respectively with slight reduction in cabbage yield.

CHAPTER - III

MATERIALS AND METHODS

The present investigation entitled " A study of intercropping in Brinjal (Solanum melongena L.) " was laid out at the Department of Horticulture, College of Agriculture, Marathwada Agricultural University,Parbhani during rabi/winter season of 1989-90.

3.1 Climate :

Parbhani is situated at 409 meters above mean sea level and falls on latitude 19.16° N and longitude 17.97° E and has a subtropical climate. The average maximum and minimum temperatures are 43° C and 6.5° C in the months of April and November respectively. The average rainfall is 750-850 mm per year.

3.2 Soil :

3.2.1 Soil type and chemical composition :

The soil type of experiment plot was well drained, uniform, medium black having the depth of 1.5 meters. The chemical composition of experimental field is given in Table 1.

Table 1 : Chemical composition of experimental field

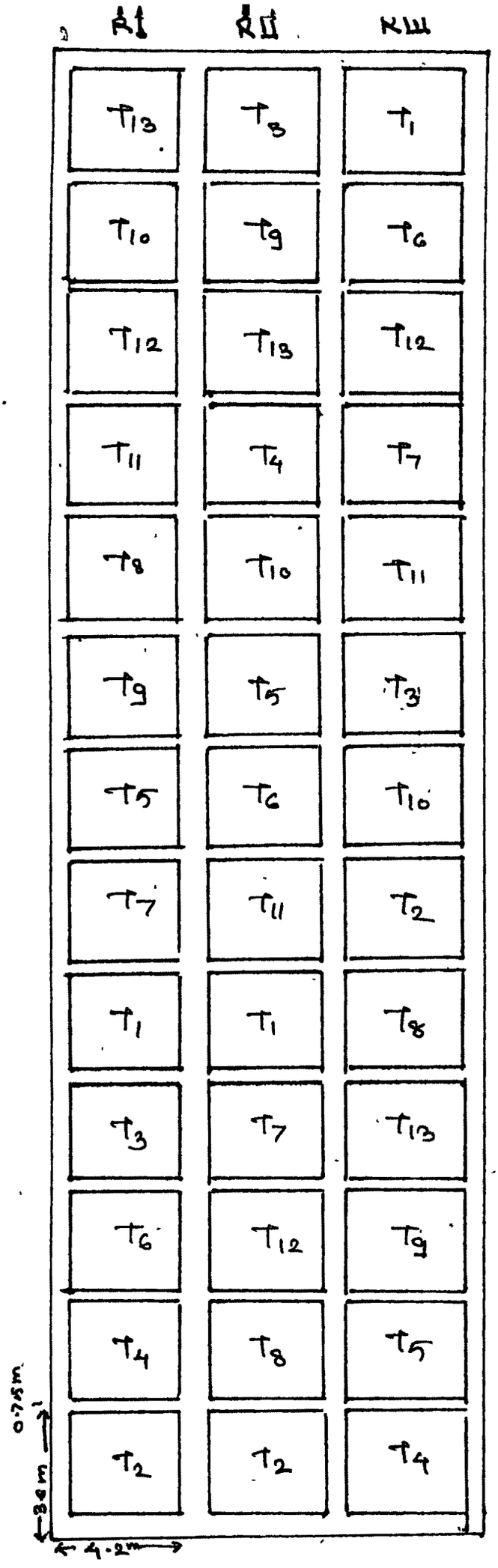
pH	Total N	Available P_2O_5	Available K_2O	Organic carbon	Total soluble salts
8.1	0.054	0.004	0.042	0.07	0.12

3.2.2 Plot history :

In the last year in the experimental field the crop of onion (sole crop) was taken.

3.3 Experimental details :

1. Design : Randomized Block Design (RBD).
2. Number of replications : Three.
3. Number of treatments : Thirteen.
4. Number of crops : Five.
5. Plot size :
   a) Total plots : (39)
   b) Gross plot size : 4.2 x 3.6 m
   c) Net plot size : 3.0 x 2.4 m
6. Distance between two plots and two replications : 0.75 m
7. Spacing :
   a) Main crops (Brinjal) : 60 x 60 cm
   b) Intercrop : Onion, radish, palak and coriender are sown on opposite side of the ridge.



DESIGN - RBD
REPLICATION - 3
TREATMENTS - 13
plotsize -
3.6 x 4.2 m

8. Plant units :

a) Number of plants in gross plot : 42

b) Number of plants in net plot : 20

9. Total experimental area : 786.78 sq.mt.

10. Date of sowing/transplanting : 29th November, 1989.

3.4 Treatment details :

Sr. No.	Treatments	Abbrevations
1.	Brinjal + onion and no application of additional dose of fertilizers.	T_1
2.	Brinjal + radish and no application of additional dose of fertilizers.	T_2
3.	Brinjal + palak and no application of additional dose of fertilizers.	T_3
4.	Brinjal + coriender and no application of additional dose of fertilizers.	T_4
5.	Brinjal + onion and 1/3rd recommended dose of onion.	T_5
6.	Brinjal + radish and 1/3rd recommended dose of radish.	T_6
7.	Brinjal + palak and 1/3rd recommended dose of palak.	T_7

GENERAL VIEW

BRINJAL + ONION

BRINJAL + RADISH

BRINJAL + PALAK

BRINJAL + CORIENDER

BRINJAL SOLE CROP

Sr. No.	Treatments	Abbrevations
8.	Brinjal + coriender and 1/3rd recommended dose of coriender.	T_8
9.	Brinjal + onion and 2/3rd recommended dose of onion.	T_9
10.	Brinjal + radish and 2/3rd recommended dose of radish.	T_{10}
11.	Brinjal + palak and 2/3rd recommended dose of palak.	T_{11}
12.	Brinjal + coriender and 2/3rd recommended dose of coriender.	T_{12}
13.	Brinjal sole crop.	T_{13}

3.5 Varieties planted :

Sr. No.	Name of crop	Variety
1.	Brinjal	Aurangabad Brinjal Variety-1 (ABV-1)
2.	Onion	N-53
3.	Radish	Japanese White.
4.	Palak	Pusa all green.
5.	Coriender	Local.

3.6 Source of seed :

The seed materials of different crops under study were obtained from the different sources, which are given in Table 2.

Table 2 : Name of crop, variety and source used in experiment

Sr. No.	Name of crop	Variety	Source
1.	Brinjal	ABV-1	MAU : Parbhani.
2.	Onion	N-53	Parbhani Market
3.	Radish	Japanese White	Parbhani Market
4.	Palak	Pusa all green	MAU : Parbhani.
5.	Goriender	Local	MAU : Parbhani.

3.7 Raising of seedlings :

Raised beds of 6m x 1m x 0.15m size were prepared. The upper layer of 5 cm of each bed were added and mixed with 1 Ghamela of FYM/bed and soil application of BHC 100 gm/bed. Than application of fytolan (Copper oxychloride) 30 gm in 10 litres of water was done on raised beds to avoid the attack of diseases and pests and preventing the seedlings from damping off. Seeds of brinjal (ABV-1) were sown in rows 10cm apart on

28th October, 1989 at the rate of 20 gms of seeds per bed. Seeds of onion (N-53) were sown on 28th September, 1989 at the rate of 100 gms of seeds per bed. Watering was done regularly by watercan. Seedlings were sprayed with 0.05 per cent malathion to avoid attack of insects, pests and particularly aphids.

3.8 Land preparation :

Experimental plot was ploughed deeply in the month of October, harrowing was done four times, well rotten farm yard manures was applied at the rate of 50 cart loads per hectare. F.Y.M. was broadcasted in the experimental plot before last harrowing. The plot was laid out as per the plan shown in Fig. 1, before 15 days prior to transplanting i.e. on 14th November, 1989.

3.9 Transplanting of seedlings :

Ridges and furrows of 60 x 60 cm distance were prepared on 28th November, 1989, which were irrigated on 29th November, 1989 before transplanting. Healthy, uniform sized brinjal seedlings were transplanted on 1/3rd height of ridge by keeping 60 cm spacing in between two seedlings. One seedling was planted at one hill on one side of ridge. Sowing of intercrop was done on 30th November, 1989 on the other side of the ridge.

The seed requirement per hectare of various crops is given in Table 3.

Table 3 : Statement showing seed rate/ha, number of seeds per hill

Sr. No.	Name of crop	Number of seeds per hill	Seed rate per ha	Seed rate of intercrop
1.	Brinjal	One seedling	500-600 gms	-
2.	Onion	One seedling	10 kgs	3 kg
3.	Radish	4 to 5 seeds	8 kgs	2.5 kg
4.	Palak	5 seeds	30 kgs	10 kgs
5.	Coriender	8 to 10 seeds	30 kgs	10 kgs

3.10 Fertilizer application :

The recommended dose of fertilizers viz. nitrogen, phosphorus and potassium per hectare were appliedto the crops through urea, single superphosphate and murate of potash.

Half dose of nitrogen and full dose of phosphorus and potash of brinjal was applied before transplanting to all plots. Similarly 1/3rd dose and 2/3rd dose of fertilizers of respective intercrop was also applied in the randomly

distributed plots as per treatment before transplanting. Remaining dose of nitrogen was applied after 30 days of transplanting.

Recommended doses of fertilizers to various crops are given below in Table 4.

Table 4 : Recommended doses of various crops

Sr. No.	Name of crop	Recommended dose (kg/ha)		
		N	P	K
1.	Brinjal	100	50	50
2.	Onion	100	50	50
3.	Radish	100	50	50
4.	Palak	100	50	50
5.	Coriender	50	50	50

The recommended doses of various intercrops per hectare are calculated and the plot size of various treatments are taken into consideration accordingly the fertilizer doses are calculated and given below in Table 5.

Table 5 : Calculated doses of various treatments

Sr. No.	Abbrevation	Requirement of fertilizers		
		Urea	Superphosphate	Murate of potash
1.	T_1	330	475	126
2.	T_2	330	475	126
3.	T_3	330	475	126
4.	T_4	165	475	126
5.	T_5	440	633	168
6.	T_6	440	633	168
7.	T_7	440	633	168
8.	T_8	220	633	168
9.	T_9	550	790	210
10.	T_{10}	550	790	210
11.	T_{11}	550	790	210
12.	T_{12}	275	790	210
13.	T_{13}	330	475	126

3.11 Gap filling and thinning :

Gap filling of main crop (brinjal) was carried out after 20 days of transplanting viz. 20th December, 1989. Thinning of radish was done by keeping only one seedling at one hill on 8th December, 1989.

3.12 Irrigation :

One irrigation was given before transplanting. Lateron irrigations to the experimental plots were given regularly till the harvest at an intervalof 6 to 10 days depending upon the season.

3.13 Interculture operations :

In order to keep the field free from weeds, two weedings were carried out during the entire crop period. Earthing up was carried out after 30 days of transplanting to provide support to plants. Second earthing up was done after the harvest of the intercrops.

3.14 Plant protection :

For control of aphids, thrips, jassids, spraying of endosulphan 15 ml, spraying of rogor 5 ml in 10 litres of water was carried out. For control of fruit and shoot borer of brinjal regular sprays of 40 gms sevin or carbaryl in 10 litres of water was carried out regularly at intervalof 15 days.

3.15 Harvesting :

Harvesting of different crops as given in Table 6.

Table 6 : Days required for harvesting of various crops

Sr. No.	Name of crop	Number of days required for harvesting
1.	Brinjal	70 - 120
2.	Onion	120
3.	Radish	35 - 45
4.	Palak	35 - 45
5.	Coriender	35 - 40

Harvesting of brinjal started after 70 days and 7 harvestings were done at interval of 7 days. The harvesting of onion was done when the bulbs were ready for harvesting after the falling of leaves. The harvesting of radish was followed when it was developed, but not spongy and fibrous. Harvesting of leafy vegetables like palak and coriender done before flowering.

3.16 Observations :

Five plants were selected from each net plot at random and they were labelled to record the observations in respect of growth and yield of various crops.

3.16.1 Growth observations :

The various observations of main crop in respect of height of plant, number of branches, number of leaves, circumference of stem, plants spread were noted at an interval of 30 days of transplanting and were continued upto 120 days.

a) Height of plant : Height of plant from ground level to the tip of main stem was recorded in centimetres and average was calculated.

b) Number of branches : Number of branches produced on main plant were recorded by taking count and average was worked out.

c) Number of leaves : Number of functional leaves were only counted and recorded and average was calculated.

d) Diameter of stem of plant : Stem diameter of plant was recorded with the help of verniers calliper and average was worked out.

e) Plants spread : Spread was measured in centimetres and converted into square centimetres.

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3.16.2 Flowering and fruiting observation :

1) Number of flowers per plant : Number of flowers per plant of five plants in each net plot counted and recorded.

2) Number of fruits per plant : Number of fruits per plant of five plants in each net plot counted and recorded.

3) Percentage of fruit setting : The count of flowers and fruit set from the initiation of flowering up to 120 days were recorded daily. On that basis an observation on percentage of setting was calculated.

3.16.3 Yield attributes :

1) Yield of fruits per plot of main crop : Harvesting of fruits per plot was carried out seperately and yield per plot was noted in kg.

2) Yield of fruits per hectare of main crop : Fruit yield per plot was converted into quintals per hectare.

3) Yield of intercrop : Produce of intercrop from net plot was harvested, weighed and was recorded in kgs/plot and in quintals per hectares.

3.17 Economics :

The per hectare yield was multiplied by the average prices of various vegetables which are shown in Appendix-C. This was treated as gross profit.

Net profit per hectare was calculated by deducting the cost of cultivation (Appendix-B) from the gross profit of individual plots,which were statistically analysed on hectare basis.

3.18 Statistical analysis :

The statistical analysis of the data was done,by using analysis of variance techniques as suggested by Panse and Sukhatme (1957), critical difference was worked out at 5 per cent level of significance.

CHAPTER - IV

RESULTS

The observations obtained in respect of growth, yield and monetary returns were subjected to statistical analysis. Results of the same are presented in these chapters.

4.1 Growth observations :

The different growth attributes height of plant, number of branches, number of leaves, circumference and plant spread of the plant were noted at an interval of 30 days after transplanting till the plants attain full growth up to120 days.

4.1.1 Height of plant :

Periodically reported data were statistically analysed which results are presented in Table 7 and graphically depicted in Figure 2.

It is clear from the Table 7 that there were significant differences on the height of brinjal crop at all the stages of growth. The treatment T_{12} recorded significantly tallest plants of brinjal at all the stages of growth starting from 30 days to final stage over control (T_{13}) and where 1/3rd additional dose of fertilizers of respective crop was applied and no additional dose was applied treatments.

Table 7 : Average height of brinjal plant in cm

Treatments	Days after transplanting			
	30	60	90	120
T_1	16.00	30.00	36.00	43.20
T_2	16.23	31.00	39.00	43.80
T_3	16.13	30.40	37.13	43.00
T_4	16.40	32.00	39.73	44.00
T_5	17.00	32.26	44.93	46.50
T_6	17.66	33.00	44.93	48.40
T_7	17.53	32.53	43.42	47.00
T_8	17.86	35.13	45.73	48.80
T_9	18.00	35.80	46.00	48.00
T_{10}	18.20	37.26	46.40	49.10
T_{11}	18.10	36.00	46.10	48.90
T_{12}	18.42	39.33	47.00	50.06
T_{13}	16.80	34.30	44.80	46.30
S.E. ±	0.52	0.48	0.47	0.56
C.D. at 5%	1.54	1.40	1.39	1.63

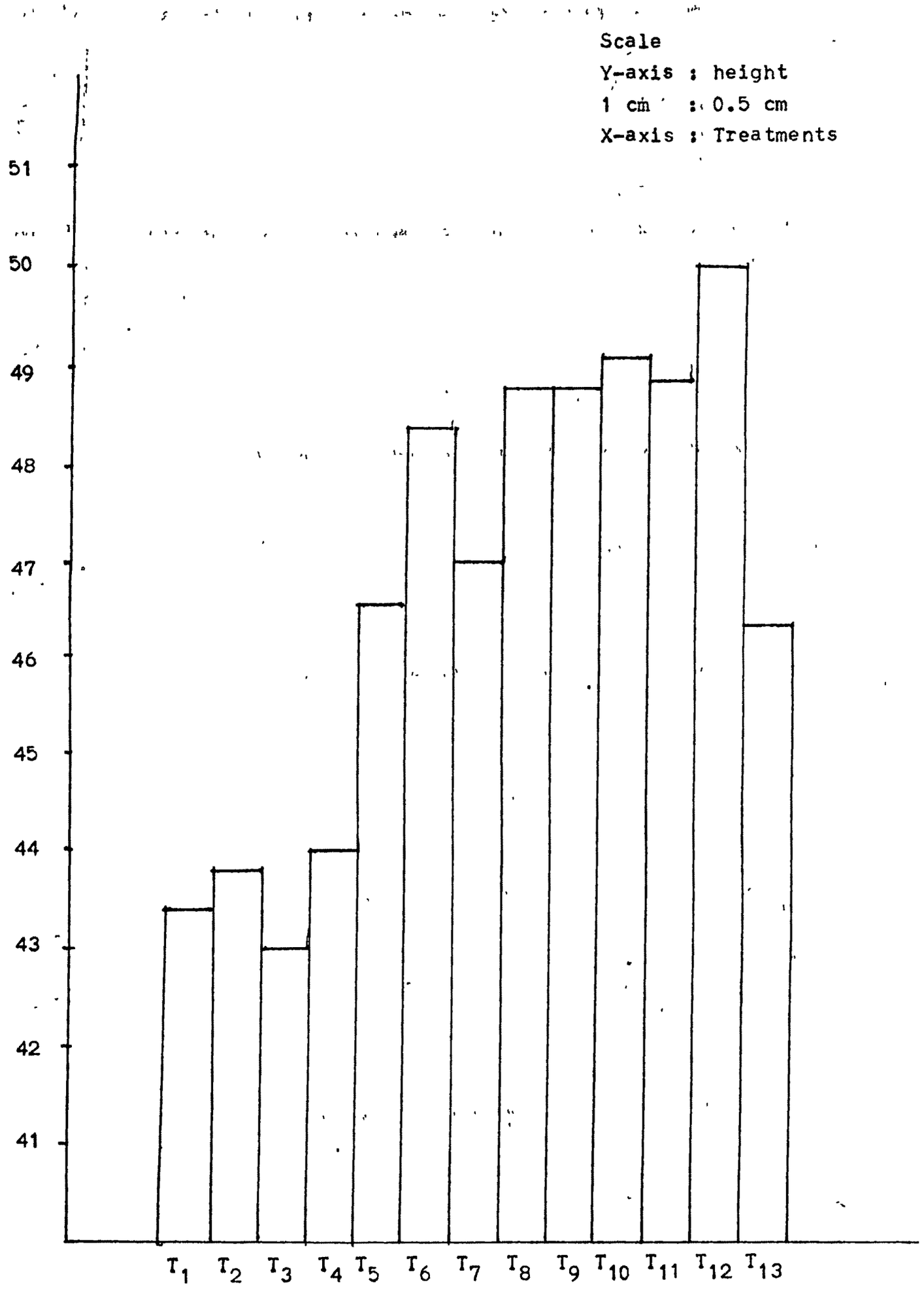

Fig. 2 : EFFECT OF INTERCROPPING ON HEIGHT IN CM.

The next best treatments were T_{10}, T_{11} and T_9, all these treatments recorded more height of plants but they failed to show any statistical difference from control and the treatments of intercrops where 1/3rd additional dose of fertilizers was applied at 30 days after transplanting observations.

The observations after 60 days onwards indicated that these later three treatments also recorded significantly more height of plant as compared to control and remaining treatments.

The growth of the plants in treatments where 1/3rd additional dose of fertilizer was applied (T_5 to T_8) and control was observed statistically similar and significantly better than the treatments where no additional fertilizers were applied (T_1 to T_4) after 60 days onwards.

4.1.2 Number of branches per plant :

The observations of average number of branches was recorded after 30 days after transplanting at an interval of 30 days. The same observations were subjected to statistical analysis and results of same are shown in Table 8.

Table 8 : Average numbers of branches in brinjal

Treatments	Days after transplanting			
	30	60	90	120
T_1	2.66	5.11	6.50	6.75
T_2	2.86	5.90	6.90	7.05
T_3	2.33	5.65	6.80	7.00
T_4	2.60	6.10	7.35	7.55
T_5	3.13	6.12	7.80	8.05
T_6	3.51	6.09	7.59	8.10
T_7	3.06	6.43	7.89	8.06
T_8	3.86	7.10	8.50	8.65
T_9	3.60	7.21	8.65	8.77
T_{10}	3.00	7.90	9.00	9.06
T_{11}	3.00	7.65	8.90	9.02
T_{12}	3.80	8.10	9.55	9.73
T_{13}	3.06	6.11	7.60	8.03
S.E. ±	0.55	0.56	0.56	0.57
C.D. at 5%	-	1.65	1.65	1.68

It is evident from the data of Table 8 that the differences on the production of number of branches per plant were significant due to various treatments starting from 60 days to final stage (120 days). However, after 30 days results on number of branches were noted to be non significant.

The treatment T_{12} (Brinjal + coriender with 2/3rd additional dose of fertilizer of coriender) produced significantly more number of branches as compared to control and treatments T_7, T_5 as well as all the treatments where no additional dose of fertilizer was applied after 60 days onwards.

The treatments of 2/3rd additional dose of fertilizer to intercrops, treatmets T_7 and T_5 produced more number of branches than control but results were non significant after 60 days onwards. Similarly inthe remaining treatments the production of number of branches per plant was less as compared to control but the results were statistically similar with each other. The lowest number of branches per plant was recorded in treatment T_1, which was significantly lesser than the treatments from T_8 to T_{12}.

4.1.3 Number of leaves per plant :

The data recorded at an interval of 30 days was subjected to statistical analysis, the results of the same are depicted in Table 9.

Table 9 : Average number of leaves of brinjal plant

Treatments	Days after transplanting			
	30	60	90	120
T_1	12.60	35.10	41.44	43.65
T_2	12.55	35.70	41.85	44.00
T_3	12.65	35.65	41.75	43.97
T_4	12.67	35.95	42.80	44.34
T_5	12.70	42.46	48.30	49.87
T_6	12.65	43.10	48.85	50.15
T_7	12.74	42.90	48.60	50.35
T_8	12.78	43.75	49.00	50.91
T_9	12.80	46.90	50.03	51.36
T_{10}	12.75	47.60	50.55	51.98
T_{11}	12.82	47.38	50.35	51.89
T_{12}	12.84	48.10	50.95	52.95
T_{13}	12.68	42.15	48.10	48.70
S.E. ±	0.57	0.59	0.53	0.61
C.D. at 5%	N.S.	1.72	1.57	1.79

It can be seen from the Table 9 that the results obtained on number of leaves per plant were non-significant after 30 days of transplanting. However, the significant differences were noted in this respect after 60 days of transplanting onwards due to various treatments under study.

The treatments T_9 to T_{12} where 2/3rd additional dose of fertilizer was applied where remain statistically not different from each other, and significantly superior to remaining treatments at final stage. Nearabout same trend was also observed after 90 days and 60 days after transplanting except that treatments T_7 and T_6 were at par with treatment T_9 after 90 days.

In the other treatments where 1/3rd additional dose of fertilizer was applied, also produced more number of leaves per plant as compared to control, but differences were non significant, except T_8 at final stage which produced significantly more number of branches as compared to control.

All the observations of the treatments T_1 to T_4 where no additional fertilizers were applied remained statistically similar and significantly lesser in the production of number of leaves per plant over other treatments.

4.1.4 Average Diameter of stem :

The recorded data was statistically analysed the results of the same are given in Table 10.

Table 10 :- Average Diameter of stem of brinjal plant

Treatments	Days after transplanting			
	30	60	90	120
T_1	0.57	0.72	0.84	1.00
T_2	0.50	0.78	0.88	1.08
T_3	0.52	0.76	0.86	1.05
T_4	0.55	0.81	0.92	1.08
T_5	0.56	0.83	1.02	1.16
T_6	0.54	0.88	1.03	1.18
T_7	0.56	0.86	1.02	1.17
T_8	0.52	0.90	1.05	1.19
T_9	0.60	1.02	1.06	1.20
T_{10}	0.56	1.02	1.08	1.23
T_{11}	0.54	1.00	1.08	1.21
T_{12}	0.54	1.05	1.10	1.23
T_{13}	0.55	1.00	1.06	1.23
S.E. ±	0.006	0.006	0.013	0.023
C.D. at 5%	N-S.	0.028	0.046	0.070

A close perusal at the data of Table 10 reveals that the treatments of 1/3rd or 2/3rd additional dose of fertilizer application and control (treatments T_5 to T_{13}) were observed statistically similar with each other and significantly superior over the treatments T_1 to T_4 where no additional dose of fertilizers were applied after 90 days onwards, except T_{12} after 90 days was also significantly superior to T_8, T_6, T_7 and T_5.

After 60 days, treatment T_{12} recorded significantly thicker stem as compared to other treatments. The treatments T_9, T_{10}, T_{11} and T_{13} were next best which were statistically similar and significantly better than treatments T_1 to T_8. Significantly thinner stem was noted in treatment T_1 as compared to other treatments followed by T_3 and T_2 which were at par with each other. Remaining treatments were intermediate in this respect.

The observations noted after 30 days were observed to be non significant in case of number of branches per plant.

4.1.5 Average plant spread :

Periodically noted observations at an interval of 30 days was subjected to statistical analysis. The results obtained are given in Table 11.

Table 11 : Average plant spread of brinjal plant (sq.cm)

Treatments	Days after transplanting			
	30	60	90	120
T_1	549.40	1819.65	3156.22	3743.16
T_2	629.92	2208.85	3376.09	3860.30
T_3	559.42	2057.00	3334.12	3826.09
T_4	624,60	2163.71	3355.10	3848.93
T_5	681.26	2314.32	3442.59	4040.40
T_6	850.29	2328.65	3590.84	4180.56
T_7	737.39	2310.65	3453.34	4064.29
T_8	799.59	2320.00	3520.19	4160.10
T_9	896.00	2368.85	3762.15	4343.25
T_{10}	1063.51	2528.39	4098.37	4530.52
T_{11}	988.80	2424.59	3810.28	4430.43
T_{12}	1056.91	2480.34	3985.51	4493.84
T_{13}	660.00	2310.00	3830.14	4115.14
S.E. ±	53.12	55.00	83.34	69.02
C.D. at 5%	-	160.51	243.20	201.43

The data presented in Table 11 shows that significantly more spread was recorded in the treatments T_9 to T_{12} (where 2/3rd additional dose of fertilizers was applied of the respective crop) over other treatments including control at the final stage of growth after 120 days. At this time the other treatments with 1/3rd additional dose of fertilizer application and control were statistically not different and significantly superior to the treatments without additional application of fertilizers (T_1 to T_4), except T_5 which was at par with T_2 and T_4.

The observations after 90 days from Table 11 clearly indicated that the treatment T_{10} produced significantly more spread over other treatments, except T_{12}. This T_{12} treatment was at par with T_{13}, T_{11} and T_9 but significantly better than other treatments. The treatments with 1/3rd additional application of fertilizers were statistically similar and significantly inferior to control. However, these treatments observed to be significantly superior over treatments T_1 to T_4. The treatments T_1 to T_4 were also statistically similar with each other.

Observations recorded after 60 days were noted to be significant. The treatment T_{10} was at par with treatments T_{12}, T_{11} and T_9, while significantly superior over other treatments. Treatment T_{12} was next best being statistically

similar with T_{11}, T_9, T_6 and significantly superior to remaining treatments. The minimum spread was noted in treatment T_1 which was significantly lower over other treatments, followed by T_3. Remaining all other treatments were intermediate.

Observations after 30 days were recorded to be non-significant.

4.2 Observations on flowering :

4.2.1 Number of flowers, number of fruits per plant and percentage of fruit setting :

Number of flower clusters seen at every 15 days were counted from 5 observational plants and total flower produced upto 150 days were totaled and averages were statistically analysed. Similarly, the number of fruits per plant were also counted at an interval of 15 days. They were totaled and statistically analysed which results are given in Table 12.

For percentage of fruit set one branch of observational plant to all sides was labeled and flowers produced on that branch were counted daily and fruit setting was seen by counting the number of fruits produced on that branch.

Total number of flowers and fruits produced on that branch and the percentages were calculated and the results are shown in Table 12.

Table 12 : Average number of flowers, fruits per plant and percentage of fruit setting in brinjal plant

Treatments	Number of flowers	Number of fruits	Percentage of fruit setting
T_1	28.00	15.00	43.57
T_2	29.70	17.00	48.43
T_3	28.56	15.61	45.75
T_4	29.94	17.50	46.45
T_5	31.61	19.03	52.77
T_6	33.00	21.00	53.63
T_7	31.84	19.85	52.34
T_8	33.10	21.12	54.80
T_9	33.20	21.74	56.30
T_{10}	34.43	23.28	57.61
T_{11}	33.99	22.64	56.60
T_{12}	35.00	24.00	58.57
T_{13}	30.22	18.00	49.56
S.E. ±	0.56	0.74	0.53
C.D. at 5%	1.64	2.16	1.57

4.2.1.1 Number of flowers :

It is evident from the data presented in Table 12 that, there was significant effect on number of flowers per plant due to various treatments. Treatment T_{12} recorded maximum number of flowers (35) which were significantly more than other treatments. The other treatments receiving 1/3rd or 2/3rd additional dose of fertilizers recorded statistically similar and significantly more number of flowers over control and the treatments without additional application of fertilizers (T_1 to T_4), except T_7 and T_5 which were statistically similar with control. These two treatments were also significantly inferior to treatments T_{10} and T_{11}. The treatments T_1 and T_3 recorded significantly lowest number of flowers as compared to control.

4.2.1.2 Number of fruits :

It can be seen from Table 12 that treatments T_{12} recorded maximum number of fruits per plant which was statistically similar with T_{10} and T_{11} and significantly superior than other treatments. These two treatments were statistically similar with T_9 and T_8 and significantly better than remaining treatments. The other treatments which had produced significantly more number of fruits over

control were T_6, T_7 and T_5. These were at par with each other. The treatments received no additional fertilizer produced less number of fruits as compared to control. Out of these four treatments T_2 and T_4 were statistically similar and T_1 and T_3 were statistically similar and T_1 and T_3 were statistically inferior in the production of number of fruits per plant as compared to control.

4.2.1.3 Percentage of fruit set :

The significantly highest percentage of setting was noted in T_{12} (58.57%) as compared to other treatments except T_{10}. The treatments T_{10} was also statistically similar to T_{11} and T_9 and significantly superior over that of other treatments.

The treatments receiving 1/3rd dose of additional fertilizer also recorded significantly higher percentage of fruit setting as compared to control and no additional fertilizer application treatment. In these treatments T_8 was statistically similar to T_6 and significantly superior to other treatments. While remaining three treatments of this category was at par with each other. In all the treatments without additional application of fertilizers noted significantly less percentage of fruit setting as compared to control, except T_2 which was statistically similar with control.

4.3 Yield observations :

The yield obtained from net plot including the yield of observational plants were statistically analysed. The yield per hectare was calculated by multiplying the calculated factor. This was also subjected to statistical analysis, and results are presented in Table 13 and graphically shown in Figure 3.

Table 13 : Average yield per plot and per hectare of brinjal

Treatments	Yield per plot (kg)	Yield quintal/ hectare
T_1	13.60	188.88
T_2	14.10	195.83
T_3	14.00	194.44
T_4	14.30	198.61
T_5	15.00	208.33
T_6	15.60	216.66
T_7	15.20	211.11
T_8	15.90	220.83
T_9	16.79	233.33
T_{10}	17.30	240.27
T_{11}	17.00	236.11
T_{12}	17.60	244.44
T_{13}	14.80	205.55
S.E. ±	0.27	3.74
C.D. at 5%	0.78	10.93

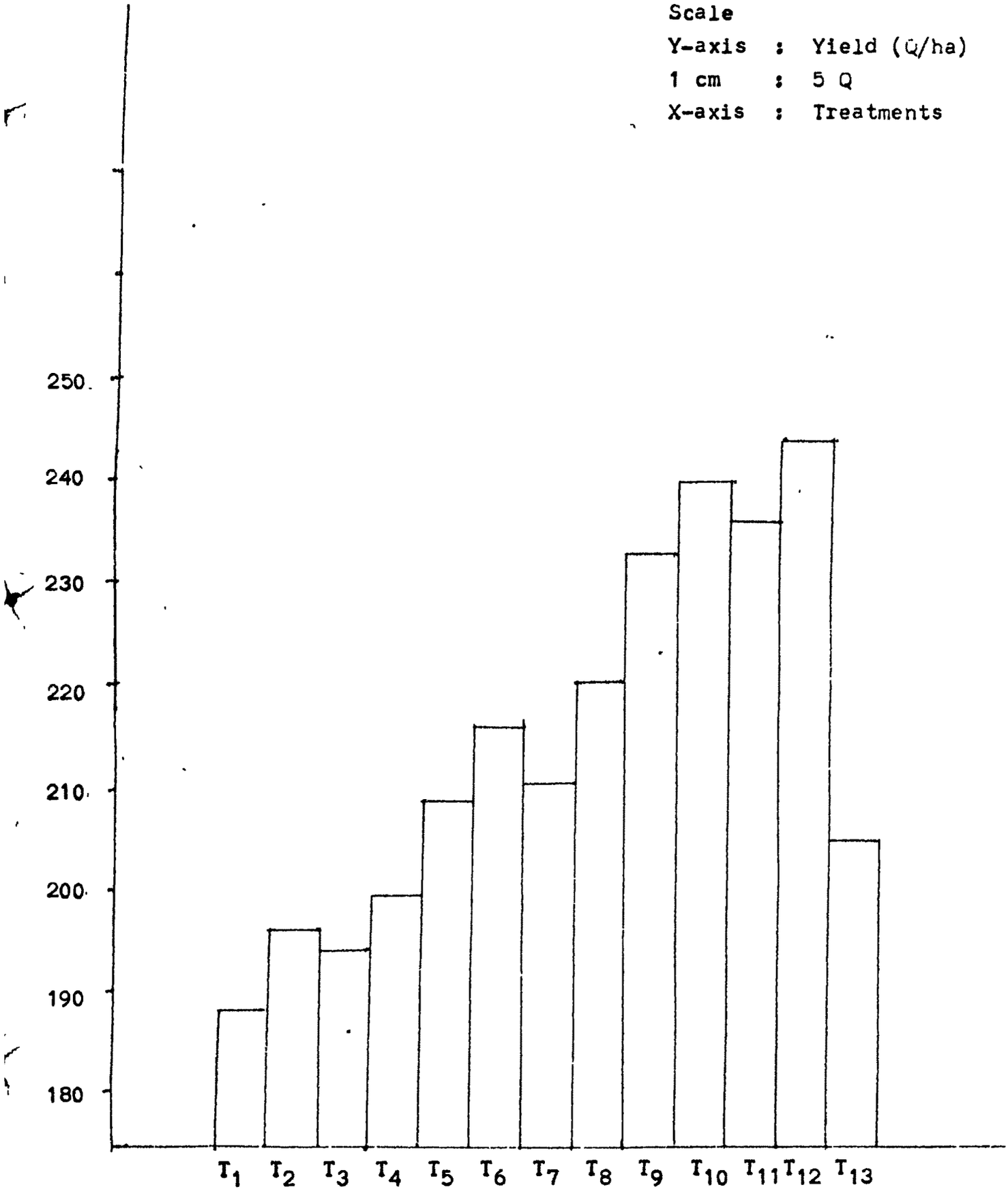

Fig. 3 : EFFECT OF INTERCROPPING ON YIELD (Q/ha)

On studying the data recorded in Table 13 indicated that the yield per plot and per hectared of brinjal crop was significantly more in T_{12} as compared to other treatments except T_{10} and T_{11} which were at par with T_{12}. These two treatments also recorded statistically similar yields with T_9 and significantly more yield over other treatments. In the treatments with 1/3rd additional dose of fertilizers applied, the yield recorded per plot and per hectare was higher than control, but treatments T_8 and T_6 could produce significantly more yield than control. All the treatments without additional fertilizer application recorded lesser yields than control. However, treatments T_4 and T_2 have produced statistically similar yield as compared to control.

4.3.1 Yield of intercrops :

Yield from net plot of various intercrops was harvested. The obtained data were subjected to statistical analysis, results of the same are given in Table 14. Converted data on hectare basis was also statistically analysed, that is also given in the following table.

Considering the average prices at that time (Appendix - C) monetary return was worked out significantly, statistically analysed data is presented in Table 14.

Table 14 : Average yield per plot and per hectare and monetary returns from intercrop

Treatments	Yield per plot (kg)	Yield in q/ha	Monetary returns from intercrop
T_1	5.20	72.22	7222.00
T_2	4.92	68.33	6833.00
T_3	8.80	122.22	12222.00
T_4	0.78	11.11	5555.00
T_5	5.50	76.33	7630.00
T_6	5.28	73.33	7333.00
T_7	9.54	132.50	13233.33
T_8	0.88	12.22	6110.00
T_9	6.00	83.33	8333.00
T_{10}	5.73	79.58	7958.00
T_{11}	10.08	140.00	14000.00
T_{12}	0.94	13.05	6265.00
S.E. ±	0.27	3.74	117.93
C.D. at 5%	0.81	10.91	345.90

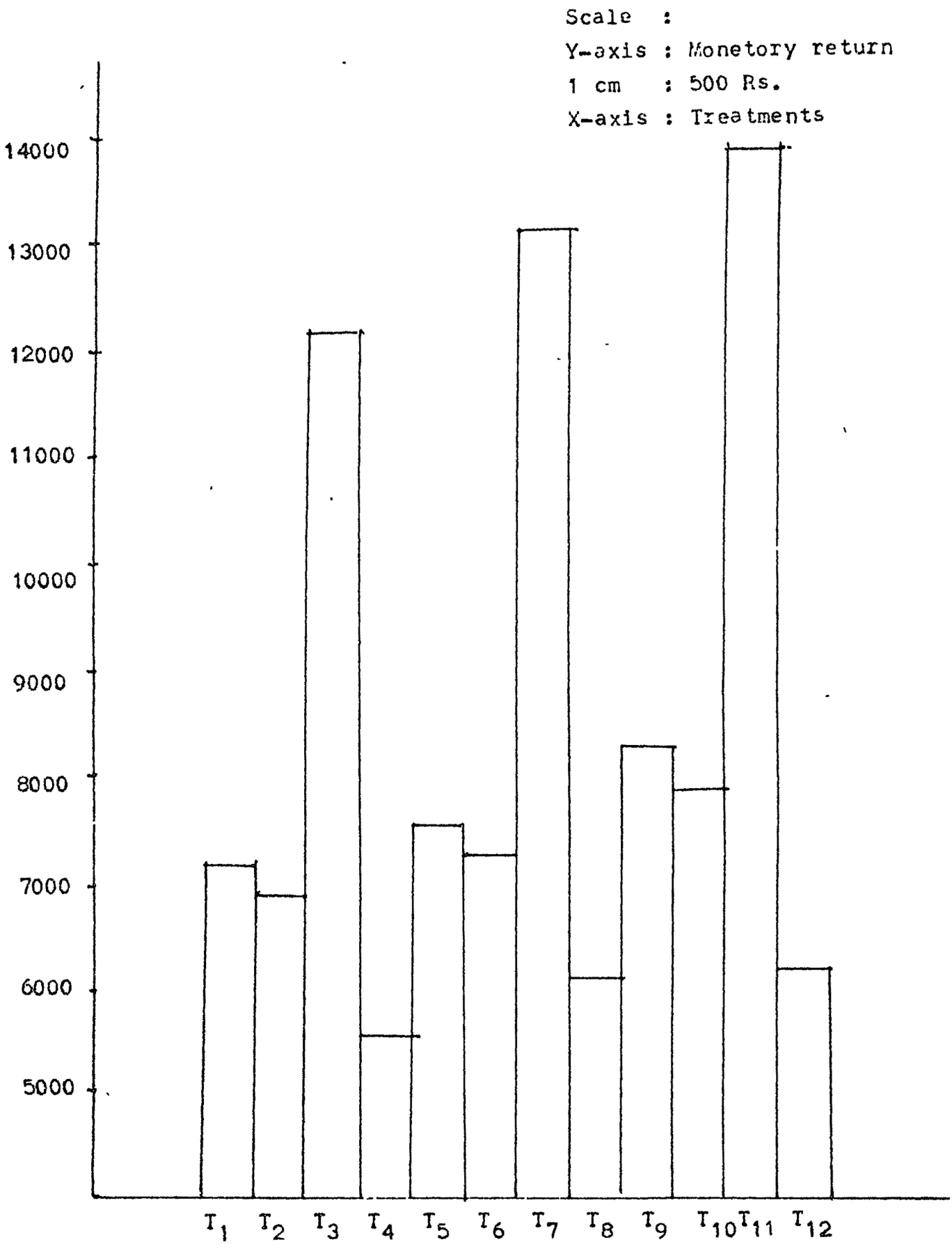

Fig. 6 . EFFECT OF [illegible]

It indicates from the Table 14 that per plant and per hectare yield of palak as an intercrop was significantly more in treatment T_{11}. This was followed by the palak treatments T_7 and T_3, these two treatments were at par and significantly superior as compared to other intercrop treatments.

The next best intercrop in giving the per plot and per hectare yield was onion. Onion recorded a yield of 83.33 quintal, 76.33 quintal and 72.22 quintal per hectare in treatments T_9, T_5 and T_1 respectively. These were also statistically similar with the yield of radish as an intercrop in treatment T_{10} and T_6 and significantly superior to T_2 and the yields obtained by coriender in all treatments. T_2 was significantly inferior to treatment T_{10} and statistically similar with T_6.

According to prices given in Appendix the monetary return of various intercrops was significantly affected due to various treatments. Significantly more returns of intercrop of Rs. 14,000/- was gained from the treatment T_{11}. The next best treatments were T_7 and T_3 (both of palak) as compared to intercrops.

The onion as an intercrop in T_9 treatment was fourth in order giving monetary return of Rs. 8,333/- which was significantly superior to remaining treatments. This was followed by T_{10}, T_5, T_6 and T_1 in sequence. However, less monetary return was obtained from coriender as an intercrop.

4.4 Economics :

4.4.1 Effect on gross profit and net profit :

Considering the prices given in Appendix the gross and net profit were calculated. The obtained data was statistically analysed and results are given in Table 15, and graphically depicted in Figure 4.

The additional income data was worked out by deducting the net profit of control treatment from the net profit of various intercrops which is recorded in Table 15 and graphically shown in Figure 5.

The data of the Table 15 indicates that, the gross and net profit gained from all the intercropping treatments along with additional fertilizer application treatments were significantly more than control. The highest gross

Table 15 : Gross profit and net profit in rupees

Treatments	Gross profit (Rs.)	Net pfofit (Rs.)	Additional income(Rs.)
T_1	35554.00	28970.00	4026.50
T_2	36207.50	29848.50	4905.00
T_3	41388.00	35063.00	10119.50
T_4	35346.50	29141.50	4198.00
T_5	38879.50	32157.50	7214.00
T_6	39832.00	33335.00	8391.50
T_7	44916.50	38453.50	13510.00
T_8	34346.50	28003.50	3060.00
T_9	43332.50	36361.50	11418.00
T_{10}	44004.50	37258.50	12315.00
T_{11}	49416.50	42704.50	17761.00
T_{12}	39971.00	31379.00	6435.50
T_{13}	30832.50	24943.50	
S.E. $\pm$	81.62	81.62	
C.D. at 5%	238.25	238.25	

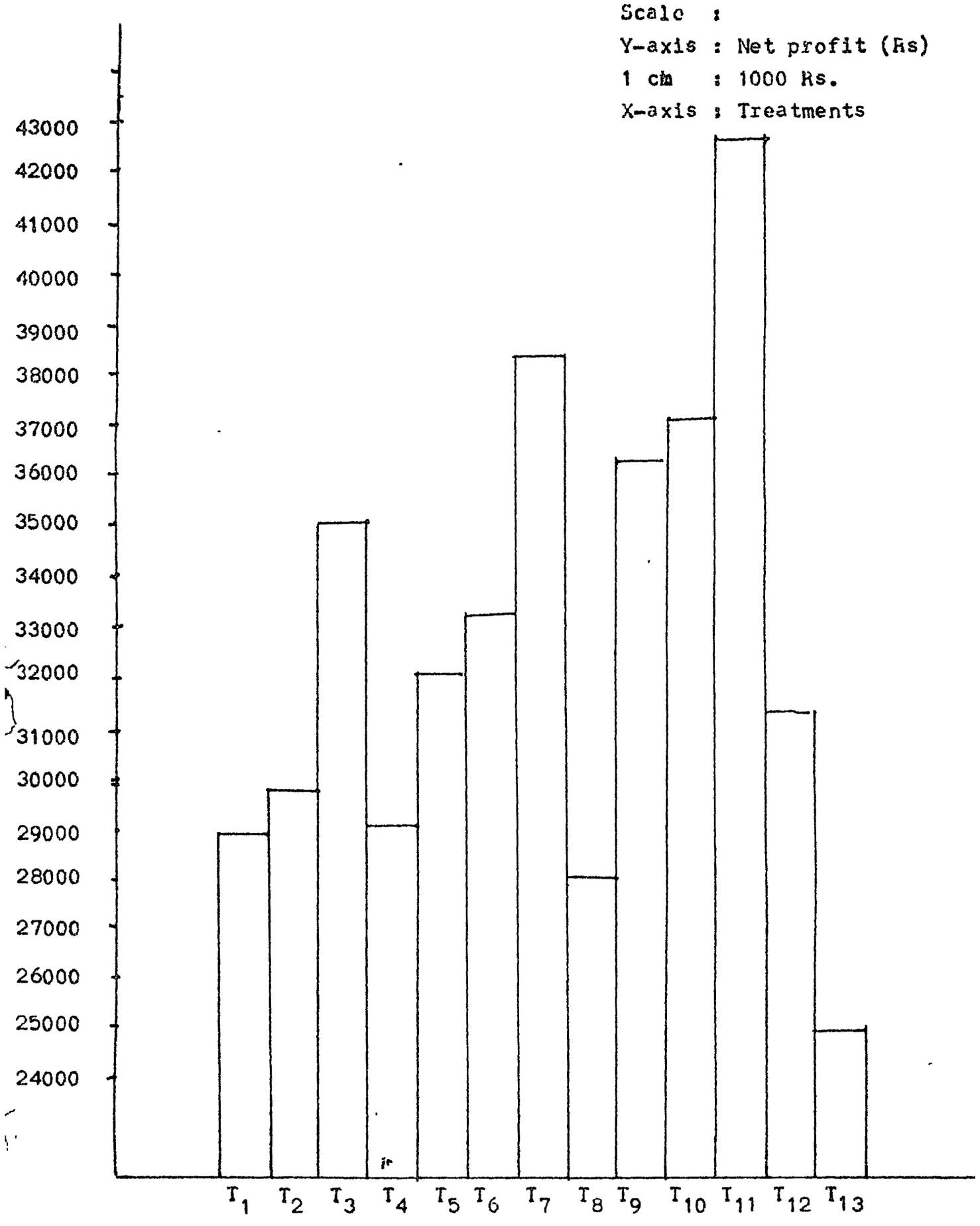

Fig. 4 : EFFECT OF INTERCHOPPING ON NET PROFIT.

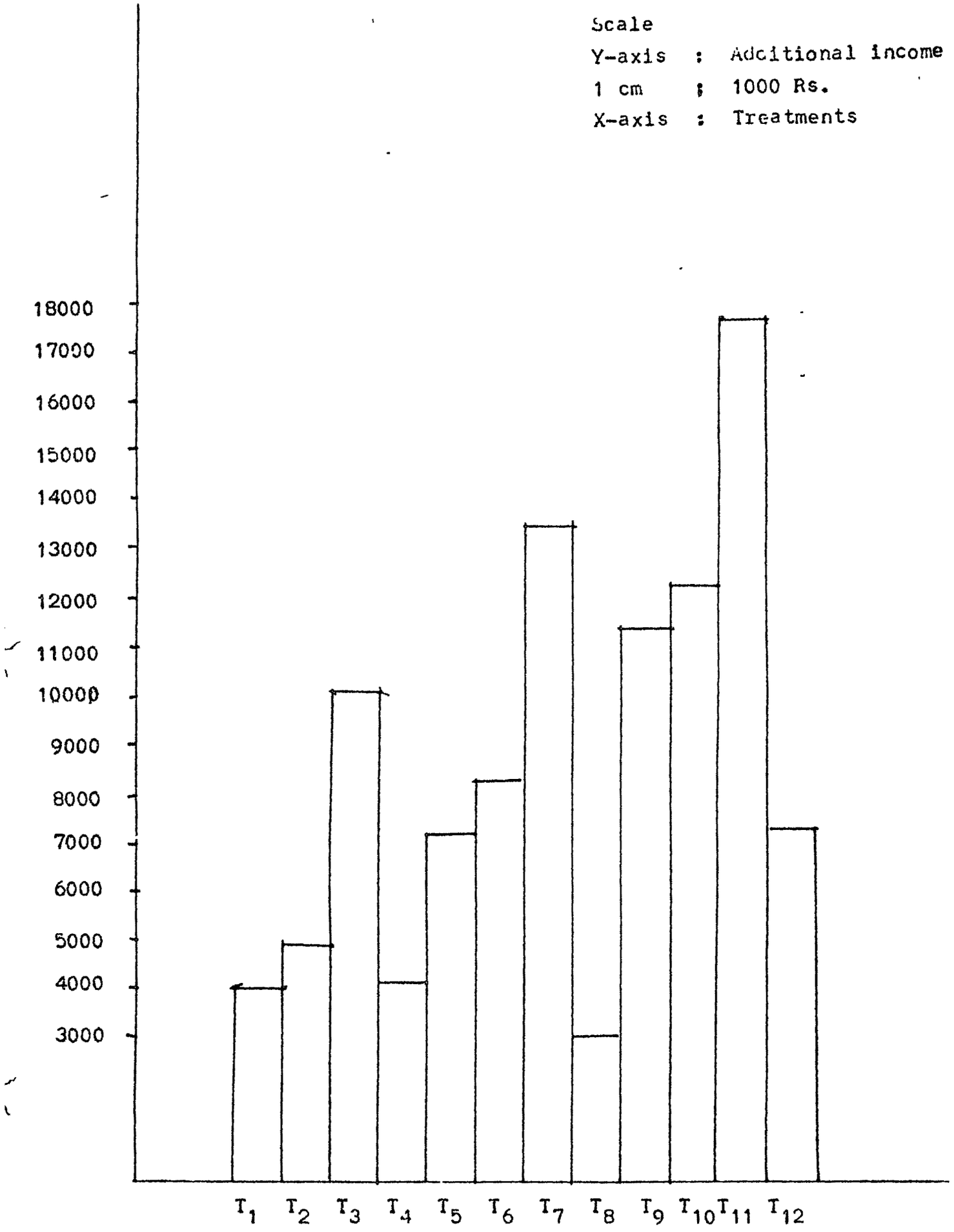

Fig. 5 : EFFECT OF INTERCROPPING ON ADDITIONAL INCOME.

and net profit of Rs. 49,416/- and Rs. 42,704.50 respectively was gained from treatment T_{11} (Brinjal + palak with 2/3 additional dose of fertilizer), which was significantly more than other treatments. It was followed by T_7, T_{10}, T_9 and T_3. All these treatments recorded more than Rs. 40,000/- as a gross profit and more than 35,000/- net profit per hectare.

The maximum additional income of Rs. 17,761/- was obtained from treatment T_{11}. It was followed by T_7, T_{10}, T_9 and T_3. In all these treatments an addition income of Rs. 13,510/-, Rs. 12,315/-, Rs. 11,418/- and Rs. 10,119.50 was gained respectively.

In fact all the intercropping treatments with or without additional fertilizers gave addition income as comparedto sole cropping.

CHAPTER - V

DISCUSSION

Various advantages of intercropping of vegetables in vegetable are mentioned by Thompson and Kelly (1959). They stated that by intercropping there is economy of space, which is important with high priced land, saving of tillage as the same ploughing and tilling of the land serve for two or more crops. More complete utilization of the nutrients and surplus applied to one crop being available for another. Increase gross return from the area cultivated.

On the contrary they have mentioned certain dis - advantages also, as increase in labour cost, larger demand of nutrients and moisture and greater difficulty in controlling insect and diseases.

Taking in to consideration of the above advantages the intercropping of short duration crops like, palak, coriender, radish and straight growing crop like onion can be taken in the widely spaced crops like brinjal. As, this crop starts flowering after 55 to 60 days after transplanting by producing very few growth and hence, much of the land in between these crops remain unutilized, if some intercrops as mentioned above are taken that will be additional farm income.

While taking intercrops it is highly essential to give additional doses of fertilizers to fulfill the requirement of main crop as the use of fertilizer is one of the essentials required for increasing the yields of vegetable crops.

Keeping the view in mind the present study was undertaken. Results obtained from the same on growth, flowering and fruiting, yield and economics are discussed in this chapter.

5.1 Growth observations :

The growth observations recorded on height of plant and number of branches (Table 7 and 8) indicate that there were significant differences in various treatments on growth of these aspect, in various treatments. Treatment T_{12} (Brinjal + coriender with 2/3rd additional dose of fertilizer of coriender, recorded more height (50.06 cm) and branches 9.73) after 60 days onwards, which were significantly superior over other treatments in respect of height. The next best treatments were T_{10}, T_{11} and T_9 in sequence. All these treatments were received 2/3rd additional dose of fertilizer of respective crops. The control (sole crop of brinjal) was statistically not

different from the observations where 1/3rd dose of fertilizer was applied to respective intercrops except T_8 and T_6 in respect of height of plant. Significantly lesser growth in these respect were noted in no additional fertilizer application treatments.

The more growth in respect of height and number of branches in T_{12} might have obtained due to 2/3rd additional doses applied and the less growth and short duration of coriender as an intercrop. The growth in the treatments were more, where higher additional doses were applied might be due to surplus nutrients applied to various intercrops.

These findings are supported by findings of Thompson and Kelly (1959), they have reported that due to inter--cropping surplus nutrients applied to one crop can be utilized by another crop. The need of additional fertilizer is also mentioned by Kar et al. (1972) in caseof sugarcane and Yadav et al. (1987).

Number of leaves and spread of plant produced (Table 9 and 11) was more in T_{12} at the final stage, similarly the plants receiving 2/3rd additional dose of fertilizers recorded significantly more number of leaves and spread of plant as compared to other treatments.

The control (sole cropping of brinjal) was statistically not different from the treatments receiving 1/3rd additional dose of fertilizers (treatments T_5 to T_8) significantly lowest number of leaves and spread were noted in the treatments where no additional fertilizers were applied. However, no effect of any intercrop on the growth of brinjal was noted in the catagories of available fertilizer doses. It indicates that due to higher application of fertilizers more growth, increment of number of leaves and spread was produced. At the same time 1/3rd additional dose was observed optimum to produce normal growth as in case of sole crop. However, there was adverse effect on the production of number of leaves and spread per plant where no additional fertilizers were applied as compared to control.

The results are in agreement with the results obtained by Randhawa and Sharma (1973) they reported that radish and mung can safely be taken as intercrop without affecting the growth of themain crop by the additional dose of fertilizer.

It is revealed from Table 10 diameter of stem indicates that the treatments of 1/3rd or 2/3rd additional dose of fertilizers application and control treatments

(T_5 to T_{13}) were observed statistically similar with each other and significantly superior over the treatments (T_1 to T_4) where no additional dose of fertilizer applied at final stage. No adverse effect on growth of main crop was noted due to additional doses of fertilizers was noted by Randhawa and Sharma (1973) and Kar et al. (1972).

There wasno effect on growth due to various intercrops on main crop was noted in the similar conditions of fertilizer application from zero to 2/3rd additional dose of fertilizer of respective crop.

5.2 Fruiting and flowering observation :

Manufacture of carbohydrates in the plants directly depend on vegetative growth which help in more flowering and fruit set.

The results obtained from Table 12 clearly indicates that there was significant effect on the production of number of flowers per plant due to various treatments. The treatments receiving 1/3rd or 2/3rd additional doses recorded significantly more number of flowers per plant as compared to control except T_5 and T_7 which were numerically more but statistically not different from control. Significantly less number of flowers was recorded

in the treatments where no additional fertilizers were applied as compared to treatments from T_5 to T_{13}, except T_2 and T_4 these were numerically lesser but statistically similar to control.

As regards numbers of fruits per plant significantly highest number of fruits (24) was harvested from treatment T_{12}, as compared to treatments of 1/3rd additional dose of fertilizer application, no additional fertilizer application treatments and control. All the treatments receiving 1/3rd or 2/3rd additional fertilizers treatments recorded significantly more number of fruits per plant as compared to control, except T_5 and T_7 which were at par with control. Treatments with no application of additional fertilizers recorded lesser number of fruits as compared to control.

This may be due to more growth produced in the treatments. As the growth and vigour is a sign of forcefulness of plants is responsible to produce more number of flowers and retain more number of fruits on plants. Similarly due to additional application of nutrients might have provided sufficient food to intercrops aswell as to main crop, for growth and development. The decrease in number of flowers and fruits on main crop in the treatments without additional fertilizer application may be

due to lesser growth recorded in these treatments may be due to competition of intercrops with main crop for want of nutrients and air for proper development of style of brinjal flower for fertilization.

On studying the data of Table 12 regarding the percentage of fruit setting indicated that treatment T_{12} recorded maximum fruit setting percentage (58.57%). All the treatments receiving 1/3rd or 2/3rd additional dose of fertilizers retained mere number of fruits and thereby significantly increasing fruit setting percentage in these treatments as compared to control and without application of additional fertilizers treatment. The increase in more setting percentage may be due to better development of style of flower for fertilization because ABV-1 a cluster bearing variety which produce more number of long or medium style flower. It needs proper development, which might have happened in these treatments. The lesser setting percentage is without additional fertilizer application treatments might be due to drop of more number of flowers without fertilization, due to improper development of style due to lack of optimum nutrients.

5.3 Yield observations :

5.3.1 Yield ofmain crop :

It is evident from the data of Table 14 that there were significant differences on theyield ofmain crop per plot and per hectare basis. Treatment T_{12} recorded significantly more yield per plot and per hectare as compared to other treatments, except T_{10} and T_{11}. All the treatments receiving 2/3rd additional dose of fertilizers were significantly superior to control. While treatments receiving 1/3rd additional dose of fertilizers were statistically similar and numerically more in giving the yield per plot and per hectare as compared to control. Lesser yield was noted in the treatments from T_1 to T_4. This may be due to more growth produced in these treatments thereby increased number of fruits and setting percentage might have increased the yield in these treatments. Secondly the differences in the production of fruits and yield of main crop due to growing intercrop, were very little but due to additional doses of fertilizers, thereby supplying the required nutrients, the growth and yield of main crop was increased. The results are closely in agreement with the results obtained by Avatarsingh and Srivastava (1987) reported that cauliflower yield was highest in monoculture, however, profitability/ha was greatest when it was intercropped with spinach, especially of the

higher N level. Obiefuna (1989) reported that in plantain/ cassava intercrop receiving 480 kg N/ha, plantain intercropped with Yam and fertilized with 320 kg N/ha matured early and produced better bunches than other treatments. Plantain/ yam or cocoyam intercropping systems fertilized with 320 kg N/ha were recommended because of improved plantain establishment and increased combined crop yields.

5.3.2 Yield of intercrops :

Significantly more yield of an intercrop was noted by Palak in treatment T_{11}. The same intercrop (Palak) also produced statistically similar and significantly superior yield of intercrop in the treatments T_7 and T_3. The next best intercrops were onion, radish and coriender in sequence. In all these intercrops the yield was increased as the dose of additional fertilizer was increased from 0 to 2/3rd. This may be due to good growth produced by intercrops due to additional fertilizer application. The maximum yield nearabout 1½ times more was noted in palak due to double harvesting. It is also a additional advantage to palak.

5.4 Economics :

5.4.1 Monetary returns of intercrop :

It can be seen from Table 14 that the treatments of palak T_{11}, T_7 and T_3 recorded highest monetary return of

Rs. 14,000/-, Rs. 13,233/- and Rs. 12,222/- respectively, which was significantly superior over other treatments. The next best intercrop was onion followed by radish. Similarly as the dose of fertilizer was increased there was increase in the monetary return of intercrops, it may be due to the higher yield obtained in these treatments.

5.4.2 Gross profit and net profit per hectare :

The highest gross and net profit (Table 15) was gained of Rs. 49,416/- and Rs. 42,704.50 respectively from treatment T_{11} which was significantly more than other treatments. It was followed by T_7, T_{10}, T_9 and T_3. All these treatments recorded more than Rs. 40,000/- as a gross profit and more than Rs. 35,000/- net profit per hectare.

All the intercrops gave additional income over control. The minimum income of Rs. 3,060/- was noted in T_8 and maximum of Rs. 17,761/- in palak treatment T_{11}. The results are in agreement with the results obtained by Meenakshi et al. (1974) reported that cultivation of bhendi alongwith maize gave an additional return of Rs. 934/ha and cowpea with maize gave an additional return of Rs. 700/- per hectare Ramakrishna Nayar (1976) reported that intercropping of ginger, turmeric and elephant foot in young robusta coffee was profitable.

Patil (1988) also gained additional income by growing various intercrops like onion, radish, palak and coriender in solanaceous crops.

CHAPTER - VI

SUMMARY AND CONCLUSION

An experiment * A study of intercropping in brinjal * was under taken at Department of Horticulture, Marathwada Agriculture University, Parbhani in rabi season of 1989-90.

The experiment was laid out in randomized block design with thirteen treatments and three replications.

The intercrops studied in brinjal were onion (Allium cepa L.) , radish (Raphanus sativus L.), Palak (Beta vulgaris L.) and coriender (Coriandrum sativum L.).

The observations recorded in respect of growth , flowering and fruiting, yield and economics are summarised below :

1. The growth in respect of height of plant and number of branches of brinjal was significantly more in treatment T_{12} (Brinjal + coriender with 2/3rd additional dose of fertilizer of coriender). This was followed in T_{10}, T_{11} and T_9. In all these four treatments 2/3rd additional dose of fertilizer of respective crop was applied. The control and 1/3rd dose of fertilizer application were statistically similar in these respect. Lowest growth was noted in the treatments where no fertilizers were applied.

2. Number of leaves per plant and spread of plant was significantly more where highest additional fertilizers were applied. The growth in these respects was equal to sole crop in the treatments where 1/3rd dose of additional fertilizer was applied indicating that 1/3rd additional dose of fertilizer is optimum of the respective intercrops.

3. The adverse effect ongrowth of main crop in all respectswas noted where no additional fertilizers were applied as compared to control.

4. There was no effect on growth due to various intercrops on main crop was noted in the similar conditions of fertilizer application from zero to 2/3d additional dose of fertilizer of respective crop.

5. The treatments receiving 1/3rd or 2/3rd additional doses recorded significantly more number of flowers per plant as compared to control except T_5 and T_7 which were numerically more but statistically not different from control. significantly less number of flowers was recorded in the treatments where no additional fertilizers were applied as compared to treatments from T_5 to T_{13} except T_2 and T_4 these were numerically lesser but statistically similar to control.

6. All the treatments receiving 2/3rd or 1/3rd additional doses of fertilizers of respective intercrops recorded more number of fruits per plant as compared to control. As the dose was increased from 1/3rd to 2/3 rd there was increase in number of fruits per plant. The less number of fruits as compared to control was noted where no additional fertilizers were applied.

7. Treatment T_{12} recorded maximum fruit setting percentage (58.57%). All the treatments receiving 1/3rd or 2/3rd additional dose of fertilizers retained more setting percentage as compared to control. Lesser fruit setting was noted in the treatments where no additional fertilizers was applied to respective intercrops as compared to control.

8. Treatment T_{12} recorded highest yield per plot and per hectare of main crop. Similarly all the treatments receiving 2/3rd additional dose of fertilizers were significantly superior to control. While treatments receiving 1/3rd additional dose of fertilizers were statistically similar and numerically more in giving the yield per plot and per hectare as compared to control. Lesser yield was obtained in the treatment from T_1 to T_4.

9. The intercrop palak recorded significantly more yield in treatment T_{11}, the same intercrop also produced maximum yield in treatment T_7 and T_3 due to double harvesting of palak. The other best intercrops for the yield were onion, radish and coriender in sequence.

10. As the dose of fertilizer was increased there was increase in the same kind of intercrop.

11. Treatments of palak T_{11}, T_7 and T_3 recorded highest monetary return of Rs. 14,000/-, Rs. 13,233/- and Rs. 12,222/- respectively, which was significantly superior over other treatments. The next best intercrop was onion followed by radish.

12. The highest gross and net profit (Table 15) was gained of Rs. 49,416/- and Rs. 42,704.50 respectively from treatment T_{11} which was significantly more than other treatments. It was followedby T_7, T_{10}, T_9 and T_3. All these treatments recorded more than Rs.40,000/- as a gross pfotit and morethan Rs. 35,000 net profit per hectare.

13. All the intercrops gave additional income over control. The minimum income of Rs. 3060/- was noted in T_8 and maximum of Rs. 17,761/- in palak treatment T_{11}.

Conclusion :

From the study it can be concluded that intercropping in brinjal crop by palak, onion, radish and coriender was beneficial. Palak as an intercrop can be harvested two times thereby increasing the yield of palak as an intercrop and, it has given the highest additional income to the tune of Rs. 17,761. All the intercrops gave additional income over control. The growth, yield and monetary returns were maximum in the highest fertilizer application treatments. The results are from one year data hence there is a need to study these treatments for two more seasons.

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APPENDIX - A

Monthly average meteorological data from September, 1989 to March,1990

Month	Temp. °C		Humidity %		Evapo-ration in mm	Rainfall in mm	Number of rainy days	Bright sun shine
	Max.	Min.	A.M.	P.M.				
Sept.	32.3	23.8	87	55	5.4	100.4	6	7.2
Oct.	34.2	17.9	75	31	6.2	18.0	1	9.4
Nov.	32.1	13.9	74	29	5.9	0.0	0	9.5
Dec.	28.7	10.9	71	33	5.1	7.0	2	8.5
Jan.	31.6	10.9	77	27	5.5	0.0	0	9.8
Feb.	32.7	13.4	55	20	7.0	0.0	0	10.2
Mar.	35.5	16.9	41	14	9.1	0.0	0	10.4

APPENDIX - B

Treatments	Cost of seed (Rs.)	Raising of seedlings (Rs.)	Preparatory tillage (Rs.)	Cost of manures and fertilizers (Rs.)	Application cost of fertilizers (Rs.)	Preparation of ridges and furrows (Rs.)	Transplanting/ sowing (Rs.)
T_1	280	390	345	2763	120	96	480
T_2	250	195	345	2763	120	96	480
T_3	200	195	345	2763	120	96	480
T_4	220	195	345	2663	120	96	480
T_5	280	390	345	2901	120	96	480
T_6	250	195	345	2901	120	96	480
T_7	200	195	345	2901	120	96	480
T_8	220	195	345	2801	120	96	480
T_9	280	390	345	3150	120	96	480
T_{10}	250	195	345	3150	120	96	480
T_{11}	200	195	345	3150	120	96	480
T_{12}	220	195	345	3050	120	96	480
T_{13}	100	195	345	2763	120	96	240

(Continued)

APPENDIX - B (Continued) :

Treatments	Secondary tillage (Rs.)	Cost of plant protection (Rs.)	Irriga-tion cost (Rs.)	Cost of harvest-ing (Rs.)	Market-ing (Rs.)	Misc. (Rs.)
T_1	480	650	275	580	100	25
T_2	480	650	275	580	100	25
T_3	480	650	275	596	100	25
T_4	480	650	275	556	100	25
T_5	480	650	275	580	100	25
T_6	480	650	275	580	100	25
T_7	480	650	275	596	100	25
T_8	480	650	275	556	100	25
T_9	480	650	275	580	100	25
T_{10}	480	650	275	580	100	25
T_{11}	480	650	275	596	100	25
T_{12}	480	650	275	556	100	25
T_{13}	480	650	275	500	100	25

(continued)

APPENDIX - B (Continued) :

Treat-ments	Total cost (Rs.)	Yield of main crop (q/ha)	Yield of inter crop (q/ha)	Total pro--duce (q/ha)	Monetary returns (Rs.)	Net profit (Rs.)
T_1	6584	188.88	72.22	261.10	35554	28970
T_2	6359	195.83	68.33	264.16	36207	29848
T_3	6325	194.44	122.22	316.66	41388	35063
T_4	6205	198.61	11.11	209.72	35346	29141
T_5	6722	208.33	76.30	284.63	38879	32157
T_6	6497	216.66	73.33	289.99	39832	33335
T_7	6463	211.11	132.50	343.61	44916	38453
T_8	6343	220.83	12.22	333.05	39234	32891
T_9	6971	233.33	83.33	316.66	43332	36361
T_{10}	6746	240.27	79.58	319.85	43998	37252
T_{11}	6712	236.11	140.00	376.11	49416	42704
T_{12}	6592	244.44	13.05	257.49	43191	36599
T_{13}	5889	205.55	-	205.55	30832	24943

APPENDIX - C

Sr. No.	Name of crops	Range of prices from November-April (Rs. per kg)	Price taken for calculation (Rs.)
1.	Brinjal	1.00 to 2.00	1.50
2.	Onion	0.80 to 1.50	1.00
3.	Radish	0.50 to 1.50	1.00
4.	Palak	0.50 to 2.00	1.00
5.	Coriender	4.00 to 6.00	5.00