PRODUCTIVITY OF ASHGOURD AS INFLUENCED BY CROP COMBINATIONS

By

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THESIS

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DECLARATION

I hereby declare that the thesis entitled '**Productivity of ashgourd as influenced by crop combinations**' is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, fellowship or other similar title of any other University or Society.

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

Introduction

INTRODUCTION

Vegetables are considered as protective supplementary foods as they contain large quantities of minerals, vitamins and essential amino acids required for our daily diet. India is the second largest producer of vegetables contributing 12 per cent of world production. But the production and consumption are rather low and inadequate. At present an alarming gap exists between the requirement and production of vegetables in Kerala. Even for day to day requirement of vegetables we depend heavily on the neighbouring states resulting in a substantial drain of money.

At present it is unlikely that more area can be brought under cultivation. An acute shortage of vegetables and an acute scarcity of land area compel a farmer to exploit the full potential of the available limited land resources to the maximum possible extent through intensive cropping and intercropping. The intensive cropping systems that utilise the resources efficiently and produce high yields to meet the present and the projected demands.

The need for greater intensification of crop production over time than space was recognised as early as in sixties when more than 45 per cent of the geographical area of the country was under cultivation (Kanwar, 1972).

Importance of system approach in crop production is being realised by research workers. Intercropping system with vegetables have been found profitable because of yield advantage. Recent developments in the field of crop management like organic farming, use of biofertilizers, soil amendments etc. have enabled multiple cropping system to be feasible.

Growing two or more crops together will exploit the resources better than when grown seperately. The system provides greater stability in yield during adverse weather conditions and during epidemics of diseases and pests which is of considerable importance to subsistent farmers. Intercropping is advantageous from the point of view of economy of space, savings in tillage, complete utilization of surplus nutrients, better utilization of solar energy, soil moisture reserve and increase gross return from a unit area

Considering the above aspects the present investigation was undertaken to evaluate the productivity of ashgourd, an important vegetable crop when grown along with intercrops. As the crop of ashgourd takes a long time to fill out the area due to wide spacing (4.5 x 2 m) provided for trailing, much of the land area is wasted initially which could be effectively utilised for raising other crops in the interspace.

The base crop ashgourd is grown on homestead level as well as on commercial scale for its fleshy fruits. The fruits are used in culinary preparations. confectionaries and also used for various medicinal preparations.

The intercrops selected were cucumber and pole cowpea which could be grown in the same pit/trench of ashgourd and bush cowpea and amaranthus which were raised in the interspaces.

Information on specific vegetable - based cropping systems are too meagre in the agro-ecological systems of Kerala. Hence the present investigation was undertaken with the following objectives.

1. To evaluate the productivity of ashgourd as influenced by crop combinations.
2. To find out a suitable planting system for an ashgourd based intercropping system.
3. To work out the economics of growing crops in combinations.

Review of Literature

REVIEW OF LITERATURE

In order to utilise all the natural resources to the best extent per unit area and per unit time and to make farming more economical, cropping systems have been formulated based on farmers experiences and scientific studies Several cropping systems which include cereals, grains, pulses and oil seeds are in common practice. Combining vegetables with these systems is rather a relatively new concept to be explored fully to benefit the farmer and to increase vegetable production. A study was undertaken to evaluate the productivity of ashgourd when it was grown along with intercrops.

Although research on vegetable - based intercropping system has started in recent years there is still a dearth of informations. The information on this aspect and that in the related fields are reviewed hereunder.

2.1 Performance of vegetables in intercropping system

Monetary advantage of intercropping different vegetable crops like radish and suran in methi was reported by Koregave, (1964).

Vegetable cropping systems with cropping intensities from 200-500 per cent have been reported by Singh and Singh (1972). Wilson and Adenisan (1976) opined that an intercropping system of cassava with a sequence of three vegetables, tomato, okra and french bean was more efficient than any of the crops grown alone.

According to Kale *et al.* (1981) radish and palak could be intercropped successfully in cabbage. Shultz *et al.* (1982) found that polyculture of cucumber and tomato was beneficial over monoculture

Prabhakar and Srinivas (1982) from IIHR, Bangalore opined that it was possible to intercrop bhendi with radish, cowpea and cluster bean. Both radish and cowpea performed better when intercropped with bhendi but the returns from bhendi was reduced to 11-18 per cent due to intercropping. Higher nutritional yield were obtained with intercropping beetroot, peas or knolkhol with okra or capsicum; okra + radish and okra + French bean recorded higher returns than the sole crop (Prabhakar *et al.*, 1983).

Vegetable legumes such as lablab bean, cowpea and cluster bean could be remunerative and can form better component crops in intercropping system (Rao *et al.*, 1983). Intercropping vegetables such as broccoli, Chinese cabbage and radish with chilli was a promising production system under Taiwan conditions (AVRDC Programme Report, 1990).

Budisantoso *et al.* (1991) conducted a study to determine the effect of intercropping vegetable crops on mulberry leaf production and found that potato, cabbage and tomato did not affect the mulberry leaf production. The success of intercropping depends on crop suitability (Natarajan, 1992).

Sheshadri *et al.* (1992) reported that it is possible to intercrop tobacco with vegetables like chilli and cowpea. Leafy vegetables like coriander, fenugreek and safflower could be intercropped safely in maize crop as opined by Jadhav *et al.* (1992). Aiyellagbe and Jolaoso (1992) found that intercropping of papaya with bhendi, water melon, sweet potato, amaranthus and potato indicated that all combinations were more advantageous than the monocrop of papaya.

2.1.1 Effect of intercropping on yield and yield attributing characters

Meenakshi *et al.* (1974) suggested that intercropping of bhendi cowpea radish, cluster bean, lablab bean, beetroot, knolkhol and carrot did not affect the yield of maize crop. The yield of short statured vegetables like beetroot, knolkhol, onion and pea were superior when intercropped with okra and capsicum (Prabhakar *et al.*, 1983).

Chavan *et al.* (1985) suggested that radish and palak were found to be the most suitable intercrops for cabbage and cauliflower from the point of total vegetable yield. Lai (1985) reported that potato-maize intercropping gave higher food production and greater income/unit land area.

Yield of cassava and maize was not seen affected by intercropping with bhendi or melon as reported by Ikeorgu *et al.* (1989). Ramachander *et al.* (1989) recorded highest yield of bhendi under bhendi + knolkhol intercropping system and chilli in chilli + onion combination. Yadav and Prasad (1990) reported that french bean when intercropped in autumn sugarcane produced higher bean yield

Ikeorgu (1990) found that amaranthus gave the highest vegetable and dry matter yield when intercropped with both celosia and corchorus compared to sole crop of amaranthus. Hosmani (1990) reported that when chilli was intercropped with onion and cotton, the yield of these crops were more, compared to sole crop. Jayabal and Chockalingam (1990) reported that when sugarcane was intercropped with coriander, knolkhol, french bean, onion, radish, carrot, bhendi and cowpea. cane yield was not affected. However, the highest sugar yield (16.1 t/ha) and net return were obtained from radish intercrop while the lowest sugar yield (12.8 t/ha) was obtained with bhendias intercrop

Amma and Ramadas (1991) reported that amaranthus when intercropped with bhendi recorded the highest yield for bhendi (10.36 t ha^{-1}) than the pure crop of bhendi (9.66 t ha^{-1}). In french bean potato intercropping system, Kushwaha and Masoodali (1991) observed higher yield for both french bean and potato than the monocrops. Sugarcane with amaranthus recorded higher cane yield of 71.2 per ha over sole crop of sugarcane and an additional yield of 55 q green vegetable per ha from amaranthus (Dixit and Misra, 1991).

Patel *et al.* (1991) opined that it was possible to intercrop vegetables like bhendi, chilli, brinjal, onion and radish with sugarcane. The highest cane yield was recorded when sugarcane was intercropped with radish which was followed by sole crop of sugarcane and sugarcane + onion. Walter Dedio (1991) reported that intercropping of sunflower with garden pea gave an yield advantage upto 30 per cent. The yield of sunflower was 12 per cent more when it was intercropped with peas than the sole crop yield of sunflower.

Shah *et al.* (1991) found that intercropping gave additional seed yield in maize-french bean system. Kashi (1992) observed that cucumber yields were significantly greater when intercropped with sweet peppers or aubergines than in monoculture. It was due to increase in fruit number and weight/plant than by increasing average fruit weight. Potatoes intercropped with *Brassica juncea* Varuna produced the highest tuber yield (19.41 t/ha) and highest *B. juncea* seed yields (1.96 t/ha) (Rathi *et al.*, 1993).

Mallanagouda *et al.* (1995) obtained higher yields of chilli when intercropped with onion, garlic and coriander. Chilli dry yield was highest when intercropped with garlic (3.87 q/ha), compared to sole cropping (1.84 q/ha). Significantly higher yields of maize (27-57%) were found in maize + cowpea

intercropping with a correspondingly lower number of stem borers (Skovgard and Pats, 1997).

2.1.2 Effect of intercropping on growth characters

Ikeorgu (1990) remarked that amaranthus performed better in mixtures than under sole cropping and that the plant height and root length were more in intercropped amaranthus compared to sole crop. When cowpea was intercropped with maize there was a significant increase in length of pods and peduncles and significant reduction in number of branches (Gethi *et al.*, 1993).

Ramamurthy *et al.* (1993) reported that in chilli + fingermillet intercropping system, the number of productive tillers per hill of fingermillet was significantly higher in intercropping than in sole cropping, where as, fruit yield of chilli was significantly lower under intercropping than under sole cropping. Moreno *et al.* (1995) reported that when okra was cultivated along with potato, the shading caused by okra significantly increased tuber size and yield with the additional benefit of an okra crop. Cowpea in cowpea-okra-tomato intercropping had the highest nodule weight at ten weeks (Raji and Agboola, 1995).

Chilli + french bean intercropping system recorded higher leaf number, leaf area, branches, dry matter production, fruit number, length, girth and volume of fruits and fresh and dry weight of fruits compared to chilli + amaranthus and sole crop of chilli according to Anitha (1995). Significantly higher number of tillers, millable canes and cane yield were recorded by Singh and Chaudhary (1996) under sugarcane + maize intercropping system.

2.1.3 Effect of intercropping on biological efficiency

Intercropping increased leaf area index and efficiency of light use due to multi-storey spatial effects (Lai, 1985). Olasantan (1985a) reported that relative yield totals increased to a maximum of 1.42 when tomato cv. Ibadan Local was grown with okra. The combined yield of the two crops in mixtures was more than the means of the species in monoculture. Ramachander *et al.* (1989) reported that the Land Equivalent Ratio (LER) was greater than one when chilli was intercropped with french bean (LER = 2.2), peas (LER = 1.9), knolkhol (LER = 1.1) and onion (LER = 1.8). They also observed a higher LER values when okra was intercropped with french bean (LER = 2.2), peas (LER = 1.5), knolkhol (LER = 2.0) and onion (LER = 1.8).

The sequential intercropping system (okra + french bean) - (capsicum + onion) - (muskmelon + radish) out yielded the sequential sole crop system of okra-capsicum-muskmelon by 93 per cent and increased the crop land use efficiency from 300 to 500 per cent (Prabhakar and Shukla, 1989). Narwal and Vedprakash (1989) reported that in an intercropping study on potato with gobhi sarson and mustard, intercropping of gobhi sarson produced higher LER (1.34) than intercropping with Indian mustard (1.21).

Chilli and vegetable system had a combined yield advantage of LER greater than one (AVRDC Programme Report, 1990). Ikeorgu (1990) noted that when amaranthus was intercropped with celosia and corchorus LER was increased from 2.0 in sole crop to 3.8 in intercropping. Amaranthus was identified as the most aggressive species and performed better in mixtures than in pure stands.

Marin (1990) observed that eventhough the leaf area index was lower in intercrops than in pure stands in a canavalia-pumpkin intercropping system, the LAI

of the intercrop as a whole (i.e., both species combined) was not different from that of its component crops in pure stands.

Intercropping of legumes with maize appeared to be more aggressive than sole planting of maize or legumes and the monetary advantage index was highest in intercropped stand of maize and french bean. (Shah *et al.*, (1991). Singh (1991) reported that tomato, french bean and onion combinations gave significantly higher equivalent yield compared to pure crop of tomato. Sharma *et al.* (1992) reported that sugarcane french bean intercropping system gave higher sugarcane equivalent yield over sole crop of sugarcane.

French bean-maize intercropping system recorded an LER of 1.69 indicating greater biological efficiency of intercropping system (Singh and Singh. 1993). The biosuitability of chilli-amaranthus intercropping system observed by Anitha (1995) revealed a higher Land Equivalent Ratio (2.74), Land Equivalent Coefficient (1.52), Area Time Equivalent Ratio (1.61) and Crop Equivalent Yield (10421 kg/ha) compared to chilli + french bean and chilli sole cropping system.

According to the experiments conducted by Dubey *et al.* (1995) intercropping of sorghum with soybean and pigeon pea recorded 20.87 and 39 per cent higher land-equivalent ratio, 22 12 and 49.79 per cent higher production efficiency, 21.63 and 37.74 per cent higher net profit and 19.80 and 28.72 per cent higher benefit cost ratio than mixed cropping and sole cropping of sorghum respectively. According to Nandekar *et al.* (1995) the potato and onion intercropping system produced the highest potato equivalent yield and gave the highest net return.

2.1.4 Effect of intercropping on economic efficiency

Thomas *et al.* (1982) reported that french bean-cassava intercropping system gave an additional income of Rs.2400/- per ha over pure crop of cassava. Cauliflower intercropped with spinach beet, methi, radish and coriander gave better returns over cauliflower alone (Singh, 1984; Chavan *et al.*, 1985). Patel and Sheelavantar (1985) reported that intercropping of peas with chilli and cotton was found most suitable for harvesting natural resources and deriving higher benefits from the capital invested and labour utilised. This system gave the highest net return of Rs. 6104 per ha.

Prabhakar and Shukla (1984, 1985) opined that okra could be profitably intercropped with radish and french bean. The economic value of the intercrop was double than that of the pure stand in a maize-bean-pumpkin intercropping system (Chaves, 1988). Kadali *et al.* (1988) studied the economics of mixed cropping of chilli with different vegetables like onion and french bean and indicated that an additional net income of Rs.4952/- per ha was realised when chilli was interplanted with kharif sown onion followed by french bean and gave 192 per cent higher income over chilli alone.

Prabhakar and Shukla (1988) observed that intercroping capsicum, planted at normal plant density, with beetroot gave the highest return. Intercropping of green gram, cluster bean, onion, beetroot and wheat proved more profitable in cotton (Shanmugam and Basu, 1989). Amaranthus when intercropped with bhendi fetched an additional income and resulted in higher economic returns of Rs.9290 per ha as against Rs.5096 per ha in a pure crop of bhendi (Amma and Ramadas, 1991).

Dixit and Misra (1991) observed that a net return of Rs.7016/- per ha could be obtained when amaranthus was intercropped with sugarcane compared to the return of Rs.4065/- per ha for sole crop of sugarcane. Prabhakar and Shukla (1991) reported that okra and radish intercropping system gave higher return than their respective sole crops. Singh (1991) reported that tomato-onion combination gave the highest net return of Rs.44046/- and maximum profit (390 per cent) and generated an additional income of Rs.13379/- compared with pure crop of tomato.

The economics of chilli, bhindi intercropping system revealed that bhindi was the best intercrop for chilli (Natarajan, 1992). Total biological productivity and monitary return was greater when cowpea and cotton was grown as intercrops than from either crop grown as a pure stand (Natarajan and Naik, 1992). Sharma *et al.* (1992) reported that an additional income of Rs.28771/- could be obtained by intercropping french bean with sugarcane. Dodamani *et al.* (1993) suggested that intercropping chilli with cotton and onion gave higher net return of Rs.29255/- per ha.

Rathi *et al.* (1993) obtained four times greater net returns when potato was intercropped with *Brassica juncea* than when potato was raised as pure crop. Singh and Singh (1993) noted that the highest net return of Rs.10032/- per ha and monitary advantage of Rs.11941 per ha was realised by intercropping french bean with maize.

Chilli + amaranthus intercropping system gave a higher gross return (Rs.156246/-), net return (Rs.119926/-) and per day return (Rs.1499/-) compared to their sole crops according to Anitha (1995) indicating the economic superiority of this system. There was an increase of Rs.3506.52 and Rs.227 of net return from bhindi + cowpea intercropping system over that of sole crop bhindi and sole crop cowpea respectively according to Kalarani (1995). Khurana and Bhatia (1995)

reported increased net returns when potato was intercropped with onion or fennel and the returns from potatoe + onion was higher than from potatoe + fennel.

Prasad and Mohan (1995) reported that intercropping of aubergine and *Phaseolus vulgaris* gave the highest net returns and benefit cost ratio (1.99). Babu *et al.* (1996) reported highest gross return by intercropping onion with cotton. There was an increase of of 24.61 per cent in net returns when sugarcane was grown along with maize compared to sole cropping of sugarcane as observed by Singh and Chaudhary (1996).

2.2 Effect of planting system on performance of vegetables

Paired row planting of crops facilitated the cultivation of intercrops since the interspaces available between the plants were more than that available in solid stand (Tarahalkar and Rao, 1975). To make intercropping feasible and remunerative a modification of the planting pattern of the base crop can be made, for better utilisation of available space, nutrients and light. Variation in base crop yield was nil when the orientation of rows were altered, while keeping the plant population per unit area constant (De *et al.*, 1978).

Prasad and Singh (1991) found that intercropping of oats and chinese cabbage in 1:1 row ratio was better than 2:2 row ratio.

2.2.1 Effect of planting system on yield and yield attributing characters

Andrade and De (1987) reported that maximum yield of french bean was obtained when the crop was sown with one line of bean between the single rows of cassava as compared to three lines between double rows of cassava. Tathode and Dhoble (1987) reported that in a sorghum-pigeonpea intercropping system paired

row planting pattern with intercrop gave significantly higher yield for sorghum over normal planting pattern.

According to Venkateswarlu (1987) total capsule and bean yield of castor obtained in uniform and paired row systems of castor and cluster bean were at par Balyan and Seth (1991) suggested that grain yield and yield attributes of pearlmillet and yield of guar in pearlmillet 2:2 and 2:1 intercropping system, were not significant. When mungbean was intercropped with maize, higher yield of mung bean was recorded in paired row planting (2:2) followed by alternate row (1:1) (Dhingra *et al.*, 1991).

Koraddi *et al.* (1991) found that the seed yield of cotton in paired row planting was 12.4 per cent higher than in normal planting when intercropped with groundnut and the mean yield of groundnut was 7.3 per cent higher in normal method of planting than in paired row planting. Neto *et al.* (1991) reported that in cotton + cowpea intercropping system with different planting pattern, the productivity of cotton with two rows of cotton for every one row of cowpea (2:1) was superior to the 1:1 row arrangement.

Meera *et al.* (1992) reported that tuber yield of cassava intercropped with groundnut and cowpea was marginally higher under paired row planting compared to uniform planting. The yield of cowpea was more under uniform planting than paired row planting but the intercrop yield of groundnut was more under paired row planting, though this difference was not statistically signfiicant. Natarajan (1992) reported that chilli when intercropped with country onion, bhindi, coriander, green gram, black gram and cowpea the yield of intercrop was lower on paired row system than in normal row system.

A study on sesamum + mungbean intercropping system by Sarkar and Pramanik (1992) revealed that 2:2 row ratio planting pattern gave higher total yield of 11.3 q/ha followed by 10.7 q/ha in 1:1 row ratio and 10.1 q/ha in paired row planting of mungbean with one row of sesamum. When onion was planted 15 cm away from chilli it resulted in higher yield of 71.79 q ha^{-1} of onion and a lower yield of chilli than when planted 30 cm away from chilli according to Dodamani *et al.* (1993).

Mishra *et al.* (1993) observed variation in plant population, from single row to triple row, increased the yield by 44.02 per cent in onion and 45.26 per cent in radish when intercropped with arum (*Colocasia esculenta*). Pino *et al.* (1994) concluded that three rows of tomatoes alternated with one of maize resulted in highest tomato yield equivalent of 54 per cent increase in economic value. The fruit quality of tomato was not affected by intercropping. Intercropping of potato and sugarcane by Yin and Yang (1994), revealed that double row intercropping of potato recorded a higher yield (17 t/ha) as compared to single row intercropping (13.4 t/ha).

Planting bhindi at 60 x 45 cm spacing and growing one row of cowpea in between the row spacing of bhindi was the best planting pattern according to Kalarani (1995) and this system gave a combined intercrop yield of 160.05 q/ha where as sole crop yield of bhindi was only 150.87 q/ha. Sharma and Tiwari (1996) cultivated tomato along with maize and observed that as the frequency of maize rows increased, light intensity reaching tomato plants, soil temperature and fruit diameter decreased, but percentage fruit set, number and weight of fruits per plant, juice and seed content and total and marketable yields increased.

2.2.2 Effect of planting system on growth characters

In maize + bhendi intercropping system, bhendi plant grown on alternate rows with maize had the least number of branches, tallest stem and least dry matter production (Fowusi, 1985). Olasantan and Aina (1987) reported that the best planting ratio for bhendi/tomato + cowpea intercropping system was one row of bhendi or tomato to one row of cowpea. The plant height and leaf area per plant of bhendi was increased when bhendi and cowpea were planted in alternate rows but slightly reduced the branch number compared to alternate pair of rows.

Biju (1989) conducted a study on planting geometry and double intercropping in cassava with french bean and groundnut and showed that cassava planted in paired rows with groundnut and french bean as first and second intercrops respectively recorded the maximum number of tubers per hill. In maize + mungbean intercropping system, paired planting (2:2) recorded maximum total LAI. In the case of maize alone, LAI was maximum in alternate row (1:1) arrangement, where as, in mung bean maximum LAI was recorded in 2:2 planting pattern according to Dhingra *et al.* (1991).

Natarajan (1992) conducted a study on intercropping in chilli. The treatments included six intercrops viz., country onion, bhendi, coriander, green gram, black gram and cowpea in two systems of planting of chilli. The plant height was comparatively higher in paired row system than that in normal row system and least in the treatment with cowpea as intercrop in normal row system. Among the treatments, chilli + coriander under paired row system produced taller plants with more number of branches.

2.2.3 Effect of planting system on biological efficiency

Giri *et al.* (1983) reported that by intercropping pigeonpea with mungbean, soybean and groundnut under 2:1, 2:2 and 1:1 row arrangement, the grain yield equivalent was increased significantly by intercropping groundnut in two rows in the interspace of paired rows of pigeon pea (2:2). Land equivalent ratio of a tomato-cowpea intercropping system ranged from 1.05 to 1.41 and was highest with crops in alternate paired rows (Olasantan, 1985b).

Kushwaha and Masoodali (1991) noted that LER was higher for french bean-potato intercropping system, with two rows of french bean planted between paired rows of potato in 2:2 system. Shah *et al.* (1991) reported that maize intercropped with soybean in 4:1 row ratio recorded the highest mean biological maize equivalent compared to its sole cropping. They also observed that maize + rajmash recorded highest mean LER (1.81) followed by maize + cowpea (1.74) and maize + soybean (1.59) all sown in the ratio of 2:1.

Sesame intercropped with mungbean at 2:2 row ratio was most productive with LER of 1.74 followed by sesame with mungbean in 1:1 ratio with LER 1.65 (Sarkar and Pramanik, 1992). According to Singh and Singh (1993) intercropping system of paired rows of maize with french-bean recorded the highest maize grain equivalent. Kalarani (1995) studied the possibility of raising cowpea as an intercrop in bhendi and found that the values of LER and ATER for all the treatments were above 1.5 indicating that intercropping of bhendi + cowpea is biologically efficient. The aggressivity value was positive for cowpea at both normal and paired row planting pattern indicating that cowpea is signfiicantly more aggressive than bhendi in bhendi cowpea intercropping system.

Wheat + pear in 1:1 row replacement series gave the highest wheat yield equivalent value (3.02 t/ha) followed by wheat + lentil (2 91 t/ha). When the actual proportion of seeding was considered wheat + lentil (1:1) resulted in maximum average yield loss (+0.610) and intercropping advantage (+0.279) values and gave maximum monetary advantage (Rs.5985.45 /ha) according to Banik (1996). Mandal *et al.* (1996) observed that net return, land equivalent ratio, area time equivalent ratio and relative value total were highest when wheat and chickpea were sown in 4:2 ratio.

2.2.4 Effect of planting system on economic efficiency

By paired row planting of banana with cucumber and amaranthus as intercrop, income would be increased by 40-60 per cent compared to square system (KAU, 1986). Ojeifo and Lucas (1987) found that to get maximum economic return from corchorus + tomato intercropping, the best row ratio should be one row of corchorus to two rows of tomato.

In a cassava + french bean intercropping system, Biju (1989) observed that paired row system fetched an additional profit of Rs.5000/- per hectare compared to ordinary method. According to Narwal and Vedprakash (1989), single row intercropping of gobhi sarson or Indian mustard with potato was highly economic (Rs.13,848/ha) than when compared to paired row intercropping (Rs.11,467/ha). Intercropping of one row of gobhi sarson and three rows of potato (1:3) gave maximum net returns (Rs.14,930/ha) because both component crops could give the maximum yield.

Srivastava and Srivastava (1991) reported that intercropping pigeonpea + maize (1:1 ratio) was the most remunerative system with a net return of Rs.8189/ha, whereas sole pigeonpea and maize gave a net return of Rs.6687 and Rs.2350/ha

respectively. Meera *et al.* (1992) suggested that the paired row planting of cassava with cowpea recorded the highest net income of Rs.11385/- per hectare followed by uniform planting of cassava with cowpea with net income of Rs.10433/- per hectare.

Chilli with bhendi under normal row system recorded the highest gross income of Rs.29660/- per hectare compared to paired row system which had a gross income of Rs.25960/- per hectare (Natarajan, 1992). An economic analysis by Porwal *et al.* (1994) on net income per rupee investment indicated that onion either in companionship with autumn cane (+1.94) or in sequence with spring cane (+1.61) was superior, followed by garlic (+1.47) and potato (+1.33) with autumn cane. According to Sarkar *et al.* (1995) intercropping 2 rows of groundnut in between 2 rows of redgram planted at 75 x 30 cm spacing is highly economical.

2.3 Effect of intercropping on pest and disease incidence

There are yield advantages under conditions where intercropping reduces insect pest density. Intercropping can thus form a component of integrated pest management programme.

Rathi (1981) working on intercropping of mustard with potato stated that mustard aphids (*Lipaphis erysime* Kalt) neither colonizes on potato crop nor transmit any of the potato viruses. Sharaiha *et al.* (1989) found that row intercropping reduced the incidence and severity of alternaria leaf spot on faba beans and reduction of rust of maize when they were grown as intercrops. A similar reduction of late blight of potato (*Phytophthora infestans*) was recorded when potatoes were intercropped with faba bean. Intercropping cabbage with mustard - 25 rows cabbage + 2 rows mustard - attracted diamond back moth to mustard was

easily controlled by spraying mustard alone thus reducing the insect attack and pesticide load in main crop cabbage (Srinivasan and Krishnamurthy, 1990).

The incidence of *Maruca testulalis* and *Helicoverpa armigera* was significantly lower in intercropped and higher plant populations than in pure stands and lower plant populations of *Phaseolus vulgaris* when intercropped with maize (Karel, 1993). According to Ampongnyarko *et al.* (1994) intercropping of sorghum and cowpea reduced the attack of stem borer in sorghum and thrips in cowpea.

Pino *et al.* (1994) observed that the incidence of pest and diseases was lower in intercropped tomato plants than in those grown alone. The incidence and severity of anthracnose was lower when cowpea was intercropped with maize and also when the spacing within and between rows were increased in mono and intercropped stands according to Adebitan and Ikotun (1996).

Chakravarthy *et al.* (1997) reported that intercropping cotton with onion reduced the populations of *Amrasca biguttula, Aphis gossypii* and *Bemisia tabaci* by >50 per cent, compared to pure crop. Populations of all these pests were decreased with groundnut and chilli as intercrops. The intercropping experiments showed that bruchid infestation was significantly reduced in the intercropped cowpea (Olubayo and Port, 1997).

2.4 Effect of intercropping on weed population

Potato as an intercrop in sugarcane reduced the weed intensity and weed growth compared to sole crop of sugarcane (Nankare *et al.*, 1985). Amma and Ramadas (1991) reported that amaranthus when intercropped with bhendi reduced the weed population.

Weed infestation was reduced considerably when cassava was intercropped with maize. According to Olasantan *et al.* (1994) the weeds which might otherwise build up before cassava covers the ground could be replaced by the cereal. The weed infestation and labour input for weeding was greatly reduced because of limited weed growth in intercropping of legumes and maize as observed by Mishra and Gautam (1995).

From the literature reviewed above it is seen that even though there are works on intercropping those on a vegetable based intercropping is very limitted. Hence the present study was undertaken to evaluate the performance of vegetables in an intercrpopping system.

Materials and Methods

MATERIALS AND METHODS

The investigation entitled 'Productivity of ashgourd as influenced by crop combinations' was carried out with the objective of assessing the possibility of intercropping, in ashgourd based cropping system. The materials used and the methods adopted for the study are detailed below.

3.1 Experimental site

The experiment was conducted in the Vegetable Research Plot of the Department of Olericulture, College of Horticulture, Thrissur. The Research plot is located at 70°3' N latitude and 76° 16' E longitude at an altitude of 22.5 m above mean sea level. The location enjoys a warm humid tropical climate.

3.2 Season

The crop was grown in two seasons. First crop was planted on 25th of April and second crop on 30th of September, 1996.

3.3 Weather conditions

The details of the meteorological observations recorded during the crop period is presented in Appendix I.

3.4 Materials

3.4.1 List of test crops and their major characteristics

Crop	Variety	Source	Characters
Ashgourd	BH 21	KAU	Poor branching type with thick vines and early flowering. Fruits are oblong cylindrical with medium ashyness on maturity. Duration 120 days.
Cucumber	Mudikode Local	KAU	Green pubiscent angular stems. Leaves are orbicular with slightly serrated margin and blunt tip. Fruits are medium long and golden yellow in colour on maturity. Duration 90 days
Pole cowpea	Sarika	KAU	Trailing habit, light green pods with red tips, black seeds and 30 cm length. Duration.100 days
Bush cowpea	Pusa Komal	IARI, New Delhi	Erect growth habit with light green pods Duration 70 days
Amaranthus	Kannara Local	KAU	Red coloured, broad ovate leaved, high yielding, photosensitive day type. Duration 75 days

3.4.2 Manures and fertilizers

FYM obtained from local source @ 20 t ha^{-1} was applied. Urea (46% N), Factamphos (20% N, 20% P_2O_5) and MOP (60% K_2O) were used as sources of N, P and K respectively.

3.5 Methods

3.5.1 Design and layout

The experiment was laid out in split plot design with four replications. Layout is given in figure 1.

3.5.2 Treatments

There were 13 treatments involving one base crop ashgourd, four intercrops and their monocrop combinations as detailed below:

Base crop - Ashgourd

Intercrops

1. Cucumber
2. Pole cowpea
3. Bush cowpea
4. Amaranthus

3.5.3 Total treatment combinations

T_1 Ashgourd + cucumber in same pit or trench

T_2 Ashgourd + pole cowpea in same pit or trench

T_3 Ashgourd + bush cowpea in interspace

T_4 Ashgourd + amaranthus in interspace

T_5 Ashgourd + cucumber in pit or trench + bush cowpea in interspace

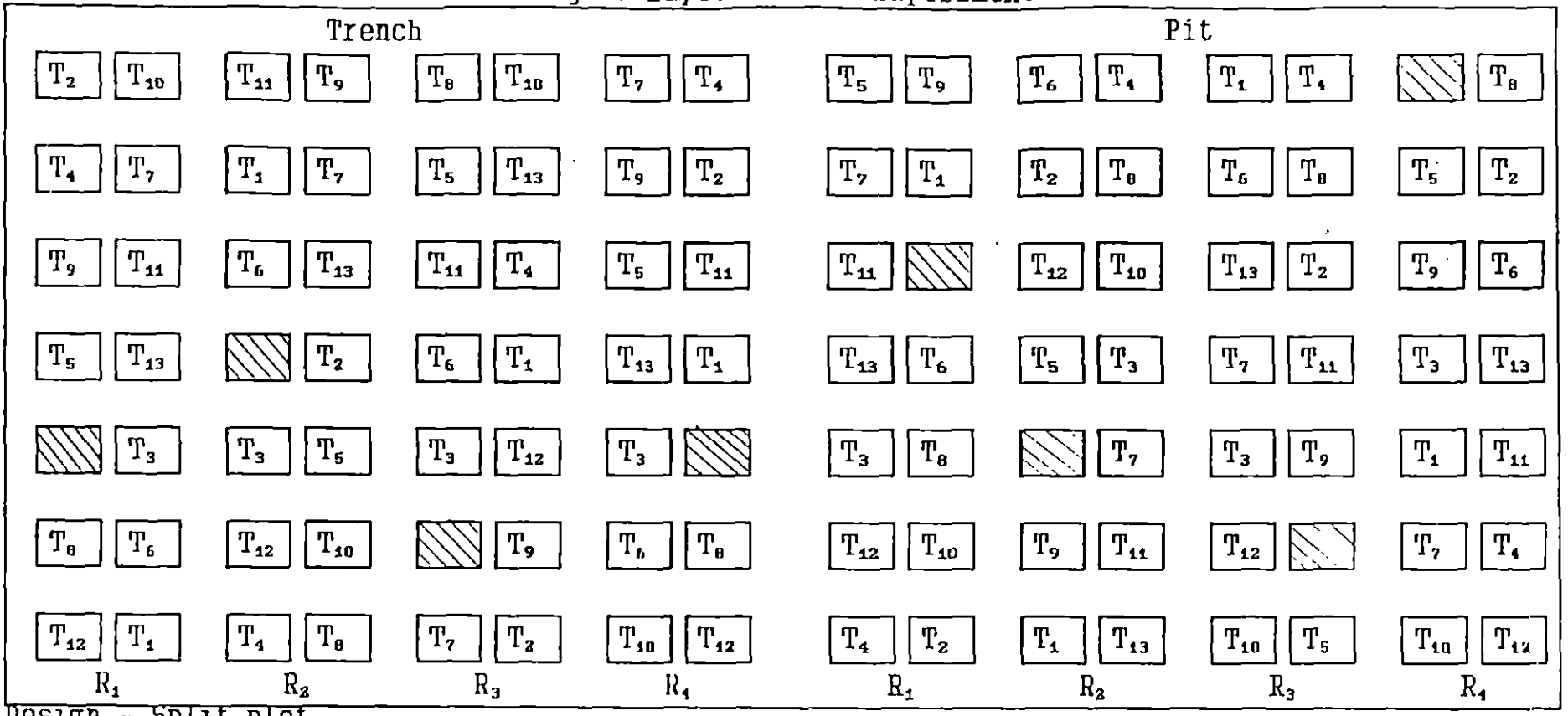
T_6 Ashgourd + cucumber in pit or trench + amaranthus in interspace

T_7 Ashgourd + pole cowpea in pit or trench + bush cowpea in interspace

T_8 Ashgourd + pole cowpea in pit or trench + amaranthus in interspace

T_9 Sole crop of ashgourd

Fig 1. Layout of the Experiment



Design - Split plot
Main plot treatment - System of planting (pit/trench)
Subplot treatments

T_1 - Ashgourd + cucumber
T_2 - Ashgourd + pole cowpea
T_3 - Ashgourd + bush cowpea
T_4 - Ashgourd + amaranthus
T_5 - Ashgourd + cucumber + bush cowpea
T_6 - Ashgourd + cucumber + amaranthus
T_7 - Ashgourd + pole cowpea + bush cowpea
T_8 - Ashgourd + pole cowpea + amaranthus
T_9 - Sole crop of ashgourd
T_{10} - Sole crop of cucumber
T^{11} - Sole crop of pole cowpea
T_{12} - Sole crop of bush cowpea
T_{13} - Sole crop of amaranthus

T_{10} Sole crop of cucumber

T_{11} Sole crop of pole cowpea

T_{12} Sole crop of bush cowpea

T_{13} Sole crop of amaranthus

No. of replications - 4

No. of plots/replication - 13

Plot size:

Pit system (2 pits) - 18 m^2

Trench system - 9 m^2

3.5.4 Test crop spacing and plant population per plot

Crop (planting system)	Spacing	Net plot size	No. of plants/plot
Ashgourd (pit)	4.5 m x 2 m	18 m^2	4
Ashgourd (trench)		9 m^2	8
Cucumber (pit)	4.5 m x 2m	18 m^2	4
Cucumber (trench)		9 m^2	8
Pole cowpea (pit)	4.5 m x 2 m	18 m^2	4
Pole cowpea (trench)		9 m^2	8
Bush cowpea (pit)	20 x 25	8 m^2	160
Bush cowpea (trench)	20 x 25	4 m^2	80
Amaranthus (pit)	20 x 20	8 m^2	200
Amaranthus (trench)	20 x 20	4 m^2	100

The field view of the different crop combinations tested are presented in Plates 1 to 9.

Plate 1. Field view

Plate 2. Crop combination of ashgourd and cucumber

Plate 3. Crop combination of ashgourd and pole cowpea

Plate 4. Crop combination of ashgourd and bush cowpea

Plate 5. Crop combination of ashgourd and amaranthus

Plate 6. Crop combination of ashgourd, cucumber and bush cowpea

Plate 7. Crop combination of ashgourd, cucumber and amaranthus

Plate 8. Crop combination of ashgourd, pole cowpea and bush cowpea

Plate 9. Crop combination of ashgourd, pole cowpea and amaranthus

3.6 Cultivation aspects

3.6.1 Land preparation

The land was prepared by ploughing once, stubbles were removed, clods were broken and levelled. The field was then laid out into blocks and plots as per the experimental design. The plots were seperated by channels of 30 cm width. The individual plots were thoroughly dug and levelled.

3.6.2 Manures and fertilizer application

Fertilisers were applied as per Package of Practices Recommendation (KAU, 1993) for ashgourd, bush cowpea and amaranthus. No additional fertilisers were given for crops raised in the pit or trench along with ashgourd.

Fertilizer recommendation and schedule of fertilizer application

Crop	Recommendation (kg ha^{-1})			Schedule of application
	N	P_2O_5	K_2O	
Ashgourd	70	25	25	1/2 N, full P and K as basal dose remaining 1/2 N in 2 equal splits at the time of vine growth and full bloom
Cucumber	70	25	25	
Pole cowpea	20	30	10	1/2 N, full P and 1/2 K basal
Bush cowpea	20	30	10	1/2 N and 1/2 K 20 DAS
Amaranthus	50	50	50	N was applied at regular intervals as top dressing. 1/2 K and full P basal and 1/2 K top dressing 20 DAS

3.6.3 Sowing

All the crops were sown on the same date except amaranths which was transplanted. Crop arrangement was followed according to the treatments.

The main crop of ashgourd was sown in pits of 60 cm diameter with 30 cm depth, taken at a spacing of 4.5 x 2 m and in trenches of size 2 m x 60 cm x 30 cm. The available interspace was used to raise amaranths and bush cowpea. Cucumber and pole cowpea were sown in the same pit or trench along with ashgourd. Gap filling and thinning were done to secure a uniform stand of the crop.

3.6.4 After cultivation

Fertilisers were applied as per the Package of Practices Recommendations (KAU, 1993). Crop was irrigated on alternate days during summer. Weeding was done as and when required.

3.6.5 Plant protection

Necessary plant protection measures were taken as and when there was incidence of pest and diseases.

3.6.5 Harvesting

Harvesting was done when the fruits or leaves were ready for harvesting.

3.7 Observations recorded

3.7.1 Ashgourd and cucumber

1. Days to 1st female flower anthesis

Number of days taken for anthesis from the date of sowing was observed.

2. Days to 1st male flower anthesis

Number of days taken for anthesis from the date of sowing was observed.

3. Node at which 1st female flower appears

Node at which first female flower appeared was counted from the base.

4. Number of female flowers and percentage set

Number of female flowers produced were counted and the percentage set was worked out.

5. Length of main vine (cm)

Length of the vine was taken during the final stage of the crop.

6. Number of primary branches/plant

The number of primary branches were counted at the final stage of the crop.

7. Internodal length (cm)

The internodal length was measured at the final stage of the crop.

8. Number of fruits

Number of fruits from each harvest was counted and average was worked out.

9. Weight of fruits

Weight of the individual fruits were taken and average was worked out.

10. Circumference of fruits (cm)

This was measured by winding a thread around the middle of the fruit. The average was then worked out.

11. Length of fruit(cm)

The length of fruits were measured from tip to the stalk end of the fruit.

12. Flesh thickness of fruits (cm)

Flesh thickness was taken by cutting the fruits into half.

13. Yield/plant (kg)

The yield obtained at each harvest was noted and was converted to yield per hectare.

14. Duration

The duration was noted from sowing to last day of harvest.

15. Incidence of pest and disease

Identification of the pest and disease found on the plants was done.

3.7.2 Cowpea (pole and bush)

1. Height or length of vine (cm)

The height or length was measured from the base to the growing point and the average was worked out.

2. Days to 1st flowering

Number of days taken from the date of sowing to flowering was observed.

3. Weight of fruits (g)

The weight of individual fruit at each harvest was taken and average was worked out.

4. Yield/plot (kg)

The yield obtained at each harvest was noted and the total yield per hectare was calculated.

5. Duration

The duration from time of sowing to last harvest was noted.

6. Incidence of pest and disease

Identification of pest and diseases found on the crop was done.

3.7.3 Amaranthus

1. Number of cuttings

The number of times the harvesting was done was recorded.

2. Yield at each harvest (g)

The yield obtained at each harvest was recorded

3. Incidence of pest and disease

Identification of pest and diseases found was done

3.8 Biological efficiency

The biological efficiency of intercropping is determined by comparing the productivity of a given area of intercropping with that of sole crops.

The competition functions proposed to describe the competitive relationships in intercropping are detailed below.

1. Land equivalent ratio (LER)

LER was worked out from the data on the yield of main crop and intercrops in mixture and pure stands. It was worked out by using the formula suggested by Mead and Willey (1980).

$$LER = \frac{Yab}{Yaa \times Zab} + \frac{Yba}{Ybb \times Zba}$$

Yab and Yba are the individual crop yield in intercropping and Yaa and Ybb are their yields as sole crop. Zab and Zba are proportion of land area occupied in intercropping when compared to sole crop for species 'a' and 'b' respectively.

2. Land equivalent coefficient (LEC)

LEC was worked out for the mixture plots using the formula suggested by Adetiloye *et al.* (1983).

$$LEC = LA \times LB$$

LA = LER of main crop
LB = LER of intercrop

3. Area-time equivalent ratio (ATER)

ATER was worked out by using the formula suggested by Hiebsch and Mc Collum (1987) as detailed below.

$$ATER = \frac{(Rya \times ta) + (Ryb \times tb)}{T}$$

Ry = Relative yield of species 'a' or 'b' ie., yield of intercrop/yield of main crop

t = duration (days) for species 'a' or 'b'

T = duration (days) of the intercropping system

4. Aggressivity

Aggressivity was calculated using the formula proposed by McGilchrist (1965).

$$Aab = \frac{Yba}{Ybb \times Zba} - \frac{Yab}{Yaa \times Zab}$$

Yab and Yba are the individual crop yield in intercropping and Yaa and Ybb are their yields as sole crop. Zab and Zba are proportion of land area occupied on intercropping when compared to sole crop for species 'a' and 'b' respectively.

5. Relative crowding coefficient

RCC was calculated using the formula

$$RCC = \frac{\text{Mixture yield of species 'a'}}{\text{Pure yield of species 'a' - mixture yield of species 'a'}}$$

6. Total biomass production

The biomass production was taken as the weight of the whole plant along with its economic yield.

7. Leaf area index

Leaf area index (LAI) was calculated using the formula,

$$LAI = \frac{\text{Total leaf area}}{\text{Land area}}$$

The leaf area of individual plants were found out which is as follows:

Ashgourd : Leaf area = L x B x 0.828 (Radhakrishnan *et al.*, 1991)

Cucumber : Length and width measurement of leaf lamina from 25 leaves of cucumber var. Mudikode Local were used for tests for equality of regression from which a single model, A = 16.24 + 0.79 (L x B) was obtained. This was used for calculation of leaf area.

Cowpea : Leaf area = L x B x 0.665 (Sharma *et al.*, 1987)

Amaranthus : Length and width measurements of leaf lamina from 50 leaves of amaranthus var. Kannara local were used for tests for equality of regression from

which a single model, A = 0.34 + 0.64 (L x B) was obtained. This was used for calculation of leaf area.

8. Ashgourd equivalent yield

This was calculated by converting the yield of intercrop into yield of base crop ashgourd considering the market rates. It was calculated using the formula suggested by Prasad and Srivastava (1991).

$$\text{Ashgourd equivalent yield (kg ha}^{-1}\text{)} = \frac{\text{Yield of intercrop}}{\text{market price of ashgourd}} \times \text{market price of intercrop}$$

9. Fresh weight of weeds from interspace

The entire plot was weeded and the weight of weeds was taken 35 days after sowing and was expressed as Kg.

3.9 Economic suitability

The ultimate aim of intercropping is to increase the monetary returns per unit area. So economic evaluation becomes a necessity to assess how best an intercropping system is economically viable. The following economic indices were used to evaluate the system.

1. Gross return

This was calculated on the basis of price of the produce followed in Kerala Agricultural University and expressed as rupees per hectare. The price was

fixed as ashgourd - Rs.5, cucumber - Rs.4, cowpea - Rs.6 and amaranthus - Rs 4, Labour cost - Rs.120.

2. Net return

This is calculated by substracting total cost of cultivation from the gross return of different treatments.

3. Per day return

Per day return was calculated using the formula suggested by Palaniappan, 1988.

$$PDR = \frac{\text{Net return}}{\text{Cropping period (in days)}}$$

4. Benefit cost ratio

BCR was worked out as per the formula given below

$$BCR = \frac{\text{Gross return}}{\text{Cost of cultivation}}$$

5. Return per rupee invested on inputs

a. Return per rupee invested on labour (RPL)

This was worked out by using the formula

$$RPL = \frac{\text{Gross return - cost of cultivation except that incurred on labour}}{\text{Cost of labour}}$$

b. Return per rupee invested on fertilizers (RPF)

It gives an estimate of the production per unit cost spent as fertilizers for different treatments. It was calculated by using the formula

$$RPF = \frac{\text{Gross return - cost of cultivation except that incurred on fertilizers}}{\text{Cost of fertilizers}}$$

4.0 Statistical analysis

Data relating to different characters were analysed statistically by applying the technique of analysis of variance for split plot and significance was tested by Duncans Multiple Range Test.

Treatments having same alphabets as superscripts belong to one homogenous group

RESULTS

An investigation was conducted to study the productivity of ashgourd as influenced by intercrops. The experimental data collected were statistically analysed and the results are presented hereunder.

4.1 Growth and yield characters of ashgourd

4.1.1 Length of main vine

The effect of planting system and intercrops on the length of main vine in ashgourd is given in Table 1.

The planting system did not significantly influence the length of main vine in both the seasons. Trench system recorded a mean length of 5.45 cm and 5.75 cm and pit system recorded 5.58 cm and 5.17 cm in first and second season respectively.

Intercrops had significant effect on the vine length of ashgourd. During the first season sole crop of ashgourd recorded the maximum vine length (6.60 cm). This was followed by the combination of ashgourd and cucumber + amaranthus (T_6). All other treatments were statistically on par. The combination of ashgourd + amaranthus (T_4) recorded the lowest length (4.89 cm). In the second season the sole crop of ashgourd recorded significantly superior length of 7.21 cm followed by ashgourd + amaranthus combination (5.92 cm). The lowest length was recorded in ashgourd + cucumber (T_1). The treatments T_2, T_5, T_7 and T_8 were statistically on par.

None of the interaction between treatments was found to be significant.

Table 1. Effect of planting system and intercrops on length of main vine, number of primary branches and internodal length of ashgourd

Treatment	Length of main vine		No.of primary branches		Internodal length	
	I season	II season	I season	II season	I season	II season
Methods of planting						
Trench	5.45	5.74	3.18	3.16	10.49	10.57
Pit	5.57	5.17	3.06	3.13	10.36	10.57
Crop combinations						
T_1	5.70^{bc}	4.52^{d}	3.12^{a}	3.06^{b}	10.50^{abc}	10.62^{abc}
T_2	5.12^{bc}	5.12^{bcd}	3.12^{a}	2.93^{b}	10.39^{abc}	10.79^{ab}
T_3	5.62^{bc}	5.67^{bc}	3.18^{a}	3.18^{ab}	10.14^{c}	10.33^{c}
T_4	4.89^{c}	5.92^{b}	3.12^{a}	3.18^{ab}	10.19^{bc}	10.40^{bc}
T_5	5.17^{bc}	5.39^{bcd}	3.06^{a}	3.18^{ab}	10.88^{a}	10.87^{a}.
T_6	5.84^{b}	4.87^{cd}	3.18^{a}	3.06^{b}	10.67^{ab}	10.75^{abc}
T_7	5.37^{bc}	5.00^{bcd}	3.00^{a}	3.12^{b}	10.44^{abc}	10.53^{abc}
T_8	5.29^{bc}	5.43^{bcd}	3.00^{a}	3.06^{b}	10.50^{abc}	10.42^{bc}
T_9	6.60^{a}	7.21^{a}	3.31^{a}	3.56^{a}	10.13^{c}	10.38^{bc}
Interaction	NS	NS	NS	NS	NS	NS

T_1 - ashgourd + cucumber, T_2 - ashgourd + pole cowpea, T_3 - ashgourd + bush cowpea, T_4 - ashgourd + amaranthus, T_5 - ashgourd + cucumber + bush cowpea, T_6 - ashgourd + cucumber + amaranthus, T_7 - ashgourd + pole cowpea + bush cowpea, T_8 - ashgourd + pole cowpea + amaranthus, T_9 - sole crop of ashgourd, NS - Non significant

Treatments having same alphabets as superscripts belong to one homogenous group

4.1.2 Number of primary branches

The influence of planting systems and crop combinations on the number of primary branches on ashgourd is given in Table 1.

Planting systems and crop combinations did not significantly influence the number of primary branches during both the seasons. It was higher in trench system of planting as compared to pit system. In both the seasons the sole crop of ashgourd (T_9) recorded the highest mean value. In the Ist season it recorded a mean value of 3.31, but all other treatments were statistically on par with this. In second season also T_9 recorded the highest mean of 3.56 cm. This was followed by treatments T_1, T_2. T_6, T_7 and T_8. Treatments T_3, T_4 and T_5 were statistically on par with all others.

The number of primary branches produced by ashgourd in both the seasons was not significantly influenced by interactions also.

4.1.3 Internodal length

The effect of planting pattern and crop combinations on the internodal length of ashgourd is presented in Table 1.

Planting pattern did not significantly influence the internodal length of ashgourd. In both the seasons trench system recorded a higher internodal length of 10.49 cm and 10.57 cm as compared to pit system which recorded 10.36 cm and 10.57 cm in first and second seasons respectively.

Crop combinations significantly influenced the internodal length during the two cropping seasons. During the first season ashgourd + cucumber + bush

cowpea (T_5) recorded significantly superior internodal length (10.88 cm) but it was on par with the treatments T_1, T_2, T_6, T_7 and T_8. The lowest internodal length was recorded by T_9 (10.13) which was statistically on par with the treatments T_1, T_2, T_3, T_4, T_7 and T_8. In the second season also T_5 recorded significantly higher internodal length (10.87 cm) which was on par with the treatments T_1, T_2, T_6 and T_7. The lowest internodal length was recorded by the treatment T_3 (10.33). This was on par with the treatments T_1 T_4, T_6, T_7, T_8 and T_9. Interaction had no significant influence on the internodal length of ashgourd.

4.1.4 Days to first female flower anthesis

The effect of planting system and intercrops on the number of days taken for the first female flower anthesis is given in Table 2.

Planting pattern had no significant influence on the number of days taken for female flower anthesis. Trench system recorded a mean value of 52.81 and 53.41 days where as pit system recorded 52.87 and 53.30 days in first and second seasons respectively.

Intercrops exerted a significant effect on the number of days for the first female flower anthesis during the first season. Maximum number of days (53.87) was taken by ashgourd + pole cowpea (T_2) combination which was statistically on par with the treatments T_4, T_5 and T_6. Least number of days was taken by the sole crop of ashgourd (51.68 days) which was on par with the treatments T_1, T_3, T_7 and T_8. The intercrops had no significant influence on the number of days for the first female flower anthesis in the second season. Here also maximum number of days was taken by T_2 (53.87 days). It was statistically on par with all other treatments except T_9 (52.06 days) which recorded the least number of days. The treatments T_6, T_7 and T_8 were on par with the rest of the treatments.

Table 2. Effect of planting system and intercrops on days for male and female flower anthesis in ashgourd

Treatment	Days to 1st male flower anthesis		Days to 1st female flower anthesis	
	I season	II season	I season	II season
Methods of planting				
Trench	52.81	53.41	50.81	51.37
Pit	52.87	53.30	50.90	51.47
Crop combinations				
T_1	52.06^{cd}	53.68^{a}	50.37^{bc}	51.62^{a}
T_2	53.87^{a}	53.87^{a}	51.68^{a}	52.00^{a}
T_3	52.62^{bcd}	53.50^{a}	50.62^{abc}	51.37^{a}
T_4	53.56^{ab}	53.56^{a}	51.56^{a}	51.37^{a}
T_5	58.06^{abc}	53.68^{a}	51.06^{abc}	51.56^{a}
T_6	53.68^{ab}	53.25^{ab}	51.25^{ab}	51.12^{a}
T_7	52.68^{bcd}	53.25^{ab}	50.68^{abc}	51.18^{a}
T_8	52.37^{cd}	53.37^{ab}	50.43^{bc}	51.93^{a}
T_9	51.68^{d}	52.06^{b}	50.06^{c}	50.62^{a}
Interaction	NS	NS	NS	NS

T_1 - ashgourd + cucumber, T_2 - ashgourd + pole cowpea, T_3 - ashgourd + bush cowpea, T_4 - ashgourd + amaranthus, T_5 - ashgourd + cucumber + bush cowpea, T_6 - ashgourd + cucumber + amaranthus, T_7 - ashgourd + pole cowpea + bush cowpea, T_8 - ashgourd + pole cowpea + amaranthus, T_9 - sole crop of ashgourd, NS - Non significant

The interaction effect of planting system and crop combinations were not statistically significant during both the seasons.

4.1.5 Days fo first male flower anthesis

Table 2 shows the mean value of number of days taken for the first male flower anthesis.

The number of days taken for the first male flower anthesis did not differ significantly due to planting system in both the season. In trench system the mean number of days taken was 50.81 and 51.37 and in the pit system it was 50.90 and 51.47 in the first and second seasons respectively.

Intercrops significantly influenced the number of days during the first season. Maximum number of days (51.68) was taken by the treatment T_2 (Ashgourd + pole cowpea) which was on par with the treatments T_3, T_4, T_5, T_6 and T_7. Sole crop of ashgourd took significantly least number of days (50.06) for the first male flower anthesis. In the second season the influence of crop combinations was found to be non significant. Here also sole crop of ashgourd took the least number of days to form the first male flower (50.62 days) and ashgourd + pole cowpea took maximum number of days (52.00). All other treatments were on par with these two.

The interaction effect was found to be non significant in both the seasons.

4.1.6 Node at which first female flower appeared

The effect of planting pattern and crop combination on the node at which first female flower appeared is given in Table 3.

Planting pattern did not significantly influence the node at which first female flower appeared. Trench system recorded a mean value of 12.55 and 11.61 and pit system recorded 12.54 and 11.73 in the first and second seasons respectively.

Node at which first female flower appeared differed significantly in first season due to the intercrops. T_6 recorded a significantly higher node number (13.43) which was followed by T_8 (13.06). All other treatments except the pure crop of ashgourd were on par with this. Pure crop of ashgourd (T_9) recorded significantly lowest node number (11.00). During the second season, effect of intercrops on node number was non significant. Here T_5 recorded the highest node number (12.25) and the lowest was recorded by T_9 (10.87).

The interaction between the planting systems and crop combinations were found to be non significant during both the seasons.

4.1.7 Number of female flowers

The mean value of the number of female flowers per plant is presented in Table 3.

The effect of planting systems and the interaction between planting systems and intercrops were not significant during both the seasons.

The number of female flowers were significantly influenced by the intercrops. In the first season the sole crop of ashgourd (T_9) produced significantly higher number of female flowers (6.68) but this was on par with the treatments T_3, T_4, T_5, T_6, T_7 and T_8. Ashgourd + cucumber combination (T_1) produced significantly lower number of flowers (5.00) which was on par with the treatments

Table 3. Effect of planting system and intercrops on node at which first female flower appeared, number of flowers and percent fruit set in ashgourd

Treatment	Node at which first female flower appeared		No. of female flowers		Percentage fruit set	
	I season	II season	I season	II season	I season	II season
Methods of planting						
Trench	12.55	11.61	5.59	6.44	40 99	40.93
Pit	12.54	11.73	6 30	6.76	41 33	40 72
Crop combinations						
T_1	12.31^{a}	11.56^{a}	5.00^{b}	6.43^{bc}	39.30^{b}	38.95^{d}
T_2	13.00^{a}	11.75^{a}	5.00^{b}	6.56^{bc}	40.70^{b}	40.52^{cd}
T_3	12.43^{a}	11.62^{a}	5.87^{ab}	7.06^{ab}	43.32^{a}	42.35^{bc}
T_4	12.50^{a}	11.87^{a}	6.25^{a}	6.93^{ab}	44.20^{a}	42.61^{b}
T_5	12.87^{a}	12.25^{a}	6.18^{a}	6.12^{bc}	40.88^{b}	39.66^{d}
T_6	13.43^{a}	11.25^{a}	6.12^{a}	6.31^{bc}	39.81^{b}	39.65^{d}
T_7	12.31^{a}	11.93^{a}	6.50^{a}	6.75^{ab}	38.81^{b}	38.81^{d}
T_8	13.06^{a}	11.93^{a}	5.93^{ab}	5.68^{c}	38.91^{b}	40.10^{d}
T_9	11.00^{b}	10.87^{a}	6.68^{a}	7.56^{a}	44.53^{a}	44.83^{a}
Interaction	NS	NS	NS	NS	NS	NS

T_1 - ashgourd + cucumber, T_2 - ashgourd + pole cowpea, T_3 - ashgourd + bush cowpea, T_4 - ashgourd + amaranthus, T_5 - ashgourd + cucumber + bush cowpea, T_6 - ashgourd + cucumber + amaranthus, T_7 - ashgourd + pole cowpea + bush cowpea, T_8 - ashgourd + pole cowpea + amaranthus, T_9 - sole crop of ashgourd, NS - Non significant

T_2, T_3 and T_8. In the second season also T_9 recorded highest number of female flowers (7.56). This was followed by T_3 (Ashgourd + bush cowpea) and T_4 (Ashgourd + amaranthus) which recorded mean values of 7.06 and 6.93 respectively. T_8 (Ashgourd + pole cowpea + amaranthus) recorded the lowest number of flowers (5.68) but it was on par with the treatments T_1, T_2, T_5 and T_6.

4.1.8 Per cent fruit set

The effect of planting systems and intercropping on per cent fruit set is given in Table 3.

Planting systems did not significantly influence the per cent fruit set during the two seasons. The per cent fruit set was 40.99 and 40.93 in trench system and 41.33 and 40.72 in pit system in first and second seasons respectively.

There was significant variation in per cent fruit set due to intercrops. During the first season significntly higher fruit set (44.53%) was noted in sole crop of ashgourd (T_9). This was followed by T_4 (ashgourd + amaranthus) and T_3 (ashgourd + bush cowpea) which recorded a mean fruit set of 44.2 per cent and 43.32 per cent respectively. The treatments T_3, T_4 and T_9 were statistically superior to the rest of the treatments. Lowest fruit set was recorded by T_7 (ashgourd + pole cowpea + bush cowpea). The treatments T_1, T_2, T_5, T_6 and T_8 were on par with this. During the second season also T_9 recorded significantly superior fruit set (44.83%) and the lowest by T_7 (38.81%).

The interaction effect on per cent fruit set was found to be statistically non significant.

4.1.9 Number of fruits

The effect of intercropping and planting systems on number of fruits in ashgourd is presented in Table 4.

Planting systems significantly influenced the number of fruits in ashgourd. More number of fruits were produced under trench system of planting compared to the pit system. During first and second seasons trench system recorded an average of 10.44 and 13.63 fruits/plot where as under pit system only 4.58 and 6.22 fruits per plot were realised.

Intercrops also had significant influence on the number of fruits in ashgourd. Treatments T_3, T_4 and T_9 produced significantly higher number of fruits with mean values of 8.50, 8.12 and 8.12 respectively. Significantly lower number of fruits was produced by T_8 (6.87) but it was on par with the treatments T_1, T_2, T_5, T_6 and T_7. During the second season also T_3, T_4 and T_9 produced significantly higher number of fruits (11.12, 11.12, 10.62) compared to other treatments. Significantly lower number of fruits (9.12) was produced by ashgourd + cucumber (T_1) combination and it was statistically on par with the treatments T_2, T_5, T_6, T_7 and T_8.

The interaction between planting system and intercrops were found to be non significant in the case of number of fruits produced during the two seasons.

4.1.10 Average weight of fruits

Table 4 shows the effect of planting system and intercrops on the weight of fruits.

Table 4. Effect of planting system and intercrops on number of fruits, weight of fruits and circumference of fruits in ashgourd

Treatment	Number of fruits/plot		Weight of fruits		Circumference of fruit	
	I season	II season	I season	II season	I season	II season
Methods of planting						
Trench	10.44	13.63	1.31	1.49	45.33	46.16
Pit	4.58	6.22	1.50	2.20	46.11	47.35
Crop combinations						
T_1	7.12^{c}	9.12^{c}	1.20^{bc}	1.84^{ab}	41.63^{f}	43.77^{e}
T_2	7.25^{bc}	9.50^{c}	1.52^{a}	1.92^{a}	44.83^{cd}	44.68^{de}
T_3	8.50^{a}	11.12^{a}	1.44^{abc}	1.79^{ab}	47.52^{b}	49.28^{b}
T_4	8.12^{ab}	11.12^{a}	1.53^{a}	1.74^{ab}	46.90^{b}	49.48^{b}
T_5	7.37^{bc}	9.50^{c}	1.17^{c}	1.66^{b}	42.64^{ef}	44.36^{de}
T_6	7.12^{c}	9.12^{c}	1.21^{bc}	1.80^{ab}	44.12^{de}	44.29^{de}
T_7	7.12^{c}	9.62^{bc}	1.44^{abc}	1.94^{a}	46.91^{b}	45.78^{cd}
T_8	6.87^{c}	9.62^{c}	1.49^{ab}	1.89^{ab}	46.49^{bc}	46.95^{c}
T_9	8.12^{ab}	10.62^{ab}	1.54^{a}	1.95^{a}	50.43^{a}	52.21^{a}
Interaction	NS	NS	NS	NS	NS	NS

T_1 - ashgourd + cucumber, T_2 - ashgourd + pole cowpea, T_3 - ashgourd + bush cowpea, T_4 - ashgourd + amaranthus, T_5 - ashgourd + cucumber + bush cowpea, T_6 - ashgourd + cucumber + amaranthus, T_7 - ashgourd + pole cowpea + bush cowpea, T_8 - ashgourd + pole cowpea + amaranthus, T_9 - sole crop of ashgourd, NS - Non significant

Weight of fruits differed significantly due to planting systems during both the seasons. Significantly lower average fruit weight was recorded under trench system of planting compared to the pit system. Average fruit weight under pit system of planting was 1.50 Kg and 2.20 Kg whereas under trench system it was 1.31 Kg and 1.49 Kg during first and second seasons respectively.

Intercrops exerted a significant influence on average fruit weight during first season only. During both the seasons T_2 recorded significantly higher average fruit weight (1.52 kg and 1.92 kg) followed by T_9 (1.54 kg and 1.95 kg). The treatment T_5 recorded significantly lowest fruit weight of 1.17 and 1.66 kg in first and second season respectively.

Interaction effect did not significantly influence the weight of fruits in the first and second season.

4.1.11 Circumference of fruits

Effect of planting systems and intercrops on circumference of fruits is presented in Table 4.

Planting systems did not significantly influence the circumference of fruits in both the seasons. Pit system recorded a higher mean value of 46.11 cm and 47.35 cm as compared to the trench system which recorded 45.33 and 46.16 cm in first and second season respectively.

Intercrops had significant influence on the circumference of fruits in both seasons. Sole crop of ashgourd (T_9) recorded significantly superior circumference of fruits (50.53 cm and 52.21 cm) where as ashgourd + cucumber (T_1) gave

significantly lowest value of 41.64 cm and 43.77 cm in first and second season respectively.

The interaction effect was found to be non significant in both the seasons.

4.1.12 Length of fruits

The effect of planting system and crop combination on the length of fruits is given in Table 5.

Planting system had no significant influence on the length of fruits in both seasons. Trench system recorded a mean fruit length of 31.91 cm and 32.58 cm and pit system recorded 32.77 cm and 32.33 cm in first and second season respectively.

Intercrops significantly influenced the length of fruits during the first season. Pure crop of ashgourd (T_9) recorded significantly greater fruit length of 36.76 cm and ashgourd + cucumber (T_1) recorded the lowest (28.71 cm).

During the second season also ashgourd as a pure crop gave the highest fruit length (36.83 cm) which was on par with ashgourd + amaranthus (T_4) combination. Ashgourd + cucumber (T_1) recorded a mean value of 28.232 cm which was statistically inferior to all other treatments.

The interaction between planting pattern and intercrops was found to be non significant in the two seasons.

Table 5. Effect of planting system and intercrops on length and flesh thickness of fruits and yield per ha in ashgourd

Treatment	Length of fruits		Flesh thickness of fruits		Yield (Kg ha^{-1})	
	I season	II season	I season	II season	I season	II season
Methods of planting						
Trench	31.91	32.58	4.38	4.58	15122.06	22371.14
Pit	32.77	32.33	4.40	4.64	3735.34	7576.77
Crop combinations						
T_1	28.70^{d}	28.23^{f}	3.95^{d}	4.22^{d}	$7963\ 88^{g}$	13517.36^{g}
T_2	30.89^{c}	31.33^{e}	4.34^{c}	4.30^{d}	9839.93^{d}	15028.47^{f}
T_3	33.93^{b}	34.54^{bc}	4.52^{bc}	4.85^{abc}	10931.25^{b}	16432.63^{b}
T_4	34.33^{b}	36.00^{ab}	4.84^{ab}	4.92^{ab}	10888.88^{c}	16382.63^{c}
T_5	30.56^{c}	32.54^{de}	4.24^{cd}	4.58^{bcd}	7777.77^{i}	12917.70^{i}
T_6	32.20^{c}	27.15^{f}	4.32^{cd}	4.46^{cd}	7906.59^{h}	13389.58^{h}
T_7	31.73^{c}	33.36^{cd}	4.14^{cd}	4.49^{bcd}	9325.00^{e}	15288.19^{d}
T_8	31.97^{c}	32.15^{de}	4.19^{cd}	4.59^{bcd}	9204.16^{f}	15059.02^{e}
T_9	36.76^{a}	36.83^{a}	4.96^{a}	5.09^{a}	11020.83^{a}	16750.00^{a}
Interaction	NS	NS	Sig	Sig	Sig	NS

T_1 - ashgourd + cucumber, T_2 - ashgourd + pole cowpea, T_3 - ashgourd + bush cowpea, T_4 - ashgourd + amaranthus, T_5 - ashgourd + cucumber + bush cowpea, T_6 - ashgourd + cucumber + amaranthus, T_7 - ashgourd + pole cowpea + bush cowpea, T_8 - ashgourd + pole cowpea + amaranthus, T_9 - sole crop of ashgourd, NS - Non significant, Sig - Significant

Table 6. Interaction effect of planting system and intercrops on flesh thickness and yield of ashgourd

Treatment	Flesh thickness				Yield/ha	
	I season		II season		I season	
	Trench	Pit	Trench	Pit	Trench	Pit
Crop combinations						
T_1	4.00^{f}	3.90^{f}	4.26^{cdef}	4.17^{def}	13011.11^{g}	2916.67^{a}
T_2	4.09^{def}	4.59^{abcde}	4.55^{abcdef}	4.05^{ef}	15758.33^{d}	3921.53^{m}
T_3	4.31^{cdef}	4.73^{abc}	4.87^{abc}	4.84^{abc}	17223.61^{b}	4638.89^{j}
T_4	4.76^{abc}	4.92^{ab}	4.81^{abcd}	5.02^{ab}	17104.17^{c}	4673.61^{k}
T_5	4.06^{def}	4.43^{bcdef}	4.75^{abcd}	4.42^{bcdef}	12540.28^{i}	3015.28^{p}
T_6	4.62^{abcd}	4.03^{f}	4.00^{f}	4.91^{abc}	12911.11^{h}	2902.08^{r}
T_7	4.39^{bcdef}	3.90^{f}	4.28^{cdef}	4.71^{abcd}	15325.00^{e}	3325.00^{o}
T_8	4.32^{cdef}	4.06^{ef}	4.64^{abcde}	4.54^{abcdef}	14961.11^{f}	3447.22^{n}
T_9	4.92^{ab}	5.01^{b}	5.06^{ab}	5.12^{a}	17263.88^{a}	4777.78^{k}

T_1 - ashgourd + cucumber, T_2 - ashgourd + pole cowpea, T_3 - ashgourd + bush cowpea, T_4 - ashgourd + amaranthus, T_5 - ashgourd + cucumber + bush cowpea, T_6 - ashgourd + cucumber + amaranthus, T_7 - ashgourd + pole cowpea + bush cowpea, T_8 - ashgourd + pole cowpea + amaranthus, T_9 - sole crop of ashgourd

4.1.13 Flesh thickness of fruits

The data on flesh thickness of fruits is presented in Table 5.

Planting pattern had no significant influence on the flesh thickness of fruits. Pit system recorded higher mean flesh thickness compared to trench system.

Intercrops exerted significant influence on flesh thickness of fruits. In first season T_9 recorded significantly superior value (4.96 cm) which was on par with T_4 (4.84). Lowest flesh thickness was recorded by T_1 but it was statistically on par with T_5, T_6, T_7 and T_8. In the second season also T_9 recorded superior mean value of 5.09 cm. T_9 was statistically on par with the treatments T_3 and T_4. T_1 recorded the lowest flesh thickness of 4.22 cm followed by T_2 (4.30 cm). These two treatments were on par with the treatments T_5, T_6, T_7 and T_8.

There was significant interaction between planting systems and intercrops on flesh thickness of fruits in both the seasons. The data is presented in Table 6.

The highest flesh thickness was recorded by the treatment T_9 of the pit system which gave a significantly superior value of 5.01 cm is first season and 5.12 in second season. In first season it was statistically on par with the treatments T_2, T_3 and T_4 of pit system and T_4, T_6 and T_9 of the trench system. In the second season T_9 of pit system was on par with T_3, T_4, T_6, T_7 and T_8 of pit system and T_2, T_3, T_4, T_5, T_8 and T_9 of trench system. The least flesh thickness of 3.9 cm was recorded by T_7 of pit system in first season and T_6 of trench system in second season.

4.1.14 Yield/ha

The effect of planting system and intercrops on the yield of ashgourd is presented in Table 5.

Planting system significantly affected the yield potential of ashgourd in both the seasons. Trench system recorded a superior yield compared to the pit system. During the first season the yield obtained under trench system was 15122.07 kg ha^{-1} where as it was only 3735.34 kg ha^{-1} under pit system. In second season trench system recorded a higher yield of 22371.14 kg ha^{-1} and the pit system recorded only 7576.77 kg ha^{-1}.

The intercrops also had significant influence on the yield performance of ashgourd. During the first season sole crop of ashgourd recorded an yield of 11020.83 kg ha^{-1} which was statistically superior to all other treatments. This was followed by ashgourd + bush cowpea and ashgourd + amaranthus combination which recorded mean yields of 10931.25 kg ha^{-1} and 1088.89 kg ha^{-1} respectively. The lowest yield (7777.78 kg ha^{-1}) of ashgourd was recorded in the combination of ashgourd + cucumber + bush cowpea (T_5). An average yield of 9839.93 kg ha^{-1} was realised under the combination ashgourd + pole cowpea.

During the second season also significantly higher yield was recorded by the pure crop of ashgourd (16750.00 kg ha^{-1}) which was followed by ashgourd + bush cowpea (1643.64 kg ha^{-1}) and ashgourd + amaranthus (16382.64 kg ha^{-1}). Combination of ashgourd + cucumber + bush cowpea recorded an average yield of 12917.71 kg ha^{-1} and was lowest among all the treatments. The treatments (T_7) and (T_8) recorded an average yield of 15288.19 kg ha^{-1} and 15059.03 kg ha^{-1} respectively.

The interaction of planting systems and intercrops was found to be significant in the first season. The data is presented in Table 6.

Treatment T_9 of trench system recorded a yield of 17263.88 kg ha^{-1} which was statistically superior to all other treatments. The lowest yield was recorded by T_6 of the pit system with a mean value of 2902.08 kg ha^{-1}.

The interaction was found to be non significant in the second season.

4.2 Cucumber

4.2.1 Length of main vine

The effect of planting systems and intercrops on length of main vine of cucumber is presented in Table 7.

Planting system had no significant influence on the length of main vine of cucumber. In the first season cucumber plants under trench system recorded the highest length of main vine (2.39 cm) where as in the second season plants under pit system gave the highest mean length of vine (3.06 cm).

Intercrops had significant influence in the length of main vine. Sole crop of cucumber recorded significantly higher vine length of 2.66 m and 3.19 m during first and second seasons respectively. Lowest vine length was for ashgourd + cucumber combination. All other treatments were on par with this during the two seasons.

Interaction effect on length of main vine was found to be statistically non significant in both seasons.

4.2.2 Number of primary branches/plant

The data on the number of primary branches/plant is given in Table 7.

Table 7. Effect of planting system and intercrops on length of main vine, number of primary branches and internodal length of cucumber

Treatment	Length of main vine (cm)		No.of primary branches per plant		Internodal length (cm)	
	I season	II season	I season	II season	I season	II season
Methods of planting						
Trench	2.38	2.79	5.03	4.96	5.18	5.48
Pit	2.14	3.06	4.84	4.90	5.31	5.58
Crop combinations						
T_1	2.10^b	2.77^b	4.62^b	4.43^c	5.25^a	5.68^a
T_5	2.19^b	2.92^b	4.93^{ab}	4.93^b	5.26^a	5.35^b
T_6	2.11^b	2.82^b	4.68^b	4.87^b	5.30^a	5.63^{ab}
T_{10}	2.65^a	3.18^a	5.50^a	5.50^a	5.19^a	5.46^{ab}
Interaction	NS	NS	NS	NS	NS	NS

T_1 - ashgourd + cucumber, T_5 - ashgourd + cucumber + bush cowpea, T_6 - ashgourd + cucumber + amaranthus, T_{10} - Sole crop of cucumber, NS - Non significant

Table 8. Effect of planting system and intercrops on days to first male and female flower anthesis and node of first female flower in component crop cucumber

Treatment	Days to first female flower anthesis		Days to first male flower anthesis		Node at which first female flower appeared	
	I season	II season	I season	II season	I season	II season
Methods of planting						
Trench	32.34	32.87	30.21	30.50	5.96	6.12
Pit	32.43	31.93	30.68	29.65	6.12	6.00
Crop combinations						
T_1	32.68^{ab}	33.31^a	30.56^{ab}	30.50^a	5.75^a	5.81^a
T_5	32.31^{ab}	32.87^a	30.37^{ab}	30.68^a	6.31^a	6.37^a
T_6	32.93^a	32.00^b	31.37^a	29.68^b	6.12^a	6.12^a
T_{10}	31.62^b	31.43^b	29.50^b	29.43^b	6.00^a	5.93^a
Interaction	NS	NS	NS	NS	NS	NS

T_1 - ashgourd + cucumber, T_5 - ashgourd + cucumber + bush cowpea, T_6 - ashgourd + cucumber + amaranthus, T_{10} - sole crop of cucumber, NS - Non significant

The influence of planting system and interaction between planting system and intercrops was found to be non significant in both seasons in the case of number of primary branches per plant.

The intercrops had significant influence on the primary branches. During the first season T_{10} (sole crop of cucumber) recorded significantly higher number (5.5) which was on par with T_5. In second season also T_{10} recorded the highest mean of 5.5 which was statistically superior to all other treatments.

4.2.3 Internodal length

The effect of planting pattern and intercrops on internodal length of cucumber is presented in Table 7.

Internodal length of cucumber was not influenced either by the planting system, intercrops or their interaction in both the seasons.

Th internodal length of sole crop of cucumber was on par with intercropped cucumber plants in both the seasons.

4.2.4 Days to first female flower anthesis

The data on the effect of planting system and intercrops on the number of days taken for first female flower anthesis is given in Table 8.

In the first season the influence of planting systems, intercrops and their interaction on the number of days for first female flower anthesis was found to be non significant. In second season planting pattern and intercrops had significant influence on the number of days. In trench system the number of days taken was

32.88 and in pit system it was 31.94 days. Maximum number of days (33.31) was taken by T_1 which was on par with T_5. Least number of days for female flower anthesis was taken by the treatment T_{10}.

The interaction effect was found to be non significant in second season also.

4.2.5 Days to first male flower anthesis

The data on the days to first male flower anthesis is presented in Table 8.

During the first season, planting system had no significant influence on the number of days for first male flower anthesis. Pure crop of cucumber (T_{10}) took the least number of days (29.5) for first male flower formation which was on par with T_1 and T_5.

In the second season, planting system and intercrops exerted significant influence on male flower anthesis. Trench system took more number of days (30.5) compared to pit system (29.66). T_{10} recorded the least number of days (29.44) and maximum number of days was taken by T_5 (30.69).

Interaction was statistically non significant in both the seasons.

4.2.6 Node at which first female flower appeared

The effect of intercrops and planting system on the node at which first female flower appeared is presented in Table 8.

The node at which first female flower appeared was not influenced either by the planting system or intercrops and their interactions in both the seasons.

The node number at which first female flower appeared in pure crop was on par with intercropped cucumber in first and second season.

4.2.7 Number of female flowers

The effect of planting systems and intercrops on number of female flowers is given in Table 9.

Planting system had no significant influence on number of female flowers in cucumber. Trench system recorded a mean number of days of 9.06 and 9.28 and pit system recorded 8.72 and 9.22 in first and second seasons respectively.

Intercrops exerted a significant influence over the number of female flowers. Maximum number of female flowers was obtained in T_{10} (10 and 9.88 in first and second season).

The interaction effect was statistically non significant in the two seasons.

4.2.8 Fruit set percentage

The effect of planting system and intercrops on the fruit set percentage is given in Table 9.

The planting system and interaction between planting system and intercrops had no significant influence on the fruit set percentage.

Table 9. Effect of planting system and intercrops on number of female flowers and percent fruit set in component crop cucumber

Treatment	Number of female flowers		Percentage fruit set	
	I season	II season	I season	II season
Methods of planting				
Trench	9.06	9.28	51.51	51.56
Pit	8.71	9.21	51.93	52.85
Crop combinations				
T_1	8.18^{b}	9.12^{ab}	50.31^{b}	51.51^{b}
T_5	8.87^{ab}	9.31^{ab}	49.42^{b}	51.78^{b}
T_6	8.50^{b}	8.68^{b}	51.20^{b}	50.80^{b}
T_{10}	10.00^{a}	9.87^{a}	55.95^{a}	54.75^{a}
Interaction	NS	NS	NS	NS

T_1 - ashgourd + cucumber, T_5 - ashgourd + cucumber + bush cowpea, T_6 - ashgourd + cucumber + amaranthus, T_{10} - sole crop of cucumber, NS - Non significant

Table 10. Effect of planting system and intercrops on number of fruits, weight and circumferences of fruits in component crop cucumber

Treatment	Number of fruits		Weight of fruits (kg)		Circumference of fruits (cm)	
	I season	II season	I season	II season	I season	II season
Methods of planting						
Trench	9.00	12.37	1.19	1.22	15.81	17.96
Pit	3.93	5.37	1.59	2.07	14 61	16.97
Crop combinations						
T_1	5.87^{b}	8.75^{b}	1.36^{b}	1.59^{ab}	16.21^{a}	17.59^{a}
T_5	6.25^{b}	7.87^{c}	1.30^{b}	1.70^{a}	13.78^{b}	17.65^{a}
T_6	6.37^{b}	8.75^{b}	1.25^{b}	1.55^{b}	14.12^{b}	15.68^{b}
T_{10}	7.37^{a}	10.12^{a}	1.64^{a}	1.73^{a}	16.72^{a}	18.95^{a}
Interaction	NS	NS	NS	NS	NS	NS

T_1 - ashgourd + cucumber, T_5 - ashgourd + cucumber + bush cowpea, T_6 - ashgourd + cucumber + amaranthus, T_{10} - sole crop of cucumber, NS - Non significant

Intercrops had significant influence over the fruit set percentage. T_{10} recorded a mean fruit set percentage of 55.95 in first season and 54.75 in second season which was statistically superior to all other treatments which were on par with each other.

4.2.9 Number of fruits

The data on the number of fruits obtained per plot is presented in Table 10.

Planting system had significant influence on the number of fruits. Trench system gave a significantly superior mean number of fruits 9.00 and 12.38 in first and second season where as pit system gave only 3.94 and 5.38 fruits.

Intercrops influenced the number of fruits significantly. T_{10} recorded statistically superior number of fruits of 7.38 in the first season and 10.126 in othe second season. The intercrops recorded significantly lower fruit number in the two seasons.

The interaction effect was found to be non significant in the first and second season.

4.2.10 Weight of fruits

The data on the mean fruit weight is presented in Table 10.

Planting system and intercrops had significant influence on the weight of fruits. Pit system gave a significantly higher mean fruit weight compared to the trench system in both the seasons.

In the first season T_{10} recorded significantly higher mean fruit weight (1.64). All other treatments were inferior to this. In the second season also T_{10} recorded the highest value of 1.73 kg and the treatments T_1 and T_5 were on par with T_{10}.

Interaction had no significant influence on weight of fruits.

4.2.11 Circumference of fruits

The data regarding the circumference of fruit is presented in Table 10.

Planting system and interaction of intercrops and planting system had no significant influence on the circumference of fruits.

Trench system recorded a higher mean circumference compared to pit system.

Sole crop of cucumber (T_{10}) gave the highest fruit circumference of 16.73 cm and 18.96 cm in the first and second seasons respectively. In the first season it was on par with T_1 where as in second season it was on par with T_1 and T_5.

4.2.12 Length of fruits

The effect of planting system and intercrops on the length of fruits is presented in Table 11.

Planting system had no significant influence on fruit length in both seasons.

Table 11. Effect of planting system and intercrops on length and flesh thickness of fruits and yield per ha in component crop cucumber

Treatment	Length of fruits (cm)		Flesh thickness of fruits(cm)		Yield(kg ha^{-1})	
	I season	II season	I season	II season	I season	II season
Methods of planting						
Trench	21.25	22.11	2.17	2.30	11831.25	16854.17
Pit	20.01	23.60	2.26	2.40	3548.61	6175.34
Crop combinations						
T_1	19.06^{b}	23.24^{b}	2.05^{a}	2.32^{b}	7055.55^{b}	11062.50^{b}
T_5	19.96^{b}	21.82^{bc}	2.08^{a}	2.20^{b}	6842.36^{c}	10670.13^{c}
T_6	20.72^{ab}	21.07^{c}	2.32^{a}	2.28^{b}	6986.11^{c}	10670.13^{c}
T_{10}	22.78^{a}	25.29^{a}	2.40^{a}	2.61^{a}	9875.69^{a}	13656.25^{a}
Interaction	NS	NS	NS	NS	Sig	Sig

T_1 - ashgourd + cucumber, T_5 - ashgourd + cucumber + bush cowpea, T_6 - ashgourd + cucumber + amaranthus, T_{10} - sole crop of cucumber, NS - Non significant, Sig - Significant

Table 12. Interaction effect of planting system and intercrops on yield of cucumber

Treatment	Yield (kg ha^{-1})			
	Ist season		II season	
	Trench	Pit	Trench	Pit
Crop combinations				
T_1	11069.44^{b}	3041.66^{h}	16055.55^{b}	6069.44^{h}
T_5	10483.33^{d}	3201.38^{f}	15722.22^{c}	5618.05^{f}
T_6	10902.77^{c}	3069.44^{g}	15375.00^{d}	5965.27^{g}
T_{10}	14869.44^{a}	4881.94^{e}	20263.88^{a}	7048.61^{e}

T_1 - ashgourd + cucumber, T_5 - ashgourd + cucumber + bush cowpea, T_6 - ashgourd + cucumber + amaranthus, T_{10} - sole crop of cucumber

Intercrops had significant influence on fruit length. T_{10} recorded maximum fruit length (22.78 cm) which was on par with T_6 during the first season. In second season also T_{10} recorded significantly superior fruit length (25.29 cm) compared to all other treatments.

The interaction effect of planting system and intercrops was found to be non significant in case of fruit length on both seasons.

4.2.13 Flesh thickness of fruits

The data regarding the flesh thickness of fruits is presented in Table 11.

Planting system and interaction between planting system and intercrops did not statistically affect the flesh thickness of cucumber. Pit system recorded a higher flesh thickness compared to the trench system in both seasons.

The flesh thickness (2.40 cm) of sole crop of cucumber was on par with intercropped cucumber in first season. In second season T_{10} gave a significantly superior value of 2.61 cm which was higher than all the treatments.

4.2.14 Yield per hectare

The effect of planting systems and intercrops on yield of cucumber is given in Table 11.

Planting system had significant influence on yield of cucumber. Plants under trench system gave a higher mean yield of 11831.25 kg ha^{-1} and 16854.17 kg ha^{-1} as compared to pit system which recorded a mean yield of 3548.61 kg ha^{-1} and 6175.35 kg ha^{-1} during the first and second season respectively.

Intercrops also executed a significant influence on yield of cucumber. Sole crop of cucumber recorded a significantly superior yield of 9875.69 kg ha^{-1} and 13656.25 kg ha^{-1} in first and second season respectively. This was followed by T_1 then T_5 and T_6.

The interaction was also found to be significant in the case of yield of cucumber. The data is given in Table 12.

T_{10} of the trench system recorded the highest mean yield in both the seasons. T_1 of pit system recorded the lowest yield in the two seasons.

4.3 Pole cowpea

4.3.1 Length of vine

The effect of planting pattern and intercrops on length of vine of pole cowpea is given in Table 13.

The length of vine was not significantly influenced either by planting system or intercrops and interaction between planting system and intercrops.

The sole crop of cowpea recorded almost similar vine length as with intercropped plants.

4.3.2 Days to first flowering

The data on the number of days for flowering is given in Table 13.

The effect of planting system, intercrops and their interaction was found to be non significant on the number of days taken for flowering. The least number

Table 13. Effect of planting system and intercrops on length of vine and days to first flowering in component crop pole cowpea

Treatment	Length of vine (m)		Days to first flowering	
	I season	II season	I season	II season
Methods of planting				
Trench	3.72	4.07	40.47	40.00
Pit	3.61	4.15	40.31	39.93
Crop combinations				
T_3	3.39^{b}	4.15^{a}	40.93	40.06^{a}
T_5	3.68^{ab}	4.07^{a}	40.43^{ab}	40.00^{a}
T_7	3.74^{ab}	4.05^{a}	40.45^{ab}	40.06^{a}
T_{12}	3.86^{a}	4.15^{a}	39.75^{b}	39.75^{a}
Interaction	NS	NS	NS	NS

T_3 - ashgourd + bush cowpea, T_5 - ashgourd + cucumber + bush cowpea, T_7 - ashgourd + pole cowpea + bush cowpea, T_{12} - sole crop of bush cowpea. NS - Non significant

Table 14. Effect of planting system and intercrops on average fruit weight and yield per ha in component crop pole cowpea

Treatment	Average weight of fruits (g)		Yield/ha	
	I season	II season	I season	II season
Methods of planting				
Trench	11.73	10.32	874.65	2089.93
Pit	11.29	11.93	313.36	557.63
Crop combinations				
T_3	11.34^{a}	12.00^{a}	600.00^{b}	1208.33^{d}
T_5	11.72^{a}	10.86^{a}	527.43^{d}	1213.88^{c}
T_7	11.04^{a}	10.66^{a}	544.44^{c}	1312.50^{b}
T_{12}	11.93^{a}	11.98^{a}	704.16^{a}	1560.43^{a}
Interaction	NS	NS	NS	Sig

T_3 - ashgourd + bush cowpea, T_5 - ashgourd + cucumber + bush cowpea, T_7 - ashgourd + pole cowpea + bush cowpea, T_{12} - sole crop of bush cowpea, NS - Non significant, Sig - Significant

Table 15. Interaction effect of planting system and intercrops on yield of pole cowpea in second season

Treatments	Yield (kg ha^{-1})	
	Trench	Pit
Crop combinations		
T_2	1851.389^{d}	565.278^{f}
T_7	1887.500^{c}	540.278^{g}
T_8	2087.500^{b}	537.500^{g}
T_{11}	2533.361^{a}	587.500^{e}

T_2 - ashgourd + pole cowpea, T_7 - ashgourd + pole cowpea + bush cowpea, T_8 - ashgourd + pole cowpea + amaranthus, T_{11} - sole crop of pole cowpea

of days was taken for the pure crop of pole cowpea but all other treatments were on par with this except T_2 of first season.

4.3.3 Average weight of fruits

The average weight of fruits is presented in Table 14.

Average weight of fruits was not significantly influenced by planting system, intercrops or their interaction in first season.

The planting system exerted a significant influence on fruit weight during the second season. Pit system recorded a superior fruit weight of 11.93 g as compared to trench system (10.82 g).

The effect of intercrops and the interaction between intercrops and planting system was found to be non significant. The average fruit weight of pure crop of pole cowpea was on par with the intercropped cowpea. The interaction was statistically non significant in second season.

4.3.4 Yield per hectare

The effect of planting pattern and intercrops on yield of pole cowpea is given in Table 14.

Planting system significantly influenced the yield of pole cowpea. In both seasons trench system gave significantly higher yield than the pit system. Trench system recorded a mean yield of 874.65 kg ha^{-1} and 2089.93 kg ha^{-1} and pit system recorded 313.36 kg ha^{-1} and 557.63 kg ha^{-1} during the first and second season respectively.

Intercrops also had significant influence on yield of cowpea. Sole crop of cowpea recorded significantly superior yield of 704.16 kg ha^{-1} and 1560.43 kg ha^{-1} during the first and second season respectively. All other treatments were inferior to this.

In the first season interaction was found to be non significant where as in second season there was significant interaction between planting system and intercrop. The data is presented in Table 15.

T_{11} of trench system recorded statistically superior yield compared to all other treatments. The lowest yield was recorded by T_8 of the pit system. Trench system recorded significantly superior yield compared to pit system.

4.4 Bush cowpea

4.4.1 Height of plant

The data regarding the height of plant is presented in Table 16.

Planting system, intercrops and their interaction failed to exert any significant influence on the height of the plant. Sole crop of cowpea recorded significantly higher mean height compared to intercrops.

4.4.2 Days to first flowering

The effect of planting system and intercrops on the number of days taken for flowering is given in Table 16.

The number of days for flowering was not significantly influenced either by planting system, intercrops or their interaction during both the seasons. The

Table 16. Effect of planting system and intercrops on height of plant and days to first flowering in component crop bush cowpea

Treatment	Height of plant (cm)		Days to first flowering	
	I season	II season	I season	II season
Methods of planting				
Trench	47.82	48.51	30.71	30.84
Pit	48.53	48.35	31.06	30.84
Crop combinations				
T_3	47.51^{b}	47.65^{b}	30.87^{d}	30.93^{ab}
T_5	47.58^{b}	48.37^{ab}	31.31^{a}	30.62^{ab}
T_7	48.22^{ab}	48.23^{ab}	30.81^{a}	31.31^{d}
T_{12}	49.40^{a}	49.47^{a}	30.56^{a}	30.50^{b}
Interaction	NS	NS	NS	NS

T_3 - ashgourd + bush cowpea, T_5 - ashgourd + cucumber + bush cowpea, T_7 - ashgourd + pole cowpea + bush cowpe, T_{12} - sole crop of bush cowpea, NS - Non significant

Table 17. Effect of planting system and intercrops on average fruit weight and yield per ha in component crop bush cowpea

Treatment	Average weight of fruits (g)		Yield(kg ha^{-1})	
	I season	II season	I season	II season
Methods of planting				
Trench	3.21	3.57	5440.97	5384.37
Pit	3.76	3.43	5012.84	5320.48
Crop combinations				
T_3	3.31^{a}	3.72^{a}	4930.55^{d}	5218.05^{c}
T_5	3.53^{a}	3.31^{a}	4986.11^{c}	5241.66^{b}
T_7	3.48^{a}	3.16^{a}	5319.44^{b}	5212.50^{d}
T_{12}	3.62^{a}	3.81^{a}	5671.52^{a}	5737.50^{a}
Interaction	NS	NS	NS	NS

T_3 - ashgourd + bush cowpea, T_5 - ashgourd + cucumber + bush cowpea, T_7 - ashgourd + pole cowpea + bush cowpea, T_{12} - sole crop of bush cowpea

number of days taken for first flowering by the sole crop of cowpea was on par with the number of days taken when grown as an intercrop.

4.4.3 Weight of fruits

The data on the average weight of fruits is given in Table 17.

Planting system, intercrops and their interaction had no significant influence on the average fruit weight of bush cowpea. Cowpea when grown as an intercrop under trench system recorded a mean fruit weight of 3.21 g and 3.57 g and pit system recorded 3.76 g and 3.43 g in the first and second season respectively.

4.4.4 Yield per hectare

The effect of planting system and intercrops on the yield of bush cowpea is presented in Table 17.

The yield of cowpea was not significantly influenced either by the planting system, intercrops and their interaction in both seasons. Sole crop of bush cowpea recorded the highest yield of 5671.52 kg ha^{-1} and 5737.50 kg ha^{-1} in the first and second season respectively. The lowest yield was recorded by T_3 (4930.55 kg) in first season and T_7 (5212.50 kg) in second season.

4.5 Amaranthus

4.5.1 Number of cuttings

In amaranthus the number of cuttings taken was 5 in both the seasons for all the treatments.

Table 18. Yield of amaranthus as affected by planting pattern and intercrops

Treatment	Yield (kg ha^{-1})	
	I season	II season
Methods of planting		
Trench	8281.25	9915.62
Pit	8248.95	9987.84
Crop combinations		
T_4	8246.52^b	9972.22^b
T_6	8131.94^c	9556.94^d
T_8	7854.16^d	9875.00^c
T_{13}	8827.77^a	10402.77^a
Interaction	NS	NS

T_4 - ashgourd + amaranthus, T_6 - ashgourd + cucumber + amaranthus, T_8 - ashgourd + pole cowpea + amaranthus, T_{13} - sole crop of amaranthus, NS - Non significant

4.5.2 Yield per hectare

The data on the yield of amaranthus as influenced by intercrops and planting pattern is given in Table18.

Planting system had no significant influence on the yield of amaranthus in both season.

Intercrops had significant influence on the yield in first season only where as in second season the influence was non significant. During the first and second season the sole crop of amaranthus recorded a mean yield of 8827.77 kg ha^{-1} and 10402.77 kg ha^{-1} respectively. All other treatments were significantly different from this during first season.

4.6 Biological efficiency of intercropping system

4.6.1 Land equivalent ratio (LER)

The data on LER were statistically analysed and the mean values are presented in Table 19.

The total LER of the crops were not influenced by the planting system and interaction between planting system and intercrops in the first season. But the intercrops significantly influenced the total LER.

The combination of ashgourd + pole cowpea + bush cowpea (T_7) gave the highest LER value of 2.49. This was on par with T_8. The lowest value of LER was for ashgourd + pole cowpea (T_2) combination (1.75). This was statistically on par with treatments having amaranthus and bush cowpea along with ashgourd (T_3 and T_4).

Table 19. Effect of planting system and intercrops on the parameters for evaluating the biosuitability of ashgourd based cropping system

Treatment	LER		LEC		ATER	
	I season	II season	I season	II season	I season	II season
Methods of planting						
Trench	2.09	2.14	0.64	0.68	1.71	1.75
Pit	2.00	2.25	0.59	0.79	1.62	1.82
Crop combinations						
T_1	1.36^{e}	1.62^{f}	0.46^{cde}	0.66^{cd}	1.19^{c}	1.44^{d}
T_2	1.75^{d}	1.76^{e}	0.76^{b}	0.78^{bc}	1.61^{bcd}	1.58^{c}
T_3	1.88^{d}	1.90^{de}	0.85^{ab}	0.88^{ab}	1.50^{d}	1.49^{cd}
T_4	1.92^{d}	1.93^{d}	0.92^{a}	0.93^{a}	1.58^{cd}	1.57^{c}
T_5	2.25^{c}	2.46^{c}	0.40^{e}	0.55^{d}	1.73^{bc}	1.88^{b}
T_6	2.28^{bc}	2.52^{bc}	0.43^{de}	0.60^{d}	1.76^{b}	1.96^{b}
T_7	2.49^{a}	2.65^{ab}	0.57^{c}	0.72^{c}	1.97^{a}	2.14^{a}
T_8	2.45^{ab}	2.72^{a}	0.54^{cd}	0.76^{c}	2.00^{a}	2.21^{a}
Interaction	NS	NS	NS	NS	NS	NS

T_1 - ashgourd + cucumber, T_2 - ashgourd + pole cowpea, T_3 - ashgourd + bush cowpea, T_4 - ashgourd + amaranthus, T_5 - ashgourd + cucumber + bush cowpea, T_6 - ashgourd + cucumber + amaranthus, T_7 - ashgourd + pole cowpea + bush cowpea, T_8 - ashgourd + pole cowpea + amaranthus, NS - Non significant

In the second season, planting system and intercrops had significant influence on total LER. The pit system gave a higher mean LER (2.25) than the trench system (2.14). LER (2.72) obtained with ashgourd + pole cowpea + amaranthus (T_8) was significantly superior to all other treatments and was on par with T_7. Here also ashgourd + pole cowpea gave the lowest LER (1.76) value. The interaction between planting system and intercrops did not influence the total LER significantly in the second season.

4.6.2 Land equivalent coefficient (LEC)

The data on LEC is presented in Table 19.

As in the case of LER, LEC was significantly influenced by intercrops where as the effect of planting system and the interaction between planting system and intercrops were nonsignificant in the first season. In the second season, planting system and intercrops significantly influenced the LEC where as their interaction had no effect on LEC.

In the first and second season ashgourd + amaranthus (T_4) combination gave the highest LEC value of 0.92 and 0.93 respectively which was on par with T_3. The lowest LEC value of 0.40 and 0.55 in first and second season was recorded by ashgourd + cucumber + bush cowpea combination.

4.6.3 Aggressivity

Data on aggresivity values are presented in Table 20.

Planting system significantly influenced the aggressivity values during the first season only, where the intercrops were found to be dominant in the trench

system (-0.38). In second season the influence of planting system was found to be nonsignificant.

The aggressivity values were significantly influenced by the intercrops in both the seasons. Negative aggressivity values for treatments T_1, T_2, T_5, T_6, T_7 and T_8 indicate the dominant nature of the intercrops in first season. In treatments where ashgourd is in combination with bush cowpea and amaranthus (T_3 and T_4), ashgourd was dominant over the intercrops.

In second season also the treatments T_1, T_5, T_6, T_7 and T_8 showed a dominant nature over ashgourd with a negative aggressivity value. All other treatments showed the dominant nature of ashgourd.

Interaction was found to be non significant in both the seasons.

4.6.4 Area time equivalent ratio (ATER)

The data on ATER were statistically analysed and given in Table 19.

ATER was significantly influenced by planting system and intercrops in both the seasons. In the first season trench system gave a higher ATER value (1.71) where as it was the pit system (1.82) which gave a higher value in second season.

Highest ATER value was recorded by the combination of ashgourd + pole cowpea + amaranthus (2.00 and 2.21 during the first and second season). The lowest value was for ashgourd + cucumber (1.19 and 1.44 in the first and second season).

Interaction had no significant influence on ATER in both the seasons.

Table 20. Effect of intercrops and planting system on the parameters for evaluating the biosuitability of ashgourd based cropping system

Treatment	Aggressivity		Ashgourd equivalent yield kg ha^{-1}		RCC	
	I season	II season	I season	II season	I season	II season
Methods of planting						
Trench	-0.38	-0.38	8379.71	10842.22	0.97	10.58
Pit	-0.50	-0.47	5657.81	7331.99	4.56	55.37
Crop combinations						
T_1	-0.00^{a}	-0.03^{a}	5644.44^{e}	8850.00^{b}	2.49^{a}	4.77^{b}
T_2	-0.02^{a}	0.06^{a}	720.83^{f}	1450.00^{d}	8.10^{a}	16.73^{b}
T_3	0.09^{a}	0.06^{a}	5916.67^{de}	6261.67^{c}	-10.90^{a}	17.27^{b}
T_4	0.20^{a}	0.00^{a}	6575.00^{cd}	7977.78^{bc}	-0.77^{a}	196.44^{a}
T_5	-0.88^{b}	-0.94^{b}	11245.83^{b}	14726.12^{a}	2.30^{a}	4.56^{b}
T_6	-0.96^{b}	-0.93^{b}	12094.33^{a}	14931.67^{a}	2.71^{a}	4.50^{b}
T_7	-0.90^{b}	-0.82^{b}	7016.25^{c}	9024.17^{b}	10.58^{a}	1.63^{b}
T_8	-0.88^{b}	-0.93^{b}	6936.72^{c}	9475.48^{b}	7.60^{a}	18.90^{b}
Interaction	NS	NS	Sig	Sig	NS	NS

T_1 - ashgourd + cucumber, T_2 - ashgourd + pole cowpea, T_3 - ashgourd + bush cowpea, T_4 - ashgourd + amaranthus, T_5 - ashgourd + cucumber + bush cowpea, T_6 - ashgourd + cucumber + amaranthus, T_7 - ashgourd + pole cowpea + bush cowpea, T_8 - ashgourd + pole cowpea + amaranthus, NS - Non significant, Sig - Significant

Table 21. Interaction effect of intercrops and planting system on ashgourd equivalent yield

Treatment	Ashgourd equivalent yield			
	I season		II season	
	Trench	Pit	Trench	Pit
Crop combinations				
T_1	8855.55^{bc}	2433.34^{h}	12844.45^{b}	4855.56^{de}
T_2	1036.67^{i}	405.00^{i}	2221.67^{ef}	678.33^{f}
T_3	0000.00^{fg}	5833.33^{g}	6090.00^{d}	6433.33^{d}
T_4	6577.78^{efg}	6572.22^{efg}	8066.67^{cd}	7888.89^{cd}
T_5	14455.56^{a}	8036.11^{bcd}	18724.45^{a}	10727.78^{bc}
T_6	15199.78^{a}	8988.89^{b}	16913.33^{a}	12950.00^{b}
T_7	7686.67^{cde}	6345.84^{fg}	11243.33^{b}	6505.01^{d}
T_8	7225.66^{def}	6644.78^{efg}	10633.89^{bc}	8317.08^{cd}

T_1 - ashgourd + cucumber, T_2 - ashgourd + pole cowpea, T_3 - ashgourd + bush cowpea, T_4 - ashgourd + amaranthus, T_5 - ashgourd + cucumber + bush cowpea, T_6 - ashgourd + cucumber + amaranthus, T_7 - ashgourd + pole cowpea + bush cowpea, T_8 - ashgourd + pole cowpea + amaranthus

4.6.5 Relative crowding coefficient (RCC)

The data on relative crowding coefficient was statistically analysed and is presented in Table 20.

RCC was not significantly influenced by the planting system, intercrops and their interactions in both the seasons.

The RCC value for the trench system was 0.97 and 10.58 and for the pit system it was 4.56 and 55.37 in the first and second season respectively. For the treatments T_3 and T_4 during the first season negative RCC value (-10.91) and (-0.77) was observed but for all other treatments it was greater than one.

4.6.6 Ashgourd equivalent yield

The data on ashgourd equivalent yield is presented in Table 20.

Ashgourd equivalent yield was significantly influenced by planting system and intercrops. Trench system gave a higher equivalent yield of 8379.71 kg ha^{-1} and 19843.22 kg ha^{-1} than the pit system which recorded 5657.81 kg ha^{-1} and 7331.99 kg ha^{-1} in first and second season respectively.

Among the different treatments T_6 gave the superior ashgourd equivalent yield (12094.33 kg ha^{-1} and 14931.67 kg ha^{-1}) in first and second season). The lowest ashgourd equivalent yield was recorded by treatment T_2 (720.83 kg ha^{-1} and 1450.00 kg ha^{-1} in first and second season) during the two seasons.

The interaction of planting system and intercrops were also significantly influenced in both the seasons. The data is presented in Table 21. Treatments T_5 and T_6 of the trench system gave the highest crop equivalent yield during the two seasons. The lowest equivalent yield was obtained for the treatment T_2 of the pit system which was on par with treatment T_2 of the trench system.

4.6.7 Leaf area index

The data on the effect of planting system and intercropping on the total leaf area index is given in Table 22.

Planting system and intercrops had significant influence on the total leaf area index. Trench system recorded a higher leaf area index of 2.44 and 2.64 as compared to pit system which gave a leaf area index of 1.40 and 1.46 in first and second season respectively.

Treatment T_6 recorded the highest leaf area index of 2.93 and 2.99 in the first and second seasons respectively. This was statistically on par with T_8 and T_4. T_1 gave the least leaf area index during the first season (0.89) which was on par with T_2 and T_9. During the second season also T_9 gave the least value (1.23) which was on par with T_1 and T_2.

The interaction between planting system and intercrops were found to be nonsignificant in both the seasons.

4.6.8 Total biomass production

The data on the total biomass production in ashgourd is given in Table 22.

Table 22. Effect of intercrops and planting system on biomass production in ashgourd, total leaf area index and weed weight (35 DAS)

Treatment	Leaf area index		Total biomass production (kg/plant)		Weed weight (kg/plot)	
	I season	II season	I season	II season	I season	II season
Methods of planting						
Trench	2.44	2.64	3.59	4.58	5.75	4.85
Pit	1.40	1.46	3.90	5.81	9.36	7.50
Crop combinations						
T_1	0.89^{c}	1.24^{c}	3.55^{c}	4.98^{c}	9.30^{a}	7.42^{b}
T_2	0.92^{c}	1.02^{c}	3.87^{b}	5.34^{b}	9.12^{a}	7.94^{a}
T_3	1.86^{b}	2.17^{b}	4.30^{a}	5.70^{a}	7.25^{b}	5.67^{c}
T_4	2.87^{a}	2.83^{a}	4.38^{a}	5.67^{a}	7.42^{b}	5.82^{c}
T_5	1.80^{b}	2.13^{b}	3.24^{d}	4.49^{e}	5.88^{cd}	5.03^{d}
T_6	2.93^{a}	2.99^{a}	3.09^{d}	4.62^{de}	5.16^{d}	4.29^{e}
T_7	2.09^{b}	2.02^{b}	3.30^{d}	5.11^{bc}	6.83^{bc}	5.95^{c}
T_8	2.83^{a}	2.84^{a}	3.55^{c}	4.88^{cd}	7.09^{bc}	5.68^{c}
T_9	1.06^{c}	1.23^{c}	4.40^{a}	5.98^{a}	8.94^{a}	7.80^{ab}
Interaction	NS	NS	NS	NS	Sig	Sig

T_1 - ashgourd + cucumber, T_2 - ashgourd + pole cowpea, T_3 - ashgourd + bush cowpea, T_4 - ashgourd + amaranthus, T_5 - ashgourd + cucumber + bush cowpea, T_6 - ashgourd + cucumber + amaranthus, T_7 - ashgourd + pole cowpea + bush cowpea, T_8 - ashgourd + pole cowpea + amaranthus, T_9 - Sole crop of ashgourd, NS - Non significant, Sig - Significant

Table 23. Interaction effect of intercrops and planting system on weed supression in ashgourd based cropping system

Treatment	Weight of weeds (kg/plot)			
	I season		II season	
	Trench	Pit	Trench	Pit
Crop combinations				
T_1	6.92^{fgh}	9.68^{ab}	5.49^{fgh}	9.35^{b}
T_2	7.09^{efg}	10.15^{a}	5.98^{ef}	9.90^{ab}
T_3	5.70^{ghi}	8.81^{cdef}	4.66^{ij}	6.67^{cd}
T_4	5.81^{ghi}	9.03^{bcde}	4.64^{ij}	7.00^{c}
T_5	4.60^{i}	7.17^{efg}	4.18^{j}	5.87^{efg}
T_6	4.41^{i}	5.90^{ghi}	3.37^{ijk}	5.22^{ghi}
T_7	5.05^{hi}	8.62^{def}	4.77^{ij}	7.12^{c}
T_8	4.98^{hi}	9.19^{bc}	5.07^{hi}	8.28^{de}
T_9	7.21^{efg}	10.67^{a}	5.53^{fgh}	10.07^{a}

T_1 - ashgourd + cucumber, T_2 - ashgourd + pole cowpea, T_3 - ashgourd + bush cowpea, T_4 - ashgourd + amaranthus, T_5 - ashgourd + cucumber + bush cowpea, T_6 - ashgourd + cucumber + amaranthus, T_7 - ashgourd + pole cowpea + bush cowpea, T_8 - ashgourd + pole cowpea + amaranthus, T_9 - Sole crop of ashgourd

Planting systems and intercrops has significant influence on the total biomass production pit system gave a higher biomass of 3.90 Kg and 5.81 Kg than trench system which recorded a total biomass of 3.59 Kg and 4.58 Kg in the first and second season.

The pure crop of ashgourd produced the highest biomass in both the seasons (4.40 kg and 5.98 kg in first and second season). This was statistically on par with T_3 and T_4. The lowest biomass production was by T_6 (3.09 kg) in first season which was on par with T_5 and by T_5 (4.49 kg) in the second season which was on par with T_6.

Interaction between planting system and intercrops did not exert a significant influence on the total biomass production in ashgourd.

4.6.9 Weight of weeds

The data on the weight of weeds obtained from interspace is given in Table 22.

The weed weight was significantly influenced by the planting system, intercrops and their interaction.

Pit system recorded a higher weed weight (9.36 kg and 7.50 kg in first and second season) compared to trench system (5.75 and 4.85 in first and second season) in both the seasons. The weed weight of treatments T_1, T_2 and T_9 were on par during the two seasons. The lowest weed infestation was for T_6 (5.16 kg in first season and 4.29 kg in second season).

Significant interaction was noted in the case of weed weight of the two seasons. The data is presented in Table 23. Pure crop of ashgourd in the pit system had the highest weed infestation. The lowest weed infestation was for treatment T_6 of the trench system (5.16 kg in first season and 4.29 in second season).

4.7 Economic suitability

4.7.1 Gross return

The data on gross return was statistically analysed and presented in Table 24.

Gross return was significantly influenced by planting system and intercrops. Trench system recorded a significantly higher gross return of Rs.112475.62 per ha and Rs.160128.40 per ha in first and second season compared to pit system which recorded only Rs.44175.31 and Rs.70147.69 in first and second season respectively.

In the case of intercrops, ashgourd + cucumber + amaranthus gave the highest gross return in both seasons (Rs.100005.56 and Rs.147786.81 per ha in first and second season). This was followed by ashgourd + cucumber + bush cowpea combination. Significantly lowest gross return was obtained by sole crop of ashgourd (Rs.53000.00 per ha in first season and Rs.82390.00 per ha in second season) which was on par with ashgourd + pole cowpea combination. The gross return obtained by ashgourd and pole cowpea with amaranthus (T_6) and bush cowpea (T_5) were statistically on par.

Interaction effect was also found to be statistically significant. The data is presented in Table 25. In both the season treatments. T_6 and T_5 planted in the trench system recorded significantly higher gross return compared to all other treatments.

Table 24. The effect of planting system and intercrops on gross and net return in ashgourd based cropping system

Treatment	Gross return		Net return	
	I season	II season	Ist season	II season
Methods of planting				
Trench	112475.62	160128.40	53088.58	101066.05
Pit	44175.30	70147.69	20676.85	46593.37
Crop combinations				
T_1	68291.67^{d}	111836.81^{e}	31180.56^{d}	74788.19^{b}
T_2	52997.22^{e}	82392.36^{f}	16047.22^{e}	46039.58^{c}
T_3	84285.42^{bc}	113460.42^{de}	42268.75^{b}	71443.75^{b}
T_4	87465.97^{b}	121107.64^{cd}	42881.25^{b}	76557.65^{b}
T_5	96153.47^{a}	138217.36^{b}	53097.92^{a}	95578.47^{a}
T_6	100005.56^{a}	147786.81^{a}	54416.67^{a}	101779.86^{a}
T_7	81706.25^{bc}	114791.67^{cde}	39328.47^{bc}	72405.56^{b}
T_8	78919.44^{c}	123246.53^{c}	34033.33^{cd}	78404.86^{b}
T_9	55104.17^{e}	83402.78^{f}	18090.28^{e}	47469.45^{c}
Interaction	Sig	Sig	Sig	Sig

T_1 - ashgourd + cucumber, T_2 - ashgourd + pole cowpea, T_3 - ashgourd + bush cowpea, T_4 - ashgourd + amaranthus, T_5 - ashgourd + cucumber + bush cowpea, T_6 - ashgourd + cucumber + amaranthus, T_7 - ashgourd + pole cowpea + bush cowpea, T_8 - ashgourd + pole cowpea + amaranthus, T_9 - Sole crop of ashgourd, Sig - Significant

Table 25. Combined effect of intercrops and planting system on the net return and gross return

Treat-ment	Net return				Gross return			
	I season		II season		Ist season		II season	
	Trench	Pit	Trench	Pit	Trench	Pit	Trench	Pit
T_1	54166.67^{b}	8194.44^{c}	112097.22^{b}	37479.17^{g}	109333.34^{bc}	27250.00^{g}	167138.89^{b}	56534.72^{g}
T_2	29883.33^{d}	3411.11^{e}	66666.67^{de}	25412.50^{h}	84083.34^{d}	21911.11^{g}	120872.22^{d}	43912.50^{h}
T_3	56475.00^{b}	28062.50^{d}	92519.44^{c}	50368.06^{f}	116175.00^{bc}	52395.83^{ef}	152219.45^{c}	74701.39^{f}
T_4	56177.78^{b}	29584.72^{d}	100766.66^{bc}	52348.61^{f}	118411.11^{b}	56520.83^{ef}	163000.00^{bc}	79215.28^{f}
T_5	73869.44^{a}	32326.39^{d}	132399.99^{a}	58756.94^{ef}	134980.55^{a}	57326.39^{ef}	192677.78^{a}	83756.94^{f}
T_6	76911.11^{a}	31922.22^{d}	134155.56^{a}	69404.17^{de}	140555.56^{a}	59455.56^{e}	197802.78^{a}	97770.83^{e}
T_7	54774.99^{b}	23881.94^{d}	96508.33^{c}	48302.78^{fg}	115058.33^{bc}	48354.17^{f}	156808.33^{bc}	72775.00^{f}
T_8	44597.22^{c}	23469.45^{d}	102080.55^{bc}	54129.17^{f}	107363.89^{c}	50474.99^{ef}	165358.33^{b}	81134.72^{f}
T_9	30941.67^{d}	5238.89^{e}	71800.00^{d}	23138.89^{h}	86319.45^{d}	23888.89^{g}	125277.78^{d}	41527.78^{h}

T_1 - ashgourd + cucumber, T_2 - ashgourd + pole cowpea, T_3 - ashgourd + bush cowpea, T_4 - ashgourd + amaranthus, T_5 - ashgourd + cucumber + bush cowpea, T_6 - ashgourd + cucumber + amaranthus, T_7 - ashgourd + pole cowpea + bush cowpea, T_8 - ashgourd + pole cowpea + amaranthus, T_9 - Sole crop of ashgourd

The lowest gross return was recorded by treatment ashgourd + pole cowpea in the pit system. This was also on par with treatments T_1 (ashgourd + cucumber) and T_9 (sole crop) of the pit system.

4.7.2 Net return

The effect of intercrops and planting system on the net return obtained is presented in Table 24.

Planting system and intercrops had significant influence on the net return obtained.

As in the case of gross return significantly higher net return was recorded by the treatment T_6 (Rs.54416.67 and Rs.101779.86 in first and second season) which was statistically on par with the treatment T_5 during both the seasons. The least net return was recorded by the treatment T_2 (Rs.16647.22 and Rs.46039.58 in first and second season) and it was statistically on par with the treatment T_9.

Trench system of planting recorded significantly higher net returns of Rs.53088.58 per ha and Rs.101066.05 in first and second season respectively than the pit system of planting.

Interaction effect was also significant in both seasons. The data is presented in Table 25. Highest net return (Rs.76911.11) was recorded by the treatments T_6 followed by T_5 (Rs.73869.44) in the trench system of planting. Ashgourd + pole cowpea in pit system gave the lowest net returns (Rs.3411.11) in the first season where as in the second season it was the sole crop of ashgourd in pit system which recorded the least net return (Rs.23138.89).

4.7.3 Benefit cost ratio

The benefit cost (BC) ratio was statistically analysed and the data is presented in Table 26.

In the first season planting system had no significant influence on the BC ratio. But intercrops and the interaction between planting system and intercrops had significant influence on the BC ratio. The highest benefit cost ratio was obtained for treatment T_5 (2.25) which was statistically on par with T_6 (2.19) and the lowest was for T_2 (1.37).

Significant interaction between planting system and treatments was noticed in the first season. The data is presented in Table 27. Treatment T_5 of the pit system recorded the highest BC ratio (2.25) which was on par with treatments T_6 and T_5 of the trench system and T_6, T_3 and T_4 of the pit system. The lowest BC ratio (1.37) was for the treatment T_2 of the trench system which was statistically on par with the treatment T_9 of the trench system.

In the second season intercrops and planting system had marked influence on the BC ratio. Pit system recorded a higher BC ratio (2.94) compared to trench system (2.65).

In the case of intercrops ashgourd + cucumber + amaranthus combination recorded significantly higher BC ratio (3.31) which was statistically on par with ashgourd + cucumber + bush cowpea combination (3.24). The least BC ratio was for sole crop of ashgourd (2.29) and it was on par with ashgourd + pole cowpea combination. Treatments T_1, T_3, T_4, T_7 and T_8 were all on par.

Table 26. The effect of planting system and intercrops on benefit cost ratio and per day net return in ashgourd based cropping system

Treatment	BC ratio		Per day net return	
	I season	II season	Ist season	II season
Methods of planting				
Trench	1.89	2.65	442.41	842.22
Pit	1.82	2.94	368.13	584.56
Crop combinations				
T_1	1.71^{e}	2.87^{b}	339.24^{d}	702.63^{b}
T_2	1.37^{f}	2.30^{c}	215.81^{e}	460.75^{c}
T_3	2.05^{bc}	2.80^{b}	453.63^{b}	696.75^{b}
T_4	2.00^{c}	2.71^{b}	469.58^{b}	749.93^{b}
T_5	2.25^{a}	3.24^{a}	546.65^{a}	900.65^{a}
T_6	2.19^{ab}	3.31^{a}	568.19^{a}	966.36^{a}
T_7	1.94^{cd}	2.79^{b}	429.71^{bc}	705.35^{b}
T_8	1.79^{de}	2.82^{b}	396.13^{c}	765.89^{b}
T_9	1.42^{f}	2.29^{c}	228.46^{e}	472.19^{c}
Interaction	Sig	NS	Sig	Sig

T_1 - ashgourd + cucumber, T_2 - ashgourd + pole cowpea, T_3 - ashgourd + bush cowpea, T_4 - ashgourd + amaranthus, T_5 - ashgourd + cucumber + bush cowpea, T_6 - ashgourd + cucumber + amaranthus, T_7 - ashgourd + pole cowpea + bush cowpea, T_8 - ashgourd + pole cowpea + amaranthus, T_9 - Sole crop of ashgourd, NS - Non significant, Sig - Significant

Table 27. Interaction effect of planting system and intercrops on benefit cost ratio (first season) and per day net return

Treatments	BC ratio		Per day net return			
	I season		I season		II season	
	Trench	Pit	Trench	Pit	Trench	Pit
Crop combinations						
T_1	1.96^{bcde}	1.43^{hi}	451.39^{bc}	227.08^{e}	934.14^{b}	471.12^{g}
T_2	1.55^{gh}	1.19^{j}	249.03^{e}	182.59^{e}	555.56^{fg}	365.94^{h}
T_3	1.95^{cdef}	2.15^{abcd}	470.63^{bc}	436.63^{bcd}	770.99^{cd}	622.51^{ef}
T_4	$1.91d^{ef}$	2.10^{abcde}	468.15^{bc}	471.00^{bc}	839.72^{bc}	660.13^{ef}
T_5	2.21^{ab}	2.29^{a}	615.58^{a}	477.72^{bc}	1103.33^{a}	697.98^{de}
T_6	2.21^{ab}	2.17^{abc}	640.93^{a}	495.46^{b}	1117.96^{a}	814.76^{c}
T_7	1.90^{def}	1.98^{bcde}	456.46^{bc}	402.95^{cd}	804.23^{c}	606.46^{ef}
T_8	1.71^{fg}	1.87^{ef}	371.64^{d}	420.63^{bcd}	855.67^{bc}	676.12^{de}
T_9	1.56^{gh}	1.28^{ij}	257.85^{e}	199.07^{e}	598.33^{ef}	346.07^{h}

T_1 - ashgourd + cucumber, T_2 - ashgourd + pole cowpea, T_3 - ashgourd + bush cowpea, T_4 - ashgourd + amaranthus, T_5 - ashgourd + cucumber + bush cowpea, T_6 - ashgourd + cucumber + amaranthus, T_7 - ashgourd + pole cowpea + bush cowpea, T_8 - ashgourd + pole cowpea + amaranthus, T_9 - Sole crop of ashgourd

Interaction was not found to be statistically significant in the second season.

4.7.4 Per day net return

The data on the per day return from ashgourd based cropping system is given in Table 26.

The per day return was significantly influenced by the planting system, intercrops and also by their interaction in both the seasons.

Trench system recorded a significantly higher return per day (Rs.442.41 and Rs.842.22 in first and second season) than the pit system (368.13 and Rs.584.56 in first and second season) in both the season.

Ashgourd + cucumber + amaranthus combination gave the highest per day return which was statistically on par with ashgourd + cucumber + bush cowpea combination in both the seasons. The lowest per day return was for ashgourd + pole cowpea combination.

The data on interaction of planting system and intercrops is presented in Table 27.

Treatment T_6 of the trench system recorded significantly highest per day return (Rs.640.93 and Rs.1117.96 in first and second season) which was on par with T_5. The least per day return (Rs.182.59) was for T_2 of the pit system which was on par with T_9 and T_2 of the trench system and T_1 and T_9 of the pit system.

4.7.5 Return per rupee invested on fertilizer (RPF)

The data on return per rupee invested is presented in Table 28.

In the first season planting system did not have any significant influence on return per rupee invested on fertilizer but intercrops exerted significant influence. The highest return on fertilizer was obtained for treatment T_5 (Rs.18.89). This was followed by the treatments T_6, T_3 and T_7. These three were statistically on par. The least return (Rs.5.76) was obtained for the treatment T_2.

The interaction of planting system and intercrops were found to be significant in first season (Table 29). Treatment T_8 of pit system gave highest return per rupee on fertilizer which was on par with T_3.

The least returns (Rs.3.62) was obtained by T_2 of the pit system.

In second season planting system, intercrops and their interaction exerted significant influence on return per rupee invested on fertilizer. Pit system gave higher return of Rs.28.05 and the trench system gave only Rs.22.27.

Treatment T_5 gave significantly superior return compared to all other treatments. This was followed by treatments T_6 and T_1 which were on par. Statistically lowest return was recorded for the treatment T_9 which was on par with T_2.

The highest return per rupee invested (36.61) on fertilizer was for treatment T_5 of the pit system and treatment T_2 of the trench system recorded the lowest return (Rs.16.39).

Table 28. The effect of planting system and intercrops on return per rupee invested on fertilizer and labour

Treatment	Return per rupee invested on fertilizer		Return per rupee invested on labour	
	I season	II season	Ist season	II season
Methods of planting				
Trench	12.21	22.27	2.51	3.83
Pit	12.55	28.05	2.50	4.42
Crop combinations				
T_1	10.39^{d}	28.27^{bc}	2.13^{d}	4.21^{c}
T_2	5.76^{e}	18.43^{f}	1.57^{e}	2.94^{d}
T_3	15.54^{bc}	26.15^{cd}	2.78^{b}	4.07^{c}
T_4	13.35^{c}	23.02^{e}	2.83^{b}	4.26^{c}
T_5	18.69^{a}	32.87^{a}	3.18^{a}	4.91^{b}
T_6	15.91^{b}	30.07^{b}	3.20^{a}	5.33^{a}
T_7	14.11^{bc}	25.92^{d}	2.61^{bc}	4.06^{c}
T_8	10.81^{d}	23.59^{e}	2.49^{c}	4.34^{c}
T_9	6.86^{e}	18.11^{f}	1.71^{e}	3.02^{d}
Interaction	Sig	Sig	Sig	Sig

T_1 - ashgourd + cucumber, T_2 - ashgourd + pole cowpea, T_3 - ashgourd + bush cowpea, T_4 - ashgourd + amaranthus, T_5 - ashgourd + cucumber + bush cowpea, T_6 - ashgourd + cucumber + amaranthus, T_7 - ashgourd + pole cowpea + bush cowpea, T_8 - ashgourd + pole cowpea + amaranthus, T_9 - Sole crop of ashgourd, Sig - Significant

Table 29. Combined effect of intercrops and planting system on return per rupee invested on fertilizer and labour

Treatment	Return per rupee invested on fertilizer				Return per rupee invested on labour			
	I season		II season		Ist season		II season	
	Trench	Pit	Trench	Pit	Trench	Pit	Trench	Pit
T_1	13.50^{cde}	7.28^{gh}	26.84^{def}	29.71^{cde}	2.58^{def}	1.68^{hi}	4.31^{de}	$4.12.^{fe}$
T_2	87.89^{gh}	3.62^{j}	16.39^{i}	20.47^{gh}	1.88^{gh}	1.26^{j}	2.77^{h}	3.11^{h}
T_3	13.06^{de}	18.01^{ab}	20.78^{gh}	31.53^{bc}	2.57^{def}	2.99^{abcd}	3.58^{g}	4.57^{cde}
T_4	11.88^{ef}	14.83^{bcde}	20.56^{gh}	25.48^{f}	2.56^{def}	3.09^{abc}	3.80^{fg}	4.71^{bcd}
T_5	16.79^{bc}	20.59^{a}	29.13^{cde}	36.61^{a}	3.06^{abc}	3.29^{a}	4.67^{cd}	5.16^{b}
T_6	15.89^{bcd}	15.93^{bcd}	26.69^{ef}	33.45^{b}	3.14^{ab}	3.26^{a}	4.74^{bcd}	5.92^{a}
T_7	12.74^{def}	15.47^{bcd}	21.67^{g}	30.17^{cd}	2.53^{ef}	2.69^{cde}	3.69^{fg}	4.43^{cde}
T_8	9.65^{fg}	11.97^{ef}	20.87^{gh}	26.31^{ef}	2.25^{fg}	2.73^{bcde}	3.84^{fg}	4.84^{bc}
T_9	8.52^{g}	5.21^{hi}	17.50^{hi}	18.72^{ghi}	1.97^{gh}	1.46^{ij}	3.12^{h}	2.92^{h}

T_1 - ashgourd + cucumber, T_2 - ashgourd + pole cowpea, T_3 - ashgourd + bush cowpea, T_4 - ashgourd + amaranthus, T_5 - ashgourd + cucumber + bush cowpea, T_6 - ashgourd + cucumber + amaranthus, T_7 - ashgourd + pole cowpea + bush cowpea, T_8 - ashgourd + pole cowpea + amaranthus, T_9 - Sole crop of ashgourd

4.7.6 Return per rupee invested on labour (RPL)

The return per rupee invested on labour was statistically analysed and is presented in Table 28.

In the first season planting system did not significantly influence the return per rupee invested on labour but intercrops exerted a significant influence. the combination of ashgourd + cucumber + amaranthus recorded the highest return of Rs.3.20. This was almost equal to ashgourd + cucumber + bush cowpea combination which gave Rs.3.18. The least return was the combination involving ashgourd + pole cowpea but this was on par with the sole crop of ashgourd.

Interaction of planting system and intercrops also had significant influence on return per rupee on labour. Treatment T_5 of pit system gave the highest return (Rs.3.29) but it was on par with T_6, T_4 and T_5 of the pit system and T_6 and T_5 of the trench system. Treatment T_2 of the pit system gave the least return (Rs.1.26).

In second season planting system, intercrops and their interaction exerted a significant influence on return per rupee invested on labour. T_6 recorded a significantly superior value of Rs.5.33. This was followed by T_5. The treatments T_8, T_4, T_1, T_7 and T_3 gave almost similar return from labour. The lowest return was for treatment T_2.

T_6 of the pit system gave the highest return from labour and the lowest was for T_2 of the trench system.

4.8 Pest and disease incidence

4.8.1 Ashgourd

The data on the number of days taken for pest and disease incidence is presented in Table 30.

Table 30. Effect of planting system and intercrops on the number of days taken for pest and disease incidence in ashgourd (Days after germination)

Treatment	Pumpkin beetle		Fruit fly		Mosaic	
	I season	II season	I season	II season	I season	II season
Methods of planting						
Trench	6.30	8.22	57.97	64.33	35.86	42.28
Pit	6.22	8.13	57.83	64.11	36.00	42.33
Crop combinations						
T_1	5.88^{c}	8.25^{a}	57.50^{a}	64.13^{ab}	36.00^{a}	42.62^{a}
T_2	6.23^{ab}	8.00^{a}	58.00^{a}	64.38^{ab}	35.63^{a}	42.00^{a}
T_3	6.75^{a}	8.25^{a}	57.75^{a}	63.88^{b}	35.75^{a}	42.03^{a}
T_4	6.63^{ab}	8.38^{a}	58.00^{a}	64.25^{ab}	36.00^{a}	42.38^{a}
T_5	6.00^{bc}	8.13^{a}	57.88^{a}	64.50^{ab}	36.00^{a}	41.75^{a}
T_6	5.75^{c}	7.75^{a}	58.13^{a}	63.50^{b}	35.88^{a}	42.25^{a}
T_7	6.00^{bc}	8.13^{a}	57.88^{a}	64.13^{ab}	35.88^{a}	41.88^{a}
T_8	6.13^{abc}	8.38^{a}	57.63^{a}	63.88^{b}	35.87^{a}	42.37^{a}
T_9	6.63^{ab}	8.38^{a}	58.38^{a}	65.38^{a}	36.38^{a}	42.87^{a}
Interaction	NS	NS	NS	NS	NS	NS

T_1 - ashgourd + cucumber, T_2 - ashgourd + pole cowpea, T_3 - ashgourd + bush cowpea, T_4 - ashgourd + amaranthus, T_5 - ashgourd + cucumber + bush cowpea, T_6 - ashgourd + cucumber + amaranthus, T_7 - ashgourd + pole cowpea + bush cowpea, T_8 - ashgourd + pole cowpea + amaranthus, T_9 - Sole crop of ashgourd, NS - Non significant

Pumpkin beetle (*Aulocophora foveicollis*) and fruit fly (*Dacus cucurbitae*) were the serious pests found in ashgourd. There was significant difference in the number of days taken for the infestation of pumpkin beetle in the first season where T_1 (5.88 days) and T_6 (5.75) took the least number of days. Planting system and interaction between planting system and intercrops had no significant influence on the number of days taken for the incidence. In the second season there was no significant difference in the number of days taken for infestation due to planting system, intercrops or their interaction. In the case of fruit fly infestation there was no significant difference among treatments due to planting system, intercrops or their interaction. The infestation took place between 57.50 (T_1) and 58.38 (T_9) days in the first season and between 63.50 (T_6) and 65.38 (T_9) days in the second season.

Occurrence of mosaic disease was noticed between 35.63 (T_1) and 36.38 (T_9) number of days in the first season and 41.75 (T_5) and 42.87 (T_9) days in the second season. The difference in the number of days taken for disease incidence was not statistically significant due to planting system, intercrops or their interaction.

4.8.2 Cucumber

The data on the number of days taken for pest and disease incidence is presented in Table 31.

Fruit fly and pumpkin beetle were the serious pests found in cucumber. Mosaic disease was also seen. There was no significant difference in the number of days taken for the incidence of these pests and disease due to planting system and intercrops or their interaction during the two seasons. Severe infestation of pumpkin beetles occurred 8 and 9 days after germination. Attack of fruit fly was noticed 41st

Table 31. Effect of planting system and intercrops on the number of days taken for pest and disease incidence in cucumber (Days after germination)

Treatment	Pumpkin beetle		Fruit fly		Mosaic	
	I season	II season	I season	II season	I season	II season
Methods of planting						
Trench	8.56	9.19	41.81	42.25	24.13	29.00
Pit	8.56	8.87	41.88	43.31	23.68	29.31
Crop combinations						
T_1	8.75[a]	9.25[a]	41.88[a]	43.50[a]	24.25[a]	28.88[a]
T_5	8.63[a]	8.75[a]	41.75[a]	43.25[a]	23.38[a]	29.13[a]
T_6	8.00[a]	9.13[a]	41.88[a]	43.38[a]	23.87[a]	29.25[a]
T_{10}	8.88[a]	9.00[a]	41.88[a]	43.00[a]	24.13[a]	29.38[a]
Interaction	NS	NS	NS	NS	NS	NS

T_1 - ashgourd + cucumber, T_5 - ashgourd + cucumber + bush cowpea, T_6 - ashgourd + cucumber + amaranthus, T_{10} - Sole crop of cucumber, NS - Non significant

Table 32. Effect of planting system and intercrops on the number of days taken for incidence of pest and diseases in pole cowpea (days after germination)

Treatment	Aphid		Pod bug		Mosaic	
	I season	II season	I season	II season	I season	II season
Methods of planting						
Trench	42.00	43.39	52.94	52.44	31.00	33.81
Pit	42.13	44.00	52.44	52.50	31.31	34.31
Crop combinations						
T_2	42.00[a]	43.13[a]	52.63[a]	52.25[a]	31.12[a]	33.88[a]
T_7	41.63[a]	44.00[a]	52.50[a]	52.38[a]	31.13[a]	34.25[a]
T_8	42.00[a]	43.38[a]	52.50[a]	52.38[a]	31.13[a]	34.13[a]
T_{11}	42.63[a]	44.25[a]	53.13[a]	52.87[a]	31.25[a]	34.00[a]
Interaction	NS	NS	NS	NS	NS	NS

T_2 - ashgourd + pole cowpea, T_7 - ashgourd + pole cowpea + bush cowpea, T_8 - ashgourd + pole cowpea + amaranthus, T_{11} - Sole crop of pole cowpea, NS - Non significant

and 43rd days after germination in the first and second season respectively and mosaic on 23rd and 28th day.

4.8.3 Pole cowpea

The data on the number of days taken for pest and disease incidence is presented in Table 32.

The pests in pole cowpea were aphids (*Aphis craccivora*) and coried bugs (*Riptortus pedestris*) and the disease was mosaic. There was no significant difference among treatments in the number of days taken for pest and disease incidence due to planting system, intercrops or their interaction during the two seasons. Aphids were seen on 42nd and 44th days, coreid bugs on 53rd and 52nd days and mosaic on 31st and 34th days after germination in the first and second season respectively.

4.8.4 Bush cowpea

The data on the number of days taken for pest and disease incidence is presented in Table 33.

Aphids, coreid bugs and rust were the serious pests and disease found in bush cowpea. There was no significant difference due to planting system, intercrops or their interaction among treatments in the number of days taken for pest and disease incidence during both the seasons.

4.8.5 Amaranthus

The data on the number of days taken for pest and disease incidence is presented in Table 34.

Table 33. Effect of planting system and intercrops on the number of days taken for pest and disease incidence in bush cowpea (days after germination)

Treatment	Aphid		Pod bug		Rust disease	
	I season	II season	I season	II season	I season	II season
Methods of planting						
Trench	40.94	41.25	42.25	42.18	31.88	34.44
Pit	41.13	41.38	42.19	42.38	31.94	34.94
Crop combinations						
T_3	40.38[b]	40.75[b]	41.88[a]	42.63[a]	31.75[a]	34.38[a]
T_5	40.38[b]	40.88[b]	41.63[a]	42.38[a]	32.38[a]	34.38[a]
T_7	40.87[b]	41.00[b]	42.75[a]	41.50[a]	31.13[a]	34.75[a]
T_{12}	42.63[a]	44.25[a]	53.13[a]	52.87[a]	31.25[a]	34.00[a]
Interaction	NS	NS	NS	NS	NS	NS

T_3 - ashgourd + bush cowpea, T_5 - ashgourd + cucumber + bush cowpea, T_7 - ashgourd + pole cowpea + bush cowpea, T_{12} - Sole crop of bush cowpea, NS - Non significant

Table 34. Effect of planting system and intercrops on the number of days taken for pest and disease incidence in amaranthus (days after transplanting)

Treatment	Leaf webber		Leaf spot	
	I season	II season	Ist season	II season
Method of planting				
Trench	48.44	55.31	28.00	36.25
Pit	48.50	55.44	28.44	36.44
Crop combinations				
T_1	48.63[a]	55.25[a]	28.50[a]	36.13[a]
T_2	48.13[a]	55.63[a]	27.38[a]	36.13[a]
T_3	48.38[a]	55.13[a]	28.25[a]	36.00[a]
T_4	48.75[a]	55.50[a]	28.75[a]	37.13[a]
Interaction	NS	NS	NS	NS

T_1 - ashgourd + cucumber, T_2 - ashgourd + pole cowpea, T_3 - ashgourd + bush cowpea, T_4 - ashgourd + amaranthus, NS - Non significant

Leaf webber (*Psara basalis*) and leaf spot (*Colletotrichum* sp.) were the serious pest and disease found in amaranthus. There was no significant difference among treatments in the number of days taken for the incidence of pest and disease due to planting system, intercrops or their interaction in the two seasons.

Discussion

DISCUSSION

In vegetable crops higher cropping intensities can be practiced to get high returns. Vegetables being short duration crops fit in very well in most of the farming systems as fillers or companion crops without competing much with the main crops for vital resources.

Based on this, an investigation entitled "Productivity of ashgourd as influenced by crop combinations" was conducted at the Vegetable Research Plots of the Department of Olericulture, College of Horticulture, Vellanikkara, to assess the suitability of raising intercrops along with ashgourd in pit and trench system of planting. The study also aims at evaluating the biological efficiency and economic feasibility of ashgourd based cropping system.

The data on various growth and yield characters and biological and economic indices were analysed statistically and the results are discussed in this chapter.

5.1 Performance of ashgourd in intercropping system

Ashgourd is usually grown at a wider spacing of 4.5 m x 2 m. In certain places farmers cultivate ashgourd in trench system. Since it takes a long time to spread and cover the alloted area, a lot of space is wasted in the early half of crop growth. Hence an experiment was conducted to evaluate the productivity of ashgourd when it was grown along with intercrops like cucumber, pole cowpea, bush cowpea and amaranthus in both the pit and trench systems.

The study revealed that the intercrops had significant influence on the different growth parameters of ashgourd. The results showed that length of main

171425

vine, number of primary branches and internodal length were significantly influenced by intercrops. Pure crop of ashgourd recorded the maximum vine length and number of primary branches (Table 1). The lower values in other treatments may be due to the competition of intercrops for space and nutrients.

In sole cropping, there will be uninterrupted growth of main crop. But in intercropped system, the main crop of ashgourd was in competition with intercrops like cucumber, pole cowpea, bush cowpea and amaranthus in different treatments. The growth of intercrops might have interfered with the ashgourd at different stages of growth. This probably might have affected the general growth ashgourd indicated through vine length and primary branches of intercropped ashgourd. Such influence of intercrops in suppressing the growth of main crop was reported earlier by Soundararajan and Palaniappan (1979) in redgram, Sheela (1981) in tapioca - cowpea intercropping system and Olasantan (1991) in bhendi - cowpea intercropping system. The internodal length was the lowest in case of sole crop of ashgourd. This may be due to the intercrop - competition - mediated elongated growth of vines for search of sufficient light in the intercropped plots. Olasantan (1988) found that in melon + corchorus intercropping sole crop of melon produced maximum number of branches.

The yield and yield contributing factors of ashgourd were found to be adversely affected by intercropping.

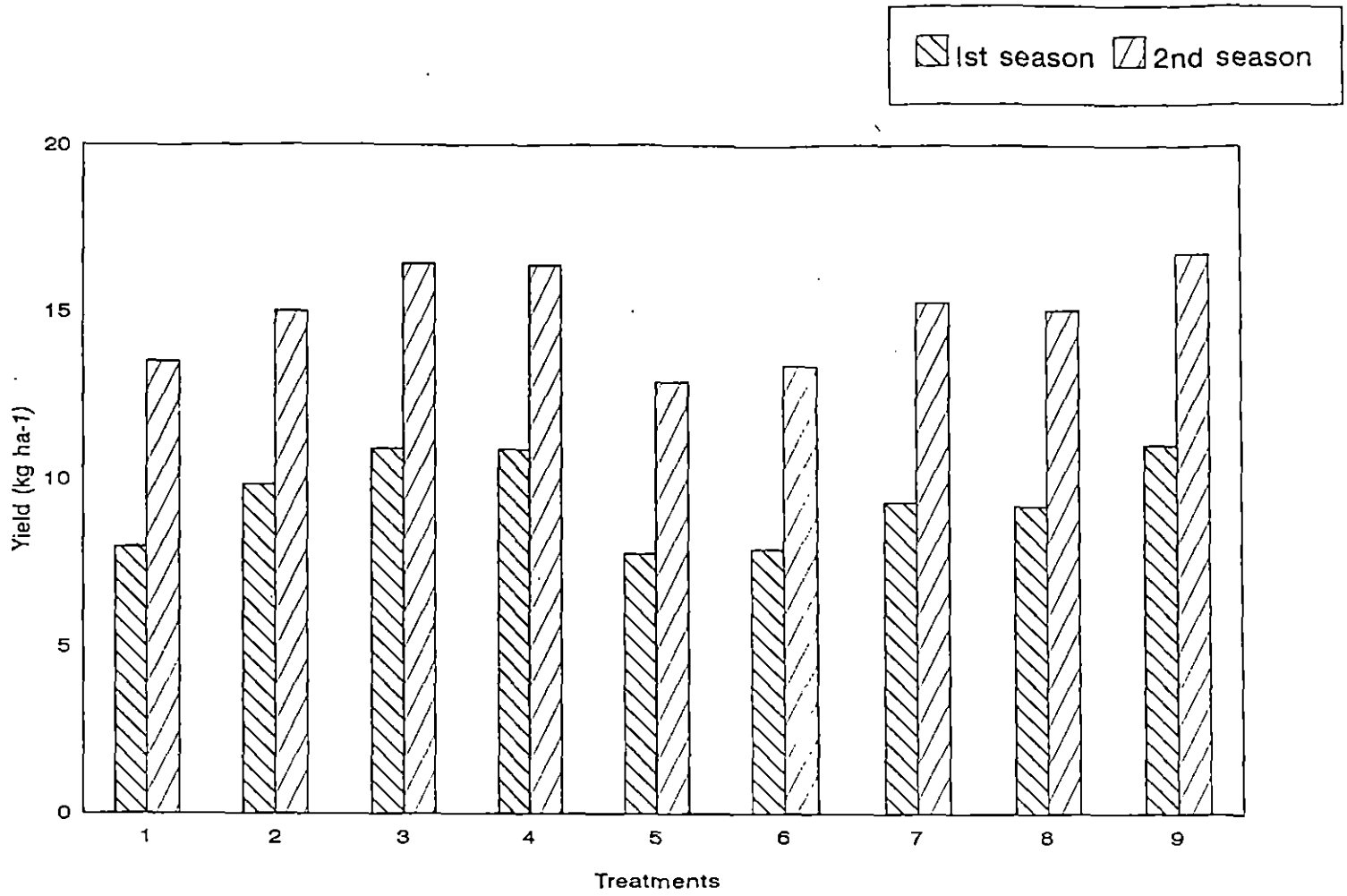
However, sole crop and intercropped ashgourd recorded more or less same days for male and female flower anthesis (Table 2) and the nodes to from the first female flower. The number of flowers and fruit set percentage was higher in the pure crop of ashgourd (Table 3).

The number of fruits per plant in sole crop of ashgourd was found to be significantly affected by intercrops (Table 4). But fruits per plant of ashgourd were on par in ashgourd + amaranthus and ashgourd + bush cowpea combinations. This might be due to the temporal difference and variation in rooting habit of ashgourd compared to amaranthus and bush cowpea. Sole crop of ashgourd produced 8.12 and 10.62 fruits where as T_3 and T_4 produced 8.50 and 11.12 and 8.12 and 11.12 in first and second season respectively. In ashgourd + cucumber and ashgourd + pole cowpea systems, the ashgourd plants had less number of fruits compared to its sole crop. More number of fruits in T_3, T_4 and T_9 may be due to more plant spread which permit the plant to produce more flowers and fruits. A similar trend of positive correlation between plant height and fruit yield per plant in bhendi has been reported by Sajitharani (1993).

The results were in accordance with the findings of Olasantan (1991) in bhendi/tomato + cowpea intercropping system and Singh (1991) in tomato based intercropping system where maximum number of fruits were recorded by sole crop of vegetables.

Fruit size indicated by average fruit weight, of intercropped ashgourd were smaller than that of sole crop in both the seasons. These results are also in accordance with the findings of Olasantan (1991) in bhendi + cowpea intercropping system and Singh (1991) in tomato based intercropping system where maximum fruit weight of vegetables were recorded under sole cropping.

Fruit size indicated by length, circumference and flesh thickness of ashgourd fruits were the highest in sole crop than in intercropped plants. The lack of competition for space and nutrients in sole crop system might have contributed to the production of bigger fruits in sole cropped plots. Geethakumari (1989) also



T_1 - ashgourd + cucumber, T_2 - ashgourd + pole cowpea, T_3 - ashgourd + bush cowpea, T_4 - ashgourd + amaranthus, T_5 - ashgourd + cucumber + bush cowpea, T_6 - ashgourd + cucumber – amaranthus. T_7 - ashgourd + pole cowpea + bush cowpea, T_8 - ashgourd + pole cowpea + amaranthus, T_9 - sole crop of ashgourd

Fig.2. Yield of ashgourd as influenced by intercropping

found that in maize + cowpea intercropping system sole crop arrangement of maize produced longer cobs than the intercropped ones.

The fruit yield of ashgourd per hectare was significantly higher in the pure crop of ashgourd. Sole crop recorded a mean yield of 11020.83 kg ha^{-1} in first season (Fig. 2) and 16750.00 kg ha^{-1} in second season. This was followed by ashgourd + bush cowpea and ashgourd + amaranthus combination. Ashgourd + pole cowpea and combination of ashgourd + pole cowpea with amaranthus and bush cowpea recorded the next superior yield. The lowest yield of ashgourd was recorded in ashgourd + cucumber combination. This might be due to the similar growth habit of ashgourd and cucumber (which belong to the same family) by which there is more competition for resources among these two components of the intercropping system.

The magnitude of direct yield contributing characters such as number of fruits per plant, length and girth of fruits, fruit weight per plant of ashgourd were higher under pure crop system than under intercropping system. Further, vegetative characters such as length of main vine and primary branches were also higher in sole cropping.

In intercropping system yield advantage occur when growth pattern of component crops differ in time to make their major demands on resources at different time. Plants having different growth habits are suitable for intercropping. This accounts for higher yield of ashgourd in ashgourd with bush cowpea, amaranthus and pole cowpea combinations and lower yield in ashgourd + cucumber combinations.

Reports are there to show the superiority of sole cropping over intercropping. Olasantan (1991) found that in bhendi + cowpea intercropping

system, intercropping caused 5 per cent loss in marketable fruit yield. Similarly Kadali *et al.* (1988) found that yield of chilli was maximum under sole cropping in chilli based cropping system. Sheela (1981) in cassava - cowpea intercropping system, Singh (1991) in tomato based intercropping system, Natarajan (1992) in chilli based intercropping system found similar effect.

The performance of ashgourd was superior in the pure crop system compared to its performance with intercrops.

5.2 Performance of intercrops in ashgourd based cropping system

5.2.1 Cucumber

Performance of cucumber was similar to that of ashgourd in the intercropping system. The sole crop of cucumber recorded the maximum vine length and number of branches. Internodal length was not significantly influenced by intercrops. In intercropping system ashgourd might have a supressing and competitive effect on cucumber which might be the reason for reduced vine length and number of branches in intercropping system.

Sole cropped and intercropped cucumber took almost same duration for male and female flower anthesis and the node at which the female flower was formed was not statistically significant (Table 8). The number of female flowers and per cent fruit set was higher in sole crop of cucumber. The fruit set percentage was 55.95 and 54.75 per cent in first and second season in the pure crop where as in ashgourd + cucumber combination it was 50.31 and 51.51 per cent.

The number of fruits and average fruit weight was the highest in sole crops than in interceopped cucumber. It produced 7.37 fruits in first season and 10.12 fruits in second season. Ashgourd and cucumber were sown in the same pit

or trench. This might be the reason for negative influence of ashgourd on cucumber. Higher circumference, length and flesh thickness (Table 10 and 11) may be the reasons for higher fruit weight in pure crop of cucumber.

The yield was also significantly higher in sole cropping of cucumber. In ashgourd + cucumber combination the yield was 7055.55 kg ha^{-1} and 11062.50 kg ha^{-1} in first and second season. In the treatments of ashgourd + cucumber in combination with bush cowpea and amaranthus the yield was the lowest. Pure crop recorded 9875.69 kg ha^{-1} and 13656.25 kg ha^{-1} in first and second season.

5.2.2 Pole cowpea

The pole cowpea was sown in the same pit or trench as that of ashgourd. But here the length of vine, days to first flowering and average weight of fruits were almost similar in pure and intercropped cowpea. In ashgourd + pole cowpea combination both the plants have different growth habit. Ashgourd is trailed on ground where as pole cowpea is trailed on poles. This might be the reason why there is no significant difference between pure and intercropped pole cowpea in competition for space.

The yield was significantly influenced by the companion crops. Here also sole crop recorded higher yield than intercrops (Table 14). This might be due to more number of fruits in pure crop compared to intercrops. For more yield advantages, greater canopy differences between component crops should be there (Patel, 1990). Reduction in cowpea yield due to intercropping was reported by Ofori and Stern (1986) and Margado (1986).

5.2.3 Bush cowpea and amaranthus

The influence of intercrops on plant height, days to first flowering, weight of fruits and yield was found to be non significant in case of bush cowpea. The mean values of intercrops were on par with sole crop but the sole crop recorded slightly higher value than the intercropped plants. The yield was also maximum in pure crop of bush cowpea (5671.52 kg ha^{-1} and 5737.50 kg ha^{-1} in first and second season). The similar observations in pure and intercrops may be due to its spatial and temporal arrangement of crops.

In case of amaranthus there was significant influence on yield in the first season only whereas in second season the effect was non significant. In both the season sole crop of amaranthus recorded slightly higher mean yield than intercrops (Table 18).

Bush cowpea and amaranthus were not planted in the same pit or trench of ashgourd as in the case of cucumber and pole cowpea. They were grown in the interspace of ashgourd plants. By the time the ashgourd attains its maturity, the peak growth period of bush cowpea and amaranthus will be over. This might be the reason why there was no significant difference between sole and inter crop of amaranthus and bush cowpea. Similar trends in the grain yield of intercropped maize to its sole crop in maize-black gram intercropping system has been reported by Singh *et al.* (1995).

5.3 Effect of planting system on performance of crops in ashgourd based cropping system

Introduction of another plant species without reducing the population of the first species from the optimum causes complex interference between the

species. A modification in planting pattern of the base crop helps to accomodate intercrops. In this experiment two planting systems were adopted for the base crop ashgourd - the pit and trench system of planting. In pit system ashgourd was planted at the recommended spacing of 4.5 x 2 m. Two pits with an area of 18 m^2 was the plot size in pit system. But in the trench system, trenches of 2 m length was taken at 4.5 m distance; here the plot size was 9 m^2.

Pole cowpea and cucumber was planted in the same pit or trench as that of ashgourd; and bush cowpea and amaranthus were planted in the interspaces of ashgourd. Bush cowpea and amaranthus were planted in an area of 4 m^2 in trench system and 8 m^2 in pit system of planting.

5.3.1 Ashgourd

In ashgourd the planting system significantly influenced the number of fruits, fruit weight and yield of the plant. Other growth characters were almost similar in both the system of planting. The individual fruit weight, circumference, length and flesh thickness of the fruit was highest in the pit system than in the trench system (Table 5). In pit system two plants were retained per pit whereas in trench system there was eight plants per trench. The competition would be higher in trench system since it accomodates more number of plants. This might be the reason for the smaller fruit size in trench system. But since we could accomodate more number of plants in trench system, the number of fruits obtained was higher and this accounted for higher yield in trench system compared to pit system. Trench system recorded a mean yield of 15122.06 kg ha^{-1} and 22371.14 kg ha^{-1} where as pit system recorded only 3735.34 kg ha^{-1} and 7576.77 kg ha^{-1} in first and second season respectively. The attack of fruit flies and mosaic infestation might be the reason for lower yield in first season compared to second season. The result was in accordance

with findings of Porwal *et al.* (1994) where closer row spacing (75 cm) of autumn cane yielded 10.7 per cent higher than 100 cm row spacing.

5.3.2 *Intercrops*

In cucumber and pole cowpea there was no significant difference in growth characters due to the pit and trench system of planting. Here also trench system recorded higher yield because it could accomodate more number of plants compared to the pit system. In pit system the fruit weight of cucumber was found to be the higher than the trench system. It may be because of more space in pit system.

Growth characters and yield contributing characters were similar under both systems of planting. The difference in plant number alone caused an increase in yield in trench system. Meera *et al.* (1992) reported that tuber yields of cassava intercropped with groundnut and cowpea were marginally higher under paired row planting compared to uniform planting. Higher yield of mung bean was reported in paired row planting in a maize-mung bean planting system (Dhingra *et al.*, 1991).

In amaranthus and bush cowpea also planting system did not significantly influence the performance of the crop. The yield was almost same in both the systems. It reveals that the spreading nature of ashgourd or cucumber did not affect the growth of both amaranthus and bush cowpea. By the time the ashgourd reaches these plants the peak growing phase will be over.

5.4 Biological efficiency of intercropping system

In general, the results indicated that intercropping causes a reduction of yield of crops as compared to their sole cropping. But in any intercropping system, evaluation of the competitive relation of component crops and their yield

advantages in intercropping situation provides a useful tool to describe different crop competitive situations (Sheelavantar, 1990). Biological efficiency parameters are used for evaluating the competitive relation between component crops in intercropping.

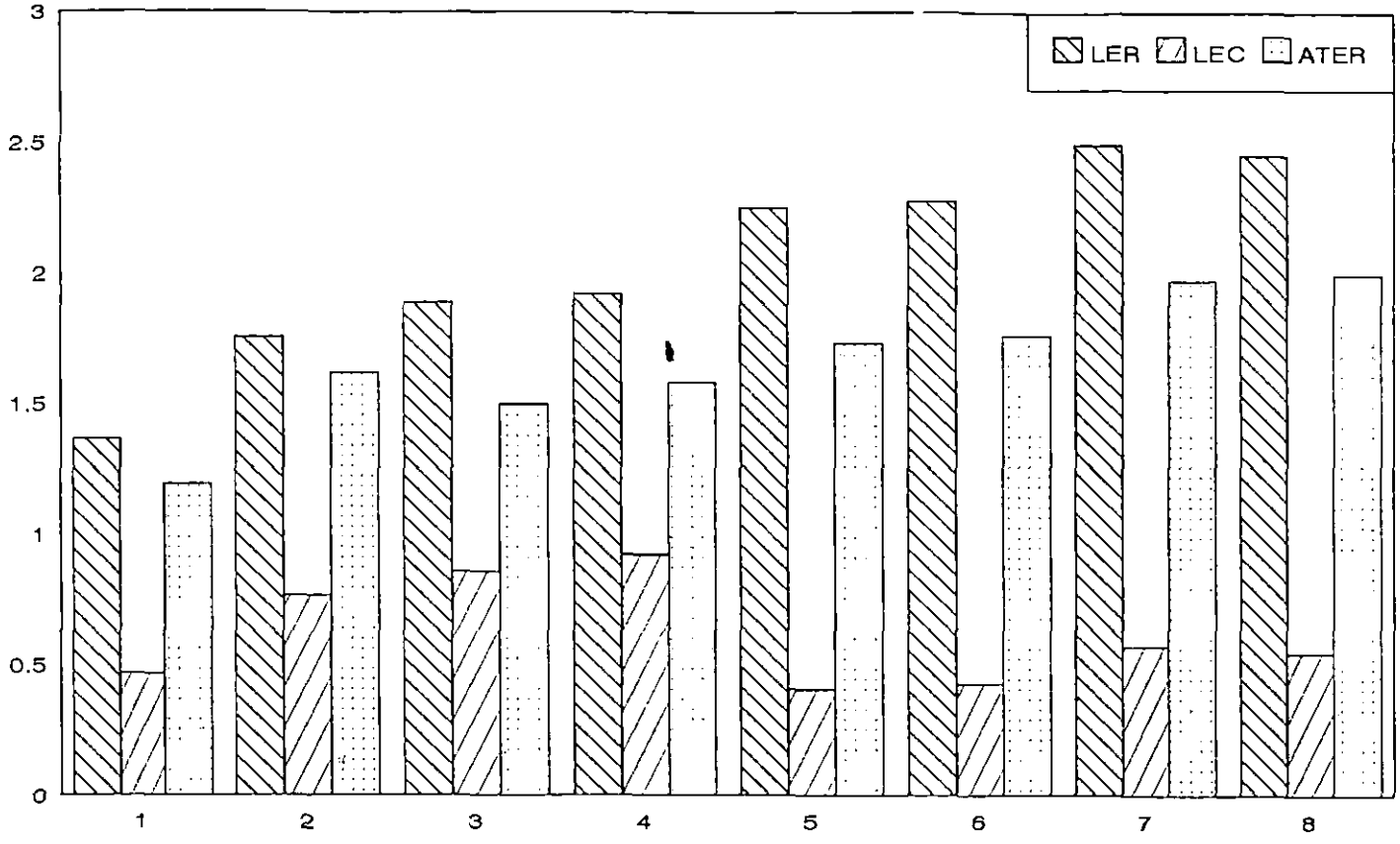
5.4.1 Land equivalent ratio (LER)

Willey (1979) concluded that the most generally used single index for expressing the yield advantage is LER, defined as the relative land area required by sole crops to produce the same yield as in intercropping. If the LER is unity there is neither gain nor loss by intercropping. Value less than unity denotes disadvantage and value more than unity represents advantage.

In all the treatment combinations the LER was found to be more than unity indicating an advantage in land use by intercropping in ashgourd. In treatments containing two crops, the combination of ashgourd and amaranthus is found to be more ideal, with values of 1.92 and 1.93 in the first (Fig. 3) and second (Fig. 4) season, than all other treatments. This was mainly due to the higher crop yield of amaranthus. Similarly in the treatment which contains three crops, ashgourd + pole cowpea + amaranthus gave a higher LER in second season (Table 19). It was slightly lower in the first season due to the low yield of the intercrop pole cowpea.

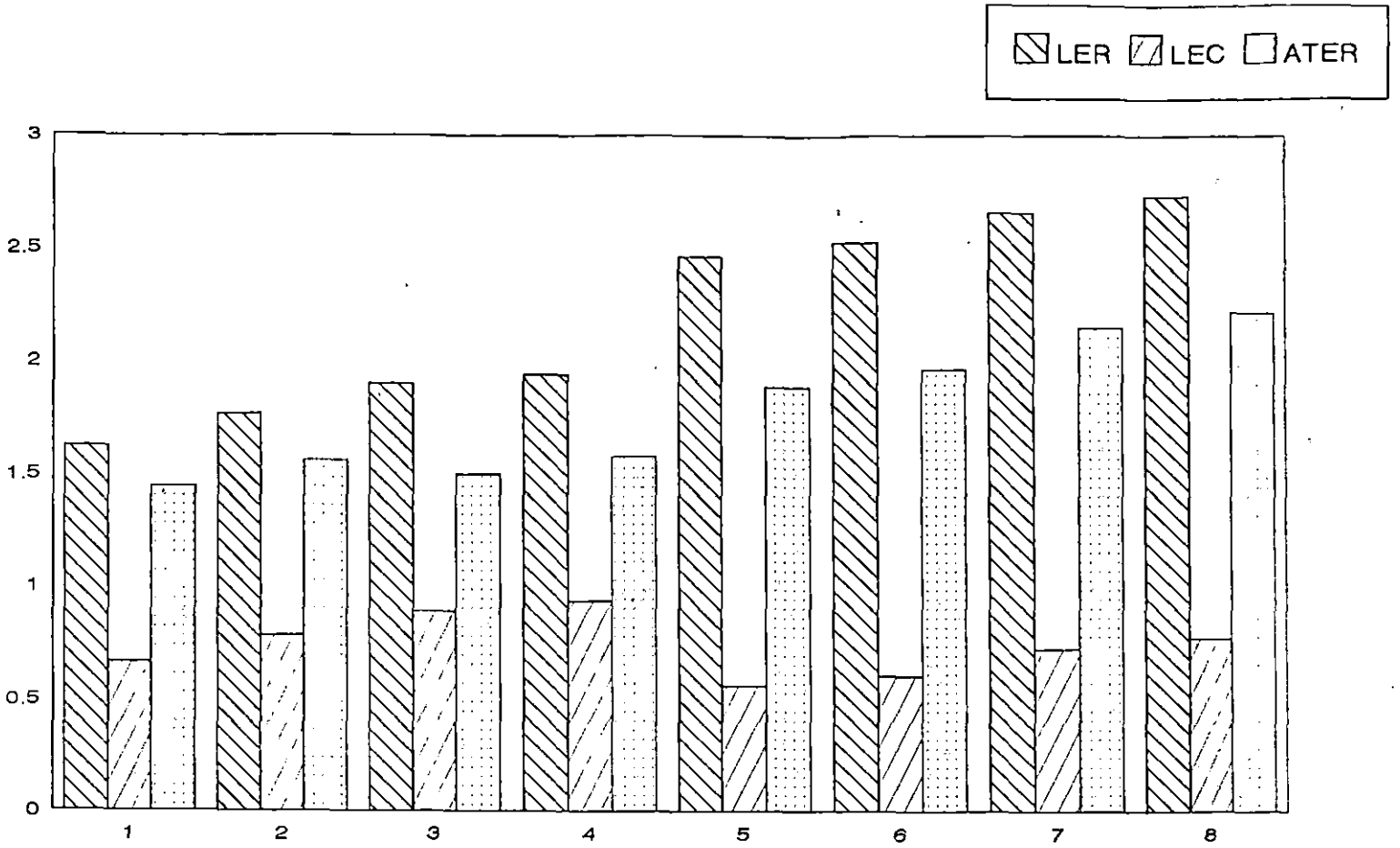
The planting pattern failed to modify the total LER significantly in the first season where the trench system recorded a high LER but in the second season pit system proved its superiority by producing higher LER (Fig. 5).

The results are in accordance with the findings of Ramachander *et al.* (1989) and Sur and Das (1992) in pigeon pea + maize intercropping, Shah *et al.* (1991) in maize + cowpea/soyabean intercropping, Olasantan (1985b) in cowpea +



T_1 - ashgourd + cucumber, T_2 - ashgourd + pole cowpea, T_3 - ashgourd + bush cowpea, T_4 - ashgourd + amaranthus, T_5 - ashgourd + cucumber + bush cowpea, T_6 - ashgourd + cucumber + amaranthus, T_7 - ashgourd + pole cowpea + bush cowpea, T_8 - ashgourd + pole cowpea + amaranthus

Fig.3. Biological efficiency of intercropping system (1st season)



T_1 - ashgourd + cucumber, T_2 - ashgourd + pole cowpea, T_3 - ashgourd + bush cowpea, T_4 - ashgourd + amaranthus, T_5 - ashgourd + cucumber + bush cowpea, T_6 - ashgourd – cucumber – amaranthus
T_7 - ashgourd + pole cowpea + bush cowpea, T_8 - ashgourd + pole cowpea + amaranthus

Fig.4. Biological efficiency of intercropping system (2nd season)

tomato intercropping, Balasubramanian *et al.* (1994) in cotton + black gram intercropping and of Dubey *et al.* (1995) in sorgham + soyabean + pigeon pea intercropping. In all these findings the intercropping gave higher LER than pure crops.

5.4.2 Land equivalent coefficient (LEC)

LEC has been found to be very effective in deciding the mixture yield. According to Willey (1979) one criterion for assessing the yield advantage of cropping system is to realise full yield from base crop and to get some extra yield from the component crop. In this study 100 per cent of the pure crop population was maintained in the intercropping system for all the crops. Any intercropping system involving two crops to become benificial should have an LEC of more than 0.25 indicating that each component crop in the system should give at least 50 per cent of their sole crop yield or the yield of either of the component should be more than expected. In this study also all treatments recorded LEC of more than 0.25. This again confirmed the suitability of intercropping in ashgourd based cropping system. Ashgourd + amaranthus gave higher LEC value (0.92 and 0.93) in both the seasons (Fig. 3 and 4) even though the LER of ashgourd was less than one. This loss in yield was compensated by the higher LER of amaranthus and thus resulted in higher LEC. Planting systems failed to give any significant effect on LEC during the first season where the trench system recorded highert LEC, but the pit system was found to the superior in the second season (Fig. 5).

5.4.3 Area time equivalent ratio (ATER)

In the evaluation of LER, the time the field was dedicated to production, is not considered. But area x time equivalent ratio (ATER) as proposed by Hiebsch and McCollum (1987) considers the land occupancy period of the crops also.

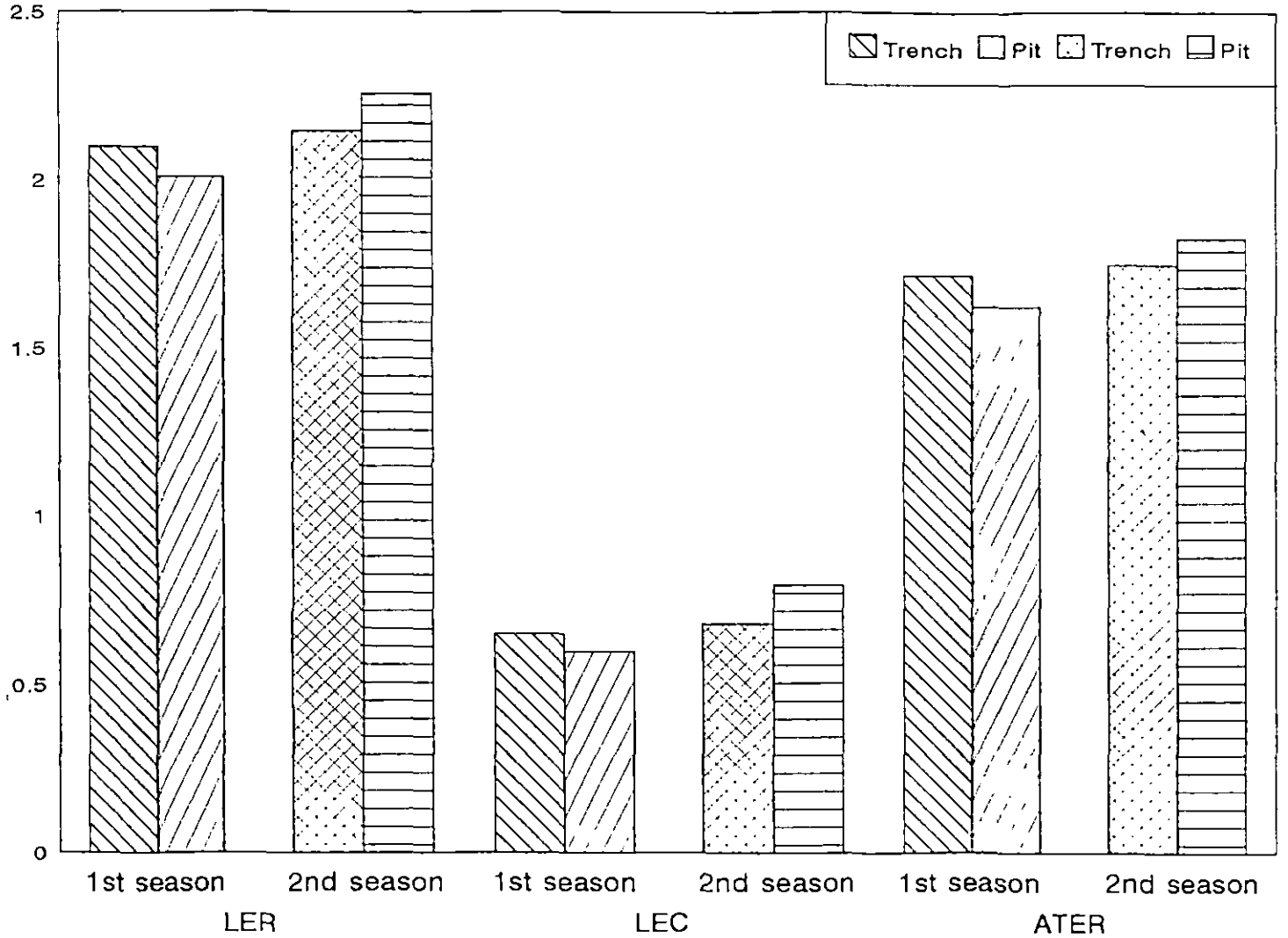


Fig.5. Biological efficiency as affected by planting system

The land occupancy period of ashgourd in this experiment was 120 days and that of cucumber, pole cowpea, bush cowpea and amaranthus were 90, 100, 70 and 75 days respectively. Considering these periods ATER was calculated for the system and the results indicated a significant effect of planting pattern and intercrops on this efficiency parameter.

Maximum utilization of space and time was observed for the treatment comprising of ashgourd + pole cowpea + amaranthus (Fig. 3 and 4). The better ATER is due to better combined intercrop yield and temporal difference which existed between the crops. This was followed by ashgourd + pole cowpea + bush cowpea. The next higher ATER was for the treatment containing ashgourd + cucumber along with bush cowpea or amaranthus. There was a combined net saving of 44 to 122 per cent in use of space and time compared to pure cropping.

5.4.4 Aggressivity

Aggressivity is a parameter that helps to assess the competitive nature of the component crops. Positive aggressivity value of a crop indicates that it is more aggressive than the component crop and negative aggressivity value indicates its dominant nature. The greater the numerical value, the bigger is the difference in the competitive abilities.

Negative aggressivity values for treatments T_5, T_6, T_7 and T_8 (Table 20) indicated the dominant nature of intercrops over ashgourd. When two more crops were grown as intercrop the growth of ashgourd was suppressed. When ashgourd was grown with cucumber also, its performance was suppressed since they are of the same growth habit. In ashgourd + pole cowpea combination pole cowpea was dominant in first season where as during the second season ashgourd was dominant

and pole cowpea the dominated one. When ashgourd was grown with bush cowpea (T_3) and amaranthus (T_4), the positive aggressivity values showed the dominant nature of ashgourd in these treatments. Since bush cowpea and amaranthus were grown away from ashgourd its performance was not affected. Positive aggressivity value for amaranthus intercropped with chilli was noticed by Ikeorgu (1990). The aggressivity value of wheat was high (-0.625) when intercropped with Indian mustard (Singh and Gupta, 1993).

5.4.5 Relative crowding coefficient (RCC)

RCC is used to determine the yield advantage due to mixing. If a component has a coefficient less than, equal to or greater than, one, it means it has produced less yield, the same yield or more yield than expected, respectively. In this experiment the pit system gave a higher RCC value which shows that mixing is advantageous in this system of planting. In trench system in the first season RCC value of less than one was observed which might be due to a general yield reduction in the first season. But in the second season RCC value of more than one indicated that there was no yield reduction due to intercropping.

5.4.6 Ashgourd equivalent yield

In intercropping if more than one species are involved it is difficult to compare the produce of different nature. Hence equivalent yield was calculated by converting the intercrop yield into base crop yield by considering the market rates of both the crops (Table 20). Ashgourd equivalent yield was the highest for the trench system of planting than the pit system. The combination of ashgourd + cucumber + amaranthus recorded the highest ashgourd equivalent yield. The intercropping system produced higher ashgourd equivalent yield than the sole crop due to maximum utilisation of renewable and non-renewable resources of production and

higher economic value of the intercrop produce. Sharma *et al.* (1992) and Yadav and Prasad (1990) also reported higher sugarcane equivalent yield in a sugarcane intercropping system compared with sole crop of sugarcane.

5.4.7 Leaf area index

Leaf area index expresses the total leaf area in relation with the total ground area in which the crop is grown. Too high index indicates a relatively higher plant population which may have shading effect and therefore, a poor photosynthesis whereas lower values indicates a sparse plant population, wastage of sunlight and hence the crop would gave lower yield from a unit area.

In the experiment trench system gave higher leaf area index compared to the pit system. Since there was no yield reduction in the trench system it could be seen that there was no overcrowding of leaves which might have resulted in reduced yield. Treatments involving amaranthus (T_4, T_6 and T_8) recorded the maximum leaf area index compared to other treatments (Table 22). This might be due to higher leaf area of amaranthus which makes it useful as a leafy vegetable. The yield of component crops were not reduced in these treatments. Lower leaf area index were recorded by treatment having cucumber (T_1) and pole cowpea (T_2) with ashgourd and pure crop of ashgourd (T_9). This shows that the interspace in these treatments can be effectively used for growing amaranthus or bush cowpea without any yield reduction. These results were in accordance with the findings of Lai (1985) where intercropping increased LAI and efficiency of light use due to multi-storey spatial effects.

5.4.8 Total biomass production

The biomass production was higher for the pit system compared to trench system. This shows that the growth and spreading habit of the plant was higher in pit system. Here the space available for the individual plant growth is higher than the trench system. But, since the performance of the crop in trench was not affected it could be inferred that both the trench and pit system are equally good with the pit system giving a slightly better performance. The pure crop of ashgourd gave the highest biomass (Table 22) compared to those with intercrops. This might be due to the suppression of growth of the main crop due to intercrops.

5.4.9 Weight of weeds

In intercropping system fewer weeds are expected than in sole crop because of their better suppression. Thus the system provides an opportunity to utilise the crops themselves for weed management. Here also the weed infestation in the intercropping system was less than that of pure crop (Table 22). Effective weed control was obtained for the treatment containing ashgourd + cucumber + amaranthus in the pit and trench system of planting. This might have probably resulted from the intensity of initial cultural operations done, to plant and accomodate the intercrops like amaranthus and bush cowpea. Such a fine clearing of interspace was not requried when the interspace was left vacant. In late maturing crops planted on wider rows, planting of an early-maturing, fast growing crop help to cover the vacant inter row space rapidly and keep weeds under check (Mishra and Gautam, 1995). Amma and Ramadas (1991) also reported reduced weed infestation when bhendi was intercropped with amaranthus.

5.5 Economic suitability

Any system to be recommended to the farmer should be economically profitable. Hence the produce of different crops are converted in terms of monetory

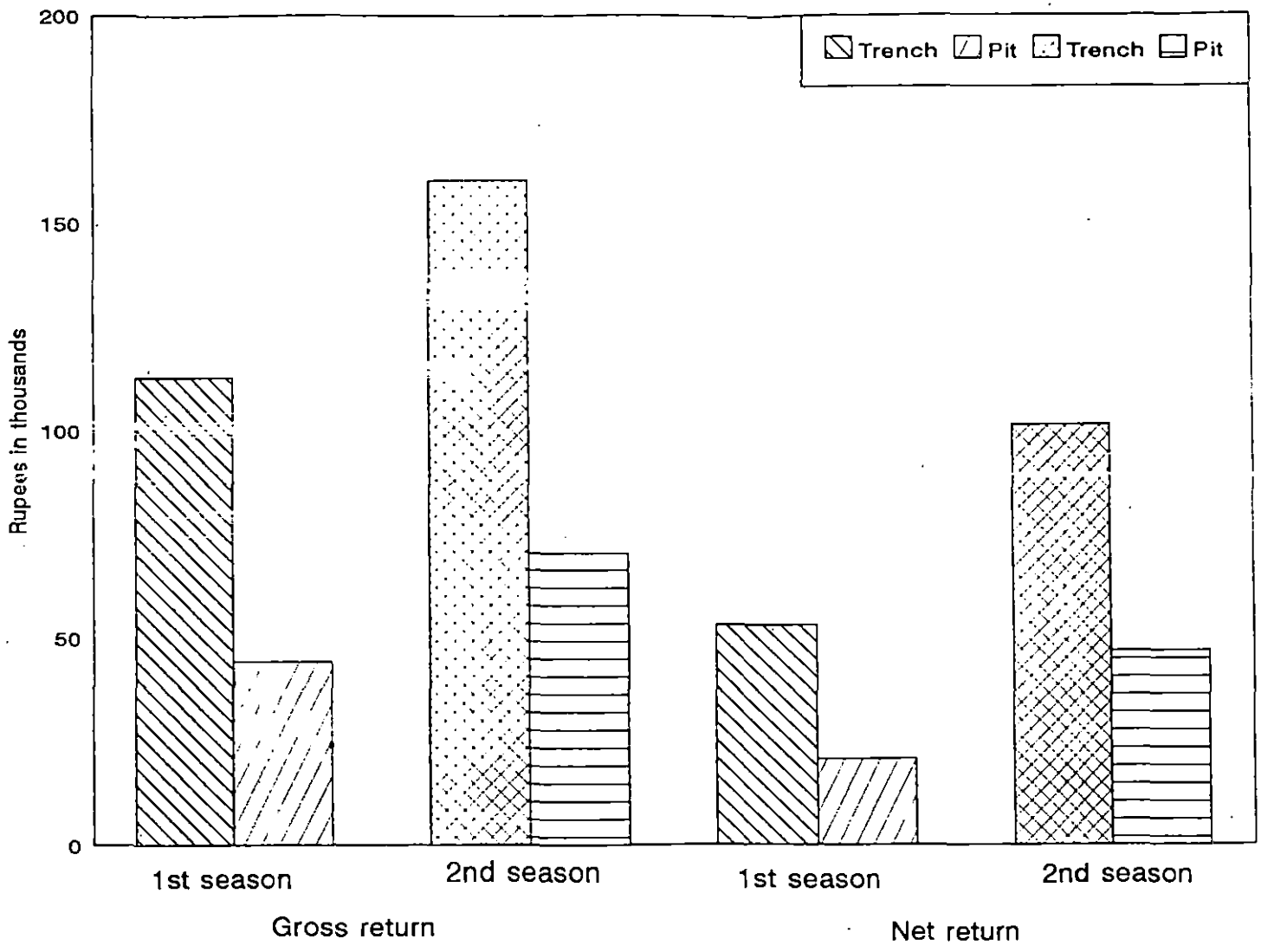


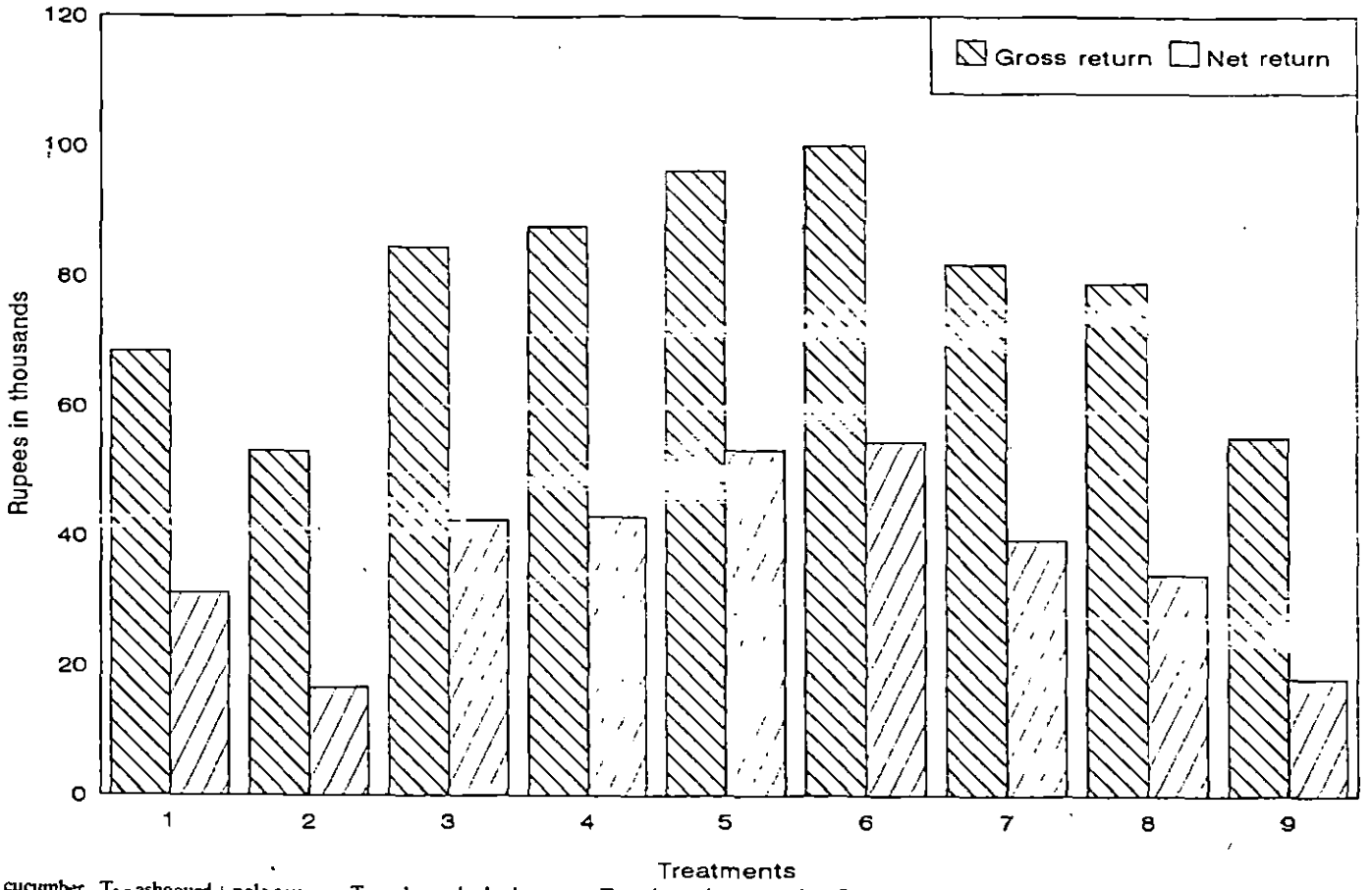
Fig.6. Economic suitability as effected by planting system

returns and is compared to assess the economic suitability. Economic feasibility was tested using various efficiency parameterslike gross return, net return, benefit cost ratio, per day return and return per rupee invested on labour and fertilizer and the results are discussed here

The results revealed that economics of the intercropping system was significantly influenced by planting system, intercrops and their interaction.

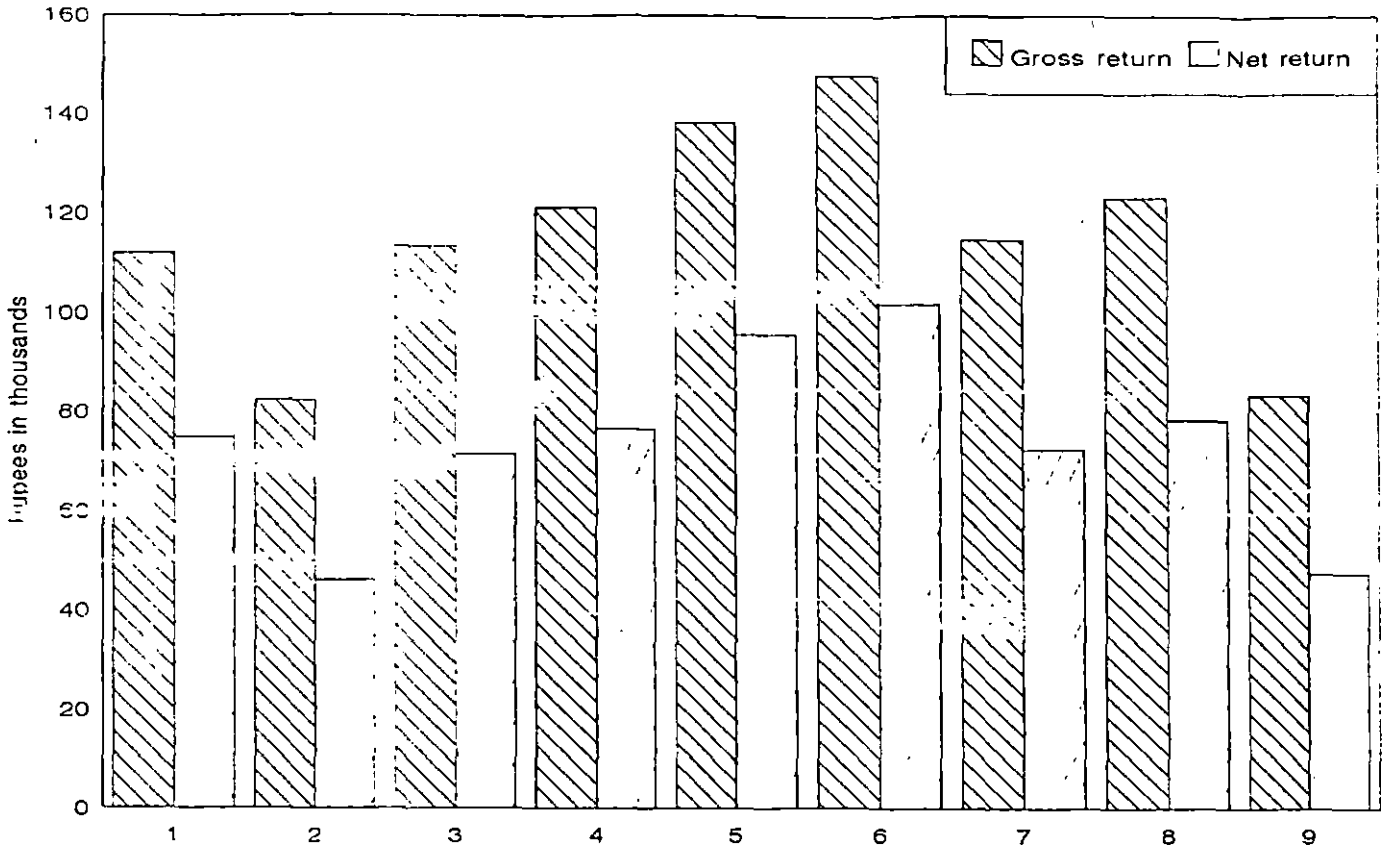
The maximum gross and net returns were obtained in the trench system of planting than in the pit system (Fig. 6). This indicates that modification of the planting pattern is beneficial as far as intercropping in ashgourd is considered. In trench system more number of plants were accomodated without considering the actual spacing of ashgourd. This did not reduce the yield of ashgourd from a unit area. In both the system of planting, even though there is yield reduction when intercrops were grown, when we consider the economics of the system as a whole it is highly beneficial than growing the pure crop of ashgourd.

The gross and net return were highest for the combination of ashgourd + cucumber + amaranthus in the two seasons (Fig. 7 and 8). This was closely followed by ashgourd + cucumber + bush cowpea. Here the reduction in yield of ashgourd was compensated by the additional yield from cucumber, amaranthus and bush cowpea. The performance of pure crop of pole cowpea was also poor during the two seasons. Hence we can come to a conclusion only after growing these combinations in other seasons too. Least gross and net return were for ashgourd + pole cowpea combination followed by pure crop of ashgourd. In the case of ashgourd + pole cowpea the poor performance of the main crop was not compensated by the additional benefit from the intercrop. As a result the return from the whole system is reduced. Hence as far as the net return to farmer is considered intercropping of ashgourd with cucumber and amaranthus is beneficial.



T_1 - ashgourd + cucumber. T_2 - ashgourd + pole cowpea, T_3 - ashgourd + bush cowpea. T_4 - ashgourd + amaranthus, T_5 - ashgourd + cucumber + bush cowpea. T_6 - ashgourd + cucumber + amaranthus. T_7 - ashgourd + pole cowpea + bush cowpea, T_8 - ashgourd + pole cowpea + amaranthus. T_9 - sole crop of ashgourd

Fig.7. Economic suitability of intercropping system (1st season)



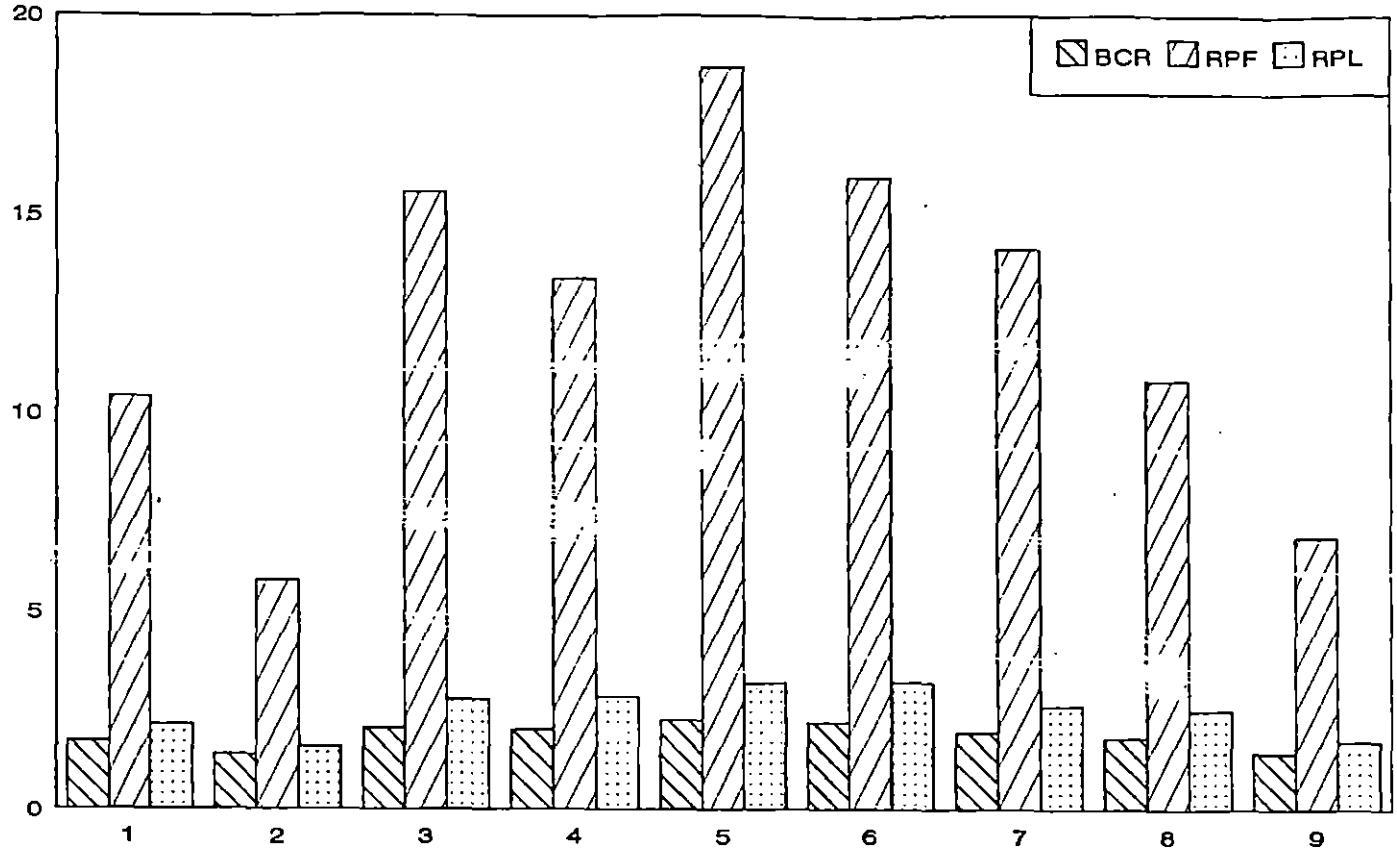
T_1 - ashgourd + cucumber, T_2 - ashgourd + pole cowpea, T_3 - ashgourd + bush cowpea, T_4 - ashgourd + amaranthus, T_5 - ashgourd + cucumber + bush cowpea, T_6 - ashgourd + cucumber + amaranthus, T- - ashgourd + pole cowpea + bush cowpea, T_8 - ashgourd + pole cowpea + amaranthus, T_9 - sole crop of ashgourd

Fig.8. Economic suitability of intercropping system (2nd season)

Growing different crops in the same season reduces the loss due to failure of base crop and thus provides income in the glut seasons. A similar response of higher gross and net return by intercropping chilli and bhendi was reported by Natarajan (1992). Increased gross and net return from intercropping as compared with sole cropping was reported by Amma and Ramdas (1991) in bhendi + amaranthus intercropping system and Prabhakar and Shukla (1991) in bhendi + radish and bhendi+ french bean intercropping system.

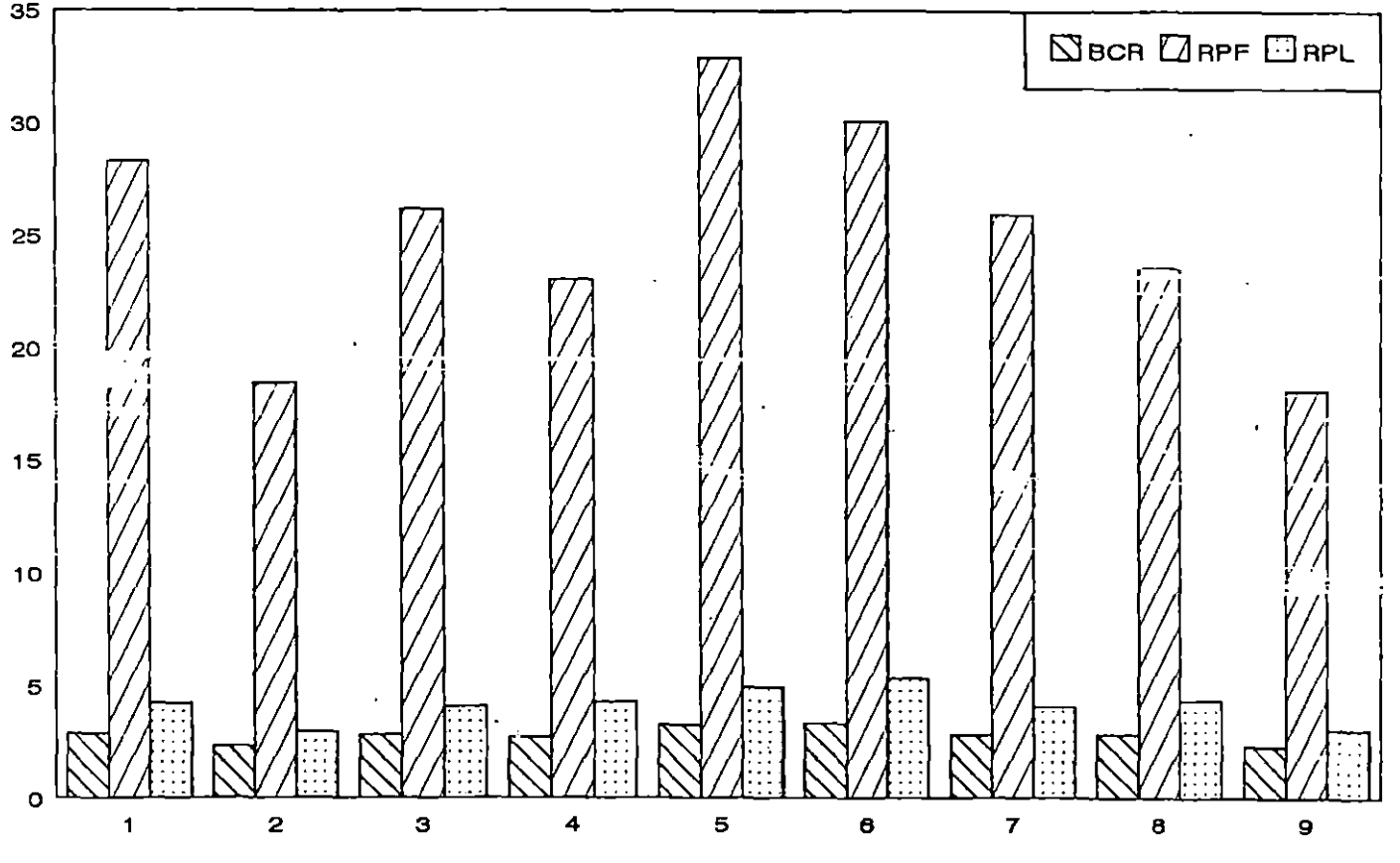
Benefit cost ratio provides an estimate of the benefit the farmer derives for the expenditure incurred in adopting a particular cropping system. BC ratio was influenced by the different intercrops. Ashgourd in combination with cucumber and amaranthus or bush cowpea gave the highest BC ratio (Fig. 9 and 10) than the sole crop of ashgourd (Table 26). The trench and pit system recorded almost similar BC ratio. In first season the trench system gave higher BC ratio (1.89) where as in second season it was the pit system which gave the highest value (2.94). This is in line with the results obtained by Ravichandran *et al.* (1993) in intercropping of sugarcane with urdbean and soybean where highest BC ratio of Rs.2.30 and Rs.2.20 where obtained as against Rs.1.98 for sole crop of sugarcane.

The observation on per day return (Table 26) also revealed significant difference due to planting pattern. It was maximum for trench system than in the pit system. When sole cropping and intercropping treatments were compared as in the other economic parameters, it was higher for treatments containing ashgourd and cucumber along with amaranthus or bush cowpea. The lowest per day return of Rs.215.81 and Rs.460.75 in the first and second season in ashgourd + pole cowpea combination shows that pole cowpea was not able to compensate the yield loss in this treatment. The per day return of all other treatments were higher than that of the sole crop of ashgourd.



T_1 - ashgourd + cucumber, T_2 - ashgourd + pole cowpea, T_3 - ashgourd + bush cowpea, T_4 - ashgourd + amaranthus, T_5 - ashgourd + cucumber + bush cowpea, T_6 - ashgourd + cucumber + amaranthus, T_7 - ashgourd + pole cowpea + bush cowpea, T_8 - ashgourd + pole cowpea + amaranthus, T_9 - sole crop of ashgourd

Fig.9. Economic suitability of intercropping system (1st season)



T_1 - ashgourd + cucumber, T_2 - ashgourd + pole cowpea, T_3 - ashgourd + bush cowpea, T_4 - ashgourd + amaranthus, T_5 - ashgourd + cucumber + bush cowpea, T_6 - ashgourd + cucumber + amaranthus, T_7 - ashgourd + pole cowpea + bush cowpea, T_8 - ashgourd + pole cowpea + amaranthus, T_9 - sole crop of ashgourd

Fig.10. Economic suitability of intercropping system (2nd season)

Since labour is a very costly input in cropping system an estimate on labour utilisation efficiency is also highly needed while going for an intercropping practice. Hence in this experiment the return per rupee invested on labour was also calculated for getting the correct estimate of the production efficiency of a particular treatment with regard to the amount spent on labour. From the result, it was found that return per rupee invested on labour was higher for pit system than in the trench system in second season where as in first season they were almost at par (Table 28). In the intercropping treatments maximum labour efficiency was obtained for ashgourd + cucumber + amaranthus combination (Fig. 9 and 10). This shows that eventhough the labour requirement for intercropping is high the returns from such a system is profitable than the pure crop of ashgourd.

Fertilizer cost is also involved in the total cost of cultivation so the return per rupee invested on fertilizer also seek importance. The results revealed that the modification in planting pattern could not exert any significant influence on cost spent on fertilizers whereas it was affected in the second season (Table 28). When sole crop and intercrops were considered, the ashgourd + cucumber + bush cowpea gave the maximum return (Fig. 9 and 10). Here no additional fertilizer was given for cucumber. Only the ashgourd and bush cowpea were given the required fertilizer dose. The returns from cucumber was obtained without giving any additional input. Hence this treatment gave the highest return. The treatments ashgourd + pole cowpea and pure crop of ashgourd gave the lowest return. In pole cowpea + ashgourd treatment also the fertilizer dose of ashgourd alone was given. It can be seen from the results that pole cowpea could not perform well in combination with ashgourd.

Thus based on the economic parameters it can be concluded that ashgourd + cucumber + amaranthus in trench system of planting is highly economical followed by ashgourd + cucumber + bush cowpea.

5.6 Pest and disease incidence

The number of days taken for the incidence of pest and disease is presented in section 4.8 In general the incidence of both the pests and diseases were severe during the first season. This lead to considerable yield reduction in the first season compared to the second one. Since ashgourd and cucumber belong to the same family they are attacked by common pests and diseases and so intercropping did not reduce the incidence of pests and diseases as expected. Bush cowpea and pole cowpea also succumb to common pests and diseases. Plants which are attacked by similar insects, pests and diseases should not be sown together in an intercropping to make the system more feasible. In this particular study crops belonging to the same botanical groups were selected which augmented the build up of pests and disease population.

Intercropping experiments by Olubayo and Port (1997) showed that burchid infestation was significantly reduced in cowpea maize combination and lower number of stem borers were reported by Skovgard and Pats (1997) in the same combination. Intercropping reduced the incidence of alternaria leaf spot on faba beans when it was intercropped with maize. A similar reduction in late blight of potato was recorded when potatoes were intercropped with faba bean (Sharaiha *et al.*, 1989). It is assumed that effective reduction of pest and disease population might have resulted if plants belonging to different families were used in the study.

The study leads to the conclusion that there is more effective utilisation of space when ashgourd is raised in trenches than when grown in pits. Though higher fruit size indicated by average fruit weight is higher in pit system of planting, there is compensatory yield increase under trench system hence higher returns. Since

wider spacing is provided for ashgourd - a crop which takes a long time for yielding there is an initial wastage of area which can be economically utilised by raising short duration intercrops like amaranthus and bush cowpea. The study indicates ashgourd + cucumber + amaranthus cropping system to be the most economical with a benefit cost ratio of 2.19 and 3.31 in the first and second season respectively.

Summary

SUMMARY

An investigation was undertaken at the Vegetable Research Plots of the Department of Olericulture in College of Horticulture, Vellanikkara to evaluate the productivity of ashgourd as influenced by crop combinations. Performance of ashgourd under the pit and trench systems of planting was studied during April-July and September-December, 1997. Biological efficiency and economic feasibility of the intercropping systems was also evaluated.

The main crop ashgourd was planted at the recommended spacing 4.5 x 2 m under both pit and trench system of planting. Among the intercrops cucumber and pole cowpea were sown in the same pit and trench as that of ashgourd and bush cowpea and amaranthus were raised in the interspaces of ashgourd. In addition to these, pure stand of all these crops were raised as control treatments.

The experiment was laid out in split plot design with four replications in two seasons. Observations were made on growth characters, yield and yield attributes. Biological efficiency and economic suitability of the intercropping system was worked out using different indices. The results obtained are summarised below.

Planting methods like pit and trench systems did not significantly influence the growth characters like length of main vine, internodal length and number of primary branches and yield characters like days to first male and female flower anthesis, number of female flowers, node at which first female flower appeared and per cent fruit set. Intercropping significantly influenced the growth and yield characters. The pure crop of ashgourd recorded higher mean growth and yield than when it was intercropped.

Fruit characters like length, circumference and flesh thickness were not significantly influenced by planting system but fruits obtained from pit system recorded higher values for those characters than the trench system. The average weight of fruits was higher in the pit system than in the trench system of planting and the pure crop of ashgourd gave the highest value.

The number of fruits and yield was higher for the trench system of planting due to higher plant population in such a system. The pure crop of ashgourd gave the maximum yield. Plants under pit system recorded a mean yield of 3735.34 kg ha^{-1} and 7576.77 kg ha^{-1} and under trench system recorded 15122.06 kg ha^{-1} and 22371.14 kg ha^{-1} in first and second season respectively. The lowest yield of ashgourd was for the combination of ashgourd with cucumber (7963.88 kg ha^{-1} and 13517.36 kg ha^{-1} in first and second season).

In the case of cucumber and pole cowpea the growth and yield attributing characters were not significantly influenced by planting pattern but by intercropping. In all the cases the pure crop recorded the maximum value than when intercropped.

The yield of cucumber and pole cowpea were higher in the trench system which was due to the higher number of plants in the trench system.

The yield of bush cowpea and amaranthus were not influenced when included in both the planting systems. Also, their performance were similar when grown as sole crop or as intercrop. This showed that the growth of ashgourd did not negatively influence these intercrops if they are accomodated as done in this experiment.

The biological efficiency indices like LER, LEC, ATER, aggressivity and RCC were worked out for the system in both planting systems. Value of LER and ATER for all the treatments were above one and this indicated that intercropping in ashgourd is biologically efficient.

Evaluation of biological efficiency showed higher LER values for the combination of ashgourd and pole cowpea along with bush cowpea (T_7) and amaranthus (T_8). The LEC value was highest for ashgourd + amaranthus (T_4) and ashgourd + bush cowpea (T_3) combination.

Negative aggressivity values for treatments containing three crop combinations indicated that the intercrops could be more aggressive. But since there is no considerable yield reduction for the base crop, ashgourd and it cannot be taken as a disadvantage.

Growth analysis parameters like LAI and total biomass production were maximum under pure crop of ashgourd than when intercropped.

Weed suppression was obtained effectively for all the intercrop combinations. Weed control was more for the trench system due to higher plant density.

No effective control of pest and diseases was obtained in any treatment combinations.

For assessing the monetary advantage economic parameters like gross return, net return, benefit/cost ratio, return per rupee invested on fertilizer, return per rupee invested on labour and per day return were worked out for both the planting patterns.

Economic analyses revealed that even though the yield was higher for pure crop, in terms of gross and net return, intercropping proved its superiority over sole cropping - ashgourd + cucumber + amaranthus combination being the best.

The other economic parameters like BC ratio, per day return, return per rupee invested on labour and fertilizer were higher for treatments containing ashgourd and cucumber along with amaranthus (T_6) and bush cowpea (T_7) during both the seasons.

Better use of resource in an intercropping system could be achieved by proper selection of crops, ideal nutrient management and suitable planting geometry. Economic returns or monetary gain per unit area and time is one of the major considerations for adoption of a certain cropping system at farm as well as on regional level.

Based on the discussions it can be concluded that though yield reduction was observed in individual crops due to intercropping, when the system as a whole is taken, there was both yield advantage and monetary advantage as observed from gross and net return and LER value above unity.

Planting ashgourd in the trench system was found to be the best and the cropping system with ashgourd along with cucumber in the same trench or pit and amaranthus in the interspace gives higher economic yield and more net returns without affecting the productivity of the main crop ashgourd.

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Appendix

APPENDIX-I

Weather data at monthly intervals during the experimental period (April 1996-January 1997)

Month	Total rainfall (mm)	Temperature °C		Relative humidity (%)	Sunshine hours
		Maximum	Minimum		
April	152.0	34.6	25.0	73	8.3
May	95.4	32.8	25.2	77	7.7
June	400.3	30.5	23.8	85	4.7
July	588.7	28.8	23.1	90	2.7
August	310.0	29.1	23.6	87	3.3
September	391.6	29.2	27.7	84	4.3
October	219.3	30.1	22.9	82	6.0
November	23.1	31.5	23.6	72	7.1
December	60.8	30.5	21.8	68	6.8
January	0.0	32.0	22.9	62	9.6

PRODUCTIVITY OF ASHGOURD AS INFLUENCED BY CROP COMBINATIONS

By

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ABSTRACT OF THE THESIS

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ABSTRACT

An investigation on the produtivity of ashgourd as influenced by crop combinations was conducted at the Vegetable Research Plots of the Department of Olericulture, College of Horticulture, Vellanikkara in 1997. The study evaluated the biological efficiency and economic feasibility of various intercropping systems.

The experiment was laid out in split plot design with four replications. The base crop ashgourd was raised in pit and trench system along with intercrops cucumber, pole cowpea, bush cowpea and amaranthus in two and three crop combinations. In addition to these treatments sole crops were raised as control plots. Observations were made on growth characters and yield and yield attributing characters. The calculations on biological efficiency and economic suitability were worked out using different indices.

The results revealed that planting pattern did not significantly influence most of the growth and yield contributing characters in ashgourd, cucumber and pole cowpea. The yield was maximum in the trench system of planting due to more number of plants that could be accomodated in this system. The performance of bush cowpea and amaranthus were similar when grown as pure crop or intercrop in this particular system. In the case of other crops, pure cropping recorded a higher growth than when intercropped.

Fruit characters like length, circumference and flesh thickness of ashgourd also were not significantly influenced by planting pattern but the pit system gave a higher value than trench system.

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Effective weed suppression was obtained due to intercropping than in the pure crops but there was no difference in the pest and disease attack in pure and intercropped conditions.

LER, LEC, ATER and aggressivity values revealed the biosuitability of ashgourd based cropping system.

As pure crops, ashgourd, cucumber, pole cowpea, bush cowpea and amaranthus recorded maximum growth and yield contributing characters and yield as compared to the intercropping treatments. However, economic analysis revealed that intercropping is advantageous than their respective sole crops.

Economic indices like gross return, net return and per day return was higher for the combination of ashgourd + cucumber + amaranthus. This was closely followed by ashgourd + cucumber + bush cowpea combination which recorded only a difference of Rs.1318.75 and Rs.6201.39 during first and second seasons respectively.

Performance of pure and intercropped pole cowpea was poor in these two seasons hence its performance in these cropping system need to be further evaluated.

Growing ashgourd and cucumber in trenches of size 2 m x 60 cm x 60 cm with amaranthus as intercrop in an area of 4 m^2 was found to be the best treatment.

Thus the study conclusively revealed the scope of recommending ashgourd-cucumber-amaranthus intercropping system as an economically viable, biologically suitable and sustainable cropping system to increase vegetable production in Kerala.