AGRONOMIC TRAITS OF SESAME AS AFFECTED BY GRAIN LEGUMES INTERCROPPING AND PLANTING PATTERNS

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A field experiment was conducted on a sandy-clay loam soil at the agronomic area, University of Agriculture, Faisalabad for two consecutive years to evaluate the effect of grain legumes intercropping and the planting patterns on the agronomic traits of sesame. The planting patterns comprised 40 cm spaced single rows, 60 cm spaced 2-row strips and 100 cm spaced 4-row strips while the intercropping systems were sesame + mungbean, sesame + mashbean, sesame + soybean and sesame + cowpea and sesame alone. The various yield components of sesame such as number of capsules plant^{-1}, seed weight plant^{-1},1000-seed weight and plant height were affected significantly by different intercropping systems and planting patterns. Grain legumes intercropping reduced the seed yield of sesame to a significant level by adversely affecting its yield components. However, the additional harvest of each intercrop compensated more than the loss in sesame production. Among the intercropping patterns sesame intercropped with mungbean, mashbean, soybean and cowpea in the pattern of 100 cm spaced 4-row strips proved to be feasible, easily workable and more productive than sesame mono-cropping. Of the intercropping systems, sesame + mungbean or sesame + mashbean were found to be superior to all other intercropping systems under study.
Key words: Agronomic traits, grain legumes, intercropping, planting patterns, sesame, Pakistan

INTRODUCTION

Traditional and non-traditional oilseed crops are the major sources of edible oil in Pakistan. Although considerable efforts have been made to propagate the cultivation of non-traditional oilseed crops like sunflower, soybean and safflower but no substantial increase in their production has been achieved because of their non-adaptability to our geo-agronomic environments. Thus there is a need to explore the maximum inherent potential of the traditional oilseed crops which are well accepted and adopted to the agro-ecological conditions of the country. Among them, sesame is of great agro-economic importance because of high protein and seed oil contents. Sesame seed contains 50% edible oil while seed cake contain 42% protein rich in tryptophan and methonine which is excellent feed for milch animal and layers (Hatam and Abbasi, 1994). Sesame oil is colourless and odorless. The presence of antioxidants such as sesamolin, sesamin and sesamol makes the sesame oil highly preservable as a result of which it does not get rancid (Ahuja *et al.*, 1971). Inspite of the multi-dimensional uses of sesame, its cultivation in Pakistan is very discouraging with very low seed yield per hectare. It is grown as a kharif oilseed crop on an area of 60 thousand hectares with a total annual production of 24.7 thousand tonnes giving an average seed yield of 502 kg ha^{-1} (Anonymous, 2004) which is much lower than the yield obtained in other countries like Egypt (1120 kg ha^{-1}), Mexico (962 kg ha^{-1}) and China (900 kg ha^{-1}) (Anonymous., 1996). Similarly, the role of legumes as a source of vegetable protein in the human diet, animal feed and their beneficial role in augmenting the soil fertility is well known.

Pakistan is a subtropical country having adequate irrigation and land resources with high intensity of sunlight for plant growth, therefore, possibility of raising two or more crops on the same piece of land in a year needs to be explored for effective and efficient utilization of these natural resources. Intercropping is being looked as an efficient and most economic production system as it not only increases the production per unit area and time but also improves the resource-use efficiency and economic standard of the growers. Now-a-days, interest in intercropping is increasing among the small growers because of their diversified needs and low farm income from the monocropping system. So in the present scenario of preponderance of small holding, surplus farm family labour, overlapping of growing season of crops, low productivity of the crops and practice of subsistence farming, intercropping seems to be a promising strategy for increasing crop productivity particularly at small farm level in Pakistan. However, the conventional method of planting sesame in 40 cm spaced single rows does not permit intercropping because of narrow inter-row spacing. Recently a new method of planting sesame in well spaced multi-row strips has been developed which not only gives relatively higher seed yield than the conventional single row planting (Siddique, 1997), but also facilitates intercropping, harvesting and handling of the intercrops without doing any damage to the base crop. Since in Pakistan, no systematic research work has been done so far to explore the possibility of intercropping grain legumes in sesame, thus there is need to develop an appropriate planting system of sesame facilitating intercropping and other agronomic practices. The present study was, therefore, planned to explore the feasibility and production potential of different sesame-legume intercropping systems under different planting patterns in irrigated environment at Faisalabad with a hope to reach an economically viable and appropriate sesame-legume intercropping system best suited to the small growers.

MATERIALS AND METHODS

The investigations into the agronomic performance of different sesame-legumes intercropping systems under various geometric arrangements were carried out at the University of Agriculture, Faisalabad for two consecutive years (2001 and 2002). The experiment was laid out in a randomized complete block design (RCBD) with split plot arrangement and replicated four times, keeping the geometric arrangements in main plots and intercropping treatments in sub-plots. The net plot size was 3.2 m x 7.0 m. The planting patterns comprised 40 cm spaced single rows, 60 cm spaced 2-row strips and 100 cm spaced 4-row strips while the intercropping systems were sesame alone, sesame + mungbean, sesame + mashbean, sesame + soybean and sesame + cowpea. Each intercrop was also sown as a sole crop to calculate the yield advantages. Chemical analysis of the experimental soil before sowing and after the harvest of component crops was done for NPK. Sesame genotype 92001 was used as a medium of the trial. The crop was sown on a well prepared fine seedbed in the first week of July each year and the respective intercrops were intercropped on the same day as per treatments. The seed was used at the rate of 5 kg ha^{-1}. A basal dose of 50-100-50 kg NPK was applied at the time of sowing while additional 50 kg N ha^{-1} was applied with first irrigation to the sesame crop only to meet its full nitrogen requirement. The sesame and other intercrops were thinned out to achieve a uniform plant population in each plot. Three irrigations each at 20 days after germination, 35 days after Ist irrigation and at flowering were applied during the entire growth period of the component crops. All other agronomic practices were kept normal and uniform for all the treatments. Both the sesame and intercrops were harvested at their physiological maturity. Standard procedures were followed to collect the data on growth and yield parameters. The data collected were statistically analysed by using computer statistical programme MSTAT-C (Freed and Eisensmith, 1986). Fishers analysis of variance technique was employed (Steel and Torrie, 1984) and the least significant difference (LSD) test at 0.05 P was used to compare the treatments, means.

RESULTS AND DISCUSSION

Seed Yield per Hectare (SYH)

The data pertaining to different agronomic traits of sesame as influenced by different grain legumes intercropping and planting patterns presented in Table 1 revealed that the sesame grown with no intercropping produced significantly higher seed yield ha^{-1} than the intercropped treatments which also differed significantly from one another. Among the intercropped

Table 1. Yield and yield components of sesame as affected by different grain legumes intercropping systems and planting patterns.

	Grain yield (kg ha^{-1})	Plant population density (m^{-2})	Number of capsules plant^{-1}	Number of seeds capsule^{-1}	1000-seed weight (g)	Plant height (cm)	Harvest Index (H.I.)
A. Intercropping Systems							
Sesame alone	740.05 a	23.10 NS	47.86 a	61.83 NS	3.62 a	129.95 a	21.43 a
Sesame + mungbean	615.00 b	22.58	39.83 b	61.55	3.47 b	118.70 b	20.55 b
Sesame + mashbean	603.45 b	22.96	39.31 bc	61.67	3.49 b	117.30 b	20.48 bc
Sesame + soybean	580.40 c	22.29	37.00 cd	61.85	3.43 bc	113.35 bc	20.40 c
Sesame + cowpea	547.75 d	22.53	35.06 d	61.40	3.36 c	106.40 c	20.31 d
B. Planting Patterns							
40 cm spaced single rows (P_1)	518.05 c	22.85 NS	34.40 c	61.71 NS	3.36 c	108.15 b	20.65 b
60 cm spaced 2-row strips (P_2)	646.55 b	22.51	40.89 b	61.60	3.49 b	106.05 b	20.50 c
100 cm spaced 4-row strips (P_3)	687.4 a	22.72	44.14 a	61.67	3.57 a	127.35 a	20.75 a

Any two means not sharing a letter differ significantly at $P \leq 0.05$.

treatments, although sesame intercropped with mungbean and mashbean produced statistically similar seed yield but it was significantly higher than the sesame intercropped with soybean or cowpea which also differed significantly from each other. Significantly the minimum seed yield was recorded for sesame intercropped with cowpea. The variation in seed yield of sesame intercropped with different legumes might be attributed to their variable competitive behaviour and allelopathic effects on the associated sesame crop.

The maximum reduction in seed yield of sesame due to cowpea intercropping was ascribed to its relatively luxuriant vegetative growth compared to mungbean, mashbean and soybean. Reduction in grain yield of sesame due to legume intercropping was also reported by Patra and Bhal (1994) and Mohiuddin and Ghosh (1997).

As regards planting patterns, the crop planted in 4-row strips produced significantly higher seed yield ha^{-1} (687.4 kg ha^{-1}) compared to the minimum (518.05 kg ha^{-1}) in 40 cm spaced single rows. Significant variation in SYH of sesame among different planting patterns was also reported by Sarkar and Pramanik (1992) and Osman (1993).

Plant population density at harvest (m^{-2})

Plant population density m^{-2} was not affected by different intercropping systems and planting patterns to significant level. This was primarily due to the fact that a uniform sesame population in each row was maintained by thinning in all the treatments. Secondly, the planting geometry was altered in such a way that number of sesame rows were the same in all the three planting patterns. De *et al.* (1978) also conducted experiments in which the plant population of the base crop was kept constant while the planting geometries were altered. Non-significant effect of intercropping legumes under different planting patterns on planting density m^{-2} of cotton has also been reported by Deshpande *et al.* (1989) and Khan (2000).

Number of Capsules $Plant^{-1}$ (NCP)

Both planting patterns and intercropping systems had a significant effect on NCP. The crop grown with no intercropping produced significantly greater NCP (47.86) than all the intercropped treatments (Table 1). Within the intercropping treatments the minimum NCP (35.06) was recorded in sesame intercropped with cowpea.As regards planting patterns, the crop planted in the pattern of 100 cm spaced 4-row strips produced significantly greater NCP (44.14) than to the minimum (34.40) in 40 cm spaced single rows. On the contrary, Avila *et al.* (1992) reported that NCP of sesame was not affected significantly by different spacing patterns.

Number of Seeds per Capsule (NSC)

There was no significant variation among different intercropping systems and planting patterns with regard to numbers of seeds per capsule (NSC). However, on an average the NSC ranged between 61.40 and 61.85. As reported by Bajwa *et al.* (1992) the number of grains per spike of wheat was not affected significantly by intercropping By contrast, Zhao *et al* (1992) recorded greater number of seeds per capsule when sesame was intercropped with wheat. Similarly Khalid *et al.* (1988) and Tareen *et al.* (1988) reported that the number of grains per spike of wheat was not affected significantly by different planting patterns.

1000-seed weight (g)

The planting patterns as well as the intercropping systems varied significantly among themselves in respect of 1000-seed weight. Sesame grown with no intercropping gave significantly higher 1000-seed weight (3.62 g) than the intercropped sesame. Significantly the minimum 1000-seed weight (3.36 g) was recorded for sesame intercropped with cowpea. Among the planting patterns, the crop planted in4-row strips gave significantly higher 1000-seed weight (3.57 g) than the crop planted in 60 cm spaced paired rows (3.49 g) compared to the minimum (3.36 g) in 40 cm spaced single rows. The differences among intercropped treatments were probably due to the variable degree of competition among the component crops for essential growth factors. Zhao *et al.* (1992) also reported that the 1000-seed weight of sesame was significantly affected when intercropped with wheat. These results are also in line with those of Malik *et al.* (1992) who reported that different row spacings had a significant effect on 1000-seed weight of sesame.

Plant height (cm)

Plant height of sesame was affected significantly both by intercropping and planting patterns. The sesame with no intercropping produced significantly taller plants (129.95 cm) than the intercropped sesame (Table 1). Significantly the minimum plant height of 106.40 cm was recorded for sesame intercropped with cowpea. Decrease in plant height of sesame due to associated cultures was also reported by Osman (1993).

Of the planting patterns, the crop planted in 4-row strips produced significantly taller plants (127.35 cm) than the crop planted in 60 cm spaced paired rows (116.05 cm) compared to the smallest (108.15 cm) in 40cm spaced single rows. Significant effect of row spacing on plant height of sesame was also reported by Osman (1993).

Harvest Index (HI)

The harvest index varied significantly among the planting patterns and intercropping systems. Mono cropped sesame showed significantly higher HI (21.43%) than all the intercropped treatments which also differed significantly from one another (Table 1). Among the intercropping systems, the crop intercropped with mungbean although gave significantly higher HI (20.55) than that intercropped with soybean or cowpea but was at par with that intercropped with mashbean. The lowest HI (20.31%) was recorded for sesame intercropped with cowpea. The reduction in HI of sesame due to intercropping might be ascribed to intensive competition among the component crops for moisture, space and light which probably reduced the ability of the sesame to convert dry matter in seed yield. Similar results were reported by Singh and Gupta (1993) and Ahmad (1997) who observed significant reduction in HI of wheat due to intercropping.

Among the planting patterns, the crop grown in 4-row strips gave significantly higher HI (20.75%) than the crop planted in 60 cm spaced paired rows against the minimum (20.65%) in 40 cm spaced single rows. These results are in line with those of Siddique *et al.* (1995) and Ahmad (1997) who reported variable HI of wheat raised at different planting patterns.

Field benefit of different sesame-based intercropping systems

The economic analysis (Table 2) indicated that the gross benefit varied from Rs. 20452 to Rs. 25315 ha^{-1}, among different intercropping systems. The highest gross benefit of Rs. 25315 ha^{-1} was recorded for sesame + mungbean intercropping system closely followed by sesame + mashbean (Rs. 23410 ha^{-1}) and sesame + soybean (Rs. 21667 ha^{-1}). However, the sesame + cowpea intercropping system gave the minimum gross benefit of Rs. 20452 ha^{-1}. The total variable cost that vary was the highest (Rs. 6540 ha^{-1}) in intercropping system of sesame + soybean. The next to follow were intercropping systems of sesame + mungbean, sesame + mashbean and sesame + cowpea with total variable cost of Rs. 5610, 5400 and 5395 ha^{-1}, respectively. It is clear from the above discussion that the net benefits of all intercropping systems in the pattern of 100 cm spaced 4-row strips and 60 cm spaced paired rows were higher than that obtained from planting sesame in 40 cm spaced single rows. Whereas the intercropping systems sesame + mungbean, sesame + mashbean, sesame + soybean and sesame + cowpea gave net benefits of Rs. 19705, 18010, 15127 and 15057 ha^{-1}, respectively.

In conclusion, intercropping sesame with mungbean, mashbean, soybean and cowpea preferably in the pattern of 100 cm spaced 4-row strips appeared to be more productive and profitable than the monocropping of sesame.

Table 2. Economic benefits of different sesame-legumes intercropping systems under various planting patterns.

	Gross benefits (Rs. ha^{-1})			Total cost that vary (Rs. ha^{-1})			Net benefits (Rs. ha^{-1})		
	Sesame	Intercrop	Total	Sesame	Intercrop	Total	Sesame	Intercrop	Total
Sesame alone	19688	-	19688	3120	-	3120	16568	-	16568
Sesame + mungbean	16359	8956	25315	3120	2490	5610	13239	6466	19705
Sesame + mashbean	16053	7357	23410	3120	2280	5400	12933	5077	18010
Sesame + soybean	15439	6228	21667	3120	3420	6540	12319	2808	15127
Sesame + cowpea	14573	5879	20452	3120	2275	5395	11453	3604	15057

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