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Competitive Behaviour of Component Crops in Different Sesame-Legume Intercropping Systems

IFTIKHAR HUSSAIN BHATTI, RIAZ AHMAD[1], ABDUL JABBAR , M.S. NAZIR AND T. MAHMOOD
Department of Agronomy, University of Agriculture, Faisalabad–38040, Pakistan
[1]Corresponding author's e-mail: riazahmaduaf@hotmail.com

ABSTRACT

The competitive behavior of components crops in different sesame-based intercropping systems under different planting patterns was studied on a sandy-clay loam soil at the University of Agriculture, Faisalabad for two consecutive years. The planting patterns comprised 40 cm spaced single row, 60 cm spaced 2-rows strips and 100 cm spaced 4-rows strips, while the intercropping systems were sesame alone, sesame + mungbean, sesame + mashbean, Sesame + soybean, and sesame + cowpea. The sesame grown in association with different grain legumes appeared to be a dominant crop as indicated by its higher values of relative crowding coefficient, competitive ratio and positive sign of the aggressivity. This led to the conclusion that sesame grown in association with mungbean, mashbean, soybean and cowpea utilized the resources more aggressively than the respective intercrops which appeared to be dominated. Regardless of the planting patterns, mungbean proved to be more competitive than mashbean, soybean and cowpea, which exhibited almost similar competitive behavior.

Key Words: Competitive behaviour, component crops, sesame-legume intercropping; Pakistan

INTRODUCTION

Under the present circumstances, any scheme or plan to increase food and oil production cannot be a total success unless and until an appropriate production-oriented cropping system and production technology for each ecological zone is not developed and properly implemented. Multiple cropping in the form of intercropping being a unique asset of tropical and subtropical areas is becoming popular day by day among small farmers as it offers the possibility of yield advantage relative to sole cropping through yield stability and improved yield. Hence there is need to explore its feasibility and other related agro-economic aspects in Pakistan too, where climate is sub-tropical and irrigation resources are inadequate. In the past monocropping of grain legumes (pulses) was a usual practice among the growers but now-a-days the interest in growing food legumes in an intercropping system is increasing (Khan *et al*. 2001). Recent evidence suggests that there are substantial advantages of legumes intercropping, which are achieved not by means of costly inputs but by the simple expedient of growing crops together in an appropriate geometry (Khan and Khaliq, 2004). When legumes are grown in association with non-legumes, there is often advantage to the non-legumes from nitrogen fixed by the legumes. Furthermore, two crops differing in height, canopy, adaptation and growth habits grow simultaneously with least competition (Keerio & Aslam, 1986). Other suggested forms of advantages are, the greater stability of yield over different seasons, better use of land resources, possibility of better control of weeds, pests and diseases.

Pakistan is a sub-tropical 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 economical 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. Presently, interest in intercropping is increasing among the small growers because of their diversified needs and low farm income from the mono-cropping system.

However, the conventional method of planting sesame in 40-cm spaced single row does not permit intercropping because of narrow 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 (Bhatti *et al.* 2005), but also facilitates intercropping, harvesting and handling of the intercrops without doing any damage to the base crop. The competitive behavior of components crops in different sesame-based intercropping systems in terms of aggressivity, relative crowding coefficient and competitive ratio have been reported by Sarkar and Chakraborty (2000), Sarkar and Sanyl (2000) and Sarkar *et al*. (2001). In Pakistan however, no systematic research work has been done so far to explore the competitive behaviour of component crops in different sesame-legumes intercropping systems. The present study was, therefore, designed accordingly.

MATERIALS AND METHODS

The present study was conducted at the agronomic research area, University of Agriculture, Faisalabad during the kharif season of 2001 and 2002 on a sandy clay loam soil. 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. Legumes were intercropped in sesame on the same day just after the sowing of sesame. The plant population was kept constant and optimum in all the three geometric arrangements. The experiment was laid out in a randomized complete block design with split plot arrangement, keeping planting patterns in main plots and intercropping systems in sub-plots with four replications. The net plot size was 3.2 m × 7.0 m. A basal dose of 50 – 100 - 50 kg NPK ha^{-1} was applied at the time of sowing while additional 50 kg N ha^{-1} was applied with first irrigation only to the sesame crop to meet its full N requirement. In all three irrigations each of 7.5 cm were given to mature the component crops. The first irrigation was given 20 days after germination, the second 35 days after germination and the third at flowering. The competitive behavior of component crops in different sesame-legume association was determined in terms of aggerssivity, relative crowding coefficient and competitive ratio which were determined by using the following formulae.

Competitive functions. The following abbreviations were used to calculate different competitive functions.

Yaa pure stand yield of crop "a".

Yab intercrop yield of crop "a".

Ybb pure stand yield of crop "b".

Yba intercrop yield of crop "b".

Zab and Zba are sown proportions of crop "a" and "b" in an intercropping system.

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

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

Where,

Aab = Aggressivity value for the component crop "a". All other abbreviations have been described above in this section.

Relative crowding coefficient. Relative crowding coefficient (K) was proposed by Dewit (1960), which was calculated by the following formula:

$$Kab = \frac{Yab}{Yaa - Yab} - \frac{Zba}{Zab}$$

Where,

Kab = Relative crowding coefficient for the component crop "a". All other abbreviations such as Yaa, Yab, Zab, Zba, have been described above in this section.

Competitive ratio. Competitive ratio (CR) was calculated by the formula proposed by Willey *et al.* (1980).

$$CRa = \frac{Yab}{Yaa \times Zab} \div \frac{Yba}{Ybb \times Zba}$$

Where,

CRa = Competitive ratio for the component crop "a". All the other abbreviations have been described above in this section.

RESULTS AND DISCUSSION

Competition functions. The competitive behaviour of component crops in different intercropping systems was determined in terms of aggressivity, relative crowding coefficient and competitive ratio.

Aggressivity (A). The competitive ability of the component crops in an intercropping system is determined by its aggressivity value. An aggressivity value of zero indicates that component crops are equally competitive. For any other situation, both crops will have the same numerical value, but the sign of the dominant species will be positive and that of dominated negative. The greater the numerical value, the bigger the differences between actual and expected yields.

The component crops did not compete equally (Table I). Regardless of the planting patterns, there was a positive sign for sesame and the negative for intercrops showing thereby that the sesame was dominant, while intercrops were dominated. However, in a sesame + cowpea intercropping system with 40 cm spaced single row, cowpea was dominated. Aggressivity value was the minimum for sesame + cowpea under all the three planting patterns, which indicated that cowpea was the most competitive crop to sesame. By contrast, mungbean and mashbean proved to be less competitive to sesame. These results are in line with the findings of Sarkar and Chakraborty (2000), Sarkar and Sanyal (2000) and Sarkar *et al*. (2001) who reported the dominant effect of sesame having a positive "A" value when grown in association with mungbean, mashbean and groundnut.

Relative crowding coefficient (RCC). The competitive effects and advantages of intercropping systems are also determined by the relative crowding coefficient. According to Willey (1979) in an intercropping system each crop has its own RCC (K). The component crop with higher 'K' is dominated. To determine if there are yield advantages of intercropping, the product of coefficient of both component crops is formed that is usually designated as `K'. If the product of RCC of two species is equal, less or greater than one, it means that the intercropping system has no advantage, disadvantage or advantage, respectively.

In all the intercropping systems included in this study except sesame + cowpea, sesame appeared to be highly dominant as it had higher value of `K' than the intercrops in different intercropping systems (Table II). It may be inferred that cowpea intercrop utilized the resources more competitively than mungbean, mashbean and soybean, which was dominated. As the product of the coefficient of component crops was greater than one, therefore, all the intercropping systems had yield advantages. Among the intercropping systems, the maximum yield advantage was obtained from sesame + mungbean as indicated by its maximum value of `K'.

Table I. Aggressivity as affected by different planting patterns and esame-legumes intercropping systems

Intercropp-ing systems	40 cm spaced single rows (P_1)		60 cm spaced 2- row strips (P_2)		100 cm spaced 4-row strips (P_3)		System ($P_1+P_2+P_3$)/3	
	Sesame (Aab)	Intercrop (Aba)	Sesame (Aab)	Intercrop (Aba)	Sesame (Aab)	Intercrop (Aba)	Sesame (Aab)	Intercrop (Aba)
Sesame + Mungbean	0.08	-0.08	0.16	-0.16	0.06	-0.06	0.1	-0.1
Sesame + Mashbean	0.06	-0.06	0.14	-0.14	0.04	-0.04	0.06	-0.06
Sesame + Soybean	0.04	-0.04	0.11	-0.11	0.02	-0.02	0.05	-0.05
Sesame + Cowpea	-0.02	+0.02	0.08	-0.08	0.02	-0.02	0.04	-0.04

Table II. Relative crowding co-efficient as influenced by different planting patterns and sesame based intercropping systems

Intercropp-ing systems	40 cm spaced single rows (P_1)			60 cm spaced 2- row strips (P_2)			100 cm spaced 4-row strips (P_3)		
	Sesame (KS)	Intercrops (KI)	System (K = KS x KI)	Sesame (KS)	Intercrops (KI)	System (K = KS x KI)	Sesame (KS)	Intercrops (KI)	System (K = KS x KI)
Sesame + Mungbean	1.84	1.36	2.50	11.43	3.45	39.43	12.78	7.29	89.59
Sesame + Mashbean	1.73	1.67	2.89	9.34	3.33	31.10	11.09	6.42	71.20
Sesame + Soybean	1.56	1.36	2.12	5.77	2.69	15.52	9.13	7.49	68.38
Sesame + Cowpea	1.24	1.32	1.64	4.22	2.66	11.23	6.91	5.60	38.70

Table III. Competitive ratio as influenced by planting patterns and sesame-based intercropping systems

Intercropping systems	40 cm spaced single rows (P_1)		60 cm spaced 2- row strips (P_2)		100 cm spaced 4-row strips (P_3)		Systems ($P_1 + P_2 + P_3$)/3	
	Sesame	Intercrop	Sesame	Intercrop	Sesame	Intercrop	Sesame	Intercrop
Sesame + Mungbean	1.13	0.88	1.19	0.83	1.07	0.94	1.13	0.88
Sesame + Mashbean	1.02	0.98	1.17	0.86	1.06	0.95	1.08	0.93
Sesame + Soybean	1.06	0.94	1.16	0.85	1.02	0.96	1.08	0.92
Sesame + Cowpea	0.96	1.04	1.11	0.90	1.01	0.98	1.03	0.97

Across the planting patterns, the yield advantages increased in 100 cm spaced 4-rows strips (P_3) over 60 cm spaced paired rows (P_2) and 40 cm spaced single row (P_1) as is indicated by the k values for P_1, P_2 and P_3 in each intercropping system (Table II). The highest RCC value of product of coefficient was also recorded by Sarkar and Chakraborty (2000) when sesame was intercropped with green gram.

Competitive ratio (CR). The competitive ratio is an important tool to know the degree with which one crop competes with the other. Higher CR values for sesame than the intercrops except cowpea under 40 cm spaced single row indicated that in all the three planting patterns sesame was more competitive than mungbean, mashbean, soybean and cowpea (Table III).

The competitive ratio was higher for cowpea in all the three planting patterns. These results suggest that among intercrops, cowpea proved to be a better competitor than all other intercrops when grown in association with sesame. It is evident from the competitive ratio that mungbean, mashbean and soybean are the most suitable crops for intercropping in sesame. A modest competitive ratio was also reported by Sarkar and Chakraborty (2000) when sesame was intercropped with mungbean in 1:1 ratio. It is evident from the data pertaining to A, RCC and CR that sesame was dominant crop in each intercropping system except sesame + cowpea. Among intercrops cowpea was a better competitor with sesame than all other intercrops.

In conclusion, sesame appeared to be the dominant crop as indicated by its higher values of relative crowding coefficient, competitive ratio and positive sign of the aggressivity. This indicates that sesame grown in association with mungbean, mashbean, soybean and cowpea utilized the resources more aggressively than the respective intercrops which appeared to be dominated. Among the intercrops, mungbean proved to be more competitive while mashbean, soybean and cowpea exhibited almost similar competitive behavior regardless of the planting pattern.

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