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COMPETITIVE BEHAVIOUR OF COMPONENT CROPS IN SESAME GREENGRAM INTERCROPPING SYSTEMS UNDER DIFFERENT NUTRIENT MANAGEMENT

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ABSTRACT

Competitive behaviour of component crops in sesame-greengram intercropping systems under different nutrient management was studied on a sandy loam soil at the University of Bidhan Chandra Krishi Viswavidyalaya Mohanpur during *summer* season for two consecutive years. Under the INM practice the yield of sesame, greengram and sesame equivalent yield were significantly higher (39.63, 18.13 and 30.02%, respectively) than organic nutrient management. Integrated nutrient management the sesame grown in association with greengram appeared to be a dominant crop as indicated by its higher values of land equivalent ratio, monetary advantage, area time equivalent ratio, relative value total, competitive ratio and positive sign of the aggressivity. This indicates that when sesame grown in association with greengram utilized the resources more aggressively in ratio sesame + greengram (2:2) is compared sesame + greengram (2:4). Among the intercrops, greengram proved to be more competitive under integrated nutrient management over the organic nutrient management.

INTRODUCTION

The global consumers are showing inclination towards health cautiousness with their day-to-day diet. Food crops grown using organic input having less or no chemicals are being preferred over conventionally produced food by the end users. 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 India too, where climate is sub-tropical and irrigation resources are inadequate. In the past mono-cropping 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. 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. 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 objectives of the present study were (i) to estimate the effect of competition within oilseed-legume intercropping systems, e.g., Sesame-greengram intercropping; (ii) to examine different competition indices in these intercropping systems and, therefore (iii) to evaluate the systems for better management of resources to obtain less competition among higher productivity, sustainability. Hence, the present study was conducted to developed suitable nutrient management practices and pattern of cropping by better growth and productivity of sesame + greengram intercropping system.

MATERIALS AND METHODS

A field experiment was carried out during pre *summer* season of 2010 and 2011 at Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, West Bengal (22.93^{0}N latitude, 88.53^{0}E longitude and at 9.75 m above mean sea level) in sub-humid to tropical climate condition with low temperature during winter and hot dry *summer* season. The experiment was laid out in split-plot design keeping two nutrient management in the main plot [N_0- organic nutrient management(FYM@ 7.5 t/ha + liquid manure Jivamrita twice at 20 and 40 DAS)] and N_1- integrated nutrient management (FYM@ 2 t/ha + RDF of crops) and four crop combinations (sole and intercrop) of sesame and greengram (T_1- sole sesame; T_2- sole greengram ; T_3- sesame + greengram 2:2 ratio; T_4- sesame + greengram 4:2 ratio) in sub-plots, replicated four times. Sesame (var. Rama) and greengram (var. Bireswar) were sown with a seed rate of 4 and 25 kg/ha respectively on 4th week of February with a spacing 30 cm in both sole and intercropping. The fertilizer dose 40 kg N, 45 kg P_2O_5 and 45 kg K_2O /ha for sesame and 15 kg N, 45 kg P_2O_5 and 30 kg K_2O /ha for greengram was applied through urea, single super phosphate and muriate of potash, respectively in sole cropping plots of integrated main plots as basal. In the intercropping plots along with 40 kg N, 30 kg P_2O_5, and 30 kg K_2O /ha additional 5.5 kg P_2O_5 /ha were applied. Another 20 kg N /ha was top-dressed to sesame rows both sole and intercropping plots at 20 DAS. FYM was also applied @ 2 t /ha in the integrated main plots. In case of organic plots 7.5 t /ha of FYM and two spray of liquid manure were applied done at 20 and 40 DAS respectively.

The competitive functions were computed in the form of aggressivity, competitive ratio, land equivalent ratio, area time equivalent ratio, monetary advantage and relative value total. Abbreviations used to calculate different competitive functions were 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. The aggressivity (A) shows the degree of dominance of one crop over other when sown together. Aggressivity value was calculated by the formula proposed by McGilchrist (1965) as Aab = (Yab/Yaa + Zab) – (Yba/Yba + Zba), where Aab is aggressivity value for the component crop "a". Competitive ratio (CR) was calculated by the formula proposed by Willey *et al*. (1980) as CRa = (Yab/ Yaa × Zab) ÷ (Yba/Ybb × Zba), where CRa is competitive ratio for the component crop "a". All the other abbreviations have been described above in this section. LER is defined as the relative land area under sole crop that is required to produce the yield achieved in intercropping. LER = Yab/Yaa + Yba/ Ybb. Land equivalent coefficient (LEC), a measure of interaction related to the relationship strength was calculated as: LEC = La × Lb (Lithourgidis *et al*. 2006). Monetary advantage as suggested by Willey (1979) was calculated as follows: Monetary advantage = LER-1/LER × Value of combined intercrop yield. The values of produces were estimated on the basis of price rate available in local market. LER can only consider the profitability of intercropping in terms of land area but not the time. So, unlikely of LER, the measure of ATER can consider both land area as well as the time for which the crops were on the land. According to him, ATER is calculated as follows: ATER = ($R_{ya} \times t_a$) + ($R_{yb} \times t_b$)/ T, Where, R_y = Relative yield of species 'c' or 'p', t = duration (day) for species 'a' or 'b', T = duration (days) of the intercropping system. The LER combined the two crops according to their yields. Alternative methods of combination could be based on their relative monetary value. For this purpose, the RVT for intercrop was calculated using the formula. RVT = ($V_a + V_b$)/Vs. Where, V_a and V_b are the monetary values of species 'a' and 'b' from the intercrop treatment and appropriate sole crop monetary value. Vandermeer (1992) suggested that Vs should be the higher sole crop return. Since the error variable was heterogeneous, year-wise data were developed for discussion and interpretation.

RESULTS AND DISCUSSION

Yield of sesame and greegram

The yield of sesame and greengram were significantly influenced by the nutrient management practice. Significantly higher value was obtained from the integrated nutrient management (Table 1). The integrated nutrient management produced 39.63% and 18.13% higher average yield of sesame, greengram respectively. (Mondal *et al*. (2008), Shaikh *et al*. (2010), Nagarajan and Balachandar (2001) and Rajkhowa *et al*. (2002)) reported similar kind of result previously. The cropping system had significant influence on the yield of sesame and greengram. The significantly higher yield was obtained from the sole cropping of sesame and greengram in both the year. This is in confirmation of Arunachalam and Venkateswamy (1984). Sesame produced higher yield under 4:2 intercropping situation while the yield of greengram was low, mainly because of higher population of sesame plants (75%) than greengram (25%). The sole cropping of sesame and greengram under integrated nutrient management produced significantly higher yield than the other treatments

Table 1: Grain yield and Land equivalent ratio (LER) of sesame and greengram both under sole and intercropping situation

Treatment	Yield (kg/ha) of sesame		Yield (kg/ha) of greengram		Sesame equivalent yield (kg/ha)		LER of sesame		LER of greengram	
	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
Nutrient management										
Organic	487.24	524.33	400.92	401.33	709.07	737.25	0.81	0.80	0.58	0.59
INM	797.67	878.00	492.08	487.83	1020.04	1076.64	0.82	0.84	0.61	0.61
S.Em+	1.319	0.51	3.12	1.98	3.46	1.59	0.002	0.002	0.003	0.005
CD (P=0.05)	5.936	2.29	14.04	8.89	15.57	7.14	0.009	0.011	0.012	0.022
Cropping system										
Sole sesame	788.50	852.75	-	-	788.50	852.75	1.00	1.00	-	-
Sole greengram	-	-	748.88	741.00	855.86	846.86	-	-	1.00	1.00
Sesame + Greengram (2:2)	508.69	571.38	396.13	407.00	961.40	1036.52	0.64	0.66	0.53	0.55
Sesame + Greengram (4:2)	630.17	679.38	194.50	185.75	852.45	891.66	0.80	0.79	0.26	0.25
S.Em+	2.01	1.63	2.89	3.65	3.60	3.89	0.003	0.002	0.002	0.003
CD (P=0.05)	6.19	5.02	8.92	11.26	10.70	11.55	0.009	0.006	0.007	0.009

INM; Integrated nutrient management

Table 2: Different competition function as influence by nutrient management and sesame-greengram intercropping system

Nutrientmanagement	Area time equivalent ratio (ATER)		Competitive ratio (CR)				Monetary advantage (MA)	
	Sesame + Geengram (2:2)	Sesame + Geengram (2:4)	Sesame + Geengram (2:2)		Sesame + Geengram (2:4)		Sesame + Geengram (2:2)	Sesame + Geengram(2:4)
Organic	1.04	1.01	1.24		1.54		2480	934.5
INM	1.16	1.01	1.19		1.59		7135	1584
	Land equivalent coefficient(LEC)		Aggressivity (A)				Relative value total (RVT)	
			Aab	Aba	Aab	Aba		
Organic	0.31	0.21	0.12	-0.12	1.45	-1.45	0.88	0.74
INM	0.39	0.20	0.11	-0.11	1.57	-1.57	1.36	1.13

INM; Integrated nutrient management

due to the interaction effect of nutrient management and different cropping system.

The seed of sesame and greengram are very different from each other. Hence, comparison of two crops on the basis of their seed yield did not find much validity (Table 1). Therefore sesame-equivalent yields were calculated taking into account the seed yield and the price rate of sesame and greengram seed (Rs. 28 for sesame and Rs 32 per kg for greengram in 2010 and Rs.30 per kg for sesame and Rs. 35 per kg for greengram in 2011). The nutrient management had significant influence on the sesame- equivalent yield. The higher yield was obtained from the integrated nutrient management. Similar result was previously reported by Ghosh *et al.* (1995). The sesame equivalents of intercropping system was found significantly higher than sole stand of either sesame or greengram which seems to be due to utilization of growth resources by components crops particularly sesame in intercropping system as compared to sole stand Awasthi *et al.* (2012). Sesame-equivalent yield in different intercropping systems were much higher than that of respective sole crops during both the years. The sesame equivalent yield was much higher i.e., 21.73% more (998.96 kg/ha) in 2:2 intercropping system and 6.26% more (872.06 kg/ha) in 4:2 intercropping system over the yield of sole cropping of sesame (820.63kg/ha). The significantly higher sesame-equivalent yield was obtained under sesame + greengram (2:2). Awasthi *et al.* (2012) reported similar result. The interaction effect of nutrient management and different cropping systems had significant influence on the sesame-equivalent yield. The significantly higher equivalent yield was obtained under sesame + greengram (2:2) with integrated nutrient management practice. The lowest value was obtained in sole cropping of sesame under organic nutrient management.

Various competitions between sesame and greengram

The different nutrient management had significant influence on the land equivalent ratio (LER) of sesame and greengram (Table 1). The higher value of LER was obtained from integrated nutrient management. Land equivalent ratio (LER) values for sesame yield under different cropping system indicated that all the intercropping systems (sesame + greengram with 2:2 and 4:2 ratio) recorded LER values of sesame and greengram (0.65, 0.80, 0.54 and 0.26 respectively). Sown proportion or intercrop population of sesame and greengram, under intercropping, was 50%, 75%, and 25% respectively which indicated that all the intercropping were advantageous in respect of LER of sesame during both years. LER of sole treatments was more than 1.0. It was due to beneficial effect of sole crop on component crop productivity. Similar kind of result reported that Patra *et al.*(2004) and Awasthi *et al.* (2012).

Sesame was more aggressive in the mixture than greengram at all treatment combinations in both the years (Table 2). 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. The aggressiveness of sesame significantly increased with intercropping of sesame with greengram in 2:4 row arrangement under integrated nutrient management recorded the highest aggressivity value (1.57), followed by intercropping of sesame with greengram intercropping in 2:4 under organic nutrient management. 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 and groundnut.

Intercropping of sesame with greengram in 2:2 row arrangement under integrated nutrient management recorded the highest ATER value (1.16), followed by intercropping of sesame with greengram intercropping in 2:2 under organic nutrient management (Table 2). The lowest value was obtained from the other two intercropping systems. However, all the intercropping was found to be advantageous in respect of ATER (values being more than one), the extent of which varied in different systems. High ATER values of sesame-greengram intercropping system were also reported by Ghosh *et al*. (1995).

The competitive ratio is an important tool to know the degree with which one crop competes with the other. The higher CR values for sesame in both the years under integrated nutriment management practices and planting arrangement compared to greengram, is an indication that sesame was more competitive than greengram (Table 2). The CR values of the two crops are the reciprocals of each other; therefore the values of only one component crops of sesame. As the CR values of sesame is much higher than 1 (1.24, 1.54, 1.19, 1.58) in both the years it may be concluded that the sesame crop to be most dominant over associated legume crop in these intercropping systems. A modest competitive ratio was also reported by Sarkar and Chakraborty (2000) when sesame was intercropped with mungbean in 1:1 ratio.

Land equivalent coefficient values ranged from 0.39 to 0.20. Treatments had LEC values of 0.39, 0.31 and 0.21, 0.20 for sesame + greengram (2:2), sesame + greengram (2:4) under different nutriment management system (Table 2). The highest land equivalent coefficient was found sesame + greengram (2:2) ratio. LEC was greater than 0.25 under sesame + greengram (2:2) treatments. According to Adetiloye *et al*., 1983, for a two-crop mixture, the minimum expected productivity coefficient (PC) is 25%. This indicates that greengram can grow in mixture with sesame under sesame + greengram (2:2) ratio treatments without major adverse effects.

The highest monetary advantage (₹7135 /ha) was obtained from intercropping of 2:2 row ratio of sesame with greengram under integrated nutrient management (Table 2). The lowest MA was obtained from 4:2 row arrangement of sesame with greengram under organic nutrient management (935 /ha).

Highest RVT value was obtained from sesame+ geengram (2:2) followed by sesame+ geengram (2:4) under integrated nutrient management (Table 2). In both the row ratios, the RVT of sesame+ geengram was found to be superior under integrated nutrient management over that of organic nutrient management.

CONCLUSION

In conclusion, sesame appeared to be the dominant crop as indicated by its higher values of land equivalent ratio, monetary advantage, area time equivalent ratio, relative value total, competitive ratio and positive sign of the aggressivity. This indicates that sesame grown in association with greengram utilized the resources more aggressively than the respective intercrops which appeared to be dominated. Among the intercrops, greengram proved to be more competitive under integrated nutrient management over the organic nutrient management.

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