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Production potential and economic feasibility of sesame (*Sesamum indicum*)-based intercropping system with pulse and oilseed crops on rice fallow land

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ABSTRACT

A field experiment was conducted during the spring season of 1997 and 1998 at Baruipur, West Bengal, to evaluate the economically and biologically sustainable intercrop association of sesame (*Sesamum indicum* L.) with greengram (*Phaseolus radiatus* L.), blackgram (*P. mungo* L.), groundnut (*Arachis hypogaea* L.), and sunflower (*Helianthus annuus* L.) on rice fallow land. An intercropping of groundnut with sesame was found most beneficial to sole stand yield of sesame. Among the intercrop associations, sesame + groundnut under 3:2 row proportion gave the maximum sesame-equivalent yield (947 kg/ha), land-equivalent ratio (1.31), product of relative crowding coefficient (K 3.87), monetary advantage (Rs 2,913/ha), net returns (Rs 5, 321/ha), income equivalent ratio (1.21) and also indicated a modest competitive ratio (0.86 : 1.16) and aggressivity factor (± 0.37). It proved the best intercrop stand among all the crop associations.

Key words : Intercropping, Sesame, Rice fallow land, Economic productivity, Biological feasibility

In eastern states of India due to late harvest of long-duration traditional *aman* rice (photoperiodically season bound) in November–December and late receding of water from lowlying fields, timely sowing of important winter crops after rice is practically not possible. Moreover, irrigation facilities in such rice-growing areas are very much lacking. For exploitation of land and human resources, the utilization of such rice fallows is very important. Sesame and many oilseed and pulse crops, which are more adaptable and more drought-resistant (Rafey and Prasad, 1991) having the capacity to grow fairly well under moderate level of management conditions, can be ideal ones for sustainable cropping system on rainfed rice fallow land. Under such conditions, intercropping can increase the production and productivity by better utilization of resources and thereby helps minimize the

risks and brings stability. Selection of crops and spatial arrangement in intercropping have important effects on the balance of competition between component crops and on their productivity. Hence an experiment was conducted to explore the feasibility of growing 2 each of pulse and oilseed crops in association with sesame at different spatial arrangements on rice fallow land.

MATERIALS AND METHODS

The field experiment was conducted during the spring season of 1997 and 1998 after the harvest of *aman* rice at the Agricultural Experimental Farm of Calcutta University, Baruipur, West Bengal, in Gangetic alluvial soil of clay loam (Entisol). The soil had 0.72% organic carbon, 30 and 260 kg/ha available P and K respectively with pH 6.2. Treatments consisted of 'Tilottoma' sesame, 'T 44' greengram, 'T9' blackgram, 'AK 12-24' groundnut and 'Morden' sunflower varieties as the pure crops, and seasme intercropped with each of these crops at 2:1 and 3:2 row ratios thus forming 13 treatments. The treatments were laid out in randomized block design with 3 replications on rice fallow land. The crops were sown on 3 January 1997 and 5 January 1998 in lines 30 cm apart, keeping intra-row spacing for sesame, greengram and blackgram 10 cm and for groundnut and sunflower 20 cm. The fertilizer dose given for sesame and sunflower was at 60, 40 and 40 kg; for greengram and blackgram at 20, 40 and 20 kg; and for groundnut at 30, 60, and 30 kg N, P_2O_5 and K_2O/ha, respectively, while the intercrops received fertilizer dose as per their row ratios. In general, sesame, greengram, blackgram, groundnut and sunflower were harvested respectively 121, 130, 80, 78 and 114 days after sowing. The total rainfall received during the crop period of January to May in 1997 and 1998 was 85.6 and 80.5 mm respectively. The error variances both for seed yield of sesame and those of individual intercrops were found to be homogenous during the 2 years and therefore the pooling of results on economic productivity and biological parameters was done. The pooled data were further computed for different competition functions and ecomical parameters, viz. land-equivalent ratio, relative crowding coefficient and their products, aggressivity factor, competitive ratio, monetary advantage and income equivalent ratio as described by Willey (1979). It was further calculated for area-time equivalent ratio as proposed by Heibsch (1978). Sesame-equivalent yield and moneraty returns were calculated considering prevailing market prices of all the crops on pooled basis.

RESULTS AND DISCUSSION

In general, the yield levels of different crops were comparatively low due to insufficient rainfall during reproductive phase of crops and thus gave low yield.

Effect of intercrops on base crop

Intercropping significantly reduced the yield of sesame compared with sole sesame due to competition effect. The average reduction in seed yield of sesame varied from 25.8 to 36.5%, depending on nature of intercrops and planting pattern. Sesame yield decreased due to intercropping at both

2:1 and 3:2 row ratios, however, the latter row ratio showed lesser reduction in yield over the former because the depressing effect of intercrop on sesame was minimized due to lesser number of intercrops rows and more space occupied by sesame. Maximum recovery (74.4%) or minimum reduction (25.6%) in sesame yield was with groundnut due to complementary nature of legume component. The maximum reduction (36.5%) in seed yield of sesame was found with sunflower due to suppressive effect of tall growing, vigorous growth of broad leaf canopied intercrop. Sarkar and Chakraborty (1995) also reported more suppressing effect of sunflower on associate crop of sesame.

Effect of base crop on intercrop

The yield of all the intercrops reduced considerably due to intercropping with sesame. Maximum reduction (62%) in yield of sunflower was noted with sesame, indicating sunflower most sensitive in association with sesame. However, minimum reduction in yield of groundnut (42.5%) was found in intercropping with sesame, indicating groundnut a compatible intercrop with sesame. In 2:1 row ratio, the reduction in yield of intercrops was more pronounced due to depressing effect of greater population pressure of sesame on lesser population of intercrop.

Economic productivity

Among the cropping systems, sesame + groundnut in 3:2 row ratio gave significantly highest economic productivity in terms of sesame-equivalent yield, followed by sesame + groundnut in 2:1 row ratio (Table 1) mainly owing to higher additional advantage of intercrop yield and higher monetary value of intercrop. Sesame + groundnut association irrespective of spatial arrangement proved most productive probably because groundnut utilizes early season resources efficiently and has the capacity to make effifient use of low light levels (Reddy and Willey, 1980) and less competition to associate crop of sesame. Sesame + greengram association irrespective of row ratio proved moderately productive. Sesame + sunflower system was found inferior to all other intercrop associations mainly due to their exhaustive nature.

Biological feasibility

Higher land-equivalent ratio (31%) was found in sesame + groundnut, followed by sesame + greengram (25%) in 3:2 row ratio over sole crops (Table 2), indicating greater biological efficiency of the systems. Sesame + groundnut and sesame + greengram systems both under 3:2 row ratio proved advantageous and the associations gave higher values of relative crowding coefficient (Table 2) which further established from the products of crowding coefficients (K = 3.87 and 2.91). The companion crop either greengram, blackgram, groundnut or sunflower appeared more competitive than sesame under 2:1 row ratio by giving positive value of aggressivity factor which is further substantiated by competitive ratio where intercrops were found dominant by giving higher values. Under 3:2 ratio sesame was dominant and intercrops were recessive to

Table 1. Yield and economics of sesame-based intercropping systems

Cropping system	Seed yield (kg/ha)						Pooled sesame-equivalent yield (kg/ha)	Mean gross return (Rs/ha)	Mean cost of cultivation (Rs/ha)	Mean net return (Rs/ha)
	1997		1998		Pooled					
	S	I	S	I	S	I				
Sesame sole	656		674	665			665	8,645	4,275	4,370
Greengram sole	656		670	663			510	6,630	3,720	2,910
Blackgram sole	698		702	700			485	6,305	3,650	2,655
Groundnut sole	930		938	934			790	10,270	7,250	3,020
Sunflower sole	1,035		1,071		1,053		607	7,891	4,750	3,141
Sesame + greengram (2:1)	429	340	441	352	435	346	706	9,113	5,010	4,103
Sesame + blackgram (2:1)	420	344	432	336	426	340	661	8,593	4,870	3,723
Sesame + groundnut (2:1)	435	496	441	488	438	492	854	11,102	6,730	4,372
Sesame + sunflower (2:1)	416	398	412	402	414	400	644	8,372	5,130	3,242
Sesame + greengram (3:2)	458	360	468	384	436	372	749	9,737	4,840	4,897
Sesame + blackgram (3:2)	451	351	457	347	454	349	696	9,408	5,165	3,883
Sesame + groundnut (3:2)	488	539	498	535	493	537	947	12,311	6,990	5,321
Sesame + sunflower (3:2)	436	404	428	410	432	407	667	8,671	4,950	3,721
CD (P = 0.05)	4.3		3.4		2.6		106.77	49.95	45.42	28.18

S, Sole crop; I, intercrop

Market price of produce (Rs/kg) on pooled basis : Sesame, 13; greengram, 10; blackgram, 9; groundnut, 11; sunflower, 7.5

Table 2. Biological and economic parameters of sesame-based intercropping systems (mean data of 2 years)

Intercropping system	LER	RCC		K	A		CR		ATER	IER	MA (Rs/ha)
		M	I		I	M	I	M			
Sesame + greengram (2:1)	1.17	0.94	2.18	2.05	–0.58	0.58	0.62	1.59	0.97	0.93	1,324
Sesame + blackgram (2:1)	1.12	0.89	1.88	1.67	–0.45	0.45	0.65	1.51	0.93	0.85	920
Sesame + groundnut (2:1)	1.18	0.96	2.22	2.13	–0.60	0.60	0.62	1.59	1.14	1.00	1,693
Sesame + sunflower (2:1)	1.01	0.82	1.22	1.00	–0.20	0.20	0.82	1.21	0.95	0.74	8
Sesame + greengram (3:2)	1.25	1.52	1.91	2.91	0.32	–0.32	0.82	1.20	1.04	1.12	1,947
Sesame + blackgram (3:2)	1.18	1.43	1.49	2.13	0.39	–0.39	0.91	1.09	0.98	0.88	1,380
Sesame + groundnut (3:2)	1.31	1.91	2.02	3.87	0.37	–0.37	0.86	1.16	1.27	1.21	2,913
Sesame + sunflower (3:2)	1.03	1.23	0.94	1.16	0.51	–0.51	1.12	0.89	0.98	0.85	252
CD (P = 0.05)											

M, Main crop; I, intercrop; LER, land-equivalent ratio; RCC, relative crowding coefficient; K, product of relative crowding coefficient; CR, competitive ratio; ATER, area-time equivalent ratio; IER, income-equivalennt ratio; MA, monetary advantage

sesame. Higher area-time equivalent ratio was recorded with sesame + groundnut in 3:2 row ratio (1.27), indicating a more efficient use of area-time by the intercrops over other systems. Thus the biological parameters indicated that intercropping of groundnut with sesame could be biologically sustainable on rainfed rice fallow land.

Economic viability

Among the cropping systems, intercropping of sesame with groundnut and greengram under 3:2 row ratio gave higher net returns which were respectively 22 and 12% more than that of sole sesame. The income-equivalent ratio (Table 2) supported that intercropping of sesame with groundnut and greengram in 3:2 row ratio was better among the intercropping systems, having higher income-equivalent ratio (1.21 and 1.12) than sole sesame (IER 1.00). The monetary advantage evaluated over sole crops indicated a definite gain from intercropping systems. The maximum monetary advantage was obtained from sesame + groundnut under 3:2 row ratio, followed by sesame + greengran in 3:2 ratio. However, intercropping of sesame with sunflower led to meagre monetary advantage.

Thus association of sesame with groundnut under 3:2 ratio is more sustainable, as it gives maximum sesame-equivalent yield and results in a more economically viable systems which was further supported by different biological parameters.

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