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Production potential and economic feasibility of sunflower (*Helianthus annuus*) based intercropping systems under different seeding methods in rice fallow land

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ABSTRACT

A field experiment was conducted during the early spring season of 1996 and 1997 at Baruipur to evaluate the feasibility of intercropping greengram (*Vigna radiatus* L.), blackgram (*Vigna mungo* L.) and sesame (*Sesamum indicum* L.) in sunflower (*Helianthus annuus* L.) under different seeding methods in rice fallow Gangetic alluvial land. Paired-row planting (30/60 cm) of sunflower intercropped with greengram (1 row) resulted in maximum sunflower-seed equivalent (18.78 q/ha), monetary advantage (Rs 3,555/ha), net return (Rs 7,549/ha) and income-equivalent ratio (1.16). The same treatment also accounted for maximum land equivalent ratio (1.31), area-time equivalent ration (1.15) and greater product of crowding coefficient (K, 3.93) with moderate aggressivity factor (± 1.42) and higher benefit-cost ratio (1.00) and relative net return (Rs 1.29) which proved the most efficient.

Key words: Intercropping, Sunflower, Greengram, Blackgram, Sesame

Recently, attempts are being made to utilize vast *aman* (photoperiodically season bound) rice fallows by growing suitable crops availing residual moisture even under delayed sowing due to late harvest of rice and late receding of water from low lying rice fields. Sunflower (*Helianthus annuus* L.), a day-neutral, short duration, deep rooted, drought tolerant crop with high yield potential may be ideal one for sustainable cropping system under rainfed conditions on rice fallow Gangetic alluvial land. Under rainfed conditions and aberrant weather situations, intercropping system of sunflower with suitable crops may bring stability in yields and returns over space and time. The intercropping in paired-row planting, helps to maintain full population of main crop and harness the maximum yield advantage in intercropping system. Since the nature of feeding and growth pattern of component crops differ, seeding practices

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may be an important factor for efficient use of growth resources and increase in yield of each crop. Hence an experiment was conducted to explore the feasibility of growing sunflower with suitable intercrops and increasing the profitability of the system as a whole on rice-fallow Gangetic alluvial land.

MATERIALS AND METHODS

The experiment was conducted during the early spring season of 1996 and 1997 at the Experimental Farm of Calcutta University, Baruipur, on Gangetic alluvial soil (Entisol) having 0.72% organic carbon, 26 and 260 kg/ha available P_2O_5 and K_2O with pH 6.0. The treatment consisted of 4 sole stands of each sunflower (*Helianthus annuus* L.), greengram (*Vigna radiatus* L.), blackgram (*Vigna mungo* L.) and sesame (*Sesamum indicum* L.) and intercrop association of paired-row sunflower with each of the intercrop as per lay out plan (Table 1). Sole sunflower was sown in uniform row of 45 cm × 10 cm and sole stands greengram, blackgram and sesame were sown at a spacing of 30 cm, leaving 60 cm space between 2 pairs with plant-to-plant spacing of 10 cm. The 13 treatments were tested in randomized block design with 3 replications. Sole sunflower and sesame received 60 kg N and 40 kg each of P_2O_5 and K_2O/ha, whereas blackgram and greengram received 20 kg N and 40 kg each of P_2O_5 and K_2O/ha at the time of planting. In intercropping system, fertilizer dose according to area occupied by intercrop along with recommended dose for sole sunflower was applied. The total rainfall recorded during the crop growth from January to April in 1996 and 1997 was 135 and 145 mm, respectively. The yields of individual years and pooled yields were statistically analysed. The pooled yields were further computed for different competition functions as suggested by Willey (1979). It was further calculated for area-time equivalent ratio as proposed by Heibisch (1978). It was also evaluated on the basis of different economical parameters. Relative net return was also worked out as per Jain and Rao (1980).

RESULTS AND DISCUSSION

The trends in grain yield and performance of different treatments during 1996 and 1997 were almost similar due to similar amount and distribution pattern of rainfall during both the years. The error variances both for yield of base crop and intercrops under respective treatments were found homogenoeus during 2 years and therefore the pooling of results was done.

Effect on main crop

The seed yield of sunflower in pure stand was significantly higher than in its intercropped stand (Table 1). Sunflower yield was affected differently by intercrops. Among the intercropping systems, paired-row sunflower + greegram (1 row) gave the highest seed yield than others due to addition of N in soil by greengram and also due to non-significant crop competition offered by greengram owing to its short duration, small stature and non-depletive nature. It revealed that greengram is most compatible crop for intercropping with sunflower, as it had less deleterious effect on sunflower seed yield. Sarkar *et al.* (1997) also reported minimum reduction in seed yield of sunflower due to intercropping with greengram. The maximum reduction (39%) in yield of sunflower was with sesame irrespective of its seeding methods, due to their mutual competitive effects compared with the other intercropping systems.

Table 1. Yield and economic of sunflower-based intercropping system (pooled data of 2 years)

Treatment	Seed yield (q/ha)		Sunflower seed equiva-lent (q/ha)	Cost of cultivation (Rs/ha)	Net return	Cost benefit ratio
	Main crop	Intercrop				
Sunflower	15.40	-	15.40	5,850	6,470	1.10
Greengram	-	10.20	12.75	5,000	5,200	1.04
Blackgram	-	8.55	9.61	4,900	2,788	0.58
Sesame	-	5.95	8.92	5,500	1,636	0.29
Sunflower (PR) + greengram (1 row)	11.60	5.75	18.78	7,475	7,549	1.00
Sunflower (PR) + blackgram (1 row)	10.94	4.47	15.96	7,350	5,418	0.73
Sunflower (PR) + sesame (1 row)	9.58	3.55	14.90	7,628	4,292	0.58
Sunflower (PR) + greengram (2 row)	11.17	5.92	18.57	7,685	7,171	0.93
Sunflower (PR) + blackgram (2 row)	10.45	4.76	15.80	7,575	5,065	0.66
Sunflower (PR) + sesame (2 rows)	9.48	3.61	14.89	7,735	4,177	0.54
Sunflower (PR) + greengram (broadcast)	10.75	5.57	17.71	7,715	6,453	0.83
Sunflower (PR) + blackgram (broadcast)	10.25	4.35	15.41	7,630	4,482	0.58
Sunflower (PR) + sesame (broadcast)	8.90	3.55	14.22	7,798	3,578	0.45
CD (P = 0.05)	1.15	-	1.89	-	-	-

PR, paired row

Market price (Rs/q) : Sunflower, 800; greengram, 1000; blackgram, 900; and sesame, 1200

Table 2. Biological parameters, monetary advantage, income-equivalent ratio and relative net return as influenced by sunflower based intercropping system (mean data of 2 years)

Treatment	LER	Ksi	Kis	K	Asi	Ais	ATER	Monetary advantage (Rs/ha)	Income equivalent ratio	Relative net return (Rs)
Sunflower (PR) + greengram (1 row)	1.31	3.04	1.29	3.93	1.42	-1.42	1.15	3.555	1.16	1.29
Sunflower (PR) + blackgram (1 row)	1.23	2.45	1.09	2.67	1.35	-1.35	1.10	2.387	0.83	1.20
Sunflower (PR) + sesame (1 row)	1.21	1.71	1.47	2.51	0.97	-0.97	1.19	2.068	0.66	1.23
Sunflower (PR) + greengram (2 rows)	1.30	2.64	1.38	3.64	0.29	-0.29	1.13	3.428	1.1	1.36
Sunflower (PR) + blackgram (2 rows)	1.22	2.11	1.25	2.63	0.24	-0.24	1.09	2.279	0.78	1.23
Sunflower (PR) + sesame (2 rows)	1.21	1.60	1.54	2.46	0.02	-0.02	1.19	2.067	0.64	1.24
Sunflower (PR) + greengram (broadcast)	1.23	4.61	0.93	4.29	1.28	-1.28	1.08	2.649	0.99	1.32
Sunflower (PR) + blackgram (broadcast)	1.21	3.99	0.51	2.03	1.24	-1.24	1.04	2.102	0.69	1.32
Sunflower (PR) + sesame (broadcast)	1.16	2.74	0.73	2.00	0.23	-0.23	1.14	1.569	0.55	1.26

LER, Land equivalent ratio; Ksi and Kis, relative crowding coefficients of sunflower on intercrop and of intercrop on sunflower.
K, product of crowding coefficients; Asi and Ais, aggressivity of sunflower on intercrop and of intercrop on sunflower.
ATER, area-time equivalent ratio.

Effect of intercrop

Intercropping reduced the yields of all intercrops compared to their sole stands due to interspecific competition. An overall decrease of 44.42 and 45% in intercrop yield was recorded under 1:1, 1:2 and broadcast method of planting respectively when compared to their respective sole stand. Greater reduction in intercrop yield under broadcast in between paired rows of sunflower was mainly due to more intra-plant competition. Seed yield of greengram irrespective of sowing method in intercropping was reduced by 44% whereas of blackgram by 47%. This indicated greengram is more compatible than blackgram for intercropping in sunflower. The minimum reduction (40%) in yield of sesame was due to profuse growth and longer duration of intercrop which competed well with sunflower.

Total productivity

The total productivity in terms of sunflower seed equivalent increased significantly by intercropping greengram. Sunflower + greengram (1 row) system recorded 19% higher sunflower seed equivalent yield than sole cropping due to additional advantage of intercrop yield and proportionately higher yield of sunflower. Sole sesame gave the lowest sunflower seed equivalent yield (Table 1). However, accommodation of 1 and 2 rows of greengram in paired-row sunflower was found equally good for sunflower seed equivalent yield.

Biological feasibility

All the intercropping systems recorded land-equivalent ratio more than 1 indicating greater biological efficiency and yield advantage due to efficient utilization of resources. Intercropping treatments resulted in 16-21% yield advantage depending on the systems involved. Sunflower + greengram (1 row) system recorded the highest land-equivalent ratio (1.31) as against the lowest (1.61) by sunflower + sesame (broadcast). The relative crowding coefficient of sunflower + greengram (1 row) indicated greater advantage for this coefficient (Table 2), which was further established from the maximum value of the product of crowding coefficient. This indicated that the system can be biologically sustainable over sole cropping of sunflower. Sunflower proved the dominant companion to intercrops having positive sign of aggressivity factor and intercrops dominated. All the associations recorded area-time-equivalent ratio more than 1 indicating efficient use of area-time by the intercrop and thereby advantage in yield. However, intercropping in sunflower with 1 row of greengram or sesame and 2 rows of sesame indicated more efficient use of area-time by the intercrop.

Economic feasibility

The monetary advantage (Table 2) based on land-equivalent ratio indicated a definite benefit from intercropping over sole stands of both the components. The maximum monetary advantage (Rs 3,555/ha) was recorded from sunflower + greengram (1 row) system due to higher values of combined intercrops. The economic evaluation further revealed that sunflower + greengram (1 row) system fetched the maximum net return (Rs 7,549/ha) with 10 and 31% more net returns than sole sunflower and greengram respectively along with highest income-equivalent ratio (1.16). Among the systems, sunflower + greengram (1 row) system alone recorded benefit-cost ratio 1, indicating economic profitability of

this association. All the intercrop associations recorded higher relative net returns than sole stand of sunflower. Association of 1 or 2 row of greengram or its broadcast seeding with sunflower gave higher relative net return.

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