Indian Journal of Agronomy **48** (3) : 164–167 (September 2003)

Productivity potential and economic feasibility of sesame (*Sesamum indicum*)-based intercropping system with different planting patterns on rainfed upland

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Received : September 2002

ABSTRACT

A field experiment was conducted during the rainy season of 2000 and 2001 to determine productivity and economic feasibility of sesame (*Sesamum indicum* L.)-based intercropping system on Gangetic alluvial rainfed upland. All the intercropping systems registered significant and appreciable increase in total productivity in terms of sesame-equivalent yield over sole sesame. Among different intercropping patterns of sesame with pulse and oilseed crops, paired row planted sesame (30/60 cm) +1 row groundnut (*Arachis hypogaea* L.) resulted in maximum sesame-equivalent yield (1,654 kg/ha), net return (Rs 9,414 kg/ha), land-equivalent ratio (1.59), monetary advantage (Rs 6,751 kg/ha), and indicated a modest aggressivity index (±0.29) owing to minimum competition between crops. This system, thus, proved most efficient and sustainable on rainfed upland ecosystem.

Key words : Intercropping, Sesame, Paired row planting, Productivity potential, Economic feasibility

The rainfed uplands are commonly sown with direct-seeded rice in the monsoon season in eastern India. The yield of rainfed upland rice is very poor and unstable due to aberrant weather conditions. Sesame having expansive root-system, drought tolerance and wide adaptability to diverse soil types and possessing with high potential yield of good quality may be grown as rice substituting crop in rainfed high lands during rainy season. Moreover, under such upland ecosystem, intercropping may be potential system of crop production providing certain insurance against biotic and environmental stress and bringing stability in production and productivity under rainfed upland ecosystem. Spatial arrangement in intercropping is one of the most important factors for better yield advantage. Hence the present study was undertaken to identify most appropriate sesame-based intercropping system vis-a-vis planting pattern for maximization of productivity and return per unit area on rainfed upland ecosystem.

MATERIALS AND METHODS

A field experiment was conducted at the Experimental Station, Baruipur (88° 28' N, 22° 22' E and 3.5 m above mean sea-level) during rainy season of 2000 and 2001 on Gangetic alluvial soil (Entisol) under rainfed upland ecosystem. The soil had 0.72% organic carbon, 22 kg available P_2O_5/ha, 236 kg available K_2O/ha, with pH 6.2. The treatments consisted of sole sesame in uniform and paired rows, sole greengram (*Phaseolus radiatus* L.), blackgram (*P. mungo* L.), sunflower (*Helianthus annuus* L.) and groundnut and their intercropping in uniform and paired row planted sesame with each of intercrop. In uniform row planting sole sesame was sown 45 cm apart while in paired row planting sesame was sown 30/60 cm apart. One row of intercrop was sown between rows of normal planted sesame and in interspace between pairs of paired row planted sesame. All other sole crops were sown at row distance of 30 cm. Full population of sesame was maintained at both the planting patterns. In all 14 treatments were tested in randomized block design with 3 replications. Crop varieties were ' Vinayok', 'B 105', 'T 9', 'Morden' and 'JL 24' for sesame, greengram. blackgram, sunflower and groundnut respectively. All the crops were sown 15 June 2000 and 18 June 2001. All sole crops were fertilized with recommended dose of fertilizers at 60, 40 and 40 kg N, P_2O_5 and K_2O/ha for sesame and sunflower and 20, 40 and 40 kg N, P_2O_5 and K_2O/ha for greengram, blackgram and groundnut, and in intercropping the fertilizer dose was adjusted for proportionate areas of the crop. The total rainfall received during crop growth period was 1,170 mm and 1,225 mm in 2000 and 2001 respectively. Sesame, greengram, blackgram, sunflower and groundnut were harvested 95, 70, 80, 105 and 120 days after sowing respectively. Economics was worked out on the existing market price. Sesame-equivalent yield was calculated on the basis of support prices of all the crops in pooled basis. Different biological indices were calculated as per Willey (1979).

RESULTS AND DISCUSSION

Growth and yield-attributing characters of main crop

Growth and yield-attributing characters of the main crop sesame showed significant variation due to planting patterns and intercropping system (Table 1). Higher values of growth and yield attributes were noticed with sole sesame. Among intercropping patterns, intercropping with normal row sesame with sunflower had relatively greater adverse effect on growth and yield attributes of sesame due to vigorous growth and suppressing effect of sunflower. Among intercroppings, paired row sesame (30/60) + sunflower had higher values of growth and yield attributes in sesame owing to more favourable environment of sesame under paired row combination.

Growth and yield attributes of intercrops

All the growth parameters and yield-attributing characters of intercrops were higher in sole stands over their intercropped stands (Table 1). The growth and yield parameters of all intercrops reduced under intercropped stands with sesame under both the planting patterns. Paired row planting of sesame showed more reduction in growth and yield attributes of intercrops. Intercropping of sesame caused lesser reduction in growth and yield attributes of intercropped groundnut.

Yield of maincrop

The seed yield of sesame was significantly higher in sole cropping than that recorded in intercropping. Paired row planting of sesame proved superior to normal row planting of sesame. Seed yield of main crop sesame reduced significantly due to intercropping with greengram, blackgram, sunflower and groundnut under both the planting patterns compared with sole stand of sesame. Production of seed yield of intercropped sesame varied from 76.22 to 84.08% depending on planting pattern and nature of intercrop. Lower reduction in seed yield of paired row planted sesame compared with normal planting might be due to more space, light penetration and more uptake of nutrients. Maximum reduction (23.77%) in seed yield of normal planting sesame was noted with sunflower because of its vigorous growth and shading effect (Sarkar and Chakraborty, 1995). Among the intercropping treatments, paired row planting of sesame in intercropping with groundnut recorded significantly higher seed yield of sesame due to more number of plants/unit area and lesser competition for space and nutrients under paired row planting pattern.

Yield of intercrops

The seed yield of all intercrops under intercropping system decreased significantly compared to their sole stands. This indicated that inter-specific competition was more than intra-specific competition of sole stand. Paired row planting of sesame had more depressing effect on yield of intercrop than normal row planting due to high competitive pressure of sesame. Maximum reduction (52.78%) in yield of sunflower was found with paired row

Table 1. Growth and yield parameters of component crops under sesame-based intercropping system (mean of 2 years pooled data)

Treatment	Plant height (cm)		Branches/ plant		Capsules or pods/plant		Seeds or kernels or capsule or pod or head		1,000-seed or 100-kernel weight (g)	
	Main crop	Intercrop	Main crop	Intercrop	Main crop	Intercrop	Main crop	Intercrop	Main crop	Intercrop
Sesame sole (45 URS)	131.2		5.2		54.4		71.9		3.6	
Sesame sole (30/60 cm PRS)	138.4		5.2		58.2		74.7		3.7	
Greengram sole (30 cm)		39.3		11.5		191.5		9.1		31.1
Blackgram sole (30 cm)		35.4		9.9		186.4		8.8		40.2
Sunflower sole (30 cm)		185.2						671.4		39.9
Groundnut sole (30 cm)		38.7		8.6		21.8		1.8		38.9
Sesame + greengram (1 : 1 URS)	126.7	36.4	4.0	9.4	48.3	176.4	64.3	7.8	3.1	28.2
Sesame + greengram (2 : 1 PRS)	131.5	34.2	4.4	9.0	49.2	173.4	66.4	7.5	3.3	27.6
Sesame + blackgram (1 : 1 URS)	128.0	31.2	4.3	8.8	49.3	178.6	66.5	8.0	3.4	35.4
Sesame + blackgram (2 : 1 PRS)	132.6	28.6	4.6	8.4	51.4	180.4	69.2	7.7	3.5	34.1
Sesame + sunflower (1 : 1 URS)	121.8	177.3	3.9		48.2		60.8	613.2	3.0	34.8
Sesame + sunflower (2 : 1 PRS)	124.6	174.4	3.6		46.4		62.9	596.3	3.2	33.0
Sesame + groundnut (1 : 1 URS)	128.2	35.6	4.8	8.2	49.2	19.6	67.2	1.7	3.5	34.6
Sesame + groundnut (2 : 1 PRS)	133.1	34.8	5.1	7.9	52.5	18.4	70.5	1.6	3.6	35.3
CD (P=0.05)	2.27		0.75		2.17		2.30		0.41	

URS, Uniform row spacing; PRS, paired row spacing

planting of sesame due to increased stress from inter- and intra-crop competition, indicating sunflower most sensitive in association with sesame. The minimum reduction (22.58%) in yield of groundnut was with normal planting of sesame due to less inter- and intra-species competition, indicating groundnut a most compatible intercrop with sesame. The results confirm the findings of Sarkar and Kundu (2001).

Total productivity

All the intercropping systems showed superiority to sole cropping in total productivity, as evident by sesame-equivalent yield. The higher equivalent yield dictated higher biomass production and efficient use of available growth resources under intercropping than sole cropping. However, among the cropping systems, intercropping system of paired row sesame +groundnut recorded the maximum sesame-equivalent yield which being at par with intercropping of normal sown sesame + groundnut gave significantly 78.81% and 68.77% higher yield over normal row and paired row planting of sole sesame respectively. Such higher yields under these systems may be attributed to better utilization of resources in intercropping as well as good yield potential of groundnut as intercrop. Sesame + groundnut intercropping system irrespective of planting pattern proved most productive probably because groundnut utilizes early season resources efficiently and has the capacity to make efficient use of low light levels (Reddy and Willey, 1980) and less competition to associate crop of sesame. The results are in conformity with those of Sarkar and Sanyal (2002).

Biological feasibility

The mean land-equivalent ratio (LER) in 2 years ranged from 1.24 to 1.59, indicating biological sustainability of intercropping over sole cropping. Both the intercropping patterns, normal planting and paired row planting of sesame with intercrop groundnut recorded the maximum LER of 1.59 indicating that intercropping though reduced the yield of sesame by 21.00%, these systems as a whole were more productive with yield advantage of 59%. This indicates that intercropping was more efficient in utilizing natural resources than sole cropping of component crops. Sesame with positive aggressivity factor was aggressive under both the planting patterns in intercropping and acted as a dominant crop component. Paired row sown sesame + groundnut showed modest aggressivity factor indicating the combination as compatible.

Economic viability

Pooled economic evaluation in terms of monetary return showed that all the intercropping systems gave higher gross and net returns than sole cropping of all component crops (Table 1), indicating intercropping a productive and remunerative system of cultivation on rainfed upland. However, among the cropping systems, intercropping of paired row sesame + groundnut followed by intercropping of normal planted sesame + groundnut fetched higher gross and net monetary returns. All the intercropping treatments gave relative values total (RVT) greater than unity indicating that intercropping resulted in higher productivity/unit land than monoculture of intercrop components.

Table 2. Yield biological and economical parameters of sesame-based intercropping system (mean of 2 years pooled data)

Treatment	Seed yield (kg/ha)		Sesame-equivalent yield (kg/ha)	Cost of production (Rs/ha)	Net return (Rs/ha)	Land-equivalent ratio	Aggressivity index	Monetary advantage (Rs/ha)	Relative value total
	Main crop	Intercrop							
Sesame sole (45 URS)	925		925	5,450	4,725				
Sesame sole (30/60 cm PRS)	980		980	5,635	5,145				
Greengram sole (30 cm)		855	933	4,780	5,483				
Blackgram sole (30 cm)		915	915	4,850	5,215				
Sunflower sole (30 cm)		1,328	966	4,920	5,706				
Groundnut sole (30 cm)		930	1,099	6,654	5,435				
Sesame + greengram (1 : 1 URS)	722	560	1,332	5,820	8,832	1.43	0.13	4,406	1.44
Sesame + greengram (2 : 1 PRS)	760	540	1,349	5,940	8,899	1.40	0.30	4,240	1.37
Sesame + blackgram (1 : 1 URS)	735	590	1,325	6,220	8,355	1.37	0.09	3.936	1.47
Sesame + blackgram (2 : 1 PRS)	784	565	1,325	6,435	8,404	1.41	0.33	4,315	1.37
Sesame + sunflower (1 : 1 URS)	715	632	1,174	7,420	5,494	1.24	0.30	2,500	1.26
Sesame + sunflower (2 : 1 PRS)	758	627	1,214	7,615	5,739	1.24	0.36	2,585	1.23
Sesame + groundnut (1 : 1 URS)	740	735	1,608	8,548	9,140	1.59	0.01	6,563	1.73
Sesame + groundnut (2 : 1 PRS)	803	720	1,654	8,780	9,414	1.59	0.29	6,751	1.68
CD (P=0.05)	8.70		9.31						

URS, Uniform row spacing; PRS, paired row spacing

Price (Rs/kg): Sesame, 11; greengram, 12; blackgram, 11; sunflower, 8

Intercropping of sesame in both normal and paired row planting with intercrop of groundnut gave higher relative value total (RVT). The value of additional product/ha of land in intercropping ranged from Rs 2,500 to 6,751, the maximum being in the treatment where groundnut was sown in paired row planting of intercropped sesame, followed by intercropping system of normal planted sesame with groundnut.

Thus intercropping system of paired row sesame with groundnut is biologically and economically efficient system for rainfed upland of Gangetic alluvial soil.

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