Indian J. Agron. **40** (1) : 20–25 (March 1995)

Intercropping of maize (*Zea mays*) and rice (*Oryza sativa*) with blackgram (*Phaseolus mungo*)

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Received: April 1993

ABSTRACT

An experiment was carried out during April 1989–August 1990 to evaluate the intercropping of maize (*Zea mays* L.) and rice (*Oryza sativa* L.) with blackgram (*Phaseolus mungo* L.). *Aus* rice ('BR 21'), maize ('Barnali') and blackgram ('Barimash') as sole crops and blackgram as intercrop or strip crop with rice and maize were the treatment variable during early rainy season (summer). *Aus* rice yield varied from 1.43 to 2.23 tonnes/ha, depending on the treatments. Reduction in yield of rice under inter or strip cropping with blackgram was almost proportional to the land area. Blackgram yield ranged from 0.33 to 0.79 tonne/ha and that of maize from 2.48 to 3.39 tonnes/ha. The highest rice-equivalent yield (3.35 tonnes/ha) and gross return (Rs 14,103/ha) were obtained from maize-paired row (100%) + blackgram rows (44%).

Inadequate and uncertain distribution of rainfall and low radiation due to cloudy weather in the rainy season limits the yield of rice (*Oryza sativa* L.). Chandrashekor *et al.* (1983) reported that intercropping shows superiority to sole cropping in terms of monetary return. Farmers prefer intercropping because this system provides satisfactory yield even in a adverse condition. Stability of crop yield can be achieved in upland through crop substitution and intercropping (Rao *et al.*, 1982). In this context, an experiment was undertaken to evaluate intercropping of maize (*Zea mays* L.) and rice with blackgram (*Phaseolus mungo* L.) under adverse climatic condition.

MATERIALS AND METHODS

The experiment was conducted at the Central Research Station of the BARI, Joydebpur (14.0′N and 92.25′E), Gazipur, during rainy (summer) season of 1989 and 1990. The climate of the area is subtropical. The soil was silty clay with pH 6.3 belonging to Chhitta series of Grey Terrace soil, having moderately slow permeability. The soil was low in organic matter (1.10%), nitrogen (14 mg/kg), phosphorus (15 mg/ha), potassium (66 mg/kg) and sulphur (16 mg/kg). April, May, June and July are the hottest months, with mean maximum temperature 30–35°C and minimum temperature 12°C. Mean normal rainfall is 1,404 mm, with an average of 1,007 mm (25 years average) during monsoon period. June, July and August are the wettest months.

The treatment were: T_1, broadcast sole *aus* rice (periodically fixed maturity rice variety, grown during March–April); T_2, row-seeded sole *aus* rice, 25 cm apart; T_3 row-seeded blackgram sole, 25 cm apart; T_4, uniform maize row in sole, 75 cm x 25 cm; T_5, maize paired row, 37.5 cm distance between rows, 150 cm between 2 such

paired (100%) + blackgram rows (44%), T_6, maize paired row (100%) + *aus* rice rows (44%); and T_7, row-seeded *aus* rice (67%) + blackgram in rows (33%). The experiment was set up in randomized block design with 4 replications. The unit plot size was 5 m x 4.5 m. The variety 'Barnali', 'BR 21' and 'Barimash' were used for maize, rice and blackgram respectively. The experimental plot was fertilized with 20 kg N/ha as basal dose for sole blackgram and rice and intercrop situation, 20 kg N/ha as top-dressing 15–20 days after seeding and rest 20 kg N/ha 35–40 days after sowing for *aus* rice sole and intercrop, whereas 40 kg N/ha as basal dose, 40 kg N/ha 25 days after seeding and 40 kg N/ha 42 days for maize rows only as side-dressing. Full amount of phosphorus (60 kg P_2O_5/ha), potash (940 kg K_2O/ha) and gypsum (20 kg S/ha) were applied as basal dose. The crop seeds were sown on 3 May and 12 April in 1989 and 1990 respectively. Blackgram pods were collected on 14 and 1 July 1989 and 1990 respectively. Maize was harvested on 3 and 20 August and rice on 16 August and 27 July in 1989 and 1990 respectively. Rice-equivalent yields were computed by converting the yields of intercrops into the yield of rice on the basis of prevailing market price of individual crops. The cost of cultivation and net monetary return/ha for different crops and crop combinations were computed on the basis prevailing market rates of the different commodities. The treatment effect during both years were more or less similar and hence 2-year data were pooled for statistical analysis.

RESULT AND DISCUSSION

Grain yield of rice

Sole row-seeded rice gave significantly highest grain yield compared with sole broadcast *aus* rice, rice strip and intercrop situation (Table 1). The reduction in yield was 58–68% in rice when maize or blackgram was grown in inter- or strip-crop situation due to less land area occupied by rice than sole rice. Instead of 18 rows (100%) in sole rice, there were 8 rows (44%) of rice in maize and 12 rows of rice (67%) in blackgram. Rice strip cropped with blackgram gave significantly higher yield than the rice intercropped with maize, owing to more number of rows of rice in this treatments. Similar trend was followed in both the years.

Grain yield of maize

The planting of maize alone in normally spaced rows gave significantly highest grain yield than that obtained from maize + blackgram and maize + rice intercropped combinations. The uniform and well-distributed rainfall resulted in higher yield in 1990. The maize yield under intercropping treatment was significantly lower than that under pure stand, though the population of maize was constant regardless of treatment (Table 1). The reduction in maize yield was probably due to intercrop competition for the growth resources. However, additional yield from blackgram and rice not only compensated the deficit but also gave extra income. Sobti and Bains (1979) also reported greater yield under maize + blackgram cropping system than pure maize yield, though the maize yield was reduced.

Seed yield of blackgram

Seeding of blackgram as sole crop significantly gave higher seed yield than when intercropped with maize or rice. Blackgram intercropped with maize or strip cropped with rice had identical contribution towards yield in both the years. Reduced

Table 1. Grain yield of *aus* rice, maize and blackgram as influenced by different early rainy-season crops and crop combinations

Treatment	Grain yield of *aus* rice (q/ha)			Grain yield of maize (q/ha)			Grain yield of blackgram (q/ha)		
	1989	1990	Pooled	1989	1990	Pooled	1989	1990	Pooled
Broadcast sole *aus* rice	21.10	20.80	20.95						
Row-seeded sole *aus* rice	24.00	23.90	23.95						
Row-seeded blackgram (sole)							8.50	6.90	7.70
Uniform maize row in sole stand				28.90	39.00	33.96			
Maize paired row (100%) + blackgram rows (44%)				20.60	34.80	27.70	3.50	3.30	3.40
Maize paired row (100%) + *aus* rice (44%)	11.90	9.80	10.86	18.60	31.10	24.85			
Row-seeded *aus* rice (67%) + blackgram rows (33%)	16.30	17.00	16.65				3.60	3.20	3.40
CD (P = 0.05)	0.60	1.60	1.00	2.00	2.70	2.30	0.60	0.50	0.60
CV (%)	2.34	6.53	4.60	4.83	5.06	4.95	6.93	6.08	6.45

Table 2. Rice-equivalent yield (q/ha) and land-equivalent ratio of different early rainy-season crops and crop combinations

Treatment	Rice-equivalent yield			Land-equivalent ratio		
	1989	1990	Pooled	1989	1990	Pooled
Broadcast sole *aus* rice	21.10	20.80	20.95	1.00	1.00	1.00
Row-seeded sole *aus* rice	24.00	23.90	23.90			
Row-seeded blackgram in sole	17.20	14.00	15.60	1.00	1.00	1.00
Uniform maize row in sole stand	26.40	34.80	30.00	1.00	1.00	1.00
Maize paired row (100%) + blackgram row (44%)	26.90	38.50	32.70	1.12	1.37	1.24
Maize paried row (100%) + *aus* rice (44%)	28.80	38.20	33.50	1.20	1.27	1.23
Row-seeded *aus* rice (67%) blackgram rows (33%)	23.60	23.90	23.75	1.19	1.28	1.24
CD (P = 0.05)	2.00	2.50	1.90	0.13	0.10	0.12

yield of blackgram in different situation was also observed by Edje (1980). The lower yield of crop under or inter- or strip cropping situation was due to less area covered (33%) compared with sole crop of blackgram (100%).

Rice-equivalent yield

A higher rice-equivalent yield was recorded in maize intercropped with rice and also in maize intercropped with blackgram. These treatments gave higher rice-equivalent yield than sole crop of rice, maize and blackgram. Row-seeded *aus* rice (67%) + blackgram in rows (33%) gave higher rice-equivalent yield than sole broadcast *aus* rice. The lowest rice-equivalent yield was obtained from sole blackgram (Table 2).

Land-equivalent ratio

Maize paired row (100%) + blackgram rows (44%) gave higher land-equivalent ratio in 1990 and maize paired row (100%) + rice (44%) in 1989, but on the basis average years, it was found similar when blackgram was intercropped with maize or rice (Table 2).

Cost of cultivation (Rs/ha)

Higher cost of cultivation (Rs 6,174/ha) was incurred in maize paired row (100%) + rice (44%) system on the basis of pooled data. Similar results were noted in 1989 and 1990. The higher cost of cultivation was due to 2 cereal crops (maize and rice) in this treatment. The lower cost of cultivation (Rs 4,057/ha) was found from sole blackgram. The cost of cultivation increased in the intercropping system (maize with blackgram and rice) but decreased in rice + blackgram system compared with respective sole crop of maize or rice (Table 3).

Net returns (Rs/ha)

Higher net return was obtained from

Table 3. Economics of different early rainy-season crops and their combinations

Treatment	Gross return (Rs/ha)			Cost of cultivation (Rs/ha)			Net return (Rs/ha)		
	1989	1990	Pooled	1989	1990	Pooled	1989	1990	Pooled
Broadcast *aus* rice (sole)	8,716	8,548	8,632	5,223	5,340	5,231	3,493 (0.69)	3,308 (0.63)	3,401 (0.65)
Row-seeded *aus* rice (sole)	9,873	9,826	9,949	5,083	5,128	5,105	4,790 (0.94)	4,698 (0.92)	4,744 (0.93)
Row-seeded blackgram (sole)	1,017	5,679	6,348	4,038	4,077	4,057	2,979 (0.74)	1,602 (0.39)	2,291 (0.56)
Uniform maize row (sole)	10,917	14,601	12,759	5,072	5,146	5,109	5,845 (1.15)	9,455 (1.84)	7,650 (1.50)
Maize paired row (100%) + blackgram rows (44%)	11,737	15,791	13,764	5,459	5,568	5,513	6,278 (1.15)	10,223 (1.84)	8,251 (1.50)
Maize paired row (100%) + *aus* rice (44%)	12,497	15,710	14,103	6,105	6,243	6,174	6,392 (1.05)	9,467 (1.52)	7,929 (1.28)
Row-seeded *aus* rice (67%) + blackgram rows (33%)	9,640	9,784	9,712	4,868	5,008	4,938	4,772 (0.98)	4,776 (0.95)	4,774 (0.97)

Figures in parentheses indicate net return/Re invested

maize intercropped with blackgram (Table 3). Similar trend was noticed in 1989 and 1990. The net return from sole rice in broadcast or row-seeded was lower than that from maize intercropped with blackgram and rice, uniform maize row (sole) and rice strip cropped with blackgram. Thus net return could be increased considerably on maize intercropping with blackgram. Higher net returns from system involving legumes and non-legumes compared with pure stands were obtained by Krantz *et al.* (1976), indicating better utilization of different resources.

Maize paired row (100%) + blackgram (44%) gave highest net return/Re invested (1.50). Similar trend was noted in 1989 and 1990. Rice (67%) + blackgram (33%) combination gave higher net return/Re invested compared with pure crop of rice in broadcast or row-seeded method. Maize paired row (100%) + blackgram (44%) would be better in rainfed situation, because if 1 crop fails due to climatic hazards another crop would compensate for the loss. Rice (67%) + blackgram (33%) system was also preferable than pure crop of *aus* rice either broadcast or row-seeded in rainfed condition.

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