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Production potential and economic feasibility of sunflower (*Helianthus annuus*) and pigeonpea (*Cajanus cajan*) intercropping system on rainfed upland condition

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ABSTRACT

A field experiment was conducted during the rainy season of 1999 and 2000 at Baruipur, to evaluate different planting patterns of sunflower (*Helianthus annuus* L.) and pigeonpea [*Cajanus cajan* (L.) Millsp.] intercropping. Various growth and yield attributes and yield of sunflower and pigeonpea were superior under sole cropping. Intercropping of sunflower and pigeonpea in 3:1 row proportion and in 2:2 row proportion showed better manifestation of growth and yield attributes in sunflower and pigeonpea respectively. All the intercropping patterns were superior in terms of sunflower-equivalent yield and income-equivalent ratio (IER) values to sole crops. Intercropping of sunflower and pigeonpea in 3:1 row proportion was the best system, recording the highest sunflower-equivalent yield (2,480 kg/ha), land-equivalent ratio (1.38), product of crowding coefficient (k 5.94), income-equivalent ratio (1.73), benefit : cost ratio (2.06), gross (Rs 19.840/ha) and net returns (Rs 10,212/ha) and monetary advantage (Rs 5,463/ha).

Key words : Intercropping, Sunflower, Pigeonpea, Sunflower-equivalent yield

Rainfed upland rice in the country constitutes about 17% of the total rice area of 43 million ha. In west Bengal, such area accounts for about 10% of total rice area of 5.95 million ha. The productivity of direct-seeded rice on such upland ecosystem is very unstable and poor ranging from 0.50 to 0.60 tonne/ha due to poor and impoverished soils and erratic monsoon. Continuous growing of rice on upland has adverse effects on soil stability and properties. Hence it is important to substitute rice crop by growing other potential crops on such rainfed upland ecosystem. Non-traditional crop like sunflower and traditionally grown crop like pigeonpea having wide adaptability may be suitable substitute for upland rice. Inclusion of grain legumes and oilseeds as intercrops or substitute crops may enhance their production to meet national requirement. Intercropping of oilseed and pulse crops is one of the ways to increase their production as intercropping is more advantageous than sole cropping of either oilseeds or pulses (Prasad and Srivastava, 1991). Intercropping may be potential system of crop production providing biological insurance against risks under aberrant monsoon on rainfed upland ecosystem with complex and unpredictable nature. Hence it is proposed to evaluate an alternate cropping system comprising sunflower and pigeonpea in intercropping for yield and advantages on rainfed upland ecosystem.

MATERIALS AND METHODS

The field experiment was conducted during the rainy season of 1999 and 2000 at the Experimental Farm of Calcutta University, Baruipur (88°28'N, 22° 22'E and 3.5 m above mean sea-level) on Gangetic alluvial soils (Entisols) under rainfed upland ecosystem. The soil was clay loam, having 0.72% organic carbon, 20 kg and 238 kg available phosphorus and potassium/ha, respectively, with pH 5.8. The experiment consisted of 7 treatments (Table 1) and arranged in randomized block design with 4 replications. The plot size was 5m × 3 m. Variety 'Morden' and 'UPAS 120' were used for sunflower and pigeonpea respectively. Sole sunflower received 80 kg N + 60 kg P_2O_5 + 40 K_2O/ha and sole pigeonpea received 20 kg N + 60 kg P_2O_5 + 30 kg K_2O/ha. In intercropping system the component crops received fertilizer proportionate to plant density. Rainfall received during crop period of 1999 and 2000 was 1,085 mm and 1,135 mm respectively. The economics of each system was computed with prevailing rate of market. The pooled data for 2 years were statistically analysed. The yield were further computed for different biological parameters like land-equivalent ratio (LER), relative crowding coefficient (RCC) income-equivalent ratio (IER), monetary advantage index (MA) as suggested by Willey (1979). Relative net returns were calculated as per Jain and Rao (1980).

RESULTS AND DISCUSSION

Growth parameters and yield attributes

Sunflower : Plant height, diameter of head, seeds/head and 1,000-seed weight showed significant variation (Table 1). Growth and yield parameters reduced by intercropping system as compared to sole cropping. Reduction was maximum on sunflower in 2:2 row ratio of sunflower and pigeonpea system due to suppressing and competition effect by pigeonpea with high population density. Sunflower intercropped with pigeonpea in 3:1 row ratio, recorded higher growth and yield parameters than other intercropped stands.

Pigeonpea: Growth parameters and yield attributes of pigeonpea decreased under intercropped stands as compared to pure stand (Table 1). These parameters were generally superior in pigeonpea with sunflower under 2 : 2 row ratio of planting. Paired planting of sunflower (30/60) + 1 row of pigeonpea showed the maximum reduction in growth and yield-contributing characters of pigeonpea due to increased proportion of sunflower which offered stiff competition to associate crop.

Sunflower yield

Sole crop sunflower recorded the highest grain yield. Planting of sunflower in association with pigeonpea reduced the sunflower yield due to competition effects. The yield of sunflower in intercropping with pigeonpea was generally reduced by 18.38 to 33.16%, depending on planting pattern. Sunflower grain yield was lowered maximum by 33.61% when intercropped with pigeonpea at 2:2 row ratio due to greater reduction in yield attributes of sunflower in the system. Such reduction in yield of sunflower in intercropping with legume crop was also reported by Singh and Giri (2001). Among the intercropping treatments sunflower with pigeonpea under 3:1 row ratio could recover maximum of its sole crop yield (81.61%) owing to higher plant density of main crop and complementary effect of legume in terms of N-fixation. This is attributable to better manifestation of growth and yield attributes of sunflower under the system.

Pigeonpea yield

The highest pigeonpea yield was obtained in solid planting of pigeonpea. Pigeonpea yields in intercropping system were significantly reduced compared to sole pigeonpea yield due to planting of sunflower. Ponia (1984) reported that intercropping with pigeonpea in non-legumes is not feasible without sacrificing the grain yield of pigeonpea. Maximum reduction (47.7%) in pigeonpea yield was recorded under paired planting of sunflower (30/60) + 1 row of pigeonpea system due to reduction in intercrop population and competition with sunflower. The lower values of growth and yield attributes of pigeonpea accounted for such reduction in yield of the crop in this system. Maximum recovery (60.25%) in pigeonpea yield was recorded at 2:2 row proportion of planting due to higher values of pigeonpea-yield attributes in this system.

Sunflower-equivalent yield

All the intercropping patterns of sunflower and pigeonpea increased the mean total productivity of the system by 52.10 and 26.78% respectively in terms of sun-

Table 1. Growth parameters and yield attributes of sunflower and pigeonpea in intercroping system (mean of 2 years pooled data)

Treatment	Plant height (cm)		Branches/ pigeonpea plant	Diameter of sunflower head (cm)	Sunflower seeds/ head	Pigeonpea pods/ plant	1,000-seed weight (g)	
	Sunflower	Pigeonpea					Sunflower	Pigeonpea
Sole sunflower (45 cm)	186.2			18.8	768.2		43.6	
Sole pigeonpea (60 cm)		154.4	20.1			181.0		68.8
Alternate planting of sunflower and pigeonpea	177.5	147.3	16.4	15.9	683.4	154.5	39.4	64.4
2 rows of sunflower + 2 rows of pigeonpea	174.3	151.8	17.3	15.4	642.6	166.5	39.0	65.1
Paired row planting of sunflower (30/60)+ 1 row of pigeonpea	180.4	145.8	14.9	16.2	754.6	151.2	40.6	62.4
Sunflower and pigeonpea planting in 2:1 row proportion	178.4	149.6	15.4	16.0	717.4	162.4	39.6	63.2
Sunflower and pigeonpea planting in 3:1 row proportion	182.4	151.5	16.2	17.3	756.2	166.3	39.9	63.7
CD (P=0.05)	1.91	3.94	2.24	2.04	12.73	8.92	2.18	2.31

Table 2. Yield, biological and economical parameters of sunflower and pigeonpea intercropping system (mean of 2 years pooled data)

Treatment	Yield (kg/ha)		Sun-flower equiva-lent yield (kg/ha)	Cost of produc-tion (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	Benefit : cost ratio	Land-equiva-lent ratio (LER)	Relative crowding coefficient		Product of crowding coefficient (K)	Income equiva-lent ratio (IER)	Relative net return over sole sunflower (Rs)	Monetary advan-tage (Rs/ha)
	Sun-flower	Pigeon-pea							Sun-flower	Pigeon-pea				
Sole sunflower (45 cm)	1,550		1,550	6,520	12,400	5,880	1.90	1.00						
Sole pigeonpea (60 cm)		1,540	2,117	8.525	16,936	8,411	1.98	1.00						
Alternate planting of sunflower and pigeonpea	1,130	825	2,264	9,250	18,112	8,862	1.95	1.25	2.69	1.15	3.10	1.50	1.45	3,622
2 rows of sunflower + 2 rows of pigeonpea	1,029	928	2,305	9,530	18,440	8,910	1.93	1.26	1.97	1.51	2.98	1.51	1.48	3,805
Paired row planting of sunflower (30/60)+ 1 row of pigeonpea	1,245	810	2,358	9,365	18,864	9,499	2.01	1.35	2.04	2.21	4.52	1.61	1.51	4,890
Sunflower and pigeonpea planting in 2 : 1 row proportion	1,188	868	2,381	9,385	19,048	9,663	2.02	1.32	1.64	2.58	4.23	1.64	1.53	4,617
Sunflower and pigeonpea planting in 3:1 row proportion	1,265	884	2,480	9,628	19,840	10,212	2.06	1.38	1.47	4.04	5.94	1.73	1.59	5,463
CD (P=0.05)	10.11	11.83	50.90											
CV (%)	14.29	28.65	14.08											

flower-equivalent yield over sole sunflower and pigeonpea on pooled basis (Table 2). Higher sunflower - equivalent yield in intercropping system of sunflower with legumes over sole cropping was also reported by Sarker and Chakraborty (1999). However, among the cropping systems, planting of sunflower and pigeonpea in 3:1 row proportion recorded significantly highest sunflower-equivalent yield over rest of the treatments in pooled analysis. This increase might be due to spatial complementary action and additional contribution from pigeonpea to the extent of 51.0% towards total sunflower-equivalent yield of the system.

Land-equivalent ratio

All the intercropping patterns of sunflower and pigeonpea exhibited land-equivalent ratio greater than unity, indicating greater biological efficiency of intercropping system of sunflower and pigeonpea and thereby resulting in higher productivity per unit of space (Table 2). Planting of sunflower and pigeonpea in 3:1 row proportion recorded the highest land-equivalent ratio value (1.38), indicating 38% yield increased compared to monoculture of sunflower or pigeonpea. This revealed a greater degree of efficiency and compatibility of the intercrop pigeonpea in sunflower particularly with that system which provided the maximum advantage.

Competition function

All the intercropping treatments having higher relative crowding coefficient values indicated yield advantage in the system. Relative crowding coefficient indicated that the system of sunflower and pigeonpea in 3:1 row proportion gave more yield than expected yield. Planting of sunflower and pigeonpea in 3:1 row proportion appeared more advantageous with higher value of product of relative crowding efficient.

Economic viability

All the intercropping systems were more remunerative than the sole sunflower with monetary benefit of 50.7 to 63.7%. However, among the cropping system, planting of sunflower and pigeonpea in 3:1 row proportion appeared more remunerative with higher gross (Rs 19,840/ha) and net return (Rs 10,212/ha), benefit : cost ratio (2.06), income-equivalent ratio (1.73), monetary advantage (Rs 5,463/ha) and relative net return (Rs 1.59). This system increased the net returns by Rs 4,332/ha over sole sunflower.

Hence it was concluded that intercrop of sunflower with pigeonpea in 3:1 row ratio is biologically and economically sustainable intercropping system for rainfed upland ecosystem.

REFERENCES

Jain, T.C. and Rao, N.G. 1980. Note on a new approach to analysis of yield data in intercropping. *Indian Journal of Agricultural Sciences* **50**(12) : 570–572.

Ponia, K.L. 1984. Companion cropping in rainfed Arhar (*Cajanus cajan* L.) Millsp. *Madras Agricultural Journal* **75**(5) : 342–344.

Prasad, K. and Srivastava, V.C. 1999. Pigeonpea (*Cajanus cajan*) and soybean (*Glycine max*) intercropping systems under rainfed situation. *Indian Journal of Agricultural Sciences* **61** : 243–246.

Sarkar, R.K. and Chakarborty, A. 1999. Production potential and economic feasibility of sunflower (*Helianthus annuus*) based intercropping system under different seeding methods in rice fallow land. *Indian Journal of Agronomy* **44**(2) : 275–280.

Singh, V.B. and Giri, G. 2001. Influence of intercropping and weed-control measures on dry-matter accumulation and nutrient uptake by sunflower (*Helianthus annuus*) and groundnut (*Arachis hypogaea*) and their effect on succeeding maize. *Indian Journal of Agronomy* **46**(1) : 50–55.

Willey, R.W. 1979. Intercropping—its importance and research needs. Part 1. Competition and yield advantages. *Field Crops Abstracts* **32**(1) 1–10.