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Production potential of pigeonpea (*Cajanus cajan*) and greengram (*Phaseolus radiatus*) intercropping patterns in semi-arid tract of Haryana

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ABSTRACT

A 2-year field study was conducted during the rainy (*kharif*) season of 1999 and 2000, to evaluate different planting patterns of pigeonpea [*Cajanus cajan* (L.) Millsp.] and greengram (*Phaseolus radiatus* L.) intercropping in different row spacings. Higher monetary advantage (Rs 7,197/ha) and benefit : cost ratio (1.67) were recorded with sole pigeonpea at 45 cm row spacing and these were reduced with the increase in row spacing. All the intercropping patterns were superior in terms of pigeonpea-equivalent yield and land-equivalent ratio to sole crops. Among different intercropping patterns, pigeonpea (75 cm)+ greengram 1:2 ratio gave the highest total yield (2,352 kg/ha), net return and benefit : cost ratio (2.09). Greengram as an intercrop in different systems gave significantly lower grain yield compared to sole crop. However, 1:2 ratio of planting resulted in the higher seed yield of intercrop compared to 1:1 ratio system irrespective of row spacing.

Key words : Intercropping, Pigeonpea, Greengram, Seed yield, LER, Monetry advantage

Pigeonpea has slow initial growth and is planted at wider spacing. So a lot of space between rows remains unutilized during the initial crop growth period. This space can be utilized for growing of short-duration intercrop. Growing of greengram as intercrop helps to sustain the productivity of the system. Therefore to increase the productivity of pulses per unit area particularly in rainy (*kharif*) season, intercropping of short-duration crops seems an alternative. This system not only provides certain insurance against biotic and a biotic stresses but also provides extra yield advantage by simple expedient of growing crops (Willey, 1979). Moreover, the beneficial effects of intercropping system depend on the ratio of its components and it may be assessed through various competition functions. A lot of information is available on cereal-legume intercropping system but it lacks for legume-legume intercropping. The present study was therefore undertaken to assess the productivity of pigeonpea and greengram in relation to component ratio under different row spacing.

MATERIALS AND METHODS

The field experiment was conducted during *kharif* season of 1999 and 2000 at research farm of CCS Haryana Agricultural University, Hisar. The soil was sandy loam in texture, alkaline in reaction, poor in available nitrogen (124.4 kg/ha), medium in available phosphorus (17.6 kg/ha) and rich in available potassium (469 kg/ha), having pH 7.9. Twelve treatment combinations (Table 1) were compared in randomized block design with 3 replications. The crop pigeonpea 'Manak', and greengram 'Asha' was sown on 19 and 23 June during 1999 and 2000 respectively. The plant-to-plant spacing of pigeonpea was maintained at 20 cm by thinning out extra plants 15 days after sowing. The total rainfall during the crop period was 160.8 and 88.6 mm, respectively, during 1999 and 2000. However, the average rainfall of the region is 400 mm. A basal dose of 20 kg N and 40 kg P_2O_5/ha was furrow placed at the time of sowing. One irrigation at 60 days after sowing was applied during both the years. The crop was sprayed with Endosulphan @ 1,500 ml/ha at 50% pod-formation stage for the control of pod-borer. Intercrop was harvested 100 and 93 days after sowing during 1999 and 2000 respectively.

RESULTS AND DISCUSSION

Seed yield of sole pigeonpea (PP) was significantly decreased with the increase in row spacing from 60 cm to 75 cm and 90 cm; however, differences in seed yield of 45 cm and 60 cm and 75 cm and 90 cm row spacing were found at par with each other. The lower grain yield in widely spaced crop of pigeonpea (Table 1) might be due to lesser number of plants per unit area. All the attributes, viz. branches, pods/plant and seeds/pod, failed to compensate the loss in yield of widely spaced pigeonpea. Similar observations were made by Intal *et al.* (1994). Intercrop-

ping of single row of greengram (GG) in between 2 rows of pigeonpea planted at 45 cm reduced the pigeonpea yield significantly as compared with sole crop at same spacing. Poor development of pod-bearing branches due to competition between crops was the reason for low yield in this intercropping system (Table 1), whereas inclusion of 1 or 2 rows greengram in 60,75 90 cm spaced pigeonpea did not influence the pigeonpea seed yield in comparison to its sole crop during both the years and in pooled analysis except in 60 cm row spacing where inclusion of 2 rows of greengram reduced the seed yield of pigeonpea significantly as compared to sole crop at this spacing. The 100- seed weight of pigeonpea remained to be non-significant in both the years. But yield/plant of sole pigeonpea between 45 and 60 cm and 75 and 90 cm row spacing was at par with each other; however planting in wider row spacing of 75 cm or 90 cm resulted significantly more per plant yield compared to narrow row spacing during both the years. Similar trend of row spacing was recorded under different intercropping system. No effect of 1:1 and 1:2 ratio was observed in different row spacing. Intercropping of greengram in widely spaced pigeonpea failed to reduce the pigeonpea seed yield significantly, which was due to competition-free environment under this systems. Bains and Chaudhary (1971) also reported no adverse effects of greengram intercropping on the yield of principal crop of pigeonpea planted at wider spacing.

Greengram yield, under all the intercropping patterns, decreased significantly compared with the sole greengram (Table 2). This indicated that inter-specific competition in intercropping was more than intra-specific competition of sole stand. Based on the pooled analysis, planting of 2 rows of intercrop in pigeonpea at 60 cm and 75 cm row spacing increased the greengram yield significantly compared with single row. Planting of 2 rows of greengram at 90 cm row spacing although improved the seed yield of greengram but was found statistically at par with single row. Higher seed yield of greengram in 1:2 row ratio was owing to more number of plants of intercrop accommodated in this system compared with 1:1 system. The difference in pods/plant was non-significant between 1:1 and 1:2 intercropping systems irrespective of row spacing; however, the pods/plant were more in 1:1 row ratio which might be due to more space available for intercrop resulting in less competition with base crop. However, the higher number of pods/plant in 1:1 ratio failed to compensate the increase in yield of greengram in 1:2 row ratio because of higher number of plants per unit area accommodated in this system. Plants of greengram were also taller in closer spacing compared to wider spacing (Table 2). Among different intercropping patterns, PP (75 cm) + GG (1:2) gave the higher pooled grain yield of greengram than PP (60 cm) + GG and PP (90 cm) + GG either 1:1 or 1:2 ratio.

- The total mean yield (PP+GG) of the system was also maximum (23.52 q/ha) in PP (75 cm) + GG (1:2), followed by PP (60 cm) +GG(1:2) intercropping pattern (23.18 q/ha).

Pigeonpea-equivalent yield

Significant difference in pigeonpea-equivalent yield under different intercropping patterns of pigeonpea and greengram was recorded over their respective sole stands. All the intercropping patterns, irrespective of row spacing and number of rows of intercrop had more pigeonpea-equivalent yield compared with sole pigeonpea (Table 3). Among different intercropping patterns PP(75 cm) + GG (1:2) gave maximum pigeonpea equivalent. Higher pigeonpea-equivalent yields under various intercropping patterns of pigeonpea and greengram under different row spacing may be due to the better utilization of natural resources, viz. light, space, nutrients etc. than sole stand. Pandhi *et al.* (1992) also reported the higher pigeonpea - equivalent yield with pigeonpea and greengram intercropping compared with their pure stand.

Land-equivalent ratio

Land-equivalent ratio (LER) was higher in all the intercropping systems, irrespective of row spacing and ratios of intercrops compared to sole crop. The highest LER (1.66) was recorded in PP(75 cm) + GG (1:2) system during both years, followed by PP (90 cm) + GG (1:2) and PP (60 cm) + GG (1:2) system (Table 3). Singh and Rahman (1999) also reported higher LER in PP+Groundnut (1:2) intercropping system.

Monetary advantage index

Higher value of monetary index of sole pigeonpea was recorded at a row spacing of 45 cm. Moreover, pigeonpea resulted in more monetary advantage than greengram. Among different intercropping system, pigeonpea planted at 75 cm spacing along with 2 rows of greengram gave the highest monetary advantage (Table 3). Planting of 2 rows of greengram in pigeonpea at 60, 75 and 90 cm resulted in Rs 910, Rs 1,920 and Rs 70 higher monetary advantage, respectively, compared to single row in respective spacing. Higher monetary advantage in double rows of greengram between pigeonpea rows was because of higher yield of minor component, i.e. greengram (Table 2). The higher return from intercropping system in redgram was also reported by Dwivedi and Bajpai (1997).

Table 1. Yield attributes and seed yield of pigeonpea as influenced by intercropping pattern of pigeonpea and greengram

Treatment	Row ratio	Branches/ plant		Pods/ plant		Seeds/ pod		100-seed weight (g)		Yield/plant (g)		Seed yield (kg/ha)		
		1999	2000	1999	2000	1999	2000	1999	2000	1999	2000	1999	2000	Pooled
Sole PP (45 cm)		11.9	10.7	79.6	75.3	3.1	2.9	6.5	6.3	15.4	15.3	1,865	1,730	1,797
Sole PP (60 cm)		12.3	11.4	82.3	80.7	3.1	2.9	7.0	6.4	16.3	16.1	1,750	1,610	1,680
Sole PP (75 cm)		14.1	13.3	88.8	86.2	3.4	3.1	6.8	6.5	21.1	18.7	1,580	1,488	1,534
Sole PP (90 cm)		16.8	14.7	99.6	92.9	3.6	3.3	6.5	6.5	21.7	18.7	1,520	1,414	1,467
PP (45 cm) + GG	1:1	9.9	9.3	77.2	73.6	3.0	3.2	6.7	6.3	13.0	14.0	1,700	1,492	1,596
PP (60 cm) + GG	1:1	11.3	10.5	81.1	79.5	3.5	3.6	6.5	6.4	14.6	14.2	1,720	1,517	1,618
PP (60 cm) + GG	1:2	10.2	9.7	79.2	77.7	3.3	3.3	7.0	6.4	14.1	14.0	1,626	1,481	1,553
PP (75 cm) + GG	1:1	12.9	12.0	85.1	83.8	3.5	3.7	6.7	6.5	21.4	18.3	1,600	1,426	1,513
PP (75 cm) + GG	1:2	12.4	11.6	83.2	84.1	3.6	3.8	7.2	6.6	21.8	19.1	1,625	1,451	1,538
PP (90 cm) + GG	1:1	15.2	14.1	98.8	93.4	3.5	3.8	6.6	6.6	20.8	18.9	1,545	1,413	1,479
PP (90 cm) + GG	1:2	14.3	13.7	97.2	92.8	3.3	3.7	6.8	6.6	20.8	19.1	1,485	1,338	1,411
CD (P=0.05)	-	1.1	0.9	5.6	4.6	NS	NS	NS	NS	1.2	0.8	143	122	112

PP, Pigeonpea; GG, greengram

Table 2. Growth, yield attributes and yield of intercrop (greengram) as influenced by intercropping patterns of pigeonpea and greengram

Treatment	Row ratio	Plant height (cm)		Branches/ plant		Pods/ plant		Seeds/ Pod		Seed yield (kg/ha)		
		1999	2000	1999	2000	1999	2000	1999	2000	1999	2000	Pooled
Sole GG (30 cm)		82.5	74.1	5.70	5.81	41.90	44.14	10.91	11.03	1,103	1,344	1,223
PP (45 cm) + GG	1:1	92.8	83.3	3.30	4.01	23.24	26.22	9.81	9.98	413	573	493
PP (60 cm) + GG	1:1	90.6	82.4	4.60	4.92	30.82	32.60	10.82	10.96	550	619	584
PP (60 cm) + GG	1:2	83.2	83.1	3.50	4.20	25.32	31.78	10.40	10.53	680	851	765
PP (75 cm) + GG	1:1	85.8	75.3	5.30	5.66	42.12	43.16	10.31	11.20	606	638	622
PP (75 cm) + GG	1:2	86.5	76.2	5.76	5.83	40.12	41.80	10.52	11.18	726	902	814
PP (90 cm) + GG	1:1	82.8	73.2	5.61	5.72	43.21	43.98	11.03	11.21	637	663	650
PP (90 cm) + GG	1:2	85.2	74.4	5.20	5.36	41.78	42.00	10.60	11.18	716	844	710
CD (P=0.05)		4.7	4.1	0.86	0.63	4.66	3.83	NS	NS	83	78	92

PP, Pigeonpea; GG, greengram

Table 3. Pigeonpea-equivalent yield, land-equivalent ratio, total yield and economics of sole and different intercroping systems of pigeonpea and greengram

Treatment	Row ratio	Pigeonpea equivalent (kg/ha)		Land-equivalent ratio			Total mean yield (PP+GG) (kg/ha)	Mean monetary advantage (Rs/ha)	Benefit : cost ratio
		1999	2000	1999	2000	Mean			
Sole PP (45 cm)		1,865	1,730	1.00	1.00	1.00	1,797	7,197	1.67
Sole PP (60cm)		1,750	1,610	1.00	1.00	1.00	1,680	6,174	1.58
Sole PP (75 cm)		1,580	1,488	1.00	1.00	1.00	1,534	4,848	1.46
Sole PP (90 cm)		1,520	1,414	1.00	1.00	1.00	1,467	4,272	1.41
Sole GG (30 cm)		1,103	1,344	1.00	1.00	1.00	1,223	1,457	1.13
PP (45 cm) + GG	1:1	2,113	2,065	1.28	1.29	1.28	2,089	9,617	1.85
PP (60 cm) + GG	1:1	2,270	2,136	1.48	1.41	1.44	2,202	10,934	1.98
PP (60 cm) + GG	1:2	2,296	2,332	1.53	1.55	1.54	2,318	11,844	2.01
PP (75 cm) + GG	1:1	2,206	2,064	1.56	1.43	1.49	2,135	10,358	1.94
PP (75 cm) + GG	1:2	2,351	2,353	1.68	1.65	1.66	2,352	12,278	2.09
PP (90 cm) + GG	1:1	2,182	2,076	1.56	1.49	1.52	2,129	10,192	1.91
PP (90 cm) + GG	1:2	2,201	2,048	1.62	1.50	1.56	2,124	10,262	1.92
CD (P=0.05)	-	159	120	0.05	0.04		111	319	0.10

PP, Pigeonpea; GG, greengram

Benefit : cost ratio

All the cropping system gave a benefit : cost ratio more than 1 (Table 3). However, amongst different intercropping systems, PP (75 cm) + GG (1:2) ratio proved the most beneficial and gave the highest benefit : cost ratio (2.09), followed by PP (60 cm) + GG 1:2 (2.01). Higher benefit : cost ratio was attributed to higher pigeonpea equivalent yield under this cropping pattern.

Hence it was concluded that intercropping of pigeonpea and greengram in 1:2 ratio in pigeonpea planted at 75 cm row spacing is biologically and economically sustainable system for semi- arid condition of Haryana.

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