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Effect of row ratio of fodder sorghum (*Sorghum bicolor*) in pigeonpea (*Cajanus cajan*) intercropping system on productivity, competition functions and economics under rainfed conditions of north India

S.S. VERMA, Y. P. JOSHI AND S.C. SAXENA

Department of Agronomy, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Uttaranchal 263 145

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ABSTRACT

An experiment was conducted during the rainy season of 3 consecutive years from 2000 to 2002 at the Livestock Research Centre of the Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, to study the effect of row ratio of fodder sorghum [*Sorghum bicolor* (L.) Moench] in pigeonpea [*Cajanus cajan* (L.) Millsp.] intercropping systems. Intercropping of fodder sorghum in narrow row space of pigeonpea (75 cm) with a row ratio of 1:2 recorded the highest pigeonpea-equivalent yield (34.36 q/ha), net returns (Rs 30,179/ha), benefit : cost ratio (4.96), aggressivity index (0.533), area-time equivalent ratio (1.21), land-equivalent ratio (1.583) and relative crowding co-efficient (15.07). Thus, the intercropping system may be adopted for higher net return, benefit: cost ratio and pegionpea-equivalent yield.

Key words : Fodder sorghum–pigeonpea intercropping, Aggressivity index, Land-equivalent ratio, Area-time equivalent ratio, Benefit : cost ratio, Relative crowding co-efficient

An intercropping of fodder sorghum with pigeonpea produces better fodder in a short period without any adverse effect on growth, development and productivity of sole crop of pigeonpea and it also helps in soil and water conservation with increasing soil fertility and benefit : cost ratio. The beneficial effects of a suitable row ratio in cereal–legume intercropping system may be assessed through various competition functions (Rafey and Prasad, 1996). Therefore, a field experiment was conducted to study the effect of row ratio of fodder sorghum in pigeonpea intercropping system on productivity, competition functions and economics under rainfed conditions of north India.

MATERIALS AND METHODS

The experiment was conducted during the rainy season of 3 consecutive years from 2000 to 2002 at the Livestock Research Centre of the Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Uttaranchal, in randomized block design with 3 replications. Eight treatments consisted of 2 row spacing of pigeonpea, viz. 75 and 100 cm, and 3 row ratios of fodder sorghum, viz 1:3, 1:2 and 1:1 (Table 1). The soil of experimental plot was silty clay loam and contained 10 % sand, 60.2% silt and 29.8% clay with a bulk density of 1.33 g/cm^3. The soil was high in organic carbon (1.14%), 0.09% total nitrogen, medium in available phosphorus (25.0 kg /ha) and available potassium (345 kg /ha) with neutral in reaction (7.1 pH) having cation-exchange capacity 3.5 meq/100 g soil.

The sorghum 'Pant chari 5' and pigeonpea 'UPAS 120' were sown in the rainy season on 26, 28 and 29 June in 2000, 2001 and 2002, respectively, with recommended seed rate of fodder sorghum, pigeonpea as a sole crop and intercropping system. The sole crop of pigeonpea and intercropping with fodder sorghum was fertilized with a basal application of fertilizer dose, i.e. 20, 60 and 40 kg and 50, 60 and 40 kg NPK/ha, respectively. While fodder sorghum was grown with recommended dose of fertilizer, i.e. 100, 50, 40 kg, N, P, K/ha. Fresh herbage yield was recorded at harvesting time with 50% flowering stage. The growth and yield attributing characters of pigeonpea such as plant height, branches/plant, pods/plant, grains/pod and test weight, were recorded at physiological maturity and the crop was harvested at maturity. The productivity and economics were calculated on the basis of prevailing market prices. Different competition indices were calculated (Willey, 1979) as per the standard procedures.

RESULTS AND DISCUSSION

Yield

Higher pigeonpea-equivalent yield was obtained on all the intercropping systems over sole crop of pigeonpea and fodder sorghum (Table 1). However, significantly highest pigeonpea-equivalent yield (34.36 q/ha) was recorded in narrow row space pigeonpea (75 cm) with fodder sorghum in a row ratio of 1.2 followed by treatments T_8, T_6, T_7, and T_5 in intercropping system. Treatment T_8 being at par with T_6 also showed significant superiority to T_7 and T_5 in pigeonpea-equivalent yield, while T_6,T_7 and T_5 were at par with each other. Balyan and Seth (1991) also reported higher productivity in intercropped system than monocropping. This might be owing to the efficient use of space, light penetration and more efficient use of nutrients. These resources have positive effect on growth and yield of both crops in foresaid treatment (T_4).

Seed yield of pigeonpea was higher in wide row spaced (100 cm) than narrow spaced pigeonpea (75 cm) in both as sole and intercropping systems. This might be owing to more growth and yield attributes which positively affected with available resources and optimum plant competition. Almost similar finding was reported by the Salunkhe *et al.* (1990).

Aggressivity index

Intercropping of fodder sorghum in row space of pigeonpea with a row ratio 1:2 recorded higher aggressivity index (0.533) than other intercropping systems followed by T_5, T_8 , T_7 and T_6 (Table 2). The increase in number of rows of fodder sorghum and pigeonpea rows in between increased the competition between sorghum plants and thereby resulted in the increase in dominance power of pigeonpea. Abbas *et al.* (1995) recorded almost similar finding in maize with legumes intercropping system.

Area-time equivalent ratio (ATER)

All the intercropping systems recorded area-time equivalent ratio (ATER) value more than 1 indicating better land-utilization efficiency than their sole crops. Fodder sorghum + pigeonpea intercropping with a row ratio of 1:2 had maximum ATER values (1.21), followed by T_5, T_8, T_7 and T_6 treatments (Table 2). This showed that it had better land-utilization efficiency under these treatments, which gave higher productivity ranging from 15.5 to 27.9% than sole cropping. Similar finding was reported by Patra *et al.* (1990).

Land-equivalent ratio

Intercropping of fodder sorghum with pigeonpea resulted in land-equivalent ratio (LER) more than 1 as compared to sole cropping of each crop. Fodder sorghum in narrow row space pigeonpea with a row ratio 1:2 (T_4) recorded the highest LER (1.583), followed by treatments T_5, T_6, T_7 and T_8 (Table 2). Among intercropping systems, the difference in LER was not more 21.4% and it varies from 17.6 to 21.4%. This might be due to combined effect of natural and input resources, which utilized efficiently by component crops, having different rooting pattern, canopy distribution and nutrient requirement in the cropping system. The results were in accordance with the findings of Patra *et al.* (1990).

Relative crowding co-efficient

In all intercropping systems relative crowding coefficient (RCC) value recorded more than 1 showing better land utilization with higher plant population than their sole crops (Table 2). Intercropping of fodder sorghum with pigeonpea in row ratio 1:2 (T_4) and 1:1 (T_5) had higher relative crowding coeffient values (15.07 and 9.19) than rest of intercropping system respectively. However, treatment T_4 showed superiority to other treatments. Narrow

Table 1. Yield, total pigeonpea-equivalent yield and yield attributes under different treatment in pigeonpea-fodder sorghum intercropping system (mean data of 3 years)

Treatment	Pigeonpea grain yield (q/ha)	Sorghum yield (q/ha): Green fodder	Sorghum yield (q/ha): Dry-matter yield	Sorghum yield (q/ha): Pigenpea equivalent (q/ha)	Total pigeonpea equivalent (q/ha)	Sorghum plant height (cm)	Pigeonpea: Plant height (cm)	Pigeonpea: Branches/ plant	Pigeonpea: Pods/ plant	Pigeonpea: Test weight (g)
T_1, Sorghum at 25 cm row spacing		524.7	151.3	17.84	17.84	262				
T_2, Pigeonpea at 75 cm row spacing	24.76				24.76		212	20.8	65.2	70.5
T_3, Pigeonpea at 100 cm row spacing	29.03				29.03		215	23.3	72.3	75.6
T_4, T_2 + 2 row of sorghum (1:2)	21.86	367.6	103.0	12.50	34.36	248	214	16.4	53.2	67.9
T_5,T_2 + 1 rows of sorghum (1:1)	22.33	267.5	76.3	9.10	31.43	252	212	17.6	57.3	68.6
T_6, T_3 + 3 rows of sorghum (1:3)	17.77	418.7	117.9	14.23	32.00	246	211	16.4	45.6	65.9
T_7, T_3 + 2 rows of sorghum (1:2)	19.89	345.3	98.3	11.74	31.63	249	218	19.1	56.8	67.6
T_8, T_3+1 row of sorghum (1:1)	24.18	247.2	71.1	8.40	32.58	250	220	20.4	61.1	69.2
CD (P=0.05)					0.73	1.1	1.0	2.2	2.8	3.3

Table 2. Gross return, net return, benefit : cost ratio, aggressivity index, area - time equivalent ratio, land-equivalent ratio and relative crowding co-efficient under different treatments in pigeonpea–fodder sorghum intercropping system (mean data of 3 years)

Treatment	Gross return (Rs/ha)	Net return (Rs/ha)	Benefit : cost	Aggressivity index	Area-time equivalent ratio	Land-equivalent ratio	Relative crowding coefficient
T_1, Sorghum at 25 cm row spacing	19,624	11,524	2.42				
T_2, Pigeonpea at 75 cm row spacing	27,236	20,656	4.14				
T_3, Pigeonpea at 100 cm row spacing	31,933	25,433	4.91				
T_4, T_2+ 2 row of sorghum (1:2)	37,796	30,179	4.96	0.533	1.21	1.583	15.07
T_5, T_2+ 1 rows of sorghum (1:1)	34,573	27,008	4.57	0.392	1.12	1.412	9.19
T_6, T_3+ 3 rows of sorghum (1:3)	35,200	27,687	4.68	0.346	0.99	1.410	4.73
T_7, T_3+ 2 rows of sorghum (1:2)	34,793	27,326	4.66	0.356	1.00	1.343	4.35
T_8, T_3+ 1 row of sorghum (1:1)	35,838	28,428	4.84	0.362	1.04	1.304	4.97
CD (P=0.05)	955	715	0.10				

Selling price (Rs/q) : Sorghum green-fodder, 40; pigeonpea grain, 1,100

row space pigeonpea (75 cm) treatments showed better performance than wide row space pigeonpea (100 cm), as the higher plant population and better land-utilization efficiency with component crops recorded higher productivity of component crop. This might be owing to higher yield of component crops. Patra *et al.* (1990) also observed similar results in maize + pigeonpea intercropping system.

Net returns

All intercropping systems had higher net return than sole crop of fodder sorghum and pigeonpea. Among intercropping systems, fodder sorghum in narrow row space pigeonpea with a row ratio 1:2 (T_4) gave significantly higher net return (Rs 30,179/ha) compared to the other treatments followed by T_8, while minimum net return was obtained with sole crops of fodder sorghum and pigeonpea (Table 2). Higher net profit in a foresaid intercropping treatment might be owing to higher pigeonpea equivalent (Table 1) and higher selling price of pigeonpea (Table 2). Similar treand was also observed in maize + legume intercropping by Sharma (1994) and Pandita *et al.* (2000).

Benefit : cost ratio

In all the treatments, intercropping system had significantly higher benefit : cost ratio than other sole treatments except sole crop of pigeonpea at wide row space (T_3) which was at par with T_4 and T_8 with respect of benefit : cost ratio (Table 2). However, fodder sorghum in narrow row space pigeonpea (75 cm) with a row ratio of 1: 2 (T_4) gave significantly higher benefit : cost ratio (4.96) than other treatments and remained at par with T_3 (4.91), followed by T_8 (4.84). However, minimum benefit : cost ratio (2.42) was obtained with sole cropping of sorghum (T_1). This might be due to higher pigeonpea-equivalent yield (Table 1) and selling price of pigeonpea (Table 2). These findings are in confirmity with the findings of Sharma (1994) and Singh and Balyan (2000).

Thus, it may be concluded that intercropping of fodder sorghum in narrow row space pigeonpea (75 cm) with a row ratio of 1:2 was found most suitable and profitable intercropping system under rainfed condition of north India.

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