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Research Communication

Response of pigeonpea (*Cajanus cajan*) variety Pusa Arhar 16 to different row spacing and intercropping systems

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ABSTRACT

The experiment was conducted at Students Research Farm, Khalsa College, Guru Nanak Dev University, Amritsar, Punjab, during the rainy (*kharif*) season of 2020–21, to study the effect of different row spacing and intercropping systems on growth and yield of 'Pusa Arhar 16' pigeonpea [*Cajanus cajan* (L.) Millsp.]. Results showed that, number of branches/plant and yield attributes were significantly higher under 100 cm × 20 cm than in 50 cm × 20 cm, while the seed yield of pigeonpea (1.41 tonnes/ha) and pigeonpea-equivalent yield (1.78 tonnes/ha) were found significantly higher under narrow spacing 50 cm × 20 cm than wider spacing, i.e., 100 cm × 20 cm (1.02 and 1.33 tonnes/ha). Higher net returns (80.4 × 10^3 ₹/ha) and benefit: cost (B : C) ratio (4.08) were recorded in 50 cm × 20 cm than in 75 cm × 20 cm (73.4 × 10^3 ₹/ha and 3.84) and 100 cm × 20 cm (53.9 × 10^3 ₹/ha and 3.10). Among the different intercropping systems, pigeonpea + pearlmillet [*Pennisetum glaucum* (L.) R. Br.] fodder gave the maximum pigeonpea-equivalent yield of 1.85 tonnes/ha, being superior to 1.31 tonnes/ha in sole pigeonpea and 1.38 tonnes/ha of pigeonpea + fingermillet, while it was at par with pigeonpea + greengram [*Vigna radiata* (L.) R. Wilczek] (1.80 tonnes/ha). Pigeonpea + pearlmillet fodder fetched higher net returns (84.8 × 10^3 ₹/ha) and B : C (4.25) ratio among the different intercropping systems.

Key words: Economic returns, Intercropping systems, Pusa Arhar-16, Row spacing

Pigeon pea [*Cajanus cajan* (L.) Millsp.] is one of the most important pulse crops of India, grown during the rainy (*kharif*) season both as sole and intercrop. In India, pigeonpea occupies second position after chickpea and contributed 4.25 million tonnes from an area of 4.43 million ha, with average productivity of 960 kg/ha. Pigeonpea cultivation covered 2.6 thousand ha in Punjab, with total production of 2.7 thousand tonnes during 2017–18 (PAU, 2019). Pigeonpea grown as a sole crop shows inefficient utilization of resources, especially the space because of its slow initial growth rate. Hence cultivation of pigeonpea as a sole crop is reported less profitable due to longer duration and wider spacing (Sekhon *et al*., 2018). To make the cultivation of pigeonpea more viable, it is necessary to utilize the inter-row space through intercropping. Intercropping with short-duration pulse like greengram [*Vigna radiata* (L.) R. Wilczek], pearlmillet [*Pennisetum glaucum* (L.) R. Br.] for fodder purpose and millet like finger millet (*Eleusine coracana* Gaertn.] in pigeonpea may enhance total productivity and may also provide early cash flow. Presently, Punjab is facing a problem of extensive rice–wheat cropping system due to which the level of groundwater is going down at a very fast rate. Besides, rice requires huge amount of fertilizers and pesticides which are also hazardous for human health and environment. Rice is a labour-intensive crop, and another major issue is straw burning which has adverse effect both on soil health and environment. To overcome these problems, environment-friendly crop like pigeonpea can be grown which requires less amount of water, fertilizer, pesticides and labour.

The experiment was conducted during the rainy (*kharif*) season of 2020–21 at Students Research Farm, Khalsa College, Guru Nanak Dev University, Amritsar, Punjab. The soil of experimental field was sandy loam, with *p*H (8.4), electrical conductivity (0.23 ds/m), medium in organic carbon (0.75%), medium in available N (480 kg/ha), very high in available P_2O_5 (63.36 kg/ha) and high in available K (223 kg/ha). The experiment was laid out in a split-plot design with 3 different spacing, viz. 50 cm × 20 cm, 75 cm × 20 cm and 100 cm × 20 cm in main plots, while the 3 intercropping system, viz. pigeonpea + pearlmillet

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fodder, pigeonpea + finger millet and pigeonpea + greengram along with pigeonpea sole, in subplots with 3 replications. The seeds were sown manually with pora (Indigenous single line drill) method on 9 July 2020. One row of intercrop was sown between 2 rows of pigeonpea on the same day. Randomly 5 plants were tagged in net plot area for recording various observation on crop growth characteristics, yield attributes and yield of pigeonpea. Pearlmillet fodder and greengram were harvested at 55 and 70 days after sowing (DAS), respectively, while finger millet and pigeonpea were harvested on 25 November 2020. The produce of pigeonpea from each plot after harvesting was tied in bundles with attached tag and left in the field for complete drying. At the end, manually threshing operations were performed plot–wise. Pigeonpea-equivalent yield (PEY) was computed by converting yield of intercrops to pigeonpea yield based on their market prices by using the following formula.

$$\text{PEY} = \text{Grain yield of pigeonpea} + \frac{\text{Yield of intercrops} \times \text{price of intercrop}}{\text{Price of pigeonpea}}$$

The data on various parameters were statistically analyzed by using CPCS-1.

Plant height, dry-matter accumulation and crop-growth rate of pigeonpea were non-significantly influenced by different row spacings and intercropping systems. Of the intercrops, though finger millet alone having almost same duration as the pigeonpea, it could not hamper the growth and development of pigeonpea because of vigorous growth habit of pigeonpea. However, significantly higher number of branches (15.3%) were recorded in wider row spacing 100 cm × 20 cm as compare to 50 cm × 20 cm spacing (Table 1). This might be owing to availability of more space per plant which leads to better plant geometry. Kuri *et al.* (2018) reported significantly higher number of branches at wider row spacing. Widest row spacing of 100 cm × 20 cm resulted in significantly higher yield attributes of pigeonpea, viz. pods/plant (13.6 and 8.1%), pod length (16.7 and 8.1%), seeds/pod (30.1 and 13.1%) and 100-seed weight (4.8 and 2.7%) as compared to the narrow spacings of 50 cm × 20 and 75 cm × 20 cm respectively. This might be owing to less competition between the plants and better availability of nutrients. Tigga *et al.* (2017) also reported higher yield attributes in wider row spacing. Among the intercropping systems, non-significantly higher yield attributes were observed in pigeonpea + greengram, followed by pigeonpea sole, pigeonpea + fingermillet and pigeonpea + pearlmillet fodder. Seed yield (1.41 tonnes/ha), stover yield (4.84 tonnes/ha) and biological yield (6.25 tonnes/ha) were found significantly higher in 50 cm × 20 cm in comparison to 100 cm × 20 cm (1.02 tonnes/ha, 3.54 tonnes/ha and 4.58 tonnes/ha) respectively. Higher seed yield (38.3%), stover yield (36.7%) and biological yield (36.5%) under spacing 50 cm × 20 cm might be because of more number of plants (50%) than in 100 cm × 20 cm spacing. Better yield attributes under 100 cm × 20 cm spacing could not fully compensated the yield loss due to difference in plant population. Kuri *et al.* (2018) also reported the similar results. Different intercropping systems did not show any significant effect on seed yield and stover yield; however, pigeonpea + greengram (5.87 tonnes/ha) and pigeonpea sole (5.71 tonnes/ha), being at par, gave significantly higher (18.4 and 15.1%) biological yield than pigeonpea + pearlmillet fodder (4.96 tonnes/ha). Our results confirm the findings of Barod *et al.* (2017). Harvest index did not vary significantly under different row spacing and intercropping systems. Spacing of 50 cm × 20 cm (1.78 tonnes/ha) resulted in significantly higher pigeonpea -equivalent yield than spacing of 100 cm × 20 cm (1.33 tonnes/ha), but this was statistically at par with 75 cm × 20 cm (1.66 tonnes/ha). Corresponding increase in 50 cm × 20 cm spacing was 7.3 and 31.6% over 75 cm × 20 cm and 100 cm × 20 cm spacing respectively. This might be owing higher yield of all the intercrops and pigeonpea in 50 cm × 20 cm spacing. The results are in conformity with findings of Udhaya *et al.* (2014). Among the different intercropping systems, pigeonpea + pearlmillet fodder gave the maximum pigeonpea-equivalent yield (1.85 tonnes/ha) which was statically superior to pigeonpea sole (1.31 tonnes/ha) and pigeonpea + finger millet (1.38 tonnes/ha), while it remained at par with pigeonpea + greengram (1.80 tonnes/ha). Corresponding increase in pigeonpea + pearlmillet fodder was 41.2 and 34.1% over pigeonpea sole and pigeonpea + fingermillet respectively. Higher pigeonpea-equivalent yield under pigeonpea + pearlmillet intercropping system was mainly owing to a higher fodder yield of pearlmillet. Garud *et al.* (2018) also observed that, pigeonpea-equivalent yield was significantly influenced by different intercropping systems. Net returns and benefit: cost ratio were higher in 50 cm × 20 cm spacing than that in 75 cm × 20 cm and 100 × 20 cm. Atik *et al.* (2018) also reported higher net returns and benefit: cost ratio under narrow row spacing. Among the intercropping systems, pigeonpea + pearlmillet fodder fetched higher net returns and benefit cost ratio than the others. Sharma *et al.* (2012) also recorded higher net returns and benefit: cost ratio under intercropping than in sole.

Inter-row spacing of 50 cm × 20 cm was optimum to get higher seed yield (1.41 tonnes/ha), pigeonpea-equivalent yield (1.78 tonnes/ha), net returns (80.4×10^3 /ha) and benefit: cost ratio (4.08) (Table 2). This spacing gave more monetary benefit of ₹6.98×10^3 and ₹26.5×10^3/ha than 75 cm × 20 cm and 100 cm × 20 cm spacing respectively. Pigeonpea + pearlmillet (fodder) gave maximum

Table 1. Effect of different row spacing and intercropping systems on crop-growth parameters, branches/plant and yield attributes of pigeonpea

Treatment	Crop-growth parameters				Yield attributes			
	Plant height (cm)	Dry-matter accumulation (g/plant)	Crop-growth rate (g/ plant/day)	Branches/ plant	Pods/ plant	Pod length (cm)	Seeds/ pod	100-seed weight (g)
Spacing (cm × cm)								
50 × 20	157.08	97.50	1.84	15.0	161.92	4.44	3.52	7.18
75 × 20	155.67	99.00	1.90	16.0	170.08	4.79	4.05	7.33
100 × 20	154.33	100.17	2.00	17.3	183.91	5.18	4.58	7.53
SEm±	1.30	1.25	0.21	0.87	2.10	0.12	0.16	0.05
CD (P=0.05)	NS	NS	NS	2.41	5.83	0.33	0.44	0.13
Intercropping systems								
Pigeonpea sole	154.50	99.11	1.93	16.6	172.77	4.82	4.07	7.34
Pigeonpea + pearlmillet	156.50	97.83	1.73	15.5	170.33	4.75	4.00	7.36
Pigeonpea + finger millet	155.78	98.27	1.87	15.6	171.11	4.80	4.04	7.32
Pigeonpea + greengram	156.00	100.34	2.12	16.7	173.66	4.84	4.09	7.37
SEm±	1.10	1.24	0.20	0.62	1.70	0.05	0.05	0.04
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS

Table 2. Effect of different row spacing and intercropping systems on seed yield, straw yield, biological yield, harvest index, pigeonpea-equivalent yield, net returns and benefit: cost ratio in pigeonpea

Treatment	Seed yield (t/ha)	Stover yield (t/ha)	Biological yield (t/ha)	Harvest index (%)	Pigeonpea equivalent yield (t/ha)	Net returns (× 10^3 ₹/ha)	Benefit: cost ratio
Spacing (cm × cm)							
50 × 20	1.41	4.84	6.25	23.09	1.78	80.4	4.08
75 × 20	1.37	4.28	5.62	24.85	1.66	73.4	3.84
100 × 20	1.02	3.54	4.58	24.36	1.33	53.9	3.10
SEm±	1.20	3.51	3.22	0.65	0.90	—	—
CD (P=0.05)	3.33	9.74	8.94	NS	2.50	—	—
Intercropping systems							
Pigeonpea sole	1.26	4.46	5.71	23.54	1.31	53.0	3.08
Pigeonpea + pearlmillet	1.18	3.78	4.96	24.43	1.85	84.8	4.25
Pigeonpea + Finger millet	1.25	4.14	5.39	24.21	1.38	57.6	3.25
Pigeonpea + greengram	1.39	4.49	5.87	24.22	1.80	81.5	4.08
SEm±	1.10	3.50	2.97	0.44	0.88	—	—
CD (P=0.05)	NS	NS	6.31	NS	1.84	—	—

pigeonpea-equivalent yield (1.85 tonnes /ha), net returns (84.8×10^3 /ha) and benefit: cost ratio (4.25), whereas greengram was most suitable intercrop on the basis of seed yield of pigeonpea only. Highest monetary gain was recorded ₹31.8×10^3 with pigeonpea + pearlmillet (fodder) intercropping.

Based on the above findings it can be conducted that narrow sparing (50 × 20 cm) is optimum for pigeonpea variety 'Pusa Arhar 16' and pigeonpea + pearlmillet followed by pigeonpea + greengram intercropping systems are more production and profitable for northern plain.

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