

Effect of planting geometry and nutrients levels on yield, yield attributes and economics of pigeonpea genotypes

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Abstract: A field experiment was conducted at the Research Farm of Agricultural College, Raichur with three pigeonpea genotypes, two planting geometries and two nutrient levels under rainfed conditions during 2013-14. The results revealed that the differences in seed yield differed significantly among the three pigeonpea genotypes. The seed yield produced by genotype GRG-811 (1726 kg ha⁻¹) was found to be significantly higher than the seed yield produced by ICP-8863 (1502 kg ha⁻¹), which was on par with TS-3R (1616 kg ha⁻¹). The extent of reduction in seed yield by ICP-8863 and TS-3R was fifteen and seven per cent when compared with GRG-811, respectively. The net returns (Rs. 46905 ha⁻¹) and BC ratio (2.94) were found to be significantly higher for GRG-811 as compared with ICP-8863 (₹ 38250 ha⁻¹ and 2.43) and it was on par with TS-3R (₹ 42637 ha⁻¹ and 2.59), respectively. Among different combinations, the spacing 90 x 30 cm and nutrient level NP 125% of the recommended dose recorded significantly higher seed yield (1693 kg ha⁻¹) and net returns (₹ 46198 ha⁻¹) when compared with all other combinations of spacing and nutrient levels viz., 60 x 30 cm with 100 per cent NP (1566 kg ha⁻¹ and ₹ 39239 ha⁻¹), 60 x 30 cm with 125 per cent NP (1576 kg ha⁻¹ and ₹ 40845 ha⁻¹) and was on par with 90 x 30 cm + 100 per cent NP (1625 kg ha⁻¹ and ₹ 44107 ha⁻¹), respectively.

Key words: Economics, Genotypes, Nutrient levels, Pigeonpea, Planting geometry

Introduction

Pigeonpea [*Cajanus cajan* (L.) Millsp.] is the second most important pulse crop of India after chickpea. It has occupied an area of 4.42 million hectares with a production of 2.89 million tonnes and average productivity of 655 kg ha⁻¹ (Anon., 2012). India has a virtual monopoly in pigeonpea production by accounting 90 per cent of the world's total production. It is one of the protein rich legume crops of semi-arid and subtropics and requires due attention in view of large scale shortage of pulses to meet the domestic requirement. This crop has the privilege of occupying the first place both in area and production among kharif grown legumes. Although pigeonpea ranks sixth in area and production in the world in comparison to other grain legumes such as beans, peas and chickpeas, it is used in more diverse ways than other legumes. Thus, there is an urgent need to increase the production of pulses to meet the increasing demand by manipulating the production technologies appropriately. The yield of pigeonpea is limited by a number of factors such as agronomic, pathogenic, entomological, genetic and their interaction with environment. Among the agronomic practices limiting the yield, choice of a suitable geometry and nutrient levels for a particular genotype is one of the important factors. Adaptation of proper planting geometry and nutrient levels to a particular genotype will go a long way in making efficient use of limited growth resources and thus to stabilize yield.

Material and methods

A field experiment was conducted at the Research Farm of the Agricultural College, Raichur, Karnataka, during kharif 2013. The soil of the experimental plot was medium black with sandy loam texture having 0.54 per cent organic carbon, 239.19 kg ha⁻¹ available nitrogen, 31.43 kg ha⁻¹ available phosphorus,

269.34 kg ha⁻¹ available potassium and pH 8.36. The entire dose of fertilizers recommended for pigeonpea (25:50 N: P₂O₅ kg ha⁻¹) was applied at the time of sowing. The experiment consisted of twelve treatment combinations, comprising of three genotypes which were allotted in main-plots (GRG-811, TS-3R and ICP-8863) and four combinations of spacing and nutrient levels in sub-plots (60 x 30 cm with 100 per cent NP, 60 x 30 cm with 125 per cent NP, 90 x 30 cm with 100 per cent NP and 90 x 30 cm with 125 per cent NP) and were laid out in split plot design with three replications. Five plants were tagged at random in net plot area for recording various yield components like number of pods per plant, number of seeds per pod, seed yield per plant (g) and 100 seeds weight (g). Seed yield (kg ha⁻¹) was computed by threshing pods from net plot, cleaned and the seed weight was recorded. From this, seed yield per hectare was computed. The net returns (₹ ha⁻¹) was calculated by deducting cost of cultivation (₹ ha⁻¹) from gross returns, and BC ratio was worked out as a ratio of gross returns (₹ ha⁻¹) to cost of cultivation (₹ ha⁻¹).

Results and discussion

Comparison of pigeonpea genotypes viz., GRG-811, ICP-8863 and TS-3R, indicates that they differ significantly with respect to seed yield (Table 1). The genotype GRG-811 produced significantly higher seed yield (1726 kg ha⁻¹) as compared to ICP-8863 (1502 kg ha⁻¹) which was on par with TS-3R (1616 kg ha⁻¹). The significantly higher yield of GRG-811 than ICP-8863 was mainly due to significantly higher yield and growth components. The difference in seed yield of pigeonpea genotypes was also reported by Prashanthi *et al.* (2001).

Among the yield components, the number of pods per plant, seed weight per plant and 100 seeds weight were closely

Table 1. Yield and yield parameters of pigeonpea genotypes as influenced by planting geometry and nutrient levels

Treatments	Number of pods per plant	Number of seeds per pod	Seed yield per plant (g)	Hundred seed weight (g)	Seed yield (kg ha ⁻¹)	Stalk yield (kg ha ⁻¹)	Husk yield (kg ha ⁻¹)	Harvest index
Genotypes (G)								
G ₁ : GRG-811	166.29	3.70	39.16	10.10	1726	5316	1370	0.204
G ₂ : TS-3R	158.63	3.67	36.31	9.76	1616	5143	1315	0.201
G ₃ : ICP-8863	141.49	3.44	34.12	9.38	1502	4863	1211	0.198
Mean	155.47	3.60	36.53	9.74	1615	5107	1299	0.201
S.E.m.±	6.81	0.11	1.23	0.23	39	79	27	0.001
C.D. at 5%	21.21	NS	4.00	0.68	121	253	82	0.004
Spacings and nutrient levels (S)								
S ₁ : 60 cm x 30 cm with 100% NP	139.00	3.37	28.23	9.48	1566	5054	1235	0.199
S ₂ : 60 cm x 30 cm with 125% NP	145.79	3.57	29.31	9.55	1576	5063	1260	0.200
S ₃ : 90 cm x 30 cm with 100% NP	166.81	3.62	42.91	9.84	1625	5106	1316	0.202
S ₄ : 90 cm x 30 cm with 125% NP	170.28	3.84	45.67	10.11	1693	5206	1384	0.204
Mean	155.47	3.60	36.53	9.74	1615	5107	1299	0.201
S.E.m.±	7.24	0.13	4.52	0.17	24	13	25	0.001
C.D. at 5%	21.79	NS	13.63	0.49	69	42	74	0.003
Interaction								
S at the same G level								
S.E.m.±	10.95	0.23	2.38	0.29	55	107	43	0.004
C. D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS
G at the same or different S levels								
S.E.m.±	10.91	0.22	2.30	0.30	57	113	43	0.005
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS

NS- Non significant

associated with the seed yield per hectare. The other factors, which indirectly influenced the seed yield were growth attributes such as number of leaves, number of primary branches, dry matter production and its distribution in various plant parts. The differences in seed yield of genotypes have been discussed in the light of observations made on various yield attributes.

Stalk yield differed significantly among the genotypes (Table 1). The genotypes, GRG-811 recorded significantly higher stalk yield (5316 kg ha⁻¹) and it was nine and three per cent higher than ICP-8863 and TS-3R (4863 and 5143 kg ha⁻¹, respectively). Similarly, Kashyap *et al.* (2003) reported significant differences in stalk yield of pigeonpea genotypes. The higher stalk yield of GRG-811 was attributed to significantly higher dry matter accumulation in stem.

Among the different pigeonpea genotypes, GRG-811 recorded the highest cost of cultivation (₹ 26958 ha⁻¹) due to its higher seed yield, which resulted in higher marketing and handling charges (2% of produce gross value). However, it also recorded higher gross returns (₹ 73863 ha⁻¹) compared to ICP-8863 and TS-3R (₹ 65038 and 69474 ha⁻¹, respectively). The net returns and B:C (₹ 46905 ha⁻¹ and 2.74, respectively) recorded by GRG-811 were significantly higher as compared to ICP-8863 (₹ 38250 and 2.43, respectively), and was on par with TS-3R (₹ 42637 ha⁻¹ and 2.59, respectively) (Table 2). The significantly higher net returns with genotype GRG-811 was due to significantly higher seed yield recorded compared to ICP-8863 (Table 1). These results are in agreement with the findings of Pramod and Pujari (2007) and Bhavi *et al.* (2013).

Table 2. Economic analysis of pigeonpea genotypes as influenced by planting geometry and nutrient levels

Treatments	Cost of cultivation (₹ ha ⁻¹)	Gross returns (₹ ha ⁻¹)	Net returns (₹ ha ⁻¹)	BC Ratio
Genotypes (G)				
G ₁ : GRG-811	26958	73863	46905	2.74
G ₂ : TS-3R	26837	69474	42637	2.59
G ₃ : ICP-8863	26788	65038	38250	2.43
Mean	26861	69458	42597	2.59
S.E.m.±	—	—	2015	0.06
C.D. at 5%	—	—	6254	0.20
Spacings and nutrient levels (S)				
S ₁ : 60 cm x 30 cm with 100% NP	26648	65887	39239	2.47
S ₂ : 60 cm x 30 cm with 125% NP	27414	68259	40845	2.49
S ₃ : 90 cm x 30 cm with 100% NP	26308	70415	44107	2.68
S ₄ : 90 cm x 30 cm with 125% NP	27074	73272	46198	2.71
Mean	26861	69458	42597	2.59
S.E.m.±	—	—	1251	0.06
C.D. at 5%	—	—	3716	0.19
Interaction				
S at the same G level				
S.E.m.±	—	—	2166	0.09
C. D. at 5%	—	—	NS	NS
G at the same or different S levels				
S.E.m.±	—	—	2461	0.09
C.D. at 5%	—	—	NS	NS

NS- Non significant

In the present investigation, the plant geometry of 90 x 30 cm with population of 37037 plants ha⁻¹ and 125 per cent NP recorded significantly higher seed yield (1693 kg ha⁻¹) as compared to the plant geometry of 60 x 30 cm with population of 55555 plants ha⁻¹ and 100 per cent NP (1566 kg ha⁻¹), 60 x 30 cm with population of 55555 plants ha⁻¹ and 125 per cent NP (1576 kg ha⁻¹), and was on par with the planting geometry of 90 x 30 cm with population of 37037 plants ha⁻¹ and 100 per cent NP (1625 kg ha⁻¹) (Table 1). The better availability of growth resources like water, nutrients, air, better cultural practices in wider plant geometry helped the plants to exhibit their full potential and produced higher yield than closely spaced plants, and increased availability of nitrogen and phosphorus had a boosting effect on the crop. Similar results were reported by Meena *et al.* (2011), Kantwa *et al.* (2006) and Saritha *et al.* (2012) in pigeonpea, who reported a higher grain yield of pigeonpea with wider plant geometry and higher nutrient level over closer plant geometry and lesser nutrients level on account of improved growth and yield contributing parameters.

The seed weight per plant is governed by yield components like number of pods per plant and hundred seed weight. Significantly higher number of pods (170.28 plant⁻¹) was recorded with 90 x 30 cm and 125 per cent NP when compared with 60 x 30 cm and 100 per cent NP (139.00 plant⁻¹) and 60 x 30 cm and 125 per cent NP (145.79 plant⁻¹), and was on par with 90 x 30 cm and 100 per cent NP (166.81 plant⁻¹). The wider spacing (90 x 30 cm) with higher nutrients level (125% NP) recorded significantly higher seed yield per plant than the pigeonpea sown at narrow spacing (60 x 30 cm) and lesser nutrients level (100% NP) and was on par with 90 x 30 cm and 100 per cent NP. Significant increase in seed yield per plant was attributed to significantly higher number of pods per plant and hundred seed weight (Table 1). These results are in accordance with the results obtained by Kantwa *et al.* (2006) and Meena *et al.* (2011), who recorded significantly higher seed weight per plant, pods per plant and hundred seed weight under wider row spacing and higher nutrients levels over narrow row spacing and lesser nutrients levels.

The better performance of plant at wider row spacing and 125 per cent NP might be attributed to least inter plant competition and greater availability of growth resources *viz.*, light, moisture and increased availability of nitrogen and phosphorus, and space for each plant.

Significantly higher yield components obtained at spacing of 90 x 30 cm and 125 per cent NP could be attributed to better plant development resulting in more uniform distribution of plants over cropped area, coupled with greater light interception, moisture utilization, nutrient and solar energy availability under lower degree of inter-plant and intra-plant competition and availability of additional amount of nutrients which favoured the development of root system, and improved rate of

photosynthesis. These favorable conditions for growth caused significantly higher values of yield components under wider row spacing with higher nutrients level. Hence, wider row spacing with higher nutrients level recorded significantly higher yield as compared to closer spacing with lesser nutrients level. Similar increase in yield under wider spacing and higher nutrients level was reported by Meena *et al.* (2011) and Saritha *et al.* (2012). Significant differences in stalk yield of pigeonpea genotypes were noticed among various spacings and nutrients level (Table 1). Significantly higher stalk yield of 5206 kg ha⁻¹ was recorded under spacing of 90 x 30 cm with 125 per cent NP, which was on par with that in 90 x 30 cm with 100 per cent NP and significantly superior over other spacing and nutrients levels *viz.*, 60 x 30 cm with 100 per cent NP and 60 x 30 cm with 125 per cent NP. Higher stalk yield with wider spacing and higher nutrients levels was due to increased dry matter production per plant. Similar results were reported by Promod and Pujari (2007), Meena *et al.* (2011) and Nagaraj (2008).

Among different combinations of spacing and nutrients levels, the spacing of 60 x 30 cm with 125 per cent NP recorded higher cost of cultivation (₹ 27414 ha⁻¹), since in this treatment higher quantity of fertilizers and seeds was used as compared with other combinations of spacings and nutrients levels. Spacing of 90 x 30 cm with 125 per cent NP recorded higher gross returns (₹ 73272 ha⁻¹) when compared with other combinations of spacing and nutrients levels. It recorded significantly higher net returns (₹ 46198 ha⁻¹) as compared to other combinations of spacings and nutrient levels due to its higher seed yield than other combinations of spacings and nutrients levels *viz.*, 60 x 30 cm with 100 per cent NP (₹ 39239 ha⁻¹) and 60 x 30 cm with 125 per cent NP (₹ 40845 ha⁻¹), which was on par with 90 x 30 cm with 100 per cent NP (₹ 44107 ha⁻¹). The benefit cost ratio was found significantly higher with spacing of 90 x 30 cm with 125 per cent NP (2.71) when compared with other combinations of spacings and nutrients levels *viz.*, 60 x 30 cm with 100 per cent NP (2.47) and 60 x 30 cm with 125 per cent NP (2.49), and was on par with 90 x 30 cm with 100 per cent NP (2.68). This is due to higher gross returns recorded under spacing of 90 x 30 cm with 125 per cent NP as compared to other combinations. These results are in agreement with the findings of Sharma *et al.* (2003).

From the results of this investigation, it can be concluded that pigeonpea genotype, GRG-811 was found promising and recorded significantly higher seed yield, net returns and BC ratio than ICP-8863 and was on par with TS-3R during *kharif* season. The pigeonpea spaced at 90 x 30 cm with 125 per cent NP recorded significantly higher seed yield, net returns and BC ratio as compared to 60 x 30 cm with 100 per cent NP and 60 x 30 cm with 125 per cent NP, and was on par with 90 x 30 cm with 100 per cent NP during *kharif* season.

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