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Management of seedling age and plant geometry of transplanted pigeon pea

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Abstract
A field experiment was conducted during *kharif* 2011-12 and 2012-13 to study the response of hybrid pigeon pea to planting geometry and age of seedling. Maximum plant spread (93.56 cm) and test weight were recorded with plant geometry of 75 cm x 25 cm which was 64.46 and 3.61 percent more than 90 cm x 20 cm. This geometry also recorded more pod length as well as 4.8 and 4.2 days early in 50% flowering and pod formation stage compared to 75 cm x 25 cm spacing. Both plant geometry being similar, geometry of 75 cm x 25 cm with population of 53,333 plants ha^{-1} recorded higher grain yield (2.64 t ha^{-1}) than that of 90 cm x 20 cm with population of 55,555 plants ha^{-1} (2.4 t ha^{-1}). Transplanting of pigeon pea 15 days old seedling recorded maximum plant height, primary and secondary branches, plant spread (East to West), pods per plant, test weight, yield, gross return, net return as well as B:C ratio and less number of days taken to 50% flowering and pod formation. 15 days old seedling was similar to 30 days old seedling with respect to plant spread (East to West), number of pods per plant and days taken to 50% pod formation and was also similar with direct seeded pigeon pea with respect to number of pods per plant and days taken to 50% pod formation. Transplanting of 15 days old seedling was also similar to 30 days old seedling and direct seeding in terms of net return and B:C ratio as it recorded 18.56, 18.56, 20.33 and 8.1 percent higher seed yield, gross return, net return as well as B:C ratio than direct seeded pigeon pea i.e. 2.48 t/ ha, □136343, □109378 and 4.05 respectively. The interaction effect revealed that seed yield and net return under 75 cm x 25 cm plant geometry with 15 days old seedling being similar to 90 cm x 20 cm spacing with 15 and 30 days old seedling and also 75 cm x 25 cm spacing with direct seeding were significantly higher than any other combinations of plant geometry and seedling age.

Keywords: Hybrid pigeon pea, ICPH-2671, Plant geometry, Yield attributes, Yield

Introduction
The legume crops are generally grown under low inputs and risk-prone marginal environments, especially in semi-arid tropics. Pigeon pea [Cajanus cajan (L.) Mills.] is an important grain legume due to its high protein (20-22%) content occupying the first place both in area and production among *kharif* grown legumes. India is the largest producer and consumer of pigeon pea as it plays an important role in food security, balanced diet and alleviation of poverty (Rao *et al.* 2002). Globally pigeon pea occupies 4.6 m ha area with annual production of 3.4 million tons and productivity of 893 kg/ha (Mula and Saxena 2010). In India, pigeon pea covers 3.5 m ha area with 2.4 million tons production having low productivity of 685 kg/ha. System of rice intensification has enhancement in crop productivity by managing age of seedling and plant geometry as such has gained popularity among farmers. Manipulation of plant spacing between and within rows place a significant role in boosting up of crop yield (Sarkar and Malik, 2004). Hence, to increase the productivity of pigeon pea such new methods have been adopted by transplanting pigeon pea seedlings of different age with varying plant geometry. So far as varieties cultivated in Jharkhand are traditional and poor yielders and are susceptible to pests and diseases. There is in contrast, hybrids are high yielders giving remunerative price to the farmers. The variety ICPH-2671 released from ICRISAT found promising than present existing popular cultivars. It is not only high yielder but also tolerant to pests and diseases as compared to other cultivars. Agronomic activities are regarded as important factor in increasing crop production influencing pigeon peas growth and development (Sinha *et al.* 1988). Hence, the present study was undertaken to investigate the response of hybrid (ICPH-2671) pigeon pea to transplanting at different age of seedlings and planting geometry.

Materials and Methods
A field experiment was conducted during *kharif* 2011-12 and 2012-13 at Birsa Agricultural University. The experiment was laid out in split plot design, comprising of two spacing i.e., 90 cm X 20 cm and 75 cm x 25 cm in main plot and method of establishment i.e., three seedling

age 15, 30, 45 days old seedlings and one direct seeded pigeon pea in sub plot and were replicated five times. The pigeon pea variety ICPH-2671 (hybrid) was sown on 7th and 19th July during 2011 and 2012, respectively, in the field (direct seeded) as well as simultaneously in pre mixed sand, soil and FYM poly bags in nursery. The poly bags were filled with mixture of sand, soil and FYM were mixed in 1:1:1 proportion. Direct sowing was done in plots by dibbling seeds up to 4 to 5 cm depth in the rows with spacing as per the treatments. The soil was silt loam in texture with pH 6.0 having 250.25, 16.45 and 136.0 kg ha^{-1} available N, P and K, respectively. Recommended dose of fertilizer 50:100:50:40:10 kg N, P_2O_5, K_2O, S and B ha^{-1} was applied through urea, single super phosphate, muriate of potash, and borex respectively. Borex was applied at the time of flower initiation. The yield attributing parameters and yield of the crop were recorded after physiological maturity. The growth and yield observations were recorded in five plants randomly selected in each treatment. The total seed yield (kg/ha) was computed on per plot basis. The statistical analysis of variance was computed as per Gomez and Gomez, (2003).

Results and Discussion

In the present investigation, the plant geometry did not affect the plant height, primary and secondary branches, pods per plant, seeds per pod as well as yield and economics of pigeon pea. However, plant spread (East to West), test weight, days to 50% flowering and pod formation were significantly affected. Maximum plant spread (93.56 cm) and test weights were recorded with plant geometry of 75 cm x 25 cm which was 64.46 and 3.61 percent more than 90 cm x 20 cm. (Table 1). Plant geometry of 90 cm x 20 cm recorded more pod length as well as 4.8 and 4.2 days early in 50% flowering and pod formation compared to 75 cm x 25 cm spacing.

Both plant geometry being similar, geometry of 75 cm x 25 cm with population of 53,333 plants ha^{-1} recorded higher grain yield (2.64 t ha^{-1}) than that of 90 cm x 20 cm with population of 55,555 plants ha^{-1} (2.4 t ha^{-1}) (Table 2). Similar results were reported by Sathe and Patil (2012 a and 2012b) and Tuppad *et al.* (2012). Increase in grain yield per plant was due to higher number of pods per plant and more test weight. The better availability of growth resources like water, nutrients, air and better cultural practices in wider plant geometry helped the plants to exhibit their full potential and produced higher yield than closely spaced plants. Plant geometry of 75 cm x 25 cm is 4.2 percent more spacious than that of 90 cm x 20 cm. The results are in conformity with the findings of Sathe and Patil (2012 b) Meena *et al*. (2015).

Among age of seedling, transplanting 15 days old seedling of pigeon pea recorded maximum plant height, primary and secondary branches, plant spread (East to West), pods per plant, test weight, yield, gross return, net return as well as B:C ratio and less number of days taken to 50% flowering and pod formation. 15 days old seedling was similar to 30 days old seedling with respect to plant spread (East to West), number of pods per plant and days taken to50% pod formation and was also similar with direct seeded pigeon pea with respect to number of pods per plant and days taken to 50% pod formation. Transplanting of 15 days old seedling was also similar to 30 days old seedling and direct seeding in terms of net return and B:C ratio as it recorded 18.56, 18.56, 20.33 and 8.1 percent higher seed yield, gross return, net return as well as B:C ratio than direct seeded pigeon pea i.e. 2.48 t/ ha, □136343, □109378 and 4.05 respectively. The higher yield under transplanting of 15 days old seedling was attributable to more branches, pods per plant and test weight owing to early and enhanced vegetative growth and eventually more fruiting points. Similar results were also reported by Pundarikaushudu *et al.* (1992) and these results establish the superiority of adopting transplanting as technically sound and economically feasible, practical approach for growing pigeon pea. The less age along with more space, light, air etc. to the plant resulted in higher grain yield. The interaction effect (Table 3) revealed that seed yield and net return under 75 cm x 25 cm plant geometry with 15 days old seedling being similar to 90 cm x 20 cm spacing with 15 and 30 days old seedling and also 75 cm x 25 cm spacing with direct seeding were significantly higher than any other combinations of plant geometry and seedling age.

Table 1: Growth parameters of hybrid pigeon pea (ICPH 2671) as influenced by plant geometries and age of seedlings

Treatments	Plant height (cm)	Number of branches per plant		Plant spread East-West (cm)	Number of Pods/ plant	Pod length / plant	Seeds/ pod	100 Seed weight (g)	Days to 50% flowering	Days to 50% pod formation
		Primary	Secondary							
Plant geometry										
90 x 20 cm	168	10.32	17.81	56.89	185	5.73	4.80	10.11	132.15	139.90
75 x 25 cm	158	10.05	16.57	93.56	197	5.40	4.61	10.47	136.90	144.10
SEm±	4	0.64	1.53	5.11	6.83	0.07	0.07	0.06	0.58	0.68
CD (P=0.05)	NS	NS	NS	20.05	NS	0.26	NS	0.24	2.27	2.67
Age of seedlings										
15 days old seedling	223	14.04	23.10	104.66	212	5.80	4.73	10.79	130.80	138.80
30 days old seedling	174	10.46	17.98	85.38	197	5.60	4.72	10.37	134.30	140.30
45 days old seedling	126	8.46	13.54	47.92	166	5.32	4.68	9.75	139.30	147.90
Direct seeding	127	7.78	14.14	62.94	189	5.54	4.68	10.24	133.70	141.00
SEm±	14	1.12	1.35	9.12	9.26	0.15	0.14	0.13	0.85	0.96
CD (P=0.05)	41	3.28	3.95	26.61	27.03	NS	NS	0.37	2.49	2.81
SEm±	20	1.59	1.91	12.89	13.10	0.21	0.20	0.18	1.21	1.36
CD (P=0.05)	NS	4.64	NS	NS	NS	NS	NS	NS	3.52	3.97

Table 2: Yield and economics of hybrid pigeon pea (ICPH 2671) as influenced by plant geometries and age of seedlings

Treatments	Yield/ ha (Tons)	Gross return (□/ha)	Net return (□/ha)	B:C
Plant geometry				
90 x 20 cm	2.40	132240	103610	3.62
75 x 25 cm	2.64	145336	115425	3.87
SEm±	0.09	4786	4786	0.16
CD (P=0.05)	NS	NS	NS	NS
Age of seedlings				
15 days old seedling	2.94	161652	131613	4.38
30 days old seedling	2.60	143004	112965	3.77
45 days old seedling	2.08	114154	84115	2.80
Direct seeding	2.48	136343	109378	4.05
SEm±	0.14	7840	7840	0.27
CD (P=0.05)	0.42	22879	22879	0.80
SEm±	0.20	11087	11087	0.39
CD (P=0.05)	NS	NS	NS	NS

Table 3: Interaction effect of plant geometries and age of seedlings

Plant geometry	Age of seedlings							
	15 days old seedling		30 days old seedling		45 days old seedling		Direct seeding	
	Yield (t/ha)	Net return (□/ha)	Yield (t/ha)	Net return (□/ha)	Yield (t/ha)	Net return (□/ha)	Yield (t/ha)	Net return (□/ha)
90x20	2.72	120041	2.69	118636	1.99	80037	2.22	80037
75x25	3.16	143186	2.51	107294	2.16	88194	2.74	88194

	Yield	Net return
SEm±	0.20	11087
CD (P=0.05)	0.59	32356

Conclusion

It can be inferred from the above findings that transplanting of 15 days old seedling of pigeon pea with spacing of 75 cm x 25 cm is more beneficial for higher productivity and profitability of pigeon pea.

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