A-5978
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RESEARCH ARTICLE Indian Journal of Agricultural Research, Volume Issue : ()

Response of Super Early Varieties of Pigeonpea to Crop Geometry under Rainfed Conditions

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10.18805/IJARe.A-5978

ABSTRACT

Background: In Sri Potti Sriramulu Nellore district of Andhra Pradesh long duration varieties of pigeonpea (160-180 days) is grown during *rabi* under rainfed conditions. Late or advancement of north east monsoon, prolonged breaks and early cessation of rainfall may have devastating effects on pigeonpea yield in rainfed areas of Sri Potti Sriramulu Nellore district, Andhra Pradesh even if the mean annual rainfall is normal. In this context, there is a need for introduction of suitable super early varieties of pigeonpea which are ideal even under changing climatic situations, with suitable crop geometry to enhance the yields of pigeonpea.

Methods: A field experiment was conducted during *rabi*, 2018-19 and 2019-20 at Agricultural Research Station, Podalakur, Sri Potti Sriramulu Nellore andhra Pradesh, to find out the suitable super early variety of pigeonpea and their response to different crop geometries. The present field experiment was laid out in a split plot design with 4 varieties of pigeonpea (V_1: ICPL 20338; V_2: ICPL 20325; V_3: ICPL 11255; V_4: LRG 52) as main plot treatments and 3 crop geometries (S_1: 30 cm × 15 cm; S_2: 45 cm × 15 cm); S_3: 60 cm × 15 cm) as subplot treatments and replicated thrice.

Result: Super early variety ICPL- 20325 recorded the highest mean grain yield (1098 kg ha^{-1}) among the four varieties of pigeonpea tested. Among the three crop geometries tested significantly the highest grain yield (930 kg ha^{-1}) was recorded at 45 cm × 15 cm. Super early varieties ICPL- 20325 (1256 kg ha^{-1}), ICPL- 11255 (930 kg ha^{-1}) and ICPL- 20338 (817 kg ha^{-1}) recorded higher mean grain yield at crop geometry of 45 cm × 15 cm. LRG-52 (996 kg ha^{-1}) variety recorded higher grain yield at crop geometry of 60 cm × 15 cm.

Key words: Crop geometry, Net returns, Pigeonpea, Super early varieties.

INTRODUCTION

Sri Potti Sriramulu Nellore district of Andhra Pradesh is mainly influenced by north-east monsoon and *rabi* is the main cropping season. A late or advancement of north east monsoon, prolonged breaks and early cessation of monsoon may have devastating effects on agriculture in rainfed areas of Sri Potti Sriramulu Nellore district, even if the mean annual rainfall is normal. However, this early cessation of rainfall, leads to terminal moisture stress in long duration crops like pigeonpea [*Cajanus cajan* (L.) Millsp.] at critical stages, which resulted in the lower productivity of pigeonpea.

Pigeonpea is the second most important pulse crop of India after chickpea. In India, it is grown over an area of 48.24 lakh hectares with a production of 38.8 lakh tones and the productivity is 804 kg ha^{-1}. During the period, traditional long-duration types (more than 180 days) have been continually replaced by short (120-140 days) and medium duration (160-180 days) varieties to escape terminal moisture stress in the changing climate scenario. Due to ever increasing pressure on land there is need for intensification of cropping systems in a sustainable way. The indirect impact of these improved super early varieties (85-100 days) has been on the enhancement of overall cropping intensity.

The medium and long duration varieties of pigeonpea have long vegetative growth phase (120-160 days) mainly attributed to slow initial growth (Saxena, 2008). This leads to poor productivity and less efficient utilization of land and other resources. In this context, there is a need for photo insensitive super early varieties of pigeonpea which are ideal for sowing round the year and to escape terminal moisture stress even under changing climatic situations.

Choice of a suitable geometry for a particular genotype is one of the important factors among the different agronomic practices limiting the yield of pigeonpea. Adaptation of proper planting geometry to a particular genotype will go a long way in making efficient use of limited growth resources and thus to stabilize yield. Super early varieties of pigeonpea having determinate and indeterminate growth habits respond very well to crop geometry. Keeping this in view we prosed to study the performance of different pigeonpea varieties and to find out optimum spacing for these varieties for *rabi* season under rainfed conditions of coastal region.

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How to cite this article: Sujathamma, P., Nedunchezhiyan, M. and Naik, B.S.K. (2022). Response of Super Early Varieties of Pigeonpea to Crop Geometry under Rainfed Conditions. Indian Journal of Agricultural Research. DOI: 10.18805/IJARe.A-5978.

Submitted: 04-03-2022 **Accepted:** 21-06-2022 **Online:** 13-07-2022

MATERIALS AND METHODS

Experimental site and soil information

The experiment was conducted during *rabi*, 2018-19 and 2019-20 at Agricultural Research Station, Podalakur (14°22′N latitude, 79°44′E longitude and 43m above mean sea-level), Sri Potti Sriramulu Nellore district Andhra Pradesh. The climatic condition of Sothern zone is sub-tropical influenced by north-east monsoon. The soils are clay loam in texture, porous and grayish black having pH of 8.48, EC of 0.229 dSm^{-1}, organic carbon 0.3%, available nitrogen 201 kg ha^{-1}, available phosphorus 46 kg ha^{-1} and available potassium 225 kg ha^{-1}.

Experimental design and treatment combination

The present field experiment was laid out in a split plot design with 4 varieties of pigeonpea (V_1: ICPL 20338 (days to maturity 85 days, determinate growth); V_2: ICPL 20325 (days to maturity 97 days, indeterminate growth); V_3: ICPL 11255 (days to maturity 85 days, determinate growth) ; V_4: LRG 52 (days to maturity 150 days, indeterminate growth)as main plot treatments and 3 crop geometries S_1: 30 cm × 15 cm; S_2: (45 cm × 15 cm); S_3: (60 cm × 15 cm) as sub plot treatments in three replications.

Crop management

Sowings were performed on 06-10-2018 and 09-10-2019 during 2018-19 and 2019-20, respectively. The recommended dose of fertilizer @ 20 kg N and 50 kg P_2O_5 per hectare were applied as basal at the time of sowing uniformly in all the treatments. Nitrogen and phosphorus were applied in the form of Urea and Single Super Phosphate, respectively. The total rainfall of 290.3 mm was received in 10 rainy days during 2018-19 and 449.7 mm was received in 26 rainy days during 2019-20. Hand weeding was done twice at 21 and 43 days after sowing. Need based plant protection measures were taken up.

Plant sampling

Five random plant samples were collected from each plot (25.92 m^2) at the time of harvesting for recording observations on plant height, no. of branches per plant yield attributing characters and grain as well as stalk yields were recorded per plot. Harvest Index and net returns were calculated from this data.

Statistical analysis

Experimental data collected was subjected to statistical analysis by adopting Fishers method of analysis of variance (ANOVA) as outlined by Gomez and Gomez (1984), Critical Difference (CD) as calculated wherever the 'F' test was found significant at 5 per cent level.

RESULTS AND DISCUSSION

The data on plant height, number of branches plant^{-1}, number of pods per plant, pod length, 100 seed weight and grain yield, along with the stalk yield of pigeonpea as influenced by varieties, crop geometry and their interaction during the course of investigation are critically interpreted and results are presented below.

Effect of variety on growth, yield parameters, yield and economics of pigeonpea

In both the years the plant height recorded at harvest were significantly influenced by varieties. Among the four varieties tested significantly the highest plant height was recorded with LRG-52 in both the years (Table 1). This might be due its indeterminate growth habit of LRG 52 compared to determinate growth habit of super early varieties. The lowest plant height was recorded with ICPL 20338, but which was at par with ICPL 11255.

The number of branches plant^{-1} was significantly influenced by varieties in both the years, significantly the highest number of branches per plant was recorded with LRG 52. Among the three super early varieties, ICPL-20325 produced the more number of branches plant^{-1}. More number of branches plant^{-1}might be due to the indeterminate nature of these genotypes.

Number of pods plant^{-1}and pod length were significantly influenced by varieties in both the years, ICPL- 20325 was recorded significantly the highest number of pods plant^{-1} and highest pod length (Table 2). The highest number of pods per plant might be due to genetic nature of the variety and availability at bud initiation and grain filling stages. Similar observations have also been reported by Kashyap *et al.* (2003), Tickle and Gupta (2006) and Birendra *et al.* (2017). The100 grainweight was significantly influenced by varieties, among the four varieties LRG 52 recorded the highest test weight, this might be due to its long duration and genetic nature of the variety.

In both the years as well as mean grain yield was significantly influenced by varieties (Table 3), the highest grain yield was recorded with ICPL- 20325 (1098 kg ha^{-1}). ICPL- 20325 (V_2) variety could escape moisture stress at pod filling stage as it is extra early duration variety (97 days), while, LRG 52 couldn't as it is of 150 days duration variety. Similar results were reported by Ramanjaneyulu *et al*. (2017). Among the super early varieties the higher grain yield of ICPL- 20325 might be due to high genetic yield potential, which was reflected through higher values of certain growth and yield attributes of this genotypes and their cumulative effect on yields. The genetical differences in seed yields were might be partially due to genetical efficiency of the genotype to convert biological yield into economic yield. These results were in conformity with the findings of Singh *et al.* (2014). Check variety LRG 52 recorded the lowest pod yield due to moisture stress coincides with grain filling, which is the critical period for moisture stress.

Harvest index in both the years was significantly influenced by varieties, the highest was recorded with ICPL- 11255, but which was statistically on par with ICPL- 20338 during 2018-19 and which was also on par with ICPL- 20325 during 2019-20. This might be due to less vegetative growth of super early varieties (determinate growth habit) compared

Table 1: Growth and yield parameters of pigeonpea influenced by varieties and crop geometry during 2018-19 and 2019-20.

Treatment	Plant height (cm) at harvest		Mean number of branches plant^{-1}		Number of pods plant^{-1}		Pod length (cm)	
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
Varieties								
ICPL- 20338	45.9	58.7	10.9	13.5	58.3	65.0	5.04	5.11
ICPL- 20325	91.8	120.5	11.2	13.7	79.7	109.6	6.22	5.46
ICPL- 11255	47.9	59.0	10.1	12.9	73.4	77.8	5.40	5.29
LRG- 52	143.1	171.2	20.8	22.4	68.1	94.9	5.26	5.34
S.E (m) ±	3.76	1.51	0.57	0.27	2.55	4.79	0.10	0.041
CD (0.05)	13.3	5.3	2.0	1.0	9.0	16.9	0.35	0.15
Crop geometry								
30 cm × 15 cm	83.8	103.8	12.5	14.2	67.9	81.3	5.44	5.25
45 cm × 15 cm	83.1	101.0	13.4	15.9	73.9	89.2	5.46	5.33
60 cm × 15 cm	79.7	102.2	14.0	16.8	67.9	89.9	5.54	5.33
S.E (m) ±	1.93	2.0	0.3	0.24	1.75	2.37	0.067	0.081
CD (0.05)	N.S.	N.S.	1.04	0.7	5.3	7.2	N.S.	N.S.
Interaction								
CD (0.05)	N.S.	N.S.	N.S.	N.S.	Significant	Significant	N.S.	N.S.

Table 2: No. of pods/plant of pigeonpea as influenced by interaction of different varieties and crop geometry.

Varieties/ Spacing	ICPL- 20338		ICPL- 20325		ICPL- 11255		LRG- 52	
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
30 cm × 15 cm	62.9	58.9	74.9	98.0	75.2	81.5	58.5	86.8
45 cm × 15 cm	59.2	67.3	94.3	125.3	74.3	70.0	67.7	94.4
60 cm × 15 cm	52.7	68.8	70.1	105.7	70.6	81.8	78.1	103.5
Mean	58.3	65.0	79.7	109.6	73.4	77.8	68.1	94.9

	S.E (m) ±		CD (0.05)	
	2018-19	2019-20	2018-19	2019-20
Crop geometry at the same varieties	4.42	8.3	11..4	15.8
Varieties at the same level spacing	3.83	6.16	12.4	20.5

Table 3: Yield parameters and yield of pigeonpea as influenced by varieties and crop geometry during 2018-19 and 2019-20.

Treatment	100 grain wt. (g)		Grain yield (kg ha^{-1})			Harvest index		Net returns (Rs. ha^{-1})	
	2018-19	2019-20	2018-19	2019-20	Mean	2018-19	2019-20	2018-19	2019-20
Varieties									
ICPL- 20338	8.4	8.8	835	596	715	0.393	0.353	27770	12952
ICPL- 20325	8.6	7.8	987	1208	1098	0.317	0.350	36701	50292
ICPL- 11255	8.3	7.4	869	624	746	0.413	0.354	29444	14688
LRG- 52	9.4	10.0	888	881	885	0.287	0.146	30612	30622
S.E (m) ±	0.12	0.07	13.03	23.55	14.7	0.01	0.014	-	-
CD (0.05)	0.43	0.24	46.0	83.1	51.9	0.034	0.048	-	-
Crop geometry									
30 cm × 15 cm	8.9	8.55	885	779	832	0.283	0.275	30428	24298
45 cm × 15 cm	9.1	8.49	936	924	930	0.317	0.312	33564	33288
60 cm × 15 cm	9.0	8.48	864	778	821	0.323	0.316	29136	24236
S.E (m) ±	0.09	0.086	9.24	33.9	16.4	0.009	0.007	-	-
CD (0.05)	N.S.	N.S.	27.9	102.6	49.5	0.027	0.020	-	-
Interaction									
CD (0.05)	N.S.	N.S.	Significant	Significant	Significant	N.S.	N.S.	-	-

to check variety LRG-52. The check variety LRG-52 recorded the lowest harvest index. Among the varieties ICPL- 20325 recorded the higher net returns.

Effect of crop geometry on growth, yield parameters, yield and economics of pigeonpea

Crop geometry didn't have any significant influence on the plant height. The number of branches plant^{-1} was significantly influenced by crop geometry and found superior at 60 cm × 15 cm (Table 1) as compared to other. The more number of branches per plant in wider spacing might be due to better growth of plant because of optimum resources available to individual plant and their maximum utilization throughout the growth period. Pod length was not significantly influenced by crop geometry.

Among the crop geometries, the highest number of pods plant^{-1} with 45 cm × 15 cm during 2018-19 and with 60 cm × 15 cm during 2019-20, but which was on par with 45 cm × 15 cm (Table 1). In contrast, lower values of pods/ plant were observed from closer spacing. 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 attributes than closely spaced plants.

The results presented in Table 3 revealed that 100 seed weight was not significantly influenced by the crop geometry and the finding was in accordance with that of Islam *et al*. (2008) and Parameswari *et al*. (2003). In both the years as well as mean grain yield of pigeonpea was significantly influenced by crop geometry, significantly the highest grain yield was recorded at 45 cm × 15 cm (Table 3). This might be due to higher number of pods per plant at 45 cm × 15 cm and optimum plant population compared to 30 cm × 15 cm and 60 cm × 15 cm. These findings are in conformity with the observations of Ammaiyappan *et al*. (2021).

In both the years of testing, harvest index was significantly influenced by crop geometry, the highest harvest index was recorded with 60 cm × 15 cm, but which was on par with 45 cm × 15 cm in both the years. Higher net returns were recorded with crop geometry of 45 cm × 15 cm.

Interaction effect of varieties and crop geometry on growth, yield parameters and yield of pigeonpea

Interaction between varieties and crop geometry didn't have any significant influence on the plant height, number of branches plant^{-1} and pod length (Table 1) as well as on 100 grain weight (Table 3) in both the years. Interaction had a significant influence on number of pods plant^{-1}in both the years. ICPL 20325 at crop geometry of 45 cm × 15 cm recorded the highest number of pods per plant. LRG 52 at 60 cm × 15 cm recorded the more number of pods per plant. Interaction between varieties and crop geometry has a significant influence on grain yield of both the years (Table 4) as well as on mean grain yield (Table 5). Pigeonpea varieties ICPL- 20325 and ICPL- 11255 recorded higher grain yield at crop geometry of 45 cm × 15 cm. ICPL- 20338 at crop geometry of 45 cm × 15 cm recorded higher grain yield during 2019-20 (Table 4) and mean grain yield (Table 5). LRG-52 variety recorded higher grain yield at crop geometry of 60 cm × 15 cm.

In both the years, harvest index was not significantly influenced by interaction effect. Higher net returns were recorded with ICPL- 20325 at 45 cm × 15 cm.

Table 4: Grain yield of (kg ha^{-1}) pigeonpea as influenced by interaction of different varieties and crop geometry.

Varieties/	ICPL- 20338		ICPL- 20325		ICPL- 11255		LRG- 52	
Spacing	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
30 cm × 15 cm	869	564	986	1196	881	611	804	744
45 cm × 15 cm	853	675	1071	1440	931	704	890	877
60 cm × 15 cm	784	547	904	988	796	556	970	1022
Mean	835	596	987	1208	869	624	888	881

	S.E (m) ±		CD (0.05)	
	2018-19	2019-20	2018-19	2019-20
Crop geometry at the same varieties	22.57	40.8	59.87	210.4
Varieties at the same level spacing	19.94	60.2	64.58	186.7

Table 5: Mean grain yield (kg ha^{-1}) of pigeonpea as influenced by interaction of different varieties and crop geometry.

Varieties/ Spacing	ICPL- 20338	ICPL- 20325	ICPL- 11255	LRG- 52	Mean
30 cm × 15 cm	716	1091	746	774	832
45 cm × 15 cm	930	1256	817	884	972
60 cm × 15 cm	665	946	676	996	821
Mean	715	1098	746	885	

	S.E (m) ±	CD (0.05)
Crop geometry at the same varieties	25.5	102.7
Varieties at the same level spacing	30.5	95.7

CONCLUSION

The present investigation revealed that, the yield and monetary advantages were higher in ICPL- 20325, which indicated that for *rabi* season under rainfed conditions of coastal region, an early maturing indeterminate variety was more profitable than super early and late maturing varieties. Crop geometry of 45 cm × 15 cm was found optimum for super early and early maturing varieties (ICPL- 20325, ICPL-11255 and ICPL- 20338), whereas late maturing variety (LRG-52) 60 cm × 15 cm was found optimum for *rabi* season under rainfed conditions of coastal region.

Conflict of interest: None.

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