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RESEARCH ARTICLE :

Effect of plant spacing on different genotype of pigeonpea [*Cajanus cajan* (L.) Millisp]

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SUMMARY : A field investigation entitled "Effect of plant spacing on different genotype of pigeonpea [*Cajanus cajan* (L.) Millisp] was conducted during *Kharif* 2013-14 at experimental farm Department of Agronomy, College of Agriculture, Vasantrao Naik Marathwada KrishiVidyapeeth, Parbhani, to study effect of spacing on the growth and yield of pigeonpea, to evaluate performance of genotype of pigeonpea on different spacings. The experiment was conducted in split plot design with four spacings *i.e.* S_1 – 60 x 30 cm , S_2 – 90 x 20 cm, S_3- 120 x 15 cm, and S_4- 60 x 60 – 120 cm in main plot and three genotypes G_1-BSMR-853, G_2-MUTANT(M)-853 and G_3-BDN-711 in sub plots with twelve treatment combinations. It can be concluded that, the spacing of 120 x 15 cm (2341 kg ha^{-1}) and 60 x 60 – 120 cm (2237 kg ha^{-1}) were found highly productive as compared to 90 x 20 cm, 60 x 30 cm. Among the genotypes of pigeonpea BDN-711 (2119 kg ha^{-1}), found significantly higher over BSMR-853, however it was at par with MUTANT (M)-853 (2000 kg ha^{-1}).

KEY WORDS :
Genotype, Spacing, Pigeonpea, Yield

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BACKGROUND AND OBJECTIVES

Pigeonpea is commonly known in India as Red gram or Arhar or Tur. It is a tropical crop grown in India, predominantly, during the *Kharif* season both as a sole crop and as aintercrop, though found in wide range of Agro-Ecological situations. Its deep rooting and drought tolerant character make it as successful crop in areas of low and uncertain rainfall. The plants owes a large measure of its popularity to the fact that it possesses valuable properties as restorative of nitrogen to the soil and adds lot of organic matter to the soil and thus, pigeonpea finds a promising place in crop rotation and crop mixtures. Being a leguminous crop, plant is capable of fixing atmospheric nitrogen and there by restore nitrogen in the soil. Its deep rooting system helps in extracting the nutrient and moisture from deeper soil layers, thus, making it suitable for rainfed condition. Deeper root system of the crop also helps in breaking the plough pans and improving soil structure and hence it is called as 'Biological plough'.

Pigeonpea [*Cajanus cajan* (L.) Millsp] was cultivated in the semi-arid areas of tropics and sub tropics. It is native of Africa and the early traders have introduced the crop in India.

The ability of pigeonpea to produce economical yields under moisture deficit soil characteristics makes it an important crop of dry land agriculture. Farmer grows it an important crop using long established traditional practices.Pigeonpea grain contains 23.3 per cent protein, 35 per cent minerals, 57.6 per cent carbohydrates and provides 335 kcw energy/100 g (Anonymous, 1981). The primary objective of pigeonpea cultivation has been to meet surplus of grains as such there was not much increase in production and productivity of pigeonpea. India accounts for 90 per cent of the pigeonpea area and production of the world, which is grown on an area of 3.47 m ha with production of 2.46 million tones and productivity of 711 kg ha^{-1}. Distributed in states Maharashtra, Uttar Pradesh, Madhya Pradesh, Gujarat, Andhra Pradesh, Karnataka and Tamil Nadu. It is grown on 10.93 lakh ha with production of 9.19 lakh tonnes and productivity 841 kg ha^{-1} (Anonymous, 2010).

The pigeonpea yield is limited by number of factors such as agronomic, pathogenic, entomological, genetic factors and their interaction with environment. Among the different agronomic practices limiting the yield *viz*., choice of a suitable geometry (plant spacing), optimum population, high yielding genotype etc. are the most important factors. Seed yield is product of plant populations and the single plant yield. Maximum yield in a particular cultivars and environment can be obtained at the density where competition between the plants is low. This will be attained at an optimum plant density, which not only utilizes light, moisture and nutrients more efficiently but also avoids excessive competition among the plants.

Considering the above point, it was felt essential to find out the "Effect of plant spacing on different genotype of pigeonpea [*Cajanus cajan* (L.) Millisp]." Accordingly, a field experiment was conducted during *Kharif* 2013-2014 at experimental farm, Department of Agronomy, VNMKVParbhani.

RESOURCES AND METHODS

The experiment was laid out in field plot A-4 at Experimental Farm of Agronomy Department, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during *Kharif* season of 2013.The topography of experimental plot was fairly levelled. The soil of experimental black in colour, high retentive of moisture, deep and fairly well drained, clayey in texture, medium in organic carbon, poor in nitrogen, medium in available phosphorus, high in potash and slightly alkaline in reaction. Agro climatically Parbhani situated at latitude, longitude and altitude of, 19^0 16' N, $76^0$47'E and 409 m above M.S.L (Mean Sea Level), respectively. Parbhani comes under tropical climate. The average annual precipitation of last 35 years was 960.7 mm. July is wetted month of the year covering about 27.4 per cent of annual rainfall. The precipitation is assured for *Kharif*season and for sowing *Rabi* crops. Most of the rainfall is received from South West monsoon. The mean Maximum temperature varied from 29.9^0C in second and third week of December, 42.6^0C during middle May and the mean minimum temperature varied from 11.4^0C to 25.4^0C during last week of December and May, respectively. The total precipitation received during crop growth period in 2013-14 was 1172.6 mm with 56 rainy days. The experiment was laid out in split plot design where in the main plot were assigned to four spacings (S_{1-}60 x 30 cm, S_2- 90 x 20 cm, S_3- 120 x 15 cm,S_4 -60 x 60 - 120 cm. (Paired row)and subplots to three genotypes (G_1-BSMR-853,G_2 -MUTANT(M)-853,G_3 -BDN-711) these twelve treatment combinations were replicated thrice. The treatments were allotted randomly to each replication. The gross plot size was 7.2 m x 5.4 m. Sowing was done by dibbling with 2 seed per hill on 21 June 2013 object of dibbling was to maintain fairly uniform plant population in each row. The seeds were treated with thirum 80 WP @ 3 g / kg seed for controlling seed borne diseases.The fertilizer application was also done at the time of sowing @25:50:00 kg NPK ha^{-1}.

Biometric observations and plant characters as an indicator of crop growth viz., plant height, number of leaves, leaf area, number of branches, and total dry matter per selected plant from net plot were recorded at 30 days interval from 30 days onwards till to harvest of the crop. The post harvest biometric observation of yield attributes and yield was taken after the harvesting of crop. The harvest index was calculated by the following formula

$$\text{Harvest index} = \frac{\text{Economical yield}}{\text{Biological yield}} \times 100$$

OBSERVATIONS AND ANALYSIS

The results obtained from the present study as well as discussions have been summarized under following heads and Table 1 to 4:

Effect of plant spacing's :

The plant height was significantly more under 120 x 15 cm at all growth stages except at 30 DAS where it was found non significant. It was observed that the former spacing was at par with 90 x 20 cm and 60 x 60 - 120 cm at 60 and 150 DAS, respectively. This might due to the sunlight, moisture and nutrients might be readily available to the plant which promotes to increased height. Parmeswari *et al.*(2003) also supported the above findings. The wider row spacing 120 x 15 recorded significantly more number of functional leaves and leaf area as compared to rest of the row spacing however, it

Table 1 : Growth attributes of pigeonpea as influenced by different treatments

Treatments	Plant height (cm)	No. of functional leaves	leaf area (dm^2)	Primary branches plant^{-1}	Secondary branches plant^{-1}	Total dry matter (g)
Spacing (S)						
S_1 : 60 x 30 cm	166.49	267.67	44.96	3.44	12.31	316.3
S_2 : 90 x 20 cm	168.91	270.94	46.00	3.62	12.58	320.7
S_3 : 120 x 15 cm	170.67	273.17	47.79	4.15	13.36	331.2
S_4 : 60 x 60 -120 cm	170.58	273.32	46.90	3.80	12.83	322.2
S.E. ±	0.65	0.74	0.55	0.11	0.44	2.39
C.D. (P=0.05)	1.94	2.19	1.63	0.31	0.87	7.09
Genotypes (G)						
G_1- G_1-BSMR-853	167.40	266.72	45.08	3.18	12.83	316.3
G_2-MUTANT(M)-853	169.96	274.48	46.77	3.88	12.97	324.4
G_3-BDN-711	170.13	272.63	47.38	4.21	13.01	327.1
S.E. ±	0.79	1.73	0.61	0.20	0.33	1.18
C.D. (P=0.05)	2.36	5.13	1.80	0.60	0.92	3.48
Interaction (S x G)						
S.E. ±	1.58	3.45	1.21	0.40	0.66	2.34
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS
General mean	169.13	271.27	46.41	3.75	13.26	322.6

NS=Non-significant

Table 2 : Yield attributes of pigeonpea as influenced by different treatments

Treatments	No. of pods plant^{-1}	No. of seeds pod^{-1}	Seed weight pod^{-1}(g)	No. of seeds plant^{-1}	Seed weight plant^{-1} (g)	100 seed weight (g)
Spacing (S)						
S_1 : 60x30 cm	300.56	3.10	0.43	1034.39	104.20	10.18
S_2 : 90x20 cm	312.11	3.41	0.44	1073.89	107.56	10.08
S_3 : 120x15 cm	340.00	4.00	0.50	1189.89	117.22	11.13
S_4 : 60x60-120 cm	333.89	3.64	0.46	1174.22	113.67	10.50
S.E. ±	5.75	0.15	0.01	25.31	2.38	0.23
C.D. (P=0.05)	17.07	0.43	0.04	75.09	7.07	NS
Genotypes (G)						
G_1- G_1-BSMR-853	312.98	3.21	0.41	1100.83	108.74	10.41
G_2-MUTANT(M)-853	319.50	3.53	0.46	1112.21	109.74	10.45
G_3- BDN-711	332.00	3.88	0.49	1141.25	113.50	10.50
S.E. ±	4.07	0.13	0.02	10.77	1.27	0.23
C.D. (P=0.05)	12.07	0.39	0.05	31.97	3.78	N.S
Interaction (S x G)						
S.E. ±	8.13	0.26	0.036	21.54	2.54	0.45
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS
General mean	321.63	3.53	0.45	1118.09	110.66	10.47

NS=Non-significant

was at par with 60 x 60 - 120 cm at all crop growth stages. Shaik (1997) also observed the similar results, because canopy was more under wider row spacing. Primary and secondary branches were more at 120 x 15 cm spacing than rest of the spacings, it might be due to wider row spacing (Ahuja, 1984). The dry matter accumulation plant^{-1} found increasing with increasing row spacing, at 120 cm row spacing higher dry matter accumulation was observed. Dry matter accumulation was less with 60 cm row spacing as compared to the row spacing of 120 and 90 cm. Increase in dry matter with increase in row spacing may be the combined

Table 3 : Mean seed yield, stalk yield, Bhoosa yield, biological yield and harvest index of pigeonpea as influenced by different treatments

Treatments	Seed yield (kg ha^{-1})	Stalk yield (kg ha^{-1})	Bhoosa yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)
Spacing (S)					
S_1 : 60x30 cm	1569	4472	777	6812	22.88
S_2 : 90x20 cm	1698	4640	838	7173	23.67
S_3 : 120x15 cm	2341	6617	1011	9810	23.86
S_4 : 60x60-120 cm	2237	6500	881	9614	23.22
S.E. ±	73	196	27	249	61
C.D. (P=0.05)	218	582	80	738	NS
Genotypes (G)					
G_1- BSMR-853	1766	5440	839	8014	22.04
G_2-MUTANT(M)-853	2000	5532	879	8286	24.14
G_3- BDN-711	2119	5701	912	8758	24.20
S.E. ±	55	62	19	81	0.71
C.D. (P=0.05)	163	184	56	240	2.10
Interaction (S x G)					
S.E. ±	109	123	37	161	2.41
C.D. (P=0.05)	NS	NS	NS	NS	NS
General mean	1961	5557	876	8352	23.40

NS=Non-significant

Table: 4 Gross monetary returns, net monetary returns and B:C ratio of pigeonpea as influenced by different treatments

Treatments	Gross Monetary returns (Rs. ha^{-1})	Net Monetary returns (Rs. ha^{-1})	B:C ratio
Spacing (S)			
S_1 : 60 x 30 cm	63039	38872	2.60
S_2 : 90 x 20 cm	68125	43821	2.86
S_3 : 120 x 15 cm	93935	65934	3.50
S_4 : 60 x 60 - 120 cm	89823	63210	3.26
S.E. ±	2857	2441	-
C.D. (P=0.05)	8476	7243	-
Genotypes (G)			
G_1-BSMR-853	71114	45759	2.93
G_2-MUTANT(M)-853	78939	52204	3.16
G_3-BDN-711	86139	60914	3.24
S.E. ±	2105	2157	-
C.D. (P=0.05)	6246	6401	-
Interaction (S x G)			
S.E. ±	4211	4315	-
C.D. (P=0.05)	NS	NS	-
General mean	78731	52959	3.07

NS=Non-significant

beneficial effects of more photosynthetic surface for longer duration due to better availability of space, light and nutrients. Similar result observed by Puste (1988).

Effect of genotype :

The plant height was significantly more under BDN-711, but it was comparable with MUTANT(M)-853. Similarly, mean number of functional leaves plant^{-1}were found significantly higher under BDN-711 as compared to other genotypes and it was at par with MUTANT(M)-853 at all crop growth stages except 60 DAS.BDN-711 produces significantly more leaf area plant^{-1}than BSMR-853 at all crop growth stages except at 60 and 120 DAS. Where, it was at par with MUTANT(M)-853, because it may be the genetical characteristics of the genotypes. The primary and secondary branches were more with BDN-711 genotype as compared to MUTANT(M)-853 and BSMR-853. It has profuse branching habit, hence the number of branches under former genotype. BDN-711 produced maximum dry matter which was comparable with MUTANT(M)-853. The dry matter plant^{-1} was more in these two genotypes due to more number of branches, functional leaves and pods.

Yield attributes :

Effect of plant spacing's :

Numbers of pods plant^{-1} found to be increased with every increase in inter row spacing from 90 to 120 cm. This might be due to more space and nutrients available to individual plant at wider spacing compared to narrow spacing. Similar effects due to increase in row spacing were noted by Dubey and Upadhayaya (1991). Substantial number of seeds pod^{-1} was observed by increasing row spacing.An average seed weight pod^{-1} was 0.45 g and statistically it was higher with 120 x 15 cm spacing because numbers of seeds pod^{-1} were higher under this treatment Manjhi *et al.* (1973).The number of seeds and seed weight plant^{-1}were 1118.09 and 110.66 g, respectively. It was more with 120 x 15 cm spacing than rest of the spacings. It might be the contribution of more number of branches plant^{-1} ultimately seed weight plant^{-1} increased (Halli, 2001).The 100 seed weight of pigeonpea was increased in wider row spacing but not influenced significantly.

Effect of genotype :

Among the genotypes, BDN-711 observed to be superior in producing number of pods plant^{-1}.The number of seeds pod^{-1} and seed weight pod^{-1} was also higher in BDN-711 which was comparable with MUTANT(M)-853. It might be due to high capacity to convert photosynthetic into grain in the genotypes.The number of seeds and seed weight plant^{-1} was also higher in BDN-711 and MUTANT-853 than BSMR-853 because of more branches in these genotypes.This might be attributed to the genetic character of this genotype.Genotype BDN-711 was superior to genotypes MUTANT (M)-853 and BSMR-853 in producing bolder seeds but seed index not influenced significantly due to different genotype.

Yield :

Effect of plant spacing's :

The higher seed yield, stalk yield, bhoosa yield and biological yield ha^{-1} was obtained at 120 x 15 cm spacing which was remarkably more than closer row spacing of 60 cm and 90 cm. In this study most of the growth and yield attributes observed to be lower under closer row spacing. The low yield plant^{-1} under closer spacing may be due to less availability of space under dense plant population suppressing individual plant growth. However, result in yield ha^{-1} from wider spacing was higher due to collective effect of different yield attributing characters. (Antaravalli *et al.*, 2002). Harvest index does not influence significantly due to different plant spacing's.

Effect of genotype :

Genotype BDN-711 produced beyond doubt higher seed yield, stalk yield, bhoosa yield and biological yield ha^{-1} as compared to genotypes MUTANT(M)-853 and BSMR-853. The high yield of genotype BDN-711 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. Harvest index does not influence significantly due to different genotype.

Economics :

Effect of plant spacing's :

The gross and net monetary returns was significantly higher (Rs. 93935 and Rs. 65994, respectively) under 120 x 15 cm spacings as compared to other spacings, but statistically it was at par with 60 x 60 – 120 cm. The wider row spacing recorded the highest seed yield than closer row spacing, which is converted in to higher gross and net monetary returns (Karle and Pawar, 1998). Similarly higher benefit: cost ratio was also recorded under 120 x 15 cm plant spacings.

Effect of genotype :

Significantly the higher gross (Rs. 86139) and net monetary returns (Rs. 60914) was observed under BDN-711 followed by MUTANT(M)-853 (Rs. 78939, Rs. 52204 and 3.16, respectively). This might be due to higher seed yield under these genotypes. Higher benefit: cost ratio was also recorded by BDN-11 over rest of genotype

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