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Productivity and Morpho-phenological Characters of Pigeonpea [*Cajanus cajan* (L.) Millsp.] as Influenced by Crop Geometry and Nipping Practice

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ABSTRACT

Background: One of the possible agronomic ways for increasing productivity of pigeonpea is adoption of suitable crop geometry with nipping practices for getting suitable crop architecture for optimum utilization of resources. This investigation was planned to study the influence of crop geometry and nipping practices on production potential of pigeonpea.

Methods: The field experiment was conducted at experimental farm of the Department of Pulses, TNAU, Coimbatore, during *kharif* season of 2021 and 2022. The experiment was laid out in split plot design with each four main and sub plot treatments. The main plot treatments comprised of four crop geometries while thesub plot treatments were nipping practices which includes no nipping, mechanical nipping and chemical nipping.

Result: Various crop geometries shown remarkable effect on growth and development of pigeonpea. The crop geometry of 90 cm × 30 cm and 90 cm × 45 cm recorded maximum plant height of pigeonpea as compared to other wider crop geometries. While in case of all the other growth attributes *viz*. number of functional leaves per plant, leaf area, number of branches per plant and dry matter accumulation per plant crop geometry of 120 cm × 45 cm and 120 cm × 30 cm were found superior as compared to othertreatments and were at par with each other. The yield per hectare was increased at wider crop geometry 120 cm 45 cm as the higher per plant yield was compensated by lesser plant population. The crop geometry 120 cm × 45 cm produced significantly higher seed yield (1187, 1275 and 1231 kg ha^{-1} during 2021, 2022 and pooled mean respectively) over crop geometry of 90 cm × 30 cm and crop geometry 90 cm × 45 cm, but it was found at par with crop geometry 120 cm × 30 cm. Among the nipping practices, growth characters *viz*., plant height, number of functional leaves, leaf area, number of branches and dry matter accumulation per plant as well as phenological characters were enhanced with the foliar application of chlormequat chloride @500 ppm during both the years of study. Foliar application of chlormequat chloride @ 500 ppm also recorded significantly highest seed yield (1152, 1237and 1195 kg ha^{-1} during 2021, 2022 and in pooled data, respectively), while it was at par with foliar application of mepiquat chloride @ 500 ppm.

Key words: Chemical nipping, Crop geometry, Nipping, Pigeonpea.

INTRODUCTION

Pigeonpea [*Cajanus cajan* (L.) Millsp.] is an important protein-rich annual pulse crop, grown throughout the tropical and sub-tropical regions of the world. It is a deep-rooted legume crop, well known for its drought tolerance under *Kharif* rainfed upland ecosystem (Emefiene *et al.*, 2013). Among the different crop management techniques, suitable crop geometry for a particular genotype is one of the major factors to decide the optimum population which leads to the final yield of pigeonpea. The architecture of pigeonpea genotypes varies widely.

In pigeon pea, the vegetative and reproductive stages occur concurrently; as a result, the vegetative and reproductive sinks are always competing for available assimilates. PGRs have thus been characterized as the agriculturist's most effective component for increasing crop yields. Plant hormones are compounds that, when given in minute quantities stimulate or restrict natural plant development (Kumar, 2001). It improves photo- assimilation and the source-sink relationship and thus increases the photosynthetic capacity of the plant, which is helpful in increasing productivity and thus leads to higher crop yield (Amanullah *et al.,* 2010). The foliar application of nutrients at critical stages of crop growth is the most appropriate and accurate method of correcting nutrient deficiencies and helps to achieve maximum potential yield of the crop and ultimately sufficient plant nutrition is absolutely essential for improving

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productivity (Thakur *et al.*, 2017). Microclimate coupled with physiological process may include internal hormonal imbalance and may result in abscission of flowers and immature pods and drastic reduction in yield of pigeonpea. Plant growth regulators have the capacity to stimulate and inhibit physiological processes, which directly or indirectly might affect crop yield and quality. The plant growth regulators are also known to enhance the source sink relationship and stimulate the translocation of photo assimilates, thereby increase the productivity.

MATERIALS AND METHODS

Field research experiments were conducted at farm of Department of Pulses, Tamil Nadu Agricultural University, Coimbatore during *kharif* season of 2021 and 2022. The experiment was laid out in split plot design with three replications. Treatments consisted of sixteen combinations comprising four crop geometry in main plot and nipping methods in sub plot. Crop geometry adopted in main plot were 120 cm × 45 cm, 120 cm × 30 cm, 90 cm × 45 cm and 90 cm × 30 cm whiles sub plot treatments were mechanical nipping, foliar application of mepiquat chloride @ 500 ppm, Chlormequate chloride @ 500 ppm and control (No nipping). Periodical observations on growth and yield contributing characters of pigeonpea along with the yield data were recorded during harvesting stage by following Sadasivam and Manickam (1996). The data collected for the various study parameters were statistically analysed using the analysis of variance (ANOVA) method for split-plot design. The 5% least significant difference was used to calculate the significance of the treatments (Gomez and Gomez, 1984). Data on seed yield and straw yield were further subjected to calculations on harvest index and economic analysis.

RESULTS AND DISCUSSION

The data on morpho-phonological parameters *viz*. number of functional leaves per plant, leaf area, number of branches per plant and dry matter accumulation per plant, along with the seed yield of pigeonpea as influenced by crop geometry and nipping practice during the course of investigation are critically analysed and results are presented below.

Effect of crop geometry on growth, phenological parameters, yield and net returns of pigeonpea

Various crop geometries shown remarkable effect on growth of pigeonpea. The crop geometry of 90 cm × 45 cm and 90 cm × 30 cm recorded maximum plant height of pigeonpea as compared to other wider crop geometries (Table 1). While in case of all the other growth attributes *viz*. number of functional leaves per plant, leaf area and number of branches per plant, dry matter accumulation per plant, crop geometry of 120 cm × 45 cm and 120 cm × 30 cm were found superior as compared to other. The crop geometry of 120 cm × 45 cm and 120 cm × 30 cm were at par with each other, this might be due to better availability of growth factors like moisture, space *etc.* for enhanced development of individual plant. Similar results were obtained by Waghmare *et al.* (2016). Maximum mean dry matter production per plant of pigeonpea was recorded with crop geometry of 120 cm × 45 cm , it was

Table 1: Mean plant height (cm), number of functional leaves plant^{-1}, leaf area plant^{-1} (cm^2), number of branches plant^{-1}, dry matter accumulation plant^{-1} (g) of pigeonpea as influenced by different treatments during 2021 and 2022.

Treatment	Plant height (cm)		No of functional leaves per plant		Leaf area (cm ^{2} per plant)		Mean number of branches per plant		Dry matter accumulation per plant (g)	
	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
Main plot (crop geometry)										
M_1- 90 × 30 cm	212.84	225.32	226.0	213.8	1329	1435	21.7	23.0	125.6	118.8
M_2- 90 × 45 cm	203.38	217.18	237.3	225.1	1492	1611	24.3	25.7	131.9	125.0
M_3- 120 × 30 cm	193.48	198.65	252.1	237.7	2015	2176	26.9	28.5	140.1	132.0
M_4- 120 × 45 cm	187.35	190.34	268.3	241.1	2126	2296	29.2	31.0	149.1	134.0
S.E.(m)±	1.58	1.75	5.35	3.18	53.93	64.42	0.84	1.00	3.42	3.58
CD at 5%	6.00	6.89	20.05	12.02	154.24	184.23	2.41	2.87	9.78	10.24
Sub plot (Nipping method)										
S_1- Mechanical nipping	187.45	192.41	223.9	217.5	1708	1845	24.7	26.2	124.4	120.8
S_2- Mepiquat chloride	197.72	204.17	236.3	241.7	1820	1965	25.8	27.4	131.3	134.3
S_3- Chlormequat chloride	195.45	201.74	252.8	245.7	1852	2000	28.6	30.3	140.4	136.5
S_4- Control (No nipping)	214.50	221.32	216.5	213.8	1582	1709	22.9	24.2	118.3	112.8
S.E.(m)±	1.67	1.89	7.82	3.21	36.51	39.41	0.62	0.75	1.35	1.49
CD at 5%	4.48	5.42	27.50	11.50	104.41	112.72	1.76	2.14	3.86	4.25
M × S interaction										
S.E.(m)±	4.51	5.63	20.67	27.50	75.42	84.37	1.05	1.87	4.37	5.14
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	12.50	14.70

at par with crop geometry of 120 cm × 30 cm and significantly superior over crop geometry of 90 cm × 45 cm and 90 cm × 30 cm. The increased dry matter accumulation per plant of pigeonpea plants at wider spacing may be attributed to less competition between plants and greater availability of growth resources for each plant which might have increased production and accumulation of photosynthates resulting in more dry matter accumulation. The above findings are in line with those reported by Pavan *et al.* (2011) and Sujatha *et al.* (2018). The mean duration for flower initiation and 50% flowering of pigeonpea was delayed during 2022 as compared to during 2021 (Table 2). The flower initiation and 50% flowering of pigeonpea were earlier in crop geometry 90 cm × 30 cm and 90 cm × 45 cm as compared to crop geometry of 120 cm × 30 cm and 120 × 45cm.

Different crop geometries had significant influence on the seed yield of pigeonpea. The crop geometry 120 cm × 45 cm produced significantly higher seed yield (1231 kg ha^{-1}) as well as net returns over crop geometry of 90 cm × 30 cm and 90 cm × 45 cm, but it was found at par with crop geometry 120 cm × 30 cm. The percent increase in seed yield of pigeonpea recorded with crop geometry 120 cm × 45 cm (M_4) over crop geometry of 90 cm × 45 cm (M_2) and 90 × 30 (M_1) was 19 and 26 per cent, respectively on pooled basis. The probable reason behind this increase in the seed yield at wider crop geometry as compared to closermight be that, the wider spacing showed higher values of attributes per plant like seed weight per plant, pods per plant and higher per plant yield. At wider spacing, reduction of plant population per unit area was compensated by higher per plant yield.Also planting with crop geometry of 120 cm × 30 cm (M_3) helped in optimum and efficient utilization of the available resources and ultimately enhanced the yield.

Effect of nipping practice on morpho-phenological parameters yield and net returns of pigeonpea

Different nipping practices showed a remarkable influence on various growth attributes of pigeonpea (Table 1). Growth characters *viz.*, number of functional leaves, leaf area and dry matter accumulation per plant were enhanced with the foliar application of chlormequat chloride @ 500 ppm and application of mepiquat chloride @ 500 ppm during both the years and was significantly higher than control (No nipping) and mechanical nipping practice. Decrease in plant height of pigeonpea sprayed with mepiqaut chloride might be due to the interference in gibberellic acid biosynthetic pathway as the reduced amount of gibberellins in the plant system affects the growth and decrease plant height. These results correlates with the findings of Kshirsagar *et al.* (2008) and Kashid *et al.* (2010) who reported decrease in plant height with foliar application of mepiquat chloride and cycocel treated plants. Among the nipping practices, chemical nipping with foliar application of chlormequat chloride @ 500 ppm and foliar application of mepiqaut chloride@ 500 ppm recorded numerically higher values of chlorophyll content over other treatments. The data presented in Table 3 indicated that the foliar application of chlormequat chloride @ 500 ppm recorded higher seed yield as well net returns (Table 3) and was at par with foliar application of mepiquat chloride @ 500 ppm and significantly superior over other treatments, during both the years of experimentation and in pooled analysis. The magnitude of increase in seed yield recorded under the foliar application of chlormequat chloride @ 500 ppm (S_3) over mechanical nipping and control (S_1) on pooled basis was 21 per cent and 12.9 per cent respectively. The maximum yield recorded

Table 2: Days to flower initiation and days to 50% flowering of pigeonpea as influenced by different treatments during 2021 and 2022.

Treatment	Days to flower initiation		Days to 50% flowering	
	2021	2022	2021	2022
Main plot (crop geometry)				
M_1- 90 × 30 cm	131.47	128.42	146.85	152.26
M_2- 90 × 45 cm	132.57	129.87	148.28	153.17
M_3- 120 × 30 cm	134.42	132.14	150.24	155.62
M_4- 120 × 45 cm	135.62	133.98	150.36	155.24
S.E.(m)±	0.33	0.30	0.53	0.62
CD at 5%	0.96	0.86	1.52	1.77
Sub plot - Nipping method				
S_1- Mechanical nipping	132.45	136.85	150.45	155.85
S_2- Mepiquat chloride	134.65	138.24	152.65	157.24
S_3- Chlormequat chloride	134.48	138.12	152.48	157.12
S_4- Control (No nipping)	135.24	137.25	153.24	156.25
S.E.(m)±	0.286	0.35	0.89	0.98
CD at 5%	0.82	0.98	NS	NS
M × S interaction				
S.E.(m)±	1.20	1.15	1.07	1.24
CD at 5%	NS	NS	NS	NS

Table 3: Seed yield (kg ha^{-1}), harvest index and net returns (Rs. ha^{-1}) of pigeonpea as influenced by different treatments during 2021, 2022 and pooled mean.

Treatment	Seed yield (kg /ha)			Harvest index			Net return (Rs./ha)		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
Main plot (crop geometry)									
M_1- 90 × 30 cm	944	1007	976	22.10	18.89	20.50	51921	55373	53647
M_2 - 90 × 45 cm	1001	1071	1036	23.12	20.26	21.69	55039	58880	56960
M_3- 120 × 30 cm	1099	1170	1135	26.30	22.68	24.49	60422	64364	62393
M_4- 120 × 45 cm	1187	1275	1231	28.25	23.89	26.07	65299	70151	67725
S.E.(m)±	28.18	35.46	31.37	0.33	0.48	0.5	-	-	-
CD at 5%	80.61	101.42	89.72	0.94	1.37	1.43	-	-	-
Sub plot- Nipping method									
S_1- Mechanical nipping	1022	1094	1058	24.05	20.30	22.18	56221	60179	58200
S_2- Mepiquat chloride	1106	1175	1141	25.48	22.38	23.93	60818	64632	62725
S_3- Chlormequat chloride	1152	1237	1195	26.79	23.16	24.98	63353	68049	65701
S_4- Control (No nipping)	951	1017	984	23.46	19.88	21.67	52289	55908	54099
S.E.(m)±	29.72	67.62	50.68	0.34	0.48	0.58	-	-	-
CD at 5%	85.01	193.39	144.94	0.97	1.37	1.66	-	-	-
M × S interaction									
S.E.(m)±	32.10	73.03	54.73	0.37	0.52	0.63	-	-	-
CD at 5%	91.81	208.86	156.54	1.05	1.48	1.79	-	-	-

Table 4: Interaction effect of crop geometry and nipping practice on seed yield (kg /ha) and net returns (Rs. /ha) of pigeonpea in pooled analysis.

Treatments	S_1- mechanical nipping	S_2- mepiquat chloride	S_3- chlormequat chloride	S_4- control	Mean	S_1- mechanical nipping	S_2- mepiquat chloride	S_3- chlormequat chloride	S_4- control	Mean
M_1- 90 × 30 cm	917	1038	1071	876	975	50436	57081	58893	48176	53647
M_2- 90 × 45 cm	985	1092	1154	911	1036	54198	60071	63476	50092	56959
M_3- 120 × 30 cm	1108	1178	1215	1037	1134	60954	64777	66818	57024	62393
M_4- 120 × 45 cm	1222	1254	1338	1111	1231	67210	68973	73616	61102	67725
Mean	1058	1140	1195	984		58200	62725	65701	54098	

by chlormequat chloride might be due to better vegetative growth, enhanced pod number, pod weight and seed yield per plant. These results are in line with findings reported by Kashyap *et al.* (2002), Ramesh and Ramprasad (2013) and Sumathi *et al.* (2016).

Interaction effect

It was observed that interaction between crop geometry 120 cm × 45 cm (M_4) with foliar application of chlormequat chloride @ 500 ppm (S_3) recorded higher seed yield and net returns, (Table 4) it was at par with interaction between crop geometry 120 cm × 45 cm (M_4) with foliar application of mepiquat chloride @ 500 ppm (S_2).

CONCLUSION

Based on the two years findings of present investigation, it can be concluded that, crop geometry of 120 cm × 45 cm for pigeonpea was found to be productive and remunerative, as compared to other crop geometries. While among the different nipping practices, chemical nipping with foliar application of chlormepiquate chloride@ 500 ppm (01 spray at bud initiation stage) was found to be beneficial in improving morpho-phenological parameters along with chlorophyll content, early flower initiation, seed yield and net returns of pigeonpea, as compared to other nipping practices.

Conflict of interest: None.

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