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Effect of spacing and nipping on growth, yield attributes and yield of Pigeonpea (*Cajanus cajan* (L.) Millsp.)

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Abstract
The experimental study entitled "Effect of spacing and nipping on growth, yield attributes and yield of pigeonpea (*Cajanus cajan* L. Millsp.)" was performed out at the Research farm of Barrister Thakur Chhedilal College of Agriculture and Research Station, Bilaspur (C.G.) during *kharif* 2021-22. The experiment was carried in clayey loam type of soil and was sown on 17th July 2021 in Randomized complete block design with two factors namely spacing (Three spacings: (S_1) 40cm x 20 cm, (S_2) 60 cm x 20 cm, (S_3) 80 cm x 20 cm) and nipping (Three stages: (N_1) No nipping, (N_2) Nipping at 30 DAS, (N_3) Nipping at 30 DAS and 60 DAS) with nine treatment combinations. Each experimental unit was replicated thrice with gross plot size of 4.8 m x 4 m and net plot size of 4 m x 3.6 m for 40 cm x 20 cm spacing, 3.6 m x 3.6 m for 60 cm x 20 cm spacing, 3.2 m x 3.6 m for 80 cm x 20 cm respectively. Among the growth parameters, significantly higher plant height was seen in (S_1) 40 cm x 20 cm while number of primary and secondary branches were seen in the spacing (S_3) 80 cm x 20 cm, however in nipping, highest plant height was seen in the nipping treatment (N_1) no nipping, and maximum number of primary branches and secondary branches were discovered in nipping at 30 DAS and 60 DAS (N_3). Eventually with yield attributes, the highest number of pods plant^{-1}, number of grains pod^{-1}, 1000 grain weight gave best result in the spacing (S_3) 80 cm x 20 cm although in nipping, they were maximum in (N_3) Nipping at 30 DAS and 60 DAS. Similarly, higher grain yield, gross returns, net returns and B:C ratio were found in spacing (S_3) 80 cm x 20 cm and least was observed in the spacing (S_1) 40 cm x 20 cm and in nipping at 30 DAS and 60 DAS (N_3) as compared to no nipping (N_1).

Keywords: Spacing, nipping, yield, B:C ratio

Introduction
Pulses are an important part of the vegetarian diet in India. They preserve soil fertility through biological nitrogen fixation and improve soil organic matter by defoliation at maturity stage. As a result, pulses are widely used in various cropping system and crop mixtures and play an important role in promoting sustainable agriculture. Pigeonpea (*Cajanus cajan* L.) is the world's fifth most popular grain legume and India's second important pulse crop after chickpea (Narendra *et al*., 2013) [5]. In the tropics and subtropics, it is a major multi-functional pulse legume crop and are an important source of protein for vegetarians in India as they provide necessary amino acids, vitamins and minerals to supplement the diet's staple grains. It has a protein content of 22-24%, which is comparable to that of other grain legumes and is nearly twice that of wheat and thrice that of rice. Pigeonpea total area, production and productivity are roughly 4.54 million ha, 3.83 million tonnes and 842 kg ha^{-1} respectively, at the global level in 2019-20 (4th Advance estimates, Directorate of Economics and Statistics). Currently (2019-20), total area under pulses in India is 28.34 million hectares with a production of 23.15 million tones and yield of 817 kg ha^{-1}. In Chhattisgarh as of 2020-2021, the area for pigeonpea growth is about 119.3 thousand ha and productivity of about 601 kg ha^{-1}.

Pigeonpea, also known as red gram, arhar and tur is the most important *kharif* grain legume crop. Some important elements that inhibit pigeonpea production are adoption of an inappropriate geometry (plant spacing), optimum population, irrigation facilities, fertilizers and other agronomic practices.

Pigeonpea requires a certain amount of moisture and an ideal temperature particularly during their pod development stage. However, the crop's productivity is extremely low. One method of enhancing its productivity is intensive cultivation with the right crop geometry.

Pigeonpea reacts well to spacing due to its photo-sensitivity, high branching and indeterminate growth habit. To achieve maximum yield, it is essential to maintain optimum plant population for effective use of moisture, nutrients and solar radiation.

Nipping is an important agronomic measure that reduces apical dominance, increases the number of branches, increases % pod set, improves the source-sink relationship and increases plant production thus involving removing of the tendrils. These tendrils operate as a sink in the plant, inhibiting photosynthate transfer to the reproductive parts of the plant. It has been discovered that nipping tendrils increases the number of branches and pods plant^{-1}. (Arjun Sharma *et al.* 2001) [1]. As a result, nipping and plant density are closely related and must be standardized.

Hence, keeping this above facts in view an experiment was laid out to study-

1. The effect of spacing on growth, yield attributes and yield of pigeonpea
2. The effect of nipping on growth, yield attributes and yield of pigeonpea
3. To workout the economics under study.

Materials and Methods

An experiment entitled "Effect of spacing and nipping on growth, yield attributes and yield of pigeonpea" variety 'Rajeev lochan' was conducted at the research farm of Barrister Thakur Chhedilal College of Agriculture and Research Station, Bilaspur (C.G.). The topography of the experimental site was leveled and the soil was clayey loam, well drained with poor nitrogen content and medium availability of phosphorous and potassium. The maximum and minimum temperature recorded during the crop growth period were (33.3 °C and 6.4 °C), relative humidity ranged between 84.6% - 96% and rainfall (841.06 mm). The crop was sown on 17th July and the recommended dose of fertilizer was 20:50:20 NPK kg ha^{-1}.

The experiment was laid out in Randomized complete block design with two factors namely spacing (Three spacings: (S_1) 40cm x 20 cm, (S_2) 60 cm x 20 cm, (S_3) 80 cm x 20 cm) and nipping (Three stages: (N_1) No nipping, (N_2) Nipping at 30 DAS, (N_3) Nipping at 30 DAS and 60 DAS) with nine treatment combinations. Each experimental unit was replicated thrice with gross plot size of 4.8 m x 4 m and net plot size of 4 m x 3.6 m for 40 cm x 20 cm spacing, 3.6 m x 3.6 m for 60 cm x 20 cm spacing, 3.2 m x 3.6 m for 80 cm x 20 cm respectively.

Observations on growth parameters, *viz*., plant height, number of primary branches and secondary branches were taken at crop growth stage and yield attributes were calculated. Grain yield, stover yield and harvest index were taken at harvest, calculated and analyzed as per statistical procedure described by Panse and Sukhatme (1985) [6]. Economics of the treatment combinations including gross return, net return and B:C ratio were calculated and compared for economic feasibility.

Results and Discussion

Plant Height

Spacing influenced the plant height of pigeonpea significantly at different growth stages. Among the growth parameters, significantly higher plant height (146.11 cm), was seen in the spacing (S_1) 40 cm x 20 cm at followed by (S_2) 60 cm x 20 cm and least was recorded in (S_3) 80 cm x 20 cm, however in nipping, highest plant height (144.89 cm) was seen in the nipping treatment (N_1) no nipping. Similar outcomes were observed by Singh and Singh (1992) [7] in pea which stated that nipping at 60, 75, 90 DAS and at harvest affected the plant height at different stages of plant growth which clearly indicated that the energy which was provisionally used by the plant was diverted towards branching and higher pod formation.

Number of primary and secondary branches

Number of primary branches showed significant variation due to both varying spacing and nipping. Maximum number of primary branches (17.59) were recorded in the spacing (S_3) 80 cm x 20 cm followed by (S_2) and least was recorded in (S_1) and in nipping number of primary branches (18.42) were found maximum with nipping at 30 DAS and 60 DAS (N_3) followed by (N_2) and minimum in no nipping (N_1) treatment.

Number of secondary branches also showed significant effect due to different spacing and nipping. Maximum number of secondary branches were recorded in the spacing (S_3) 80 cm x 20 cm (25.56) followed by (S_2) and least was recorded in (S_1) and in nipping number of secondary branches (25.72) were found maximum with nipping at 30 DAS and 60 DAS (N_3) followed by (N_2) and minimum in no nipping (N_1) treatment. Similar findings were made by Srinivasan and Srinivasa Raju (1997) [9], who also noted that there were more branches on each plant with wider spacings. Additionally, as the apical dominance is reduced, the plant tends to make modifications to promote the formation of auxiliary buds that may develop into branches. Arjun *et al*. found comparable result with pigeonpea (2003). Due to the successful translocation of growth regulators, particularly auxins, to the potential and tertiary shoot buds that normally remain dormant, nipping led to the formation of more total branches and promotes the stop of vertical growth.

Yield Attributes

Various yield attributes of pigeonpea were taken at harvest. The number of pods plant^{-1} (139.91), number of grains pod^{-1} (5.11) and 1000 grain weight (g) (103.51) were observed in the spacing (S_3) 80 cm x 20 cm followed by (S_2) 60 cm x 20 cm and least was recorded in (S_1) 40 cm x 20 cm while in case of nipping maximum number of pods plant^{-1} (139.04), number of grains pod^{-1} (4.93) and 1000 grain weight (g) (103.70) in nipping at 30 DAS and 60 DAS (N_3) followed by nipping at 30 DAS (N_2) and least was recorded in no nipping treatment (N_1). Due to more number of primary and secondary branches plant^{-1}, there were also more pods produced plant^{-1}. The increase in pod weight and number of pods plant^{-1} contributed to the increase in grain weight plant^{-1}. The findings are consistent with those of Tripathi and Chauhan (1990) [10], Legha and Dhingra (1992) [4] and others.

Yield

Among yield, spacing (S_3) 80 cm x 20 cm recorded the highest grain yield (17.23 q ha^{-1}) and stover yield (42.41 q ha^{-1}) followed by (S_2) 60 cm x 20 cm and least was observed in (S_1) 40 cm x 20 cm. In nipping, the highest grain yield (17.36 q ha^{-1}) and stover yield (43.46 q ha^{-1}) were recorded in nipping at 30 DAS and 60 DAS (N_3) and minimum was found to be in no nipping treatment (N_1).

The harvest index was found to be non-significant in both spacing and nipping treatments. Similar conclusions were

achieved by Arjun Sharma *et al.* (2003) [1] in pigeonpea, who identified an increase in grain output as a result of a considerable decrease in plant height and an increase in the number of primary and secondary branches and pods plant^{-1}. Himayatullah *et al.* (1980) [3] and Aurangzeb *et al.* (1996) [2] also found a correlation in chickpea.

Economics

Economics for each treatment combination was computed to find out economic feasibility of the recommended practice. For spacing, the highest cost of cultivation (Rs 34167.50 ha^{-1}) was in (S_1) 40 cm x 20 cm followed by (S_2) 60 cm x 20 cm and minimum was in (S_3) 80 cm x 20 cm and higher gross returns (Rs 112086.67 ha^{-1}), net returns (Rs 78344.42 ha^{-1}) and B:C ratio (2.32) were significantly maximum in the spacing (S_3) 80 cm x 20 cm and lowest in (S_1) 40 cm x 20 cm. However, in nipping, the highest cost of cultivation (Rs 34881.25 ha^{-1}), gross returns (Rs 113692.56 ha^{-1}), net returns (Rs. 78811.31 ha^{-1}) and B:C ratio (2.26) were maximum with nipping at 30 DAS and 60 DAS (N_3) followed by nipping at 30 DAS (N_2) and minimum was without nipping (N_1).

Table 1: Effect of spacing and nipping on growth attributes of pigeonpea

Treatments		Plant height (cm)	Number of primary branches	Number of secondary branches
S_1	40cm x 20cm	146.11	14.86	20.31
S_2	60cm x 20cm	131.33	16.06	23.02
S_3	80cm x 20cm	117.33	17.59	25.56
S.Em±		4.38	0.56	0.80
C.D. (0.05)		13.12	1.69	.41
N_1	No Nipping	144.89	13.44	20.24
N_2	Nipping at 30 DAS	131.33	16.64	22.93
S.Em±		4.38	0.56	0.80
CD. (0.05)		13.12	1.69	2.41

Table 2: Effect of spacing and nipping on yield attributes of pigeonpea

Treatments		Yield attributes		
		Number of pods plant^{-1}	Number of grains pod^{-1}	1000 grain weight (g)
Spacing				
S_1	40cm x 20cm	110.63	4.22	94.23
S_2	60cm x 20cm	124.37	4.65	99.13
S_3	80cm x 20cm	139.91	5.11	103.51
S.Em±		4.29	0.15	1.36
C.D. (0.05)		12.86	0.43	4.09
Nipping				
N_1	No Nipping	110.67	4.44	94.57
N_2	Nipping at 30 DAS	125.19	4.61	98.59
N_3	Nipping at 30 DAS and 60 DAS	139.04	4.93	103.70
S.Em±		4.29	0.15	1.36
C.D. (0.05)		12.86	NS	4.09

Table 3: Effect of spacing and nipping on yields of pigeonpea

Treatments		Yields		
		Grain yield (quintal ha^{-1})	Stover yield`(quintal ha^{-1})	Harvest index (%)
Spacing				
S_1	40cm x 20cm	13.04	35.38	26.90
S_2	60cm x 20cm	15.14	39.75	27.48
S_3	80cm x 20cm	17.23	42.41	28.77
S.Em±		0.65	1.36	0.72
C.D.(0.05)		1.96	4.08	NS
Nipping				
N_1	No Nipping	12.80	34.88	26.73
N_2	Nipping at 30 DAS	15.26	39.20	27.94
N_3	Nipping at 30 DAS and 60 DAS	17.36	43.46	28.48
S.Em±		0.65	1.36	0.72
C.D.(0.05)		1.96	4.08	NS

Table 4: Effect of spacing and nipping on economics of pigeonpea

Treatments		Economics			
		Gross return (Rs./ha)	Cost (Rs./ha)	Net return (Rs./ha)	B:C ratio
Spacing					
S_1	40cm x 20cm	86414.33	34167.50	52246.83	1.52
S_2	60cm x 20cm	99377.89	33884.00	65493.89	1.93
S_3	80cm x 20cm	112086.67	33742.25	78344.42	2.32
Nipping					
N_1	No Nipping	84107.00	32981.25	51125.75	1.55
N_2	Nipping at 30 DAS	100079.33	33931.25	66148.08	1.95
N_3	Nipping at 30 DAS and 60 DAS	113692.56	34881.25	78811.31	2.26

Conclusion

In terms of spacing, the spacing (S_3) 80 cm x 20 cm produced the highest grain yield, net profitable returns and B:C ratio compared to the spacing (S_2) 60 cm x 20 cm and spacing (S_3) 40 cm x 20 cm. When growth, yield attributes, yield and B:C ratio of pigeonpea were considered, the pigeonpea nipping at 30 DAS and 60 DAS (N_3) were most efficient and profitable for obtaining high returns.

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