



## Effect of plant growth regulators on reproductive efficiency and seed yield of pigeonpea (*Cajanus cajan* L.)

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**Abstract:** A field experiment was conducted during kharif season of 2006-07 and 2007-08 to study the effect of plant growth regulators on reproductive efficiency and seed yield in pigeonpea. Two pigeonpea genotypes (Bahar and PDA-87-3E), indeterminate type and long duration were sprayed with 3 concentrations of a growth retardant, 10 days prior to flowering followed by a spray of 3 concentration of a growth promoter at 50 per cent flowering stage. There were two control treatments as no spray and water spray. Significant increase in number of flowers produced per plant, number of pods per plant, pod setting percent and 100- seed weight was observed due to growth regulator treatments. There was reduction in number of flowers shed per plant and flower drop per cent due to growth regulators. CCC (4000 ppm): NAA (40 ppm) showed the minimum number of flowers shed per plant and percent flower drop but CCC (4000 ppm): NAA (20 ppm) showed the maximum number of pods per plant. Seed yield on per plant and Kg per ha basis and harvest index showed significant increase due to growth regulator treatment with CCC (4000 ppm): NAA (20 ppm) giving the best results.

**Key words:** CCC, Flower drop, NAA, Pigeonpea, Plant growth regulators, Pod drop, Seed yield

### Introduction

Pigeonpea is the second largest pulse crop of India accounting for 18.2% of the total pulse production (17.29 m t) during 2010-11. Flower production in pulses in general, and in pigeonpea in particular is profuse but only a limited number of pods are set (Setter *et al.*, 1984). Physical removal of flowers and young pods stimulate flower production but has no effects on final yield (Grover *et al.*, 1985). Singh and Singh (2000) reported that the total number of flower drop per plant was greater in indeterminate than in determinate genotypes. It has been pointed out that pods per plant is strongly related with assimilation during early pod growth (Thirathon *et al.*, 1987) but Deshpande and Nimbarkar (1982) and Setter *et al.* (1984) have reported diversion of carbon assimilation during pod growth to stem and other vegetative organs. There is a great deal of experimental evidence in the literature showing that endogenous growth substances are involved in many processes which lead to growth and development. Plants have also been shown to respond to exogenous application of plant growth regulators. Plant growth regulators (PGR's) are known to improve physiological efficiency including photosynthetic ability of plants and offer a significant role in realizing higher crop yields. The PGR's are also known to enhance the source-sink relationship and stimulate the translocation of photo-assimilates, thereby increasing the productivity. Keeping in view of the above facts a field experiment with two indeterminate pigeonpea genotypes involving foliar spray of growth retardant was planned at maximal leaf area development stage to check dry matter partitioning for vegetative organs and

increase translocation of dry matter to pods. Growth promoter spray was planned at flowering stage to check flower drop. The effect of plant growth regulators on reproductive efficiency and seed yield of pigeonpea was studied.

### Materials and Methods

The field experiments were conducted during two consecutive years in Kharif seasons of 2006-07 and 2007-08 at Agricultural Research Farm, Institute of Agricultural Sciences, B.H.U., Varanasi. The N, P, K contents in the soil of experimental field was 228.0, 17.0 and 180.0 Kg/ha, respectively with the pH of 7.3. Two pigeonpea genotypes (Bahar and PDA-87-3E) and eleven growth regulator treatments [control (no spray), water spray and combinations of three concentration of CCC and three concentration of NAA] were evaluated in a randomized complete block design (RCBD) with three replications. CCC was sprayed 10 days before flowering, whereas, NAA was sprayed at flowering stage. Recommended dose of fertilizers (27.5:62.5:30:: N: P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O kg /ha) was applied at the time of sowing. Seeds were sown on July 30, 2006 and July 25, 2007 in 60 cm rows apart keeping plant to plant distance at 20 cm. (Aslam *et al.*, 2008). The total rainfall during the crop period in 2006-07 and 2007-08 was 393.6 and 410.8 mm, respectively. Flowers shed per plant was calculated by spreading a polythene sheet in central rows of each plot covering an area of four plants, counted and averaged to obtain number of flowers shed per plant. The flowers dropped were collected and counted at 5 days interval from the onset of first flowering and upto 60 days (Aslam *et al.*, 2010). The per cent flower drop was taken as the

**Table-1:** Reproductive efficiency of pigeonpea as influenced as by plant growth regulator treatments (Mean of 5 plants and expressed on plant<sup>-1</sup> basis)

Treatments	Number of flowers produced plant <sup>-1</sup>		Number of flowers shed plant <sup>-1</sup>		Flower drop (%)		Pod setting (%)	
	Bahar	PDA-87-3E	Bahar	PDA-87-3E	Bahar	PDA-87-3E	Bahar	PDA-87-3E
CCC(2000 ppm):NAA(20 ppm)	752.67	641.00	309.33	313.67	41.13	48.93	43.1	41.9
CCC(2000 ppm):NAA(30 ppm)	746.00	638.00	305.33	305.00	40.92	48.01	44.5	42.4
CCC(2000 ppm):NAA(40 ppm)	755.67	644.33	292.67	303.33	38.69	47.04	45.1	42.1
CCC(3000 ppm):NAA(20 ppm)	758.67	650.33	270.33	279.00	35.63	42.93	45.9	43.4
CCC(3000 ppm):NAA(30 ppm)	764.00	653.67	262.33	275.00	34.30	42.09	46.0	43.5
CCC(3000 ppm):NAA(40 ppm)	767.67	658.33	253.33	258.67	33.02	39.32	46.1	43.5
CCC(4000 ppm):NAA(20 ppm)	785.33	661.33	242.33	255.33	30.89	38.66	47.0	47.8
CCC(4000 ppm):NAA(30 ppm)	794.67	664.33	223.67	235.00	28.17	35.38	46.8	47.2
CCC(4000 ppm):NAA(40 ppm)	784.00	659.00	219.33	229.00	27.96	34.76	47.0	47.2
Water Spray	735.33	635.00	355.33	388.67	48.38	61.25	42.8	41.0
No Spray	726.00	633.67	372.33	396.00	51.10	62.68	42.1	40.2
<b>For Comparing</b>	<b>SEm±</b>	<b>C.D. at 5%</b>	<b>SEm±</b>	<b>C.D. at 5%</b>	<b>SEm±</b>	<b>C.D. at 5%</b>	<b>SEm±</b>	<b>C.D. at 5%</b>
Genotypes (G)	4.75	13.63	4.77	NS	0.68	1.96	0.3	0.9
Treatments (T)	1.14	31.96	11.19	32.11	1.60	4.59	0.7	2.0
Interaction (G×T)	15.76	NS	15.83	NS	2.26	NS	1.0	NS

**Table-2:** Seed yield and its components of pigeonpea as influenced by plant growth regulators

Treatments	Number of pods plant <sup>-1</sup>		Number of seeds plant <sup>-1</sup>		100-seed weight		Seed yield (g plant <sup>-1</sup> )	
	Bahar	PDA-87-3E	Bahar	PDA-87-3E	Bahar	PDA-87-3E	Bahar	PDA-87-3E
CCC(2000 ppm):NAA(20 ppm)	324.0	268.3	3.70	3.31	7.31	7.15	87.6	63.5
CCC(2000 ppm):NAA(30 ppm)	332.0	269.7	3.65	3.33	7.35	7.18	89.2	64.5
CCC(2000 ppm):NAA(40 ppm)	340.7	271.0	3.66	3.35	7.36	7.20	91.8	65.4
CCC(3000 ppm):NAA(20 ppm)	348.3	281.7	3.67	3.48	7.47	7.29	95.5	71.4
CCC(3000 ppm):NAA(30 ppm)	351.3	283.3	3.67	3.49	7.47	7.32	96.3	72.3
CCC(3000 ppm):NAA(40 ppm)	353.3	286.0	3.67	3.51	7.52	7.32	97.6	73.5
CCC(4000 ppm):NAA(20 ppm)	368.3	316.0	3.76	3.44	7.65	7.47	105.3	81.2
CCC(4000 ppm):NAA(30 ppm)	372.0	313.3	3.69	3.42	7.63	7.40	104.6	79.3
CCC(4000 ppm):NAA(40 ppm)	368.0	310.7	3.75	3.44	7.60	7.37	105.0	78.7
Water Spray	314.3	260.0	3.29	3.21	7.28	7.12	75.3	59.5
No Spray	305.0	254.0	3.28	3.24	7.26	7.11	72.5	58.5
<b>For Comparing</b>	<b>SEm±</b>	<b>C.D. at 5%</b>	<b>SEm±</b>	<b>C.D. at 5%</b>	<b>SEm±</b>	<b>C.D. at 5%</b>	<b>SEm±</b>	<b>C.D. at 5%</b>
Genotypes (G)	0.7	1.9	0.01	0.04	0.01	0.02	0.2	0.6
Treatments (T)	1.6	4.4	0.03	0.09	0.02	0.05	0.5	1.5
Interaction (G×T)	2.2	6.3	0.04	0.12	0.02	NS	0.7	2.1

**Table-3:** Correlation co-efficient of reproductive characters and yield determining characters in pigeonpea subjected to plant growth regulator treatments

Parameters	2	3	4	5	6	7	8
1. Number of flowers produced plant <sup>-1</sup>	-0.36	-0.65**	0.93**	0.52*	0.80**	0.77**	0.97**
2. Number of flowers shed plant <sup>-1</sup>	-	0.94**	-0.63**	-0.88**	-0.69**	-0.80**	-0.68**
3. Flower drop (%)	-	-	-0.84**	-0.90**	-0.85**	-0.91**	-0.87**
4. Number of pods plant <sup>-1</sup>	-	-	-	0.79**	0.86**	0.93**	0.99**
5. Pod setting (%)	-	-	-	-	0.68**	0.89**	0.79**
6. Number of seeds pod <sup>-1</sup>	-	-	-	-	-	0.83**	0.92**
7. 100 seed weight	-	-	-	-	-	-	0.94**
8. Seed yield (g plant <sup>-1</sup> )	-	-	-	-	-	-	-

\*\* Correlation at 0.01 (2 tailed): r = 0.54, \* Correlation at 0.05 (2 tailed): r = 0.43

ratio of total number of flowers shed per plant to the total number of flowers produced per plant, multiplied by 100. Number of flowers formed per plant was calculated by adding the number of flowers shed per plant, number of pods formed per plant and number of pods dropped per plant. The number of pods from five randomly selected plants were counted and averaged to find the number of pods per plant. The per cent pod set was taken as the ratio of total number of pods formed per plant to the total number of flowers produced per plant multiplied by 100. Hundred seeds at random were selected from the seed yield of five harvested plants and weighed on an electronic balance to obtain 100-seed weight. The crop from 1 m<sup>2</sup> land area was harvested from each plot and the seed yield obtained was used for calculating the seed yield on per ha basis.

### Results and Discussion

**Reproductive efficiency:** The number of flowers produced per plant differed significantly due to growth regulator treatments (Table 1). There was significant increase in number of flowers produced at different CCC concentrations with maximum number of flowers at CCC (4000 ppm): NAA (30 ppm). Different NAA concentrations was not significantly found to affect number of flowers produced. The increase in number of flowers due to growth retardants can be explained, as they are known to initiate early flowering, increase dry matter production and increase number of reproductive structures. CCC (4000 ppm): (NAA 40 ppm) showed the least number of flowers shed per plant and per cent flower drop. Treatments having different concentrations of CCC, resulted in significant variation for number of flower shed per plant and per cent flower drop. Highest concentration of CCC recorded minimum number of flower shed per plant and per cent flower drop. Treatments with higher NAA concentrations reduced the number of flowers shed per plant and per cent flower drop but treatments with different NAA concentrations did not vary significantly among themselves. Growth retardants due to better availability of photoassimilates might have significantly reduced number of flower shed per plant and per cent flower drop.

**Yield and yield attributes:** There was significant increase in number of pods per plant and per cent pod set due to growth regulator treatments as compared to control. CCC (4000 ppm): NAA (20 ppm) recorded the highest number of pods per plant and per cent pod set. Number of seeds per pod, 100-seed weight and seed yield per hectare in pigeonpea genotypes also increased significantly due to growth regulator treatments (Table 2). CCC (4000 ppm): NAA (20 ppm) recorded the maximum number of seeds per pod, 100-seed weight and seed yield per hectare as compared to other treatments and control. Among the treatments, it was observed that treatments having different concentration of growth retardants varied significantly for yield and yield components and the maximum yield and yield components was attained with CCC (4000 ppm). Similar, increase in number of pods per plant, yield and yield components in other crops due to application of growth retardants have been reported by earlier workers (Mishriky *et al.*,

1990; Jeyakumar and Thangaraj, 1996; Rathore *et al.*, 1990; Chandrababu *et al.*, 1995).

**Correlation studies:** Seed yield was found to have strong positive correlation with number of flowers produced per plant, per cent pod set and yield components as influenced by plant growth regulator treatments (Table 3). Seed yield had strong negative correlation with number of flowers shed per plant and per cent flower drop. A strong negative correlation was observed between number of flowers shed per plant and per cent flower drop with all the yield components.

It is concluded that CCC (4000 ppm): NAA (20 ppm) which recorded the maximum number of pods per plant, seeds per pod, 100-seed weight and seed yield per hectare can be the best treatment for increasing productivity in pigeonpea. It is postulated that increase in yield and yield components by growth retardants could be due to more dry matter accumulation and better partitioning of photoassimilates to support more number of flowers and pods. NAA reduced the number of flowers shed per plant but did not effect yield and yield components probably because pigeonpea produces large amount of flowers which is not a limitation for yield.

### References

- Aslam, M., H.K. Ahmad, Himayatullah, M. Ayaz, E. Ahmad and M. Arshad: Effect of available soil moisture depletion levels and topping treatments on crop growth rate and total dry biomass in chickpea. *J. Agric. Res.*, **46**: 229-243 (2008).
- Aslam, M., E. Ahmad Khan, Himayatullah, M. Ayaz, H.K. Ahmad. M. Mansoor and K. Hussain: Effect of available soil moisture depletions and de-topping treatments on yield and yield components of chickpea. *Sarhad J. Agric.*, **26**: 177-186 (2010).
- Chandrababu R., Manian K., Nagarajan M. and Ramachandran T.K.: Effect of mepiquat chloride on growth and yield of groundnut. *Madras Agricultural Journal*, **82**: 229-230 (1995).
- Deshpande R. and Nimbarkar J.D.: Effect of salt stress on translocation of photosynthates in pigeonpea. *Plant and Soil*, **65**: 129-132 (1982).
- Grover A., Koundal K.R. and Sinha S.K.: Senescence of attached leaves: Regulation by developing pods. *Physiologia Plantarum*, **63**: 87-92 (1985).
- Jeyakumar P. and Thangaraj M.: Effect of mepiquat chloride on certain physiological and yield characteristics of groundnut (*Arachis hypogaea* L.). *Journal of Agronomy and Crop Science*, **176**: 159-164 (1996).
- Mishriky J.F., El-Fadaly K.A. and Badawi M.A.: Effect of gibberellic acid (GA<sub>3</sub>) and chloromequat (CCC) on growth, yield and quality of peas (*Pisum sativum* L.). *Bulletin of Faculty of Agriculture, University of Cairo*, **41**: 785-797 (1990).
- Rathore S.V.S., Kumar P., Singh D.R. and Kumar P.: Effect of intra row spacing and cycocel on the performance of seed crop of vegetable cluster bean (*Cyamopsis tetragonoloba* L. Taub). *Haryana Journal of Horticultural Sciences*, **19**: 219-221 (1990).
- Setter T.L., McDavid C.R. and Lopez F.B.: Photosynthates partitioning in pigeonpea in response to defoliation and shedding. *Crop Science*, **24**: 221-224 (1984).
- Singh I. and Singh I.: Flowering and podding behaviour in determinate and indeterminate pigeonpea genotype. *Ind. J. Agric. Res.*, **34**: 67-70 (2000).
- Thirathon A., Byth D.E., Fischer K.S. and Whiteman P.C.: Effect on sink development of changes in assimilate supply during different growth stages of short season pigeonpea. In: Food Legume Development for Asian Farming System : Proceedings of International Workshop in Pigeonpea, ES Wallis and DE Byth (Eds), Khon Kaen, Thailand, ACIAR, Canberra, Australia. p. 252 (1987).