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Effect of foliar spray of NAA (Naphthalene acaetic acid) on flower drop and seed yield of pigeonpea (*Cajanus cajan* (L.) Millsp.)

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Abstract
A field experiment was conducted at Experimental farm, Department of Agricultural Botany, VNMKV, Parbhani, during *kharif* 2020-21 to evaluate "Effect of foliar spray of NAA (Naphthalene acetic acid) on yield and flower drop of pigeonpea (*Cajanus cajan* (L.) Millsp.)" using variety BSMR-736. The experiment was laid out in randomized block design with eight treatments and three replications. The different treatments were foliar application of NAA of various concentrations *Viz.*, 10, 20, 30, 40, 50, 60, 70, 80 ppm along with one control. Spraying was done at flower initiation and 30 days after first spray. Observations on number of flower drop per plant and different yield attributing traits were recorded. Considering various concentration of NAA, T_8 (80 ppm NAA) was found more effective in decreasing number of flower drop per plant and also in increasing yield attributing traits when compared with all other treatments and control.

Keywords: pigeonpea, NAA, foliar spray, flower drop and yield attributing traits

Introduction
Pigeonpea [*Cajanus cajan* (L.) Millsp.] is an important legume and belongs to genus *Cajanus.* It is second most important pulse crop after chickpea. It is also known as arhar, redgram, tur, dal (India). It comes under family fabaceae with (2n=2x=22) diploid chromosome number. It is an often cross-pollinated (20-70%) crop. It is also known as arhar, redgram, tur, dal (India). Its drought tolerance and the ability to use residual moisture during the dry season make it an important crop.

High flower drop and pod drop in pigeonpea result in low yield of pigeonpea due to poor pod set. If checked, we can greatly enhance the yield. There will be significant increase in number of flowers produced per plant, number of pods per plant, pod setting percentage and 100-seed weight due to growth regulator treatments. With the use of growth regulators, there was reduction in flower shed per plant and flower drop percent. NAA (Naphthalene Acetic Acid) is the synthetic auxin. Auxin like NAA stimulate cell elongation, elongation of shoot, cell division, membrane permeability to water uptake and RNA synthesis. Under the influence of plant growth regulators, it maintains swelling forces against the softening of cell wall by osmotic uptake of water. They also help in direct transport of assimilates from source to sink. NAA has properties similar to naturally occurring auxin. It reduces flower drop by preventing formation of abscission layer. In a broad sense, plant growth regulators are organic compounds which play a vital role in preventing the fruit and flower drop thereby improving plant growth and yield. So an attempt has been made to reduce the number of flower drop and also to increase seed yield with foliar spray of NAA of various concentrations.

Materials and Methods
A field experiment was conducted at Experimental farm, Department of Agricultural Botany, VNMKV, Parbhani, during *kharif* 2020-21 to evaluate "Effect of foliar spray of NAA (Naphthalene acetic acid) on yield and flower drop of pigeonpea (*Cajanus cajan* (L.) Millsp.)" Using variety BSMR-736. The experiment was laid out in randomized block design with eight treatments and three replications. Gross plot size was 5.4 m x 5.5 m. Seeds were sown at the rate of 10 kg ha^{-1} by dibbling method at a spacing of 120 cm x 120 cm on 15th July 2020. Treatments comprised of T_0 (control). T_1 (10 ppm NAA), T_2 (20 ppm NAA), T_3 (30 ppm NAA), T_4 (40 ppm NAA), T_5 (50 ppm NAA), T_6 (60 ppm NAA), T_7 (70 ppm NAA) T_8 (80 ppm NAA) along with one control.

Foliar application of NAA was done at two stages i. e. at flower initiation and at 30 days after first spray. Observations on number of flower drop per plant and different yield attributing traits *viz*., number of branches per plant, leaf area, number of buds per plot, number of pods per plot, number of seeds per pod, plant total dry weight, length of pod (5 seeded, 4 seeded, 3 seeded), biological yield and harvest index were recorded.

Results and Discussion

Number of branches per plant

Data regarding number of branches plant^{-1} is presented in table 1. Significant and highest number of branches per plant was recorded in treatment T_8 (80 ppm NAA) 24.65, followed by treatment T_7 (70 ppm NAA) 23.61, and treatment T_6 (60 ppm NAA) 22.83 when compared with rest of the treatments and control. Similar results were reported by Sharief *et al.* (2017) [8], NAA level upto 60 ppm significantly increased number of branches per plant in broadbean, Gyandev *et al.* (2019) reported NAA @ 50 ppm resulted increase in number of productive branches in chickpea, Rai *et al.* (2019) [1] reported NAA @75 ppm showed maximum value for number of branches in greengram.

Leaf area (cm^2)

Data regarding leaf area (cm^2) is presented in table 1. Significant and highest leaf area was recorded in treatment T_8 (80 ppm NAA) 7235.00 cm^2, followed by treatment T_7 (70 ppm NAA) 6911.33 cm^2 and treatment T_6 (60 ppm NAA) 6887.00 cm^2 when compared with rest of the treatments and control. The results are in accordance with those reported by Selvanathan (1989), among various concentrations of NAA (10, 20, 40 ppm) under his study, NAA @ 40 ppm resulted significantly in increase in leaf area in greengram, Shruthi (2015) [9] reported that foliar application of NAA @ 40 ppm significantly increased leaf area in blackgram.

Number of buds per plot

Data regarding number of buds per plot is represented in table 1. Data ranges from (T_0) 11099.20 buds (T_8) 11986.32 buds per plot. Significant and highest number of buds per plot was recorded in treatment T_8 (80 ppm NAA) 11986.32, followed by treatment T_7 (70 ppm NAA) 11916.92 buds and T_6 (60 ppm NAA) 11839.32 buds when compared with rest of the treatments and control.

Number of flower drop per plant

Data regarding number of flower drop per plant is represented in table 1. Less number of flower drop per plant was recorded by treatment T_8 (80 ppm NAA) 250.33, followed by treatment T_7 (70 ppm NAA) 275 and treatment T_6 (60 ppm NAA) 312. It revealed that all the NAA treatments recorded less number of flower drop when compared with control. Similar results was observed by Selvanthan (1989), among various concentrations of NAA (10, 20, 40 ppm) under his study, NAA @ 40 ppm significantly resulted in decrease in flower drop by 58-70% in greengram, Sharief *et al.* (2017) [8] reported that NAA level upto 60 ppm significantly decreased number of shedding flowers in broad bean.

Number of pods per plot

Data regarding number of pods per plot is represented in table 1. Data ranges from (T_0) 5016.00 to (T_8) 8972.00 pods per plot. Significant and highest number of pods per plot was recorded in treatment T_8 (NAA @ 80 ppm) 8972.00 followed by treatment T_7 (NAA @ 70 ppm) 8552.00 pods and treatment T_6 (NAA @ 60 ppm) 8096.00 pods. All the NAA treatments have significant and positive effect on number of pods per plot when compared to control. Similar findings was observed by Selvanthan (1989) reported that among various concentrations of NAA (10, 20, 40 ppm) under his study, NAA @ 40 ppm significantly resulted in increase in pod number in greengram, Sharief *et al.* (2017) [8] reported that NAA level upto 60 ppm significantly decreased percentage of shedding pods in broad bean, Gyandev *et al.* (2017) recorded that plants sprayed with NAA 50 ppm resulted increase in number of pods per plant, Sarkar *et al.* (2017) [6] reported that there was highest number of pods per plant with use of NAA 100 ppm in mungbean.

Number of seeds per pod

Data pertaining to number of seeds per pod is presented in table 1. Significant and highest number of seeds per pod in treatment T_8 (80 ppm NAA) 4.59, followed by treatment T_7 (70 ppm NAA) 4.55 and treatment T_6 (60 ppm NAA) 4.51 when compared with rest of the treatments and control. In the present study, it revealed that all the NAA treatments had significantly increased the number of seeds per pod when compared to control. Similar findings was observed by Sharief *et al.* (2017) [8] reported that NAA level upto 60 ppm significantly increased seeds number per pod in broad bean, Shruthi *et al.* (2015) [9] reported that NAA @ 40 ppm resulted in significant increase in number of seeds per pod in blackgram, Sarkar *et al.* (2017) [6] revealed that there was highest number of seeds per pod with use of NAA 100 ppm in mungbean.

Plant total dry weight (g)

Data regarding plant total dry weight is represented in table 1. Significant and highest plant total dry weight was recorded in the treatment T_8 (80 ppm NAA) 397.47 g followed by treatment T_7 (70 ppm NAA) 394.20 g and treatment T_6 (60 ppm NAA) 383.00 g when compared to rest of the treatments and control. Similar results were reported by Sarkar *et al.* (2017) [6] and there was highest dry weight plant with use of NAA 100 ppm in mungbean, Beulan and Gautam (2020) revealed that NAA @ 40 ppm is the best treatment for obtaining highest plant dry weight.

Length of pod (5 seeded, 4 seeded, 3 seeded)

Data regarding length of pod (5 seeded, 4 seeded, 3 seeded) is represented in table 1. Significant and maximum length of pod (5 seeded, 4 seeded, 3 seeded) was recorded in the treatment T_8 (80 ppm NAA) 7.65, 6.64, 5.81, followed by treatment T_7 (70 ppm NAA) 7.62, 6.49, 5.51 and treatment T_6 (60 ppm NAA) 7.47, 6.37, 5.36 when compared with rest of the treatments and control. The results are in accordance with those reported by Sarkar *et al.* (2017) [6] and there was highest pod length with use of NAA 100 ppm in mungbean, Siddik *et al.* (2012) [10] reported that NAA 50 ppm resulted in increase in pod length in sesame.

Biological yield per plot (kg)

Data pertaining to biological yield is presented in the table 1. Significant and highest biological yield per plot was recorded in treatment T_8 (80 ppm NAA) 3.74 kg, followed by treatment

T_7 (70 ppm NAA) 3.69 kg and treatment T_6 (60 ppm NAA) 3.66 kg when compared with rest of the treatments and control. Similar findings was observed by Sarkar *et al.* (2017) [6] and there was highest biological yield per ha with use of NAA 100 ppm in mungbean, Aslam *et al.* (2010) [1] reported that with application of NAA 4.5% resulted in increase in biological yield in chickpea.

Seed yield per plot (kg)

Statistical data on seed yield per plot is represented in table 1. Significant and highest seed yield per plot was recorded in treatment T_8 (80 ppm NAA) 1.35 kg, followed by treatment T_7 (70 ppm NAA) 1.28 kg and treatment T_6 (60 ppm NAA) 1.23 kg when compared with rest of the treatments and control The results obtained in the present investigation are confirmed with findings of several workers. Sarkar *et al.* (2017) [6] reported that there was highest seed yield / ha with use of NAA 100 ppm in mungbean, Sharief *et al.* (2017) [8] reported that NAA level upto 60 ppm significantly increased seed yield per ha in broad bean, Khan *et al.* (2013) [4] recorded that there was increase in seed yield with use of NAA @ 100 ppm in okra, Prasad *et al.* (2013) [5] reported that among various concentrations of NAA (25, 50, 75 and 100 ppm) under study, there was maximum yield with the use of NAA @ 100 ppm in tomato.

Harvest index (%)

Data pertaining to harvest index is presented in the table 1. Significant and maximum harvest index was recorded in treatment T_8 (80 ppm NAA) 36.00, followed by treatment T_7 (70 ppm NAA) 34.69 and treatment T_6 (60 ppm NAA) 33.48 as compared to rest of the treatments and control. Similar findings were reported by Sarkar *et al.* (2017) [6] and there was highest harvest index with use of NAA 100 ppm in mungbean.

Table 1: Effect of foliar spray of NAA on number of flower drop per plant and yield attributing traits

Treatments	Number of branches/ plant	Leaf area (cm^2)	Number of buds per plot	Number of flower drop per plant	Number of pods per plot	Number of seeds per pod	Plant total dry weight (g)	Length of pod (5 seeded, 4 seeded, 3 seeded)			Biological yield per plot (kg)	Seed yield per plot (kg)	Harvest index (%)
								5 seeded	4 seeded	3 seeded			
T_0 (Control)	17.99	5322.33	11099.20	508.00	5016.00	4.18	328.48	6.07	5.10	4.14	2.54	0.69	27.33
T_1 (10 ppm NAA)	19.11	5497.67	11454.93	494.67	5520.00	4.22	331.71	6.30	5.25	4.31	2.73	0.76	27.08
T_2 (20 ppm NAA)	19.86	5544.67	11495.72	454.00	6024.00	4.28	336.38	6.47	5.45	4.31	2.87	0.82	28.42
T_3 (30 ppm NAA)	20.96	5712.33	11507.20	425.00	6408.00	4.32	346.31	7.00	5.53	4.52	3.08	0.89	29.11
T_4 (40 ppm NAA)	21.97	6436.33	11546.92	385.00	6928.00	4.40	356.32	7.10	5.88	4.91	3.52	1.12	31.75
T_5 (50 ppm NAA)	22.58	6763.33	11616.37	362.67	7232.00	4.44	371.20	7.37	6.07	5.17	3.61	1.16	32.14
T_6 (60 ppm NAA)	22.83	6887.00	11839.32	312.00	8096.00	4.51	383.00	7.47	6.37	5.36	3.66	1.23	33.48
T_7 (70 ppm NAA)	23.61	6911.33	11916.92	275.00	8552.00	4.55	394.20	7.62	6.49	5.51	3.69	1.28	34.68
T_8 (80 ppm NAA)	24.64	7235.00	11986.32	250.33	8972.00	4.59	397.47	7.65	6.64	5.81	3.74	1.35	36.00
SE (m)±	0.12	1.23	21.37	0.75	23.35	0.01	0.66	0.07	0.03	0.03	0.01	0.01	0.22
CD at 5%	0.36	3.73	64.61	2.28	70.61	0.03	1.98	0.22	0.08	0.09	0.03	0.02	0.67

Conclusion

Results revealed that treatment T_8 (80 ppm NAA) was found significantly superior for increasing yield and yield contributing traits i.e, number of branches per plant, leaf area, number of buds per plot. number of pods per plot, number of seeds per pod, total dry weight, length of pod (5 seeded, 4 seeded, 3 seeded), biological yield and harvest index while decrease in number of flower drop per plan were favourable respectively to have an increasing effect on the seed yield when compared with control and rest of the treatments. when compared to rest of the treatments and control.

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