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Effect of Foliar Application of Salicylic Acid and Naphthalene Acetic Acid (NAA) on Growth and Yield Parameters of Mungbean (*Vigna radiata* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present study aimed to investigate "Effect of foliar application of Salicylic acid and Naphthalene Acetic Acid (NAA) on growth and yield parameters of Mungbean (*Vigna radiata* L.)". This research was conducted during the kharif season 2018 at the Student Instructional Farm (SIF) of Narendra Deva University of Agriculture & Technology in Kumarganj, Ayodhya. The experiment followed a randomized block design (RBD) with three replications and involved seven treatments. The Mungbean variety used in the study was Narendra Mung-1 (NDM-1). Seven treatments as comprised of T1 - control (distilled water spray at 30 & 40 DAS), T2 - foliar spray of SA @ 50 ppm at 30 DAS, T3 - foliar spray of SA @ 80 ppm at 30 DAS, T4 - foliar spray of NAA @ 50 ppm at 30 DAS, T5 - foliar spray of NAA @ 80 ppm at 30 DAS, T6 - foliar spray of NAA @ 50 ppm at 40 DAS,

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T7 – Foliar spray of NAA @ 80 ppm at 40 DAS. The results indicated that the treatment T5 (foliar application of NAA @ 80 ppm at 30 DAS) showed significant increase on growth parameters like plant height (cm), total number of branch plant^{-1}, total dry biomass (g) plant^{-1} and yield & yield attributes like number of pods clusters^{-1}, number of pods plant^{-1}, pod length (cm), number of seeds plant^{-1}, number of seeds pod^{-1}with T5, followed by T7 treatment (foliar application of NAA @ 80 ppm at 40 DAS), respectively over the control.

Keywords: NAA; SA; growth; yield.

1. INTRODUCTION

Green gram, also known as mung bean (*Vigna radiata* L.), is a plant in the leguminosea family. By fixing atmospheric nitrogen, it is crucial for boosting soil fertility in addition to being significant for human food [1] It is valued among the pulse crops because its seeds are rich in dietary protein required for health, simple to digest, and produce little flatulence when eaten as food [2].

Green gram is the third most important pulse crop in India. It is quite versatile crop grown for seeds, green manure and forage and it is also considered as “Golden Bean” because of its nutritive values and suitability to increase soil fertility, by the way of addition of nitrogen to the soil. According to Engel[3] mung beans are a good source of protein.

It has high nutritive value and due to this, has an advantage over the other pulses. The seed contains 24.20% protein content, 1.30% fat, and 60.4% carbohydrates, calcium (Ca) 118 and phosphorus (P) is 340 mg per 100 g of seed, respectively (Imran *et al*., 2016).

Mungbean is grown on about more than 4.0 mha in the country mainly in Rajasthan, Maharastra, Andhra Pradesh, Karnatka, Orrisa and Bihar. A phenomenal increase in area, production and productivity has occurred since 1965-66. The production has increased from 0.53 million tonnes in 1965-66 to 2.17 million tonnes in 2016-17. (Annual Report-AICRP on MULLaRP 2017-18). All over India, total pulse production was recorded about 23.95 million tonnes in 2017-18. Being leguminous crop, pulses have the ability to fix atmospheric nitrogen in a symbiotic relationship with *Rhizobium spp*. bacteria, which enables them to meet their own nitrogen and succeeding cereal crop to the extent of 25 to 50 percent. Pulses are also an excellent feed and fodder for live stock. Besides, their dietary value and nitrogen fixing ability, pulses also play an important role in sustaining intensive agriculture by improving physical, chemical and biological properties of soil and are considered excellent crops for diversification of cereal based cropping system. Salicylic acid plays a crucial part in the ability to withstand several environmental conditions [4].

India is a premier pulse growing country. Pulses are important constituents of the Indian diet and supply a major part of the protein requirement. Pulse crop besides rich in protein, also contains some of the essential amino acids. Pulse crops enrich the soil through symbiotic nitrogen fixation from atmosphere. Mungbean (*Vigna radiata* L. Wilczek) is also known as green gram, it is an important pulse crop of India is grown in *Rabi* (South India), *Kharif* and *Zaid* seasons. It is green with husk and yellow when dehusked. The beans are small, ovoid in shape and green in colour. Green gram plant is a small herbaceous annual with a twining habit [5,6]. Plant grows up to 45-60 cm depending upon the type and nature of crop raised. The stems are ridged and succulent having 6-9 branches on them. The central stem is more or less erect, while side branches are semi-erect. The leaves are trifoliate, ovate, and entire and arranged in alternate and opposite position on the stem. Both the stems and leaves are covered with short hair, generally shorter than those of black gram. The flowers appear in axillary receme in clusters of 10-20 in number. They are self-pollinated and develop into 6-10 cm long hairy pods, which are round, slender and used to bear about 7-11 seeds in them. The seeds are small and nearly globular. The hilum is white, more or less flat. Germination of green gram is epigeal.

The grains are globose in shape with a flat hilum and are green or brown in colour. The key benefits of the crop are that it is a legume, therefore it does not need nitrogen fertilisation (Murakami et al., [7]. has a short growth cycle (75–90 days), uses minimal water, and is simple to incorporate into crop rotations with cereals. It thrives in the majority of challenging dry and semiarid climates.

2. MATERIALS AND METHODS

The present investigation entitled “Effect of foliar application of Salicylic acid and Naphthalene

Acetic acid (NAA) on growth and yield parameters of Mungbean (*Vigna radiata* L.)" was carried out in the Student Instructional Farm (SIF), Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya (U.P.) under field condition during *Kharif* season of 2018. The seven treatments applied were as follows:

T_1 -Control: Distilled water spray at 30 and 40 DAS.
T_2 -Foliar spray of SA at a concentration of 50 ppm at 30 DAS.
T_3 -Foliar spray of SA at a concentration of 80 ppm at 30 DAS.
T_4 - Foliar spray of NAA at a concentration of 50 ppm at 30 DAS.
T_5 -Foliar spray of NAA at a concentration of 80 ppm at 30 DAS.
T_6 -Foliar spray of NAA at a concentration of 50 ppm at 40 DAS.
T_7 -Foliar spray of NAA at a concentration of 80 ppm at 40 DAS.

2.1 Growth Parameters

2.1.1 Plant height (cm)

The plant height of three tagged plants was measured in cm from soil level to its tip at different crop growth stages (35, 45, 55 DAS and at maturity stages) with the help of meter scale and an average was taken.

2.1.2 Total number of branches plant^{-1}

The total number of branches was recorded at 35, 45, 55 DAS and at maturity. The total number of mean branches calculated on three plants basis.

2.1.3 Total dry biomass (g plant^{-1})

Whole sampled plants were oven dried at 80 ^{0}C ±1for 24 hours and their dry weights were recorded at each sampling stage. The average dry weight of biomass plant^{-1} was calculated on the basis of three plants.

2.2 Yield Parameters

2.2.1 Number of pods clusters plant^{-1}

The mature pod clusters were picked from sampled plants and their number was counted and average was calculated.

2.2.2 Number of pods plant^{-1}

The pods were counted on three selected plants for each treatment and the average was worked out.

2.2.3 Pod length (cm)

Five pods were selected randomly from each plant and length of each pod was measured to workout average pod length.

2.2.4 Number of seeds plant^{-1}

Total number of seeds from three tagged plants was counted and divided by total number of pods of three plants from each treatment to find out number of seeds per plant.

2.2.5 Number of seeds pod^{-1}

Seeds were counted for average number of seed per pod in each treatment on the basis of five pods.

3. RESULTS AND DISCUSSION

3.1 Plant Height (cm)

Data pertaining to plant height as affected by foliar application of various PGRs (SA & NAA) along with control at different growth stages have been presented in Table- 1. The maximum plant height (26.2, 39.1, 43.0 & 51.9 cm at 35, 45 & 55 DAS and maturity stage, respectively) was recorded with foliar application of NAA (80 ppm) applied at 30 DAS followed by foliar application of NAA (80 ppm) applied at 40 DAS (35.1, 39.7 & 50.6 cm at 45 & 55 DAS & maturity stage, respectively) over the control. However, minimum plant height (34.3, 36.5 & 41.1 cm at 45 & 55 DAS & maturity stage, respectively) was recorded with foliar application of SA (50 ppm) applied at 30 DAS over the control. The significant increase in plant height was noticed in T_5 treatment at 45 & 55 DAS & maturity stage and treatment T_7 showed a significant effect in plant height at 55 DAS & maturity stages over the control. Treatments T_6& T_4 showed significant effect in plant height at maturity stage only over the control. Plant height at 35 DAS showed non significant effect as compare to the controls. These results are in accordance with Prakash *et al*., [8] observed that foliar application of plant growth regulators showed a significant increase in number of branches and plant height in black gram and [9] found that foliar application of bioregulatores like NAA (10, 200, and 300 ppm), kinetin (10, 20, and 30 ppm) and KNO_3 (100, 200 and 300 ppm) sprayed at bud initiation and pod formation stages of chickpea increased the plant height, number of branches.

Table 1. Effect of SA and NAA on plant height of mungbean at different growth stages

S. No.	Treatments	Plant height (cm)			
		35 DAS	45 DAS	55 DAS	At maturity
T_1	Control	23.6	33.9	35.4	38.6
T_2	SA 50 ppm at 30 DAS	23.2	34.3	36.5	41.1
T_3	SA 80 ppm at 30 DAS	23.4	34.5	36.8	41.3
T_4	NAA 50 ppm at 30 DAS	25.7	34.2	36.8	49.6
T_5	NAA 80 ppm at 30 DAS	26.2	39.1	43.0	51.9
T_6	NAA 50 ppm at 40 DAS	23.3	34.1	36.7	48.6
T_7	NAA 80 ppm at 40 DAS	23.3	35.1	39.7	50.6
SEm±		1.29	0.49	0.62	1.14
CD at 5%		NS	1.51	1.92	3.51

3.2 Total Number of Branches Plant^{-1}

The data pertaining to total number of branches plant^{-1} as influenced by foliar applications of various PGRs (SA & NAA) along with control at different growth stages have been presented in Table- 2. The maximum total number of branches plant^{-1} (3.3, 4.1, 4.7 & 4.8 branches plant^{-1} at 35, 45 & 55 DAS & maturity stage, respectively) was recorded with foliar application of NAA (80 ppm) applied at 30 DAS followed by foliar application of NAA (80 ppm) applied at 40 DAS (3.9, 4.6 & 4.6 branches plant^{-1} at 45 & 55 DAS & maturity stage, respectively) over control. However, minimum total number of branches plant^{-1} (3.8, 4.2 & 4.2 branches plant^{-1} at 45 & 55 DAS & maturity stage, respectively) was recorded with foliar application of SA (50 ppm) applied at 30 DAS over controls. Significant increase in total number of branches plant^{-1} was noticed in T_5& T_7 at 45 & 55 DAS & at maturity stages over the control. However, T_3, T_4& T_6 treatments showed significant effect in total number of branches plant^{-1} at 55 DAS & maturity stage over the control. Total number of branches plant^{-1} at 35 DAS showed non significant effect as compared to control.This type of findings also supported by Prakash *et al*., [8] observed that foliar application of plant growth regulators showed significant increase in number of branches and plant height in black gram. Shah *et al.,* [9] also found that foliar application of Bioregulatores like NAA (10, 200, and 300 ppm), kinetin (10, 20, and 30 ppm) and KNO_3 (100, 200 and 300 ppm) sprayed at bud initiation and pod formation stages of chickpea increased the plant height, number of branches.

3.3 Total Dry Biomass (g plant^{-1})

The mean data regarding total dry biomass plant^{-1} was recorded by foliar application of various PGRs (SA & NAA) along with control are represented in Table- 3. The maximum total dry biomass plant^{-1} (8.84, 12.90, 18.84 & 28.83 g plant^{-1} at 35, 45 & 55 DAS & maturity stages, respectively) was observed with foliar application of NAA (80 ppm) applied at 30 DAS followed by foliar application of NAA (80 ppm) applied at 40 DAS (12.42, 18.78 & 28.67 g plant^{-1} at 45 & 55 DAS and maturity stage, respectively) over control. However, minimum total dry biomass (11.87, 15.29 & 23.93 g plant^{-1} at 45, 55 and maturity stage, respectively) were recorded with foliar application of SA (50 ppm) applied at 30 DAS over the control. Significant increase in total dry biomass (g plant^{-1}) was recorded in all treatments at 45 & 55 DAS &maturity stage over the control. Total dry biomass at 35 DAS showed non significant effect as compare to control.These results are in accordance with Prakash *et al*.,[8] that foliar application of plant growth regulators showed a significant increase in number of branches, dry biomass and plant height in black gram and Upadhyay (2004) alsoreported thatdry matter partitioning was improved with the application of NAA followed by GA_3 and kinetin in chickpea variety H-208.

3.4 Yield Parameters

3.4.1 Number of pods clusters plant^{-1}

The data regarding on number of pods clusters plant^{-1} have been presented in Table- 4. Among the treatments, maximum pods clusters plant^{-1} (6.8) was recorded with foliar application of NAA (80 ppm) applied at 30 DAS followed by T_7 (6.5 pods clusters plant^{-1}). However, minimum number of pods clusters plant^{-1} (5.6) was recorded with foliar application of SA (50 ppm) applied at 30 DAS. Whereas, significant increase in number of pods clusters plant^{-1} was found in all treatments except T_2 treatment over the control.These findings are in close conformity with Rajesh *et al*., [10] reported that the seed yield increased significantly with NAA (20 ppm)

followed by mepiquat chloride 5% AS, brassinosteroids (20 ppm) and chlormequat chloride.

3.4.2 Number of pods plant^{-1}

The data concerning number of pods plant^{-1} have been presented in Table- 4. Statistical analysis of variance indicated that effect of all treatments was found significant on formation of pods plant^{-1} over the control. Among the treatments, maximum number of pods plant^{-1} (43.4) was recorded in T_5 (NAA 80 ppm) applied at 30 DAS followed by T_7 (NAA 80 ppm) applied at 40 DAS (41.4 pod plant^{-1}). However, minimum number of pod plant^{-1} (36.2) was recorded in T_2 (SA 50 ppm) over the control.These findings are in close conformity with Rajesh *et al*., (2014) reported that the seed yield increased significantly with NAA (20 ppm) followed by mepiquat chloride 5% AS, brassinosteroids (20 ppm) and chlormequat chloride.

Table 2. Effect of SA and NAA on total number of branches plant^{-1} of mungbean at different growth stages

S. No.	Treatments	Total number of branches plant^{-1}			
		35 DAS	45 DAS	55 DAS	At maturity
T_1	Control	3.1	3.5	3.9	4.00
T_2	SA 50 ppm at 30 DAS	3.0	3.8	4.2	4.2
T_3	SA 80 ppm at 30 DAS	3.1	3.8	4.3	4.4
T_4	NAA 50 ppm at 30 DAS	3.2	3.6	4.5	4.5
T_5	NAA 80 ppm at 30 DAS	3.3	4.1	4.7	4.8
T_6	NAA 50 ppm at 40 DAS	2.9	3.5	4.4	4.5
T_7	NAA 80 ppm at 40 DAS	3.0	3.9	4.6	4.6
SEm±		0.12	0.11	0.12	0.10
CD at 5%		NS	0.33	0.37	0.32

Table 3. Effect of SA and NAA on plant dry biomass of mungbean at different growth stages

S. No.	Treatments	Total dry biomass(g plant^{-1})			
		35 DAS	45 DAS	55 DAS	At maturity
T_1	Control	8.13	10.24	14.13	22.10
T_2	SA 50 ppm at 30 DAS	8.00	11.87	15.29	23.93
T_3	SA 80 ppm at 30 DAS	8.61	11.93	16.78	24.43
T_4	NAA 50 ppm at 30 DAS	8.70	12.13	18.24	27.39
T_5	NAA 80 ppm at 30 DAS	8.84	12.90	18.84	28.83
T_6	NAA 50 ppm at 40 DAS	7.83	12.42	18.37	27.63
T_7	NAA 80 ppm at 40 DAS	8.00	12.82	18.78	28.67
SEm±		0.43	0.20	0.22	0.27
CD at 5%		NS	0.61	0.67	0.83

Table 4. Effect of SA and NAA on yield and yield parameters of mungbean

S. No.	Treatments	Number of pods cluster plant^{-1}	Number of pods plant^{-1}	Pod length (cm)
T_1	Control	4.8	25.3	6.7
T_2	SA 50 ppm at 30 DAS	5.6	36.2	7.2
T_3	SA 80 ppm at 30 DAS	5.8	38.7	7.4
T_4	NAA 50 ppm at 30 DAS	6.4	40.5	7.7
T_5	NAA 80 ppm at 30 DAS	6.8	43.4	8.0
T_6	NAA 50 ppm at 40 DAS	6.2	39.0	7.2
T_7	NAA 80 ppm at 40 DAS	6.5	41.4	7.9
SEm±		0.28	0.74	0.20
CD at 5%		0.85	2.29	0.62

Table 5. Effect of SA and NAA on yield and yield parameters of mungbean

S. No.	Treatments	Number of seed plant^{-1}	Number of seeds pod^{-1}	100 seed weight (g)
T_1	Control	287	9.5	2.67
T_2	SA 50 ppm at 30 DAS	332	10.1	3.02
T_3	SA 80 ppm at 30 DAS	361	10.4	3.06
T_4	NAA 50 ppm at 30 DAS	387	10.6	3.12
T_5	NAA 80 ppm at 30 DAS	458	11.3	3.17
T_6	NAA 50 ppm at 40 DAS	364	10.3	3.12
T_7	NAA 80 ppm at 40 DAS	427	10.9	3.16
SEm±		10.81	0.25	0.10
CD at 5%		33.29	0.77	0.30

3.4.3 Pod length (cm)

The data regarding on pod length (cm) have been presented in Table- 4. The mean data revealed that the foliar application of all treatments significantly increased the pod length except T_2 over the control. Maximum pod length (8.0 cm) was recorded with NAA (80 ppm) applied at 30 DAS, followed by NAA (80 ppm) applied at 40 DAS (7.9 cm). Among the treatments, minimum pod length (7.2 cm) was recorded with T_2& T_6 treatments but it was higher over the control. These findings are in close conformity to Rajesh*et al*., (2014) reported that the seed yield increased significantly with NAA (20 ppm) followed by mepiquat chloride 5% AS, brassinosteroids (20 ppm) and chlormequat chloride.

3.4.4 Number of seeds plant^{-1}

The data concerning on number of seeds plant^{-1} have been presented in Table- 5. Statistical analysis of variance indicated that effect of all treatment was significant on number of seeds plant^{-1} over the control. Among the treatments, maximum number of seeds plant^{-1} (458) was recorded in T_5 (NAA 80 ppm) followed by T_7 - NAA 80 ppm (427 seeds plant^{-1}) over the control. However, minimum number of seeds plant^{-1} (331.8) was recorded in T_2 over the rest treatments but it was higher in comparison to control.These findings are in close conformity to Rajesh*et al*., (2014) reported that the seed yield increased significantly with NAA (20 ppm) followed by mepiquat chloride 5% AS, brassinosteroids (20 ppm) and chlormequat chloride.

3.4.5 Number of seeds pod^{-1}

The data regarding on number of seeds pod^{-1} have been presented in Table- 5. Effect of foliar application of PGRs (SA & NAA) was found significant on seeds pod^{-1} in all treatments except T_2 over the control. Among the treatments, maximum number of seeds pod^{-1} (11.3 seeds) was recorded T_5 (NAA 80 ppm) followed by T_7-NAA 80 ppm (10.9 seeds pod^{-1}). However, minimum number of seeds pod^{-1} (10.1 seeds) was recorded with T_2 (SA 50 ppm)over the all treatments but higher than control.These findings are in close conformity to Rajesh*et al*., (2014) reported that the seed yield increased significantly with NAA (20 ppm) followed by mepiquat chloride 5% AS, brassinosteroids (20 ppm) and chlormequat chloride.

3.4.6 100 seed weight (g)

The data regarding on 100 seed weight (g) have been presented in Table- 5. The mean data revealed that the foliar application of various PGRs (SA & NAA) significantly increased the 100 seed weight (g) over the control. Among the treatments, maximum weight (3.17 g) was recorded with T_5 (NAA 80 ppm)followed by T_7-NAA 80 (3.16 g). However, minimum weight (3.02 g) was recorded in T_2 (SA 50 ppm) over the control.These findings are in close conformity to Rajesh*et al*., (2014) reported that the seed yield increased significantly with NAA (20 ppm) followed by mepiquat chloride 5% AS, brassinosteroids (20 ppm) and chlormequat chloride.

4. CONCLUSION

Foliar application of SA 80 ppm and NAA 80 ppm applied at 30 DAS may be used as a potential tools to enhance growth parameters (plant height, total number of branches plant^{-1}, total dry biomass plant^{-1}) and yield and attribute traits also increased over the control and foliar application of NAA 80 ppm and SA 80 ppm applied at 30 DAS have been found appropriate dose for

improving growth parameters and grain yield of Mungbean. Thus, it can be concluded that the NAA 80 ppm and SA 80 ppm at 30 DAS which is highly linked with yield.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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