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Effect of foliar spray of plant growth regulators on growth and yield of mung bean (*Vigna radiata* L.)

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Abstract
The observations were recorded at 45, 55 DAS and at physiological maturity of the crop. Results of field study indicated that, the growth parameters yield attributing traits and quality of green gram were significantly increased due to foliar sprayed of plant growth regulators. The foliar sprayed of salicylic acid 100 ppm was found most effective for increasing the number of branches plant^{-1} (7.83) *viz*: number of pod clusters^{-1} (8.78), number of pods plant^{-1} (45.44), pod length (8.40 cm), number of seeds pods^{-1} (9.48), number of seeds plant^{-1} (431.33), 100 seed weight (4.08g), seed yield plant^{-1} (17.57g), seed yield q ha^{-1} (12.24) and harvest index (36.52%) followed by foliar sprayed of GA_3 100 ppm over rest of the treatments. However, growth parameter like plant height (66.35 cm) was measured significantly increased due to foliar spared of GA_3 100 ppm followed by foliar sprayed of salicylic acid 100 ppm over other treatments including control.

Keywords: Plant growth regulators, Mung bean, GA_3, yield

Introduction
Mung bean (*Vigna radiata* L. wilezek) is also known as green gram, it is an important pulse crop of India and 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 color. The mung bean (*Vigna radiata*), alternatively known as the moong bean, monggo, green gram, or mung Sanskrit mugd, is a plant species in the legume family. The mung bean is mainly cultivated in India, Pakistan, Bangladesh, Nepal, China, Korea, South Asia and Southeast Asia. It is used as an ingredient in both savory and sweet dishes.

Mungbean is third most important pulse crop of India after chickpea and pigeonpea. The nutritive value of mungbean is a high with easily digestible protein (approximately 25-28%), oil 1.0-1.5%, fiber 3.5-4.5%, ash 4.5-5.5%, carbohydrate 62-65%, water 9.1%, and vitamins on dry weight basis (Singh and Srivastava, 2014).

Mungbean (*Vigna radiata* L. Wilczek) is a summer pulse crop with short duration (70-90 days) and high nutritive value. It has many effective uses, green pod is cooked as peas, sprout rich in vitamins and amino acids. This crop can be used for both seed and forage since it produce a large amount of biomass and then recover after grazing to yield abundant seeds (Lawn and Ahniaas) and then can be used in broilers diets as a non-traditional feed stuff (El-Karamany *et al.* 2003).

Production of pulses is restricted to Asian countries to a large extent and particularly in the Indian sub continent. Apart from India some of the other countries producing pulses are: Myanmar, Brazil, Pakistan, Canada, Australia and Turkey, US and Tanzania.

In India, production of pulses is around 13.5-15 million tonnes during the last decade, while annual domestic demand is 18-19 million tonnes. The yield of pulses remained virtually stagnant for the last 40 year (539 Kg ha-1 in 1961 to 544 Kg ha-1 in 2005 to 696 Kg ha-1 in 2016-17). India is short of supply by 4 to 5 million tonnes annually (FAOSTAT, 2016-17). In Uttar Pradesh, it is being cultivated in an area of 0.89 lakhs hectare with 0.62 lakhs tonnes production (GOI, 2017).

Plant growth hormones regulates almost every phase of plant growth and development. Plant growth and development are known to be under the control of internal and external factors. The effect of growth regulators is found to be largely dependent upon various factors as concentration and type of growth regulator, method of application, time of application, soil type and other conditions. Gibberellins are gibbane skelt on compounds and biologically active in stimulating cell enlargement, rooting replacement of chilling treatment in short day plant

etc. Among them, gibberellic acid is most active and widely used. It is also used for seed germination, breaking of dormancy and producing maleness in certain plants. At the moment, the most important agriculture use of gibberellins is for inducing parthenocarpy and better fruits set. Plant growth regulators can play important role in increasing yield by making the plants photosynthetically more effective (Sinha *et al.*, 1973).

The physiological constraints identified for low yield in pulses are many including poor early leaf area dry matter accumulation, harvest index, poor pod setting due to extensive flower drop and hormonal imbalance etc. In order to increase the productivity of this crop, it has become necessary to study its requirements for growth and production. Seeding date is an important factor affecting growth and yield traits which vary depending on the environmental conditions associated with the agriculture, particularly temperature, light and humidity which determines the best time for Mung bean cultivation. Growth is affected negatively or positively by plant growth regulators including salicylic acid which works to improve the productivity of crop through its effect on the important physiological process in the plant such as growth, photosynthesis, flowering and drought resistance

Material and methods

In the present study, Narendra mung-1 was taken as experimental material to find out the response of plant growth regulator salicylic acid, and GA3 on morpho-physiological, and yield contributes of mungbean. The variety was collected at Nagipur farm of seed processing plant N.D.U.A. &T. Kumarganj, Ayodhya.

Under present investigation was conducted during *Kharif* 2017 at Student Instructional Farm of N.D. University of Agriculture and Technology, Narendra Nagar (Kumarganj), Ayodhya.

Growth regulators solutions were prepared on weight by volume basis in desired concentration. The hormonal solutions were prepared by dissolving in organic solvent then maintained the desired concentration in distilled water. Solution of GA3 50 ppm, GA3 80 ppm, GA3 100 ppm and salicylic acid 50 ppm, salicylic acid 80 ppm, salicylic acid 100 ppm were prepared at 30 days after sowing and sprayed on the foliage of plants with the help of hand sprayer as per treatment. While in untreated control distilled water was sprayed. The experiment was lay out Randomized Block Design during d *Kharif*, 2017.

The Growth characters and observation were recorded on nineteen different seed yield traits viz., Number of Branches plant-1, Number of pod clusters plant-1, Number of pods plant-1, Pod length (cm), Number of seeds pod-1, Number of seeds plant-1, 100 seed weight (g), Seed yield (g) plant-1, Seed yield (q ha-1) plot-1, Harvest Index (%).

Statistical Analysis Data recorded on various growth and yield attributes were subjected to statistical analysis by Fisher method of analysis of variance (Fisher and Yates 1949).

Foliar spray of plant growth regulators at different growth stages enhanced natural plant growth and simulating the growth behavior right from seed germination to senescence of any crops. The yield attributes parameter *viz*, number of pod clusters plant-1, number of pods plant-1, pod length, number of seeds pod-1, number of seeds plant-1,100 seed weight (g), seed yield (g) plant-1, seed yield quintal ha-1 and harvest index have been increased significantly by foliar application of salicylic acid and GA3 as compared to control. The maximum number of number of pod clusters plant-1, number of pods plant-1, pod length, was recorded with 100 ppm salicylic acid. The above higher yield attributes obtained with 100 ppm salicylic acid which may be because of maximum net photosynthetic rate in leaves and better translocation of photosynthates and metabolites (nutrients etc.). The maximum number of seeds plant-1 and 100 seed weight was counted with 100 ppm salicylic acid. The higher number of seeds plant-1 obtained with 100 ppm SA may be because of increased cell division, promotion of orderly development of embryos of seeds and higher level of photosynthates that led to increase in number of seeds plant-1. Similar findings also reported by Kuttimani and Velayuthan (2011).

The seed yield (g) plant-1 and seed yield quintal ha-1 were significantly affected with foliar application of salicylic acid and GA3. The maximum seed yield (17.57 g plant-1) was achieved with foliar application of 100 ppm salicylic acid followed by 100 ppm GA3 (14.93 g plant-1) and the maximum grain yield 12.24 quintal ha-1 was achieved with foliar application of 100 ppm salicylic acid followed by 100 ppm GA3 12.10 quintal ha-1. The higher seed yield obtained with 100 ppm salicylic acid which might be due to increased yield attributing traits *viz*, number of pods plant-1, number of seeds pod-1, number of seeds plant-1, 100 seed weight (g) and seed yield (g) plant-1. The above parameters combination contributed a lot improvement in grain yield quintal ha-1 of mung bean during present investigation.

Result and Discussion

The maximum plant height was measured with the foliar sprayed of GA3 100 ppm (47.53, 62.16 and 66.35 cm) at 45, 55 DAS and at physiological maturity stages, respectively, followed by foliar sprayed salicylic acid 100 ppm at 45, 55 DAS and at physiological maturity over rest of treatments.

The more number of branches plant-1 was calculated with the foliar sprayed of salicylic acid 100 ppm (3.67, 6.22 and 7.83 plant-1) at 45, 55 DAS and at physiological maturity, respectively, followed by GA3 100 ppm at 45, 55 DAS and at physiological maturity over rest of treatments including control.

The highest total dry biomass plant-1 was recorded with foliar sprayed of salicylic acid 100 ppm (11.08, 20.72 and 29.55 g plant-1) at 45, 55 DAS and at physiological maturity, respectively, followed by foliar sprayed GA3 100 ppm at 45, 55 DAS and at physiological maturity over rest of treatments including control

The foliar sprayed of salicylic acid 100 ppm resulted significantly higher protein content (24.11%) in seed.

Significant improvement in number of pod clusters plant-1 (8.78), number of pods plant-1 (45.44), and pod length (8.40 cm) observed with the foliar sprayed of salicylic acid 100 ppm followed by foliar sprayed GA3 100 ppm and the lowest being in control.

The maximum number of seeds pod-1 (9.48), number of seeds plant-1 (431.33), and seed yield (17.57 g) plant-1 achieved with foliar sprayed of salicylic acid 100 ppm as compare to control and other treatments

The higher seed index (4.08 g) of seeds was weighed with foliar sprayed of salicylic acid 100 ppm and lowest being in control.

Significantly higher seed yield (12.24 q ha-1) has been achieved by the foliar sprayed of salicylic acid 100 ppm as compared to control.

Conclusion

The significant maximum plant growth has been obtained by the foliar sprayed of various growth regulators particularly

higher dose of GA3 (100 ppm) at all various growth stages of the crop.

From overall experimental results it is concluded that higher economic return as well as dietary value in term of protein obtained from higher seed yield of mungbean having better quality influenced with foliar application of salicylic acid 100 ppm followed by GA3 100 ppm (higher growth improvement noticed).

The optimal requirement of growth regulators (salicylic acid followed by GA3) have been determined in present study for higher seed yield of mungbean (*Vigna radiata* L.) var. Narendra mung-1, which would be helpful to pulse grows specially farmers of our country including U.P.

In the present context (21st century) the crop, mungbean attached significance particularly in view of pulse requirement in our state (U.P.), country and world, which is lacking even normal requirement for the people (basic requirements of proteins especially vegetarian people).

According to FAO/WHO recommendation every individual needs 85 g of pulses/day to meet the protein requirement but at present, per capita availability of pulses is only 40 g/day in India. This situation warrants producing 3-fold increase as that of current pulse production, even to meet the minimum need.

There is, therefore, further need to work out the efficiency of higher doses of various growth regulators (salicylic acid GA3 etc.) and also manures and fertilizers specially organic manures coupled with high yielding pulse varieties under sodic/ waste land conditions in addition to normal soil for improving sustainable/ inclusive/ holistic growth in pulse production including mungbean to meet out normal requirement of pulses for protein requirement as well as improving the fertility status (addition of nitrogen as organic based) of soil. The standardized packages and practices of pulses including mungbean would be helpful in expansion of new areas of pulse in Uttar Pradesh and other pulse growing states of the country through diversification of wasteland/ marginal lands and also under various physiological stresses particularly in the context of fast shrinking cultivable lands in our country including Uttar Pradesh because of increasing population and industrialization.

Table 1: Effect of plant growth regulators on yield attributes of mung bean during *kharif season*

Treatments	Number of pod clusters plant-1	Number of pods plant-1	Pod length (cm)	Number of seeds pod-1	Number of seeds plant-1	100 Seed weight (g)	Seed yield (g) plant-1	Seed yield (q ha-1)	Harvest index (%)
T1 : Control	5.56	31.11	6.81	7.47	232.66	2.94	6.83	9.88	31.93
T2 : GA3 50 ppm	6.89	34.89	7.05	7.96	277.88	3.27	9.07	10.66	34.67
T3 : GA3 80 ppm	7.89	38.77	7.94	8.52	330.66	3.61	11.92	10.94	35.49
T4 : GA3 100 ppm	8.44	42.78	8.20	9.07	388.88	3.9	14.93	12.1	35.91
T5 : Salicylic acid 50 ppm	7.33	36.55	7.37	8.44	309.11	3.52	10.84	11.15	35.42
T6 : Salicylic acid 80 ppm	8.22	41.89	7.74	8.93	374.03	3.85	14.57	11.54	35.83
T7:Salicylic acid 100 ppm	8.78	45.44	8.40	9.48	431.33	4.08	17.57	12.24	36.52
SEm ±	0.11	0.86	0.10	0.19	10.36	0.03	0.36	0.05	1.28
CD at 5%	0.33	2.67	0.32	0.39	32.29	0.11	1.14	0.17	3.95

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