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Effect of seed priming with plant growth regulators on growth, biochemical changes and yield of Mung bean (*Vigna radiata* L.)

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Abstract
Seed priming is employed for better crop stand and higher yield in a range of crops. In order to evaluate the effect of seed treatments with growth regulators on the yield and yield components of mung bean (*Vigna radiata* L.) variety, a experiment was carried out under field condition at students instructional farm of Acharaya Narendra Deva University of Agriculture & Technology, Narendra Nagar, (Kumarganj), Ayodhya U.P. during *kharif* season 2019 based on a Randomized Blok Design with three replications variety of Narendra Mung-1 with seven treatments were taken. The maximum germination percentage (90.25%) was recorded with seed priming of GA_3- 100ppm over other treatments including control. Growth characters as plant height, total dry biomass, and chlorophyll content and nitrogen content in green leaves and protein content in mature seeds were found significantly superior with seed priming of GA_3-100ppm followed by NAA-100ppm over control. Yield and yield contributing traits *viz*: number of pod clusters per plant (8.33), number of pods per plant (48.26), pod length (7.66cm), number of seeds per plant (416.66), number of seeds per pod (10.33), 100 seed weight (3.92g), seed yield per plant (14.36g), seed yield (11.66 q h^{-1}) and harvest index (36.06%) were also found statistically superior with seed priming of GA_3-100ppm followed by priming in NAA-100ppm over control. Generally, the use of growth regulators as a pre-treatment of seed increased the yield and yield components.

Keywords: Mung bean, GA_3, biochemical, physiological, NAA, salicylic acid

Introduction
Mungbean is the third most important pulse crop of India after chickpea and pigeonpea (Singh and Singh, 2014) [22]. Mung bean (*Vigna radiata* (L.) Wilczek) is native to India and central Asia especially in tropical and subtropical Asia and belong to family Fabaceae and sub- family Papilionaceae (Singh and Singh, 2014) [22]. The nutritive value of mungbean is high and easily digestible protein with 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 *et al*., 2014) [22]. In India, pulses are grown over an area of 29.28 m ha with a production and productivity of about 22.40 m tonnes and 765 kg/ ha, respectively (Anonymous, 2017) [3]. This covers about 20% of total area and 8% of total grain production. These are the cheapest and best sources of vegetable proteins consisting of about 27 per cent of total dietary protein in our country and India has largest area and production of pulses in the world.

Plant growth regulators (PGRs) are known to influence plant growth and development at very low concentrations. They are non-toxic to plants over a wide range of concentration and effective in promoting the root system of a large number of plant species (Taiz and Zeiger 2006) [23]. Gibberellins (GAs) are the most important natural growth regulators and generally involved in the growth and development of different plant. They control seed germination, leaf expansion, stem elongation, and flowering (Magome *et al*., 2004 and Kumar *et al*., 2018) [15, 11, 12]. Gibberellic acid (GA) is used to induce great changes in the growth characters, chemical composition, and yield criteria of the plant (Choudhury *et al*., 2013) [5].

Salicylic acid (SA) is a phytohormone of phenolic nature. It is ubiquitous in plants generating a considerable impact on plant growth, development, mineral uptake and transport, photosynthesis, and transpiration. Salicylic acid and other salicylates are known to affect various physiological and biochemical activities of plants and may play a key role in regulating their growth and productivity (Arberg, 1981) [4].

Materials and Methods

The field experiments were carried out during *kharif* season of 2019 on students instructional farm of Acharya Narendra Deva University of Agriculture & Technology, Narendra Nagar, (Kumarganj), Ayodhya. The seeds of mungbean (Narender mung-1) were soaked for 12 hr. with bio regulators gibberellic acid (GA_3), Salicylic acid and NAA with different concentrations as follows: control (unpriming), gibbrellic acid (50 ppm), gibbrellic acid (100 ppm), salicylic acid (50 ppm), salicylic acid (100 ppm), NAA (50 ppm), and NAA (100 ppm). The experiment was planed with complete randomized block design in three replications and morpho-physiological parameter were taken, Germination (%) **=** **(**Number of seeds germinated/ Total number of seeds)x100, Plant height (20, 40, 60 DAS and at maturity), Dry weight per plant**,** Days to maturity, Chlorophyll and Nitrogen content (SPAD meter, Model:X55/M-PEA), Harvest Index (%) = [(Economic yield)/(Biological Yield)] ×100.

Isolation of protein content in seeds: The soluble and insoluble protein content was estimated by using method of Lowery *et al.* 1951. The final colour is the result of biuret reaction of the protein with copper ion in alkaline medium and reaction of phosphomalybdic turgustic reagent by the tyrosine and tryptophan present in the treated protein. Reagent: (A) 2% Na_2 CO_3 in 0.1 N NaOH. (B) 0.5% $CuSO_4$, $5H_2O$ in 1% sodium potassium tartarte. (C) Alkaline copper solution mix 50 ml of reagent A with reagent B, (Discarded after day). (D) Carbonate copper solution, is the same as C expect for omissions of NaOH. (E) Diluted folin reagent. Extraction**:** First of all crushed the seed in powdery form and moist with 80% ethanol and centrifuged at 4000 rpm for 20 minutes. The residue left after 80% ethanol extraction was hydrolyzed in 5.0 ml of 0.3 NaOH for one hour and then centrifuged. Both the supernatants were pooled and the volume was made to 10 ml. Procedure**:** 0.5 ml aliquot was taken in test tube and mixed with 5 ml of reagent C allowed to stand for 10 minutes. Thereafter, 0.5 ml of reagent D was added with instant mixing after 30 minutes, OD was measured at 750 nm.

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) [7].

Result and Discussion

Seed germination percentage: Seed priming enhanced germination percentage and maximum germination percentage was recorded GA_3 acid and NAA with respect to control. Similar findings were also reported by Umair *et al*. (2010), Kundu, *et al*. (2017) [13] Kumar *et al*. (2017) the effect of different concentrations of GA_3 is the best germination rate of 92% was achieved in (GA_3-100ppm) followed by 80% in (NAA-100ppm) and 70% in (salicylic acid-100ppm).

Plant height (cm): The maximum plant height (14.15, 39.07, 52.33, 59.33 at harvest respectively) was recorded with seed priming of GA_3 (100ppm) as compared to control at all the stages of crop growth (20, 40, 60, DAS and at harvest stages). The higher plant height was achieved with application of GA_3 and NAA was found more pronounced and both treatments registered significant increase in plant height as compared to unprimed control at all the stages of observation., which might be due to enhanced stem elongation because of application of plant growth regulators particularly GA_3 contributed a lot in affecting plant height of mungbean. These results are agreement with these results is in accordance to Hoque *et al*. (2002) [8] and Kumar *et al.* (2017).

Table 1: Effect of seed Priming with plant growth regulators on germination percentage and plant height of mung bean during *kharif* season

Treatments	Germination (%)	20 DAS	40 DAS	60 DAS	At harvest
Control	79.66	9.04	28.29	43.75	47.00
GA_3 (50ppm)	83.26	11.03	33.33	47.33	54.66
GA_3 (100ppm)	90.25	14.15	39.07	52.33	59.33
Salicylic acid (50ppm)	83.87	10.49	33.00	46.33	54.29
Salicylic acid (100ppm)	85.45	12.66	35.33	47.00	56.33
NAA (50ppm)	83.72	10.75	33.33	43.66	54.41
NAA (100ppm)	86.56	13.48	36.66	48.00	57.08
SEm±	1.14	0.39	0.64	0.58	0.62
CD at 5%	3.52	1.20	1.98	1.78	1.90

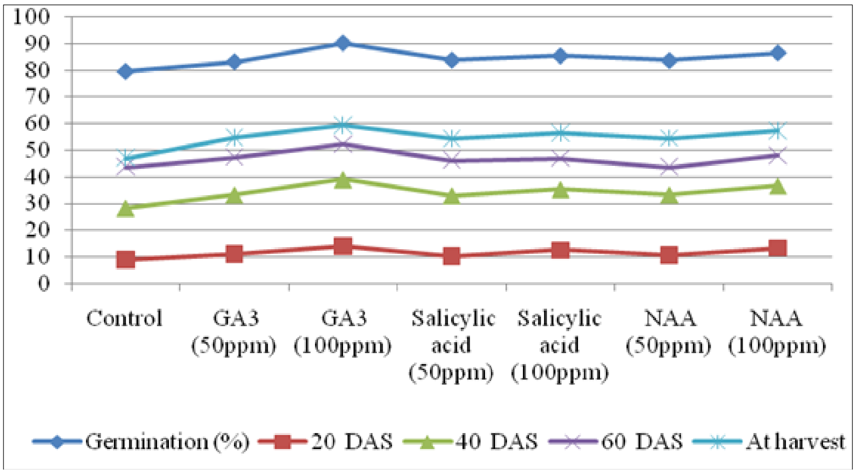

Fig 1: Effect of seed priming with plant growth regulators on germination percentage and plant height of mungbean during *kharif* season

Number of branches per plant: All the treatments showed significant difference on number of branches at all the growth stages of observations with respect to control at 40 and 60 DAS and at harvest stages. Statistically significant more number of branches has observed with seed priming of GA_3 100 ppm (6.66, 8.66 and 8.99 branches per plant) at 40 and 60 DAS, at harvest respectively, followed by seed priming with NAA 100 ppm over rest of the treatments. Where as, minimum number of branches was recorded with seed priming of NAA 50 ppm (5.05, 6.26, & 6.33 plant^{-1}) at 40, 60 DAS and at harvest stage over control.

Total dry biomass (g): The maximum increase in total dry biomass (2.66, 9.95, 19.08 and 29.88g) was observed with seed priming of GA_3-100ppm at 20, 40, 60 DAS and at harvest stages. The higher total dry biomass achieved with seed priming of GA_3-100ppm registered significant increase in the dry biomass per plant as compared to unprimied control at 20, 40, 60 DAS and at harvest stages of crop which might be due to stem elongation, increase in cell size of leaves and another possible growth factors as influenced by GA_3 application. The increase in plant dry biomass due to seed priming treatments indicated that the photosynthetic activity and efficiency of the leaves have been increased which contributed to dry biomass production. This is further supported by similar finding have been reported by Ibrahim *et al.* (2007) [9] revealed that GA_3 (100ppm) application led to increase in plant height, average number of leaves, leaf area per plant and dry weight of shoot in *vicia faba*, These findings was accordance with Fatma *et al*. (2012) [6].

Table 2: Effect of seed priming on number of branches per plant and total dry biomass per plant (g) of mung bean during *kharif* season

	Number of branches per plant			Total dry biomass (g) per plant			
Treatments	40 DAS	60 DAS	At harvest	20 DAS	40 DAS	60 DAS	At harvest
Control	3.93	5.00	6.00	1.96	6.01	15.00	25.56
GA_3 (50ppm)	5.33	6.66	6.85	2.06	7.63	16.53	27.33
GA_3 (100ppm)	6.66	8.66	8.99	2.66	9.95	19.08	29.88
Salicylic acid (50ppm)	5.75	6.26	6.98	2.00	7.62	16.44	26.15
Salicylic acid (100ppm)	5.84	6.73	8.26	2.38	8.5	16.83	27.65
NAA (50ppm)	5.05	6.26	6.98	2.07	7.9	16.44	26.87
NAA (100ppm)	5.95	7.33	8.41	2.43	8.13	17.00	28.00
SEm±	0.28	0.32	0.26	0.15	0.39	0.45	0.53
CD at 5%	0.87	0.98	0.80	0.40	1.20	1.30	1.55

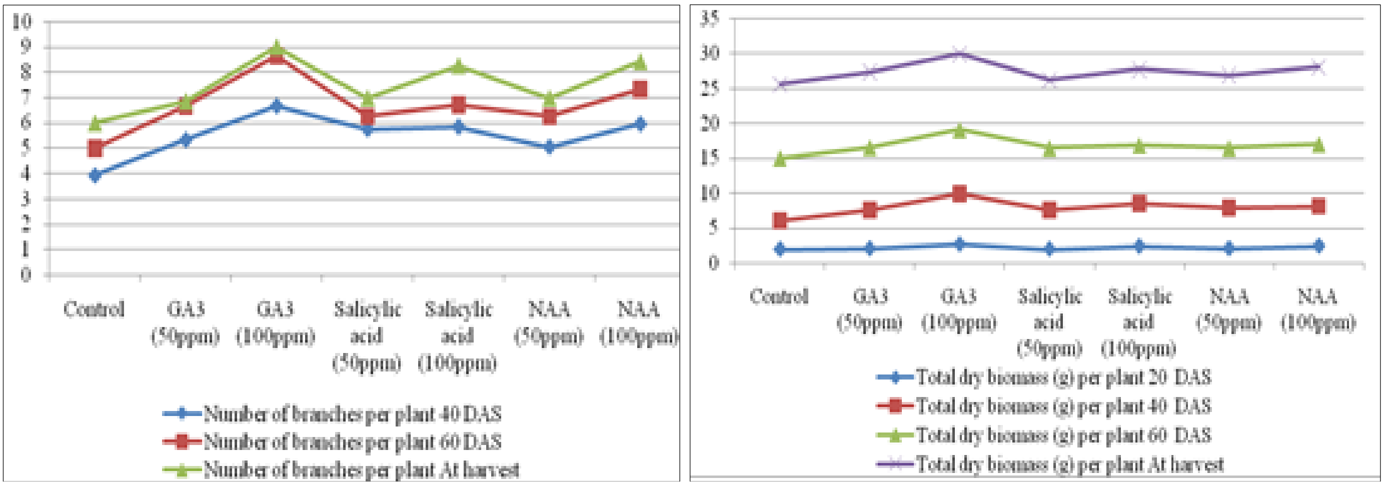

Fig 2: Effect of seed priming on number of branches per plant and total dry biomass per plant (g) of mung bean during *kharif* season

Chlorophyll content: Chlorophyll content in green leaves have been significantly affected by seed priming of plant growth regulators at various stages of the crop. The maximum chlorophyll content in leaves (9.96, 10.66, and 10.33 SPAD Value) was analyzed with seed priming of GA_3-100ppm at 20, 40 and 60 DAS of the crop. The higher chlorophyll content analyzed due GA_3-100ppm which might be due to enhanced cell division and increased chloroplast development in the plant that may contribute in improving chlorophyll content in leaves. These results are supported by Shairy and Hegazi (2009) [19] the effect of GA_3-100ppm, NAA-100ppm and salicylic acid-100ppm applied as foliar spray at different growth stages on chlorophyll content in pea. They reported significantly Increase in total chlorophyll content in leaves. Preeti *et al.* (2018) seeds were primed with salicylic acid (SA) @ 20 µg mL-1 and 40 µg mL-1 along with hydro priming for overnight and non-primed seeds as control before both sowings i.e., normal and delayed sowing.

Protein content: The higher protein content in seeds was also obtained with application of GA_3-100ppm. The higher protein content in seeds analyzed with GA_3-100ppm which attributed with increased in structural component of RNA molecules of amino acids and also GA_3 cause marked increase DNA, RNA and protein synthesis in ribosome which is known as site of protein synthesis in plants. The increase in protein content was also supported by Shairy *et al.* (2009) [19] conducted pot experiment to investigate the effect of acetylsalicylic acid (10 and 20 ppm), IBA (50 and 100 ppm) and GA_3 (50 and 100 ppm) on protein at different growth stages. They reported significantly increase in total soluble protein in pea and Jain *et al*. (2008) [10].

Table 3: Effect of plant growth regulators on chlorophyll content, nitrogen content (SPAD value) and protein content in mung bean during *kharif* season

	Chlorophyll content			Nitrogen content			Protein content (%)
Treatments	**20 DAS**	**40 DAS**	**60 DAS**	**20 DAS**	**40 DAS**	**60 DAS**	
Control	7.04	7.59	7.71	0.42	0.45	0.41	23.01
GA_3 (50ppm)	8.44	8.73	8.92	0.44	0.50	0.42	23.15
GA_3 (100ppm)	9.96	10.66	10.33	0.57	0.58	0.46	24.26
Salicylic acid (50ppm)	8.48	8.91	8.68	0.49	0.53	0.42	23.03
Salicylic acid (100ppm)	8.64	9.31	9.03	0.55	0.55	0.44	23.90
NAA (50ppm)	8.09	8.44	8.25	0.52	0.54	0.42	23.03
NAA (100ppm)	9.00	9.57	9.41	0.56	0.57	0.45	24.03
SEm±	0.43	0.27	0.23	0.02	0.02	0.02	0.31
CD at 5%	1.25	0.84	0.71	0.08	0.06	0.05	0.94

Fig 3: Effect of plant growth regulators on chlorophyll content, nitrogen content (SPAD value) and protein content in mungbean during *kharif* season

Yield and yield contributing parameters: The maximum number of pod clusters per plant and number of pods per plant, pod length ware recorded with seed priming of GA_3-100ppm. The above higher yield contributing parameters obtained with seed priming GA_3-100ppm which might be due to maximum net photosynthetic rate in leaves and better translocation of photosynthates and metabolites. Though, the way of various physiological mechanisms involves in the plant with seed priming of NAA-100ppm also played a significant role in enhancing above yield attributes up to some extent. The present finding is in accordance with Salman *et al.* (2015) reported that the response of seed priming and foliar application of plant growth regulators (GA_3), NAA and osmotic salicylic acid increase number of pod cluster per plant, 100 seed weight and seed yield per plants of the mung bean.

The higher number of seeds per plant obtained with seed priming of GA_3-100 ppm. 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 per plant. The Similar findings also reported by Ali and Muhsen (2014) [2]. The seed yield (q ha^{1}) was significantly affected with seed priming of various primers. Similar result was found by Ali and Mahmood (2013) [1].

The maximum seed yield (11.66 q ha^{1}) was found with seed priming of GA_3-100 ppm closely followed by seed priming with NAA-100 ppm (10.66 q ha^{1}) and seed priming with salicylic acid-50 ppm (9.66 q ha^{1}). The higher seed yield obtained with seed priming with GA_3-100 ppm which might be due to increased yield contributing parameters *viz.*, number of pods clusters and pods per plant, pod length, number of seeds per pod, number of seeds per plant, 100 seed weight and seed yield per plant which in combination contributed a lot in improving seed yield (q ha^1) of mungbean during present investigation. The higher harvest index (36.06%) was calculated with seed priming of GA_3-100 ppm followed by seed priming with NAA-100 ppm (35.55%). The present finding is closed conformity with Umair *et al.* (2011). These findings was accordance with Naqvi and Nooris (2014) [16] an experiment was conducted to determine the most effective PGRs for the optimum performance of chickpea cultivars and to select the most promising cultivar. The PGRs GA_3 (100ppm) and followed by NAA (100ppm). Were found in increasing of harvest index.

Table 4: Effect of seed priming on yield attributes of mungbean during *kharif* season

Treatments	Number of Pod Clusters per Plant	Number of Pods per Plant	Pod Length (Cm)	Number of Seed per Plant	Number of Seeds per pod	100 Seed Weight (g)	Seed yield (g) per plant	Seed yield per (q ha)	Harvest index (%)
Control	5.66	36.14	4.74	307.66	6.45	2.93	10.73	9.00	31.12
GA_3 (50ppm)	6.66	40.44	6.00	378.00	8.07	3.29	12.35	10.32	33.36
GA_3 (100ppm)	8.33	48.26	7.66	416.66	10.33	3.92	14.36	11.66	36.06
Salicylic acid (50ppm)	6.33	40.81	6.07	345.33	8.33	3.32	12.07	9.66	32.63
Salicylic acid (100ppm)	7.00	43.66	6.94	395.00	8.82	3.50	12.75	10.18	34.96
NAA (50ppm)	6.33	41.07	6.37	355.07	8.33	3.30	12.56	9.66	33.96
NAA (100ppm)	7.33	45.00	7.07	401.22	9.00	3.62	13.33	10.08	35.55
SEm±	0.32	1.29	0.40	16.54	0.35	0.15	0.41	0.24	0.50
CD at 5%	0.98	3.21	1.23	48.26	1.06	0.46	1.26	0.73	1.47

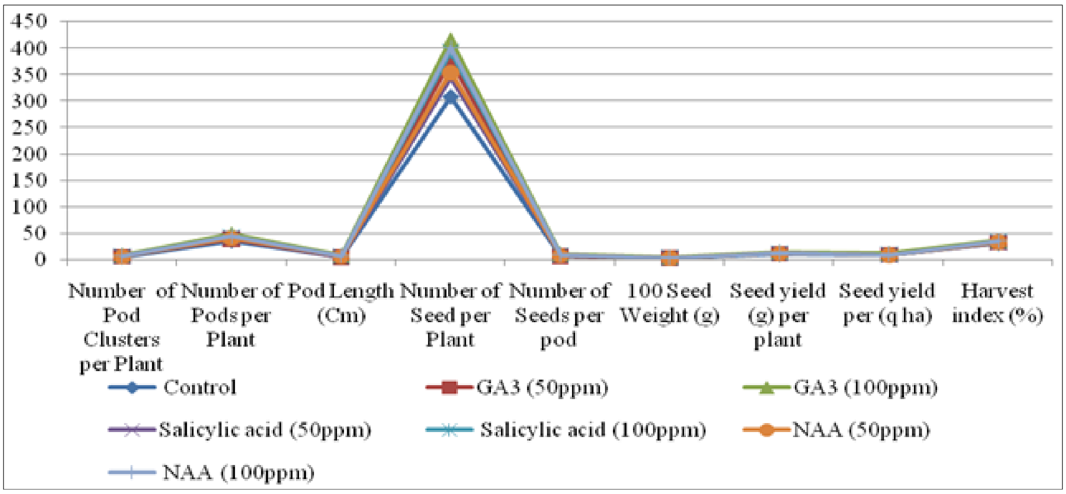

Fig 4: Effect of seed priming on yield attributes of mung bean during *kharif* season

Conclusion

It can be concluded that seed priming of GA_3 at 100ppm and NAA at 100ppm was an effective treatment to increase mung bean growth, photosynthetic pigments, metabolic activities, yield, yield components, and chemical composition of the yielded seeds as low input technology for improving the yield of mung bean. It was a needed complementary research on mungbean as double purpose crop (forage and seed).

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