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EFFECTS OF GA_3 ON GROWTH, YIELD AND PIGMENTS CONTENT OF MUNGBEAN (*VIGNA RADIATA* L. WILCZEK)

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Abstract

A field trial was carried to explore the effect of GA_3 (foliar, seed soaking or both) on growth, yield and photosynthetic pigments content of BARI Mung-6. The trial comprised of ten treatments *viz.* T_0 = Control (Distilled water), T_1, T_2 and T_3 = seed soaking with 25, 50 and 100 ppm GA_3 respectively; T_4, T_5 and T_6 = foliar spray of 25, 50 and 100 ppm GA_3 respectively; T_7 = 12.5 ppm GA_3 as seed soaking + 12.5 ppm GA_3 as foliar spray, T_8 = 25 ppm GA_3 as seed soaking + 25 ppm GA_3 as foliar spray and T_9 = 50 ppm GA_3 as seed soaking + 50 ppm GA_3 as foliar spray. Results revealed that foliar spray of 50 ppm GA_3 produced significantly taller plant (48.0 cm) than all other treatments although statistically identical to 25 ppm foliar treatment. The maximum number of branches (5.17) and leaves per plant (17.33), highest dry weight of leaves (0.73 g) and roots were noted from 25 ppm foliar application. Foliar application of 25 ppm GA_3 also produced higher shoot-root ratio, biomass duration, absolute growth rate and relative growth rate than control. Outcome indicated that the highest number of pods per plant (5.50), longest pod (8.01cm), highest fresh (3.60 g) and dry weight (2.99 g) of pods, maximum number of seeds per plant (49.00), 1000-seed weight (47.72 g), yield per plant (2.34 g), yield per hectare (0.78 ton) and harvest index (62.46%) were obtained from 25 ppm foliar GA_3 treatment. Increase in yield per plant due to foliar application of 25 ppm GA_3 was 42.88% higher than control followed by seed soaking with 50 ppm (18.29%), 50 ppm foliar + 50 ppm seed soaking (13.42%) and seed soaking with 25 ppm (10.37%) treatments, respectively. Pigments content of leaves was remarkably influenced by GA_3 treatments but varies depending on the methods application, concentration and plant growth. Out of ten treatments, foliar spray of 25 ppm GA_3 produced better stimulation.

Keywords: Growth, Yield, Pigments, BARI Mung-6, GA_3

Introduction

Mungbean (*Vigna radiata* L. Wilczek) is one of the most important pulse crops and an excellent source of vegetable protein of Bangladesh. Among the pulse crops, it is the only crop that can be grown in three seasons (BARI, 2008) and can contribute a lot to meet up the demand of pulses. Seeds contains 1-3 % fat, 50.4 % carbohydrates, 4 % minerals, 3 % vitamins, 10 % moisture, 3.5-4.5 % fibers and 4.5-5.5 % ash with significant amount of

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calcium and phosphorus (Frauque *et al*., 2000). In addition, the mature seeds supply an invaluable source of digestible protein for humans where meat is deficient (AVRDC, 2012). Mungbean is mostly grown in alternation with cereal crops having its short duration, least care, nominal input, and drought liberal nature. In cereal cropping system it can also boost sustainability of agriculture by increasing farm income and saving irrigation, water (Hussain *et al.,* 2012).

The yield of mungbean is very low than the other legumes *viz*. grasspea, chickpea and lentil (FAO, 2007). Bangladesh faces an acute shortage of pulses and yield of pluses should be improved immediately to meet up the national demand, avoid import as well as to save foreign currency. This demand needs urgent boost up in the crop yield from existing area where, use of plant growth regulators plays dramatic role. Plant growth regulators (PGRs) are magic substances that can modify various physiological processes of plants in minute concentration (Tan *et al.*, 2012). However, the success of these chemicals depends on concentration, timing and different modes of application (Sachin-Kumar *et al.,* 2018).

Gibberellic acid (GA_3) at appropriate concentrations has inducing effect in promoting growth and yield of a number of plants throughout the world *viz.* strawberry (Asadi *et al.,* 2013), cowpea (Nabi *et al.,* 2014), okra (Mohammadi *et al*., 2014), eastern black walnut (Parvin *et al.,* 2015), chickpea (Jahan *et al.,* 2018) etc. In Bangladesh, limited study has been done regarding the application of GA_3 on mungbean varieties (Hoque and Haque, 2002 and Tasnim *et al.*, 2019) and there is no recommended dose for the application of this hormone at farmer level. Therefore, the current investigation was taken to assess the effect of GA_3 on growth, yield and photosynthetic pigments of BARI Mung-6.

Materials and Methods

A field experiment was carried out at the research field of the botanical garden of the Jagannath University, Dhaka during Kharif-1 (April-June) season. The trial was laid out in a RBD with three replications. Seed of a high yielding, photoinsensitive and mungbean yellow mosaic virus tolerent variety of mungbean var. BARI Mung-6 was collected from BARI (Bangladesh Agricultural Research Institute), Joydebpur, Gazipur. The soil of the experimental land was prepared conventionally. The area of the experimental field was 33 m^2 area having foot paths of 50 cm in between. The size of the individual plot was approximately 0.366 m^2. The inter row spacing was 30cm with an inter plant spacing of 10 cm. Recommended amount of cow-dung (7,790 kg/ha) and chemicals fertilizer *viz.* urea (44 kg/ha), TSP (100 kg/ha), MP (40 kg/ha) and boric acid (7.5 kg/ha) were applied as described in FRG (2012). Seeds were surface sterilized with 0.05 % calcium hypochlorite solution to avoid fungal infection. Gibberellic acid (GA_3) was used as seed soaking, foliar spray alone and in combination in this investigation. Seeds were soaked with water (control) and different concentrations (25, 50 and 100 ppm) of GA_3 for 24 hours. The trial comprised of ten treatments *viz.* T_0 = Control (Distilled water), T_1, T_2 and T_3 = seed soaking with 25, 50 and 100 ppm GA_3 respectively; T_4, T_5 and T_6 = foliar spray of 25, 50 and 100 ppm GA_3 respectively; T_7 = 12.5 ppm GA_3 as seed soaking + 12.5 ppm GA_3 as foliar spray, T_8 = 25 ppm GA_3 as seed soaking + 25 ppm GA_3 as foliar spray and T_9 = 50 ppm GA_3 as seed soaking + 50 ppm GA_3 as foliar spray. Foliar spray was given at the age of 21 days in sunny morning. Cultural practices and fertilizer application were maintained as described by (Chowdhury and Hassan, 2013).

Growth parameters and yield parameters were recorded at harvest. Biomass duration, absolute growth rate and relative growth rate were analyzed following standard methods (Sestak *et al.,* 1971 and Gardner *et al.,* 1985). Photosynthetic pigment content of leaves were estimated at flowering, pod filling and harvest stages with the help of approved procedures (Mckinney, 1940; von Wettstein, 1957; Maclachalan and Zalik, 1963). Six plants (2 from each replication) were collected separately to record data on various parameters. Collected data were subjected for statistical analysis and treatment means were compared by LSD test at 5% level of significance (Steel *et al.*, 1997).

Results and Discussion

Results presented in Table 1 revealed that plant height of BARI Mung-6 was positively influenced following different GA_3 treatments where significantly taller plants were noted from foliar application of 50 and 100 ppm treatments although identical to each other. Similar results of increases due to GA_3 treatments have been found in various plants by different researchers (Houque and Hauque, 2002; Mohammadi *et al*., 2014; Nabi *et al*., 2014, Rahman *et al.*, 2015, Jahan *et al.*, 2018 and Tasnim *et al.*, 2019).

Number of branches of BARI Mung-6 responded differently by different GA_3 treatments although, seed soaking treatments produced better stimulations than foliar spray alone and in combination with an exception (Table 1). However, the highest number of branches per plant (5.17) was noted from 25 ppm foliar GA_3 treatment but statistically identical to all other treatments. Positive responses in number of branches per plant due to GA_3 treatments have also been observed in cowpea (Nabi *et al*., 2014), chickpea (Jahan *et al.*, 2018) and mungbean (Tasnim *et al.,* 2019). Although, Asadi *et al*., (2013) did not find any significant response of GA_3 application on strawberry. Thus, the current results are in harmony with the results of earlier works.

Application of GA_3 had inducing effects on the number of leaves per plant of BARI Mung-6 except 100 ppm foliar GA_3 alone and 50 ppm GA_3 as seed soaking + 50 ppm GA_3 as foliar spray treatment but with insignificant variations (Table 1). Nabi *et al*., (2014) recorded increased number of leaves due to GA_3 application on cowpea. Findings indicated that biomass of leaves, stem and root per plant were positively stimulated following GA_3 treatments but with few exceptions.

Foliar application of 100 ppm GA_3 produced maximum biomass of leaves and root where the number of leaves per plant was significantly higher than the control. But in case of dry weight of stem, foliar spray of 100 ppm GA_3 produced significantly higher weight of stem than control. Outcome of the present investigation are fairly supported to the results of Jahan *et al.,* 2018 on chickpea. Shoot-root ratio of BARI Mung-6 was both positively and negatively influenced by GA_3 treatments with non-significant variations. By applying IAA as growth promoting substance, Sen (2015) also recorded similar results in BARI mung-6.

Results obtained from Table 1 indicated that foliar spray of GA_3 had inducing responses on biomass duration of BARI Mung-6 where 25 ppm resulted significantly higher biomass duration than control. Although, the maximum BMD (11.26) was noted from combination of 12.5 ppm foliar and 12.5 ppm seed soaking treatments but statistically identical to the seed soaking with 100 ppm, foliar spray of 25 and 50 ppm treatments. Present results are in accord with the outcome of Sen (2015) in BARI Mung-6. Outcome revealed that absolute growth rate and relative growth rate were positively stimulated following GA_3 application except due to seed soaking treatment with 100 ppm in both the cases and foliar spray of 50 ppm in case of relative growth rate. Current findinmgs are in agreement with report of Nabi *et al*., (2014) on cowpea.

Yield parameters of BARI Mung-6 were both positively and negatively influenced depending on the concentrations and methods of GA_3 application (Table 2).

Foliar application of 25 ppm GA_3 and seed soaking with 25 ppm GA_3 and 50 ppm foliar+50 ppm seed soaking treatments resulted higher number of pods per plant but statistically identical to the rest of the treatments. Increase in number of pod per plant due to this GA_3 treatments has been obtained by Nabi *et al.*, (2014) and Tasnim *et al.,* (2019). However, Rahman *et al., (*2015) recorded both increase and decrease in number of fruits per plant in tomato due to GA_3 treatments. Thus, the present results are in agreement with the findings of previous results. Results revealed that length of pods were increased following most of the GA_3 treatments and the maximum length (8.01 cm) was obtained from foliar application of 25 ppm treatment. The stimulative effect of GA_3 on pod length was observed by Nabi *et al*., (2014) on cowpea. However, Mohammadi *et al.,* (2014) found non-significant effect on pod length in okra.

Findings showed that increases in fresh and dry weight of pods per plant were noted from seed soaking with 25, 50 ppm, foliar spray of 25 ppm and 25 ppm foliar+25 ppm seed soaking treatments only with similar statistical valuesr. Application of 25 ppm foliar GA_3 had resulted significantly higher fresh and dry weight of pods than control. Significant increase in fresh and dry weight of pods were also noted from the experiment of Hoque and Haque, (2002), Nabi *et al*., (2014) and Jahan *et al.*, (2018). Thus, the outcome are in accord with the findings of previous research. Number of seeds per pod was found to increase following all GA_3 application except 100 ppm foliar application but affected non-significantly. Similar results of increases in the number of seeds per pod following GA_3 were found by Mohammadi *et al*., (2014), Jahan *et al.,* (2018) and Tasnim *et al.,* (2019). However, Nabi *et al*., (2014) recorded both positive and negative responses following GA_3 treatments in cowpea. Application of 25 ppm GA_3, seed soaking with 25 ppm GA_3 and combination of 50 ppm foliar+50 ppm seed soaking treatments produced higher number of pods per plant although statistically similar to each other. This result is very much resembled to the findings of Hoque and Haque (2002) and Tasnim *et al.,* (2019). Weight of 1000-seed was both significantly and non-significantly affected by different GA_3 treatments (Table 2). Foliar application of 25 ppm foliar treatment resulted maximum 1000-seeds weight (47.72 g) which was significantly higher than control but statistically identical to 25 (T_1) and 50 ppm (T_2) seed soaking treatment, 12.5 ppm foliar+12.5 ppm seed soaking treatment (T_7) and 50 ppm foliar+50 ppm seed soaking treatment (T_7). These results are in fully agreement with the reports of Nabi *et al*., (2014) on cowpea, Jahan *et al.,* (2018) on chickpea and Tasnim *et al,* (2019) on mungbean. However, Mohammadi *et al*., (2014) reported that 100-seeds weight of okra was not affected by GA_3 application. Thus, the findings of current study are in concurrence with the outcome of previous workers.

Yield per plant and yield per hectare were both positively and negatively influenced following GA_3 application (Table 2). Seed soaking with 25, 50 ppm GA_3, foliar application of 25 ppm GA_3 and 50 ppm foliar + 50 ppm seed soaking treatments resulted higher yield per plant and yield per hectare although statistically identical to each other but significantly different from rest of the treatments. Foliar application of 25 ppm GA_3 as foliar treatment produced 42.88% higher yield than control followed by seed soaking with 50 ppm (18.29%), 50 ppm foliar + 50 ppm seed soaking (13.42%) and seed soaking

Table 1. Effects of GA_3 on growth parameters of BARI Mung-6 at harvest.

Treatments	Height (cm)	No.of branches/ plant	No. of leaves/ plant	Dry weight of leaves/ plant (g)	Dry weight of stem/ plant (g)	Dry weight of root/ plant (g)	Shoot-root ratio	Biomass duration	Absolute growth rate (g/day)	Relative growth rate (g/g/day)
T_0	39.55c	4.33	15.00	0.46bc	0.54bc	0.20	5.49	8.51bc	-0.02c	0.00cd
T_1	40.45bc	4.67	16.00	0.53a-c	0.53c	0.26	3.99	8.33bc	0.04a-c	0.03a-d
T_2	42.18bc	4.67	16.00	0.45bc	0.69a-c	0.19	6.69	7.83bc	0.08ab	0.07a-c
T_3	43.45bc	5.00	17.00	0.52bc	0.54bc	0.23	4.81	9.23ab	-0.03c	-0.02d
T_4	43.23bc	5.17	17.33	0.73a	0.77a-c	0.27	6.52	11.12a	0.05ab	0.04a-d
T_5	48.00a	5.00	17.00	0.56a-c	0.52c	0.25	4.63	9.52ab	-0.01bc	-0.01cd
T_6	44.58ab	4.17	14.50	0.46bc	0.80a	0.25	5.09	8.66bc	0.11a	0.09ab
T_7	42.07bc	4.23	16.50	0.64ab	0.79ab	0.20	9.05	11.26a	0.01bc	0.01b-d
T_8	43.38bc	5.00	17.00	0.52bc	0.65a-c	0.18	6.07	7.62bc	0.11a	0.11a
T_9	41.8bc	3.83	13.50	0.43c	0.53c	0.20	5.30	7.14c	0.05a-c	0.05a-d
CV (%)	9.26	23.06	20.14	29.51	31.07	30.62	48.07	20.99	193.20	166.05
LSD (0.05)	4.14	NS	15.00	0.20	0.25	NS	NS	2.26	0.09	0.08

Mean followed by same letter (vertically) or without letter are statistically similar at 5 % level.
[T_0 = Control (Distilled water), T_1, T_2 and T_3 = seed soaking with 25, 50 and 100 ppm GA_3 respectively; T_4, T_5 and T_6 = foliar spray of 25, 50 and 100 ppm GA_3 respectively; T_7 = 12.5 ppm GA_3 as seed soaking + 12.5 ppm GA_3 as foliar spray, T_8 = 25 ppm GA_3 as seed soaking + 25 ppm GA_3 as foliar spray and T_9 = 50 ppm GA_3 as seed soaking + 50 ppm GA_3 as foliar spray]

Table 2. Effects of GA_3 on yield parameters of BARI Mung-6 at harvest.

Treatments	No. of pods/plant	Length of pod (cm)	Fresh weight of pods/plant (g)	Dry weight of pods/ plant (g)	No. of seeds/ pod	No. of seeds/ plant	1000-seeds weight (g)	Yield/ plant (g)	Yield / hectare (ton)	Harvest index (%)
T_0	4.50a-c	7.25	2.32b-d	1.85b-d	8.46	37.83a-d	43.18cd	1.64a-d	0.55a-d	60.33ab
T_1	4.50a-c	7.54	2.69a-c	2.20a-c	9.28	39.83a-d	45.47a-c	1.81a-c	0.60a-c	60.33ab
T_2	4.17a-c	7.62	2.84ab	2.40ab	9.30	41. 83a-c	46.35ab	1.94ab	0.65ab	61.55ab
T_3	3.00cd	7.19	1.76cd	1.31d	8.36	25.50cd	43.32cd	1.11cd	0.37cd	49.99de
T_4	5.50a	8.01	3.60a	2.99a	9.88	49.00a	47.72a	2.34a	0.78a	62.46a
T_5	3.67b-d	7.25	1.98b-d	1.63b-d	8.56	30.83b-d	42.68cd	1.32b-d	0.44b-d	52.95cd
T_6	3.00cd	7.62	1.82cd	1.43cd	9.54	28.50b-d	45.08b-d	1.29b-d	0.43b-d	47.64e
T_7	2.17d	7.75	1.43d	1.23d	9.95	20.83d	46.42ab	0.97d	0.32d	40.71f
T_8	4.83ab	7.40	2.66a-c	2.29a	8.95	43.17ab	43.00d	1.86a-c	0.62ab	61.26ab
T_9	3.50b-d	7.75	2.16b-d	1.80b-d	9.75	33.00a-d	45.98ab	1.49b-d	0.50b-d	56.53bc
CV (%)	49.06	8.15	54.31	49.42	12.36	49.74	5.96	50.79	50.67	22.14
LSD (0.05)	1.81	NS	0.97	0.81	NS	17.18	2.36	0.78	0.26	5.28

Mean followed by same letter (vertically) or without letter are statistically similar at 5 % level.
[T_0 = Control (Distilled water), T_1, T_2 and T_3 = seed soaking with 25, 50 and 100 ppm GA_3 respectively; T_4, T_5 and T_6 = foliar spray of 25, 50 and 100 ppm GA_3 respectively; T_7 = 12.5 ppm GA_3 as seed soaking + 12.5 ppm GA_3 as foliar spray, T_8 = 25 ppm GA_3 as seed soaking + 25 ppm GA_3 as foliar spray and T_9 = 50 ppm GA_3 as seed soaking + 50 ppm GA_3 as foliar spray]

Table 3. Effects of GA_3 on photosynthetic pigment of BARI Mung-6 at three different stages.

Treatments	Flowering stage			Pod filling stage			At harvest		
	Chl.a	Chl.b	Carotenoids	Chl.a	Chl.b	Carotenoids	Chl.a	Chl.b	Carotenoids
T_0	0.39bc	0.12bc	2.16bc	0.25bc	0.10	1.87	0.45bc	0.17bc	3.42cd
T_1	0.37bc	0.14bc	2.61bc	0.46bc	0.22	3.38	0.86a	0.25ab	5.19ab
T_2	0.15c	0.06c	0.99c	0.61ab	0.33	4.07	0.77a	0.26ab	5.40a
T_3	0.31c	0.15bc	2.14bc	0.31bc	0.15	3.15	0.61ab	0.22ab	4.57a-c
T_4	0.22c	0.13bc	2.05bc	0.61ab	0.40	2.57	0.29c	0.18a	3.37cd
T_5	0.67ab	0.25ab	3.45ab	0.08c	0.07	1.86	0.36bc	0.27a	4.66a-c
T_6	0.74a	0.27ab	2.59bc	0.34bc	0.16	2.02	0.23cd	0.18ab	4.16a-d
T_7	0.82a	0.32a	2.69bc	0.09c	0.09	2.45	0.08d	0.08c	2.65d
T_8	0.65ab	0.24ab	4.91a	0.87a	0.43	5.41	0.40bc	0.19ab	3.79b-d
T_9	0.24c	0.15bc	1.96bc	0.89a	0.44	4.31	0.43bc	0.22ab	4.23a-c
CV (%)	61.61	53.21	54.41	77.39	71.88	50.71	73.10	44.11	35.36
LSD (0.05)	0.33	0.16	1.77	0.39	NS	NS	0.25	0.09	1.53

Mean followed by same letter (vertically) or without letter are statistically similar at 5 % level.
[T_0 = Control (Distilled water), T_1, T_2 and T_3 = seed soaking with 25, 50 and 100 ppm GA_3 respectively; T_4, T_5 and T_6 = foliar spray of 25, 50 and 100 ppm GA_3 respectively; T_7 = 12.5 ppm GA_3 as seed soaking + 12.5 ppm GA_3 as foliar spray, T_8 = 25 ppm GA_3 as seed soaking + 25 ppm GA_3 as foliar spray and T_9 = 50 ppm GA_3 as seed soaking + 50 ppm GA_3 as foliar spray]

with 25 ppm (10.37%) treatments respectively. Outcome revealed that treatments *viz.* seed soaking with 25 ppm GA_3, foliar application of 25 ppm GA_3 and 50 ppm foliar + 50 ppm seed soaking produced higher harvest index than control although statistically similar to each other. Results obtained in case of yield per plant and harvest index are in agreement with the results of many workers on various plants *viz.* mungbean (Hoque and Haque, 2002, Tasnim *et al.,* 2019), cowpea (Nabi *et al*., 2014) and chickpea (Jahan *et al.,* 2018).

Photosynthetic pigment content was positively affected by most of the GA_3 treatments at three stages *viz.* flowering, pod filling and at harvest with both significant and non-significant variations (Table 3). At flowering stage, chlorophyll a content was recorded higher due to foliar application of 50 and 100 ppm, 25 ppm foliar +25 ppm seed soaking and 50 ppm foliar +50 ppm seed soaking treatments only where foliar application of 100 ppm and 12.5 ppm foliar +12.5 ppm seed soaking treatments resulted significantly superior than control. Results raveled that chlorophyll a contents of leaves at pod filling stage were noted maximum from 50 ppm foliar +50 ppm seed soaking treatment followed by and 25 ppm foliar +25 ppm seed soaking treatments where both the treatments produced significantly higher chlorophyll a content than the control treatment. In case of harvest, higher amount of Chl.a has been estimated from seed soaking of 25, 50 and 100 ppm treatments where 25 and 50 ppm GA_3 produced significantly higher amount than the control. Results of the present exploration also show that different concentration of GA_3 as foliar or seed soaking and in combination had positive effects on chlorophyll b and carotenoids content of leaves at three stages with few exceptions (Table 3). The affirmative effects of GA_3 on the photosynthetic pigments was reported by Rahman *et al.,* (2015) on tomato and Jahan *et al.,* (2018) on chickpea. Thus, the results are in compliance with the conclusion of other workers.

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