Bangladesh J. Bot. **53**(3): 459-464, 2024 (September) DOI: https://doi.org/10.3329/bjb.v53i3.76254

FOLIAR APPLICATION OF IAA AND GA_3 ON GRWOTH AND YIELD ATTRIBUTES OF MUNGBEAN (*VIGNA RADIATA* L. R. WILCZEK)

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Keywords: BARI Mung-6, Gibberellic Acid (GA_3), Indole Acetic Acid (IAA), Plant growth regulators, *Vigna radiata*

Abstract

A field experiment was conducted to assess the effects of foliar application of Indole acetic acid (IAA) and Gibberellic acid (GA_3) on the growth and yield of mungbean (BARI Mung-6) plants. Nine treatments were administered, including various concentrations of IAA and GA_3, applied individually and in combination. The experiment followed a randomized complete block design (RCBD) with three replications, data were recorded on growth and yield parameters at 30 days after sowing (DAS) and at harvest. Results indicated that treatment T_8 (IAA 50 mg/l + GA_3 50 mg/l) significantly enhanced growth and yield attributes. Notably, T_8 exhibited the highest values for plant height (57.50 cm), number of leaves per plant (47.33), number of branches per plant (7.67), chlorophyll content (55.14 SPAD value), shortest duration to 80% flowering (35.33 days) with 80% pod maturity (55.33 days), number of pods per plant (37.67), pod length (14.99 cm), number of seeds per pod (13.78), weight of 1000 seeds (54.95g), seed yield (1.68 t/ha), biological yield (3.52 t/ha), and harvest index (47.73%). Conversely, the untreated control (T_0) exhibited the lowest performance across all parameters. Therefore, foliar application of IAA and GA_3, particularly at 50 mg/l concentration each, demonstrated significant improvements in growth, yield, and related attributes of mungbean.

Introduction

Pulses, renowned for their high protein content and essential nutrients, play a pivotal role in providing sustenance, particularly in developing nations where they are known as the "poor man's meat". Mungbean (*Vigna radiata* L. R. Wilczek) belongs to the family Fabaceae holds a significant position owing to its nutritional richness and adaptability to diverse agricultural systems (Raina *et al.* 2016). It offers a valuable dietary supplement, especially in regions like Bangladesh where it holds cultural and economic importance (Islam *et al.* 2017, Noble *et al.* 2018).

Despite its nutritional benefits and adaptability, the cultivation of mungbean faces challenges, including declining production trends (Bangar *et al.* 2019). In Bangladesh, where mungbean holds strategic importance in the agricultural economy, the need to enhance its yield becomes imperative to meet growing food demands (BBS 2019). BARI Mung-6 and BARI Mung-8 are the high-yielding varieties but the yield in the farmer's field is very low as compared to their yield potential (Islam *et al.* 2020). Factors such inadequate production technologies contribute to suboptimal yields, emphasizing the urgency for innovative cultivation approaches (Haque *et al.* 2014).

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Plant growth regulators (PGRs) emerge as promising tools to address yield constraints in mungbean cultivation (Giannakoula *et al.* 2012). Their application offered opportunities to manipulate growth processes, enhance physiological functions, and optimize yield potentials (Ammanullah *et al.* 2010). Among these regulators, indole-3-acetic acid (IAA) and gibberellic acid (GA_3) stood out for their roles in promoting growth, development, and yield enhancement in various crops (Choudhury *et al.* 2013, Sadak *et al.* 2013).

Understanding the specific effects of IAA and GA_3 on mungbean growth and yield parameters becomes paramount for devising effective cultivation strategies. This study aims to assess the impact of these plant growth regulators on mungbean growth and yield parameters. By identifying optimal concentrations of IAA and GA_3, the research seeks to provide insights into enhancing mungbean productivity and quality.

Materials and Methods

The experiment was conducted at the research field of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh, located at 23.74° N latitude and 90.35° E longitude, with an elevation of 8.2 m above sea level. For this experiment high yielding mungbean variety BARI Mung-6 was selected (Islam *et al.* 2020) and seeds were obtained from Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur. The experimental design employed was a randomized complete block design (RCBD) with three replications. The total area allocated for the experiment was 300 m^2, divided into three blocks, each consisting of nine plots. Hence, there were a total of 27 unit plots, each measuring 3 m × 2 m. Distances between plot to plot and replication to replication were maintained at 0.50 m and 1.00 m, respectively. The experiment comprised of nine treatments including an untreated control, i.e. T_0 (Control – without IAA and GA_3), T_1 (IAA 25 mg/l), T_2 (IAA 50 mg/l), T_3 (GA_3 25 mg/l), T_4 (GA_3 50 mg/l), T_5 (IAA 25 mg/l + GA_3 25 mg/l), T_6 (IAA 25 mg/l + GA_3 50 mg/l), T_7 (IAA 50 mg/l + GA_3 25 mg/l), T_8 (IAA 50 mg/l + GA_3 50 mg/l). Fertilization followed recommendations from BARI, involving urea, TSP, and MoP. Standard practices were employed for thinning, weed control, irrigation, and drainage. Treatments were applied to plants at 30 days after sowing (DAS) as foliar spray.

Data collection included various parameters such as plant height (cm), number of leaves per plant, number of branches per plant, chlorophyll content (SPAD value), days to 80% flowering, days to 80% pod maturity, pods per plant, pod length (cm), seeds per pod, 1000 seeds weight (g), grain yield (t/ha), stover yield (t/ha), biological yield (t/ha), and harvest index (%). Statistical analysis was performed using the analysis of variance (ANOVA) technique with the aid of the R computer package program. Treatment means were compared using Duncan's New Multiple Range Test (DMRT).

Results and Discussion

Application of IAA and GA_3 alone and together with different concentrations showed significant ($P < 0.05$) influence on the plant height, number of leaves and number of branches per plant of mungbean (Table 1). At 30 days after sowing (DAS), the tallest plants (19.17 cm) were observed in the T_1 treatment, while nearly all treatments exhibited statistically similar results except T_2 treatment. At harvest, the tallest plants (57.50 cm) were recorded in the T_8 treatment, contrasting with the shortest plants in T_0. This could be attributed to a greater number or length of internodes, potentially caused by an increase in cell quantity. The findings are consistent with the previous studies of Mojtaba *et al.* (2014). Similarly, the maximum number of leaves per plant (18.67) was recorded in T_2 at 30 DAS, while nearly all treatments exhibited statistically similar results except T_3. At harvest, the highest leaf count (47.33) was observed in T_8 whereas the lowest

(40.00) was found in T_0. Regarding branches per plant, no significant differences ($P > 0.05$) were observed among the treatments at 30 DAS. However, at harvest, the maximum number of branches per plant (7.67) was recorded in T_8, statistically similar to T_6, while the minimum (3.33) was observed in T_0. Rastogi *et al.* (2013) also observed similar results with IAA and GA_3. IAA a type of auxin and GA_3 a type of gibberellin has been shown to enhance plant growth and development by stimulating various processes including cell elongation, tissue growth, phototropism, lateral root initiation, vascular tissue differentiation etc. (Taiz and Zeiger 2006).

Table 1. Effects of IAA and GA_3 on mungbean plant height, leaf number, and branch count.

Treatments	Plant height (cm) at 30 DAS	Plant height (cm) at harvest	No. of leaves per plant at 30 DAS	No. of leaves per plant at harvest	No. of branches per plant at 30 DAS	No. of branches per plant at harvest
T_0	17.83 ab	40.50 g	17.67 ab	40.00 f	1.67 a	3.33 g
T_1	19.17 a	41.50 g	18.00 ab	40.67 ef	1.33 a	4.00 f
T_2	16.50 b	42.83 f	18.67 a	41.33 e	2.67 a	4.67 e
T_3	17.00 ab	44.67 e	17.00 b	43.00 d	1.67 a	5.33 d
T_4	18.50 ab	48.50 d	18.33 a	44.33 c	1.67 a	6.00 c
T_5	17.67 ab	49.50 d	18.00 ab	45.67 b	2.33 a	6.33 bc
T_6	17.17 ab	55.50 c	19.33 a	46.33 ab	2.33 a	7.33 a
T_7	17.83 ab	54.10 b	18.33 a	45.33 bc	1.67 a	6.67 b
T_8	17.33 ab	57.50 a	18.00 ab	47.33 a	2.00 a	7.67 a
Level of sig.	NS	**	NS	*	NS	**
CV %	8.55	9.16	5.63	7.24	6.08	9.61

Values having different letter(s) differ significantly at 1% and 5% levels of probability. ** and *= Significant at 1% and 5% levels of probability, respectively NS= Not significant, CV = Coefficient of variation. T_0 (Control – without IAA and GA_3), T_1 (IAA 25 mg/l), T_2 (IAA 50mg/l), T_3 (GA_3 25 mg/l), T_4 (GA_3 50 mg/l), T_5 (IAA 25 mg/l + GA_3 25 mg/l), T_6 (IAA 25 mg/l + GA_3 50 mg/l), T_7 (IAA 50 mg/l + GA_3 25 mg/l), T_8 (IAA 50 mg/l + GA_3 50 mg/l).

The application of IAA and GA_3, both individually and in combination showed significant effects ($P < 0.05$) on the chlorophyll content, days to 80% flowering and 80% pod maturity of mungbean (Fig. 1). At 45 DAS, the highest chlorophyll content (55.14 SPAD value) was observed in T_8, which was statistically comparable to T_6 and T_7. Conversely, the lowest chlorophyll content (42.33 SPAD value) was recorded in T_0 (Fig 1a). In case of days to 80% flowering, the T_0 exhibited the longest duration, requiring 41.67 days which was statistically similar to treatments T_1 and T_2 (Fig. 1b). In contrast, the shortest duration to reach 80% flowering (35.33 days) was noted in T_8, followed by T_6. Similarly, the T_0 demanded the maximum time (61.67 days) to attain 80% pod maturity, followed by T_1 and T_2 (Fig. 1b). Conversely, treatment T_8 exhibited the shortest duration (55.33 days) to achieve 80% pod maturity. The results demonstrated that IAA and/or GA_3 positively affect the constituents of photosynthetic pigments. These obtained results of different treatments are similar to those obtained by Sharma *et al.* (2020). The beneficial impact of IAA is likely due to its role in expanding leaf size and enhancing photosynthetic activity, as shown in Fig. 1a (Naeem *et al.* 2004). Furthermore, Atteya *et al.* (2018) revealed that gibberellic acid enhances the growth characteristics of *Simmondsia chinensis*.

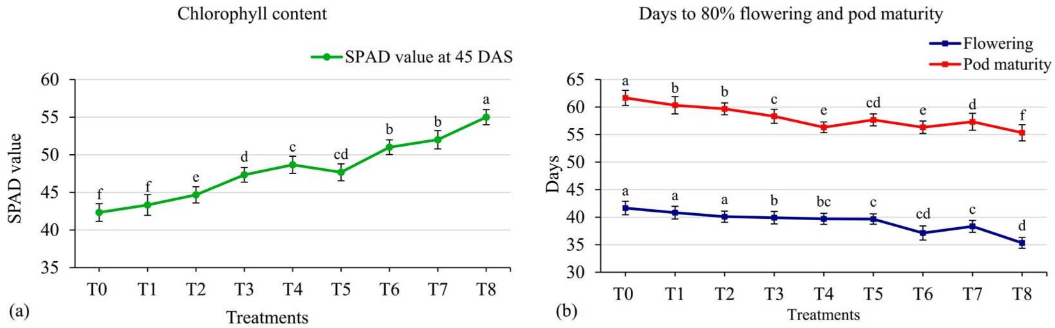

Fig. 1. Effects of IAA and GA_3 on chlorophyll content, 80% flowering, and 80% pod maturity in mungbean plants. Vertical bars represent standard error. Different letters indicate significant differences at 5% level of probability. DAS = Days after sowing. T_0 (Control – without IAA and GA_3), T_1 (IAA 25 mg/l), T_2 (IAA 50mg/l), T_3 (GA_3 25 mg/l), T_4 (GA_3 50 mg/l), T_5 (IAA 25 mg/l + GA_3 25 mg/l), T_6 (IAA 25 mg/l + GA_3 50 mg/l), T_7 (IAA 50 mg/l + GA_3 25 mg/l), T_8 (IAA 50 mg/l + GA_3 50 mg/l).

The application of various growth regulators significantly influenced ($P < 0.05$) yield-contributing parameters in mungbean. Notably, pods per plant, pod length, number of seeds per pod, and thousand seed weight exhibited considerable variations across different treatments (Table 2). In terms of pods per plant, the highest yield (37.67 pods) was achieved with T_8 which was followed by T_6 and T_7. It may result from breaking apical dominance in plants, increasing flowering branches and pod count. These findings supported by the prior research of Kumar *et al.* (2018). Pod length was also significantly affected by the treatments where T_8 demonstrated the longest pods (14.99 cm) while shortest (8.60 cm) was by T_0. Moreover, treatment T_8 showed the highest number (13.78) of seeds per pod. Furthermore, thousand seed weight exhibited significant variations across treatments where treatment T_8 yielded the highest thousand seed weight (54.95 g), followed by T_6, T_4 and T_7 treatments, respectively. The increase in seed weights may be due to the stimulating effects of IAA and/or GA_3, which enhance the production of assimilates and their movement from the leaves to the fruits (Kumar *et al.* 2018). These obtained results similar with the findings of Foysal (2014), indicating the consistent impact of growth regulators on enhancing pod characteristics and seed weight.

The application of plant growth regulators significantly impacted ($P < 0.05$) various yield parameters of mungbean (Fig. 2). In terms of seed yield, T_8 treatment emerged as the most effective, yielding 1.68 t/ha whereas, the control (T_0) was found to produce the lowest yield (Fig. 2a). This result supported by the previous research findings of Foysal (2014). In case of stover yield, T_7 treatment demonstrated the highest stover yield (1.93 t/ha) and the lowest with T_5 (Fig. 2a). These findings corroborate the observations made by Parvez *et al.* (2013). Biological yield, exhibited notable variations among different levels of growth regulators. T_8 treatment yielded the highest biological yield which was 3.52 t/ha (Fig. 2a). Harvest index, varied significantly ($P < 0.05$) across the treatments (Fig. 2b). T_8 treatment demonstrated the highest harvest index at 47.73%. These results accord with the previous findings of Quaderi *et al.* (2006). These findings indicate that IAA and/or GA_3 treatments increased yield and its attributes. IAA promotes stem elongation, growth rate and yield, while gibberellins enhance cell proliferation and elongation by removing growth-inhibiting proteins (Abdoli *et al.* 2013, Ubeda-Tomas *et al.* 2009).

Table 2. Effects of IAA and GA_3 on mungbean pod count, length, seeds per pod, and seed weight.

Treatments	No. of pods/ plant	Pod length (cm)	No. of seeds/ pod	Weight of 1000 seeds (g)
T_0	27.33 g	08.60 g	09.29 g	45.37 d
T_1	28.67 f	10.33 f	10.09 f	46.31 d
T_2	30.33 e	11.39 e	11.03 e	47.06 d
T_3	31.67 d	12.30 d	11.67 d	47.54 cd
T_4	33.67 c	13.29 bc	11.96 c	52.70 ab
T_5	33.33 c	12.76 cd	11.85 cd	50.55 bc
T_6	35.67 b	13.99 b	12.89 b	53.43 ab
T_7	35.33 b	13.88 b	13.03 b	52.55 ab
T_8	37.67 a	14.99 a	13.78 a	54.95 a
Level of sig.	**	**	*	**
CV (%)	6.79	5.34	2.98	3.92

Values having different letter(s) differ significantly at 1% and 5% levels of probability. ** and *= Significant at 1% and 5% levels of probability, respectively CV = Coefficient of variation.

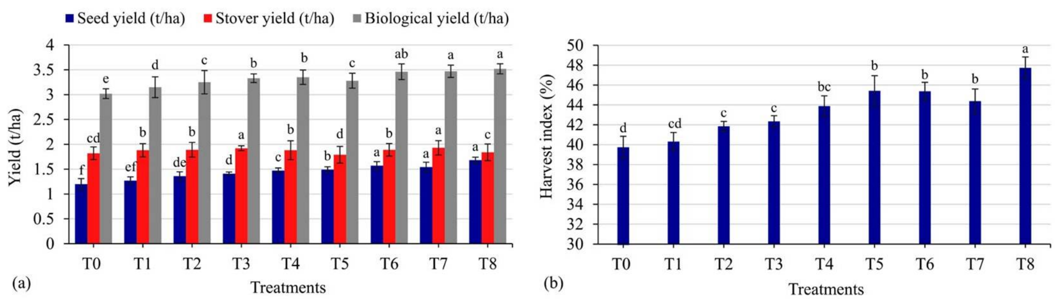

Fig. 2. Effects of IAA and GA_3 on seed yield, stover yield, biological yield, and harvest index in mungbean. Vertical bars represent standard error. Different letters indicate significant differences at 5% level of probability.

The study demonstrates that foliar application of IAA and GA_3 significantly enhances mungbean growth and yield parameters. Notably, treatment T_8 (IAA 50 mg/l + GA_3 50 mg/l) proved most effective, improving plant height, leaf and branch numbers, chlorophyll content, and yield attributes such as pods per plant, pod length, seed weight, and overall yield. These results highlight the potential of using these growth regulators to optimize mungbean production, supporting agricultural sustainability and food security.

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(Manuscript received on 10 March, 2024; revised on 10 August, 2024)