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# Effects of $GA_3$ and its Mode of Application on Morphology and Yield Parameters of Mungbean (*Vigna radiata* L.)

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**Abstract:** Two varieties of mungbean (*Vigna radiata* L.) were investigated for effects of seed treatment and foliar application of $GA_3$ at 0, 50, 100 and 200 ppm on the growth, yield and yield contributing characters. Seed treatment with $GA_3$ at 50 ppm increased plant height, number of leaves, fresh and dry weight of pod, number of seeds, 1000-seed weight, harvest index, while 200 ppm increased number of pods and 100 ppm increased pod length, seed weight per plant, seed yield (kg $ha^{-1}$). Foliar application of $GA_3$ at 200 ppm had higher plant height and number of leaf, while that at 100 ppm had greater number of pods, higher fresh and dry weight of pod, number of seeds, harvest index whereas 50 ppm of $GA_3$ resulted higher pod length, 1000-seed weight, seed yield per plant, seed yield (kg $ha^{-1}$). Between the mungbean varieties, $V_1$ (BARI-4) performed better than the $V_2$ (BARI-5) while the seeds were treated and an opposite result was found with foliar application of $GA_3$. Significant varietal differences were observed in terms of morphological characters studied. The study indicates a high potentiality to increase yield of mungbean in Bangladesh by the application of $GA_3$.

**Key words:** Mungbean, *Vigna radiata* L., $GA_3$

## Introduction

Mungbean (*Vigna radiata* L.) is an important pulse crop of global economic importance. It ranks fifth in acreage and sixth in production in Bangladesh (BBS, 1994). Total production of mungbean in Bangladesh in 1998-99 was 34,000 tons from an area of 1,37,000 acres (BBS, 1999). It is considered as poor man's meat because it is a good source of protein (Kaul, 1982). It contains almost double amount of protein as compared with cereals. It provides invaluable supplemental protein to a rice- based diet and can improve the nutritional value of food. It is easily digestible, good for all age groups and does not have any adverse effect on known diseases. Like other pulses, it is widely used as 'Dal' in Bangladesh and in other SAARC countries. Mungbean, being usually deep rooted plant, opens up soil by their penetrating root system where the roots decay and improve aeration, water percolation and add nitrogen to the soil resulting in the increase of soil fertility.

The daily consumption of pulses in Bangladesh is only 10 grams per head as compared with 45 grams in India. Production of pulses should be increased urgently to meet the demand of the people, to avoid import and save foreign currency, and to increase the pulse consumption. The yield of Mungbean is very low in Bangladesh, partly due to low yielding varieties and partly due to lack of appropriate agronomic practices. In spite of its importance and well adaptability to the agroclimatic condition of Bangladesh, the acreage production is decreasing gradually because of mounting competition from other profitable cereals, especially irrigated boro rice in medium high land (Ahmed, 1984). The crop has received very little attention by the researchers in comparison with other cereals and grain crops. However, it is of utmost necessity to improve the quantitative and qualitative values of mungbean. Various practices may help to achieve this goal. Application of growth regulators seem to be the most significant one in view of convenience, cost and labour efficacy.

Gibberellic acid ($GA_3$) can manipulate a variety of growth and developmental phenomena in various crops. It was reported to stimulate stem elongation (Deotale *et al.*, 1998; Abd El-Fattah, 1997) and increase dry weight (Hore *et al.*, 1988) as well as yield (Deotale *et al.*, 1998). In Bangladesh, very limited works have been carried out regarding the use of growth regulators in our climatic condition that could provide useful information to increase the mungbean production . Therefore, the present work was designed with the following objectives :

to study the effect of $GA_3$ on growth, development and yield of mungbean.

## Materials and Methods

The experiment was conducted at Department of Crop Botany, Bangladesh Agricultural University, Mymensingh during the period from October, 2000 to February, 2001. Two varieties of mungbean namely BARI moog-4 ($V_1$) and BARI moog-5 ($V_2$) collected from the Bangladesh Agricultural Research Institute, Joydebpur, Gazipur were used in this study.

The land of the experimental site was first opened with a power tiller. After ploughing and laddering all the stubbles and uprooted weeds were removed to make the land ready for sowing and the basal dose of fertilizers was incorporated thoroughly before planting (BARC, 1997). The experiment was laid out in randomized complete block design (RCBD) with 3 replications. The whole area was divided into 3 blocks and each block into 16 unit plots. The size of the unit plot was 2 $m^2$ and the distance between plots was 0.5 m. The plots were raised up to 15 cm from the soil surface. The seeds of mungbean were sown in rows made by hand plough on October 24, 2000. The distances between rows and seeds were 30 and 15 cm, respectively and 2 seeds were placed in each point at 2-3 cm depth. Seedlings were transferred to fill up the gaps where seeds failed to germinate. Irrigation was done as per necessity. The crop field was weeded twice: First weeding followed by thinning was done at 15 days after sowing (DAS) and second weeding was done at 45 DAS. Dimecrone 50 EC was sprayed @ 1 L $ha^{-1}$ to prevent pod borer infestation as and when required. $GA_3$ solutions for various treatments ($T_1$, Control; $T_2$, 50ppm; $T_3$, 100ppm and $T_4$, 200ppm of $GA_3$) were prepared two times first for seed treatment and second for spraying according to the procedure of Roy *et al.* (1991).

The first crop sampling was done on 15 days after sowing (DAS) and it was continued at an interval of 10 days till on 55 DAS. At the time of each harvest, five plants were selected randomly from each plot. The sampling was done until maturity. Morphological characters like plant height (cm) and number of leaves per plant, were recorded. Following yield contributing characters were studied: Number of pods/plant, pod length (cm), fresh weight of individual pod (g), dry weight of individual pod (g), number of seeds/pod, thousand seeds weight (g), seed weight/plant (g), seed yield (kg $ha^{-1}$), harvest index (HI). The data collected on different parameters under the experiment were statistically analysed to obtain the level of significance using the MSTAT-computer package programme developed by Russel (1986). The differences between pairs of means were compared by Duncan's Multiple Range Test (DMRT).

## Results and Discussion

Plant height was recorded at 10 days interval starting from 15 days after sowing (DAS) to 55 DAS. It revealed that both seed treatment and foliar spray of $GA_3$ had stimulatory effect on plant height (Table 1). Application of $GA_3$ at 50 ppm had superiority over 100 and 200 ppm in producing taller plants at all growth stages (Table 1) while, 100 ppm $GA_3$ stimulated stem elongation more efficiently than other treatments at the early stage (up to 35 DAS). However, like seed treatment, 50 ppm $GA_3$ became the most efficient treatment at the final stage (Table 1). BARI-4 had higher plant height, especially at the final stage. On the other hand, BARI-

Table 1: Morphological characters of mungbean as influenced by pre-sowing seed treatment and foliar spray with $GA_3$

| Treatments | Plant height (cm) | | | | | Number of leaves / plant | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 15 DAS | 25 DAS | 35 DAS | 45 DAS | 55 DAS | 15 DAS | 25 DAS | 35 DAS | 45 DAS | 55 DAS |
| **Pre-sowing seed treatment** | | | | | | | | | | |
| $T_1$ | 8.42 b | 19.14 ab | 25.86 | 29.50 b | 30.88 c | 3.00 | 4.22 ab | 5.55 ab | 6.39 b | 7.12 b |
| $T_2$ | 10.37 a | 19.42 ab | 26.75 | 30.67 a | 32.78 a | 3.00 | 4.28 a | 5.78 a | 6.89 a | 7.56 a |
| $T_3$ | 10.07 a | 18.89 b | 26.31 | 29.72 b | 31.33 bc | 3.00 | 4.11 bc | 5.37 ab | 5.82 c | 7.11 b |
| $T_4$ | 9.31 ab | 19.59 a | 26.21 | 30.00 ab | 32.17 ab | 3.00 | 4.05 c | 5.33 b | 6.12 bc | 6.73 c |
| LSD | 1.096 | 0.6033 | NS | 0.8958 | 1.081 | NS | 0.126 | 0.417 | 0.460 | 0.1366 |
| CV% | 4.61 | 1.76 | 3.97 | 1.20 | 1.36 | 1.90 | 1.63 | 3.03 | 2.92 | 0.83 |
| **Foliar spray** | | | | | | | | | | |
| $T_1$ | 8.13 b | 19.17 c | 27.54 b | 30.50 c | 32.44 b | 3.00 | 4.00 a | 5.61 ab | 6.52 ab | 6.50 c |
| $T_2$ | 8.52 ab | 20.28 b | 27.60 b | 33.09 a | 34.11 a | 3.00 | 4.22 a | 5.73 a | 6.26 bc | 7.06 b |
| $T_3$ | 8.97 a | 21.45 a | 28.95 a | 30.50 c | 32.56 b | 3.00 | 4.00 a | 5.56 ab | 6.17 c | 7.39 a |
| $T_4$ | 8.31 ab | 19.72 bc | 26.50 c | 32.11 b | 34.56 a | 3.00 | 4.22 a | 5.45 b | 6.78 a | 7.45 a |
| LSD | 0.6826 | 0.6692 | 0.9819 | 0.7142 | 1.267 | NS | 0.2698 | 0.2578 | 0.3252 | 0.2844 |
| CV (%) | 5.53 | 1.33 | 1.42 | 0.91 | 1.52 | 1.90 | 3.66 | 2.61 | 2.03 | 1.62 |

Figures followed by different letters within a column differ significantly by DMRT NS = Not Significant
$T_1$ = Control $T_2$ = 50 ppm of $GA_3$ $T_3$ = 100 ppm of $GA_3$ $T_4$ = 200 ppm of $GA_3$

Table 2: Morphological characters of mungbean cultivars due to the influence of pre-sowing and foliar spray of $GA_3$ treatment

| Varieties | Plant height (cm) | | | | | Number of leaves / plant | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 15 DAS | 25 DAS | 35 DAS | 45 DAS | 55 DAS | 15 DAS | 25 DAS | 35 DAS | 45 DAS | 55 DAS |
| **Pre-sowing** | | | | | | | | | | |
| $V_1$ | 8.89 b | 19.27 | 26.79 a | 30.39 | 32.55 a | 3.00 | 4.14 | 5.69 | 6.83 a | 7.63 a |
| $V_2$ | 10.20 a | 19.25 | 25.77 b | 29.56 | 31.03 b | 3.00 | 4.19 | 5.32 | 5.77 b | 6.62 b |
| LSD | 0.7815 | NS | 1.857 | NS | 0.7714 | NS | NS | NS | 0.328 | 0.0974 |
| CV (%) | 4.61 | 1.76 | 3.97 | 1.20 | 1.36 | 1.90 | 1.63 | 3.03 | 2.92 | 0.83 |
| **Foliar spray** | | | | | | | | | | |
| $V_1$ | 8.72 a | 19.10 b | 26.68 b | 31.06 b | 33.61 | 3.00 | 4.14 | 5.73 a | 6.48 a | 7.33 a |
| $V_2$ | 8.24 b | 21.21 a | 28.62 a | 32.05 a | 33.22 | 3.00 | 4.08 | 5.44 b | 6.38 b | 6.86 b |
| LSD | 0.8344 | 0.6692 | 0.9819 | 0.5094 | NS | NS | NS | 0.3614 | 0.232 | 0.2844 |
| CV (%) | 5.53 | 1.33 | 1.42 | 0.91 | 1.52 | 1.90 | 3.66 | 2.61 | 2.03 | 1.62 |

Figures followed by different letters within a column differ significantly by DMRT NS = Not significant $V_1$ = BARI– 4 $V_2$ = BARI –5

Table 3: Yield and yield contributing characters of mungbean as influenced by pre-sowing seed treatment and foliar spray with $GA_3$

| Treatment | No. of pods/ plant | Pod length (cm) | Fresh wt. of pod (g) | Dry wt. of pod (g) | No. of seeds /pod | 1000-seed wt. (g) | Seed yield / plant (g) | Seed yield (kg $ha^{-1}$) | Harvest index (%) |
|---|---|---|---|---|---|---|---|---|---|
| **Pre-sowing seed treatment** | | | | | | | | | |
| $T_1$ | 13.72 | 5.08 a | 0.355 b | 0.265 b | 5.83 | 29.93 b | 2.55 b | 459.05 c | 35.76 c |
| $T_2$ | 13.61 | 4.92 b | 0.402 a | 0.288 a | 6.23 | 31.91 a | 2.64 ab | 472.63 bc | 46.96 a |
| $T_3$ | 14.50 | 5.14 a | 0.385 a | 0.275 b | 6.22 | 31.07 ab | 2.95 a | 530.29 a | 39.63 b |
| $T_4$ | 15.06 | 5.08 a | 0.378 a | 0.288 a | 5.89 | 30.30 ab | 2.72 ab | 486.06 b | 34.13 d |
| LSD | NS | 0.1366 | 0.0227 | 0.0229 | NS | 1.551 | 0.3328 | 24.68 | 1.563 |
| CV (%) | 6.44 | 1.13 | 2.94 | 5.14 | 8.52 | 2.83 | 6.93 | 2.03 | 1.60 |
| **Foliar spray** | | | | | | | | | |
| $T_1$ | 18.28 a | 5.20 b | 0.392 b | 0.288 b | 6.47 ab | 29.10 b | 2.65 c | 476.16 c | 35.73 c |
| $T_2$ | 12.78 b | 5.90 a | 0.392 b | 0.300 ab | 6.90 ab | 31.46 a | 3.40 a | 612.07 a | 39.43 b |
| $T_3$ | 18.39 a | 5.19 b | 0.498 a | 0.333 a | 7.11 a | 29.69 b | 3.19 b | 574.27 b | 42.79 a |
| $T_4$ | 14.33 b | 5.11 b | 0.373 b | 0.265 b | 5.89 b | 26.93 c | 3.24 ab | 582.37 b | 36.80 c |
| LSD | 3.277 | 0.6784 | 0.0394 | 0.0394 | 1.037 | 1.217 | 0.1779 | 28.81 | 2.263 |
| CV (%) | 8.24 | 5.10 | 4.10 | 5.04 | 6.31 | 1.66 | 3.25 | 2.06 | 2.35 |

Figures followed by different letters within a column differ significantly by DMRT NS = Not Significant
$T_1$ = Control $T_2$ = 50 ppm of $GA_3$ $T_3$ = 100 ppm of $GA_3$ $T_4$ = 200 ppm of $GA_3$

Table 4: Yield and yield contributing character of mungbean cultivars grown after seed treatment and foliar spray with $GA_3$

| Varieties | No. of pods/ plant | Pod length (cm) | Fresh wt. of pod (g) | Dry wt. of pod (g) | No. of seeds /pod | 1000 seed wt. (g) | Seed yield / plant (g) | Seed yield (kg $ha^{-1}$) | Harvest index (%) |
|---|---|---|---|---|---|---|---|---|---|
| **Pre-sowing** | | | | | | | | | |
| $V_1$ | 13.53 b | 4.96 b | 0.353 b | 0.248 b | 6.23 a | 28.53 b | 2.42 b | 434.36 b | 39.06 |
| $V_2$ | 14.92 a | 5.15 a | 0.407 a | 0.310 a | 5.85 b | 33.07 a | 3.00 a | 539.65 a | 39.17 |
| LSD | 2.284 | 0.1366 | 0.0227 | 0.0229 | 1.284 | 2.174 | 0.4666 | 24.68 | NS |
| CV (%) | 6.44 | 1.13 | 2.94 | 5.14 | 8.52 | 2.83 | 6.93 | 2.03 | 1.60 |
| **Foliar spray** | | | | | | | | | |
| $V_1$ | 14.56 b | 5.08 b | 0.383 b | 0.266 b | 6.69 | 25.22 b | 2.49 b | 448.25 b | 35.94 b |
| $V_2$ | 17.33 a | 5.62 a | 0.444 a | 0.328 a | 6.49 | 33.36 a | 3.75 a | 674.18 a | 41.43 a |
| LSD | 2.337 | 0.4839 | 0.0394 | 0.0394 | NS | 1.217 | 0.1779 | 28.81 | 1.614 |
| CV (%) | 8.24 | 5.10 | 4.10 | 5.04 | 6.31 | 1.66 | 3.25 | 2.06 | 2.35 |

Figures followed by different letters within a column differ significantly by DMRT NS = Not Significant $V_1$ = BARI– 4 $V_2$ = BARI –5

moog-5 produced taller plants at different growth stages (Table 2). It was interesting to note that seed treatment enhanced the plant height in BARI-4 and foliar spray stimulated stem elongation in BARI-5. $GA_3$ is well known for its effective role in stem elongation in many crops. Foliar spray of $GA_3$ significantly increased plant height in beans (Beall *et al.*, 1996). Seed treatment with $GA_3$ also was reported to increase plant height (Kumer *et al.*, 1996). In the present study seed treatment with 50 ppm and foliar spray with 100 ppm were found more efficient in stem elongation.

A significant variation in number of leaves per plant due to the effect of $GA_3$ was found at different stages of plant growth except 15 DAS (Table 1). The maximum number of leaves per plant

was achieved by 50 ppm of $GA_3$ applied to seeds (Table 1). In foliar application, 200 ppm $GA_3$ was found the most in increasing the number of leaves per plant (Table 1). Number of leaves per plant was found to vary considerably between the two varieties at different growth stages, especially at the latter stages of plant growth. Both seed treated and foliar sprayed plants had higher number of leaves per plant in BARI-4 (Table 2). $GA_3$ induced higher number of leaves in soybean (Deotale *et al.*, 1998), okra (Kumer, *et al.*, 1996), faba bean (Abd El-Fattah, 1997) and french bean (Gabal *et al.*, 1990). Present findings agree well with above results.

No significant effect of seed treatment with $GA_3$ on the number of pods per plant was found but plants sprayed with $GA_3$ had higher number of pods per plant (Table 3). The data revealed that highest number of pods per plant was found with the foliar spray of 100 ppm $GA_3$. The varieties differed significantly in their inherent character to produce pods (Table 4). $GA_3$ has been reported to increase number of pods in chickpea (Mange, 1971) and spikelet in rice (Awan and Alizali, 1989). In the present study an insignificantly higher number of pods per plant was found with 100 ppm $GA_3$.

The longest pod (5.14 cm) was found in pre-sowing seed treated plants with 100 ppm $GA_3$ and (5.90cm) in plants sprayed with 50 ppm $GA_3$ (Table 3). The longer pods of 5.15cm and 5.62cm were obtained from $V_2$ (Table 4).

The highest fresh weight of pod was obtained by seed treatment with 50 ppm and foliar spray of seedlings with 100 ppm $GA_3$ (Table 3). The lowest fresh weight of pod was obtained by control and 200 ppm (Table 3). The heavier pods of 0.407g and 0.444g were obtained in BARI-5 (Table 4). $GA_3$ at 100 ppm produced the highest fresh weight per pod in pea (Lazlo, 1974). In the present study heavier pods were obtained from seed treatment with 50 ppm $GA_3$ and foliar spray of seedling with 100 ppm $GA_3$, respectively.

$GA_3$ significantly influenced the dry weight of pods. The highest dry weight per pod (0.288g, 0.333g) was obtained with pre-sowing seed treatment with 50 ppm $GA_3$ and foliar spray of 100 ppm $GA_3$ (Table 3) and the lowest dry weight of pod was found in control treatment and 200 ppm in foliar spray (Table 3). Among two cultivars a higher dry weight of pod (0.310g, 0.328g) was found in $V_2$ (Table 4). Increase in the dry weight of pod has been reported in french bean (Gabal *et al.*, 1990) and bulbs of onion (Hore *et al.* 1988). The present findings agree well with the previous results.

Pre-sowing seed treatment with different concentrations of $GA_3$ did not have significant influence but foliar spray of $GA_3$ significantly influenced the number of seeds per pod (Table 3) with the highest number in 100 ppm $GA_3$. Number of seeds per pod was significantly different in two varieties as was found with seed treatment and the maximum number of seeds per pod (6.23) was obtained by $V_1$ (Table 4). Foliar spray had no influence on the number of seeds/pod (Table 4). Kumer *et al.* (1996) noted that number of seeds per pod was significantly increased in $GA_3$ treated okra over control.

Results of the present study clearly show that application of $GA_3$ significantly influenced 1000-seed weight in mungbean (Table 3). The highest 1000-seed weight of 31.91g and 31.46g was found with seed treatment and foliar spray at 50 ppm $GA_3$, respectively (Table 3). The lowest 1000-seed weight (29.93g, 26.93g) was found with control in seed treatment and 200 ppm in foliar spray (Table 3). The highest 1000-seed weight was found in $V_2$ (Table 4). Application of 50 ppm of $GA_3$ was previously reported to increase 1000-seed weight in groundnut (Lee, 1990). The results of the present study are in agreement with the above reports.

$GA_3$ exerted significant influence on seed weight per plant (Table 3). The highest seed weight of 2.95 and 3.4g per plant was obtained by 100 ppm in seed treatment and 50 ppm in foliar spray (Table 3) and the lowest seed weight per plant was obtained by control ($T_1$) (Table 3). The varietal difference in seed weight per plant was significant and $V_2$ (BARI-5) had the highest seed weight per plant in both the treatment methods (Table 4). Application of 100 ppm of $GA_3$ increased seed yield per plant in rice, okra and tomato (Awan and Alizai, 1989; Kumer *et al.*, 1996). In present study 100 ppm of $GA_3$ was found to be the best treatment to increase seed weight in mungbean. The data revealed that the highest seed yield (530.29 and 612.07kg) was obtained with 100 ppm in seed treatment and 50 ppm in foliar spray (Table 3) and the lowest seed yield (459.05 and 476.16kg) was obtained for control ($T_1$) (Table 3). The analysis of variance indicated that the average yield differed significantly due to varietal character. The highest seed yield was obtained by $V_2$ (Table 4). There is much information regarding the increase in seed yield by 100 ppm $GA_3$ in rice (Awan and Alizai, 1989), Soybean (Deotale *et al.*, 1998) and onion (Hore *et al.*, 1998). The results of the present study clearly reflected that 100 ppm $GA_3$ increased seed yield in mungbean.

$GA_3$ exerted significant influence on harvest index (Table 3). The highest harvest index (34.13%, 35.73%) was obtained by 200 ppm in seed treatment and control ($T_1$) in foliar spray (Table 3). There was no significant varietal difference in harvest index due to the effect of seed treatment with $GA_3$. The highest harvest index (41.43%) was obtained in $V_2$ (Table 4) under foliar spray of $GA_3$. Khan (1997) noted that harvest index was increased by 75 mg/liter $GA_3$ in mustard. In the present study, $GA_3$ applied at 100 ppm had favourable influence on harvest index.

The results of the present study indicates that morphological parameters of mungbean can be favourably influenced by the application of $GA_3$ with a consequent yield increased. This result shows potential application of $GA_3$ for the increase of mungbean yield in Bangladesh.

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