Impact of GA$_3$ and NAA on Horticultural Traits of *Abelmoschus esculentus*


Abstract: To increase growth and yield of okra, an experiment was conducted in Sher-e-Bangla Agricultural University, Bangladesh using some growth hormones. It was used BARI Dherosh 1 as genetic materials and some growth regulators viz. G$_0$: Control (fresh water); G$_1$: GA$_3$ (Gibberellic acid) and G$_2$: NAA (Naphthalene acetic acid) @ 50 ppm. Tallest plant (89.0 cm), longest petiole (29.0 cm), number of leaves (49.0/plant), leaf area (29.7 cm$^2$), number of branches (5.5/plant), fresh weight (84.5 g/plant), dry weight (10.9 g/plant), number of pods (33.4/plant), pod length (17.5 cm), pod diameter (1.7 cm) and yield (338.1 g/plant, 2.9 kg/plot and 16.4 t/ha) was found from G$_1$ which was statistically identical with G$_2$ while minimum from G$_0$. GA$_3$ and NAA have the potentiality to increase the yield of okra, but GA$_3$ was found to be most effective in the present study.

Key words: Okra • PGR • Growth and yield

INTRODUCTION

Okra (*Abelmoschus esculentus*) belongs to Malvaceae family is an important vegetable crop and cultivated during summer in Bangladesh. In Bangladesh, vegetable production is not uniform round the year and plenty in winter but less in quantity in the summer. Vegetable deficiency in summer is a chronic problem of Bangladesh and to meet up our vegetable requirements okra can partially improve the vegetable production in the country. Average yield of okra was about 3.38 t/ha [1]. Plant growth regulators (PGR's) can modify plant physiological process using in small amounts and plays an essential role in plant growth and development, stem elongation and flower development [2, 3]. Application of plant growth regulators for improving the yield and quality of many vegetable crops [4-6] in several ways and it has been found to greatly enhance stem elongation. Gibberellic acid (GA$_3$) has potentiality to control growth and flowering process also it’s an application increase petiole length, leaf area [7], delayed petal abscission [8, 9] and yield also [10] that used in agriculture since long ago [11]. Naphthalene acetic acid (NAA) is a potential antifungal agent [12-14]. Naphthalene acetic acid (NAA) is a synthetic form of Auxin that play key role in cell elongation, cell division, vascular tissue, differentiation, root initiation, apical dominance, leaf senescence, leaf and fruit abscission, fruit setting ratio, prevent fruit dropping, promote flower sex ratio and flowering [15-17]. Application of NAA has also found to increase plant height, number of leaves per plant, fruit size with consequent enhancement in seed yield in different crops [18-20]. The increase in yield by number and weight was 22.1% and 18% with GA$_3$, while it was 12.7% and 10% with NAA over control in potato [21]. The aim of the current study was to find out the suitable plant growth regulators (hormones) between GA$_3$ and NAA in producing okra in Bangladesh.

MATERIALS AND METHODS

An Experiment was carried out in the Horticulture Farm, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh to find out the performance of okra (BARI Dherosh 1during April to September 2013. Three levels of growth regulators viz. G$_0$: Control (fresh water); G$_1$: GA$_3$ (Gibberellic acid) and G$_2$: NAA (Naphthalene acetic acid) @ 50 ppm in Randomized Complete Block Design with
three replications. The unit area of each plot was 1.5 m × 1.2 m. Seeds were sown in plots with maintaining distance between row to row and plant to plant was 40 cm and 50 cm, respectively. Cowdung @ 10t/ha, urea 120 @ 90 kg/ha, Triple super phosphate (TSP) @ 90 kg/ha and Muriate of Potash (MP) @ 150kg/ha were used, respectively as basal dose. Five plants were randomly selected from each unit plot for the collection of data. Data were collected on plant height, stem diameter, number of leaves/plot, number of branches/plot, length of petiole, number of internodes/plot, length of internode, leaf area, fresh weight of plant, dry matter of plant, days to 50% flowering, number of flowers buds/plot, number of pods/plot, length of pod, diameter of pod, yield/plot.

After harvesting, 150 g plant sample (above ground) previously sliced into very thin pieces were put into envelop and placed in oven maintained at 70°C for 72 hours. The sample was then transferred into desiccators and allowed to cool down at room temperature. The final weight of the sample was taken. The dry matter contents of plant were computed by simple calculation from the weight recorded by the following formula:

\[
\text{% Dry matter content of plant} = \left(\frac{\text{Dry weight}}{\text{Fresh weight}}\right) \times 100
\]

Collected data were analyzed statistically using MSTAT-C computer package program. The significance of the difference among the treatments was estimated by Duncan’s Multiple Range Test (DMRT) at 5% level of probability [22].

RESULTS AND DISCUSSION

Plant Height and Stem Diameter: Plant height and stem diameter of okra showed statistically significant differences for different growth regulators at different days after sowing (DAS). Longest plant was recorded from G1 (89.0 cm) which was statistically similar with G2 (87.5 cm), whereas shortest from G3 (78.3 cm) at 60 DAS (Fig. 1a). Plant height was increased by applying GA3 in okra [23, 24], soybean [25], rice [26], groundnut [20], check pea [27] and gerbera [7, 28] by elongation of internodes [29]. The maximum stem diameter was found from G1 and G2 (2.1 cm), while the minimum from G3 (1.8 cm) at 60 DAS (Fig. 1b).

Number of Leaves and Leaf Area: The maximum number of leaves was found from G1 (49.0/plot) which was statistically similar with G2 (48.8/plot) at 60 DAS, while the minimum from G3 (42.7/plot) (Fig. 2a). Leaves number was increased by the applying GA3 in gerbera [28], strawberry [30], soybean [25], wheat [31], faba bean [51] and bell pepper [32]. Gibberellic acid resulted in cell division and cell elongation can be cause in enhanced vegetative growth. Leaf area of okra showed significant differences among growth hormones at different DAS. The maximum leaf area was found from G1 (29.7 cm²) which was statistically identical with G2 (29.0 cm²), while the minimum from G3 (25.6 cm²) at 60 DAS (Fig. 2b). Previously it was also reported that leaf area increased by the foliar application of GA3 by Mehraj et al. [7], Jamal Uddin et al. [30], Paroussi et al. [33], Sharma and Singh [34] and Naidu and Swamy [35].

Number of Branches and Length of Petiole: The maximum number of branches was found from G1 (5.5/plot) which was statistically similar with G2 (5.3/plot), while the minimum from G3 (4.9/plot) at 60 DAS (Fig. 3a). Number of branches was increased by the application of plant growth regulators [36] in chilli [37, 38], bottle gourd [39] and soybean [25] that might be due to enhanced photosynthetic activity and efficient assimilation of photosynthetic product. The longest petiole was found from G1 (29.0 cm) which was statistically similar with G2 (28.6 cm), while the shortest from G3 (25.2 cm) at 60 DAS (Fig. 3b).

![Fig. 1: Effect of plant growth regulators on (a) plant height and (b) stem diameter of okra](image-url)
Fig. 2: Effect of plant growth regulators on (a) number of leaves and (b) leaf area of okra

Fig. 3: Effect of plant growth regulators on (a) number of branches and (b) length of petiole of okra

Fig. 4: Effect of plant growth regulators on (a) number of internodes and (b) length of internodes of okra

Number and Length of Internodes: The maximum number of internodes was found from G1 (21.8/plant) which was statistically identical with G2 (21.1/plant), whereas the minimum from G5 (19.9/plant) at 60 DAS (Fig. 4a). The longest internodes was found from G3 (12.1 cm) which was statistically identical with G4 (11.9 cm), while the minimum was found from G5 (10.5 cm) at 60 DAS (Fig. 4b).

Fresh and Dry Weight per Plant: Significant difference was found for fresh weight per plant of okra among treatments. The maximum fresh weight per plant was found from G1 (84.5 g) which was statistically identical with G3 (83.2 g), whereas the minimum from G5 (75.1 g) (Table 1). The maximum dry weight per plant was found from G1 (10.9 g) which was statistically similar with G4 (10.5 g), while the minimum from G5 (9.2 g) (Table 1). PGRs enhance photosynthetic activity that caused more accumulation of photosynthates in plant organs which increased fresh weight and dry weight per plant. By efficient photosynthetic activity gibberellins increased carbohydrate accumulation i.e. dry matter contents [40, 41].

Days to 50% Flowering: The maximum days to 50% flowering was recorded from G5 (46.7), while the minimum from G1 (43.3) (Table 1). It was found that application of GA3 influenced significantly for early flowering and similar result was also found by Mehraj et al. [7], Jamal Uddin et al. [28, 30], Hernandez [42], Awan et al. [43] and Lee et al. [44].
Table 1: Effect of growth regulators on some attributes of okra  

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Fresh weight/plant (g)</th>
<th>Dry weight/plant (g)</th>
<th>Days to 50% flowering</th>
<th>Number of flower buds/plant</th>
<th>Number of pods/plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>G0</td>
<td>75.1 b</td>
<td>9.2b</td>
<td>46.7 a</td>
<td>35.9 b</td>
<td>24.0 c</td>
</tr>
<tr>
<td>G1</td>
<td>84.5 a</td>
<td>10.9a</td>
<td>42.7 b</td>
<td>43.6 a</td>
<td>33.4 a</td>
</tr>
<tr>
<td>G2</td>
<td>83.2 a</td>
<td>10.5a</td>
<td>43.3 b</td>
<td>42.5 a</td>
<td>31.3 b</td>
</tr>
<tr>
<td>LSD(0.05)</td>
<td>4.1</td>
<td>0.4</td>
<td>2.5</td>
<td>1.8</td>
<td>2.0</td>
</tr>
<tr>
<td>CV (%)</td>
<td>7.8</td>
<td>4.3</td>
<td>7.1</td>
<td>7.3</td>
<td>5.4</td>
</tr>
</tbody>
</table>

In a column, means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.

Table 2: Response of growth regulators on yield contributing characters and yield of okra  

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Pod length (cm)</th>
<th>Pod diameter (cm)</th>
<th>Yield (g/plant)</th>
<th>Yield (kg/plot)</th>
<th>Yield (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>G0</td>
<td>15.0 b</td>
<td>1.2 b</td>
<td>284.7b</td>
<td>2.3 b</td>
<td>13.8 b</td>
</tr>
<tr>
<td>G1</td>
<td>17.5 a</td>
<td>1.7 a</td>
<td>338.1a</td>
<td>2.9 a</td>
<td>16.4 a</td>
</tr>
<tr>
<td>G2</td>
<td>17.1 a</td>
<td>1.6 a</td>
<td>334.5a</td>
<td>2.9 a</td>
<td>16.1 a</td>
</tr>
<tr>
<td>LSD(0.05)</td>
<td>0.6</td>
<td>0.1</td>
<td>5.2</td>
<td>0.3</td>
<td>0.9</td>
</tr>
<tr>
<td>CV (%)</td>
<td>5.3</td>
<td>3.6</td>
<td>5.9</td>
<td>1.4</td>
<td>8.9</td>
</tr>
</tbody>
</table>

In a column, means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.

**Number of Flower Buds:** The maximum flower buds was found from G1 (43.6/plant) which was statistically identical with G2 (42.5/plant), while the minimum from G0 (35.9/plant) (Table 1). Jamal Uddin et al. [30] also found that foliar application of GA3 increased the number of flower buds in strawberry.

**Number of pods/plant:** The maximum pods was found from G1 (33.4/plant), whereas the minimum from G0 (24.0/plant) (Table 1). Uddin et al. [46] was found that the number of okra fruit ranged from 16.5/plant to 22.5/plant, while 33.4/plant fruit was found from current study. By the application of GA3, number of pods/plant was increased. Number of pods has been reported in groundnut [20] and chickpea [45] by the application of 100 ppm of GA3.

**Pod Length and Diameter:** The longest pod was found from G1 (17.5 cm) which was statistically similar with G2 (17.1 cm), while the shortest from G0 (15.0 cm) (Table 2). The maximum pod diameter was found from G1 (1.7 cm) which was statistically identical with G2 (1.6 cm), whereas the minimum from G0 (1.3 cm) (Table 2). The maximum 17.0 cm length and 1.9 cm diameter was found in okra Uddin et al. [46] which was the resemblance of present study.

**Yield:** The maximum yield was found from G1 (338.1 g/plant, 2.9 kg/plot and 16.4 t/ha) which was statistically similar with G2 (334.5 g/plant, 2.9 kg/plot and 16.1 t/ha), whereas the minimum from G0 (284.7 g/plant, 2.3 kg/plot and 13.8 t/ha) (Table 2). Similarly 15.7 t/ha yield was found by the application of 50 ppm gibberellic acid from okra [47], while GA3 at 25 and 50 ppm (15.81 and 18.69 t/ha) gave the highest fruit yields [48]. Munda et al. [49] reported that GA3 @ 100 ppm as seed treatment was found to be most effective for weight of pod per plant. Okra plant yielded maximum 17.0 t/ha [46], while 23.63 t/ha in 2007 and 22.96 t/ha in 2008 but yield may also varied by cultivars [50].

**CONCLUSION**

Though gibberellic acid and naphthalene acetic acid was found to be statistically similar but gibberellic acid (GA3) was more effective than that of naphthalene acetic acid (NAA) in most of growth and yield contributing characters of okra. Foliar application of 50 ppm GA3 could increase the growth and yield contributing characteristics of okra plant and ultimately increases the yield.

**REFERENCES**


