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MORPHOLOGICAL AND BIOCHEMICAL ATTRIBUTES OF MUSTARD AS INFLUENCED BY DIFFERENT CONCENTRATIONS OF GIBBERELLIC ACID (GA_3)

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ABSTRACT

A plot experiment was conducted at the Crop Botany Field Laboratory, Department of Crop Botany, Bangladesh Agricultural University during November 2007 to March 2008 to evaluate the effects of Gibberellic Acid (GA_3) on morphological and biochemical features of mustard (var. BINAshorisha-6). Four concentrations *viz*. 0, 25, 50 and 75 ppm of GA_3 were sprayed on canopy at 30 days after sowing. The experiment was laid out in a randomized complete block design (RCBD) with three replications. The results showed that different levels of GA_3 significantly influenced the plant height; number of primary and secondary branches/plant; root, shoot and shell dry weight/plant; total dry matter/plant; total chlorophyll content of leaves; and protein and oil content in seeds. There were statistically similar effects between the application rate of 50 ppm and 75 ppm in all studied parameters except total dry matter/plant, while an increased value was recorded under the former application of GA_3. The research findings concluded that, plant growth, dry matter and biochemical attributes in mustard can be increased through a moderately high dose of GA_3 application.

Keywords: Morphology, biochemical attributes, mustard, GA3.

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INTRODUCTION

Mustard belongs to genus *Brassica* under the family Cruciferae. There are about 100 species of *Brassica*, of which *Brassica campestries*, *B. juncea*, *B. napus*, *B. nigra*and *B.alba* are commercially important. However, *Brassica napus*L. is a high-yielding one. Next to soybean, mustard is one of the important oil seed crops in the world (FAO, 2001).In Bangladesh, seed oil of mustard is the number one edible oil crop, covering about 80% of the total oil crops area and contributing more than 71% of the total oil crop production (BBS, 2007). Bangladesh is facing a huge deficit of edible oil. In view of the importance of this crop, attention has to be given to increase its production in order to meet the huge shortage of cooking oil in the country. According to the National Nutrition Council (NCC) of Bangladesh, the recommended dietary allowance (RDA) is estimated to be 6 gm oil per capita/day for a diet with 2700 Kcal (NNC, 1984). On this RDA basis, Bangladesh requires 0.29 million tons of oil equivalent to 0.8 million tons of oil seeds for nourishing its people.At present, the indigenous oil seed production is about 0.25 million tons which can cover only 40% of the domestic need (FAO, 2001). Mustard oil not only plays a great role as a fat substitute in our daily diet but also nourish the economy of the nation. The ordinary people of Bangladesh use it as medicine against cold. It is widely used as cooking ingredient and condiment. Oil cake produced from mustard is an important food for livestock and organic manure for crop production. The climate and edaphic conditions of Bangladesh are quite favorable for mustard cultivation (Haque et al., 1987). But the average seed yield is low (0.74 t/ha), which is unfortunately much lower than the average yield of many countries of the world (FAO, 2001). The poor yield of mustard under Bangladesh condition might be attributed to inefficient and inappropriate uses of production inputs and improved technologies of crop production.

Gibberellic acid (GA_3), a phytohormone, can alter the plant growth and development with low concentration. GA_3 enhances plant growth activities, stimulates stem elongation (Deotale et al., 1998; Abd, 1997; Lee, 1990), and increases dry weight and yield (Deotale et al., 1998 andMaske et al., 1998). Research findings admitted that the yield of mustard seed can be increased significantly by the application of phytohormones (Bruns et al., 1990). At present, many research works have been conducted in many parts of the world to increase oil seed production by using GA_3. Therefore, the research work was undertaken to study the effects of various concentrations of GA_3 on growth performance and biochemical attributes of the variety of mustardBINAshorisha-6.

METHODOLOGY

The experiment was conducted in plots in the field laboratory, Department of Crop Botany, Bangladesh Agricultural University, Mymensingh and the experimental site was located at 27.75^0N latitude and 90.5^0E longitudes. The plant material used in this experiment was the mustard variety BINA shorisha-6. The soil, collected from the Bangladesh Institute of Nuclear Agriculture BINA farm area, belonged to the Sonata series of Grey Flood Plain under the Old Brahmaputra Agro-Ecological Zone (UNDP and FAO, 1988). After land preparation and fertilizers and manures application, seeds were sown in each plot uniformly by broadcasting. The experiment was laid out in a randomized complete block design with three replications. The experiment consisted of four levels of GA_3 viz. 0, 25, 25 and 75 ppm. Gibberellic acid was prepared for spraying in the flowering stage of plants and it was sprayed on leaves at 30 days after sowing in the afternoon by using a hand sprayer. 100 ppm solution of GA_3 was prepared by dissolving 100 mg of GA_3 in 1-liter distilled water. Prior to adding in distilled water, the granular chemical was dissolved in 25 ml of ethanol. Similarly, the solutions of other concentrations of GA_3 were prepared. Data of morphological attributes were recorded as per following standard procedure. Leaf chlorophyll was measured by using the method of Yoshida et al. (1976). The formula for computing total chlorophyll was as follows:

Total chlorophyll = $(20.2 \times D_{645} + 8.02 \times D_{663}) \times \frac{5}{1000\times0.05}$ g/gflw.............(1)

where, D_{663} = absorbance at 663 nm wave length, D_{645} = absorbance at 645 nm wave length, $\frac{5}{1000\times0.05}$ = dilution factor.

Total protein content was determined by following the Kjeldahl method using the formula: $N(\%)=\frac{0.014\times\text{Normality of HCL}(0.01N)\times75\times100}{10} \times \frac{v}{g}$. ....(2)

Here, V = Final volume of 0.01N HCI, g = Weight of sample, 75 = Volume of Kjeldahl flask,10 = Volume of diluted digested sample.

The protein content was determined by multiplying the N content with a conversion factor (6.25). The oil content in seeds was determined by sox let method and expressed in percentage.The collected data on different parameters were statistically analyzed to obtain the level of significance using MSTAT-C package program(Russell,1986). The mean differences were compared by Duncan's Multiple Range Test (DMRT) at 5% level of significance (Gomez and Gomez, 1984).

RESULTS & DISCUSSION

Plant height: The experimental results showed that different levels of GA_3 had significantly influenced the plant height (Table 1). The tallest plant (96.57 cm) was produced with the application of 50 ppm GA_3 which was statistically identical with 75 ppm GA_3 and the shortest plant (82.85 cm) was observed from the control treatment. The results indicated that the application of different concentrations of GA_3 had increased the plant height over the control treatment. Significant increase in plant height induced by different levels of GA_3 was observed in rapes (Castro *et al.*, 1989). However, a gradual increase in plant height was noticed up to the application of 50 ppm GA_3. Further increase in concentration (75 ppm GA_3) had resulted in reduced plant height. The increase in plant height with different levels of GA_3 might be due to the fact that cell enlargement was accelerated with the application of gibberellic acid (Hasio*et al.*, 1976). Khan *et al.* (2002) in a field trial of *Brassica juncea* with GA_3 IAA and Kinetin at 0, 10^{-4}, 10^{-5} and 10^{-6} M and observed that GA_3 was more effective than IAA and kinetin in promoting shoot length i.e. plant height, leaf number and leaf area. Application of 50 ppm GA_3 induced the highest plant height in Rice, Okra and groundnut (Kumar *et al.*, 1996; Lee, 1990).

Table 1: Effects of different levels of GA_3 on morphological features of mustard BINA shorisha-6

Treatments	Plant height (cm)	No. of 1^0 branches $plant^{-1}$	No. of 2^0 branches $plant^{-1}$	Root dry weight (g) $plant^{-1}$	Shoot dry weight (g) $plant^{-1}$	Shell dry weight (g) $plant^{-1}$	Total dry matter (g) $plant^{-1}$

0 (Control)	82.85c	3.17c	4.11c	1.20c	6.03c	8.41c	14.73d
25 ppm	87.20b	3.61b	4.79b	2.05b	6.52b	9.20b	17.64c
50 ppm	96.57a	4.20a	5.91a	2.36a	7.90a	10.51a	20.71a
75 ppm	96.15a	4.12a	5.87a	2.20a	7.80a	10.46a	20.10b
Sig. level	**	**	**	**	**	**	**

In a column, figures having same letter (s) do not differ significantly at $p \leq 0.05$ by DMRT.

Number of primary branches/plant: Different levels of GA_3 had significant influence on the number of primary branches/plant (Fig. 1). The highest number of primary branches/plant (4.20) was produced with the application of 50 ppm GA_3 which was statistically identical with 75 ppm GA_3 and the lowest number of primary branches/plant (3.17) was produced under control treatment.

Number of secondary branches/plant: The application of different concentrations of GA_3 significant influenced the number of secondary branches/plant (Fig. 2). The highest number of secondary branches/plant (5.91) was produced with the application of 50 ppm GA_3 which was statistically identical with 75 ppm GA_3 and the lowest number of secondary branches/plant (4.11) was recorded without application of GA_3.

Root dry weight/plant: Different concentration of GA_3 had significant effects on root dry weight/plant. The application of 50 ppm GA_3 showed significantly the highest root dry weight/plant (2.36 g) and control treatment showed the lowest root dry weight/plant (1.20 g) **(Table 1)**. The increase of root dry weight with different levels of GA_3 application may be a mechanism of plant survival by absorbing more moisture through extending their root system into deeper soil.

Shoot dry weight/plant: The effects of GA_3 on shoot dry weight/plant were significant. The maximum shoot dry weight/plant (7.90 g) was found from 50 ppm GA_3, while the control plant showed significantly the lowest shoot dry weight/plant (6.03 g). Gardner (1988) stated that the GA_3 altered dry matter distribution in favour of the shoots in light dark field environment. GA_3 might increase translocation of assimilates to the shoot, which increased shoot dry weight/plant.

Shell dry weight/plant: Different concentration of GA_3 had significant effects on shell dry weight/plant. The maximum shell dry weight/plant (10.51 g) was found due to the application of 50 ppm GA_3, which was statistically similar with the application of 75 ppm GA_3 and the lowest shell dry weight/plant (8.41 g) was recorded from the control treatment. The results showed that the dry weight of shell/plant was increased with the increasing levels of GA_3upto 50 ppm concentration, however, it declined with 75 ppm. Gibberellic acid might increase translocation of assimilates to the reproductive organ which increased the pod number/plant. As a result, the higher shell dry weight was observed from different levels of GA_3 application.

Total dry matter/plant (TDM): The application of different concentrations of GA_3 significant influenced the accumulation of TDM **(Table 1).** The maximum TDM/plant (20.71 g) was obtained from 50 ppm GA_3, while the minimum (14.73 g) was recorded from the control treatment. The results showed that as different levels of GA_3 increased, the accumulation of TDM increased over the control treatment. However, this increase did not continue until the application of the highest level of GA_3 (75 ppm) rather it declined significantly. This happened obviously because of the decline in other growth and yield attributes with higher concentrationof GA_3. This indicated that GA_3 had direct effects of on TDM. The result of the present study is similar to the findings of Saxena et al. (1998), who found that total dry matter was increased with the application of 100 ppm GA_3 in mustard. The improvement of crop yield can be achieved by increasing the amount of total dry matter production and its proper distribution in useful parts. Patel and Saxena (1994) reported that presoaking seed treatment of grains with various concentrations of GA_3 showed the best results on dry weights. Application of 10^{-5} M of GA_3 on mustard at 40 or 60 days after sowing significantly increased total dry matter (Khan *et al.*, 1998). Khan *et al.* (2002) observed in a field experiment of *Brassica juncea* with the translocation of assimilates to the stem, leaf, root and seed which resulted in the maximum amount of total dry matter production from different levels of GA_3 application.

Chlorophyll content in leaves: The effects of different levels of GA_3 influenced the chlorophyll content of leaves significantly. From the results, it was observed that the highest amount of chlorophyll (1.72 g/gfw) produced from 50 ppm of GA_3, while the lowest amount of (1.10 g/gfw) was observed under control treatment **(Table 2)**. Therefore, the results showed that the concentration of 50 ppm GA_3produced higher chlorophyll contents of mustard leaves. Saran (1992) conducted an experiment with GA_3 at 0, 10 or 100 ppm and also found that chlorophyll content was increased by 10 ppm.

Table 2: Effects of different levels of GA_3 on biochemical attributes of mustard

Treatments	Total chlorophyll contents (g/g flw) of leaves	Total protein content in seed	Oil content in seed
0 (Control)	1.10c	20.30b	44.44b
25 ppm	1.43b	20.54b	45.42b
50 ppm	1.72a	21.92a	47.91a
75 ppm	1.68a	21.65a	46.85a
Sig. level	**	**	**

In a column, figures having same letter (s) do not differ significantly at $p \leq 0.05$ by DMRT.

Total protein content in mustard seeds: The effects of the application of different concentration of GA_3 on the total protein content of mustard seed was significant **(Table 2)**. However, total protein content ranged from 20.30-21.92% in different treatments of GA_3. Adlakha and Verma (1994) stated that spraying of GA_3 on mustard at the concentrations of

50 and 100 ppm increased protein content. Khan et al. (2002) reported that foliar application of GA_3 on mustard (*Brassica juncea*) also increased nitrogen used efficiency.

Oil content in mustard seeds: The results indicated that different levels of GA_3 had significant effect on oil content of mustard seeds **(Table 2)**. The highest oil content (47.91%) was obtained from 50 ppm GA_3 and the lowest oil content (44.44%) was recorded in the untreated control. The results showed that the oil content in mustard seed increased gradually with the increasing concentration of GA_3upto 50 ppm. Thereafter, oil content declined with further increase in GA_3 concentration. This finding is in agreement with those of Gundaria*et al.* (1990). They observed in a pot trial of groundnuts that the application of 25 or 50 ppm GA_3 gave the highest yield with significant increase in oil content. Khan *et al.* (2002) reported that application of 10^{-5} M GA_3 increased the oil content in mustard.

CONCLUSION

The application of appropriate concentration of GA_3 would increase mustard yield, which could contribute to increase the total production of oil seeds in Bangladesh and thus, it would reduce import oil seeds. The experimental results indicated that the application of 50 ppm GA_3 had positive impact on growth and biochemical features of mustard var. BINA shorisha-6. However, the finding is based on a single pot experiment and it needs further trials in fields to come to a concrete conclusion on the usefulness of GA_3 for large-scale mustard production.

REFERENCES

Abd, E.I. (1997). Effect of phosphorus, boron, GA_3 and their interactions on growth, flowering, pod setting, abscission and both green pod and seed yields of broad been (*Vicia faba* L.) plant. Alexandria J. Agric. Res. 42 (3): 311-332.

Adlakaha, P.A. & Verma, S.K. (1994). Effect of gibbverellic acid on the quality of tomato fruit. The punjab Hor. J., 4 (3-4): 148-151.

BBS, (2007). Statistical Yearbook of Bangladesh Bureau of Statistics. Statistics Division, Ministry of Planning, Government of the People’s Republic of Bangladesh.

Bruns, G.M., Kuchenbuch, R., & Jung, J. (1990). Influence of triazole plant growth regulator on root and shoot development and nitrogen utilization of oilseed rape (*Brassica napus* L.) J. Agron and Crop Sci. 16 (4): 257-262.

Castro, P.R.C., Evangelista, E.S., Melotto, E., & Rodrigues, E. (1989). Action of growth regulators on rape (*Brassica napus* L.). Revista decreasing Agricultural (Piracicaba) 64(1): 35-44. [Cited From Plant Growth Regulator Abst., 1990. 16 (3): 65].

Deotale, R.D., Mask, V.G., Sorte, N.V., Chimurkar, B.S. & Yerne, A.Z. (1998). Effect of GA_3 and IAA on morpho-phosiological parameters of soybean. J. soybean. J. Soils and Crops., 8 (1): 91-94 (Cited from Field Crop Abst., 1998. 51 (11): 1114.

FAO, (2001). Food and Agriculture Organization Production Yearbook. Rome, Italy. 50: 122.

Gardner, E. P. 1988. Growth and partitioning in peanut as influenced by gibberellic acid and demonized Agron. J., 80 (2): 159-163.

Gomez, K.A. and Gomez, A.A. (1984). Statistical Procedure for Agricultural Research Intl. Rice Res. Inst. John Wiley and Sons. New York, Brisbane, Tornoto, Singapore, p. 136-200.

Gundalia, J.D., Patel, M.S., Patel, M.H., & Vadher, P.G. (1990). Groundnut response to growth regulators. Gujarat Agricultural University Research Journal, 16(1), 60-62. [Cited from Plant Growth Regulator Abst., 1987. 24 (4): 290].

Haque, H.R., Ahmed, M.U. & Rahman, M.A. (1987). Irrigation scheduling for yield of mustard. Bangladesh J. Agric. Sci., 14 (1): 31-34.

Hasio, T.C., Acevedo, E., Fereres, E. & Henderson. W.D. (1976). Effect of plant growth regulator an Brassica sp. Phil. Trans. R. Soc. Bot., 27 (5): 275-500.

Khan, N.A., Ansari, H.R. & Sanullah, 1998. Effect of GA_3 spray during ontogeny of mustard on growth, nutrient uptake and yield characteristic J. Agron. Crop Sci., 18.

Khan, N. A., Ansari, H. R., Khan, M. Mir, R. & Sanuiullah. (2002). Effect of phytohormones on growth and yield of India mustard Indian J. Plant Physiol., 7 (1): 75-78.

Kumer, S., Singh, P., Katiyar, R.P., Vaish, C.P. & Khan, A.A. (1996). Beneficial effect of some growth regulators on the aged seeds of okra (Abelmoschus esculentus L.) under field condition. Seed Res., 24 (1): 11014. [Cited from plant Growth Regulator Abstr., 1997. 23 (4): 298].

Lee, H.S. (1990). Effect of pre-sowing seed treatments with GA_3 and IAA on flowering and yield components in groundnuts. Korean J. Crop Sci., 35 (1): 1-9.

Maske, V.G., Deotale, R.D. Sorte, N.B., Gorammager, H.B. & Chore, C.N. (1998). Influence of GA_3 and NAA on growth and yield contributing parameters of soybean. J. Soils Crops, 8 (1): 20-21. [Cited from Field Crop Abst., 51 (11) 11-13].

NCC. (1984). Nutrition Policy and Programme for Bangladesh. National Nutrition Council, Bangladesh. p. 70-79.

Patel. M. & Saxena, O.P. (1994). Screening of PGRs for seed treatment in green grain and black gram. Indian J. Plant Physiol., 37 (9): 206-208.

Russell, D.F. (1986). MSTAT-C Package programme. Crop and Soil Science Department, Michigan State University, USA.

Saran, B., Sinha, B.K. Sharma, A.K. & Mehta, A.S. (1992). Effect of pre sowing treatment in GA_3 on growth, yield and chlorophyll in mustard New Agriculturist, 3 (1): 59-60.

Sexena, P.P., Pandey, N., Chandak, N., Ashma, M. & Arya, V. (1998). Recovery of vigour and viability of aged seeds by gibberellic acid kinetin. In: Proceedings of the international congress of plant physiology. New Delhi, India. 15-20 Feb. Vol. 2. New Delhi, India Society for Plant Physiology and Biochemistry 1990. [Cited from plant Growth Regulators Abst., 19 (2): 125].

UNDP & FAO. (1988). Land resources appraisals of Bangladesh. Agricultural Development Report Agro-Ecological Region of Bangladesh. United Nations Development Programme and Food and Agricultural Organization: 212-221.

Yoshida, S., Forno, D. A., & Cock, J. H. (1971). Laboratory manual for physiological studies of rice. Laboratory manual for physiological studies of rice.