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EFFECT OF PLANT GROWTH REGULATORS ON SEED YIELD OF MUSTARD

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Abstract

An experiment was conducted at the research field of Regional Agricultural Research Station (RARS), Bangladesh Agricultural Research Institute (BARI), Cumilla during November 2019 to March 2021 to find out the effect of two plant growth regulators (PGR) of IAA and GA_3 on yield attributes and yield of mustard (Var. BARI Sarisha-17). There were seven treatments viz. T_1= IAA 50 ppm, T_2= IAA 75 ppm, T_3= IAA 100 ppm, T_4= GA_3 50 ppm, T_5= GA_3 75 ppm, T_6= GA_3 100 ppm, and T_7= Control. The PGRs was sprayed twice on mustard plant at 22 and 33 days after sowing. Plant height, branches plant^{-1}, siliqua plant^{-1}, 1000 -seed weight and seed yield ha^{-1} were influenced significantly by different levels of application of plant growth regulators. The highest plant height (115.9 cm), branches plant^{-1} (6.2), siliqua plant^{-1} (79.8), 1000- seed weight (4.1) and seed yield (1788.3 kg ha^{-1}) was obtained from T_5 (GA_3 - 75 ppm) treatment. The lowest seed yield was obtained from the control plants (T_7). Application of GA_3-50 ppm, GA_3-100 ppm, IAA-100 ppm, IAA-75 ppm, IAA-50 ppm gave statistical identical yield. The highest gross return (Tk. 89145 ha^{-1}), gross margin (Tk. 53215 ha^{-1}) and benefit cost ratio (2.47) were also obtained from GA_3 at 75 ppm followed by GA_3 at 50 ppm (2.43). Foliar application of GA_3 and IAA at the rate of 75 ppm could be used at early growth stage for obtaining higher seed yield and economic return.

Keywords: Giberellic acid (GA_3), Indole acetic acid (IAA), Yield, Benefit cost ratio (BCR), Mustard.

Introduction

Mustard (*Brassica sp*.) is one of the most important oil crops of global economic importance (Malek *et al.*, 2012). Its oil is used mostly for edible purpose and a partly finds for industrial applications. Oil cake is used as manure and rich animal food. About 12% of the annual edible oil supply contributed from mustard crop in the world (FAO, 2018). It has a remarkable demand for edible oil in Bangladesh. It covers about 72% of the total oilseed acreage with about 61% production. Bangladesh required 0.30 million tons of oil equivalent to 0.85 million tons of oil seeds to nourish the existing population. At present oilseed production is about 0.32 million tons which covers 30% domestic needs. In

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Bangladesh, seed yield of mustard is 1154 kg ha^{-1} (BBS, 2019) which is very low compared with other developed countries (2400 kg ha^{-1}). Improvements of existing oilseed crops by introduction of improved varieties with optimized cultural management need urgent attention for fast growing population of Bangladesh. There is a little scope for horizontal expansion of mustard. The attempt is made to increase the per unit production with attention to increase yield per unit area by adopting improved technologies and management. Scope exists for making breakthrough in yield improvement through changes of hormonal behaviors of variety.

Plant growth regulators could be an alternative to increase crop production. Spraying Plant growth regulators (PGR) at the right growth stage can improve stem quality, prevent lodging, and increase crop yields (Cailong *et al*., 2017). Plant growth regulators (PGRs) are being used as an aid to enhance crop yield (Mondal *et al*., 2016). Plant growth regulators are effective on several crop plants to balance the source sink relationship and thereby increasing them, they used as an aid to enhance in many crops. Indole acetic acid (IAA) and Gibberellic acid (GA_3) can manipulate a variety of growth and developmental phenomena in various crops. IAA has been found to increase the plant height, number of leaves per plant with consequent enhancement in seed yield in cotton and groundnut (Lee,1990). It also increases flowering, fruit set, total dry matter of crops (Gurudev and Saxena, 1991) likewise GA_3 stimulated stem elongation (Harington *et al*.,1996), increased dry matter accumulation and enhance total yield (Deotale *et al*.,1998). PGRs are the chemical substances, when applied in small amounts modify the growth of plants by stimulating or inhibiting part of the natural growth regulatory system. About 60 plant growth regulators at different groups are now commercially available and several of them have reached considerable importance in crop production. Gibberellin is a plant growth regulator which promotes cell elongation and induces cell division. It plays a great role in retarding abscission like that of IAA in lower concentrations. IAA influences plant growth by enlarging leaves and increasing photosynthetic activities in plant. Though plant growth regulators have great potentialities, its application and actual assessments etc. have to be judiciously planned in terms of optimal concentrations, stage of application, species specificity, season etc. for obtaining higher seed yield and quality (Kore *et al*., 2003). Keeping these views in mind, the present experiment was undertaken to study the effect of plant growth regulators on seed yield of mustard.

Materials and Methods

The experiment was conducted at Regional Agricultural Research Station, Bangladesh Agricultural Research Institute, Cumilla during *rabi* season of 2019-20 and 2020-21. The research plot is located in AEZ-19 (Old Meghna Estuarine floodplain). The study consisted of 7 plant growth regulators treatments viz., T_1=IAA 50 ppm, T_2= IAA 75 ppm, T_3= IAA 100 ppm, T_4=GA_3 50 ppm, T_5= GA_3 75, ppm, T_6= GA_3 100 ppm, and T_7= control. The experiment was laid out in randomized complete block design with three replications. The PGRs were applied twice pre-flowering (22 days after sowing) and post-flowering (33 days after sowing) stage with hand sprayer at 4 P.M. The solutions of 50 ppm, 75 ppm and 100 ppm of plant growth regulators (IAA and GA_3 each) were prepared by dissolving 50 mg, 75 mg and 100 mg in small quantity of acetone (5 ml) and dissolve all granules of PGR in acetone was made completely. The final volume of 1 litre by adding distilled water slowly. Finally the 50 ppm, 75 ppm and 100 ppm concentrations each of IAA and GA_3 were prepared. The soil of the experimental area is silty loam. The unit plot size was 3.0 m × 2.7 m. The variety was used in BARI Sarisha-17 as test crop. The seeds of mustard were hand sown in rows on 5 November 2020 in continuous sowing and row was 30 cm apart from each other. Seeds were placed at about 3-4 cm depth from the soil surface.

The seedlings were thinned after few days of germination 5 cm apart. Fertilizers were applied @ 120: 80: 60: 40: 4: 1 kg ha^{-1} of N: P: K: S: Zn and B from urea, TSP, MoP, gypsum, zinc sulphate and boric acid respectively. Half of the urea and all other fertilizers were applied during final land preparation. The remaining 50% urea was top dressed at 25 DAS at flower initiation stage followed by irrigation. The crop field was weeded once at 20 DAS. Two irrigations were provided to the crop during flower initiation (22 DAS) and fruit development stages (50 DAS). To control aphid, Malathion 57 EC was sprayed @ 2.0 ml L^{-1} of water at afternoon by using sprayer at late flowering and pod development stage. Rovral was sprayed @ 2.0 ml L^{-1} of water at afternoon by using sprayer at pod development stage to control leaf spot disease. Roguing was done at 40 and 55 DAS. The crop was harvested on 85 DAS. After threshing, cleaning and drying the seed yield was recorded at 12% moisture content at fresh weight basis. Economic performance of different treatment was calculated. The variable costs for each treatment were calculated based on the labor requirement for sowing, weeding and irrigation, manure and fertilizer cost, PGRs cost, spraying cost, seed cost and other input cost. The gross return was calculated based on the market price of seed of mustard. The gross margins of different treatments were estimated by deducting the production cost from the gross return. The benefit cost ratios (BCR) were calculated by dividing the gross return by total variable cost (production cost). At harvest ten plants were randomly selected from each plot for collecting yield contributing characters. The plot yield was taken and converted into kg ha^{-1}. The collected data were analyzed statistically following the analysis of variance (ANOVA) technique with the help of MSTAT-C software. The mean differences between the treatments were compared by Least Significant difference (LSD) test by this software.

Results and Discussion

The effect of foliar application of PGRs at different concentrations showed significant difference on plant height, branches plant^{-1}, siliqua plant^{-1}, 1000- seed weight and seed yield (t ha^{-1}) of mustard (Table 1). The maximum plant height (115.9 cm) was recorded in plants treated with GA_3 at 75 ppm (T_5) which was statistically similar to T_6, T_2, T_4, T_3 and T_1 treatments. The lowest plant height (102.3) was noted in control (T_7). The GA_3 and IAA treated plants showing increased plant height than control might be due to increased number of internodes or length of internodes because of increased cell number. Saied *et al.* (2018) also observed that application of GABA (PGR) in mustard plant increased plant height (8.3%).

The maximum branches plant^{-1} (6.2) was obtained from T_5 (GA_3-75) ppm and T_2 (IAA-75 ppm) treatments and it was statistically identical with T_1 (IAA-50 ppm), T_3 (IAA-100 ppm), T_4 (GA_3-50 ppm) and T_6 (GA_3-100 ppm) treatments. The results are in agreement with the findings of Samsuzzaman *et al.* (2004) who reported that branch number of mustard increased with PGRs application. The lowest number of branches (4.2) was recorded in control (T_7). The highest siliqua plant^{-1} (79.8) was recorded from GA_3 at 75 ppm (T_5) followed by IAA at 75 ppm (T_2) and the lowest (62.1) from control (T_7). Saied *et al.* (2018) also observed that application of GABA (PGR) in mustard plant increased leaf area (22.1%), total dry mass (22.2%) and absolute growth rate (9.43%) over the control. Similar result was also reported by Islam *et al.* (2007) for sesame crop.

Table 1. Effect of plant growth regulators on seed yield and yield attributes of mustard at RARS, Cumilla (pooled data of 2019-20 and 2020-21)

Treatment	Plant height (cm)	Branch plant^{-1} (no.)	Siliqua plant^{-1} (no.)	Seeds siliqua^{-1} (no.)	1000- Seed weight (g)	Seed Yield (kg ha^{-1})
T_1 (IAA -50 ppm)	107.5	5.8	73.6	32.4	3.7	1670
T_2 (IAA -75 ppm)	112.8	6.2	78.7	33.1	3.9	1722
T_3 (IAA -100 ppm)	109.8	5.9	75.1	33.0	4.1	1692
T_4 (GA_3-50 ppm)	112.5	5.8	68.0	33.0	3.7	1711
T_5 (GA_3-75 ppm)	115.9	6.2	79.8	34.6	4.1	1788
T_6 (GA_3-100 ppm)	112.9	6.0	77.3	31.4	4.1	1706
T_7 (Control)	102.3	4.2	62.1	26.9	3.4	1480
CV (%)	3.90	11.04	7.7	8.7	3.25	5.57
LSD (0.05)	9.8	1.21	10.34	NS	0.22	167.7

Table 2. Cost and return analysis of mustard under different concentrations of two plant growth regulators (pooled data of 2019-20 and 2020-21)

Treatment	Gross return (Tk. ha^{-1})	Cost of production (Tk. ha^{-1})	Gross margin (Tk. ha^{-1})	Benefit cost ratio (BCR)
T_1 (IAA -50 ppm)	83505	35200	48305	2.37
T_2 (IAA -75 ppm)	86115	36200	49915	2.38
T_3 (IAA -100 ppm)	84575	37200	47375	2.27
T_4 (GA_3-50 ppm)	85530	35200	50330	2.43
T_5 (GA_3-75 ppm)	89415	36200	53215	2.47
T_6 (GA_3-100 ppm)	85285	37200	48085	2.29
T_7 (Control)	74015	33200	40815	2.22

Price of mustard seed: 50 Tk./kg.

The maximum 1000- seed weight (4.1g) was recorded from GA_3-75 (T_5) ppm, IAA-100 ppm (T_3), and GA_3-100 ppm (T_6) which was statistically similar to IAA-75 ppm (T_2) and the lowest from control plant (T_7). The maximum seed yield (1788 kg ha^{-1}) was obtained from T_5 (GA_3-75 ppm) treatment and it was statistically identical with to T_2 (IAA -75 ppm), T_4 (GA_3 -50 ppm), T_6 (GA_3-100 ppm), T_3 (IAA -100 ppm) and T_1 (IAA -50 ppm) treatments. The lowest seed yield (1480 kg ha^{-1}) was found in T_7 (control) treatment. The increase in yield due to application of plant growth regulators at different concentrations ranged from 12.8 to 20.8% over the control plants.

The maximum seed yield was recorded with GA_3 at 75 ppm probably due to higher siliqua $plant^{-1}$, as well as increased vegetative growth and balanced C/N ratio. This might have increased the synthesis of carbohydrate which ultimately promoted higher seed yield. Similar result was reported by Hernandez, (1997) in sunflower. Seed yield decreased beyond 75 ppm concentrations of IAA and GA_3 might be due to toxic effect for growth and development of plant. Similar result was reported by Rahim (2005) in soybean.

The economic performance of plant growth regulators at different levels/concentrations were presented in table 2. The highest gross return (Tk. 89415 ha^{-1}) was obtained from plants treated with GA_3 at 75 ppm (T_5). Maximum benefit cost ratio (2.47) was also obtained from plants treated with GA_3 at 75 ppm (T_5) followed by GA_3 at 50 ppm (T_4). Hence plants treated with GA_3 at 75 ppm would be economically profitable for seed yield of mustard.

Conclusion

Results revealed that, IAA and GA_3 offer a good scope for obtaining higher seed yield of mustard var. BARI Sarisha-17. It appears that, application of GA_3 at 75 ppm could be optimum for higher seed production and economic return.

References

BBS. 2019. Statistical Year Book of Bangladesh, Government of the Peoples of Republic of Bangladesh. Bangladesh Bureau of Statistics, Ministry of Planning.

Cailong, X., Y. Gao, B. Tian, J. Ren, Q. Meng and P. Wang. 2017. Effects of EDAH, a novel plant growth regulator, on mechanical strength, stalk vascular bundles and grain yield of summer maize at high densities. *Field Crops Research*, **200:** 71-79.

Deotale, R.D., V.G. Maske, N.V. Sorte, B.S. Chimurkar and A.Z. Yerne. 1998. Effect of GA_3 and NAA on morpho-physiological parameters of soybean. *J. Soils Crops.* **8:** 91-94.

FAO. Production Year Book of 2021. Italy; **353:** 27.

Gurdev, S. and O.P. Saxena. 1991. Seed treatments with bio-regulators in relation to wheat productivity. In New Trends in Plant Physiology, Proceedings of National Symposium on Growth and Differentiation in Plants New Delhi, India 201-210.

Harrington, J.F., L. Rappaport and K.J. Hood. 1996. The influence of gibberellins on stem elongation and flowering on endive. *Science*. **125:**601.

Hernandez, P. 1997. Morphogenesis in sunflower as affected by exogenous application of plant growth regulators. *Agri. Scientia*., **13:** 3-11.

Islam, M. M. 2007. Effect of GABA on growth, yield and yield contributing characters of sesame Doctoral dissertation, Dept. Crop Bot., Bangladsh Agric. Univ., Mymensingh.

Kore, V. N., H. P. Khade, R. N. Nawale, R. S. Patil and A. V. Mane. 2003. Effect of growth regulators on growth, flowering and yield of bottle gourd variety Samrat under Konkan conditions. *J. Soils Crops*, **13:** 18-21.

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

Malek, M. A., Ismail, M. R., Monshi, F. I., Mondal, M. M. A., & Alam, M. N. (2012). Selection of promising rapeseed mutants through multi-location trials. *Bangladesh Journal of Botany*, **41**(1): 111-114.

Mondal, M., A. B. Puteh and N. C. Dafader. 2016. Foliar application of chitosan improved morpho-physiological attributes and yield in summer tomato (*Solanum lycopersicum*). *Pakistan Journal of Agricultural Sciences*, **53**(2).

Rahim, A. M. 2005. Effect of GABA on flowering pattern, floral abscission and yield attributes in soybean. Doctoral dissertation. Dept. Crop Botany, Bangladesh Agric. Univ., Mymensingh, Bangladesh.

Saied M.A, A.M.M. Momjurul and R.M. Shahidur. 2018. Foliar application of GABA improve growth and yield of mustard. *MOJ Curr. Res. & Rev*. **1**(3):119–122.

Samsuzzaman, M. 2004. Effect of NAA and GABA on growth and yield contributing characters of groundnut. Department of Crop Botany, Bangladesh Agricultural University, Mymemsingh, Bangladesh.