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Impact of GA_3 and NAA on Horticultural Traits of *Abelmoschus esculentus*

[1]H. Mehraj, [2]T. Taufique, [3]M.R. Ali, [4]R.K. Sikder and [2]A.F.M. Jamal Uddin

[1]The United Graduate School of Agricultural Sciences,
Ehime University, 3-5-7 Tarami, Matsumaya, Ehime 790-8556, Japan
[2]Department of Horticulture, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh
[3]Scientific Officer, Olericulture Division, HRC, BARI, Joydevpur, Gazipur, Dhaka, Bangladesh
[4]Horticulture Development Division, BADC, Dhaka-1000, Bangladesh

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. Gibberllic acid (GA_3) has potentiality to control growth and flowering process also it's 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

Corresponding Author: H. Mehraj, The United Graduate School of Agricultural Sciences, Ehime University, 3-5-7 Tarami, Matsumaya, Ehime 790-8556, Japan. E-mail: hmehraj02@yahoo.com.

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/plant, number of branches/plant, length of petiole, number of internodes/plant, length of internode, leaf area, fresh weight of plant, dry matter of plant, days to 50% flowering, number of flowers buds/plant, number of pods/plant, length of pod, diameter of pod, yield/plant, 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 70^0C 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:

% Dry matter content of plant = (Dry weight/Fresh weight) × 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 G_1 (89.0 cm) which was statistically similar with G_2 (87.5 cm), whereas shortest from G_0 (78.3 cm) at 60 DAS (Fig. 1a). Plant height was increased by applying GA_3 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 G_1 and G_2 (2.1 cm), while the minimum from G_0 (1.8 cm) at 60 DAS (Fig. 1b).

Number of Leaves and Leaf Area: The maximum number of leaves was found from G_1 (49.0/plant) which was statistically similar with G_2 (48.8/plant) at 60 DAS, while the minimum from G_0 (42.7/plant) (Fig. 2a). Leaves number was increased by the applying GA_3 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 G_1 (29.7 cm^2) which was statistically identical with G_2 (29.0 cm^2), while the minimum from G_0 (25.6 cm^2) at 60 DAS (Fig. 2b). Previously it was also reported that leaf area increased by the foliar application of GA_3 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 G_1 (5.5/plant) which was statistically similar with G_2 (5.3/plant), while the minimum from G_0 (4.9/plant) 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 G_1 (29.0 cm) which was statistically similar with G_2 (28.6 cm), while the shortest from G_0 (25.2 cm) at 60 DAS (Fig. 3b).

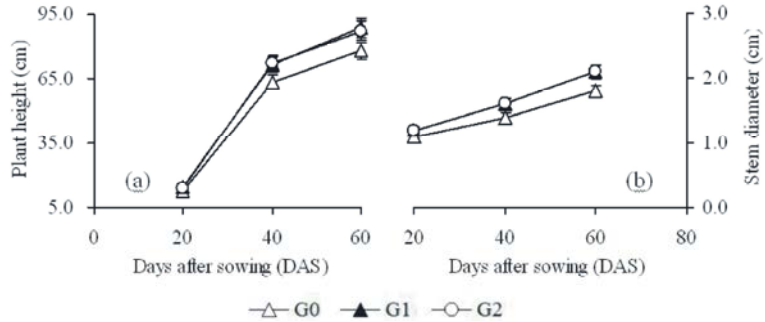

Fig. 1: Effect of plant growth regulators on (a) plant height and (b) stem diameter of okra

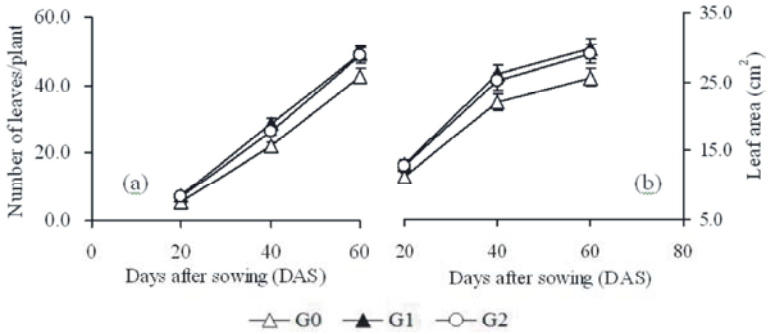

Fig. 2: Effect of plant growth regulators on (a) number of leaves and (b) leaf area of okra

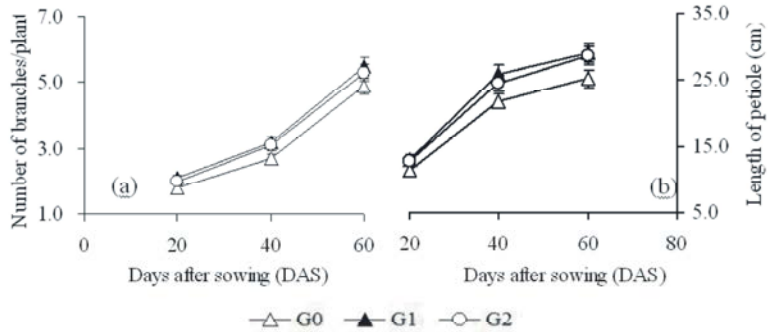

Fig. 3: Effect of plant growth regulators on (a) number of branches and (b) length of petiole of okra

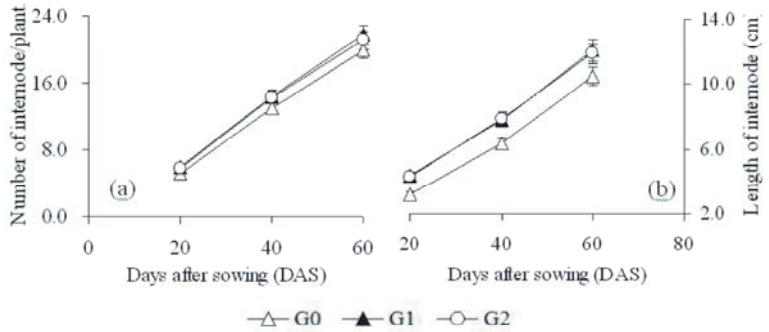

Fig. 4: Effect of plant growth regulators on (a) number of internodes and (b) length of internodes of okra

Number and Length of Internodes: The maximum number of internodes was found from G_1 (21.8/plant) which was statistically identical with G_2 (21.1/plant), whereas the minimum from G_0 (19.9/plant) at 60 DAS (Fig. 4a). The longest internodes was found from G_1 (12.1 cm) which was statistically identical with G_2 (11.9 cm), while the minimum from was found from G_0 (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 G_1 (84.5 g) which was statistically identical with G_2 (83.2 g), whereas the minimum from G_0 (75.1 g) (Table 1).The maximum dry weight per plant was found from G_1 (10.9 g) which was statistically similar with G_2(10.5 g), while the minimum from G_0 (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 G_0(46.7), while the minimum from G_1 (43.3) (Table 1). It was found that application of GA_3 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[X]

Treatments	Fresh weight/plant (g)	Dry weight/plant (g)	Days to 50% flowering	Number of flower buds/plant	Number of pods/plant
G_0	75.1 b	9.2b	46.7 a	35.9 b	24.0 c
G_1	84.5 a	10.9a	42.7 b	43.6 a	33.4 a
G_2	83.2 a	10.5a	43.3 b	42.5 a	31.3 b
LSD(0.05)	4.1	0.4	2.5	1.8	2.0
CV (%)	7.8	4.3	7.1	7.3	5.4

[X]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[X]

Treatments	Pod length (cm)	Pod diameter (cm)	Yield (g/plant)	Yield (kg/plot)	Yield (t/ha)
G_0	15.0 b	1.2 b	284.7b	2.3 b	13.8 b
G_1	17.5 a	1.7 a	338.1a	2.9 a	16.4 a
G_2	17.1 a	1.6 a	334.5a	2.9 a	16.1 a
LSD(0.05)	0.6	0.1	5.2	0.3	0.9
CV (%)	5.3	3.6	5.9	1.4	8.9

[X]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 G_1 (43.6/plant) which was statistically identical with G_2(42.5/plant), while the minimum from G_0 (35.9/plant) (Table 1). Jamal Uddin *et al.* [30] also found that foliar application of GA_3 increased the number of flower buds in strawberry.

Number of pods/plant: The maximum pods was found from G_1 (33.4/plant), whereas the minimum from G_0 (24.0/plant) (Table 1). Uddin *et al.* [46] was found that the number of okra fruit ranged from 16.5/pant to 22.5/plant, while 33.4/plant fruit was found from current study. By the application of GA_3 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 GA_3.

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 G_1 (338.1 g/plant, 2.9 kg/plot and 16.4 t/ha) which was statistically similar with G_2 (334.5 g/plant, 2.9 kg/plot and 16.1 t/ha), whereas the minimum from G_0 (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 GA_3 at 25 and 50 ppm (15.81 and 18.69 t/ha) gave the highest fruit yields [48]. Munda *et al.* [49] reported that GA_3 @ 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 (GA_3) 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 GA_3 could increase the growth and yield contributing characteristics of okra plant and ultimately increses the yield.

REFERENCES

1. BBS, Monthly Bulletin, February, 2010. Monthly Statistical Bulletin of Bangladesh. Bangladesh Bureau of Statistics, Ministry of Planning. Government of the People's Republic of Bangladesh, Dhaka, pp: 44.
2. Meera, S. and S. Poonam, 2010. Response of growth regulators on some physiological traits and yield of wheat (*Triticum aestivum* L.). Prog. Agric., 10(2): 387-388.

3. Yamaguchi, S. and Y. Kamiya, 2000. Gibberellin biosynthesis: Its regulation by endogenous and environmental signals. Plant Cell Physiol., 41: 251-257.
4. Pundir, J.P.S. and P.K. Yadav, 2001. Effect of GA3 and NAA on growth, yield and quality of tomato. Current Agric., 32(1 and 2): 137-138.
5. Bhosle, A.B., S.B. Khorbhade, P.B. Sanap and M.J. Gorad, 2002. Effect of plant hormones on growth and yield of summer tomato. (*Lycopersicon esculentum* Mill.). Orissa J. Hort., 30(2): 63-65.
6. Meena, R.S., 2008. Effect of GA3 and NAA on growth, yield and quality of tomato. (*Lycopersicon esculentum* Mill.). Current Agriculture, 32(1 and 2): 83-86.
7. Mehraj, H., T. Taufique, A.F. Ona, M.Z.K. Roni and A.F.M. Jamal Uddin, 2013. Effect of spraying frequency of gibberellic acid on growth and flowering in gerbera. J. Expt. Biosci., 4(2): 7-10.
8. Khan, A.S. and N.Y. Chaudhry, 2006. GA_3 improves flower yield in some cucurbits treated with lead and mercury. Afr. J. Biotechnol., 5: 149-153.
9. Emongor, V.E., 2004. Effect of gibberellic acid on post harvest quality and vase life of gerbera cut flowers (*Gerbera jamesonii*). J. Agron., 3: 191-195.
10. Islam, S., Sudip Chakrabortty, M.J. Uddin, H. Mehraj and A.F.M. Jamal Uddin, 2014. Growth and Yield of Wheat as Influenced by GA_3 Concentrations. Int. J. Bus. Soc. Sci. Res., 2(1): 74-78.
11. Naeem, N., M. Ishtiaq, P. Khan and N. Mohammad, 2001. Effect of gibberellic acid on growth and yield of tomato cv. Roma. Online J. Biol. Sci., 1(6): 448-460.
12. Nakamura, T., Y. Kawanabe, E. Takiyama, N. Takahashi and T. Murayama, 1978. Effects of auxin and gibberellin on conidial germination in *Neurospora crassa*. Plant Cell Physiol., 19: 705-709.
13. Tomita, K., T. Murayama and T. Nakamura, 1984. Effects of auxin and gibberellin on elongation of young hyphae in *Neurospora crassa*. Plant Cell Physiol., 25: 355-358.
14. Michniewicz, M. and B. Rozej, 1988. Is the gibberellin-limiting factor for the growth and development of Fusarium culmorum? Acta Physiol. Plant., 10: 227-236.
15. El-Otmani, M., C.W. Coggins, M. Agusti and C.J. Lovatt, 2000. Plant growth regulators in citriculture: world current uses. Crit. Rev. Plant Sci., 19: 395-447.
16. Williams, R.R. and A.M. Taji, 1989. Auxin type, gel concentration, rooting and survival of *Cheiranthera volubilis In vitro*. J. Amer. Soc. Hort. Sci., 24: 305-307.
17. Davies, P.J., 1987. Plant Hormone and their Role in Plant Growth and Development. Martinus Nijhoff Publ. Dordrecht, Netherlands.
18. Abro, G.H., T.S. Syed, M.I. Umer and J. Zhang, 2004. Effect of application of a growth regulator and micronutrients on insect pest infestation and yield components of cotton. J. Entomol., 1(1): 12-16.
19. Zahir, Z.A., A. Rahman, N. Asghar and M. Arshad, 1998. Effect of an auxin precursor L-tryptophan on growth and yield of rice. Pak. J. Biol. Sci., 1(4): 354-356.
20. 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.
21. Birbal, R.K., Singh, Vinod Kumar and V.S. Kushwa, 2005. Effect of GA and NAA on growth and yield of seed potato. Potato Journal, 32: 256.
22. Gomez, K.A. and A.A. Gomez, 1984. Statistical Procedure for Agricultural Research (2^{nd}Edn.). Int. Rice Res. Inst., A Wiley Int. Sci., pp: 28-192.
23. Chaudhry, N.Y. and M.S. Zahur, 1992. Effect of growth regulators i.e., IAA and GA_3 on *Abelmoschus esculentus* L. internal structure of hypocotyls and stem internodes. Biol. Sci., 37(2): 217-244.
24. Kumer, S., P. Singh, R.P. Katiyar, C.P. Vaish and A.A. Khan, 1996. Beneficial effect of some growth regulators on the aged seeds of okra (*Abelmoschus esculentus* L.) under field conditions. Seed Res., 24: 11-14.
25. 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.
26. Awan, I. and H.K. Alizai, 1989. Effect of plant growth regulators on ripening, grain development and rice quality. Int. Rice Res. Newslett., 149: 30-31.
27. Chudhary, N.Y. and A. Khan, 2000. Effect of growth hormones i.e., GA_3, IAA and kinetin on shoot of *Cicer arietinum* L. Pak J. Biol. Sci., 3(8): 1263-1266.
28. Jamal Uddin, A.F.M., H. Mehraj, T. Taufique, A.F. Ona and S. Parvin, 2014. Foliar Application of Gibberelic Acid on Growth and Flowering of Gerbera Cultivars. Journal of Bioscience and Agriculture Research, 2(1): 51-58.

29. Krishnamoorthy, H.N., 1981. Plant Growth Substances. McGraw Hill, New Delhi, pp: 1-82.
30. Jamal Uddin, A.F.M., M.J. Hossan, M.S. Islam, K. Ahsan and H. Mehraj, 2012. Strawberry Growth and Yield Responses to Gibberellic Acid Concentrations. J. of Expt. Biosci., 3(2): 51-56.
31. Gurdev, S. and O.P. Saxena, 1991. Seed treatments with bioregulators in relation to wheat productivity. Proceedings of the National Symposium on Growth and Differentiation in Plants, (NSGDP'91), New Delhi, India, pp: 201-210.
32. Abdul, K.S., M.M.S. Saleh and S.J. Omer, 1988. Effects of gibberellic acid and cycocel on the growth flowering and fruiting characteristics of pepper. Irgi. J. Agric. Sci., 6: 7-18.
33. Paroussi, G., D.G. Voyiatzis, E. Paroussis and P.D. Drogoudi, 2002. Growth, flowering and yield responses to GA_3 of strawberry grown under different environmental conditions. Scientia Hort., 96(1-4): 103-113.
34. Sharma, R.R. and R. Singh, 2009. Gibberellic acid influences the production of malformed and button berries and fruit yield and quality in strawberry (*Fragaria* × *ananassa* Duch.). Scientia Hort., 119(4): 430-433.
35. Naidu, C.V. and P.M. Swamy, 1995. Effect of gibberellic acid on growth, biomass production and associated physiological parameters in some selected tree species. Indian J. Plant Physiol., 38: 15-17.
36. Alagukannan, G. and M. Vijayakumar, 1999. Effect of plant growth substances on yield attributing parameters, yield and quality in fenugreek. South Indian Hort., 47: 130-133.
37. Pandita, M.L., S.C. Pandey, J.L. Mangal and G.P. Singh, 1980. Effect of various concentrations of planofix as foliar spray on plant growth and fruit yield of chillies. Haryana J. Hort. Sci., 9: 170-174.
38. Yamgar, V.T. and V.T. Desai, 1987. Effect of NAA and planofix on flowering, flower and fruit drop and fruit set in chilli. J. Maharashtra Agri. Univ., 12: 34-38.
39. Sharma, N.K., S.K. Arora and B.S. Dhankhar, 1988. Effect of plant growth substances on growth, flowering, sex expression and fruit yield in bottle gourd [*Lagenaria siceraria* (Molina) Standl.]. Haryana Agri. Univ. J. Res., 18: 291-297.
40. Saleh, M.M. and K.S. Abdul, 1980. Effect of gibberellic acid and CCC, on growth of tomato plants. Mesopotamia J. Agri., 15: 137-166.
41. Yadava, R.B.R. and P.R. Sreenath, 1975. Influence of some growth regulators on growth, flowering and yield of cowpea. Indian J. Plant Physiol., 18: 135-139.
42. Hernandez, 1997. Morphogenesis in sunflower (*Helianthus annuus* L.) as affected by exogenous application of plant growth regulators. Agric. Scientia., 13: 3-11.
43. Awan, I.U., M.S. Baloch, N.S. Sadozai and M.Z. Sulemani, 1999. Stimulatory effect of GA3 and IAA on ripening process, kernel development and quality of rice. Pak. J. Bio. Sci., 2: 410-412.
44. Lee, J., K.T. Joung, K.H. Hayain and L.S. Hee, 1999. Effect of chilling and growth regulators in seedling stage on flowering of *Lilium formolongi*. Hangut Wanye Hakcheochi., 40(2): 248-252.
45. Mange, M., 1971. Study of action of gibberellic acid on the development of *Cicer arietinum* and its relation to metabolism. Botanique, 11: 1-10.
46. Uddin, M.J., M.H. Akand, S. Islam, H. Mehraj and A.F.M. Jamal Uddin, 2014. Phosphorus Levels on Growth and Yield of Okra (*Abelmoschus esculent us*). Bangladesh Res. Pub. J., 10(2): 120-124.
47. Vijayaraghavan, H., 1999. Effect of seed treatment with plant growth regulators on bhendi (*Abelmoschus esculentus* L.) grown under sodic soil conditions. Madras Agril. J., 86(4/6): 247-249.
48. Surendra, P., C.M. Nawalagatti, M.B. Chetti and S.M. Hiremath, 2006. Effect of plant growth regulators and micronutrients on yield and yield components in okra. Karnataka J. Agric. Sci., 19(2): 264-267.
49. Munda, B.D.S., R.R. Singh and K.R. Maurya, 2000. Effect of plant growth regulators on quality of seed of Okra (*Abelmoschus esculentus*). J. Appl. Biol., 10(1): 22-25.
50. Iyagba, A.G., B.A. Onuegbu and A.E. IBE, 2012. Growth and Yield Response of Okra (*Abelmoschus esculentus* (L.) Moench) Varieties to Weed Interference in South-Eastern Nigeria. Global Journal of Science Frontier Research, 12(7): 2249-4626.
51. Abd-El-Fattah, M.A., 1997. Effect of phosphorus, Boron, GA_3 and their interaction on growth, flowering, pod setting, abscission and both green pod and seed yields of broad bean (*Vicia faba* L.) plants. Alexandria J. Agric. Res., 42: 311-332.