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Yield Response of Okra to Different Sowing Time and Application of Growth Hormones

[1]S. Dilruba, [2]Mirza Hasanuzzaman, [3]R. Karim and [4]Kamrun Nahar

[1]Department of Horticulture and Postharvest Technology,
Sher-e-Bangla Agricultural University, Dhaka, Bangladesh
[2]Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh
[3]Bangladesh Agricultural Development Corporation, Pabna, Bangladesh
[4]Department of Agricultural Botany, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh

Abstract: A field experiment was conducted to evaluate the response of sowing time and hormones on growth and yield of okra at the Horticultural Farm of Sher-e-Bangla Agricultural University, Dhaka during the period from March to August, 2007. The experiment consisted of two factors viz. Factor-A: Three sowing time i.e. March 22, April 06 and April 21 and Factor-B: Hormones (4 treatments) i.e. Control, Alga Gold, Crop care and Ripen-15. From the results it was noticed both the fruit number and fruit yield significantly affected by sowing time and hormones. In case of sowing times, 06 April sowing produced the height yield (13.88 t ha^{-1}) and 22 March sowing produced the lowest yield (10.22 t ha^{-1}). In case of hormone, Ripen-15 produced the highest yield of okra (14.06 t ha^{-1}) and control produced the lowest (10.06 t ha^{-1}). Combined effect of 06 April sowing with Ripen-15 produced the highest yield (15.98 t ha^{-1}) while 22 March sowing with no hormone gave the lowest yield (9.10 t ha^{-1}. Therefore, 06 April sowing with Ripen-15 is best for better growth and yield of okra.

Key words: Yield % Sowing % Hormones % Bangladesh

INTRODUCTION

Okra (*Abelmoschus esculentus* L. Moench) is an important summer vegetable in Bangladesh [1]. Okra is a nutritious vegetable which plays an important role to meet the demand of vegetables of the country when vegetables are scanty in the market [2]. These green fruits are rich sources of vitamins, calcium, potassium and other minerals. Okra is specially valued in different parts of the country for its tender and delicious fruits. It is cultivated throughout Bangladesh but its average national yield is poor, only 3.07 t ha^{-1} [3]. The yield is very low as compared to the yield 9.7-10 t ha^{-1} of other developed countries of the world [4]. The yield could reach as high as 30 t ha^{-1} [5].

Sowing time has a great impact on seed production and quality of okra [6-8]. Different cultivars require different climatic condition as well as different sowing time and a good cultivars sown at improper time give poor yield [9, 10]. Therefore proper and suitable date of sowing is critical to increase the production of crop. Plant growth regulators (PGR's) affect the physiology of plant growth and influence the natural rhythm of a plant. 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, fruit size with consequent enhancement in seed yield in groundnut [11] cotton [12] cowpea [13] and rice [14]. It also increases the flowering, fruit set, total dry matter of crops [15]. Likewise, GA_3 stimulated stem elongation [16] increase dry matter accumulation [17] and enhance total yield of okra [18, 19]. Very limited works have been carried out regarding the use of growth regulators on okra in Bangladesh. Ilias *et al*. [20] reported that Stem and leaf dry masses and stem length were significantly enhanced by the application of exogenous GA_3.

Therefore, the present investigation was carried out to find out the optimum sowing time and proper hormone combination for production of okra.

Corresponding Author: Mirza Hasanuzzaman, Assistant Professor, Department of Agronomy,
Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh

MATERIALS AND METHODS

The research was conducted at the Horticultural Farm of Sher-e-Bangla Agricultural University, Dhaka-1207. The experimental field is located at 90°33´ E longitude and 23°77´ N latitude at a height of 9.2 meter above the sea level [21]. The land was medium high and well drained. The soil of the experimental site belongs to the agro-ecological region of 'Madhupur Tract" (AEZ No. 28) classified by UNDP/FAO (1988). It was Deep Red Brown Terrace soil and belonged to "Nodda" cultivated series. The top soil is silty clay loam in texture. Organic matter content was very low (0.82%) and soil pH varied from 5.47-5.63.

The experiment was done with BARI dherosh 1. This variety is released by Bangladesh Agricultural Research Institute, Gazipur, Bangladesh. There were two factors in this experiment, viz. date of sowing and hormones. Three different sowing times were S_1= 22 March, S_2= 06 April and S_3= 21 April. The hormones treatments were as: H_0= No hormone, H_1= Application of Algagold (Micronutrients concentrations), H_2= Application of Crops care (Napthalene Acetic Acid, NAA 4.5%) and H_3= Application of Ripen-15 (15% Ethephon). The experiment was laid out in randomized completely block design (RCBD) with three replications.

Seeds of okra cv. BARI derosh 1 were sown based on different treatment variables. The row to row distance was 50 cm while the plant to plant distance was 40 cm. Seed sowing was done manually. Before sowing the experimental plots were fertilized with 250: 80: 130: 100: 5: 10 kg of urea: tripe superphosphate: muriate of potash: gypsym: zinc oxide: boric acid as the recommended dose. During final land preparation one half of the urea and total amount of other fertilizers were applied and incorporated into soil. Rest of the urea was top dressed at flower initiation stage. Weeding was done two times manually with 'nirani'. Thinning was done in all the unit plots with care to maintaining a one plant in a hill. Irrigation was done whenever necessary by water cane at afternoon. The crop was sprayed with Ripcord, Bavistin, Admire and Malathion 60 EC to prevent infestation of insects and vectors of virus. At maturity the crop was harvested at different intervals. The data were analyzed following Analysis of Variance (ANOVA) technique and mean differences were adjusted by the t-test [23]. Means were compared by using Duncan's New Multiple Test (DMRT) at 5% level of significance.

RESULTS AND DISCUSSION

Weight of Fruit: Sowing times and well as hormones significantly affected the weight of fruit of okra. The fresh weight of okra fruit was greatly affected by sowing times in this experiment (Table 1). Significantly highest fresh weight (28.60 g) was observed with 06 April sowing whereas the lowest weight was observed with 22 March sowing. Dry matter production in fruit also got the similar effect. In case of dry matter in fruit the maximum weight was observed with 06 April sowing (2.29 g) while the lowest dry weight was found from 22 March sowing. Yadav and Dhankhar [8] also obtained similar results.

Hormones also affected the fruit weight of okra. In case of fresh weight the application of Ripen-15 gave the highest value (32.11 g). It was followed by the results found from the application of Crop Care (28.66 g). The control plot gave the lowest fresh weight of okra in this experiment (Table 1). Application of hormones also significantly increased the dry weight of fruit which differed among the hormones. The maximum dry weight of fruit was observed due to application of Ripen-15 (2.57 g) it was next to Crop Care (2.29 g) and Alga Gold (2.05). The lowest value was observed in control plots (1.73 g). Pandita *et al*. [24] supported these findings.

The combined effect of sowing times and hormones had the remarkable effect on the fruit weight of okra (Table 2). The fresh weight was significantly affected by different combination of these factors. Significantly highest fresh weight (33.45 g) and dry weight (2.68 g) was observed from the combination of 06 April sowing and application of Ripen-15 (S_3H_3) while the 22 March sowing without hormone (S_1H_0) produced the lowest fresh weight (21.08 g) and dry weight (1.69 g) of okra fruit. It revealed that to ensure the maximum accumulation of photosynthate in okra fruit the proper sowing times as well as application of potential hormones should be maintained. This result was supported by Satpathy and Rai [25, 26, 27].

Number of Fruits per Plant: The number of fruit is an important factor to increase the yield of okra. In this experiment the sowing times had a significant effect on the number of fruit per plant (Table 3). Significantly highest number of fruit per plant (46.6) was found with 06 April sowing which was followed by 21 April sowing. The number of fruit was lowest when the okra plant was sown on 22 March. This result was supported by Palanisamy *et al*. [28] who observed the variation of increased fruit number in okra with optimum planting.

Table 1: Weight of mature fruit of okra as affected by different sowing time and hormones

Treatment	Average fresh weight of single fruit (g)	Average dry weight of single fruit (g)
Sowing time		
S_1	22.10b	1.77b
S_2	28.60a	2.29a
S_3	23.44b	1.88a
$LSD_{0.05}$	3.07	0.56
Hormones		
H_0	21.67c	1.73b
H_1	25.66bc	2.05a
H_2	28.66ab	2.29a
H_3	32.11a	2.57a
$LSD_{0.05}$	4.39	0.89
CV (%)	5.66	7.89

Means separation in columns followed by the same letter(s) are not significantly different at P=0.05

Table 2: Weight of mature fruit of okra as affected by the combined effect of sowing time and hormones

Treatment	Average fresh weight of single fruit (g)	Average dry weight of single fruit (g)
S_1H_0	21.08c	1.69d
S_1H_1	23.33bc	1.87bcd
S_1H_2	25.66bc	2.05bcd
S_1H_3	27.54abc	2.20bc
S_2H_0	22.01bc	1.76cd
S_2H_1	26.77abc	2.14bcd
S_2H_2	28.94abc	2.32ab
S_2H_3	33.45a	2.68a
S_3H_0	21.00c	1.68d
S_3H_1	22.35bc	1.79cd
S_3H_2	27.87abc	2.23bc
S_3H_3	29.08ab	2.33ab
$LSD_{0.05}$	6.85	0.41
CV (%)	8.45	6.45

Means separation in columns followed by the same letter(s) are not significantly different at P=0.05

Table 3: No. of fruits and yield of okra as affected by the different sowing times and hormones

Treatment	No. of Fruit plant^{-1}	Fruit yield plant^{-1} (g)	Fruit yield (t ha^{-1})
Sowing times			
March 22 (S_1)	38.6b	853.06c	10.22b
April 06 (S_2)	46.6a	1332.76a	13.88a
April 21 (S_3)	44.2a	1036.05b	13.46a
$LSD_{0.05}$	3.51	105.66	1.31
Hormones			
Control (H_0)	37.8b	819.13d	10.06d
Alga Gold (H_1)	42.8a	1098.25c	11.25c
Crop Care (H_2)	44.1a	1264.48b	12.56b
Ripen-15 (H_3)	45.0a	1444.95a	14.06a
$LSD_{0.05}$	2.51	96.54	1.08
CV (%)	9.32	8.76	10.32

Means separation in columns followed by the same letter(s) are not significantly different at P=0.05

Table 4: No. of fruits and yield of okra as affected by the interaction effect of sowing times and hormones

Treatment	No. of Fruit plant^{-1}	Fruit yield plant^{-1} (g)	Fruit yield (t ha^{-1})
S_1H_0	37.2g	788.39f	9.10h
S_1H_1	39.0efg	909.87e	10.23fg
S_1H_2	41.0de	1052.06d	11.24f
S_1H_3	42.7cd	1175.41c	14.05bcd
S_2H_0	37.4fg	818.77f	10.11gh
S_2H_1	39.4ef	1054.74d	12.34e
S_2H_2	42.4cd	1227.06c	13.56cd
S_2H_3	48.4a	1618.98a	15.98a
S_3H_0	38.2fg	802.20f	10.01gh
S_3H_1	41.0de	916.35e	12.43e
S_3H_2	43.2c	1203.98c	14.54bc
S_3H_3	45.8b	1331.86b	14.87b
$LSD_{0.05}$	2.14	85.76	1.05
CV (%)	9.32	8.76	10.32

Means separation in columns followed by the same letter(s) are not significantly different at P=0.05

Different hormones treatments were also significantly affected the number of fruit (Table 3). Among the treatments application of Ripen-15 gave the highest number of fruit (44.1) in this study while control plots produced the lowest number of fruits (37.8). The effect of different compound of hormones on the fruit bearing was statistically at per regarding this study. Singh *et al*. [29] also observed the increase in fruit number with these hormones.

The significant interaction was noticed between the sowing times and hormones to produce the fruit in a plant (Table 4). The study showed that the combination of 06 April sowing and application of Ripen-15 (S_3H_3) produced the highest number of fruit (48.4) while the 22 March sowing without hormone (S_1H_0) produced the lowest number of fruit (37.4). Muoneke *et al*. [30]; Nath and Saikia [31] and Brar *et al*. [32] partially supported the results.

Fruit Yield per Plant: In this experiment, fruit yield per plant was significantly varied due to different sowing times (Table 3). The plants gave the maximum fruit yield (1332.76 g) when it was sown on 06 April. It was followed by 21 April sowing (1036.05 g). The lowest fruit yield per plant was observed in 22 March sowing. The results revealed the appropriate sowing times can increase the fruit yield up to 182.99 g per plant which is 21.45% higher. The result is in close conformity with that of Hossain *et al.* [7]. Ghanti *et al*. [33] and Iremiren *et al*. [34] also supported the results.

Fruit yield per plant was also significantly affected by application of plant hormones (Table 3). Among the hormones treatments, Ripen-15 produced the highest fruit

yield of okra (1444.95 g plant^{-1}) which was followed by Crop Care (1264.48 g) and Alga Gold (1098.25 g). However, the control plots resulted with lowest fruit yield per plant (819.13 g). It was calculated that the application of Ripen-15, Crop care and Alga Gold gave 76.40%, 54.36% and 34.07% higher fruit yield, respectively over control in this experiment. Pawar *et al*. [35] found similar result. Fruit yield was found to be maximum with the application of NAA was reported by Singh and Singh [36] and Gulshan and Lal [37].

Like the single factors, the interaction effect of sowing times and hormones had also a significant contribution towards the seed yield in an okra plant (Table 4). In this study the interaction of 06 April sowing coupled with application of Ripen-15 (S_2H_3) produced the highest fruit yield (1618.98 g) while the combined effect of 22 March sowing and no hormones application (S_1H_0) gave the lowest yield (788.39 g) which was statistically at per with S_3H_0 (802.10 g) and S_2H_0 (818.77 g). This result was in agreement with Iremiren and Okiy [34] and Gadakh *et al*. [38].

Fruit Yield per Hectare: Fruit yield is the ultimate product of different yield contributing characters. As the different plant characters of okra was greatly affected by sowing times as well as hormones, the fruit yield per hectare was also affected. Different sowing times had a significant effect on the fruit yield per hectare and in this study the highest fruit yield per hectare (13.88 t) was obtained from 06 April sowing which was statistically similar with 21 April sowing (Table 3). However the lowest fruit yield per hectare (10.22 t) was observed from 22 March sowing which was 30.07% and 31.70% lower than April 06 and April 21 sowing. This finding was in agreement with Palanisamy *et al*. [28]; Singh *et al*. [6] and Yadav *et al*. [39].

Plant hormones also significantly affected the yield of okra per unit area. In this experiment significantly highest fruit yield was observed from the application of Ripen-15 (14.06 t ha^{-1}). The next higher fruit yield was observed from Crop Care (12.56 t ha^{-1}) followed by Alga Gold (11.25 t ha^{-1}). The lowest fruit yield per hectare was observed from control treatment (10.06 t ha^{-1}) which was 39.76%, 24.85% and 6.46% lower than Ripen-15, Crop Care and Alga Gold application (Table 3). Gulshan and Lal [37] also reported similar result in okra.

A significant variation of fruit yield of okra per hectare was also observed due to the combined effect of sowing times and hormones (Table 4). In the present study the combined effect of 06 April sowing coupled with application of Ripen-15 (S_2H_3) produced the highest fruit yield (15.98 t ha^{-1}) while the combined effect of 22 March sowing and no hormones application (S_1H_0) gave the lowest yield (37.2 t ha^{-1}) which was statistically at per with S_2H_0 (37.4 t ha^{-1}) and S_3H_0 (38.2 t ha^{-1}) and S_1H_1 (39.0 t ha^{-1}). Sajjan *et al*. [40] confirmed this result.

REFERENCES

1. Rashid, M.M., 1999. *Shabjibijjaya*n (In Bengali). Rashid Publishing House, 94 Old DOHS, Dhaka-1206. pp: 49.
2. Ahmed, K.U., 1995. *Pal-Phul O Shak-Shabji* (In Bengali) 5th ed. Mrs Mumtaj Kamal. Mirpur, Dhaka, Bangladesh, pp: 400.
3. Anonymous, 2000. *Yearbook of Agricultural Statistics of Bangladesh*, Bangladesh Bureau of Statistics (BBS). Ministry of planning, Govt. of the People's Republic of Bangladesh, pp: 96.
4. Thompson, H.C. and W.C. Kelley, 1979. *Vegetables Crops.* 5th Edition. McGraw Hill, New York, pp: 561-563.
5. Koay, S.H. and S.E. Chua, 1978. Effect of fertilizers on vegetative growth and pod production in okra *(Hibiscus esculentus* L.). Singapore J. Prio. Ind., 6: 76-79.
6. Sing, K.P., Y.S. Malik, S. Lal and M.L. Pandita, 1986. Effects of planting dates and spacing on seed production of okra (*Abelmoschus esculentus* (L). Moench). Haryana J. Hortic. Sci., 15(3-4): 267-271.
7. Hossain, M.D., M.A. Salam, M.S. Islam and M.A.T. Masud, 1999. Yield and quality of Okra (BARI Dherosh-1) seed as influenced by time of sowing and plant spacing. Bangladesh J. Seed Sci. Tech., 3(1-2): 83-87.
8. Yadav, S.K. and B.S. Dhankar, 2001. Seed production and quality of okra (*Abelmoschus esculentus* (L.) Moench) as affected by sowing time and position of fruit on plant. Seed Res., 29(1): 47-51.
9. Tindall, H.D., 1983. *Vegetables in the Tropics*. McMillan AVI., 33: 325-327.
10. Nonnecke, I.L., 1989. Vegetable Production. Van Nostrand Reinhold AVI Publishing, pp: 608-609.
11. 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(8): 1-9.
12. Kapgate, H.G., N.N. Potkile, N.G. Zode and A.M. Dhopte, 1989. Persistence of physiological responses of upland cotton to growth regulators. Ann. Plant Physiol., 3: 188-195.
13. Khalil, S. and H.M. Mandurah, 1989. Growth and metabolic changes of cowpea plants as affected by water deficiency and indole acetic acid. J. Agron. Crop Sci., 163: 160-166.

14. Kaur, J. and G. Singh, 1987. Hormonal regulation of grain filling in relation to peduncle anatomy in rice cultivars. Indian J. Expl. Biol., 25: 63-65.
15. Gurdev, S. and O.P. Saxena, 1991. Seed treatments with bioregulators in relation to wheat productivity. In: *New Trends in Plant Physiology*, Proceed., *National Symposium on Growth and Differentiation in Plants*. New Delhi, India, pp: 201-210.
16. Harrington, J.F., L. Rappaport and K.J. Hood, 1996. The influence of gibberellins on stem elongation and flowering on endive. Sci.,125: 601.
17. Hore, J.K., N.C. Paria and S.K. Sen, 1988. Effect of pre-sowing seed treatment on germination, growth and yield of (*Allium cepa*) var. Red Globe. Harayana J. Hort. Sci., 17: 83-87.
18. 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.
19. Maske, V.G., R.D. Deotale, N.V. Sorte, H.B. Goramnagar and C.N. Chore, 1998. Influence of GA and NAA on growth and yield contributing parameters of soyabean. J. Soils Crops., 8: 20-21.
20. Ilias, G., A. Ouzounidou, Giannakoula and P. Papadopoulou, 2007. Effects of gibberellic acid and prohexadione-calcium on growth, chlorophyll fluorescence and quality of okra plant. Indian J. Hort., 51(3): 575-578.
21. BCA (Bangladesh Country Almanac), 2004. Agricultural Statistics Database. *In:* BCA v.2.0 (CD ROM Version). CIMMYT Bangladesh.
22. UNDP/FAO, 1988. Agroecological regions of Bangladesh. *Technical Report 2*. Project BDG/81/035; FAO, Rome.
23. Gomez, K.A. and A.A. Gomez, 1984. *Statistical procedures for Agricultural Research.* John Wiley and Sons. Inc., New York, pp: 67-215.
24. Pandita, M.L.N., K. Sharnia and S.K. Arora, 1991. Effect of Miixtalol arid Vipul on growth, flowering and yield of okra (*Abelmoschus esculentus* L. Moench). Veg. Sci., 18: 32-40.
25. Satpathy, S. and S. Rai, 1998. Influence of sowing date and crop phenology on pest infestation in okra. Veg. Sci., 25(2): 178-180.
26. Alegbejo, M.D., 2001. Effect of sowing date on the incidence and severity of okra mosaic. Tymovirus. J. Veg. Crop Prod., 7(1): 9-14.
27. Passam, H.C., K. Akoumianakis and A. Sarigiannidi, 1998. The effect of time of sowing on the production of okra (*Hibiscus esculentus* L.) seed in the Mediterranean region. Plant Var. Seeds., 11(3): 145-150.
28. Palanisamy, V., K. Vanangamudi, T. Jayaraj and T.V. Karivaratharaju, 1986. Influence of date of sowing in *bhindi* (*Abelmschus esculentus* (L.) Moench.). South Indian Hort., 34(1): 23-25.
29. Singh, D.K., S.K. Jain and G. Lal, 1999. Response of plant bio-regulators and foliar feeding of urea on seed yield of okra cv. Pusa Sawani during spring-summer season. Sci. Hort., 6: 121-124.
30. Muoneke, C.O., J.E. Asiegbu and A.C.C. Udeogalanya, 1997. Effect of relative sowing time on the growth and yield of the component crops in okra/maize and okra/cowpea intercropping systems. J. Agron. Crop Sci., 179(3): 179-185.
31. Nath, P. and A.K. Saikia, 1995. Influence of sowing time on yellow vein mosaic virus of okra. Indian J. Mycol. Plant Pathol., 25(3): 277-279.
32. Brar, K.S., S.K. Arora and T.R. Ghai, 1994. Losses in fruit yield of okra due to Earias spp. as influenced by dates of sowing and varieties. J. Insect Sci., 7(2): 133-135.
33. Ghanti, P., O. Sounds and K. Verma, 1991. Effect of sowing dates on growth and yield of okra (*Abelmoschus esculentus* L. Moench) varieties. Environ. Ecol., 9: 170-179.
34. Iremiren, G.O. and D.A. Okiy, 1986. Effect of sowing date on the growth, yield and quality of okra (*Abelmoschus esculentus* (L.) Moench. in Southern Nigeria. J. Agri. Sci., 106(1): 21-26.
35. Pawar, P.R., A.T. Joshi and K.G. Mahakal, 1977. Effect of seed treatment with plant growth regulators on germination, growth and yield of okra. J. Maharashtra Agril. Univ., 2(1): 26-29.
36. Singh, R.K. and K.P. Singh, 1977. Effect of seed treatment with plant growth substances on germination, vegetative growth and yield of okra. Proceedings of the Bihar Aca. Agric. Sci., 25(2): 24-27.
37. Gulshan, L. and G. Lal, 1997. Flowering, Fruiting and seed production of okra as influenced by growth regulators and urea. Recent Hort., 4: 135-137.
38. Gadakh, S.R., K.E. Lawande and P.N. Kale, 1990. Effect of different seasons and spacing on yield and quality of Bhindi. Haryana J. Hort. Sci., 19(3-4): 329-332.
39. Yadav, S.K., B.S. Dhankhar, D.P. Deswal and R.P.S. Tomer, 2002. Effect of sowing date and plant geometry on seed production and quality of okra (*Abelmoschus esculentus* (L.) Moench) cv. Varsha Uphar. Seed Res., 29(2): 149-152.
40. Sajjan, A.S., M. Shekhargouda and V.P. Badanur, 2002. Influence of date of sowing, spacing and levels of nitrogen on yield attributes and seed yield in okra. Karnataka J. Agric. Sci., 15(2): 267-274.