Bangladesh J. Bot. **54**(2): 285-291, 2025 (June) DOI: https://doi.org/10.3329/bjb.v54i2.82296

INFLUENCE OF NAA ON GROWTH, YIELD ATTRIBUTES AND YIELD OF BRRI DHAN-48 (*ORYZA SATIVA* L.)

AMM GOLAM ADAM*, MD SHARIF MIA AND UMMA FATEMA SHAHJADEE[1]

Department of Botany, Jagannath University, Dhaka-1100, Bangladesh

Keywords: Growth, Yield, *Oryza sativa* L., NAA,

Abstract

A pot experiment was conducted to investigate the influence of NAA (0, 20, 40, 60, 80 and 100 ppm) on growth, yield attributes and yield of BRRI Dhan-48. Results showed that NAA had stimulatory effects on growth parameters where better influences were noted from higher concentration. Application of 100 ppm NAA had produced the tallest plant, maximum number of leaves, dry weight of root, leaf area per plant and leaf area duration all over the growth ages with few exceptions. The highest number of tillers per plant was obtained from 40 ppm NAA. Foliar application of 60 ppm NAA had resulted higher dry weight of shoot and biomass duration at early stages whereas, in case of net assimilation rate 80 ppm produced better responses. Yield attributes and yield of BRRI Dhan-48 was positively influenced by different concentration of NAA with few exceptions. Number of effective tillers per plant (7.63), dry weight of panicles per plant (2.99g), number of grains per panicle (88.94), percentage of filled grains (99.16), yield per plant (3.57g) and harvest index (13.24%) were obtained maximum from 40 ppm treatments. The longest length of panicle (24.64 cm) produced by 80 ppm NAA and highest 1000-grain weight (13.51g) by 60 ppm NAA were statistically similar to 40 ppm NAA treatments. Results also revealed that 40 ppm NAA produced significantly higher yield and was 67.61% over the control. Out of six treatments, 40 ppm NAA is the best option for obtaining higher yield.

Introduction

Rice is the most vital cereal crop covering approximately 80% of cropped land in Bangladesh. The per capita consumption of rice is 179.9 kg per annum in contrast to the global average of 53.5 kg per annum (FAO 2020). Reports of United Nation Population Fund (2022-2023) indicated that the population of Bangladesh will augment to 220 million by 2050 from the existing 169 million. Considering the demand, it's high time to enhance rice production consistently. Farmers generally use chemical fertilizers with little or no use of organic manures to meet the rice nutrient requirement, which results in degraded soil health and decreased rice yield (Sarkar *et al.* 2016). In addition, excessive fertilizer use is proven to cause a number of environmental and ecological problems within and outside of farmlands (Lu and Tian 2013). As a result, to reduce chemical fertilizer use as well as to increase rice yield, use of plant growth regulators (PGRs) could be an efficient and sustainable alternative. However, the success of these chemicals depends on concentration, timing and modes of application (Kumari *et al.* 2018).

Various investigations showed that application of optimum dose of naphthalene acetic acid (NAA) had pronounced effect on growth, yield, nutrient uptake and biochemical processes of major cereal crops (Liu *et al.* 2012, Sarkar *et al.* 2013, Jahan and Adam 2013, Basuchaudhuri 2016, Islam and Jahan 2016, Adam *et al.* 2020, 2023, 2024). However, reports regarding the effect of NAA on rice are meager. Therefore, the present attempt has been taken to investigate the influence of various doses of NAA treatments on a variety of rice, var. BRRI Dhan-48.

*Author for correspondence: <adamammg@bot.jnu.ac.bd>. [1]Bangladesh Council and Industrial Research (BCSIR), Dhanmondi, Dhaka-1205, Bangladesh.

Materials and Methods

A pot experiment was conducted at the botanical garden of the Department of Botany, Jagannath University, Dhaka. A high yielding transplanting Aush variety BRRI dhan-48 was used for this research which was released in 2008 (Chowdhury and Hassan 2013). This variety is popular among farmers for its higher yield and short duration. The experiment was laid out in Randomized Block Design (RBD) with four replications. Seeds were collected from Bangladesh Rice Research Institute (BRRI), Gazipur. The experiment was consisted with six treatments *viz. viz.* T_0, T_1, T_2, T_3, T_4 and T_5 which represent control, 20, 40, 60, 80 and 100 ppm NAA respectively.

Seeds were surface sterilized with 0.5% calcium hypochlorite to avoid fungal infection and soaked in distilled water for 24 hrs before sowing in the seed bed. Seedlings were transplanted to experimental pots (25×30 cm) at 4-leaf stage at the age of 25 days. Each pot was filled with 9.0 kg air dried soil. Three hills were placed in each pot, each hill containing one seedling. Cultural practices *viz.* thinning, irrigation and weeding and fertilizer application were done following Handbook of Agricultural Technology (Chowdhury and Hassan 2013) and Fertilizer Recommendation Guide (2012), respectively. Cow dung was also mixed uniformly during pot preparation. Split applications of urea as a source of nitrogen was applied twice at the rate of 2 g per pot. Foliar application of NAA was done in sunny early morning at 30 days after transplanting (DAT). Growth parameters *viz.* plant height, number of tillers and leaves per plant, dry weight of shoot and root per plant, leaf area per plant, leaf area duration, relative growth rate and net assimilation rate and biomass duration per plant were noted from the age of 30 days after transplanting at an interval of 10 days. Leaf area per plant, leaf area duration, relative growth rate and net assimilation rate and biomass duration per plant were calculated using classical growth analysis methods (Radford 1967, Sestak *et al.* 1971, Gardner *et al.* 1985). Yield parameters were recorded after harvest. Eight plants from each treatment were harvested separately to record data on different parameters. Data were analyzed statistically and treatment means were compared by LSD test at 5% level of significance (Steel *et al.* 1997).

Results and Discussion

Results presented in Fig. 1**a** showed that application of NAA had stimulating effects on plant height of BRRI Dhan-48 with few exceptions. The tallest plant was obtained from 100 ppm throughout the growth ages with an exception and varied significantly in majority of cases. The promoting effect of NAA on plant height was also reported in various crops (Jahan and Adam 2011, Jahan and Adam 2013, Islam and Jahan 2016). However, decrease in plant height due to NAA application was also noticed by Ema *et al.* (2020) on sesame.

Foliar application of NAA had positive influences on number of tillers of BRRI Dhan-48 but varied non-significantly. The highest number of tillers was obtained from 40 ppm NAA treatment all over the growth periods except 10 days after transplanting (Fig. 1**b**). Foliar application of NAA non-significantly enhanced number of tillers per plant in rice (Adam and Jahan 2011) However, results of Liu *et al.* (2012) revealed that NAA did not affect the number of tillers of two rice varieties. Jahan and Adam (2013) and Islam and Jahan (2016) also obtained stimulatory effect of NAA on the number of tillers of wheat.

Results indicated in Fig. 1**c** revealed that all concentrations of NAA had resulted higher number of leaves per plant but with non-significant variation. Results also showed that the maximum number of leaves per plant was obtained from 100 ppm NAA which are in agreement with the findings of Jahan and Adam (2011). Increase in number of leaves due to NAA application was also noticed by various investigators (Jahan and Adam 2013, Siddik *et al.* 2016, Ema *et al.* 2020).

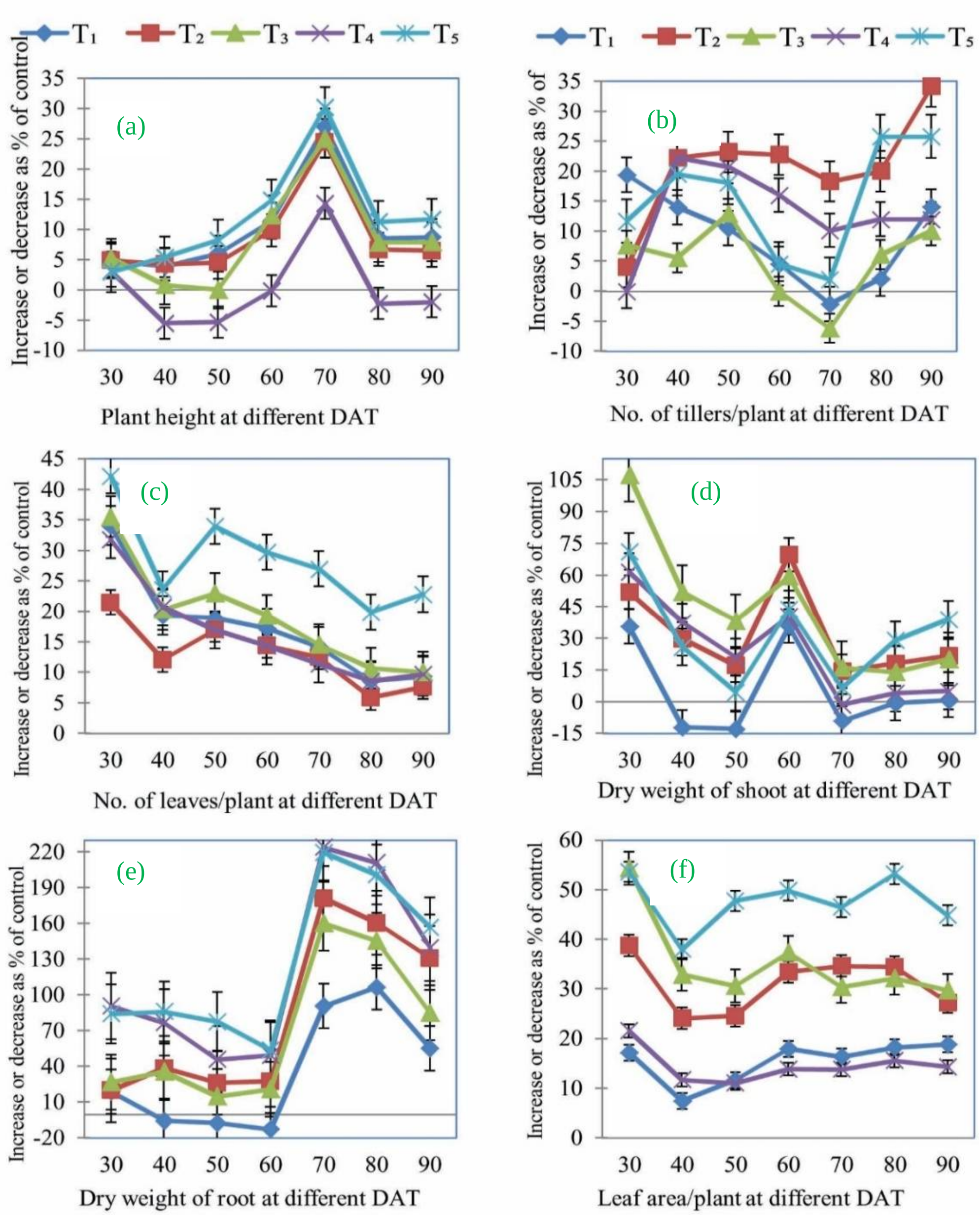

Fig.1. Influence of NAA on (a) plant height, (b) number of tillers, (c) number of leaves, (d) dry weight of shoot and (e) dry weight of root and (f) leaf area per plant of BRRI Dhan-48 at DAT (Mean ± standard error).

Results presented in Fig. 1d and 1e revealed that dry weight of shoot and root were positively influenced following NAA application in most of the cases with both significant and non-significant variations. Findings also focused that the increasing trends in dry weight of shoot was different to dry weight of root. The present results are in agreement with the findings of previous authors (Islam and Jahan 2016, Siddik *et al*. 2016, Ema *et al*. 2020).

Findings of this investigation indicated that leaf area per plant was positively influenced by NAA treatments throughout the growth ages where the highest increase was noted from 100 ppm NAA with significant variations (Fig. 1**f**). Significantly higher leaf area in maize was reported by Tollenaar (1989) which is similar to the findings of present investigation.

Foliar application of NAA had mostly inducing effects on leaf area duration (LAD), relative growth rate (RGR), net assimilation rate (NAR) and biomass duration (BMD) per plant all over the growth periods but the effect of magnitude was different depending on the concentration, growth stage and selected parameters (Fig. 2). Plant receiving 100 ppm treatment resulted significantly higher leaf area duration than control although statistically at par with 20 and 40 ppm NAA (Fig. 2a). Foliar application of NAA had stimulatory effects on LAD in okra (Surendra *et al*. 2006). In case of relative growth rate, NAA treatments did not show any general treads **(**Fig. 2b).

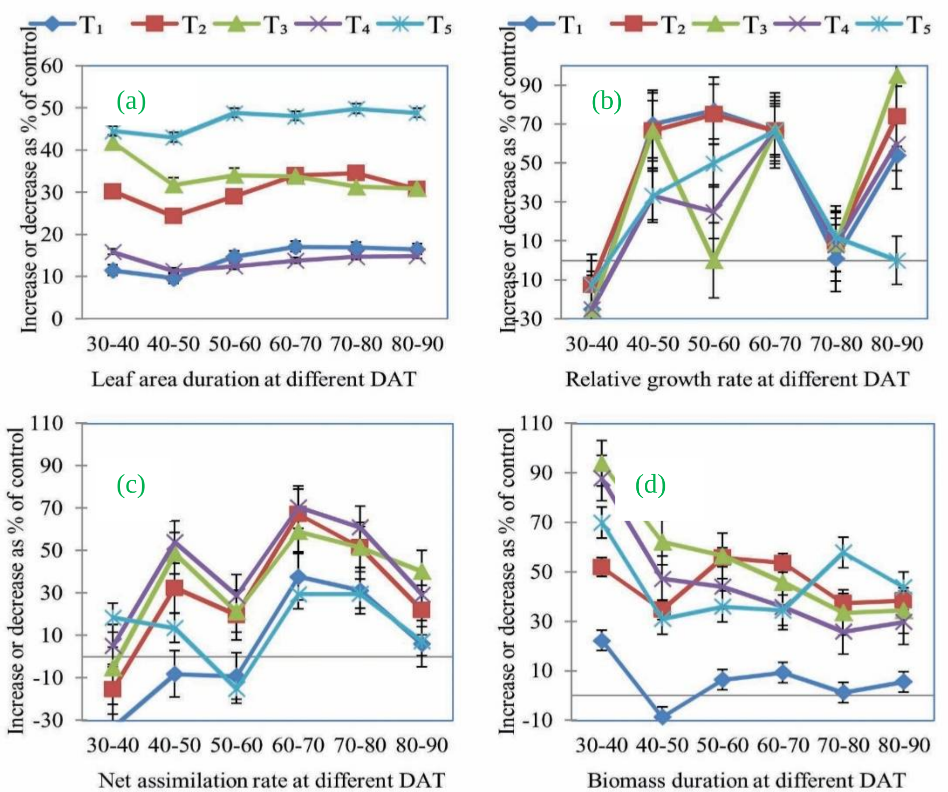

Fig. 2. Influence of NAA on (a) leaf area duration, (b) relative growth rate, (c) net assimilation rate and (d) biomass duration per plant of BRRI Dhan-48 at DAT (Mean ± standard error).

However, Behera (2015) showed that, application of growth regulators significantly increased RGR. Significantly higher net assimilation rate were noted only at 60-70 DAT and 70-80 DAT due to 80 ppm NAA treatment (Fig. 2c). Jahan and Adam (2011) found both stimulatory and retarding effect of 100 and 200 ppm NAA on NAR of two varieties of rice. By applying 20 ppm

NAA, significantly higher NAR was reported in sesame by Behera (2015). Plants treated with 60 ppm NAA had produced significantly higher biomass duration per plant than control (Fig. 2d). Present findings are in agreement with the results of Jahan and Adan (2011).

Table 1 indicated that application of NAA had remarkable effects on yield attributes and yield of BRRI dhan-48. Findings showed that NAA treatments had inducing effects on the number of effective tillers per plant where, 40 ppm NAA had resulted significantly higher value than control. By applying NAA, similar results were also noted by different authors (Adam and Jahan 2011, Liu *et al.* 2012, Duy *et al.* 2015). Table 1 also indicated that NAA had both inducing and retarding effects on the number of non-effective tillers per plant with non-significant variations. Similar results of increase and decrease in number of non-effective tillers per plant was obtained by Jahan and Adam (2013) in wheat.

Table I. Effects of NAA on yield attributes and yield of BRRI Dhan-48 at harvest.

Treatments (NAA)	No. of effective tillers/ plant	No. of non-effective tillers/ plant	Dry weight of panicle/ plant (g)	Length of panicle (cm)	No. of grains/ panicle	% of filled grains/ panicle	% of unfilled grains/ panicle	1000-grain weight (g)	Yield /plant (g)	Harvest Index (%)
0 ppm	5.38b	0.86	1.81b	22.32b	72.93ab	98.37c	1.63a	8.10bc	2.13 bc	10.37ab
20 ppm	7.25ab	0.50	2.09ab	22.81ab	84.35a	98.35c	1.65a	4.79c	1.89 c	8.85ab
40 ppm	7.63a	1.00	2.99a	24.23ab	88.94a	99.16a	0.84b	12.49a	3.57a	13.24a
60 ppm	5.63ab	1.25	2.86a	23.34ab	57.62b	98.54c	1.46a	13.51a	2.50abc	8.38ab
80 ppm	6.38ab	0.63	2.42ab	24.64a	88.11a	99.12ab	0.88b	9.95ab	3.31ab	12.09ab
100 ppm	7.25 ab	0.63	2.17 ab	22.45 b	83.71a	98.52 c	1.48 a	9.83 ab	2.15 bc	7.18 b
CV (%)	29.86	13.26	15.04	7.60	25.95	0.53	9.30	43.90	15.68	17.83
LSD (0.05)	2.03	NS	1.03	2.10	25.14	0.56	0.55	4.21	1.40	5.36

Mean in a vertical column followed by same letter or without letter do not differ significantly at 5 % level.

Dry weight of panicle was positively influenced by various NAA treatments where the maximum value (2.99g) was recorded from 40 ppm followed by 60 ppm. Dry weight of panicle produced by 40 and 60 ppm NAA although significantly higher than control but statistically at par to each other (Table 1). The present finding is similar to the findings of Ema *et al.* (2020) on sesame. Table 1 also indicated that NAA had stimulating effects on length of panicle where 80 ppm NAA produced significantly higher value than control but statistically identical to rest of the treatments. The current findings are in agreement with the results of the Jahan and Adam (2013) in wheat and Ema *et al.* (2020) on BARI Til-4.

Results presented in Table 1 showed that NAA had mostly stimulating effects on number of grains per panicle but with similar statistical values. The maximum number of grains per panicle (88.94) was found from 40 ppm NAA followed by 80 (88.11), 20 (84.35), 100 (83.71) ppm NAA, respectively. Jahan and Adam (2013) in wheat and Duy *et al.* (2015) in rice also obtained similar results.

Percentage of filled and unfilled grains per panicle was both positively and negatively influenced by NAA treatments. Application of 40 ppm NAA had resulted significantly higher percent of filled grains per panicle (99.16) than all other treatments except 80 ppm treatments (Table 1). Results also indicated that 40 ppm NAA had also produced significantly lowest percentage of unfilled grains (0.84) although statistically similar to 80 ppm treatment (0.88).

Adam and Jahan (2011) also obtained both stimulating and inhibitory effect on percent of filled and un-filled grains in rice.

The 1000-grain weight was significantly influenced by all application of NAA treatments except 20 ppm (Table 1). The maximum weight of thousand grains (13.51g) was noticed from 60 ppm NAA but not significantly different from 40 (12.49g), 80 (9.95g) and 100 (9.83g) ppm NAA treatments.) on sesame. The present results are in agreement with the findings of the previous authors (Jahan and Adam 2013, Ema *et al.* 2020).

Results indicated in Table 1 revealed that concentration above 20 ppm NAA treatments had promising influenced on yield per plant. Significantly higher yield per plant was obtained from 40 ppm NAA treatment (3.57g) only which was 67.61% over the control. Increase in yield per plant due to 60, 80 and 100 ppm NAA were 17.30, 55.40 and 0.94% over the control. Depending on the concentration, Adam and Jahan (2011) on rice and Jahan and Adam (2013) on wheat recorded both enhancing and retarding effects of NAA on yield per plant. Reports of other investigation revealed stimulatory effect of NAA on yield of different plants (Siddik *et al.* 2016, Ema *et al.* 2020). Results showed that NAA had not any significant response on harvest index. The highest harvest index was noted from 40 ppm (13.24%) followed by 80 ppm (12.09%) treatment (Table 1). Similar report was also noted by many other authors on various plants *viz.* wheat (Jahan and Adam 2013), rice (Duy *et al.* 2015).

The overall findings indicated that foliar application of NAA had stimulatory effects on growth parameters where better influences were noted from higher concentration. Results also revealed that 40 ppm NAA produced significantly higher yield than control. Out of six treatments, 40 ppm NAA is the best option for obtaining higher yield).

Acknowledgements

The authors are very much thankful to the Jagannath University and University Grants Commission of Bangladesh for providing fund in conducting this research work.

References

Adam AMMG and Jahan N 2011. Effects of naphthalene acetic acid on yield attributes and yield of two varieties of rice (*Oryza sativa* L.). Bangladesh J. Bot. **40**(1): 97-100.

Adam AMMG, Akter R and Begum HH 2024. Growth and yield responses of BARI Sweet corn-1 (*Zea mays* L.) to NAA at different nitrogen levels. Bangladesh J. Bot. **53**(2): 337-344.

Adam AMMG, Jahan N and Rashid P 2023. Growth and yield performance of wheat (*Triticum aestivum* L. var. BARI Gom-25) as affected by NAA and N-fertilizer in two sowing times. Bangladesh J. Bot. **52**(3): 853-860.

Adam AMMG, N Jahan and P Rashid 2020. Effects of NAA and nitrogen fertilizer on NPK uptake and nitrogen use efficiency of BARI Gom-25 (*Triticum_aestivum* L). Bangladesh J. Bot. **49**(3): 643-651

Basuchaudhuri P 2016. 1-Naphthalene acetic acid in rice cultivation. Curr. Sci. **110**(1): 52-56.

Behera S 2015. Effect of plant growth regulators on growth and yield characters of Sesamum. Department of plant physiology, Orissa University of Agriculture and Technology, Bhubaneswar.

Chowdhury MAH and Hassan MS 2013. Hand Book of Agricultural Technology. Bangladesh Agricultural Technology. Bangladesh Agricultural Research Council, Farmgate, Dhaka. pp. 230.

Duy MV, Hoi NT, Thuc LV, Than MV, Tung BV and Qui CN 2015. Effects of Naphthalene Acetic Acid on the Growth and Yield of Two Rice Varieties MTL560 and IR50404. J. Sci. **3**(3): 19-23.

Ema S, Adam AMMG, Kham FI and Begum HH 2020. Responses of Naphthalene acetic acid and *Pseudomonas* inoculum on growth, yield and some biochemical parameters of sesame (*Sesamum indicum* L. Var. BARI Til-4). Bangladesh J. Bot. **49**(2): 335-341.

FAO. 2020. Per capita rice consumption in Bangladesh to be highest in Asia in 2021.

Fertilizer Recommendation Guide 2012. Bangladesh Agricultural Research Council, Farmgate, Dhaka-1215. 274 pp.

Gardner FP, Pearce RB and Mitchell RL 1985. Physiology of crop plants. Iowa State University press Ames. pp. 164-186.

Islam S and Jahan N 2016. Growth and yield responses of *Triticum aestivum* L. var. BARI Gom-26 following application of Naphthalene acetic acid (NAA) at varying nitrogen levels. Bangladesh J. Bot. **45**(2): 411-418.

Jahan N and Adam AMMG 2011. Comparative growth analysis of two varieties of rice following naphthalene acetic acid application. J. Bangladesh Acad. Sci. **35**(1): 113-12

Jahan N and Adam AMMG 2013. Growth and yield responses of BARI Gom-26 (*Triticum aestivum* L.) to naphthalene acetic acid. Dhaka Univ. J. Biol. Sci. **22**(2): 119-125.

Kumari S, Bakshi P, Sharma A, Wali VK, Jasrotia A and Kour S 2018. Use of Plant growth regulators for improving fruit production in sub-tropical crops. Int. J. Curr. Microbiaol. App. Sci. **7**(3): 659-668.

Liu Y, Chen W, Ding Y, Wang Q, Li G and Wang S 2012. Effect of Gibberellic acid (GA_3) and naphthalene acetic acid (NAA) on the growth of unproductive tillers and the grain yield of rice (*Oryza sativa* L.). African J. Agril. Res. **7**(4): 534-539.

Lu C and Tian H 2013. Net greenhouse gas balance in response to nitrogen enrichment: perspectives from a coupled biogeochemical model. Glob. Change Biol. **19**: 571-588.

Radford PJ 1967. Growth analysis formulae: their use and abuse. Crop Sci. **7**: 171-175.

Sarkar BC, Roy B, Fancy R, Rahman W and Jalal S 2013. Response of root growth and yield of rice (BRRI dhan 28) under different irrigation frequencies and plant growth regulator. J. Sci. Technol. **11**: 51-55.

Sarkar MIU, Rahman MM, Rahman GKMM, Naher UA and Ahmed MN 2016. Soil test based inorganic fertilizer and integrated plant nutrition system for rice (*Oryza sativa* L.) cultivation in Inceptisols of Bangladesh. The Agriculturists **1**: 33-42.

Sestak Z, Jarvis PG and Catsky J 1971. Criteria for the selection of suitable methods. 1-48.

Siddik A, Shirazy BJ, Islam MM, Haque A and Haque M 2016. Combined effect of nitrogen and NAA on sesame (*Sesammum indicum* L.). Int. J. Biom. Sci. Engi. **3**(1): 7-1.

Steel RGD, Torrie JH and Dickey DA 1997. Principles and procedures of statistics. McGraw Hill Book Co. Inc. New York. 666 pp.

Surendra P, Nawalagatti CM, Chetti MB and Hiremath SM 2006. Effect of plant growth regulators and micronutrients on morpho-physiological and biochemical traits and yield in Okra. Karnataka J. Agric. Sci. **19**(3): 694-697.

Tollenaar M 1989. Genetic improvement in grain yield of commercial maize hybrids grown in Ontario from 1959 to 1988. Crop Sci. **29**: 1365-1371.

(Manuscript received on 17 March, 2025; revised on 28 May, 2025)