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GROWTH AND YIELD RESPONSES OF BARI SWEET CORN-1 (*ZEA MAYS* L.) TO NAA AT DIFFERENT NITROGEN LEVELS

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Abstract

A field experiment was conducted to investigate the effect of foliar application of NAA at varying N-levels on growth and yield responses of BARI Sweet Corn-1 (*Zea mays* L.). The trial consisted of ten treatments *viz.* control = without NAA and N fertilizer; RDN (recommended dose of N fertilizer); 25 ppm NAA + RDN; 50 ppm NAA + RDN; 25 ppm NAA + 50% higher RDN; 50 ppm NAA + 50% higher RDN; 25 ppm NAA + 100% higher RDN; 50 ppm NAA + 100% higher RDN; 25 ppm NAA+ 150% higher RDN and 50 ppm NAA + 150% higher RDN. Results showed that application NAA in combination with various nitrogen (N) levels produced better growth than control but with few exceptions. Growth parameters *viz.* total dry mater (TDM), leaf area (LA), relative growth rate (RGR) and net assimilation rate (NAR) were recorded maximum from 25 ppm NAA in combination with RDN treatment. Findings revealed that 25 ppm NAA in combination with RDN treatment had also produced higher number of leaves per plant, specific leaf area (SLA), biomass duration (BMD) and absolute growth rate (AGR) than RDN treatment although statistically at par to each other. The maximum number of leaves per plant, shoot-root ratio and SLA although recorded maximum from 25 ppm NAA in combination with 100% higher RDN treatment but statistically similar to rest of the combined treatments. Yield attributes and yield of BARI Sweet Corn-1 showed positive response to NAA at varying N-levels with significant variations in majority of cases. The maximum number of cobs and productive cobs per plant, dry weight of cobs, length of cob, number of seed per row and cob, dry weight of tassel, yield per plant and harvest index were also obtained from 25 ppm NAA in combination with RDN treatment. However, maximum number of cobs and productive cobs per plant were also noted from 25 ppm NAA in combination with 100% higher RDN treatment. Significantly maximum yield per plant (114.41g) obtained from 25 ppm NAA in combination with RDN treatment which was 12.02% higher over RDN treatment. Out of ten treatments, foliar application of 25 ppm NAA in combination with RDN treatment produced better stimulation in growth and yield of BARI Sweet Corn-1.

Introduction

Bangladesh is an agrarian country, with a relatively small land area but with the 8th largest world population. The population may further increase up to 186 and 202 million by the years 2030 and 2050, respectively (UN 2015). In our country, most of the arable land suitable for cropping is under cultivation but currently decreasing due to increasing demand for residential and industrial use, periodic natural calamities and climate change etc. (Hasan *et al.* 2013, Hossain and Silva 2013). The country has a long practice of cereal grains cultivation, consumption and conservation. Among cereals, maize occupies the 2nd position both in acreage and production followed by wheat and other minor cereals. Bangladesh has unique opportunity to increase maize production due to its high yield potentiality for both the rabi and kharip seasons.

Previous findings have indicated that application of higher N rate resulted better growth and yield of maize (Amanullah *et al.* 2009, Nadeem *et al.* 2009). However, excessive use of chemical fertilizers has brought several soil fertility problems *viz.* soil acidity (Sheng *et al.* 2016), soil structure and quality deterioration, and low nitrogen use efficiency (Feng and Zhu 2017) and crop

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yields (Hepperly *et al.* 2009). Findings of different investigations also revealed that application of proper dose of Naphthalene acetic acid (NAA) had prominent effect on growth and yield of major cereal crops *viz.* rice (Adam and Jahan 2011), wheat (Jahan and Adam 2013) and maize (Akter 2010). But, reports regarding the effect of NAA in combination of different doses of N-fertilizer are meager in cereal crops including maize (Islam and Jahan 2016). Thus, an attempt was taken to evaluate the effect of NAA in combination with different doses of N fertilizer on a modern variety of maize var. BARI Sweet Corn-1.

Materials and Methods

A field experiment was conducted at the botanical garden of the Department of Botany, Jagannath University, Dhaka, Bangladesh. The soil of the experimental field was sandy loam. Total nitrogen (N), available phosphorus (P) and potassium (K) contents of the experimental soil was analyzed following standard methods (Murphy and Riley 1962, Jackson 1973, Marr and Cresser 1983). Initial status of soil indicates the presence of very low amount of nitrogen (0.059%) and potassium (0.052 meq/100g) and very high amount of phosphorus (89.08 μg/g).

A high yielding variety of maize, BARI Sweet Corn-1 was used as an experimental material. The experiment was laid out in RBD with three replications. Seeds were collected from Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur. The total area of the experimental field was 40 m^2 where, inter row and inter plant spacing distance was 75cm and 20 cm respectively. Cow-dung was mixed homogenously and doses of applied fertilizers *viz.* Urea, TSP, MP, Gypsum, Zinc sulphate and Boric acid were used following Fertilizer Recommendation Guide (2012). One-thirds of urea and full of the other required fertilizers were applied as basal dose during final land preparation. Remaining two third of urea were applied in two installments where, one-third at tassel initiation and the rest at about one week before silking stage.

Seeds were sterilized with 0.05% calcium hypochlorite and then repeatedly washed in distilled water to remove any trace of calcium hypochlorite. Cultural practices *viz.* thinning, irrigation, weeding etc. were done following methods quoted in Handbook of Agricultural Technology (Chowdhury and Hassan 2013). Experiment consisted of ten treatments *viz.* control = Without NAA and N fertilizer; RDN (recommended dose of N fertilizer); 25 ppm NAA+ RDN; 50 ppm NAA+RDN; 25 ppm NAA+50% higher RDN; 50 ppm NAA + 50% higher RDN; 25 ppm NAA+100% higher RDN; 50 ppm NAA + 100% higher RDN; 25 ppm NAA+ 150% higher RDN and 50 ppm NAA+ 150% higher RDN. NAA was applied as foliar spray in sunny early morning at the age of 30 days. Data on different growth parameters *viz.* plant height, number of leaves per plant, total dry matter (TDM) per plant, shoot-root ratio, leaf area (LA), specific leaf area (SLA), biomass duration (BMD), relative growth rate (RGR), absolute growth rate (AGR) and net assimilation rate (NAR) were recorded at harvest. Parameters *viz.* LA, RGR, AGR, NAR, LAR, SLA and SLW were calculated using classical growth analysis methods (Sestak *et al.* 1971, Hunt 1978, Gardner *et al.* 1985, Dwyer and Stewart 1986). Plant samples were harvested at the age of 102 days. Six plants from each treatment were harvested separately to record data on different growth and yield 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 Table I revealed that height of BARI Sweet Corn-1 positively influenced following NAA and nitrogen fertilizers where all treatments had produced significantly taller plants than control. The tallest plant (272.65 cm) was recorded from 50 ppm NAA in combination with 150% higher RDN treatment which was statistically different from control and 25 ppm NAA

+ RDN treatments. Similar pattern of increases in plant height were also observed by Akter (2010) on maize and Islam and Jahan 2016) on wheat. Application of NAA at varying nitrogen fertilizer although resulted higher number of leaves per plant in BARI Sweet corn 1 but with non-significant variations. Islam and Jahan (2016) recorded higher number of leaves per plant following combined application of NAA and N-fertilizers. However, both increase and decrease in number of leaves was also reported by Akter (2010) in maize. Thus, the findings of the present study on the number of leaves of maize plants are in conformity with the findings of many workers.

The TDM per plant was significantly responded due to NAA at varying N levels where the highest value (193.60 g) was noted from 25 ppm NAA + RDN treatment although statistically at par to each other. Application of 25 ppm NAA in combination with 75% of the recommended N-fertilizer had produced higher TDM in wheat (Islam and Jahan 2016). Shoot-root ratio was positively influenced by NAA at varying N-levels but with non-significant variations. By increasing in the concentration of nitrogen supply better shoot-root ratio was observed in cereal crops (Lucas *et al*. 2000).

Growth parameters *viz.* shoot-root ratio, LA, RGR, AGR and NAR were influenced positively due to all application of NAA at different N-levels where, 25 ppm NAA in combination with RDN treatments resulted maximum LA (538.60 cm^2), RGR (0.037 g/g/day) and NAR (0.037 (gm^2/day) but with non-significant variations. Stimulating effects of NAA at different N levels had also pronounced effects on SLA and BMD with few exceptions. Significantly maximum BMD (1506 g/day) was at 50 ppm NAA in combination with 50% higher N-level obtained from 50 ppm NAA in combination with 50% higher N-level followed by 25 ppm NAA in combination with RDN treatment (1059.75g/day). Four to five splits application of higher N rate can maximized biomass yield (Amanullah *et al*. 2009). Application of NAA had positive impact on leaf area index in wheat and barley (Orsi and Tallarico 1983, Singh and Gill 1985). Higher nitrogen levels are also reported to increase leaf area index in maize (Cheema *et al*. 2010). Both stimulatory and retarding effects of NAA on RGR of rice was observed by Adam and Jahan (2011). However, results obtained in case of NAR was not conform to the findings of Alam and Haider (2006) on barley and Kibe *et al*. (2006) on wheat. Thus, the results obtained during the present study are in accord with the findings of previous researchers.

Foliar application of NAA at varying N-levels had positive effects on yield attributes and yield of BARI Sweet Corn-1 with significant variations in majority of cases (Table 2). Total number of cobs per plant was recorded higher following all application of NAA at different N-levels where, maximum value (3.50) was noted from 25 ppm NAA in combination with RDN and 25 ppm NAA in combination with 50% higher RDN treatments. Number of productive cobs per plant was significantly influenced by combined NAA and N treatments where 25 ppm NAA in combination with RDN and 25 ppm NAA in combination with 50 higher RDN had resulted significantly maximum productive cobs per plant (2.50). Increase in number of productive cobs per plant due to these two treatments was 25% higher that RDN treatment. Similar results of increase in number of cobs per plant due to NAA application were reported in various cereal crops *viz.* maize (Akter 2010), rice (Adam and Jahan 2011), wheat and barley (Singh and Gill 1985). Combined application of NAA and N-fertilizer had significant responses on number of effective tillers per plant where, the maximum number was recorded from 25 ppm NAA in combination with 75% of the recommended N-fertilizer (Islam and Jahan 2016). Number of non-productive cobs per plant was significantly decreased following NAA at varying N-levels treatments and this might be due to the inducing effects of NAA and availability of N fertilizer throughout the growing period.

Table 1. Responses of growth parameters of BARI Sweet Corn-1to NAA at various nitrogen levels at harvest.

Treatments	Plant height (cm)	No. of leaves/ plant	TDM/ Plant (g)	Shoot-root ratio	LA (cm^2)	SLA (cm^2g^{-1})	BMD ($gday^{-1}$)	RGR (g/g/day)	AGR (g/day)	NAR (gm^2day^{-1})
Control	221.60c	7.43	120.75 b	8.22	447.96	27.22	985.88 b-d	0.019	1.20	0.022
RDN	264.17 ab	9.50	185.67 a	14.19	517.08	36.78	854.45 d	0.036	2.30	0.033
25 ppm NAA+ RDN	233.77 bc	9.17	193.60 a	13.94	538.60	37.21	1059.75 b-d	0.037	2.45	0.037
50 ppm NAA+RDN	256.62a-c	8.17	186.09 a	11.48	510.26	33.23	954.75 cd	0.033	2.12	0.035
25 ppm NAA+50% higher RDN	246.88 a-c	9.50	187.99 a	13.58	485.09	23.80	1179.48 b	0.035	2.72	0.034
50 ppm NAA+50% higher RDN	261.35 ab	10.17	184.22 a	8.68	506.19	34.99	1506.40 a	0.021	2.13	0.027
25 ppm NAA+100% higher RDN	258.88 a-c	11.17	185.80 a	17.17	510.78	59.12	1020.35 b-d	0.019	1.22	0.029
50 ppm NAA+100% higher RDN	248.20 a-c	9.83	182.55 a	17.15	492.35	24.26	1065.60 b-d	0.027	2.66	0.024
25 ppm NAA+ 150% higher RDN	248.27 a-c	9.50	178.70 a	10.82	475.52	30.13	1046.00 b-d	0.033	2.09	0.036
50 ppm NAA+ 150% higher RDN	272.65 a	9.17	173.44 a	9.63	519.37	41.83	875.90 cd	0.023	1.39	0.025
CV (%)	8.59	14.86	36.07	29.13	15.26	45.70	19.87	27.66	28.36	10.49
LSD (0.05)	37.65	NS	27.46	NS	NS	NS	221.82	NS	NS	NS

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

Table 2. Responses of yield attributes and yields of BARI Sweet Corn-1to NAA at various nitrogen levels.

Treatments	Total no. of cobs /plant	No. of productive cobs/ plant	No. of non-productive cobs/ plant	Dry weight of cob (g)	Length of cob (cm)	No. of rows/ cob	No. of seeds/ row	No. of seeds/ cob	Dry weight of tassel (g)	1000-grain weight (g)	Yield/ plant (g)	Harvest Index (%)
Control	2.83	1.00 c	1.83 a	51.95 e	14.33 cd	13.33 b	19.86 g	280.83 g	1.08 a	174.35 e	48.97 f	40.55 b
RDN	3.00	2.00 b	1.00 c	115.67 b	16.67 ab	16.33 a	38.42 bc	401.67 cd	1.17 a	189.73 b-d	102.13 c-e	55.00 ab
25 ppm NAA + RDN	3.50	2.50 a	1.00 c	123.68 a	17.15 a	14.75 ab	46.07 a	425.33 a	1.28 a	200.48 a-c	114.41 a	59.10 a
50 ppm NAA + RDN	3.00	2.00 b	1.00 c	117.09 b	15.19 a-c	14.42 b	42.75 ab	413.00 b	1.19 a	194.83 a-c	106.45 bc	57.20 ab
25 ppm NAA + 50% higher RDN	3.50	2.50 a	1.00 c	119.26 ab	16.66 ab	15.42 ab	35.87 cd	400.08 d	1.27 a	200.63 a-c	109.34 b	58.16 a
50 ppm NAA + 50% higher RDN	3.00	2.00 b	1.00 c	115.27 b	12.81 d	14.33 b	32.08 de	386.17 f	1.22 a	189.83 b	104.33 cd	56.63 ab
25 ppm NAA + 100% higher RDN	3.33	2.00 b	1.33 b	116.80 b	14.49 b-d	13.08 b	28.43 ef	384.83 f	1.18 a	203.55 ab	104.39 cd	56.18 ab
50 ppm NAA + 100% higher RDN	3.33	2.00 b	1.33 b	113.55 bc	15.36 a-c	14.00 b	28.41ef	399.11de	1.19 a	205.52 a	103.88 cd	56.90 ab
25 ppm NAA + 150% higher RDN	3.33	2.00 b	1.33 b	108.73 cd	14.92 a-d	14.08 b	28.79 e	409.58 c	1.23 a	188.40 c-e	100.93 de	56.48 ab
50 ppm NAA + 150% higher RDN	3.00	1.55 b	1.50 b	103.76 d	14.74 b-d	14.33 b	22.89 f	390.00 ef	1.21 a	176.10 d	98.12 e	56.57 ab
CV (%)	18.14	17.02	12.66	6.39	15.33	11.11	16.30	31.95	5.17	15.28	16.02	16.89
LSD (0.05)	NS	0.48	0.32	6.22	2.28	1.72	5.68	9.35	0.34	14.11	4.87	16.76

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

Significant response in dry weight of cobs was observed due to NAA and different N-level treatments. Significantly maximum dry weight of cobs per plant was noted from 25 ppm NAA in combination with RDN treatment where the increase was 6.92% than RDN treatment. Dry matter yield of fodder maize was linearly related to mineral N fertilizer up to120 kg/ha (Cerny *et al.* 2012). Liu *et al*. (2012) recorded significant inhibition on the growth of unproductive tiller of rice plants with NAA application. Findings obtained from the investigation also suggested that the elimination of unproductive tillers promote growth of productive tillers at an appropriate concentration. Grain yield per plant was positively and significantly correlated with cob length (Viola *et al.* 2003). Length of cobs was positively influenced due to different NAA at varying N-levels and the longest one was also from 25 ppm NAA in combination with RDN treatment. This results is in conform to the findings of Islam and Jahan (2016) in wheat.

Results showed that application of NAA in combination with different N-levels had stimulatory effects on number of rows per cob where the maximum was obtained from RDN treatment although statistically identical to 25 ppm NAA in combination with both RDN and 50% higher RDN treatments. Increasing in nitrogen levels resulted the number of kernel rows per ear (Dawadi and Sah 2012). Plant receiving NAA at varying N-levels treatments had produced significantly higher number of seeds per row and number of seeds per cob than control treatment. Significantly maximum number of seeds per row was obtained from 25 ppm NAA in combination with RDN treatment which produced 19.91% higher seed than RDN treatment. Whereas, number of seeds per cob obtained from 25 ppm NAA in combination with RDN fertilizer was 5.89% higher than RDN treatment. Number of grains per spike and grains per plant were significantly influenced due to NAA and N levels and also by the interaction between N level and NAA (Islam and Jahan 2016). Results are also in conformity with the findings of Adam and Jahan (2011) on rice and Akter (2010) on maize. Findings revealed that dry weight of tassel although influenced positively but statistically identical to each other. Results also revealed that weight of 1000 grain obtained from NAA and N- fertilizer treatments were significantly higher than control having an exception. Islam and Jahan (2016) recorded both positive and negative responses of NAA at varying N-levels on 100-seed weight. Increasing nitrogen level positively influenced grain weight in maize (Sharar *et al.* 2003, Izadi and Imam 2010). Thus the present results are in agreement with the findings of previous workers.

Application of NAA in combination with various N-levels had affirmative response on yield of BARI Sweet corn-1. Significantly highest yield per plant was obtained from plant receiving 25 ppm NAA in combination with RDN treatment. Increase in yield per plant due to the best performed treatment (25 ppm NAA + RDN) was 12.02% higher over RDN treatment. Islam and Jahan (2016) recorded maximum Grain yield per plant from 25 ppm NAA in combination with 75% of the RDN. Increased grain yield due to NAA application has also been reported by different investigators on maize (Akter 2010) and rice (Liu *et al.* 2012) Harvest index was influenced positively due to all treatments and the maximum was also due to 25 ppm NAA in combination with RDN treatment. This result is in consistence to the finding of other workers (Adam and Jahan 2011 and Jahan and Adam 2013).

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