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GROWTH AND YIELD RESPONSES OF *TRITICUM AESTIVUM* L. VAR. BARI GOM-26 FOLLOWING APPLICATION OF NAPHTHALENE ACETIC ACID AT VARYING NITROGEN LEVELS

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Abstract

A field experiment was conducted to study the effects of NAA (25 and 50 ppm) in combinations with four levels of nitrogen fertilizer (0, 50, 75 and 100% of the recommended doses) on the growth and yield of wheat (*Triticum aestivum* L. var. BARI Gom-26). Plant height increased maximum due to 50 ppm NAA in combination with 50% N-fertilizer, whereas the minimum was due to 25 ppm NAA alone. Maximum number of tillers and leaves per plant were obtained due to 25 ppm NAA in combination with 50% N-fertilizer. The highest total dry matter (TDM) per plant was produced by 25 ppm NAA in combination with 75% N-fertilizer at all the stages of the growth except at 15 and 30 days after spray (DAS) and significant variation was observed at 45, 60 DAS and at harvest. Except length of spike and non-effective tillers per plant, the number of effective tillers per plant, 100-seed weight and yield (g/plant and t/ha) increased significantly due to 25 ppm NAA in combination with 75% N-fertilizer. Non-effective tillers per plant tended to increase with the application of N-fertilizer alone and showed decreasing tendency with other combinations. Harvest index varied non-significantly and highest harvest index was recorded due to 25 ppm NAA in combination with 75% N-fertilizer.

Introduction

Wheat (*Triticum aestivum* L.) is the second most important cereal crop after rice in Bangladesh and contributes 7% to the total output of food cereals (BBS 2008). However, wheat production in the country is yet much below the annual requirement and every year Bangladesh has to import around 2 million tons of wheat (BER 2015). Additionally, its consumption is increasing at 3% per year (Karim *et al*. 2010). In fact, in Bangladesh, there is no scope for bringing new land under cultivation. Rather, the problem of land scarcity is being compounded by land degradation. Therefore, to increase the wheat production coping up with the increasing demand of wheat in the next few decades will be a big challenge for Bangladesh. Fertilizer application, especially nitrogenous, has been the single most important constituent of improved wheat production technology. However, fertilizers are one of the expensive inputs and farmers generally do not use the recommended dose of fertilizer. Every year a large portion of nitrogen fertilizer leaches deep into soil with rain or irrigation water and causes environmental pollution. Therefore, to find out an alternative approach which will increase or at least maintain the present level of yield with the minimum use of nitrogen fertilizer and minimum degradation to the environment has become a timely demand. In this regard, naphthalene acetic acid (NAA), in combination with nitrogen fertilizer can be a good potential tool for increasing the growth and yield of wheat. At appropriate concentration, NAA can affect growth, development and other physiological and biochemical processes of plants (Chaudhuri *et al*. 1980, Sing and Gill 1985 and Iqbal *et al*. 2009). Moreover, it is eco-friendly and has no harmful effects on the environment. Understanding the significance, an investigation has already been made with NAA in combination with nitrogen in rice (Grewal and Gill 1986). In Bangladesh, so far very limited researches have

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been done on cereal crops with NAA (Adam and Jahan 2010, Jahan and Adam 2011, Jahan and Adam 2013 and Jahan and Adam 2014) and in case of wheat only a single study was made on the effects of NAA (Jahan and Adam 2013). Reports are yet to be available on the effects of NAA in combination with nitrogen fertilizer on wheat. Considering these points in view, the objective of the study was to investigate the effect of NAA at varying nitrogen levels on the growth and yield performance of wheat.

Materials and Methods

A field experiment was conducted in the research field of the Department of Botany, University of Dhaka, during the period from November, 2014 to March, 2015. The experiment was laid out in RCBD with split plot arrangements, replicated five times. The experimental field was prepared conventionally and divided into 60 subplots, each measuring 0.84 m × 0.90 m with a 30 cm space in between. Seeds of BARI Gom-26 were collected from BARI, Joydebpur, Gazipur. It is a high yielding and heat tolerant variety recommended for Rabi season and was released in 2010 for the commercial cultivation throughout the country. Grains are amber in color, bright and larger in size. Seeds were sterilized with 0.5% calcium hypochlorite and sown on 8 November. Row to row distances were 20 cm. Fertilizers were applied at doses recommended by BARI (260, 170, 110 and 125 kg/ha of urea, triple super phosphate, muriate of potash and gypsum, respectively). Cow-dung, two-thirds of urea and the full amount of other fertilizers were applied as a basal dose during land preparation and the rest one-third of the urea was applied at 25 days of sowing after first irrigation. Cow-dung was applied at the rate of 9880 kg/ha. Weeding was done at the age of 18 days followed by thinning to keep plant to plant distance of 10 cm. Second and third irrigations were applied at the age of 53 and 70 days after sowing. Treatment comprised of two factors. Three concentrations of NAA *viz.* without NAA (G_0), 25 ppm NAA (G_1) and 50 ppm NAA (G_2), and four levels of N-fertilizer *viz.,* without any N-fertilizer (F_0), 50% of the recommended dose (F_1), 75% of the recommended dose (F_2) and full recommended dose of urea (F_3). Altogether, there were 12 treatment combinations *viz.,* G_0F_0, G_0F_1, G_0F_2 and so on. Foliar treatments of NAA were applied at the age of 30 days. Data on plant height, number of tillers per plant, leaves per plant and total dry matter (TDM) per plant were recorded from the age of 15 days after spray (DAS) till harvest at an interval of 15 days. Final harvest was done on 8th March, 2015. Three random plants were sampled from each replication for recording data on yield attributes at harvest. Number of effective tillers, number of non-effective tillers per plant, length of spikes per plant, number of grains per spike, number of grains per plant, 100-grain weight (g), grain yield (g/plant and t/ha) and harvest index (%) were calculated after harvest. The data were compiled and subjected to statistical analysis and treatment means were compared for significance by using LSD test (Steel *et al*. 1997) at 5% level of probability.

Results and Discussion

Results presented in Table 1 revealed that following the application of NAA in combination with different doses of nitrogen fertilizer, plant height changes both significantly and non-significantly at different ages. Increasing the level of nitrogen application progressively increased plant height. When NAA was applied alone plant height decreased in almost all the ages of growth. However, plant height increased due to both 25 and 50 ppm of NAA in combination with 50% of N-fertilizer at all the ages except at 15 DAS and the increases in both the cases were more than those of full dose of N-fertilizer application alone. Foliar application of 50 ppm NAA in combination with 50% N-fertilizer resulted maximum plant height. Both increase and decrease in

plant height was reported by Jahan and Adam (2013) in wheat, Akter (2010) in maize and Jahan and Adam (2011) in rice.

Following the application of NAA, both number of tillers per plant (Table 2) and leaves per plant (Table 3) tended to increase maximum with 25 ppm NAA in combination with 50% N-fertilizer at all the ages except at 15 DAS. In case of the application of N-fertilizer alone, full recommended dose was found best among the four levels of N-fertilizer. While, application of NAA alone had shown only some marginal increase over the control. Here, number of tillers and leaves per plant obtained from the interaction was higher than that obtained due to N or NAA alone. An increase in number of tillers per plant has also been reported by Jahan and Adam (2013) and Alam *et al.* (2002) in wheat. Harsharn and Gill (1985) reported about the positive effect of NAA on the number of leaves per plant in wheat and barley. Both increase and decrease in number of leaves per plant has also been reported by Akter (2010) in maize and Jahan and Adam (2011) in rice.

Table 1. Effect of NAA at varying nitrogen levels on plant height (cm) of BARI Gom-26 at different ages.

Treatments	Days after spray (DAS)				
	15	30	45	60	At harvest
G_0F_0	36.30 b	56.60	57.60 b	63.10	64.00
G_0F_1	37.08 b	59.00	62.80 a	66.60	67.40
G_0F_2	37.60 b	58.10	60.60 b	66.50	67.30
G_0F_3	37.62 b	58.90	63.20 a	66.80	67.40
G_1F_0	34.98 c	55.20	56.50 b	62.10	63.10
G_1F_1	37.90 b	59.50	64.60 a	67.00	68.10
G_1F_2	40.80 a	60.20	65.00 a	68.00	68.80
G_1F_3	35.90 b	57.00	58.40 b	64.30	65.10
G_2F_0	35.22 c	55.90	57.00 b	63.00	64.20
G_2F_1	38.30 ab	61.00	66.60 a	68.10	69.20
G_2F_2	36.52 b	56.10	59.00 b	65.50	66.30
G_2F_3	37.00 b	58.00	59.40 b	65.90	66.60
CV (%)	6.61	7.17	8.39	6.87	6.7
LSD (0.05)	2.68	NS	4.98	NS	NS

Mean in a vertical column followed by same letter does not differ significantly at 5% level.

Results of the experiment indicated that increasing the level of nitrogen increased the total dry matter (TDM). In the absence of N fertilizer, only 25 ppm NAA showed increase in dry matter production over the control. TDM increased both significantly and non-significantly due to interaction between N levels and NAA at different ages and 25 ppm NAA in combination with 75% N-fertilizer produced maximum TDM at 45, 60 DAS and at harvest. At harvest, due to 25 ppm NAA in combination with 75% N-fertilizer, TDM increased by 44.45% over the control and 7.47% over the full recommended dose of N-fertilizer. TDM obtained due to 50 ppm NAA in combination with 50% N-fertilizer was also higher over those of full recommended dose of N-fertilizer at all the ages. Significant increases in total dry matter due to NAA application were also reported by Jahan and Adam (2013) in wheat and Akter (2010) in maize. By applying NAA on two varieties of rice, Jahan and Adam (2011) reported both significant and non-significant increase and decrease in TDM per plant in rice.

Data on yield contributing characters and yield are presented in Table 5. Number of effective tillers per plant increased significantly due to all the treatments and maximum number of effective tillers was recorded due to 25 ppm NAA in combination with 75% N-fertilizer. Orsi and Tallarico (1983) and Sing and Gill (1985) also reported about significant effect of NAA on the number of ear bearing tiller in wheat and barley.

Table 2. Effect of NAA at varying nitrogen levels on number of tillers per plant of BARI Gom-26 at different ages.

Treatments	Days after spray (DAS)				
	15	30	45	60	At harvest
G_0F_0	3.3 f	3.5 c	4.0 c	5.0	5.0
G_0F_1	5.2 c	6.6 a	7.0 a	8.0	8.0
G_0F_2	5.3 bc	7.1 a	7.7 a	8.4	8.4
G_0F_3	4.4 d	6.4 a	7.3 a	8.7	8.7
G_1F_0	4.5 d	5.5 b	6.1 a	6.8	6.8
G_1F_1	6.0 ab	8.1 a	8.9 a	8.9	8.9
G_1F_2	4.9 cd	7.3 a	8.3 a	8.4	8.4
G_1F_3	5.4 b	6.2 ab	6.6 ab	7.2	7.2
G_2F_0	4.2 de	5.2 bc	5.7 bc	6.3	6.3
G_2F_1	6.3 a	7.6 a	8.4 a	8.7	8.7
G_2F_2	4.5 d	5.9 b	6.7 a	7.3	7.3
G_2F_3	3.9 ef	5.6 b	6.2 b	7.0	7.0
CV (%)	35.06	37.04	39.13	33.77	33.77
LSD (0.05)	0.70	1.90	2.45	NS	NS

Mean in a vertical column followed by same letter does not differ significantly at 5% level.

Unlike effective tillers, the number of non-effective tillers per plant did not emerge as significant. The lowest number of non-effective tillers per plant was recorded with the application of 25 ppm NAA. However, both 25 and 50 ppm NAA in combination with 50% of N-fertilizer increased number of non-effective tillers per plant. Liu *et al*. (2012) obtained significant inhibition on the growth of unproductive tiller of rice plants with NAA application. The results obtained from the investigation also suggested that the elimination of unproductive tillers promote growth of productive tillers at an appropriate concentration.

Spike length is an important parameter because of its association with other important yield components such as number of grains and grain weight. Length of spike was also affected non-significantly. However, the length of spike increased in all the treatments from control and the maximum length of spike was obtained due to 50 ppm NAA in combination with 75% N-fertilizer. Similar results of increases following application of NAA were also reported on other plants (Adam and Jahan 2010 and Akter 2010).

Number of grains per spike and grains per plant are very important parameters contributing toward grain yield. Results revealed that the 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. Although number of grains per spike decreased due to both 25 and 50 ppm NAA treatments, but grains per plant increased by 31.23 and 31.15%, respectively over the control. Both maximum grains per spike and grains per plant were obtained due to 25 ppm NAA in combination with 75 % of the N-fertilizer which were 1.14 and 8.14% higher over those of full recommended

dose of N-fertilizer. Reports regarding increase in number of grains per spike are in conformity with the findings of other workers in different plants (Adam and Jahan 2010 and Akter 2010).

Table 3. Effect of NAA at varying nitrogen levels on number of leaves per plant of BARI Gom-26 at different ages.

Treatments	Days after spray (DAS)				
	15	30	45	60	At harvest
G_0F_0	13.2 c	13.8 e	14.4 e	18.8	19.0
G_0F_1	19.6 ab	25.2 c	30.6 a	31.0	31.0
G_0F_2	18.0 b	27.0 b	30.1 ab	32.4	32.4
G_0F_3	16.4 b	24.8 c	27.2 b	34.2	34.2
G_1F_0	16.4 b	20.8 d	23.6 c	27.8	27.8
G_1F_1	23.2 a	31.8 a	34.6 a	37.4	37.4
G_1F_2	18.6 b	28.8 ab	31.8 a	34.0	34.0
G_1F_3	20.8 a	25.4 b	25.4 bc	28.0	28.0
G_2F_0	16.4 b	20.3 d	21.4 cd	25.2	25.2
G_2F_1	24.5 a	27.8 b	32.6 a	35.4	35.4
G_2F_2	17.8 b	22.4 bc	25.2 c	28.2	28.2
G_2F_3	14.4 bc	21.4 cd	24.2 c	27.4	27.4
CV (%)	35.03	36.26	38.15	34.81	34.73
LSD (0.05)	5.34	3.49	4.7	NS	NS

Mean in a vertical column followed by same letter does not differ significantly at 5% level.

Table 4. Effect of NAA at varying nitrogen levels on total dry matter (TDM)/plant (g) of BARI Gom-26 at different ages.

Treatments	Days after spray (DAS)				
	15	30	45	60	At harvest
G_0F_0	0.87	7.31	12.26 b	14.15 b	14.45 bc
G_0F_1	1.15	9.39	15.35 a	16.90 a	18.07 a
G_0F_2	1.41	7.47	13.91 ab	16.61 a	17.63 ab
G_0F_3	1.19	7.77	16.47 a	18.01 a	19.42 a
G_1F_0	0.89	7.51	10.67 bc	14.40 b	16.01 b
G_1F_1	1.14	7.21	18.30 a	19.57 a	20.32 a
G_1F_2	1.11	7.49	18.77 a	20.72 a	20.87 a
G_1F_3	1.24	6.28	15.68 a	16.82 a	18.02 a
G_2F_0	0.88	4.47	8.78 c	11.86 b	13.09 c
G_2F_1	1.34	9.66	18.77 a	20.01 a	20.70 a
G_2F_2	1.44	8.03	9.94 c	12.25 b	15.65 b
G_2F_3	1.45	7.47	16.28 a	16.51 ab	18.42 a
CV (%)	36.69	48.53	43.16	35.28	25.55
LSD (0.05)	NS	NS	5.98	5.09	3.73

Mean in a vertical column followed by same letter does not differ significantly at 5% level.

Seed weight (100 seeds) was both positively and negatively influenced by different treatments. The maximum 100-seed weight was recorded from the treatment of 25 ppm NAA in combination with 75% N-fertilizer followed by 50 ppm NAA in combination with 50% N-fertilizer and both these were statistically identical. The maximum increase and decrease in 100-seed weight from the control were 20.29 and 4.77% due to G_1F_2 and G_2F_2, respectively. Increase and decrease in seed weight following NAA application were also reported by different investigators (Ullah *et al*. 2007, Akter 2010 and Bakhsh *et al*. 2011).

Table 5. Effect of NAA at varying nitrogen levels on yield contributing characters and yield of BARI Gom-26.

Treatments	Effective tillers/ plant (no.)	Non-effective tillers/plant (no.)	Length of spike (cm)	Grains /spike (no.)	Grains /plant (no.)	100-seed weight (g)	Grain yield/ plant (g)	Grain yield (t/ha)	Harvest index (%)
G_0F_0	3.50 c	1.50	7.97	32.2 d	113.00 c	4.19 f	4.73 d	2.37 d	35.34
G_0F_1	5.50 a	2.50	9.69	33.4 b	183.80 ab	4.64 cd	8.53 b	4.27 b	48.48
G_0F_2	5.30 ab	3.10	9.92	32.5 d	172.45 b	4.35 e	7.53 b	3.76 b	44.26
G_0F_3	5.90 a	2.80	9.85	34.8 a	205.10 a	4.75 c	9.72 a	4.86 a	50.37
G_1F_0	5.70 a	1.10	9.18	25.8 e	148.30 b	4.29 ef	6.39 d	3.19 c	39.84
G_1F_1	6.00 a	2.90	9.49	34.7 a	208.70 a	4.80 bc	10.27 a	5.14 a	51.74
G_1F_2	6.30 a	2.10	10.01	35.2 a	221.80 a	5.04 a	10.85 a	5.42 a	52.38
G_1F_3	5.10 b	2.10	9.96	33.1 c	169.15 b	4.40 e	7.46 c	3.73 bc	44.08
G_2F_0	4.70 b	1.60	9.13	31.5 d	148.20 bc	4.04 g	5.98 cd	2.99 cd	47.26
G_2F_1	6.10 a	2.60	10.00	34.3 ab	209.00 a	4.95 ab	10.74 a	5.37 a	52.02
G_2F_2	4.90 b	2.40	10.10	32.1 cd	157.50 b	3.99 g	6.28 d	3.14 c	42.92
G_2F_3	5.80 a	1.20	10.00	35.0 a	202.90 a	4.67 c	9.51 ab	4.75 ab	51.95
CV (%)	22.34	94.75	11.50	8.13	25.70	9.67	32.55	32.54	23.26
LSD (0.05)	1.17	NS	NS	1.13	39.98	0.18	2.04	1.03	NS

Mean in a vertical column followed by same letter does not differ significantly at 5% level.

Grain yields per plant and per hectare were significantly affected by different concentrations of NAA treatments and also in combination with different N levels and increased in all the treatments from the control. Both grain yield per plant and per hectare were recorded maximum due to 25 ppm NAA in combination with 75% N-fertilizer application and they were 129.39 and 128.69% higher over the control, respectively and 11.63 and 11.52% higher over the full recommended dose of N-fertilizer application, respectively. Similar increase in grain yield was reported by Alam *et al*. (2002) and Jahan and Adam (2013) in wheat. Increased grain yield of other cereal plants due to NAA application has also been reported by different investigators on different plants viz. maize (Akter 2010), rice (Bakhsh *et al*. 2011 and Liu *et al*. 2012), sorghum (Tulsa-Ram *et al.* 1997) and baby corn (Muthukumar *et al*. 2005).

Harvest index was positively and non-significantly influenced by all the treatments. The range of harvest index was 35.34 to 52.38%. The maximum harvest index was obtained due to the application of 25 ppm NAA in combination with 75% N-fertilizer which was 3.99% higher over that of full recommended dose of N-fertilizer. Due to 50 ppm NAA in combination with 50% N-fertilizer, harvest index also increased by 3.28% over the full recommended dose of N-fertilizer. This result is in consistence to the finding of other workers (Adam and Jahan 2010 and Jahan and Adam 2013). Bakhsh *et al.* (2011) also reported increase in harvest index of rice following NAA application.

The increased yield due to lower doses of N-fertilizer in combination with NAA might be due to the stimulatory effect of NAA that increased the effectiveness of N in enhancing TDM, number of effective tillers per plant, length of spike, number of grains per spike and per plant, 100-seed weight and also decrease in non-effective tillers per plant.

Findings from the present investigation revealed that the application of NAA in combination with lower doses of N-fertilizer had significant beneficial effects on growth and yield performance of BARI Gom-26 which were reflected finally in the yield. Thus, lower doses of N-fertilizer application along with NAA are as good as higher doses of nitrogen fertilizer (100%) application. Therefore, serious economic and ecological problem associated with use of higher doses of N-fertilizer could be mitigated.

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