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GROWTH AND YIELD RESPONSES OF BARI GOM-26 (*TRITICUM AESTIVUM* L.) TO NAPHTHALENE ACETIC ACID

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Abstract

The effect of various concentrations of NAA (0, 25, 50, 75, 100 mg/l) on the growth and yield components of BARI Gom-26 was investigated. Data recorded on plant height, number of tillers per plant and number of leaves per plant showed negative performance in most cases with a few exceptions (7 and 14 DAS due to 25 and 50 mg/l NAA). The 50 mg/l NAA produced the highest total dry matter (TDM) at all the stages of growth except at 21 and 28 DAS and significant variations were observed at 7 DAS. Length of spike, grains per spike and 1000-seed weight increased following all the rates of NAA applications. Number of effective tillers and maximum yield (g/plant and t/ha) increased significantly only due to application of 50 mg/l NAA and the increases were 9.09 and 12.24% higher over the control, respectively. Non-effective tillers per plant decreased with all concentrations of NAA application and the maximum decrease (60.20%) was recorded with 50 mg/l NAA. Non-significant highest harvest index was also recorded with 50 mg/l followed by 100 mg/l NAA application.

Introduction

Wheat (*Triticum aestivum* L.) is one of the most important leading cereal crops in the world. In Bangladesh, it is next to rice in importance. It occupies about 4% of the total cropped area and 11% of the area cropped in the Rabi season, and contributes 7% to the total output of food cereals(1). The projections of International Food Policy Research Institute (IFPRI) indicate that the world demand for wheat will rise from 552 million tons in 1993 to 775 million tons by 2020, and 60% in total by 2050(2). Increase in food production of the country in the next 20 years is a big challenge for Bangladesh. The average yield of wheat is very low compared to other wheat growing countries. The low yield of wheat may be attributed to number of reasons like cultivation practices, lack of improved varieties, improper fertilizer application, seed rate, water management, culture method, time of sowing etc. Increase in the yield of the major cereal crops can be achieved through the use of plant growth regulators. The use of plant growth regulators in the field of agriculture has become commercialized in many countries. Naphthalene

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Acetic Acid (NAA), a synthetic form of auxin, plays key roles in cell elongation, cell division, vascular tissue differentiation, root initiation, apical dominance, leaf senescence, leaf and fruit abscission, fruit setting and flowering[3]. In many countries NAA has been used for the enhancement of growth and yield of cereals including wheat[4-8]. In Bangladesh very limited research has been done on cereal crops with NAA[9-11]. But no reports are available on the effect of NAA on wheat. Therefore, the present research work was conducted to investigate the effect of foliar application of NAA on growth and yield performance of BARI Gom-26.

Materials and Methods

A field experiment was conducted in the research field of the Department of Botany, University of Dhaka during November 2011 to March 2012 to investigate the effect of NAA at different concentrations on growth and yield performance of BARI Gom-26. The experiment was laid out in RCBD with split plot arrangements, replicated four times. The experimental field was prepared conventionally. Seeds of BARI Gom-26 were collected from BARI, Joydebpur, Gazipur, commonly known as Hashi, semi-dwarf in height, early maturing with high yield potential released in 2010 and can be grown successfully throughout the country for commercial cultivation. Grains are amber in colour, bright and larger in size. Seeds were sterilized with 0.5% calcium hypochlorite and sown on 14 November in lines 20 cm apart. Fertilizers were applied at doses recommended by BARI (260, 170, 110 and 125 kg/h of urea, triple super phosphate, muriate of potash and gypsum, respectively). Two-thirds of urea and the full amount of the other fertilizers were applied as a basal amount during final land preparation. The remaining urea was applied immediately after the first irrigation (at the age of 23 days). Cow-dung was also mixed uniformly at the rate of 9880 kg/h. Weeding was done at the age of 18 followed by thinning to keep plant to plant distance of 10 cm. Second and third irrigations were applied at the age of 40 and 70 days. The trial consisted of five foliar treatments: T_0 = 0 mg/l (control), T_1 = 25 mg/l, T_2 = 50 mg/l, T_3 = 75 mg/l, and T_4 = 100 mg/l NAA. Treatments were applied as foliar spray at the age of 30 days. Data on plant height, number of tillers per plant, number of leaves per plant and total dry matter (TDM) per plant were recorded weekly from the age of 7 days after spray (DAS) up to harvest. Final harvest was done on 3rd March, 2012. Number of effective tillers, number of non-effective tillers per plant, number of spikes per plant, number of grains per spike, 1000-grain weight (g), grain yield (g/plant and t/ha) and harvest index (%) were calculated after harvest. The data were complied and subjected to statistical analysis and treatments means were compared for significance by using LSD test[12] at 5% level of probability.

Results and Discussion

Data presented in Table 1 revealed the changes in plant height due to the application of different concentrations of NAA. At the early stage of growth, plant height was found to increase with T_1 and T_2 treatments. Due to T_2 treatment plant height continued to increase up to 28 DAS. Treatment T_3 produced tallest plants from the age of 35 DAS till harvest, whereas, plants receiving T_4 treatment showed minimum height at all the ages except at 28 DAS. Similar results of both increase and decrease in plant height have also been reported by Alam *et al.*[5] in wheat, Akter[9] in maize and Jahan and Adam[11] in rice.

Table 1. Effect of NAA on plant height (cm) of BARI Gom-26 at different days after spray (DAS).

Treatment	Age of plants in days after spray (DAS)							
	7	14	21	28	35	42	49	At harvest
T_0	48.84 a	54.78	71.81 a	74.23	80.69	84.69 a	84.71	84.91
T_1	50.24 a	55.16	67.74 b	74.21	78.63	83.03 a	83.08	83.18
T_2	50.14 a	55.08	72.25 a	76.36	80.03	81.89 a	81.99	82.60
T_3	47.71 ab	51.44	67.23 b	73.43	81.11	84.98 a	85.09	85.34
T_4	44.83 b	50.26	66.98 b	76.10	78.43	81.90 a	82.06	82.33
CV (%)	8.93	8.76	8.47	7.22	7.59	7.20	7.49	8.42
LSD (0.05)	3.20	NS	3.86	NS	NS	4.38	NS	NS

Results obtained during the present investigation showed that number of tillers per plant and number of leaves per plant were higher due to T_1 and T_2 treatments at 7 and 14 DAS, whereas, other two treatments resulted decreases at all stages of growth (Tables 2, 3). It was also noted that at final harvest plants of T_2 treatment produced significantly lowest number of tillers per plant and leaves per plant. Alam *et al.*[5] observed that number of tillers in wheat cultivars decreased following NAA application. Jahan and Adam[11] recorded both increase and decrease in number of tillers of rice with both significant and non-significant variation. Harsharn and Gill[6] 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 in maize[9] and in rice[11].

Results of the experiment indicated that total dry matter (TDM) per plant increased from 7 to 21 DAS with all the treatments and was significant at 7 DAS due to T_2 treatment (Table 4). At 28 DAS, TDM was found to decrease non-significantly due to all the treatments and then increased up to harvest following T_2 treatment only. Total dry matter of plants treated with T_2 was higher than those of all other treatments in all stages of growth except at 28 DAS. The maximum TDM recorded from T_2 at harvest was 4.65 % higher over the control. It was also noted that at the final harvest, plants of T_3 produced higher TDM than that of the control. Significant increases in dry weight of shoot of maize at harvest were also reported by Akter[9]. By applying NAA on two varieties of rice Jahan and Adam[11] reported both significant and non-significant increase and decrease in TDM per plant.

Table 2. Effect of NAA on number of tillers per plant of BARI Gom-26 at different days after spray (DAS).

Treatment	Age of plants in days after spray (DAS)							
	7	14	21	28	35	42	49	At harvest
T_0	4.13 b	4.25	5.38 a	4.75	7.63	8.50 a	9.25 a	10.13 a
T_1	4.38 a	4.50	4.50 b	4.50	6.50	7.00 ab	7.50 b	7.75 b
T_2	4.38 a	4.50	4.50 b	4.63	5.88	5.88 b	7.25 b	7.25 b
T_3	4.00 b	4.13	4.50 b	4.50	5.50	6.13 b	6.63 b	7.38 b
T_4	3.63 c	4.13	4.63 c	4.63	5.38	6.38 b	7.38 b	8.13 b
CV (%)	13.30	15.97	21.87	20.17	33.39	32.83	34.86	33.66
LSD (0.05)	0.20	NS	0.83	NS	NS	1.69	1.19	1.65

Table 3. Effect of NAA on number of leaves/plant of BARI Gom-26 at different days after spray (DAS).

Treatment	Age of plants in days after spray (DAS)							
	7	14	21	28	35	42	49	At harvest
T_0	16.13 ab	18.50	25.13	23.00	28.38 a	32.50 a	31.38	32.00 a
T_1	16.63 a	19.25	22.25	20.38	24.63 b	28.13 b	26.63	26.13 bc
T_2	16.50 a	19.00	22.75	21.75	23.75 bc	25.00 c	24.63	24.38 bc
T_3	14.50 bc	17.63	21.50	21.88	21.88 bc	24.50 c	24.88	24.75 bc
T_4	13.25 c	16.50	21.13	21.00	21.50 c	24.75 c	26.38	27.13 ac
CV (%)	15.41	15.10	14.09	17.32	26.38	32.60	29.24	34.41
LSD (0.05)	1.96	NS	NS	NS	3.05	3.11	NS	5.24

Table 4. Effect of NAA on total dry matter (TDM) /plant (g) of BARI Gom-26 at different days after spray (DAS).

Treatment	Age of plants in days after spray (DAS)							
	7	14	21	28	35	42	49	At harvest
T_0	1.09 bc	1.91 b	3.03	5.13	7.28	9.14	12.05	18.94
T_1	1.19 ac	2.02 b	3.23	4.54	7.05	8.28	11.83	17.80
T_2	1.21 a	2.73 a	3.42	4.71	9.12	11.29	12.42	19.82
T_3	1.17 ac	2.44 ac	3.83	3.94	6.92	8.33	11.70	19.00
T_4	1.11 bc	2.22 bc	3.45	3.62	6.86	7.69	11.99	14.97
CV (%)	10.10	23.36	18.41	27.40	20.28	24.01	12.43	26.12
LSD (0.05)	0.08	0.36	NS	NS	NS	NS	NS	NS

Data on yield contributing characters and yield are presented in Table 5. Number of effective tillers per plant differed significantly due to different treatments and T_2 treatment produced 9.09% higher value over the control. Significantly minimum number of effective tillers per plant was recorded from T_3 treatment. Number of ear bearing tillers increased following NAA application in wheat and barley[7,8]. NAA had also significant effect on the number of productive tiller in transplanted coarse rice[13].

Table 5. Effect of NAA on yield contributing characters and yield of BARI Gom-26.

Treatment	Effective tillers/ plant (no.)	Non-effective tillers/ plant (no.)	Length of spike (cm)	Grains/ spike (no.)	1000-seed weight (g)	Grain yield/ plant (g)	Grain yield/ ha (t)	Harvest index (%)
T_0	5.50 b	4.63 a	7.60	38.50	49.15	10.29 ab	5.15 ab	54.33
T_1	4.50 c	3.25 ab	7.68	40.13	49.95	9.09 b	4.55 b	51.07
T_2	6.00 a	1.75 b	7.85	40.88	50.31	11.55 a	5.78 a	58.30
T_3	4.13 d	3.25 ab	7.63	39.38	49.41	8.07 b	4.00 b	42.47
T_4	4.38 c	3.75 a	7.63	39.50	49.34	8.15 b	4.11 b	54.44
CV (%)	22.06	7.75	4.87	12.34	1.75	25.40	25.27	17.07
LSD (0.05)	0.15	1.65	0.30	4.17	NS	2.28	1.15	NS

Mean in a vertical column followed by same letter or without letter do not differ significantly at 5% level. Average value of 8 plants in each treatment.

The highest number of non-effective tillers per plant was recorded with control which was statistically at par with T_1, T_3 and T_4 treatments. Significantly lowest number of non-effective tillers per plant was produced by plants receiving T_2 treatment which was at par with T_1 and T_3 treatment. Liu *et al.*[14] obtained significant inhibition on the growth of unproductive tillers of rice plants with NAA application. The results obtained from this investigation also suggested that the elimination of unproductive tillers promote the growth of productive tillers at an appropriate concentration.

Length of spike was positively but non-significantly influenced by different concentrations of NAA. The maximum length of spike (7.85 cm) was obtained from T_2 followed by T_1, T_3 and T_4 treatments, respectively where T_3 and T_4 treatment produced similar length of spike (7.63 cm). Similar results of increases were also reported on other plants[9,10]. Number of grains per spike is very important parameter contributing toward grain yield and it depends on the length of spike. Results revealed that number of grains per spike also showed positive influences to various level of NAA but non-significant. The maximum number of grains per spike was obtained from T_2 treatment (40.88) followed by T_1, T_4 and T_3 treatments, respectively. Reports regarding increase in number of grains per spike are in conformity with the findings of other workers in different plants[9,10].

Seed weight (1000 seeds) was positively influenced by all the NAA application but was non-significant. Treatment T_2 produced the maximum 1000-seed weight (50.31 g) which was 2.36 % higher over the control followed by T_1, T_3 and T_4, respectively. Positive effect of NAA on 1000-seed weight on other cereal crops were also reported by different investigators[9,14,15].

Grain yields per plant and per hectare were significantly affected by different concentrations of NAA application. Yield per plant and per hectare was found to increase due to T_2 treatment only. The increase in grain yield per plant and per hectare was 12.24% higher over the control. However, the grain yield decreased by 11.66, 21.57 and 20.80% with T_1, T_3 and T_4 treatments respectively, and these treatments were significantly different from T_2. By applying NAA on wheat Alam *et al.* [5] reported increase in grain yield of one cultivar of wheat and decrease in another. Increased grain yield of other cereal plants due to NAA application has also been reported by different investigators on different plants *viz.* maize[9], rice[13-15], sorghum[16] and baby corn[17]. However, yield per plant was increased in one variety of rice and decrease in other variety due to NAA application[10].

NAA had both positive and negative influences on harvest index and the variation was non-significant among the treatments. The range of harvest index was 42.47- 54.30%. Harvest index increased due to both T_2 and T_4 treatments over all other treatments including control and the increases were 7.31 and 0.20% over the control, respectively. Harvest index decreased with T_1 and T_3 treatments by 6.0 and 21.83%, respectively. This result is in consistence to the finding of Adam and Jahan [10]. However, Bakhsh *et al.* [13] reported only increase in harvest index of rice following NAA application.

The increased yield due to T_2 treatment (50 ppm) might be due to increase in TDM, number of effective tillers per plant, length of spike, number of grains per spike, 1000-seed weight and also decrease in non-effective tillers per plant. Therefore, the reason for increasing yield could not be mentioned due to mentioned only decrease in non-effective tillers per plants. This result is consistent with the findings of Ao *et al.*[18] who indicated that reduction of unproductive tillers did not increase the grain yield of irrigated rice.

Findings from the present investigation revealed that the application of NAA at 50 ppm had significant beneficial effects on the yield attributes of BARI Gom-26 and finally increased the grain yield. Thus, 50 ppm NAA is the best combination for economical yield of BARI Gom-26. The results obtained during the present investigation fairly agree with the findings of various workers mentioned above who obtained enhanced growth and yield in various crop plants following appropriate concentrations of NAA application.

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