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GROWTH AND YIELD PERFORMANCE OF WHEAT (*TRITICUM AESTIVUM* L.) AS INFLUENCED BY COMBINED APPLICATION OF NAA AND N-FERTILIZER IN TWO SOWING TIME

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Abstract

A field experiment was conducted to investigate the effect of NAA (both as foliar and seed soaking) in combination with different N-levels on growth and yield performance of BARI Gom-25 in two sowing time (November 15 and November 22). The experiment consisted of nine treatments *viz.* control, F_4, SOF_0, SOF_1, SOF_2, SOF_3, SOF_4, SSF_0 and SSF_1. Results revealed that seed soaking with 10 ppm NAA in combination with 75% recommended dose nitrogen (RDN) produced tallest plants and maximum number of tillers, leaves total dry matter per plant with significant variations in majority of case in both the sowing time. In case of November 15 sown wheat, seed soaking with 10 ppm NAA in combination with 75% RDN treatment resulted maximum number of effective tillers per plant (6.67), longest spike (9.75), highest dry weight of spike (16.54 cm), highest number of grains per plant (198.08) and maximum yield per plant (7.75 g). Maximum yield per plant obtained from this best performed treatment was 24.80 and 19.81% higher over 10 ppm NAA in combination with RDN and RDN treatment alone respectively. Findings showed that seed soaking treatment was more effective than foliar spray treatment and wheat sown on November 15 produced better stimulation than sown on November 22 in majority of case. Out of nine treatments, seed soaking with 10 ppm NAA in combination with 75% RDN resulted higher growth and maximum yield in BARI Gom-25.

Introduction

Wheat (*Triticum aestivum* L.) is one of the most important cereal crops that can reduce the food gap globally (Mandic *et al.* 2015). Currently, the world average yield of wheat (3.2 t/ha) is severely low (FAOSTAT 2021). Nitrogen is the most limiting nutrient for winter wheat production that affects the rapid plant growth and improves grain yield by influencing cell size and leaf area and photosynthetic activity. Crops often take up less than half the amount of N applied, while the rest is lost which reduces N use efficiency in agricultural systems (Zhang *et al.* 2015). Excessive N application causes soil degradation, nutrient imbalance, salinization, and acidification as soil pH decreases (Zhong *et al.* 2014). Hence, an appropriate nitrogen fertilizer management is indispensable for a sustainable strategy to improve crop yield by reducing environmental pollution (Trost *et al.* 2016).

On the other hand, the use of phytohormones especially Naphthalene acetic acid (NAA) has playing dramatic role in reducing the demand of N fertilizers and producing improved results in wheat (Islam and Jahan 2016, Adam *et al.* 2020). Thus, an attempt was taken to investigate the effects of NAA in combination with different nitrogen levels on growth and yield performance of wheat var. BARI Gom-25.

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Materials and Methods

A field experiment was conducted at the botanical garden of the Department of Botany, University of Dhaka. The experiment was laid out in randomized block design with four replications. The total area of the experimental field was 98.56 m^2 which was divided into two plots. Each plot was again divided into 36 sub-plot (approximately 0.32 m^2) maintaining sub-plot to sub-plot distance of 50 cm. Preparation of the experimental field was done conventionally. Nitrogen (N), phosphorus (P) and potassium (K) content of experimental soil were determined following standard methods (Murphy and Riley 1962, Jackson 1973, Marr and Cresser 1983). Initial status of soil indicates the presence of low amount of N, very high amount of P and very low amount of K. Cow dung was mixed (4 ton/ha) homogenously and chemical fertilizers *viz.* muriate of potash, gypsum and boric acid were applied at doses recommended by Fertilizer Recommendation Guide (2012). Two-thirds of urea and full of the other fertilizers were applied as basal dose during final land preparation. The remaining urea was applied immediately after the first irrigation at the age of 18 days.

Seeds were sterilized with 0.5% calcium hypochlorite followed by soaking in 10 ppm NAA for 12 hrs and then sown in lines 20 cm apart maintaining plant to plant distance of 10 cm in two sowing time *viz.* November 15 (timely sown) and November 22 (7 days late sown). Cultural practices *viz.* thinning, irrigation, weeding etc. were done following methods quoted in Handbook of Agricultural Technology (Chowdhury and Hassan 2013). This experiment consisted of nine treatments *viz.* control = No NAA and N fertilizer; F_4 = 100% RDN (recommended dose of N fertilizer); SOF_0= Seed soaking with 10 ppm NAA; SOF_1= Seed soaking with 10 ppm NAA + 25% RDN; SOF_2= Seed soaking with 10 ppm NAA + 50% RDN; SOF_3 = Seed soaking with 10 ppm NAA + 75% RDN; SOF_4= Seed soaking with 10 ppm NAA +100 % RDN; SSF_0 = Foliar spray of 20 ppm NAA; and SSF_1= Foliar spray of 20 ppm NAA + 25% RDN.

Data on plant height, number of tillers and leaves and total dry matter per plant were recorded at an interval of 15 days from the age of 30 days up to harvest. Yield attributes and yield per plants were calculated after harvest at the age of 108 days. Twelve plants (3 plants from each replication) from each treatment were taken 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 1 revealed that in both the sowing time, application of NAA in combination with different doses of N-fertilizer treatments produced taller plant than control treatment. Seed soaking with 10 ppm NAA in combination with 75% RDN (SOF_3) had resulted tallest plants in both sowing time having few exceptions. Outcome revealed that SOF_3 treatment although produced better stimulations in plant height but not significantly different to recommended nitrogen dose (F_4) and Seed soaking with 10 ppm in combination with 100% RDN (SOF_4). Findings also showed that Nov. 22 sown wheat produced taller plant than Nov. 15. Number of tillers per plant obtained from seed soaking with 10 ppm NAA in combination with 75% RDN treatments were statically identical to recommended dose treatment (F_4) when sown on November 15 but significantly different in case of November 22 sown crops with few exceptions. Results also revealed that BARI Gom-25 sown on November 22 produced higher number of tillers per plant than sown on November 15 in the majority of cases (Table 2). Outcome also revealed that NAA was more productive when applied as seed soaking treatment than foliar spray. At lower concentrations the beneficial effect of spraying NAA have also been reported in different cereal crops including wheat (Jahan and Adam 2013), rice (Adam and Jahan 2011) and barley (Mona *et al.* 2013).

Islam and Jahan (2016) found significantly promotive effect of foliar NAA in combination with N-fertilizer on the number of tillers per plant of BARI Gom-26 where, 25 ppm NAA in combination with 50% N-fertilizer produced maximum value after 15 DAS. Thus the findings of the present study on the number of tillers per plant of wheat plants are in conformity with the findings of many workers.

Positive responses have been observed in the number of leaves per plant following different NAA treatments at varying N-levels in both the sowing time (Table 3). In case of November 15 sown wheat, number of leaves per plant was positively influenced by all treatments at all ages of growth except due to 20 ppm foliar spray (SSF_0) treatment of 45 days after sowing. The maximum number of leaves per plant was obtained from seed soaking with 10 ppm NAA in combination of 75% RDN (SOF_3) throughout the growth periods and were significantly higher than all other treatments at 75 and 90 days after sowing. At harvest, the highest increase in number of leaves per plant due to SOF_3 treatment was 115.44% over the control followed by F_4 (100.13%), SOF_4 (90.24%), SOF_2 (82.45%) treatments respectively.

At harvest, the highest increase in number of leaves per plant due to SOF_3 treatment was 115.44% over the control followed by F_4 (100.13%), SOF_4 (90.24%), SOF_2 (82.45%) treatments respectively. Whereas, in case of November 22 sown wheat, application of NAA in combination with various doses of N-fertilizer had also beneficial effects on the number of leaves per plant where SOF_3 treatment also produced maximum number of leaves with both significant and non-significant variations and with few exceptions (Table 3). Findings of the present investigation also indicated that seed soaking treatments were much effective for producing higher number of leaves than foliar spray treatment. The present finding is in agreement with the finding of Islam and Jahan (2016) and Akter (2016).

Results presented in Table 4 indicated that total dry matter per plant of BARI Gom-25 were positively influenced by NAA in combination with various N-levels in both sowing time with significant variations in most cases. Significantly maximum values in total dry matter per plant were also obtained from seed soaking with 10 ppm NAA in combination with 75% RDN (SOF_3) treatment throughout the period of both sowing time except at 60 days after sowing in case of November 22 sown crops. Whereas, In case of November 15 sown crop, total dry matter per plant due to SOF_3 treatment at 30, 45, 60, 75 and 90 DAS and at harvest increased by 158.82, 207.26, 149.18, 152.99, 93.23 and 91.16% over the control and 10.69, 12.39, 15.39, 26.11, 11.19 and 24.84% over F_4 treatment respectively. In case of November 22 sown wheat, the increases due to SOF_3 treatment were 4.79, 6.38, 1.03, 6.65, 4.76 and 12.64% higher over the control and 4.79, 6.38, 1.03, 6.65, 4.76 and 12.64% higher over F_4 treatments respectively. It was also observed that seed soaking treatment was more effective than foliar spray treatment. Results are in accord with the findings of various worker on different crops *viz.* wheat (Jahan and Adam 2014), maize (Akter 2010) and rice (Jahan and Adam 2011).

Yield attributes and yield of BARI Gom-25 responded positively following most of the treatments with both significant and non-significant variations in both the sowing time (Table 5). Seed soaking with 10 ppm NAA in combination with 75% RDN (SOF_3) resulted significantly higher number of effective tillers per plant than all other treatments although statistically at par with recommended dose of N-fertilizer (F_4) alone and 10 ppm NAA in combination with recommended dose of N-fertilizer treatments (SOF_3).

However, November 15 sown wheat produced better stimulations than 7 days late sown (November 22). Bakhsh *et al.* (2011) and Mona *et al.* (2013) also reported about beneficial effect of NAA on rice and barley, respectively. Foliar application of NAA and N-fertilizer resulted significantly higher number of effective tillers per plant in maize (Akter 2016). Seed soaking with

Table 1. Effects of NAA in combination with N-fertilizer on plant height (cm) of BARI Gom-25 at different ages of two sowing time.

Treatments	Plant height of BARI Gom-25 sown on November 15						Plant height of BARI Gom-25 sown on November 22					
	Age of plants in days after sowing (DAS)											
	30	45	60	75	90	At harvest	30	45	60	75	90	At harvest
Control	32.23 g	43.34 f	64.24 f	79.37 e	82.43 e	82.54 e	33.00 d	44.10 f	65.16 f	80.09 f	83.16 d	82.53 f
F_4	35.08 bc	46.17 bc	68.01 a	82.06 ab	85.88 ab	86.05 ab	35.64 a	46.68 b	68.43 a	82.62 b	86.32 b	86.58 a
SOF_0	32.83 f	44.04 e	65.13 e	80.54 d	83.31 de	83.41 de	33.49 c	44.87 e	66.04 e	81.35 e	84.19 c	84.22 de
SOF_1	33.99 e	45.06 d	65.94 d	81.23 b-d	83.98 cd	84.07 cd	35.13 b	45.81 d	66.59 cd	81.98 d	84.49 c	84.54 cd
SOF_2	34.42 de	45.64 c	66.66 bc	81.96 a-c	84.78 bc	84.86 bc	34.93 b	45.98 cd	66.99 c	83.28 a	85.43 b	85.47 bc
SOF_3	35.86 a	46.41 b	68.52 a	82.52 a	86.57 a	86.64 a	36.01 a	46.78 b	68.58 a	83.16 a	87.38 a	86.99 a
SOF_4	35.25 b	46.23 b	68.09 a	82.19 a	85.78 ab	85.91 ab	35.67 a	46.43 bc	68.36 a	82.55 bc	85.98 b	86.03 ab
SSF_0	33.03 f	44.62 d	66.07 cd	81.22 cd	82.91 de	82.93 de	33.22 cd	45.03 e	66.33 de	82.09 cd	83.23 d	83.26 ef
SSF_1	34.63 cd	47.00 a	67.17 b	81.87 a-c	83.68 de	83.78 c-e	34.86 b	47.31 a	67.53 b	82.91 ab	83.92 cd	83.95 de
CV (%)	3.97	2.96	2.36	1.71	2.47	2.57	3.50	2.51	1.94	1.39	2.06	2.21
LSD (0.05)	0.59	0.55	0.63	0.83	1.27	1.41	0.44	0.48	0.51	0.51	0.91	1.03

Table 2. Effects of NAA in combination with N-fertilizer on number of tillers per plant of BARI Gom-25 at different ages of two sowing time.

Treatments	No. of tillers of BARI Gom-25 sown on Nov. 15						No. of tillers of BARI Gom-25 sown on Nov. 22					
	Age of plants in days after sowing (DAS)											
	30	45	60	75	90	At harvest	30	45	60	75	90	At harvest
Control	1.00 d	1.75 d	2.67 e	2.92 e	2.83 c	2.75 cd	1.00 e	1.83 e	3.42 e	3.58 d	3.42 d	3.33 c
F_4	2.25 a	4.50 a	5.42 b	6.67 a	6.50 a	6.50 a	2.25 b	4.00 b	5.08 c	6.25 b	5.92 ab	5.75 a
SOF_0	1.17 cd	1.83 d	2.75 e	2.83 e	2.67 c	2.42 d	1.25 de	2.08 de	3.50 e	3.75 d	3.67 cd	3.50 c
SOF_1	1.33 c	2.83 c	3.67 d	3.75 d	3.58 c	3.58 c	1.42 d	3.00 c	3.67 e	4.00 d	3.83 cd	3.67 c
SOF_2	1.67 b	3.50 b	4.92 c	5.17 c	5.08 b	5.00 b	1.83 c	3.33 c	5.67 bc	6.00 b	5.58 b	5.42 b
SOF_3	2.42 a	4.58 a	6.00 a	6.92 a	6.75 a	6.75 a	2.67 a	4.67 a	6.50 a	7.00 a	6.67 a	6.58 a
SOF_4	2.33 a	4.25 a	5.58 b	6.08 b	6.00 ab	6.00 ab	2.25 b	3.92 b	5.75 b	6.00 b	5.75 ab	5.75 a
SSF_0	1.00 d	1.92 d	2.83 e	2.92 e	2.83 c	2.83 cd	1.08 e	2.25 d	3.67 e	3.83 d	3.58 cd	3.58 c
SSF_1	1.25 cd	2.92 c	3.67 d	3.67 d	3.50 c	3.50 cd	1.50 d	3.17 c	4.33 d	4.92 c	4.50 c	4.42 bc
CV (%)	12.62	17.87	12.56	16.87	13.76	18.00	14.71	23.43	18.49	13.09	15.64	17.85
LSD (0.05)	0.28	0.40	0.40	0.44	0.93	1.11	0.28	0.40	0.59	0.69	1.03	1.09

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

Table 3. Effects of NAA in combination with N-fertilizer on the number of leaves per plant of BARI Gom-25 at different ages in two sowing time.

Treatments	Number of leaves of BARI Gom-25 sown on Nov. 15						Number of leaves of BARI Gom-25 sown on Nov. 22					
	Age of plants in days after sowing (DAS)											
	30	45	60	75	90	At harvest	30	45	60	75	90	At harvest
Control	3.17 d	7.92 d	11.92 d	9.25 f	7.83 e	7.58 d	3.42 f	9.17 d	12.83 d	14.50 cd	9.50 e	7.67 f
F_4	9.00 a	18.83 a	23.83 a	23.00 b	16.17 b	15.17 ab	8.17 b	17.17 a	20.50 b	22.92 a	14.92 b	14.25 b
SOF_0	4.17 d	8.25 d	12.00 a	12.08	8.83 de	8.00 cd	4.25 e	8.75 de	12.67 d	12.75 e	9.25 e	8.50 ef
SOF_1	5.50 bc	11.17 c	13.92 c	12.92 e	11.08 c	9.00 cd	5.92 d	11.58 c	14.58 c	13.50 de	11.58 c	9.33 de
SOF_2	6.50 b	13.42 b	20.50 b	19.58 c	15.00 b	13.83 b	7.00 c	11.83 c	21.75 a	20.67 b	15.33 b	14.08 b
SOF_3	10.00 a	17.83 a	24.17 a	25.42 a	19.67 a	16.33 a	9.42 a	17.00 a	22.25 a	21.58 b	18.58 a	15.58 a
SOF_4	9.50 a	14.92 b	21.67 b	22.67 b	16.58 b	14.42 b	8.83 ab	14.25 b	20.25 b	21.17 b	15.50 b	13.33 bc
SSF_0	3.50 d	7.58 d	13.66 c	11.83 e	9.33 c-e	8.33 cd	3.58 ef	8.00 e	11.67 d	12.33 e	10.08 de	8.83 ef
SSF_1	5.25 c	11.00 c	14.75 c	14.50 d	10.67 cd	9.42 c	6.17 d	11.75 c	15.42 c	15.50 c	11.42 cd	10.25 cd
CV (%)	14.88	15.65	11.08	14.34	15.41	14.47	16.88	18.17	15.46	15.03	17.14	18.14
LSD (0.05)	1.01	1.56	1.54	1.23	1.92	1.80	0.77	1.03	1.23	1.21	1.37	1.25

Table 4. Effects of NAA in combination with N-fertilizer on total dry matter per plant of BARI Gom-25 at different ages in two sowing time.

Treatments	Total dry matter of BARI Gom-25 sown on Nov. 15						Total dry matter of BARI Gom-25 sown on Nov. 22					
	Age of plants in days after sowing (DAS)											
	30	45	60	75	90	At harvest	30	45	60	75	90	At harvest
Control	0.68 i	1.24 h	3.64 g	6.51 g	10.34 f	13.91 fg	0.69 f	1.29 gh	3.29 f	6.24 g	10.12 h	12.65 e
F_4	1.59 b	3.39 b	7.86 b	13.06 b	17.97 b	21.30 bc	1.46 b	3.29 b	7.74 a	12.93 b	17.03 b	19.22 b
SOF_0	0.73 h	1.39 g	3.89 f	6.88 f	10.81 e	13.63 fg	0.70 f	1.32 g	3.83 e	6.86 f	10.80 g	13.39 e
SOF_1	1.08 f	1.67 e	4.17 e	7.86 e	11.05 e	14.89 ef	1.03 e	1.63 e	4.34 d	7.79 e	11.06 f	14.69 d
SOF_2	1.30 d	2.73 d	5.98 c	11.87 c	15.95 c	19.31 cd	1.33 c	2.59 d	5.84 b	11.90 c	15.94 d	19.93 b
SOF_3	1.76 a	3.81 a	9.07 a	16.47 a	19.98 a	26.59 a	1.53 a	3.50 a	7.82 a	13.79 a	17.84 a	21.65 a
SOF_4	1.47 c	3.21 c	7.94 b	13.19 b	18.15 b	22.99 b	1.39 c	3.18 c	7.74 a	13.03 b	16.77 c	20.25 b
SSF_0	0.84 g	1.29 h	3.04 h	6.42 g	9.73 g	11.86 g	0.73 f	1.23 h	2.78 g	5.91 h	8.94 i	10.70 f
SSF_1	1.17 e	1.51 f	5.04 d	8.96 d	13.76 d	17.62 de	1.18 d	1.51 f	5.13 c	9.08 d	14.07 e	17.87 c
CV (%)	13.38	23.60	17.13	13.96	16.27	22.11	9.93	12.10	15.34	13.18	13.87	13.39
LSD (0.05)	0.03	0.08	0.20	0.20	0.34	2.95	0.06	0.08	0.20	0.20	0.20	1.09

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

10 ppm NAA in combination with various N-levels had better stimulations than foliar NAA and recommended dose of N-fertilizer treatments on non-effective tillers in both sowing time but with non-significant variations. Application of NAA alone and in combination with N-fertilizer had resulted lowest number of non-effective tillers in wheat (Jahan and Adam 2013, Islam and Jahan 2016) and maize (Akter 2016). Thus, the findings on the number of non-effective tillers per plant are in agreement to the findings of previous workers.

Outcome revealed that length of spike was positively influenced following NAA in combination with N-fertilizers in both sowing time (Table 5). Seed soaking with 10 ppm NAA in combination with 75% N-fertilizer although produced longest spike at both sowing time but were not statistically different from recommended dose of N-fertilizer (F_4) and foliar spray of 20 ppm NAA in combination with 25% RDN fertilizer (SSF_1). Similar results of increases due to NAA application have also been reported in wheat (Islam and Jahan 2016).

Table 5. Effects of NAA in combination with N-fertilizer on yield attributes and yield of BARI Gom-25 at different ages of two sowing time.

Treatments	BARI Gom-25 sown on Nov. 15							
	No. of effective tillers/plant	No. of non-effective tillers/plant	Length of spike (cm)	Dry weight of spikes (g)	No. of grains/ plant	1000-grain weight (g)	Yield/ plant (g)	HI (%)
Control	2.50 cd	0.25	9.24	9.16 ef	67.42 e	43.82 d	3.05 e	21.75 b
F_4	6.33 a	0.17	9.72	14.01 bc	158.36 b	45.33 b	6.21 bc	28.81 a
SOF_0	2.33 d	0.08	9.45	8.95 f	77.05 de	44.16 d	2.68 e	19.50 b
SOF_1	3.50 c	0.08	9.60	9.77 ef	107.08 cd	44.92 c	4.83 d	33.13 a
SOF_2	4.92 b	0.08	9.61	12.36 cd	156.35 b	45.37 b	6.63 a-c	34.22 a
SOF_3	6.67 a	0.08	9.80	16.54 a	198.08 a	45.80 a	7.75 a	30.15 a
SOF_4	5.75 ab	0.25	9.75	15.16 ab	175.29 ab	45.19 bc	7.44 ab	33.13 a
SSF_0	2.67 cd	0.17	9.29	7.78 f	64.21 e	43.97 d	2.72 e	22.58 b
SSF_1	3.33 cd	0.17	9.65	11.13 de	112.33 c	45.83 a	5.77 cd	32.32 a
CV (%)	18.71	28.91	8.36	12.08	18.62	1.88	4.71	12.13
LSD (0.05)	1.09	NS	NS	2.04	32.55	0.34	1.29	6.12

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BARI Gom-25 sown on Nov. 22							
No. of effective tillers/plant	No. of non-effective tillers/plant	Length of spike (cm)	Dry weight of spikes (g)	No. of grains/ plant	1000-grain weight (g)	Yield/ plant (g)	HI (%)
3.17 c	0.17	9.31 b	8.84 d	84.17 d	43.69 e	3.49 d	28.44 bc
5.58 ab	0.17	9.67 ab	13.13 ab	164.34 b	45.15 bc	6.29 a-c	33.02 ab
3.33 c	0.17	9.47 ab	10.73 cd	87.84 d	44.08 d	3.84 d	25.45 c
3.58 c	0.08	9.42 ab	10.27 cd	96.83 d	45.00 c	5.31 c	32.91 ab
5.25 b	0.17	9.46 ab	13.71 ab	143.32 bc	45.26 bc	6.35 a-c	31.10 a-c
6.50 a	0.08	9.83 a	14.73 a	205.33 a	45.67 a	7.50 a	35.95 a
5.58 ab	0.17	9.75 ab	13.93 ab	167.87 b	45.34 b	7.01 ab	34.87 a
3.25 c	0.33	9.33 b	6.50 e	93.67 d	43.78 e	3.75 d	34.84 a
4.17 c	0.25	9.67 ab	11.83 bc	130.15 c	45.38 b	5.81 bc	32.14 ab
18.32	8.34	6.42	31.04	9.36	1.79	39.16	23.67
1.03	NS	0.48	2.14	26.20	0.28	1.41	5.88

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

Results presented in Table 5 indicated that dry weight of spikes were found to increase following NAA and N-fertilizer treatments. The maximum dry weight of spike was noted from seed soaking with 10 ppm NAA at 75% RDN-level in both sowing condition but in case of November 15 sown wheat it was significantly higher than most of the treatments including RDN-fertilizer alone and any foliar spray treatments. Combinations of NAA and N-levels had also promoting effect on dry weight of tassel in most cases (Akter 2016).

Increases in number of grains per plant were obtained from combined application of NAA and N-fertilizers at both sowing cases. Seed soaking with 10 ppm NAA in combination with 75% RDN had resulted significantly higher number of grains per plant than most of the treatments including RDN and foliar spray treatments at both timely and late sown condition. Combined application of NAA and N-fertilizers produced maximum number of grains per plant in maize (Akter 2016).

Weight of 1000-grain were significantly influenced following NAA at various doses of N-fertilizer at both sowing time with few exceptions. Foliar NAA in combination with 25% RDN treatment (SSF_1) resulted significantly highest value (45.83g) in November 15 sown wheat although statistically at par (45.80g) to seed soaking with 10 ppm NAA in combination with 75% RDN treatment. Significantly maximum 1000-grain weight (45.67g) was also obtained from seed soaking with 10 ppm NAA in combination with 75% RDN treatment in November 22 sown wheat. Results indicated that November 15 sown wheat produced higher 1000-grain weight than November 22 sown wheat with few exceptions and the values obtained from both the sowing time were significantly higher than RDN treatment (F_4). Madhu *et al.* (2018) obtained significantly highest 1000-grain weight from November 15 sown wheat. Combined application of NAA and N-fertilizers had both positive and negative influences on BARI Gom-26. However, Akter (2016) recorded maximum 1000-grain weight from 50 ppm NAA in combination with 50% higher rate of N-fertilizer in maize. Thus the findings of the present study are in conformity with those of previous workers.

Yield per plant of BARI Gom-25 was significantly influenced by most of the combined treatments of NAA and N-levels in both sowing time (Table 4). Results obtained from the experiment revealed that seed soaking with 10 ppm NAA in combination with 75% N-fertilizer produced maximum yield per plant in the both sowing condition where, better stimulation was observed from November 15 sown wheat. In case of November 15 sown wheat, seed soaking with 10 ppm NAA in combination with 75% RDN (SOF_3) treatment produced significantly higher yield (7.75g) than RDN-fertilizer alone and foliar spray treatments. Here, yield per plant obtained from SOF_3 treatment was 24.80 and 19.81% higher over 10 ppm NAA in combination with RDN treatment. Findings obtained in case of November 22 sown wheat revealed that 10 ppm NAA in combination with 75% RDN (SOF_3) treatment although produced maximum yield (7.50g) but statistically identical to RDN treatment alone (6.29g), 10 ppm NAA in combination with 50% RDN (6.35g) and 10 ppm NAA in combination with RDN (7.01g), respectively. Similar results of increases in grain yield following combined application of NAA and N-fertilizer was also reported by Islam and Jahan (2016) in wheat.

The overall findings revealed that seed soaking treatments was more effective than foliar spray treatment in the both sowing time. Wheat *var.* BARI Gom-25 sown on November 15 produced better stimulation in growth and yield than sown on November 22. Out of nine treatments, seed soaking with 10 ppm NAA in combination with 75% RDN (SOF_3) treatment resulted enhanced growth and maximum yield.

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