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Effect of nitrogen and naphthalene acetic acid on the growth and yield of summer onion

Mukta Gupta [1], Taslima Rahman [2], Zakaria Ahmed [2] and Mohammad Humayun Kabir [1, *]

[1] *Department of Horticulture, Sher-e-Bangla Agricultual University, SAU, Dhaka, Bangladesh.*
[2] *Bangladesh Jute Research Institute, Manik Mia Avenue, Dhaka, Bangladesh.*

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Abstract

The experiment was conducted to study the response of summer onion to N_2 and Naphthalene Acetic Acid (NAA). The experiment consisted of two factors. Factor A: 4 levels of Nitrogen viz. N_0-0kg (control), N_1-90kg ha^{-1}, N_2-110kg ha^{-1} and N_3-130kg ha^{-1} and Factor B: 4 levels of NAA viz. H_0-0ppm, H_1- 50ppm, H_2-100ppm and H_3-150ppm. The experiment was laid out in Randomized Complete Block Design with three replications. Results revealed that in terms of nitrogen, the highest bulb diameter (4.90cm), bulb weight plant^{-1} (51.48g) and bulb yield ha^{-1} (17.78t) were found from N_2 (110kg N ha^{-1}). In case of application of NAA, the highest bulb length (3.22cm), bulb diameter (4.38cm), bulb weight plant^{-1} (45.18g) and bulb yield ha^{-1} (15.49t) were recorded from H_2 (100ppm NAA). Regarding combined effect of nitrogen and NAA the highest bulb length (3.76cm), highest bulb diameter (5.26cm), highest bulb weight plant^{-1} (55.50g) and highest bulb yield ha^{-1} (19.60t) were recorded from the treatment combination of N_2H_2. Considering economic analysis, the highest BCR (2.39) was also obtained from N_2H_2 (110kg N ha^{-1} with 100ppm NAA) treatment combination.

Keywords: *Allium cepa*; Nitrogen; Naphthalene Acetic Acid (NAA); Onion

1. Introduction

Onion (*Allium cepa*) rightly called as "queen of kitchen" is one of the oldest and an important spice crop grown in Bangladesh as well as in the world. Onion is an important herbaceous bulb and spice crop in the world which belongs to the family Alliaceae. It ranks first in production and second in area among the spices. It covers almost 36% of the total areas under spices [1]. Onion is an essential part of the diets like other vegetables; it provides vitamins such as vitamin A and C, and a good amount of mineral elements to the human body [2, 3]. Onion bulb provides vitamin C 19.7%, fiber 10.8%, molybdenum 10.6%, manganese 10.5%, vitamin B 69.5%, potassium 6.6%, and tryptophan 6.2%. Onions are very low in calories (just 40 cal per 100g) and fats but rich in soluble dietary fiber. Now, it's growing all over the world. The leading onion growing countries of the world are the China, Netherlands, Korea, India etc. [4]. In Bangladesh it is commercially cultivated in the greater districts of Dhaka, Mymensingh, Rajshahi, Rangpur, Rajbari, Khustia, Khulna, Barisal and Pabna [5]. The total production of onion in Bangladesh is about 170 thousand metric tons under the total cultivated area 1,69,685 ha [5]. On an average, the total annual requirement of onion in Bangladesh is about 16,50,000 metric tons but production is 10,52,000 metric tons [6]. The major onion producing countries like Korea Republic tops the list with 65.25 t/ha followed by USA 53.91 t/ha, Spain 52.06 t/ha, Japan 47.55 t/ha [7], where as the productivity of onion in Bangladesh is 8.95 t/ha which is remarkably lower than other onion producing countries. The mean yield of onion in Bangladesh is very low (4 t/ha) compared to world average of 17.27 t/ha [8]. There is an acute shortage of onion in relation to its requirement. Every year, Bangladesh has to import a big amount of onion [9]. The high demand of onion can only be met by increasing its production vertically. In Bangladesh, onion is mainly cultivated in winter season i.e. October to November and harvesting mostly in the month from March to April. Onion cultivation during

*Corresponding author: Mohammad Humayun Kabir
Department of Horticulture, Sher-e-Bangla Agricultual University, SAU, Dhaka, Bangladesh.

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summer season is constrained due to adverse weather along with absence of summer tolerant varieties and proper cultural practice. The demand for its use is ever increasing irrespective of season. So, it is urgently needed to cultivate onion also in summer season to meet the domestic demand in Bangladesh. Recently, BARI has released two summer onion varieties for growing in kharif season as its genetic potentiality proved to be suitable for this climate [10]. Farmers generally follow traditional method for cultivating onion in Bangladesh. Improved cultivation technique is needed to increase onion production. Fertilizer management is one of the important factors that contribute in the production and yield of onion. Among the nutrients; nitrogen plays the most important role for vegetative growth of the crop, which ultimately helps in increasing bulb size and total yield of onion. Application of nitrogen increases the dry matter production and added maximum uptake of nutrient elements by onion bulb from soil [11]. Maximum bulb weight and bulb yield produced with the application of nitrogen [12]. Excess nitrogen also causes onions to be more easily able to be harmed or influenced by storage pathogens. Plant growth regulators have contributed a great deal to the progress of agricultural sciences by modifying and controlling the growth behavior of many crop plants. They have therefore become one of the most important tools for agriculturists and horticulturists to increase crop production [13]. Plant growth regulator (PGR) is need on growth and development followed by bulb formation, bulking and yield [14]. Among different 3 growth regulators, Naphthalene acetic acid (NAA) is an important growth regulator. Naphthalene Acetic Acid (NAA) is a synthetic plant hormone in the auxin family and is an ingredient in many commercial plant rooting horticultural products. Reddy et al. [15] reported that application of NAA increased yield and yield components of crop. Plant growth regulators generate metabolic and physiological responses in plants by affecting their growth and development [16]. In consideration with the aforesaid situation, the present investigation was undertaken to assess the effects of nitrogen and different concentration of NAA on summer onion (BARI Piaj-3). The present study was undertaken to determine the optimum level of nitrogen and concentration of NAA on the growth and yield of onion, and investigate the combined effect of nitrogen and NAA on the growth.

2. Material and methods

2.1. Planting Material

Seeds of one onion cultivar namely “BARI Piaj-3” were used for the experiment. The seeds were collected from BARI (Bangladesh Agricultural Research Institute), Joydevpur, Gazipur. Characters of BARI Piaj-3: is globular in size, average weight is 45-65 gm, average height is 35-50 cm and average weight is 18-22 ton ha^{-1} [17].

2.2. Field experiment

The present research work was conducted at the Horticulture Farm, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh. The experimental area is under the sub-tropical climate that is characterized by less rainfall associated with moderately low temperature during rabi season (October-March) and high temperature, high humidity and heavy rainfall with occasional gusty winds during kharif season (April-September). The soil of experimental area was sandy loam in texture with pH 5.47-5.63. The experiment consists of 4 levels of nitrogen viz. N_0= Control (0 kg N ha^{-1}), N_1= 90 kg N ha-1, N_2= 110 kg N ha^{-1} and N_3= 130 kg N ha^{-1} and 4 levels of NAA viz. H_0 = Control (0 ppm NAA), H_1= 50 ppm NAA, H_2= 100 ppm NAA and H_3= 150 ppm NAA. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The size of the unit plot was 2.5 ×2.0 m^2. The distance maintained between two plots was 0.5 m and between blocks was 0.75 m (Fig.1).Standard cultivation practices were used in seedbed preparation. Onion seeds were soaked overnight (12h) in water and allowed to sprout in a piece of moist cloth keeping in the sun shade for one day to ensure consistent germination. Seeds were treated by Vitavax-200 @ 5g/1kg seeds to protect some seed borne diseases. Healthy and 40days old seedlings were transplanted into the main field.A basal dose of well-decomposed cow dungs 10 t/ha was applied just after opening the land. The total amount of TSP, ½ MoP and full gypsum were applied at the final land preparation. Total urea and ½ MoP were applied in two installments. The first installments were applied at 20 days after transplanting; second installments were applied 35 days after transplanting as top dressing. The fertilizer was thoroughly mixed with the soil. In this experiment plant growth regulator 1-napthalene acetic acid (NAA) was applied according to Singh et al. [18, 19].

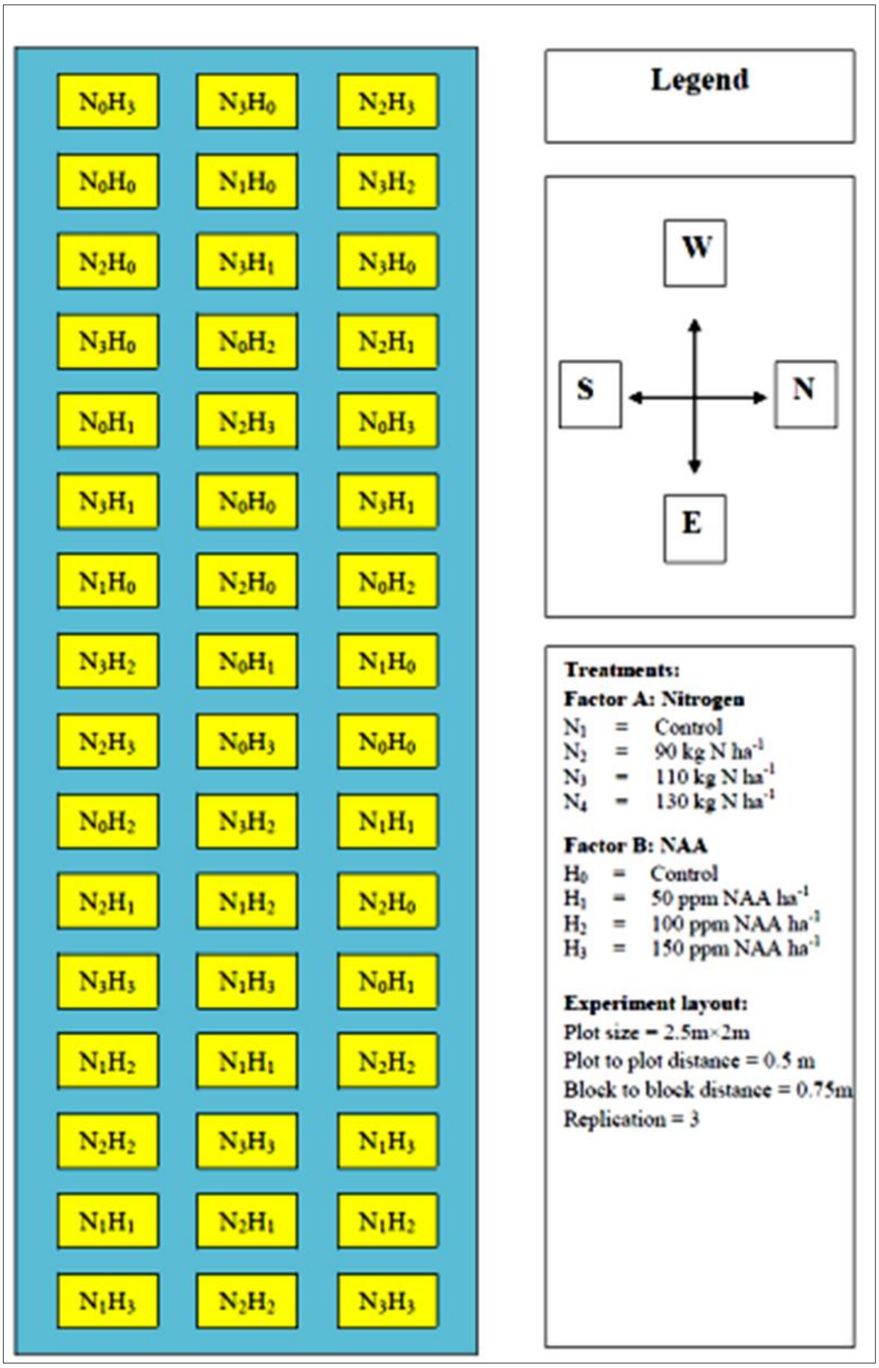


Figure 1 Layout of the experiment field

2.3. Measurements

Data were compiled on a range of parameters, shaping vegetative and reproductive growth, Bulb characteristics and yield during the crop cycle. Plant height (cm), Number of leaves /plant, Fresh weight of leaves/ plant (g) were recorded at 90 days and harvesting stage. Dry matter content of leaves (%) was calculated by the following formula:

$$\text{Dry matter (\%)} = \frac{\text{Dry weight of leaves}}{\text{Fresh weight of the sample}} \times 100$$

Whereas, Dry matter content of bulb (%) was calculated by the following formula:

$$\text{Dry matter (\%)} = \frac{\text{Dry weight of bulb}}{\text{Fresh weight of bulb}} \times 100$$

Yield contributing parameters, like neck (pseudo stem) diameter (cm), bulb length (cm), bulb diameter (cm) were taken after harvesting and their average mean was calculated and yield parameters, like bulb weight plant^{-1} (g), bulb yield ha^{-1} (t) were measured from ten randomly selected plants after harvesting and their mean value were calculated.

2.4. Statistical analysis

The collected data on various parameters under study were statistically analyzed using MSTAT-C computer package programmed. The means for all the treatments were calculated and analysis of variance for all the characters was performed by 29 the F- variance test [20]. Significance of difference between means was evaluated by Ducan's Multiple range test (DMRT) and the probability level 5% and 1% for the interpretation of results.

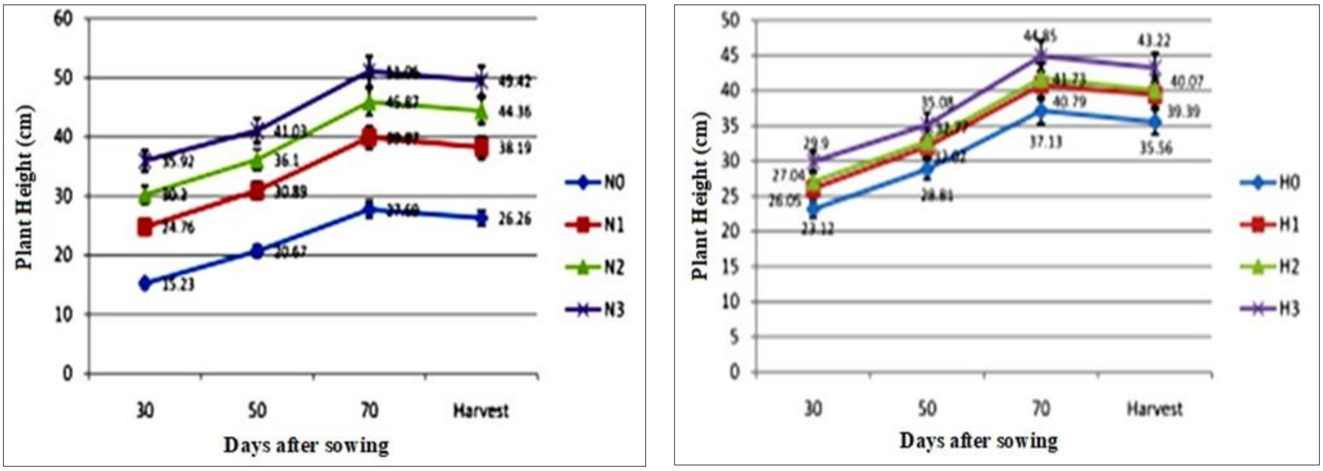
2.5. Economic analysis

Economic analysis was done to find out the cost effectiveness.

3. Results and discussion

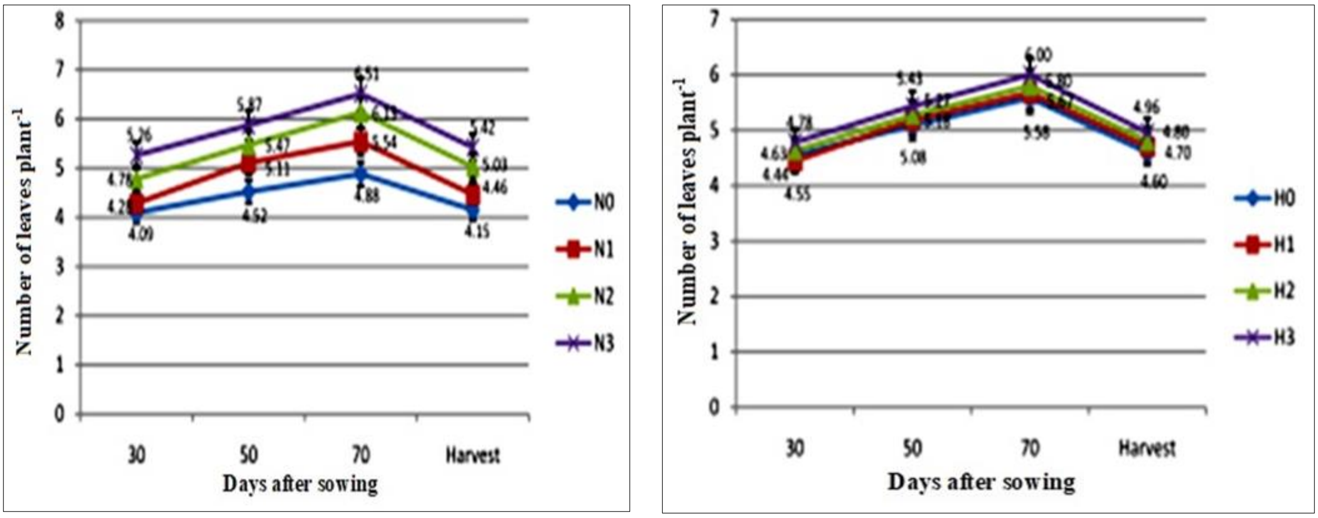
3.1. Impact of N_2 and NAA on growth parameters

Plant height was significantly influenced by different nitrogen and NAA levels at different growth stages (at 30, 50, 70 DAT and at harvest) of the test crops. Results indicated that the tallest plant (35.92, 41.03, 51.06 and 49.42 cm, at 30, 50, 70 DAT and at harvest, respectively) was found from N3 (130 kg N ha^{-1}) followed by N2 (110 kg N ha^{-1}) whereas the shortest plant (15.23, 20.67, 27.69 and 26.26 cm, at 30, 50, 70 DAT and at harvest, respectively) was observed from N_0 (Control; 0kg N ha^{-1}) followed by N_1 (90kg N ha^{-1}) (Fig. 2a).Abdissa et al [21] found that application of 69 kg N ha^{-1} enhanced the growth of onion plant and resulted in optimum fresh total and marketable bulb yield. They also found that application of 69 kg N ha^{-1} increased plant height by about 10%, over the unfertilized check.For NAA Results revealed that the tallest plant (29.90, 35.08, 44.85 and 49.42 cm, at 30, 50, 70 DAT and at harvest, respectively) was recorded from H_3 (150ppm NAA) which was statistically different from all other treatments. The shortest plant (13.12 28.81, 37.13 and 35.56 cm, at 30, 50, 70 DAT and at harvest, respectively) was observed from H_0 (Control; 0 ppm NAA) (Fig. 2b)Shashi and Shashidhar [22] observed maximum plant height (64.30 cm) was recorded from GA3 @ 60ppm and similar result was also found from NAA @ 300ppm.Number of leaves plant^{-1} was significantly influenced by different nitrogen and NAA levels at different growth stages (at 30, 50, 70 DAT and at harvest) of the test crops. Results indicated that the highest number of leaves plant-1 (5.26, 5.87, 6.51 and 5.42 at 30, 50, 70 DAT and at harvest, respectively) was found from N_3 (130 kg N ha^{-1}) followed by N_2 (110 kg N ha^{-1}) whereas the lowest number of leaves plant^{-1} (4.09, 4.52, 4.88 and 4.15 at 30, 50, 70 DAT and at harvest, respectively) was observed from N_0 (Control; 0 kg N ha^{-1}) followed by N1 (90 kg N ha^{-1}) (Fig 3a)]. Meena et al [23] found that the highest N level (150 kg/ha) recorded the maximum leaf number per plant in comparison to its lower levels (50 and 100 kg N/ha).For NAA the highest number of leaves plant^{-1} (4.78, 5.43, 6.00 and 4.96 at 30, 50, 70 DAT and at harvest, respectively) was recorded from H_3 (150ppm NAA) which was statistically identical with H_2 (100ppm NAA). The lowest number of leaves plant-1 (4.55, 5.08, 5.58 and 4.60 at 30, 50, 70 DAT and at harvest, respectively) was observed from H_0 (Control; 0 ppm NAA) [Fig. 3(b)]. Supported finding was also found by Bose et al [24]. Fresh weight of leaves plant^{-1}, Dry matter content of leaves, dry matter content of bulb were significantly influenced. Results revealed that the highest fresh weight of leaves plant^{-1} (62.72g) was found from N_3 (130 kg N ha^{-1}) but the highest dry matter content of leaves (16.84%), highest dry matter content of bulb (23.92%) were found from N_2 (110 kg N ha^{-1}). On the other hand the lowest fresh weight of leaves plant-1 (41.58 g), lowest dry matter content of leaves (10.29%), lowest dry matter content of bulb (13.94%) were observed from N_0 (Control; 0 kg N ha-1) (Table 1). In case of NAA the highest fresh weight of leaves plant-1 (55.65 g) was recorded from H_3 (150ppm NAA) but the highest dry matter content of leaves (14.65%), highest dry matter content of bulb (20.98%) were recorded from H_2 (100 ppm NAA). Again the lowest fresh weight of leaves plant-1 (51.69 g), lowest dry matter content of leaves (12.25%), lowest dry matter content of bulb (17.00%) were observed from H_0 (Control; 0ppm NAA) (Table 1) which has similarity with the results of Abdissa et al. [21], Shashi and Shashidhar [22] and Mahmoud [25].



(a)	(b)
N_0 = Control (0 kg N ha^{-1})	H_0 = Control (0 ppm NAA)
N_1 = 90 kg N ha^{-1}	H_1 = 50ppm NAA
N_2 = 110 kg N ha^{-1}	H_2 = 100ppm NAA
N_3 = 130 kg N ha^{-1}	H_3 = 150ppm NAA

Figure 2 (a) Plant height of summer onion as influenced by N2 (LSD0.05 = 1.617, 2.311, 2.415 and 3.414 at 30, 50, 70 DAS and at harvest, respectively), (b) Plant height of summer onion as influenced by NAA (LSD0.05 = 1.219, 1.062, 2.315 and 2.064 at 30, 50, 70 DAS and at harvest, respectively



(a)	(b)
N_0 = Control (0 kg N ha^{-1})	H_0 = Control (0 ppm NAA)
N_1 = 90 kg N ha^{-1}	H_1 = 50ppm NAA
N_2 = 110 kg N ha^{-1}	H_2 = 100ppm NAA
N_3 = 130 kg N ha^{-1}	H_3 = 150ppm NAA

Figure 3 (a) Number of leaves plant-1 of summer onion as influenced by N2 (LSD0.05 = 0.422 , 0.346, 0.266 and 0.281 at 30, 50, 70 DAS and at harvest, respectively), (b) Number of leaves plant-1 of summer onion as influenced by NAA (LSD0.05 = 0.161 , 0.184, 0.211 and 0.187 at 30, 50, 70 DAS and at harvest, respectively)

Table 1 Effect of N_2 and NAA on fresh weight of leaves plant^{-1} (g), dry matter content of leaves (%) and dry matter content of bulb (%)

Treatments	Fresh weight of leaves plant-1 (g)	Dry matter content of leaves (%)	Dry matter content of bulb (%)
Effect of N_2			
N_0	41.58 d	10.29 d	13.94 d
N_1	53.70 c	14.34 b	20.96 b
N_2	58.13 b	16.84 a	23.92 a
N_3	62.72 a	12.78 c	18.27 c
CV(%)	8.227	6.384	5.388
Effect of NAA			
H_0	51.69 c	12.25 c	17.00 c
H_1	53.34 b	14.00 b	20.27 a
H_2	55.46 a	14.65 a	20.98 a
H_3	55.65 a	13.34 b	18.83 b
CV(%)	8.227	6.384	5.388
Combined effect of N_2 and NAA			
N_0H_0	38.04 i	9.67 i	12.67 h
N_0H_1	41.12 hi	10.33 hi	14.00 g
N_0H_2	44.78 h	10.67 hi	14.75 g
N_0H_3	42.37 h	10.50 hi	14.33 g
N_1H_0	52.16 g	12.00 fg	16.33 f
N_1H_1	52.88 fg	13.67 de	20.67 d
N_1H_2	55.45 efg	16.80 b	24.50 ab
N_1H_3	54.32 efg	14.87 c	22.33 c
N_2H_0	56.86 def	14.60 cd	22.00 c
N_2H_1	56.26 def	17.67 ab	24.67 ab
N_2H_2	58.18 cde	18.33 a	25.33 a
N_2H_3	61.23 abc	16.67 b	23.67 b
N_3H_0	59.70 bcd	12.67 ef	17.00 f
N_3H_1	63.10 ab	14.33 cd	21.75 cd
N_3H_2	63.42 ab	12.80 ef	19.33 e
N_3H_3	64.67 a	11.33 gh	15.00 g
CV(%)	8.227	6.384	5.388

In a column, figures bearing same letter(s) do not differ significantly at 5% level of significance by DMRT

N_0 = Control (0 kg N ha^{-1})	H_0 = Control (0 ppm NAA)
N_1 = 90 kg N ha^{-1}	H_1 = 50ppm NAA
N_2 = 110 kg N ha^{-1}	H_2 = 100ppm NAA
N_3=130 kg N ha^{-1}	H_3 = 150ppm NAA

3.2. Impact of N_2 and NAA on yield contributing parameters

Significant influence was found for neck diameter, bulb length and bulb diameter of onion. Results revealed that the highest neck diameter found from N_3 (130 kg N ha^{-1}) but the highest bulb length (3.61cm) highest bulb diameter (4.90 cm) were found from N2 (110 kg N ha^{-1}). On the other hand the lowest neck diameter (0.53cm) lowest bulb length (2.25 cm), lowest bulb diameter (3.09 c m) were observed from N_0 (Control; 0kg N ha^{-1}) (Table2). NAA had significant effect on yield contributing parameters. It was found that the highest neck diameter (1.03cm) were recorded from H_3 (150ppm NAA) but the highest bulb length (3.22cm), highest bulb diameter (4.38cm) were recorded from H_2 (100ppm NAA). Again, the lowest neck diameter (0.86cm), lowest bulb length (2.85cm), lowest bulb diameter (3.74cm) were observed from H_0 (Control; 0ppm NAA) (Table 2) that are similar with the findings of Abdissa et al. [21], Meena et al. [23] and Shashi and Shashidhar [22].

Table 2 Effect of N_2 and NAA on yield contributing parameters representing neck diameter (cm), bulb length (cm) and bulb diameter (cm)

Treatments	**Yield contributing parameters**		
	Neck diameter (cm)	**Bulb length (cm)**	**Bulb diameter (cm)**
Effect of N_2			
N_0	0.53 d	2.25 d	3.09 d
N_1	0.88 c	3.33 b	4.40 b
N_2	1.09 b	3.61 a	4.90 a
N_3	1.24 a	3.05 c	3.95 c
CV(%)	5.886	7.381	6.072
Effect of NAA			
H_0	0.86 b	2.85 c	3.74 d
H_1	0.88 b	3.14 a	4.21 b
H_2	0.97 a	3.22 a	4.38 a
H_3	1.03 a	3.03 b	4.01 c
CV(%)	5.886	7.381	6.072
Combined effect of N_2 and NAA			
N_0H_0	0.42 i	2.08 j	2.92 i
N_0H_1	0.50 hi	2.25 i	3.08 hi
N_0H_2	0.58 h	2.38 i	3.26 h
N_0H_3	0.62 h	2.27 i	3.10 hi
N_1H_0	0.85 g	2.92 h	3.70 fg
N_1H_1	0.86 g	3.30 f	4.32 d
N_1H_2	0.92 fg	3.60 abc	4.98 b
N_1H_3	0.90 fg	3.48 cde	4.58 c
N_2H_0	1.04 ef	3.42 def	4.47 cd
N_2H_1	0.98 efg	3.67 ab	5.04 ab
N_2H_2	1.10 de	3.76 a	5.26 a
N_2H_3	1.25 abc	3.58 bcd	4.82 b
N_3H_0	1.12 cde	2.96 h	3.88 ef

N_3H_1	1.19 bcd	3.33 ef	4.40 cd
N_3H_2	1.28 ab	3.12 g	4.00 e
N_3H_3	1.36 a	2.80 h	3.52 g
CV(%)	5.886	7.381	6.072

In a column, figures bearing same letter(s) do not differ significantly at 5% level of significance by DMRT

N_0 = Control (0 kg N ha-1)	H_0 = Control (0 ppm NAA
N_1= 90 kg N ha^{-1}	H_1 = 50ppm NAA
N_2 = 110 kg N ha^{-1}	H_2 = 100ppm NAA
N_3=130 kg N ha	H_3 = 150ppm NAA

3.3. Impact of N_2 and NAA on yield parameters

Significant influence was found for bulb weight $plant^{-1}$ and Bulb yield ha^{-1} of onion. Results revealed that the highest bulb weight $plant^{-1}$ (51.48 g) and highest bulb yield ha^{-1} (17.78 t) were found from N_2 (110 kg N ha^{-1}). On the other hand the lowest bulb weight $plant^{-1}$ (28.50 g) and lowest bulb yield ha^{-1} (9.27 t) were observed from N_0 (Control; 0 kg N ha^1 (Table 3). Similar findings were observed by Abdissa et al [21] and Mahmoud [24]. Abdissa et al [21] recorded application, N fertilization increased average bulb weight by 24%. Mahmoud [24] observed that N fertilizers significantly increased bulb weights. The results obtained on bulb yield ha^{-1} from the present study was conformity with the findings of Abdissa et al. [21], Meena et al [23], Mahmoud [25], Kumar et al [26] and Rahman [27]. NAA also had significant effect on yield parameters. It was found that the highest bulb weight $plant^{-1}$ (45.18g) and highest bulb yield ha^{-1} (15.49t) were recorded from H_2 (100ppm NAA). Again, the lowest bulb weight $plant^{-1}$ (37.90g) and lowest bulb yield ha^{-1} (12.65t) were observed from H_0 (Control; 0ppm NAA) (Table 3). Similar results were also observed by Bose et al. [24]. Bose et al [24] found that the growth regulator NAA @ 50ppm gave the highest fresh weight per bulb (78.71g) as compared to NAA 30 ppm over control. For bulb yield the result obtained from the present study was similar with the researcher's findings [24, 13, 18, 19].

Table 3 Effect of N_2 and NAA on yield parameters representing bulb yield plant-1 (g) and bulb yield ha^{-1} (t)

Treatments	**Yield parameters**	
	Bulb weightplant^{-1} (g)	**Bulb yield ha^{-1} (t)**
Effect of N_2		
N_0	28.50 d	9.27 d
N_1	45.89 b	15.32 b
N_2	51.48 a	17.78 a
N_3	41.61 c	13.90 c
CV(%)	7.229	6.814
Effect of NAA		
H_0	37.90 d	12.65 d
H_1	43.09 b	14.27 b
H_2	45.18 a	15.49 a
H_3	41.30 c	13.86 c
CV(%)	7.229	6.814
Combined effect of N_2 and NAA		
N_0H_0	24.77 j	8.44 g
N_0H_1	28.12 i	9.14 fg
N_0H_2	31.48 i	10.12 f

N_0H_3	29.62 i	9.36 fg
N_1H_0	40.18 gh	12.96 e
N_1H_1	44.27 ef	14.60 cd
N_1H_2	51.39 bc	18.10 b
N_1H_3	47.72 de	15.60 c
N_2H_0	46.14 e	15.18 c
N_2H_1	54.16 ab	18.44 b
N_2H_2	55.50 a	19.60 a
N_2H_3	50.10 cd	17.88 b
N_3H_0	40.52 gh	14.00 d
N_3H_1	45.80 e	14.88 cd
N_3H_2	42.36 fg	14.12 d
N_3H_3	37.76 h	12.58 e
CV(%)	7.229	6.814

In a column, figures bearing same letter(s) do not differ significantly at 5% level of significance by DMRT

N_0 = Control (0 kg N ha	H_0 = Control (0 ppm NAA)
N_1 = 90 kg N ha-1	H_1 = 50 ppm NAA
N_2 = 110 kg N ha-1	H_2 = 100 ppm NAA
N_3=130 kg N ha-1	H_3 = 150 ppm NAA

Combined effect of nitrogen and NAA had significant on growth, yield and yield contributing parameters. Results indicated the tallest plant (51.65cm), highest number of leaves plant^{-1} (5.68), highest fresh weight of leaves plant^{-1} (64.67g) and highest neck diameter (1.36cm) was recorded from the treatment combination of N_3H_3 but the highest dry matter content of leaves (18.33%) highest dry matter content of bulb (25.33%), highest bulb length (3.76cm), highest bulb diameter (5.26cm), highest bulb weight plant^{-1} (55.50g) and highest bulb yield ha^{-1} (19.60t) were recorded from the treatment combination of N_2H_2. Again, shortest plant (22.84cm), lowest number of leaves plant^{-1} (4.06), lowest fresh weight of leaves plant-1 (38.04g), lowest dry matter content of leaves (9.67%), lowest dry matter content of bulb (12.67%), lowest neck diameter (0.42 cm), lowest bulb length (2.08cm), lowest bulb diameter (2.92cm), lowest bulb weight plant^{-1} (24.77g) and lowest bulb yield ha^{-1} (8.44t) were found from the treatment combination of N_0H_0 (Table 1-3). Based on the experimental results, it may be concluded that the effect of nitrogen and application of NAA had positive effect on growth characters, yield and yield attributes in onion. The treatment combination of N_2 (110 kg N ha^{-1}) with H_2 (100ppm NAA) seemed to be more suitable for getting higher yield in onion. From economic point of view the treatment combination of N_2H_2 (110 kg N ha-1 with 100 ppm NAA) was more suitable under the present study.

4. Conclusion

From the study, it was evident that both nitrogen and NAA had positive effect on growth and yield of onion in the summer season. Treatment combination of 100kg nitrogen with 100 ppm NAA was found best in terms of growth and yield of onion. Based on the economic analysis, this combination was also found more profitable in the study.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

The authors declare that they have no competing interest.

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