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Full Length Article

Response of Onion (*Allium cepa*) to Nitrogen and Potassium Fertilizers Rate on Growth and Yield in the Northwestern Region of Bangladesh

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Abstract

Onion is a vital spice crop in the Bangladeshi diet; however, its average yield remains low. This low productivity is primarily attributed to various constraints, including suboptimal nutrient management. Therefore, this study was conducted to determine how nitrogen (N) and potassium (K) affected the growth and yield attributes of onions and to determine the optimum doses of these two macronutrients to get maximum output using the bulb-to-bulb method. The treatments consisted of a factorial combination of four different doses of N 0, 50, 100 and 150 kg ha^{-1} and four K doses 0, 30, 60 and 90 kg ha^{-1} and their combination. The analysis of variance showed that the individual application of nitrogen and their interaction with 150 kg N ha^{-1} and 90 kg K ha^{-1} significantly ($P < 0.05$) affected plant height, number of leaves per plant, bulb length, blub diameter, single weight of bulb, yield per plot, and yield per hectare. The highest bulb yield (12.66 t ha^{-1}) of onion was obtained from the combined application of 150 kg N ha^{-1} + 90 kg K ha^{-1} while the lowest bulb yield was found from the control plot. Moreover, a positive correlation was found between different N and K fertilizer levels with yield. Thus, the findings indicated the potential application of N and K fertilizer to the combined application methods for getting maximum production.

Keywords: *Allium cepa*; Balanced fertilization; Nitrogen; Potassium; Growth; Yielding

Introduction

Onion (*Allium cepa*) is a member of the Amaryllidaceae family. It has been grown throughout the world in at least 175 countries since around 5000 years ago (Pareek *et al.* 2017). Around 110 million tons of onions were produced worldwide on 5.96 million ha of land, of which 2.37 million ha were in South Asia and 4.14 million ha were in Asia. The yield of onion in South Asia is almost 16.33 t/ha which is comparatively lower than Asia's 18.45 t/ha and 18.53 t/ha world average yield. However, the average yield in Europe is around 30.38 t/ha, which is very high compared to the world average, commencing the potential yield of onion (FAOSTAT 2024). While, India produces 26.641 million tons of onions annually, making it the world's greatest contributor of onions, Bangladesh stands in the 7th position among the top onion-producing countries (Anik *et al.* 2017). It occupies a total spices area of 205000 ha and yielded 2517000 metric tons in 2021-22, whereas Rajshahi district in NW Bangladesh contributes the most (Bureau of Statistics 2023). The current mean yield of Bangladesh, estimated at 8.69 t/ha, which is significantly lower than the global average of 18.33 t/ha (Anik *et al.* 2017). Because of this, the country has to import between 700 and 800 thousand MT of onions annually to meet the 2177240 MT of demand (Rana *et al.* 2021).

The proper management of fertilizer with the appropriate dose is crucial for the growth physiology of crops as well as overall production (Azad *et al.* 2021, 2022; Mondal *et al.* 2022). Nitrogen (N) is the essential macro element required for the proper growth and yield of crops (Al-Fraihat 2009). It is crucial for building up the protoplasm and proteins within the plant cells, which stimulates cell division and increases the meristematic activity of onion (Al-Fraihat 2009). Utilizing N fertilizer in the right amount not only lessens the chance of nitrates seeping into groundwater but also lowers production costs and can enhance the quality of onions (Geisseler *et al.*

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2022). Increased bulb size and yield are found to be dependent on N, which is also vital for onion production at its highest level (Geisseler *et al.* 2022). The green leaves number per plant, the bulb weight, the yield for the market, and the total soluble solids are all greatly increased by increasing the N delivery rates (Singh *et al.* 2018). A lack of N will result in smaller onion bulbs, causing them to mature more quickly (Geisseler *et al*. 2022). On the other hand, an excess of N can alter the typical maturation schedule, delaying maturity and producing larger onion bulbs (Syed *et al.* 2000).

Potassium (K) is the most widespread element, followed by N and phosphorus (P), all of which are essential to plants (Rawat *et al.* 2022). Potassium is utilized by plants for protein synthesis, water balance regulation, photosynthesis, and glucose transportation. Fertilizers containing K are frequently associated with increased handling and storage qualities and crop quality (Gebreslassie 2016). Onion plants that received higher rates of K application developed more leaves and became taller overall (El-Desuki *et al.* 2006). According to Boyhan *et al.* (2007) study, the yield of onions increased when the K level was increased. Nowadays, it is generally acknowledged that a K deficit poses a significant threat to crop productivity. When K fertilizer is applied insufficiently as part of an imbalanced fertilization strategy, the soil's K stocks are significantly depleted, crop yields are reduced, and farmers face greater financial risks (Maene 2001).

Two of the several cultural practices that have a major influence on onion output are soil moisture conservation and nutrient optimization, especially regarding N and K (Islam *et al.* 2010). Bangladesh's low yield can be attributed to inadequate management strategies and a scarcity of high-yielding varieties. Fertilizer management is a critical management aspect that can have a big impact on onion output (Mozumder *et al.* 2007). Despite the importance of onions to the country's agricultural economy, Bangladesh's average onion output is still far lower than the global average. Available data indicate that inadequate nutrient management, namely N and K fertilizer application, is impeding onion productivity in Bangladesh, especially in the Northwest. Studies that have already been conducted have shown that N and K fertilizers have a favorable impact on onion growth and output. However, there is no comprehensive research on how onions in this area react to different amounts of these fertilizers. Therefore, this study aimed to explore how onions in this area respond to different doses of N and K and determine the ideal doses for them to maximize onion growth and yield.

Materials and Methods

Experimental materials and cultivation conditions

The onion cultivar ‘Taherpuri’ was used for this experiment. This variety has bulbs that are flat round, about medium size, and resistant to *Alternaria* species. These are the distinguishing qualities of this variety. The bulbs have a highly smelly crimson skin and a rhombic shape. About 50-60% of the bulbs were of a single kind and matured in about 130-140 days. The research was conducted from October 2023 to March 2024 at the Horticulture research field under the department of Crop Science and Technology in University of Rajshahi located at 24°22'42.5"N latitude and 88°37'57.4"E longitude and 200 cm over the sea level and the soil at the site was classified as a silty loam from the High Ganges River Floodplains Tract in Argo-Ecological Zone 11 (FAO-UNDP 1988).

The soil chemical analysis revealed that the soil was silty clay with a pH of 8.12, N of 0.11%, P of 16.60 ppm, K of 0.14 C mol/kg, sulfur of 17.05 mg/L and organic carbon of 1.59% per 100 g of soil. Zinc and boron concentrations in the soil were found to be lower at 0.039 mg/L and 0.23 mg/L, respectively. The weather of Rajshahi can be described as tropical, with both rainy and dry seasons. Generally speaking, monsoons, warm temperatures, high humidity, and moderate rainfall are its defining characteristics. The warm weather season starts at the beginning of March and lasts until about the middle of July. January has the lowest temperature of 7 to 16°C, while April, May, June and July have the highest temperature of 36 to 41°C. The humidity was between 73.52 to 81.5% at any given moment.

Soil analysis

Soil samples were collected from ten randomly selected places across the field at depths ranging from 0 to 15 cm before the start of the experiment. After removing any undesired contaminants, these samples were merged to form a composite sample, which was air-dried, ground and sieved through a 2 mm mesh. The combined sample was then preserved for further physical and chemical analysis. The initial analysis included determining the texture, pH, organic matter concentration and total N. The analysis also assessed the amounts of exchangeable K, calcium and magnesium, as well as accessible phosphorus, sulfur, iron, copper, manganese, zinc and boron. The nutrient profile was determined at the Soil Resource Development Institute (SRDI), Rajshahi Regional Research Laboratory in Bangladesh (Lab. No. 14727). The soil pH was measured with a glass electrode pH meter and organic carbon was calculated using the wet oxidation method described by (Page 1974).

The organic matter content was determined by multiplying the organic carbon percentage by 1.73 (Piper 1950), whereas, the total N was calculated using the Kjeldahl method (Page *et al.* 1982). To determine P availability, the soil was extracted using a 0.5 *M* $NaHCO_3$ solution at pH 8.5. The concentration was determined spectrophotometrically at 660 nm after reducing the phosphomolybdate complex with $SnCl_2$ (Olsen *et al.* 1954).

Interchangeable K, calcium, and magnesium were taken out using a 1 *M* N1-L10AC, P117.0 solution, and K was examined using a flame photometer, while calcium and Mg were quantified using atomic absorption spectrophotometry (Page *et al.* 1982). Similarly, atomic absorption spectrophotometry was used to assess the accessible concentration of boron, zinc, iron, copper and manganese.

Experimental layout and design

The treatments consisted of a factorial combination of four different doses of N 0, 50, 100 and 150 kg ha^{-1} and four K doses 0, 30, 60 and 90 kg ha^{-1} and their combination. The three treatments with 24 combinations were assigned RCBD with three replications. The number of combinations was 24, these combinations were repeated three times, so total number of combinations were 72. To avoid the bias the three different treatments (72 combinations) were assigned to the unit plot randomly in such a way that each unit plot had equal chance to receive the treatments. There were 72 plots in total, with each plot measuring 1.5 m by 1 m. Plot to plot and row to row distances were 20 cm, while plant spacing was 15 by 15 cm. All other cultural practices such as wedding, irrigation, drainage, gap filling, disease and pest control were done by the regional recommendation.

Sampling and measurement

Only the plants in the center rows were included in the data collection, omitting the plants at the ends of each row and the outermost rows to prevent edge effects. Crop was harvested at physiological maturity; 70% of the plants' leaves had senesced by the time they reached physiological maturity. The following factors were considered for measuring the growth and yield parameters and comparing them with fertilizer doses: plant height and leaf number per plant, bulb length, bulb diameter, individual bulb weight, yield/plot and total yield. In addition, the correlation effects were measured by considering different levels of nitrogen and potassium fertilizer with yield and bulb diameter. Plant height was measured at 20, 40 and 60 days after planting (DAP). The number of leaves per plant was recorded thrice at 20, 40 and 60 DAP. Bulb length and diameter measurements were carried out at harvesting time. Measurements were made using calipers in the middle of the mature selected bulb. After harvesting individual bulb weights were measured by considering each plot of 10 bulbs. Bulb yields were determined by yield per plot and finally converted into yield (t/ha).

Statistical analysis

Data was analyzed using the JMP Pro statistical package (SAS Institute, Cary, NC, USA) software, version no. 17.2.0. Significant differences among treatments were determined by one-way analysis of variance (ANOVA). Tukey's multiple range test was used to evaluate treatment effects and conduct comparisons, while the least significant difference (LSD) test at $P \leq 0.05$ was used.

Result

Growth and yield related traits

Different doses of N and K fertilizer both in single and combined caused a significant difference in plant height at different days after planting (Table 1-2). The maximum plant height of 34.76 cm at 60 DAP was found from the treatment combination of N 150 kg/ha + K 90 kg/ha ($N_{150}K_{90}$) followed by $N_{150}K_{60}$ (34.43 cm), while the minimum (27.20 cm) obtained at the control (Table 2). However, at 20 DAP individual treatment and their combination did not bring any change in plant height (Table 1-2). Similar to plant height, the number of leaves was significantly influenced by the main effect and their interactive treatment at different DAP (Table 2). The highest number of leaves (7.92) at 60 DAP was obtained from the treatment interaction of ($N_{150}K_{90}$) consequently from $N_{150}K_{60}$ (7.87), while the minimum (5.31) was noted at the control (Table 2). Alike plant height, the number of leaves remained the same at 20 DAP with the treatment and their combination (Table 1; Table 2).

There was a significant effect of nitrogen, potassium and their combination on bulb length of onion (Table 3 and 4). Application of 150 (kg/ha) N interacted with K 90 (kg/ha) gave the highest bulb length of 6.32 cm, which was statistically similar with the treatment of $N_{150}K_{60}$, $N_{150}K_{30}$, and $N_{150}K_0$. However, the least blub length (4.22 cm) recorded from the control (Table 2-3). Application of potassium at the rate of 90 kg ha^{-1} and 60 kg ha^{-1} didn't give any considerable change on blub length of onion. The individual effect of nitrogen and potassium and their interaction showed significant results for bulb diameter (Table 3-4).

Similar to bulb length, the highest bulb diameter (4.84 cm) was recorded from the combined application of N_{150} + K_{90} (kg ha^{-1}), while the lowest bulb diameter (2.35 cm) found from control application of both fertilizers. However, the treatment combination of 100 Kg N ha^{-1} + 30 kg K ha^{-1} with 100 Kg N ha^{-1} + 0 kg K ha^{-1} and 50 kg Na ha^{-1} + 30 kg K ha^{-1} with 50 kg Na ha^{-1} + 30 kg K ha^{-1} were statistically identical. Notably, the main treatment of potassium had no effect on the bulb diameter of onion (Table 3-4). Individual bulb weight was significantly affected to the main and combined application of nitrogen and potassium (Table 3-4). As like bulb length and diameter, the application of 150 kg N ha^{-1} along with 90 kg K ha^{-1} produced the heaviest weight (26.22 g) of a single bulb followed by $N_{150}K_{60}$, while control produced the minimum weight (12.40 g) (Table 3-4). However, the treatment combination of $N_{50}K_0$, $N_{50}K_{30}$, $N_{50}K_{60}$ and N_0K_{30}, N_0K_{60} didn't give any difference statistically.

The main effect of nitrogen and potassium and their

Table 1: Effect of different levels of nitrogen and potassium fertilizers on plant height and number of leaves per plant at 20, 40 and 60 DAP

Treatment	Plant height (cm)			Number of leaves per plant		
	20 DAP	40 DAP	60 DAP	20 DAP	40 DAP	60 DAP
N_0	18.758	25.017	27.475	3.233	5.411	5.754
N_{50}	22.075	26.108	28.183	3.465	6.308	6.421
N_{100}	24.308	27.3	30.15	3.809	6.873	6.942
N_{150}	25.195	29.9	34.092	4.448	7.555	7. 539
LSD	-	0.452	0.432	-	0.504	0.234
LS	NS	**	**	NS	**	**
CV (%)	10.21	6.68	7.70	4.95	5.87	4.70
K_0	22.075	26.142	29.333	3.243	5.344	6.039
K_{30}	22.667	26.75	29.775	3.602	5.737	6.621
K_{60}	22.725	27.525	30.058	4.077	6.491	7.158
K_{90}	22.812	29.908	30.733	4.864	6.92	7.484
LSD	-	0.721	0.541	-	0.334	0.324
LS	NS	**	**	NS	**	**
CV (%)	11.23	5.63	7.75	4.98	4.73	5.70

** = Significant at 1% level of probability, NS = Non-significant, CV = Co-efficient of variation, LSD = Least Significant Difference. N_0 = Control, N_{50} = 50 kg nitrogen/ha, N_{100} = 100 kg Nitrogen/ha, N_{150} = 150 kg nitrogen/ha and K_0 = Control, K_{30} = 30 kg potassium/ha, K_{60} = 60 kg potassium/ha, K_{90} = 90 kg potassium/ha

Table 2: Effect of combined application of nitrogen and potassium on growth parameters at different days after planting (DAP)

Combined effect	Plant Height (cm)			No. of leaves per plant		
	20 DAP	40 DAP	60 DAP	20 DAP	40 DAP	60 DAP
N_0K_0	18.16	23.50 k	27.20 j	3.13	5.31 k	5.33 l
N_0K_{30}	19.76	24.90 j	27.33 ij	3.13	5.49 j	5.58 k
N_0K_{60}	19.87	25.83 hi	27.63 ij	3.26	6.13 i	6.15 i
N_0K_{90}	20.43	25.83 hi	27.73 hi	3.40	6.14 i	6.16 i
$N_{50}K_0$	21.26	25.33 ij	27.87 hi	3.46	6.14 i	6.24 hi
$N_{50}K_{30}$	21.63	26.10 gh	28.20 gh	3.46	6.32 hi	6.34 h
$N_{50}K_{60}$	22.20	26.40 fh	28.30 g	3.49	6.35 hi	6.47 g
$N_{50}K_{90}$	23.28	26.60 fg	28.56 g	3.56	6.62 fh	6.71 f
$N_{100}K_0$	24.06	26.93 ef	29.20 f	3.73	6.69 fg	6.74 f
$N_{100}K_{30}$	24.40	26.93 ef	29.36 f	3.84	6.76 fg	6.88 e
$N_{100}K_{60}$	24.56	27.43 de	30.16 e	3.90	6.79 fg	7.02 d
$N_{100}K_{90}$	24.70	27.90 d	31.86 d	3.90	7.12 de	7.12 cd
$N_{150}K_0$	24.80	28.80 c	33.26 c	4.24	7.22 cd	7.23 c
$N_{150}K_{30}$	24.86	29.06 c	34.20 c	4.27	7.44 bc	7.49 b
$N_{150}K_{60}$	25.20	30.43 b	34.43 b	4.54	7.63 ab	7.87 b
$N_{150}K_{90}$	25.31	31.30 a	34.76 a	4.73	7.82 a	7.92 a
LSD	-	0.747	0.495	-	0.302	0.120
LS	NS	**	**	NS	**	**
CV (%)	16.21	1.68	5.75	6.85	4.77	5.76

** = Significant at 1% level of probability, NS = Non-significant, CV = Co-efficient of variation, LSD = Least Significant Difference. N_0 = Control, N_{50} = 50 kg nitrogen/ha, N_{100} = 100 kg Nitrogen/ha, N_{150} = 150 kg nitrogen/ha and K_0 = Control, K_{30} = 30 kg potassium/ha, K_{60} = 60 kg potassium/ha, K_{90} = 90 kg potassium/ha

interactive action significantly influenced the yield of onion per plot (Table 3-4). The maximum amount of onion per plot of 1.90 kg was obtained from the combined application of 150 kg N ha^{-1} + 90 kg K ha^{-1} subsequently (1.85 kg) from 150 kg N ha^{-1}+ 60 kg K ha^{-1} whereas the control group showed the least amount (1.21 kg) (Table 3-4). However, a statistically significant effect wasn't found from the treatment interaction of $N_{50}K_{30}$ and $N_{50}K_{60}$. Bulb yield per hectare had significantly influenced the treatment and their combination (Table 3-4). Alike yield per plot, the maximum bulb yield (12.66 t/ha) was observed from the interactive application of 150 kg N ha^{-1} with 90 kg K ha^{-1}, followed by (12.33) from $N_{150}K_{60}$ treatment, while the minimum bulb yield (8.11 t/ha) was recorded from the control application. Application of 150 kg N ha^{-1} + 90 kg K ha^{-1} produced 4.55 ton more onion bulb compared to the control (Table 3-4). However, the combination of $N_{50}K_{30}$ with $N_{50}K_{60}$ and N_0K_{30} with N_0K_{60} was statistically at par.

Correlation between bulb diameter and different doses of fertilizers with yield

The results revealed that there was a positive and significant correlation found between bulb diameter and total yield (Fig. 1). Furthermore, different doses of N and K are also positively correlated with the yield per plot (Fig. 2).

Discussion

The findings of this study demonstrate the critical role of N and K in enhancing the growth, development and yield of onions. Nitrogen, as a vital component of amino acids, proteins, and chlorophyll, directly influences plant

Table 3: Effect of different doses of nitrogen, potassium on yield parameters of onion

Treatments		Bulb length (cm)	Bulb diameter (cm)	Individual bulb weight (g)	Yield/plot (kg)	Yield (t/ha)
Nitrogen	N_0	4.66 d	2.50 c	13.02 d	1.30 d	8.66 d
	N_{50}	5.42 c	2.75 c	15.82 c	1.49 c	9.94 c
	N_{100}	5.89 b	3.27 b	20.92 b	1.64 b	10.93 b
	N_{150}	6.24 a	4.09 a	26.22 a	1.83 a	12.20 a
	LSD	0.092	0.470	0.109	0.011	0.16
	LS	**	**	**	**	**
	CV (%)	6.49	13.59	5.54	5.63	5.78
potassium	K_0	5.31 c	3.00	17.39 c	1.49 d	9.98 d
	K_{30}	5.51 b	3.02	19.28 b	1.54 c	10.30 c
	K_{60}	5.67 a	3.09	19.37 b	1.58 b	10.54 b
	K_{90}	5.72 a	3.10	19.95 a	1.64 a	10.94 a
	LSD	0.091	--	0.109	0.01	0.15
	LS	**	NS	**	**	**
	CV (%)	6.49	13.59	5.54	5.63	5.78

** = Significant at 1% level of probability, NS = Non-significant, CV = Co-efficient of variation, LSD = Least Significant Difference. N_0 = Control, N_{50} = 50 kg nitrogen/ha, N_{100} = 100 kg Nitrogen/ha, N_{150} = 150 kg nitrogen/ha and K_0 = Control, K_{30} = 30 kg potassium/ha, K_{60} = 60 kg potassium /ha, K_{90} = 90 kg potassium/ha

Table 4: Effect of combined application of nitrogen and potassium on the yield and yield contributing character of onion

Treatments		Bulb length (cm)	Bulb diameter (cm)	Individual bulb weight (g)	Yield/plot (kg)	Yield (t/ha)
Combined (N×K)	N_0K_0	4.22 l	2.35 n	12.40 m	1.21 o	8.11 n
	N_0K_{30}	4.58 k	2.50 m	12.99 l	1.27 n	8.51 m
	N_0K_{60}	4.71 ij	2.54 l	13.21 l	1.32 m	8.84 m
	N_0K_{90}	4.85 j	2.62 k	13.48 k	1.41 l	9.40 l
	$N_{50}K_0$	5.08 i	2.69 j	15.35 j	1.45 k	9.66 k
	$N_{50}K_{30}$	5.43 h	2.73 i	15.37 j	1.48 j	9.91 j
	$N_{50}K_{60}$	5.52 gh	2.78 i	15.39 j	1.49 j	9.93 j
	$N_{50}K_{90}$	5.65 fg	2.84 h	16.21 i	1.53 i	10.24 i
	$N_{100}K_0$	5.73 ef	3.15 g	16.57 h	1.57 h	10.46 h
	$N_{100}K_{30}$	5.83 de	3.23 g	21.56 g	1.61 g	10.75 g
	$N_{100}K_{60}$	5.92 cd	3.28 f	22.38 f	1.65 f	11.04 f
	$N_{100}K_{90}$	6.09 bc	3.42 e	23.18 e	1.72 e	11.46 e
	$N_{150}K_0$	6.22 ab	4.51 d	25.25 d	1.76 d	11.75 d
	$N_{150}K_{30}$	6.22 ab	4.61 c	26.21 c	1.80 c	12.04 c
	$N_{150}K_{60}$	6.24 ab	4.72 b	26.52 b	1.85 b	12.33 b
	$N_{150}K_{90}$	6.32 a	4.84 a	26.92 a	1.90 a	12.66 a
	LSD	0.183	0.196	0.219	0.021	0.183
	LS	**	**	**	**	**
	CV (%)	6.49	13.59	5.54	5.63	5.78

** = Significant at 1% level of probability, NS = Non-significant, CV = Co-efficient of variation, LSD = Least Significant Difference. N_0 = Control, N_{50} = 50 kg nitrogen/ha, N_{100} = 100 kg Nitrogen /ha, N_{150} = 150 kg nitrogen/ha and K_0 = Control, K_{30} = 30 kg potassium /ha, K_{60} = 60 kg potassium /ha, K_{90} = 90 kg potassium/ha

metabolic activities and vegetative growth (Alhrout 2017). Our study showed that applying N at a rate of 150 kg ha^{-1} resulted in the greatest vegetative growth, consistent with findings by Etana *et al.* (2019). This enhanced growth can be attributed to improved tissue formation and cell division, which promote vegetative development and long-term production gains. Moreover, increased N levels were associated with taller onion plants and a higher number of leaves, findings that align with the research of Abdissa *et al.* (2011). The positive correlation between N application and leaf number may be due to the role of N and phosphorus in promoting meristematic activity and the synthesis of essential compounds like phosphoproteins and phospholipids, which facilitate shoot and root development (Bagali *et al.* 2012). Furthermore, results indicated that bulb length, bulb diameter, and overall yield per plot were maximized at a N application rate of 150 kg ha^{-1}. These outcomes corroborate the findings of Ali *et al*. (2007), Resende and Costa (2014), Haque *et al.* (2018) and Silva *et al.* (2022), who similarly reported increased bulb size and yield with higher nitrogen application. The increased bulb diameter observed in our study may be attributed to N's role in enhancing photosynthesis and carbohydrate synthesis, which are essential for plant growth and yield development (Subedi *et al.* 2023).

In terms of K application, our results revealed that applying 90 kg K ha^{-1} led to the highest plant height and maximum number of leaves. This aligns with findings by Atanda and Olaniyi (2016), who reported improved plant height at K levels of 150 kg ha^{-1}. Similarly, Bekele (2018) noted that increased K application resulted in a greater number of leaves per plant. Potassium's influence on plant growth can be explained by its role in regulating osmotic pressure, enzyme activation and photosynthesis. The longest bulb length and highest yield per plot observed at 90 kg K ha^{-1} in our study corroborate the previous findings by Mozumder *et al.* (2007) and Bekele (2018).

The interaction between N and K had a significant

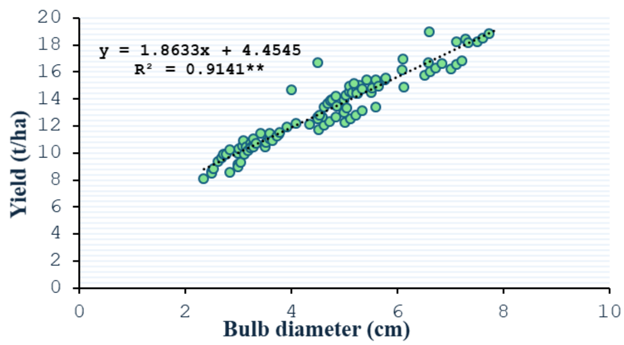

Fig. 1: Correlation between bulb diameter and yield of onion. Positive correlations were found between these parameters. ** Indicated a positive correlation between these parameters

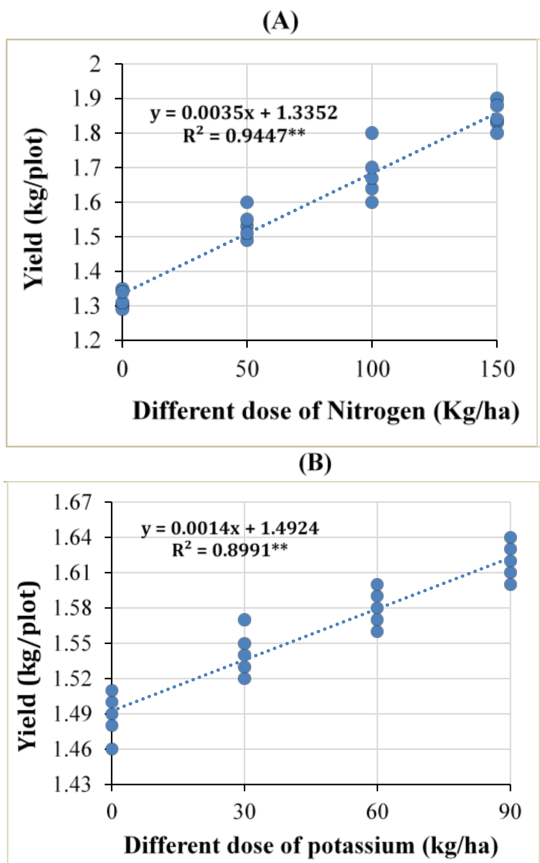

Fig. 2: Relationship between different doses of nitrogen (N) and potassium (K) fertilizer with yield. Correlation graph **(A)** were made by considering different levels of nitrogen (N) fertilizer with yield and **(B)** were made by considering different potassium doses with yield. Both figures indicate a positive correlation between these parameters, as denoted by **

effect on growth parameters such as plant height and leaf number. The combined application of 150 kg N ha^{-1} and 90 kg K ha^{-1} yielded the highest plant height and leaf number, findings consistent with El-Damarany *et al.* (2016). The increase in bulb diameter and yield per hectare observed with the combined application of N and K is in agreement with Maene (2001) and Haque *et al.* (2018). The enhanced bulb weight may be attributed to the increased photosynthetic capacity resulting from a higher leaf count, which promotes greater nutrient absorption and biomass accumulation. A significant positive correlation between bulb diameter and yield was observed in this study, indicating that larger bulbs are associated with higher yields. This finding is consistent with previous research by Geisseler *et al.* (2022) and Bal *et al.* (2019). Additionally, the correlation between different levels of N and K fertilizers exhibited highly significant positive results, suggesting that higher fertilizer doses outperform lower doses and controls in producing larger bulbs and maximizing yield.

Conclusion

The findings of this experiment indicated that the application of nitrogen, potassium and their combined doses significantly affected the various growth parameters as well as yield and yield attributes of onion. Positive correlation with nitrogen and potassium doses to yield indicates the potential application of nitrogen and potassium fertilizer to maximize the overall yield of onion. The maximum bulb yield with combined application of 150 kg N ha^{-1} with 90 kg K ha^{-1} indicates the efficient utilization of fertilizer to onion crop. The government and policymakers would take necessary initiatives based on this combining nitrogen-potassium treatment throughout the country to increase the production of onions and leading to cutting down the import propensity under various government and non-government agricultural projects.

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Authors Contribution

Conceptualization, Md. Sharif Ahmed and Md. Mehedi Hasan; Experimental set up, Md. Mehedi Hasan and Md. Sharif Ahmed; Data analysis, Md. Mehedi Hasan and Md. Sharif Ahmed; writing-original draft preparation, Md. Sharif Ahmed and Md Mukhtar Hossain, Md. Saidul Islam; writing-review and editing, Md. Mukhtar Hossain and Md. Abdul Kaium; Supervision, Md. Khairul Islam.

Conflict of Interest

The authors declare no conflict of interest.

Data Availability

Data presented in this study will be available upon request to the corresponding author.

Ethics Approval

Not applicable to this paper.

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