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Effect of Nitrogen (N) and Potassium (K) on Growth and Yield of Onion

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ABSTRACT

The experiment was conducted at the Research Farm of Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh in *rabi* season during December 2019 to March 2020 to investigate the effect of nitrogen (N) and potassium (K) on growth and yield and find out the optimum dose of N and K for maximum yield of onion. The experiment consists of 8 treatments as Control (no nitrogen+no potassium); Nitrogen @ 80 kg ha^{-1}+Potassium@ 80 kg ha^{-1}; Nitrogen @ 100 kg ha^{-1}+Potassium @ 80 kg ha^{-1}; Nitrogen @ 100 kg ha^{-1}+Potassium @ 100 kg ha^{-1}; Nitrogen @ 120 kg ha^{-1}+Potassium @ 100 kg ha^{-1}; Nitrogen @ 120 kg ha^{-1}+Potassium@ 120 kg ha^{-1}; Nitrogen @ 140 kg ha^{-1}+Potassium @ 100 kg ha^{-1}; Nitrogen @ 140 kg ha^{-1}+Potassium @ 120 kg ha^{-1}. Recommended dose of phosphorus, sulphur, zinc and boron were used in this experiment. The experiment was laid out in a randomized complete block design (RCBD) with three replications. The tested variety was BARI Piaz-4. Data were collected on different yield attributes, growth and quality of onion and postharvest soil analysis. Results of the experiment revealed that N and K significantly (p<0.05) influenced plant height, leaves $plant^{-1}$, leaf length, dry matter content of leaves, diameter of bulb, length of bulb, fresh weight of bulb $plant^{-1}$, dry matter content of bulb $plant^{-1}$, bulb yield, total nitrogen (%), available phosphorus (ppm), exchangeable potassium (meq 100 g^{-1}). Results suggested that nitrogen (N) and potassium (K) application had significant positive effect on plant and soil.

KEYWORDS: Bulb, growth, nitrogen, onion, potassium, yield

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1. INTRODUCTION

Onion (*Allium cepa* L.) is widely cultivated as a vegetable belongs to the family Amaryllidaceae of Allium genus (Hanelt, 1990). Onion has nutritional value to the human diet and has medicinal properties as well as unique flavor (Sarker et al., 2017). Onion commonly known as "Queen of the kitchen" (Selvaraj, 1976; Griffiths et al., 2002) and contains vitamin B, vitamin C and also traces of iron and calcium (Ahmed et al., 2020) and steroidal saponins (Carotenuto et al., 1999), which prevent absorption of cholesterol in the intestine (Ahmed et al., 2020).

In Bangladesh, among spices onion ranks first in respect of area (185269 ha) and production (1953800 tons) (Ahmed et al., 2020; BBS, 2020) and the gross production value of onions produced worldwide ranks second among vegetable crops after tomatoes (Anonymous, 2021). The average yield of onion is around 10.55 t ha^{-1} in Bangladesh (BBS, 2020). However, this production does not fulfill the country's demand. Moreover, neither the yield nor the area under onion cultivation has increased in Bangladesh.

Crop cultivars, agronomic practices and environmental factors have great effects on yield and quality of onion crops (Khan et al., 2002). Nitrogen (N) is an essential nutrient for plant growth (Govindasamy et al., 2023; Luo et al., 2020), which is often yield limiting factor in crop production and required by plants in larger amounts compared to most other nutrients (Geisseler et al., 2021). Nitrogen (N) contributes markedly to improve the production of onion, being absorbed in large amounts, exceeded only by potassium (K) (Porto et al., 2007, Maynard et al., 2007). However, the recovery of applied fertilizer can be low, with reported values often being between 30 and 40% (Sharma et al., 2012) or even lower (Halvorson et al., 2002). The low N fertilizer recovery is generally attributed to the shallow rooting depth of onions and the variable amount of mineral N present in the soil before sowing (Halvorson et al., 2002; Brewster, 2008). While high yields can only be achieved with adequate N, excess nitrogen (N) availability early in the season lead to an earlier maturity (Sorensen and Grevsen, 2001). High N at growing season endorsed rapid bulbing, while low N availability delayed it (Brewster and Butler, 1989). Increasing N application rates resulting in larger bulbs (Tekeste et al., 2018; Khan et al., 2019; Bezabih and Girmay, 2020; Piri and Naserin, 2020).

Potassium plays very important role in plant growth, yield (Sardans and Penuelas, 2021; Kavalcova et al., 2021; Bairwa et al., 2022) and many physiological processes like translocation of photosynthates, control of ionic balance, transpiration and opening and closing of stomata photosynthesis, plant enzymes activation and various other processes (Thompson, 2010). Potassium plays a lead role for developing resistance against pests and diseases, activation of plant catalysts, translocation of photosynthates, and regulation of plant pores (Rani et al., 2020). Potassium also improves many parameters like shining, colour, keeping quality and dry matter accumulation of many crops including onion (Subhani et al., 1990).

The present piece of work will be conducted under different treatment and the objectives were: (1) To observe the effect of N and K on the growth and yield of BARI piaz-4 (2) To find out the optimum dose of N and K for maximum yield of BARI piaz-4.

2. MATERIALS AND METHODS

2.1. *Description of the experimental site*

The experiment was conducted at the research farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh in Rabi season during December 2019 to March 2020. The experimental site is in the SAU experiment field which is situated between 23°7' N latitude and 90°35' E longitude and at an elevation of 8.2 m from sea level. The experiment started in December 2019 which harvested upto March 2020 in the rabi season. The experimental field belongs to the Agro-ecological zone 28 of "The Madhapur Tract" AEZ-28 (Anonymous, 1988). This region is a complex of relief and soils developed over the Madhapur clay, where floodplain sediments buried the dissected edges of the Madhapur Tract leaving small hillocks of red soils as 'islands' surrounded by floodplain.

2.2. *Treatment of the experiment*

The experiment was conducted comprising 8 treatment combinations as T_1: $N_0P_{45}K_0S_{30}Zn_3B_{1.5}$ (Control); T_2: $N_{80}P_{45}K_{80}S_{30}Zn_3B_{1.5}$ (kg ha^{-1}); T_3: $N_{100}P_{45}K_{80}S_{30}Zn_3B_{1.5}$ (kg ha^{-1}); T_4: $N_{100}P_{45}K_{100}S_{30}Zn_3B_{1.5}$ (kg ha^{-1}); T_5: $N_{120}P_{45}K_{100}S_{30}Zn_3B_{1.5}$ (kg ha^{-1}); T_6: $N_{120}P_{45}K_{120}S_{30}Zn_3B_{1.5}$ (kg ha^{-1}); T_7: $N_{140}P_{45}K_{100}S_{30}Zn_3B_{1.5}$ (kg ha^{-1}); T_8: $N_{140}P_{45}K_{120}S_{30}Zn_3B_{1.5}$ (kg ha^{-1}).

2.3. *Experimental design and layout*

The experiment was laid out in a randomized complete block design (RCBD) with three replications. The recommended dose of triple super phosphate, muriate of potash, gypsum, zinc oxide and half of urea were applied during the final preparation of land. Rest urea was applied in two equal installments respectively at 20 days interval after transplanting. The seedlings of onion were raised by dry-bed methods. Thirty days old seedlings of BARI Piaz 4 were carefully uprooted and transplanted in well prepared plot at a spacing of 10 cm (plant to plant)×20 cm (line to line). Different intercultural operations were performed to provide better growth and development of the crop. Plant protection measures were taken as per necessity (Table 1).

Table 1: Physical and chemical properties of experimental field soil at the beginning of experiment at a depth 15 cm of surface soil

Physical properties	Value	Chemical properties	Value
Mechanical fractions:		pH	6.1
% Sand (2.0-0.02 mm)	27	Organic carbon (%)	0.45
% Silt (0.02-0.002 mm)	43	Total N (%)	0.03
% Clay (<0.002 mm)	30	Available P (ppm)	20
Textural class	C1ay loam	Exchangeable K (me 100 g^{-1} soil)	0.1
		Available S (ppm)	18

2.4. *Harvesting of onion and collecting of data*

Plant height (cm), number of leaves $plant^{-1}$, leaf length (cm) was measured after 30, 50, 70 DAT (days after transplanting) and at harvest. The length and diameter of bulb was measured with a slide caliperse from five randomly selected plants from each plot. Their average was also recorded in centimeters (cm). Weight of single bulb and Yield of bulb (t ha^{-1}) were calculated. After recording the fresh weight of bulb of the five randomly selected plants from each plot, these were washed with distilled water and then were dried in an oven for 48 hours at 70°C. Then each dried bulb was weighed through an electric balance and their average were also recorded at the same time.

2.5. *Soil analysis*

Soil samples were analyzed at the beginning of experiment and after the harvest of onion to determine soil pH, organic carbon, total nitrogen (N), available phosphorus (P), exchangeable potassium (K), available sulphur (S). Soil pH was measured by using a pH meter in a 1:2.5 soil water ratio, organic carbon in soil sample was determined by wet oxidation method (Page et al., 1982). Kjeldahl method was used to determine the total N content of soil. Available P was determined by ascorbic acid blue color method. (Olsen et al., 1984). Exchangeable K was determined by 1N NH_4OAc (pH=7) extraction methods, available Sulphur was determined by $CaCl_2$ extraction method (Page et al., 1982).

2.6. *Statistical analysis*

The data obtained for different parameters were statistically analyzed to find out the significant difference of different treatments on yield contributing characters, yield and nutrient status of post-harvest soil. The mean values of all the characters were calculated and analysis of variance was performed by using MSTAT-C software. The significance of the difference among the treatment means was estimated by the Least Significant Difference (LSD) at 5% level of probability (Gomez and Gomez, 1984).

3. RESULTS AND DISCUSSION

3.1. *Effect of N and K on plant height*

Plant height significantly increased as the increase of N and K fertilizer doses. Plant height was recorded at 30, 50, 70 and 90 Days After Planting (DAP) and at harvest. Highest plant height was found in T_7 treatment and lowest plant height was found from T_1 treatment (Table 2). The increase in plant height might be due to higher intake of nutrients from fertilizer by the plant and more tissue protein synthesis resulting in higher meristematic growth. Vacchani and Patel (1993) reported that the height of plant increased with increasing levels of nutrients. Dash et al. (2003) stated that maximum onion plant height was obtained at highest dose of nitrogen and potash. Ali et al. (2007) stated that

Table 2: Effect of N and K on plant height (cm) at different days after planting of onion Effect of N and K on number of leaves $plant^{-1}$ (no.) at different days after planting of onion

Treatment	Plant height (cm)				Number of leaves $plant^{-1}$				Length of leaves $plant^{-1}$ (cm)			
	30 DAP	50 DAP	70 DAP	Harvest	30 DAP	50 DAP	70 DAP	Harvest	30 DAP	50 DAP	70 DAP	Harvest
T_1	18.20^{f}	30.50^{f}	36.11^{f}	42.32^{f}	3.10^{f}	5.15^{f}	5.83^{f}	6.53^{f}	16.25^{e}	26.77^{g}	31.60^{e}	39.67^{e}
T_2	19.44^{ef}	31.81^{ef}	37.25^{ef}	44.19^{ef}	3.42^{ef}	5.97^{ef}	6.20^{ef}	7.00^{ef}	17.13^{de}	28.75^{fg}	33.51^{de}	41.42^{de}
T_3	20.13^{def}	33.25^{def}	38.87^{def}	45.81^{def}	3.67^{de}	6.43^{de}	6.72^{def}	7.83^{def}	17.67^{de}	30.30^{ef}	35.27^{de}	42.63^{de}
T_4	20.95^{de}	34.47^{de}	40.12^{de}	48.77^{cde}	3.91^{d}	6.95^{cde}	7.23^{de}	8.45^{de}	18.42^{cde}	32.11^{de}	37.75^{cd}	44.80^{cd}
T_5	23.37^{bc}	38.72^{bc}	44.33^{bc}	51.85^{bc}	4.53^{bc}	7.80^{bc}	8.85^{bc}	10.20^{bc}	21.13^{bc}	35.85^{bc}	42.67^{ab}	49.15^{b}
T_6	21.80^{cd}	35.93^{cd}	42.18^{cd}	50.10^{bcd}	4.10^{cd}	7.42^{cd}	8.00^{cd}	9.33^{cd}	19.81^{bcd}	34.27^{cd}	40.13^{bc}	47.17^{bc}
T_7	26.55^{a}	43.61^{a}	49.42^{a}	57.28^{a}	5.20^{a}	9.33^{a}	10.68^{a}	12.00^{a}	24.37^{a}	40.92^{a}	46.72^{a}	53.83^{a}
T_8	24.83^{ab}	40.53^{ab}	46.77^{ab}	53.67^{ab}	4.72^{b}	8.67^{ab}	9.50^{ab}	11.17^{ab}	22.70^{ab}	38.63^{ab}	44.00^{ab}	50.25^{ab}
LSD (p=0.05)	2.12	3.73	4.00	4.61	0.43	1.19	1.28	1.51	2.95	3.27	4.59	4.06

nitrogen (N) increases the vegetative growth and produces good quality foliage and promotes carbohydrate synthesis and potassium (K) is essential for photosynthesis activity of leaf, as it helps in translocation of food. Bekele et al. (2018), Ansary et al. (2006) and Dilruba et al. (2006) supported the findings of this experiment and reported that 150 kg N with 80–120 kg K ha^{-1} gave highest result in case of maximum yield of quality bulbs.

3.2. Effect of N and K on number of leaves plant^{-1}

Significant variation in number of leaves $plant^{-1}$ was observed due to different doses of N and K application (Table 2). Number of leaves $plant^{-1}$ was collected at 30 DAP, 50 DAP, 70 DAP and at harvest. The results clearly indicated that the number of leaves $plant^{-1}$ gradually increased with the increasing levels of N and K application. Among different doses of fertilizer application T_1 showed lowest number of leaves $plant^{-1}$ and T_7 was highest. The photosynthesis and other physiological process of plant depend on nitrogen and potassium. Optimum level of nitrogen and potassium might have increased the availability of other plant nutrients to plants resulting in better performance of crop growth and ultimately produced a greater number of leaves $plant^{-1}$. El-Damarany et al. (2016) reported that nitrogen (N) increases the vegetative growth and produces good quality foliage and promotes carbohydrate synthesis and potassium (K) is essential for photosynthesis activity of leaf as it helps in translocation of food. EL-Desuki et al. (2006) stated that vegetative growth of onion plants was improved by potassium application. Baloch et al. (1991) and Islam, (1999) found that plant height and number of leaves were increased by increasing of potassium application. Bekele et al. (2018), Ansary et al. (2006) and Dilruba et al. (2006) supported the findings of this experiment and reported that 150 kg N with 80–120 kg K ha^{-1} gave highest result in case of maximum yield of quality bulbs.

3.3. Effect of N and K on length of leaf

The leaf length as affected by different doses of N and K showed a statistically significant variation (Table 2). The results clearly indicated that the length of leaf gradually increased with the increasing levels of N and K application. Among different treatments the highest leaf length (53.83 cm) was obtained with T_7 at harvest which was statistically identical with T_8 treatment. The lowest leaf length (39.67 cm) was observed in T_1 treatment at harvest. The findings of this experiment are in close conformity with Bekele et al. (2018) and reported that maximum application of N at 150 kg ha^{-1} increased mean leaf length per plants by about 16% when compared to control (33.51 cm) and K at 120 kg ha^{-1} significantly increased the mean leaf length per plants by about 8%. Rahman (2008) concluded that application of N 120 kg ha^{-1} with 120 or 60 kg K ha^{-1} gave highest leaf length (38.50 cm). Ali et al. (2007) stated that nitrogen (N) increases the vegetative growth and produces good quality foliage and promotes carbohydrate synthesis and potassium helps in the root development and increased the efficiency of leaf in the manufacture of sugar and starch. Similar findings were obtained by Mandira and Khan (2003); Rahaman, (2011) and Ullah et al. (2004) and reported that optimum nitrogen and potassium fertilizer application might be increased the vegetative growth of onion that leads to the highest leaf length.

3.4. Effect of N and K on dry matter content of leaves

Dry matter content of leaves (%) as affected by different doses of N and K showed a statistically significant variation (Table 3). The maximum dry matter content of leaves (16.83%) was obtained from T_7 treatment, whereas the lowest dry matter content of leaves (10.43%) was recorded from T_1 treatment. The results indicate that optimum levels of nitrogen and potassium application lead to a linear increase in the dry matter content of leaves (%). Mandira and Khan (2003); Rahaman (2011); Ullah et al. (2004); Bekele et al. (2018), Ansary et al. (2006) and Dilruba et al. (2006) supported the findings of this experiment. Ali et al. (2007) reported that potassium helps in the root development and increased the efficiency of leaf in the manufacture of sugar and starch. It is essential for the translocation of sugars. This element is import in grain formation and is absolutely necessary for tuber development. Mandira and Khan (2003) reported that nitrogen 150 kg ha^{-1}, potassium at 75 kg ha^{-1} and their combination recorded the best performance in terms of yield and growth of onion.

Table 3: Effect of nitrogen and potassium on dry matter content of leaves, diameter of bulb, length of bulb, dry matter content of bulb and yield of bulb of onion

Treatment	Dry matter content of leaves (%)	Diameter of bulb (cm)	Length of bulb (cm)	Dry matter content of bulb (%)	Yield (t ha^{-1})
T_1	10.43^{f}	6.18^{e}	4.76^{d}	9.81^{e}	13.25^{f}
T_2	11.67^{ef}	6.54^{de}	4.84^{cd}	10.75^{de}	14.33^{ef}
T_3	12.81^{de}	7.44^{bcd}	5.06^{bcd}	11.63^{cd}	15.13^{def}
T_4	13.50^{cd}	7.05^{cde}	5.13^{bcd}	12.40^{bc}	15.72^{de}
T_5	15.33^{ab}	8.39^{ab}	5.71^{abc}	13.43^{ab}	17.95^{bc}
T_6	14.72^{bc}	7.81^{bc}	5.38^{a-d}	12.87^{bc}	16.48^{cd}
T_7	16.83^{a}	9.24^{a}	6.10^{a}	14.33^{a}	21.83^{a}
T_8	15.67^{ab}	8.52^{ab}	5.85^{ab}	13.60^{ab}	19.67^{b}
LSD (p=0.05)	1.63	1.11	0.88	1.27	1.99

3.5. Effect of N and K on diameter of bulb

Diameter of bulb was affected by different doses of N and K showed a statistically significant variation (Table 3). The maximum bulb diameter (5.57 cm) was obtained from T_7 treatment, whereas the lowest (3.93 cm) was recorded from T_1 treatment. The results indicated that application of N 0–140 kg and K 0–100 kg ha^{-1} gradually increases the diameter of bulb. The findings of these experiments are in close conformity with Kumar et al. (2006) and reported that the bulb yield was significantly higher with the application of 150 kg N ha^{-1} and 100 kg K ha^{-1}. Optimum level of nitrogen and potassium might have increased the availability of other plant nutrients to plants resulting in increased better performance of crop growth and ultimately increased crop yield. Nagaich et al. (1999) reported that minerals uptake (P and K) was increased with potassium application. Vidigal et al. (2002) found that potassium application resulted an increased in nitrogen and potassium uptake by onion plants. Bekele et al. (2018) found that application of 150 kg N and 120 kg K ha^{-1} positively affect the bulb diameter. Ansary et al. (2006) reported that 150 kg N, 80 kg K and 60 kg S ha^{-1} gave highest result in case of maximum yield of quality bulb.

3.6. Effect of N and K on length of bulb

Different doses of N and K application showed statistically significant variation on Length of bulb (Table 3). Bulb length increases gradually with increase nitrogen and potassium application. The maximum bulb length (5.93 cm) was obtained from T_7 treatment which was statistically identical with T_5 and T_8 treatment. The minimum bulb length (3.93 cm) was recorded from T_1 treatment. The experiment results indicated that optimum N and K application increase other nutrients availability which leads to increase onion plant growth and total bulb yield. The findings of this experiments are closely related with Rahman (2011) and reported that N 150 kg ha^{-1}, K 150 kg ha^{-1} and $N_{150}K_{150}$ application gave the highest number of plant height, length of leaf, number of leaves plant^{-1}, diameter of bulb, length of bulb, single bulb weight, yield of bulb, the highest N and K contents in bulb and leaf. Ullah et al. (2004) showed that 150:80:100 of N: P_2O_5: K_2O combined application gave highest bulb growth. Mandira and Khan (2003) reported that application of nitrogen at 150 kg ha^{-1}, potassium at 75 kg ha^{-1} and their combination recorded the best performance in terms of yield and growth of onion.

3.7. *Effect of N and K on dry matter content of bulb plant^{-1}*

N and K application showed statistically significant variation on dry matter content of bulb (Table 3). The maximum dry matter content of bulb plant^{-1} (14.33%) obtained with T_7 treatment which showed statistically identical results with T_8 treatment. The minimum dry matter content of bulb plant^{-1} (9.81%) obtained with T_1 treatment. Experiment results concluded that dry matter content of bulb plant^{-1} (%) increase gradually with increasing N and K fertilizer application. Potassium is essential for a variety of process i.e., photosynthesis, fruit formation, winter hardiness and disease resistance. Nitrogen (N) increases the vegetative growth and produces good quality foliage and promotes carbohydrate synthesis. Dilruba et al. (2006) supported the result of this experiment and reported that 100 kg N with 120 kg K_2O ha^{-1} gave three times or above bulb weight in comparison with no fertilizer application.

3.8. Effect of N and K on bulb yield

Different doses of N and K fertilizer application showed statistically significant variation on bulb yield (t ha^{-1}) (Table 3). The highest bulb yield (21.83 t ha^{-1}) was obtained with T_7 treatment and the lowest bulb yield (13.25 t ha^{-1}) was obtained with T_1 treatment. Experiment results concluded that bulb yield (t ha^{-1}) increase gradually with increasing N and K fertilizer application and lowest bulb yield (t ha^{-1}) obtained when no N and K fertilizer used. The photosynthesis and other physiological process of plant depend on nitrogen and potassium. Cecilio Filho et al. (2010) reported that the application of 150 kg ha^{-1} N and 150 kg ha^{-1} K_2O favored the maximum productivity of bulbs. Vidigal et al. (2002) found that potassium application resulted an increased in nitrogen and potassium uptake by onion plants. The findings of this experiments closely similar with Rahaman, (2011) and reported that application of 150 kg ha^{-1} N, 150 kg ha^{-1} K and their combined application gave the highest number of plant height, length of leaf, number of leaves plant^{-1}, diameter of bulb, length of bulb, single bulb weight, yield of bulb, the highest N and K contents in bulb and leaf. Gambo et al. (2008) reported that highest bulb yield was obtained with 250 kg ha^{-1} potassium, 150 kg ha^{-1} nitrogen. Fatema (2015) described that 120 kg Nitrogen ha^{-1}, 50 kg phosphorus ha^{-1}, 75 kg potassium ha^{-1} and 20 kg sulphur ha^{-1} with pre harvest neck bending gave highest growth, yield and quality of onion bulb. El-Damarany et al. (2016) stated that the maximum onion seed yield was obtained by the high nitrogen rates and the medium potassium rates. Ali et al. (2007) stated that nitrogen 150 kg ha^{-1} with potassium 80-120 kg ha^{-1} showed better performance on seed yield and quality of onion. Katwale and Saraf (1994) found that application of NPK @ 125:60:100 kg ha^{-1} gave the maximum bulb yield of onion.

3.9. Effect of N and K on post-harvest properties of soil

Significant variation was recorded on post-harvest soil pH affected by N and K fertilizer application on onion field (Table 4). No significant variation was observed among T_1 and T_2 treatment. Highest soil pH (6.7) observed from T_1 ($N_0P_{45}K_0S_{30}Zn_3B_{1.5}$ kg ha^{-1}) treatment and lowest soil pH (6.2) observed from T_7 ($N_{140}P_{45}K_{100}S_{30}Zn_3B_{1.5}$ kg ha^{-1}) treatment.

Table 4: Effect of nitrogen (N) and potassium (k) on post-harvest soil properties

Treatment	pH	Organic matter (%)	Organic carbon (%)	Total N (%)	Available P (ppm)	Exchangeable K (meq 100 g^{-1})	Available S (ppm)
T_1	6.25	0.78	0.45	0.025^{f}	9.28^{d}	0.10^{c}	18.18^{e}
T_2	6.15	0.80	0.46	0.027^{ef}	9.65^{cd}	0.11^{bc}	18.67^{de}
T_3	6.10	0.82	0.47	0.031^{e}	10.00^{cd}	0.11^{bc}	19.18^{cde}
T_4	6.05	0.85	0.48	0.035^{d}	10.45^{bcd}	0.12^{abc}	19.81^{b-e}
T_5	5.95	0.88	0.51	0.044^{b}	11.26^{ab}	0.14^{ab}	20.55^{abc}
T_6	6.00	0.86	0.50	0.040^{c}	10.80^{abc}	0.13^{abc}	20.27^{bcd}
T_7	5.80	0.94	0.54	0.053^{a}	11.78^{a}	0.15^{a}	22.00^{a}
T_8	5.85	0.90	0.52	0.047^{b}	11.53^{ab}	0.14^{ab}	21.15^{ab}
LSD (p=0.05)	NS	NS	NS	0.004	1.24	0.03	1.65

Experimental data showed significant variation on post-harvest soil organic matter (%) affected by N and K fertilizer application on onion field (Table 4). No significant variation was observed among T_7 and T_8 treatment. Highest soil organic matter (0.97%) observed with T_7 ($N_{140}P_{45}K_{100}S_{30}Zn_3B_{1.5}$ kg ha^{-1}) treatment and lowest soil organic matter (0.78%) observed with T_1 ($N_0P_{45}K_0S_{30}Zn_3B_{1.5}$ kg ha^{-1}) treatment.

Significant variation was recorded on post-harvest soil organic carbon (%) affected by N and K fertilizer application on onion field (Table 4). Highest soil organic carbon (0.56%) observed with T_7 ($N_{140}P_{45}K_{100}S_{30}Zn_3B_{1.5}$ kg ha^{-1}) treatment which was statistically similar with T_8 treatment. Lowest soil organic carbon (0.45%) observed with T_1 ($N_0P_{45}K_0S_{30}Zn_3B_{1.5}$ kg ha^{-1}) treatment.

Different N and K fertilizer application showed statistically significant variation on organic carbon (%) (Table. 4). Maximum soil total N (0.053%) observed with T_7 ($N_{140}P_{45}K_{100}S_{30}Zn_3B_{1.5}$ kg ha^{-1}) treatment and minimum soil total N (0.025%) observed with T_1 ($N_0P_{45}K_0S_{30}Zn_3B_{1.5}$ kg ha^{-1}) treatment.

Significant variation was recorded on post-harvest soil available P (ppm) affected by N and K fertilizer application on onion field (Table 4). Highest soil available P (21.78 ppm) observed with T_7 ($N_{140}P_{45}K_{100}S_{30}Zn_3B_{1.5}$ kg ha^{-1}) treatment which was statistically similar with T_8 treatment. Lowest soil available P (19.28 ppm) observed with T_1 ($N_0P_{45}K_0S_{30}Zn_3B_{1.5}$ kg ha^{-1}) treatment.

Significant variation was recorded on post-harvest soil exchangeable K (meq 100 g^{-1}) affected by different N and K fertilizer application on onion field (Table 4). Results from the experiment revealed that the highest soil exchangeable K (0.15 meq 100 g^{-1}) observed with T_7 ($N_{140}P_{45}K_{100}S_{30}Zn_3B_{1.5}$ kg ha^{-1}) treatment which was statistically similar with T_4, T_5, T_6 and T_8 treatment. Lowest soil exchangeable K (0.10 meq100 g^{-1}) observed with T_1 ($N_0P_{45}K_0S_{30}Zn_3B_{1.5}$ kg ha^{-1}) treatment.

Significant variation was recorded on post-harvest soil available S (ppm) affected by N and K fertilizer application on onion field (Table 4). Highest soil available S (65.6 ppm) observed with T_7 ($N_{140}P_{45}K_{100}S_{30}Zn_3B_{1.5}$ kg ha^{-1}) treatment which was statistically similar with T_4, T_5, T_6 and T_8 treatment. Lowest soil available S (51.00 ppm) observed with T_1 ($N_0P_{45}K_0S_{30}Zn_3B_{1.5}$ kg ha^{-1}) treatment.

4. CONCLUSION

Onion growth, bulb yield and quality were significantly increased by the application of nitrogen (N) and potassium (K) at different level. Application of 140 kg nitrogen and 100 kg potassium showed the best results in respect of plant height, leaves $plant^{-1}$, leaf length, dry matter content of leaves, diameter of bulb, length of bulb, fresh weight of bulb $plant^{-1}$, dry matter content of bulb $plant^{-1}$, bulb yield and post-harvest soil properties like total nitrogen (%), available phosphorus (ppm) and exchangeable potassium (meq 100 g^{-1}).

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