

## **Assessment of Growth and Yield in Onion: Comparative Study of Three Varieties and Muriate of Potash Fertilizer Application Techniques**

### **ABSTRACT**

A comparative study on the growth and yield of onions was conducted at Sher-e-Bangla Agricultural University's Horticulture farm from October 2021 to March 2022 during the Rabi season. The experiment employed a Randomized Complete Block Design (RCBD) with two factors: onion varieties ( $V_1$ =BARI Piaz-1,  $V_2$ =BARI Piaz-4,  $V_3$ =BARI Piaz-6) and muriate of potash fertilizer application methods ( $M_1$ =Basal application (Full dose),  $M_2$  =  $\frac{1}{2}$  basal application +  $\frac{1}{2}$  25 DAT (Days after transplanting),  $M_3$  =  $\frac{1}{3}$  basal application +  $\frac{1}{3}$  25 DAT +  $\frac{1}{3}$  50 DAT). The results showed significant impacts of both onion varieties and potash fertilizer application methods on growth and yield. Among the onion varieties, BARI Piaz-4 ( $V_2$ ) exhibited the highest bulb weight per plant (66.52g), yield per plot (1.60 kg), and yield per hectare (17.74 t). Regarding potash fertilizer application, the  $\frac{1}{3}$  basal +  $\frac{1}{3}$  25 DAT +  $\frac{1}{3}$  50 DAT method ( $M_3$ ) resulted in the highest bulb weight per plant (59.97 g), bulb yield per plot (1.44 kg), and onion yield per hectare (15.99 t). The combination treatment of BARI Piaz-4 and the  $\frac{1}{3}$  basal +  $\frac{1}{3}$  25 DAT +  $\frac{1}{3}$  50 DAT potash fertilizer application ( $V_2M_3$ ) produced the best results, with the highest bulb weight per plant (73.50 g), yield per plot (1.76 kg), and bulb yield per hectare (19.59 t). In conclusion, cultivating BARI Piaz-4 with a three-times split application of muriate of potash fertilizer ( $V_2M_3$ ) can significantly enhance onion growth and yield, facilitating improved quality production.

**Keywords:** bunching onion, spacing, fertilizer, seed yield.

### **I. INTRODUCTION**

One significant bulbous crop is the onion (*Allium cepa* L.). It belongs to the Alliaceae family. It is a member of the Allium genus. The Mediterranean region serves as the secondary origin region for large type onions, whereas Central Asia serves as the major origin region for spices. One of Bangladesh's most significant and well-liked spice crops is the onion. It is also regarded as a significant vegetable crop. It is ranked first in Bangladesh among all other things. Major spices such as chili, onion, garlic, turmeric and ginger are regularly used in daily diet at large amount [1]. Onion is a basic ingredient in South Asian food and is used as a spice in almost all countries. It is a photo and thermo sensitive crop [2]. Onion stands first among the spice crops in Bangladesh both in area (1.94 lakh ha) and production (25.17 lakh metric ton) [3]. The major onion producing districts of Bangladesh in 2020-21 were Pabna, Faridpur, Rajbari, Rajshahi, Kushtia, Jhainadaha, Manikganj, Magura, Meherpur and Khulna. Onion output in Bangladesh has gradually expanded over the past few years, but so has the country's reliance on imports. In contrast, rising demand has led to an almost two-and-a-half-fold increase in import volume during the past five years. Bangladesh imported 1.35 lakh MT of onions in 2008-09; this number grew to 6.64 lakh MT in 2021-22, a 4.92-fold increase. Only by boosting output and utilizing a variety of techniques and approaches would it be possible to satisfy the huge demand for onions. In different parts of this country, numerous varieties of onions, including Taherpuri, Faridpuri, BARI piaz-1, BARI piaz-2, BARI piaz-3, BARI piaz-4, BARI piaz-5, Pabna local, Shuk Sagar, Bahadur, Lalima, and Ranga, are produced either as a crop for spices or for food. Some of these varieties (e.g., Taherpuri and Faridpuri) have very good flavour, pungency, taste and storage quality besides their excellent size and shape [4]. Due to the spread of new technology over the past two decades, such as HYV seeds, fertilizer, irrigation, pesticides, power tillers, etc., onion production has increased by many times [5]. There is a significant response of onion to both inorganic and organic fertilizer [6]. One of the crucial management elements that could have a significant impact on the output of onions is fertilizer control. Onion bulb formation, elongation, skin color development, and pungent flavor are all influenced by the nutrients nitrogen, potassium, and sulfur [7]. Best quality onion can be produced through application of well-balanced fertilizers. Potassium is essential for several processes in plant metabolism, including photosynthesis, the movement of photosynthates, the control of plant pores, the activation of plant catalysts, and pest and disease resistance. In addition to enhancing the onion's keeping quality, it also enhances the quality characteristics of various crops, including the onion, such as color, glossiness, and dry matter buildup [8]. Time of application of

potassium during the growing period of onion is important in bulb formation.[9] reported that split application of potassium gave higher weight of onion bulb than single application of same dose. Thus, to maintain development and quality, potassium must be applied to onions during crucial growth phases in the proper quantity. This study will assist farmers in growing high-quality onions, which will boost output and ensure the farmers' financial well-being. The purpose of this study is to identify suitable variety on growth and yield of onion. To observe actual application method of muriate of potash fertilizer on growth and yield of onion. It also helps to determine the combined effect of variety and fertilizer application method of muriate of potash fertilizer on growth and yield of onion.

## II. MATERIAL AND METHODS

### 1. Description of the site

The study took place from October 2021 to March 2022 at the Horticulture Farm of the Sher-e-Bangla Agricultural University in Sher-e-Bangla Nagar, Dhaka. There was an elevation of 8.6 meters above sea level at the location, which was located at 23° 77' N Latitude and 90° 35' E Longitude. In this location, the three distinct seasons of winter (November to February), pre-monsoon or hot season (March to April), and monsoon season (May to October) were all encountered. Averaging 490 mm of precipitation annually, mostly during the monsoon season, the region experienced frigid winters and hot summers. 28°C and 19°C, respectively, were the mean annual maximum and lowest temperatures.

### 2. Soil sampling and analysis

Before the experiment, soil samples were collected from the experimental plot. The soil, classified as silty loam, belonged to AEZ No. 28 within the Modhupur Tract region. Soil samples were taken from a depth of 0-15 cm and had a pH of 7.1. These samples were analyzed for their physical and chemical properties at the Soil Resources Development Institute (SRDI), Soil Testing Laboratory in Kamarhati, Dhaka. The soil was air-dried, crushed, and subjected to comprehensive testing.

### 3. Statistical Analysis

The recorded data on different parameters were statistically analyzed using Statistic 10 software. The significance of the difference among the treatments means was estimated by the least significant difference test (LSD) at 5% level of probability.

### 4. Field preparation and Treatment allocation

The plot selected for the experiment was opened with a power tiller in the middle of October 2021 and left exposed to the sun for 10 days. To achieve good tilth, the land was harrowed, ploughed, and cross-ploughed several times, followed by laddering. The experiment was laid out in a Randomized Complete Block Design (RCBD) having double factor with three replications. The experiment comprised as two factors. Factor A: Varieties of onions-3 kinds e.i. V1=BARI Piaz-1, V2=BARIPiaz-4, V3=BARI Piaz-6 and Factor B: Application method of potash fertilizer- 3 types.e.i. M1=Basal application (Full dose), M2 = ½ basal application + ½ 25 DAT (Days after transplanting), M3 = ½ basal application + ⅓ 25 DAT + ⅓ 50 DAT. Each block was divided into 09 plots where 09 treatments combination were distributed randomly and 27-unit plots altogether in the experiment. The size of each plot was 1 m × 0.9 m. The distance maintained between two blocks were 0.75 m and two plots were 0.50 m.

### 5. Planting Materials

The seeds of onion were collected from Bangladesh Agricultural Research Institute (BARI), Gazipur.

### 6. Manuring and Fertilization

Full amount of TSP and full amount of Gypsum were applied in the field as basal dose as pretreatment during final land preparation. While the rest of urea was given in 2 equal split doses at 20 and 45 days after transplanting. Muriate of potash was applied according to treatment requirement.

Table 1. The following doses manure and fertilizers were applied in the experimental plots

Fertilizer	Dose /ha
Cowdung	10 ton
Urea	240 Kg

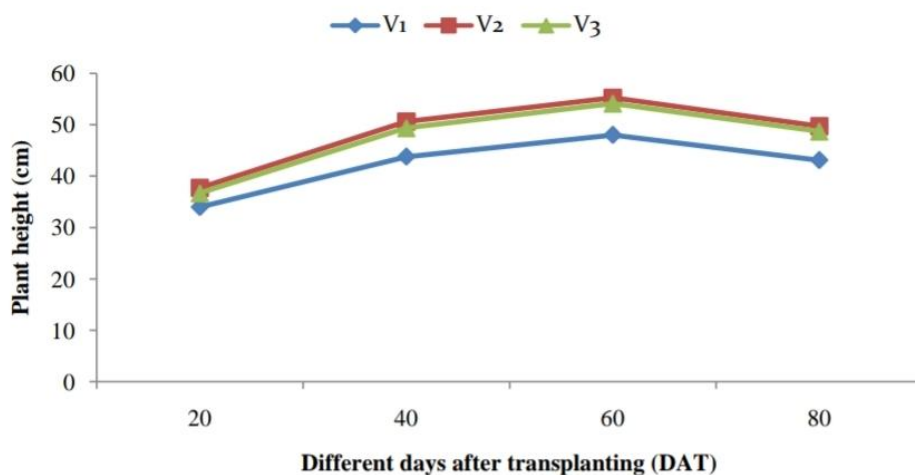
Muriate of Potash (MP)	150 Kg
Triple super phosphate	220 Kg
Gypsum	150 kg

### III. RESULT AND DISCUSSIONS

#### 1. Effect of variety

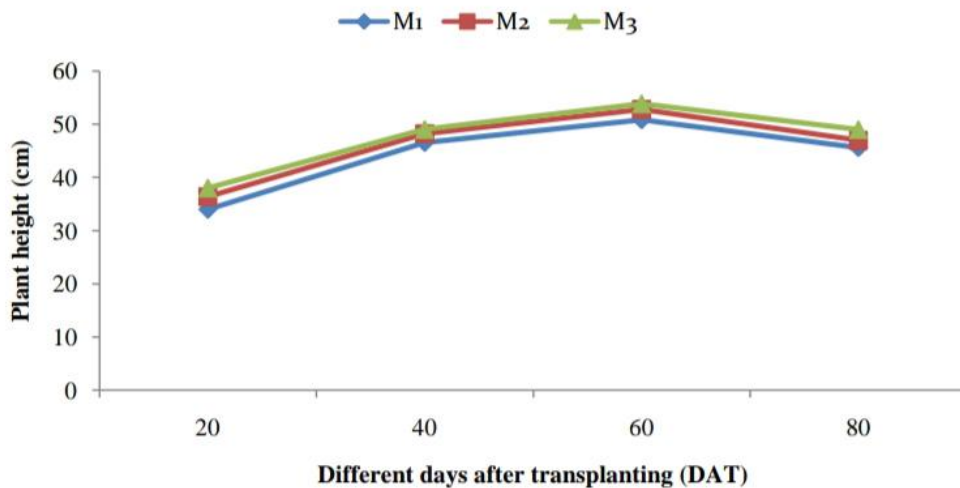
Significant differences were observed in the different parameters of plant due to different variety. The maximum plant height (55.29 cm) was measured at 60 DAT from V<sub>2</sub> (BARI Piaz-4) treatment (Fig.1). The highest number of leaves (6.02) per plant at 60 DAT was recorded from V<sub>2</sub> treatment (Fig.3). The treatment V<sub>2</sub> recorded the maximum neck diameter (1.16 cm), bulb length (5.13 cm), bulb diameter of onion (5.43cm), dry matter content of bulb (13.72%), fresh weight of leaves (25.34 g), polar diameter (1.49 cm), bulb weight per plant (66.52 g)(Table 2).The height brix percentage was measured from V<sub>2</sub>( 9.44%). The data revealed that highest yield per plot (1.60 kg), yield (17.74t) per hectore was obtained from V<sub>2</sub> treatment (Table 2).

The variation of plant height is probably due to the geneticmake-up of the varieties.[10] reported that in onion varieties height of aplant is determined by genetical character and under a given set of environment different varieties will acquire their height according to their genetical makeup.[11] found a significant difference in the number of leaves per plant among onion varieties. [12] reported that neck diameter of onion varied among different onion varieties and the highest neck thickness of the bulb (0.47 cm), was found in variety Agrifound Dark Red onion variety. The bulb length result obtained from the present study was similar with the findings [13] .The results on bulb diameter corroborate the findings [14] .They stated that bulb development and individual bulb weight were differed significantly by the onion varieties. Genetic factors influence growth and bulb development. [15].



Note: Here, V<sub>1</sub>=BARI Piaz-1, V<sub>2</sub>=BARI Piaz-4 and V<sub>3</sub>=BARI Piaz-6

**Figure 1. Effect of variety on plant height at different days after transplanting of onion**



Note: Here, M1=Basal application (Full dose), M2= $\frac{1}{2}$  basal application +  $\frac{1}{2}$  25 DAT (Days after transplanting), M3 =  $\frac{1}{3}$  basal application +  $\frac{1}{3}$  25 DAT +  $\frac{1}{3}$  50 DAT.

**Figure 2. Effect of application methods of potash fertilizer on plant height at different days after transplanting of onion**

## 2. Effect of potash fertilizer application method

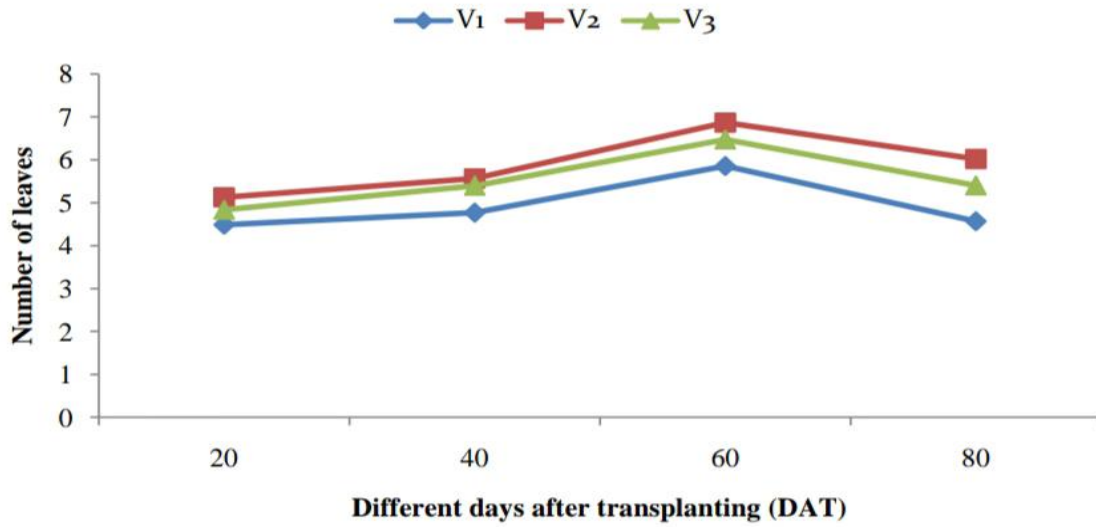
The data revealed that the different application method of potash fertilizer affected the growth and yield of onion. The maximum plant height (53.86 cm) at 60 DAT (Fig. 2) and number of leaves (7.40) at 60 DAT (Fig.4) was measured from M<sub>3</sub> treatment. The treatment M<sub>3</sub> recorded the maximum neck diameter (1.16 cm)(Table 3).Thetreatment M3 recorded thebulb length (4.81cm), bulb diameter (5.31 cm), dry matter content of leaves (12.98 %) (Table 3). The maximum polar diameter (1.53 cm), fresh weight of leaves(22.50 g) was obtained from M<sub>3</sub> treatment (Table 3).The height brix percentage (7.78) from M<sub>2</sub> treatment(Table 3).The data revealed that highest bulb weight (59.97 gm) per plant, yield (1.44 kg) per plot, yield (15.99 t) per hectare was obtained from M<sub>3</sub> Treatment (Table 3).

Optimal and regular supply of potassium fertilizer at different growth stages of crop throughsplittingapplication resulted in better utilization of potash by the plants which improved thegrowth and yieldattributes of onion. The findings were similar to[16] Who discovered that splitapplication of potash in crop significantly influenced plant growthcharacteristics. [17] reported that application of potash fertilizer influenced leafnumber of onion plant. The result obtainedfrom the present study was similar with the findings of[18] recorded bulblength of onion after harvesting indicated that, the bulb length of onion was positively influencedby split application of potassium. The result was similar with the findings of [19] who founded significantlyhigher polar and equatorial diameter of bulb. These findings agree with the results of [20] .M2 treatment gave the height brix percentage of onion. The result wassimilar with the findings of [21]. [22] reported that three split of potashfertilizer significantly influenced onion yield per plot comparable to control treatment. Thefindings were similar to those of [23] who studied the response of summer onionsto potash and its application methods and reported that the highest bulb yield.

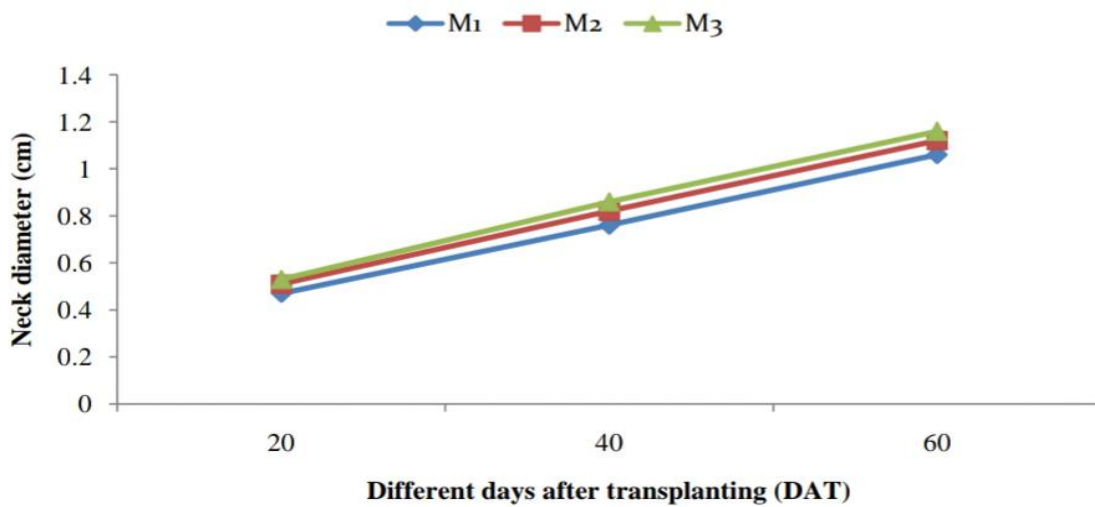
## 3. Combined effect of variety and application method of potash fertilizer

Combined effect of variety and application method of potash fertilizer was found to be statistically significant. The maximum plant height (57.13 cm) at 60 DAT was obtained from V<sub>2</sub>M<sub>3</sub> treatment combination and number of leaves per plant (7.73) at 60 DAT from V<sub>2</sub>M<sub>3</sub> treatment combination (Table 4). The treatment V<sub>2</sub>M<sub>3</sub> recorded the maximum neck diameter (1.23cm), (Table 5). The maximum bulb length (5.44 cm), bulb diameter (5.73 cm), bulb weight per plant (73.50 g),polar diameter (1.60cm),dry matter content of bulb (14.83%),fresh weight of leaves(26.50g) was obtained

from V<sub>2</sub>M<sub>3</sub> treatment (Table 5). The data revealed that highest yield per plot (1.76 kg), yield (19.59 t) per hectare was obtained from V<sub>2</sub>M<sub>3</sub> treatment and maximum brix percentage (10.17) was found from V<sub>2</sub>M<sub>2</sub> treatment (Table 5)



Note: Here, V1=BARI Piaz-1, V2=BARI Piaz-4 and V3=BARI Piaz-6  
**Figure 3. Effect of variety on number of leaves at different days after transplanting of onion**



Note: Here, M1=Basal application (Full dose), M2= $\frac{1}{2}$  basal application +  $\frac{1}{2}$  25 DAT (Days after transplanting), M3 =  $\frac{1}{3}$  basal application +  $\frac{1}{3}$  25 DAT +  $\frac{1}{3}$  50 DAT.

**Figure 4. Effect of application methods of potash fertilizer on number of leaves onion at different days after transplantation of onion**

- **Table 2. Effect of variety on Bulb length (cm), Bulb diameter (cm), Neck diameter (cm), Bulb weight per plant (g), Polar diameter (cm), Dry matter content of bulb (%), Fresh weight of leaves, Brix percentage, Yield per plot (kg), Yield per hectare (ton) of onion**

Treatment	Neck diameter (cm)	Bulb length (cm)	Bulb diameter (cm)	Bulb weight per plant (g)	Polar diameter (cm)	Dry matter content of bulb (%)	Fresh weight of leaves	Brix percentage	Yield per plot (kg)	Yield per hectare (ton)
V <sub>1</sub>	1.06 c	3.80 c	4.66 c	38.87 c	1.38	10.20 c	16.59 c	6.83 b	0.93 c	10.36 c
V <sub>2</sub>	1.16 a	5.13 a	5.43a	66.52 a	1.49	13.72a	25.34 a	9.44a	1.6 a	17.74 a
V <sub>3</sub>	1.12 b	4.70 b	5.12b	57.76 b	1.45	12.30 b	21.50 b	4.94c	1.39 b	15.4 b
LSD (0.05)	0.0343	0.3168	0.1434	1.6751	0.3202 <sup>ns</sup>	0.2571	0.5622	0.5557	0.0141	0.4467
CV%	5.87	4.21	4.89	6.23	7.25	5.48	6.85	4.95	5.11	5.24

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.

Note: Here, V<sub>1</sub>=BARI Piaz-1, V<sub>2</sub>=BARI Piaz-4 and V<sub>3</sub>=BARI Piaz-6

- **Table 3. Effect of application methods of potash fertilizer on Neck diameter (cm), Bulb length (cm), Bulb diameter (cm), Bulb weight per plant (g), Polar diameter (cm), Dry matter content of bulb (%), Fresh weight of leaves, Brix percentage, Yield per plot (kg), Yield per hectare (ton) of onion**

Treatment	Neck diameter (cm)	Bulb length (cm)	Bulb diameter (cm)	Bulb weight per plant (g)	Polar diameter (cm)	Dry matter content of bulb (%)	Fresh weight of leaves (g)	Brix percentage	Yield per plot (kg)	Yield per hectare (ton)
M <sub>1</sub>	1.06 c	4.31 b	4.84 c	48.81 c	1.36	11.20 c	20.07c	7.06 b	1.17 c	13.02 c
M <sub>2</sub>	1.12 b	4.51 ab	5.08 b	54.36 b	1.43	12.06 b	20.87 b	7.78 a	1.3b	14.49 b
M <sub>3</sub>	1.16 a	4.81 a	5.31 a	59.97 a	1.53	12.98 a	22.50 a	6.38 c	1.44 a	15.99 a
LSD (0.05)	0.0343	0.3168	0.1434	1.6751	0.3202 <sup>ns</sup>	0.2571	0.5622	0.5557	0.0141	0.4467
CV%	5.87	4.21	4.89	6.23	7.25	5.48	6.85	4.95	5.11	5.24

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.

Here, M<sub>1</sub>=Basal application (Full dose), M<sub>2</sub>=½ basal application + ½ 25 DAT (Days after transplanting), M<sub>3</sub> = ⅓ basal application + ⅓ 25 DAT + ⅓ 50 DAT.

**Table 4. Combined effect of variety and application methods of potash fertilizer on plant height and number of leaves at different days after transplanting of onion**

Treatment	Plant height (cm) at				Number of leaves at			
	20 DAT	40 DAT	60 DAT	80 DAT	20 DAT	40 DAT	60 DAT	80 DAT
V <sub>1</sub> M <sub>1</sub>	32.69 f	42.87 e	47.13 g	41.07 h	3.69 e	4.37 g	5.02 g	4.09 g
V <sub>1</sub> M <sub>2</sub>	33.73 e	44.13 d	48.33 f	42.67 g	4.60 cd	4.89 ef	5.53 fg	4.55 fg
V <sub>1</sub> F <sub>3</sub>	35.60 d	44.43 d	48.67 f	45.65 f	4.93 bc	5.05 de	7.03 bc	5.07 def
V <sub>2</sub> M <sub>1</sub>	35.27 d	48.47c	54.17 d	48.47 d	4.67cd	5.07 de	6.33 de	5.41 cd
V <sub>2</sub> M <sub>2</sub>	38.43 b	50.64 b	54.59 cd	49.54 bc	4.87 bc	5.38 cd	6.53 cd	5.81 bc
V <sub>2</sub> M <sub>3</sub>	39.53 a	52.87 a	57.13 a	51.27 a	5.85 a	6.25 a	7.73 a	6.84 a
V <sub>3</sub> M <sub>1</sub>	34.07 e	48.42 c	51.24 e	47.32 e	4.21 de	4.50 fg	5.78 ef	4.76 ef
V <sub>3</sub> M <sub>2</sub>	37.07 c	49.84 b	55.47 bc	48.73 cd	4.87 bc	5.78 bc	6.23 de	5.22 cde
V <sub>3</sub> M <sub>3</sub>	39.00 ab	49.87 b	55.77 b	50.14 b	5.43 ab	5.93 ab	7.43 ab	6.27 ab
LSD (0.05)	0.8972	0.8894	1.1824	0.9968	0.6009	0.4173	0.6356	0.6133
CV%	4.25	5.68	7.23	4.02	5.58	6.32	4.85	6.25

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 5% level of significance. Here, V<sub>1</sub>=BARI Piaz-1, V<sub>2</sub>=BARI Piaz-4, V<sub>3</sub>=BARI Piaz-6, M<sub>1</sub>=Basal application (Full dose), M<sub>2</sub>=½ basal application + ½ 25 DAT (Days after transplanting), M<sub>3</sub> = ⅓ basal application + ⅓ 25 DAT + ⅓ 50 DAT.

**Table 5. Combined effect of variety and application methods of potash fertilizer on Neck diameter (cm) Bulb length (cm), Bulb diameter (cm), Bulb weight per plant (g), Polar diameter(cm), Dry matter content of bulb (%), Fresh weight of leaves, Brix percentage, Yield per plot (kg), Yield per hector(ton) of onion**

	Neck diameter (cm)	Bulb length (cm)	Bulb diameter (cm)	Bulb weight per plant (g)	Polar diameter (cm)	Dry matter content of bulb (%)	Fresh weight of leaves	Brix percentage	Yield per plot (kg)	Yield per hector(ton)
V <sub>1</sub> M <sub>1</sub>	1.01 f	3.47 e	4.39 g	33.30 h	1.31	9.30 h	15.33 f	6.83 cd	0.80 g	8.88 h
V <sub>1</sub> M <sub>2</sub>	1.08 de	3.78 de	4.74 f	39.67 g	1.36	10.27 g	16.10 f	7.50 c	0.95 f	10.58 g
V <sub>1</sub> M <sub>3</sub>	1.09 cde	4.15 cd	4.87 ef	43.63 f	1.49	11.05 f	18.33 e	6.16 de	1.05 f	11.63 f
V <sub>2</sub> M <sub>1</sub>	1.12 cd	4.87 b	5.16 bcd	60.46 cd	1.43	12.80 cd	24.37 b	9.50 ab	1.45 cd	16.12 cd
V <sub>2</sub> M <sub>2</sub>	1.15 bc	5.08 ab	5.40 b	65.60 b	1.45	13.53 b	25.17 b	10.17 a	1.57 b	17.49 b
V <sub>2</sub> M <sub>3</sub>	1.23 a	5.44 a	5.73 a	73.50 a	1.60	14.83 a	26.50 a	8.67 b	1.76 a	19.59 a
V <sub>3</sub> M <sub>1</sub>	1.05 ef	4.59 bc	4.95 def	52.67 e	1.35	11.50 e	20.50 d	4.833 fg	1.26 e	14.04 e
V <sub>3</sub> M <sub>2</sub>	1.14 bc	4.67 bc	5.10 cde	57.83 d	1.48	12.37 d	21.33 d	5.67 ef	1.39 d	15.42 d
V <sub>3</sub> M <sub>3</sub>	1.18 ab	4.84 b	5.33 bc	62.80 bc	1.51	13.05 c	22.67 c	4.33 g	1.51 bc	16.75 bc
LSD (0.05)	0.0594	0.5486	0.2483	2.9014	0.4506 <sup>ns</sup>	0.4452	0.9737	0.9625	0.11	0.7736
CV%	5.87	4.21	4.56	8.25	7.25	5.48	6.85	4.95	5.11	5.24

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 5% level of significance. Here, V1=BARI Piaz-1, V2=BARI Piaz-4, V3=BARI Piaz-6, M1=Basal application (Full dose), M2= $\frac{1}{2}$  basal application +  $\frac{1}{2}$  25 DAT (Days after transplanting), M3 =  $\frac{1}{3}$  basal application +  $\frac{1}{3}$  25 DAT +  $\frac{1}{3}$  50 DAT.

#### IV. CONCLUSION

On the basis of present study, it is concluded that the V<sub>2</sub> variety gave highest plant height at 60 DAT of onion. V<sub>2</sub> (BARI Piaz-4) gave highest number of leaves, plant neck diameter, bulb length, bulb diameter, polar diameter, brix percentage, yield per plot, yield per hectore of onion. Among different application method of potash fertilizer height bulb length, bulb diameter, bulb weight per plant, fresh weight of leaves, dry matter content of onion, yield per plot, yield per hectore were found in the M<sub>3</sub> treatment ( $\frac{1}{3}$  basal application +  $\frac{1}{3}$  25 DAT +  $\frac{1}{3}$  50 DAT) Combination of V<sub>2</sub>M<sub>3</sub> treatment gave the highest growth and yield per hectore (19.59 t) comparable to the other treatment combination. However, from the present study it may be concluded that, the most suitable combination for a higher yield of onion was V<sub>2</sub> (BARI Piaz -4) with M<sub>3</sub> ( $\frac{1}{3}$  basal application +  $\frac{1}{3}$  25 DAT +  $\frac{1}{3}$  50 DAT)

## REFERENCE

1. Rana, M., Islam, S. and Kamruzzaman, M. (2021). Growth and instability in area, production and productivity of major spices in Bangladesh. *J. Agric. Food Res.* **6**: 4-7.
2. BARC (Bangladesh Agricultural Research Council) (2021). Availability and price volatility of rice, potato and onion in Bangladesh: an inter-institutional study in 2020. Published by: Agricultural Economics and Rural Sociology Division Bangladesh Agricultural Research Council (BARC). pp. 82-102.
3. BBS (Bangladesh Bureau of Statistics). (2022). Summary crop statistics area, yield rates and productions of minor crops in 2020-21 and 2021-22. Bureau of Statistics, Statistics and Informatics Division, Ministry of Planning, Government of the Peoples Republic of Bangladesh, Dhaka. pp. 1-3.
4. Biswas, S.C. (2021). Development of a new improved onion variety through selection. BRAC Agricultural Research and Development Centre, BRRRI, Joydebpur, Gazipur, Bangladesh. pp. 1-4.
5. Saddam, M.R.H. (2018). Profitability of onion cultivation in selected areas of Pabna district in Bangladesh. MS thesis, department of development and poverty studies. pp. 1-66.
6. Gererufael, L.A., Abraham, N.T. and Reda, T.B. (2020). Growth and yield of onion (*Allium cepa* L.) as affected by farmyard manure and nitrogen fertilizer application in Tahtay Koraro District, Northwestern Zone of Tigray, Ethiopia. *Vegetos.* **33**: 617-627.
7. El-Morsy, A.E., El-Kassas, A.A.I. and El-Tantawy, E.M. (2016). Onion plant growth and yield as affected by nitrogen, potassium and sulphur combinations under El-Arish region conditions. *Sinai J. App. Sci.* **5**(3): 345-362.
8. Balvir, K., Sraw, P.K., Kaur, A. and Singh, K. (2017). Effect of potash and sulphur on yield and quality parameters under different planting methods in onion. *J. App. Nat. Sci.* **9**(4): 2434-2437.
9. Deepa, A.H., Wagh, A.P., Nagre, P.K. and Kale, V.S. (2018). Effect of different doses and splits of potassium on quality of onion. *Int. J. Pure App. Biosci.* **5**(6): 908-912.
10. Kitila, C., Abraham, A. and Shuma, S. (2022). Growth and bulb yield of some onion (*Allium cepa* L.) varieties as influenced by NPS fertilizer at Dambi Dollo University research site, Western Ethiopia. *Cogent Food Amp. Agric.* **8**(1): 1-11.
11. Tadesse, A. and Bekele, Y. (2022). Evaluation of improved onion (*Allium Cepa* L.) varieties for growth and bulb yield under irrigated condition in lowland area of south omo zone, Southern Ethiopia. *Adv. Crop Sci. Tech.* **10**(5): 510.
12. Dubey, S., Verma, S., Chandrakar, K. and Keshari, R. (2019). Suitability of kharif onion varieties in mahasamund district of Chhattisgarh. *J. Krishi Vigyan.* **7**(2): 243-247.
13. Ahmed, S., Rahim, M., Moniruzzaman, M., Khatun, M., Jahan, F. and Akter, R. (2021). Effect of bulb sizes on the seed yield of two onion (*Allium Cepa* L.) varieties. *SAARC J. Agric.* **18**(2): 51-65.
14. Demisie, R. and Tolessa, K. (2018). Growth and bulb yield of onion (*Allium cepa* L.) in response to plant density and variety in Jimma, South Western Ethiopia. *Adv. Crop Sci. Tech.* **6**: 1-6.
15. Gosai, J.A., Rathawa, S.N., Dhakad, R.J., Jatav, A. and Verma, L.R. (2018). Evaluation of different varieties of onion (*Allium cepa* L.) under North Gujrat condition. *Int J. Curr. Microbiol. App. Sci.* **7**: 3775-3780.
16. Nand, M.M., Singh, S.P., Kishor, K., Kumar, A., Alam, M.M. and Kumar, V. (2020). Impact of split application of potassium on inbred and hybrid rice yield and its attributes in calcareous soil. *Int. J. Curr. Microbiol. App. Sci.* **9**(3): 3279-3286.
17. Naher, M.S., Brahma, S., Islam, M.A., Sarkar, M.B., Hasan, M.M. and Fahim, A.H.F. (2017). Productivity of summer onion to different sources and levels of potash. *Bangladesh Agron. J.* **20**(1), 37-43.

18. Deepa, A.H., Wagh, A.P., Nagre, P.K. and Kale, V.S. (2018). Effect of different doses and splits of potassium on quality of onion. *Int. J. Pure App. Biosci.* **5**(6): 908-912.
19. Kumara, B.R., Mansur, C.P. Girish, C., Wani, S.P., Allolli, T.B., Jagadeesh, S.L., Mesta, R.K., Satish, D., Shankar, M. and Sanjeevraddi, G.R. (2018). Effect of potassium levels, sources and time of application on yield of onion (*Allium cepa* L.). *Int. J. Pure App. Biosci.* **6**(2): 540-549.
20. Geris, L.S.M., Marey, R.A. and Morsy, M.G. (2011). Growth, yield and storability of onion influenced by potassium fertilizer application time and urea as foliar spray. *J. Plant Prod. Mansoura Univ.* **2**(8): 1073 – 1090
21. Ahmad, N., Sarfraz, M., Farooq, U., Arfan-ul-Haq, M., Mushtaq, M.Z. and Ali, M.A. (2015). Effect of potassium and its time of application on yield and quality of tomato. *Int. J. Sci. Res. Pub.* **5**(9): 1-4.
22. Holer, D.A. (2017). Effect of different doses and splits of potassium on growth, yield, quality and storage of onion. Ms thesis. Department of horticulture. Dr. Panjabrao Deshmukh Krishi Vidyapeeth Krishinagar Po, Akola, India. pp. 115-120.
23. Islam, M.A., Shamsuddoha, A.T.M., Bhuiyan, M.S.I. and Hasanuzzaman, M. (2008). Response of summer onion to potash and its application methods. *American-Eurasian J. Agron.* **1**(1): 10-15.