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Research Article

Potassium Nutrition Affects the Growth and Productivity of Onion Varieties

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ABSTRACT

Potassium (K) plays a key role in onion growth and bulb formation. Therefore, analyzing how different onion varieties respond to varying potassium levels can help to optimize the potassium usage, enhance bulb quality and improve onion production resilience, ultimately leading to better economic returns. The present study explored the response of onion varieties to different potassium doses. Four K doses (0, 50, 75 and 100 kg ha⁻¹) were tested using four onion varieties (Nasarpuri, Phulkara, Thano bulla khan and Ghotki). The significant nutritional effect was observed on all tested varieties. The increasing K supply (100 kg ha⁻¹) exhibited better performance for growth and bulb related attributes. Significantly heavier plants with maximum height and neck diameter were recorded from higher K Supply over other K doses. The plants fertilized with adequate K nutrition took more time to physiological maturity. The higher K supply also exerted significant influence on bulb related traits. The bulb harvested from plots fertilized with increasing K nutrition had maximum weight and diameter with large scales. With regards to varieties, Nasapuri and Phulkara were found to be superior for all the traits over other varieties. Highest plant height, larger and heavier leaves were recorded in Nasapuri variety. The maximum bulb weight was also found in Nasapuri followed by Phulkara variety across the K treatments. The shorter plants with minimum bulb size and weight were harvested from Ghotki variety under all K conditions. The Ghotki variety also took more time to attain physiological maturity. It is concluded that onion varieties may be nourished with K @ 100 kg ha⁻¹ for better growth and higher bulb production.

Keywords: Potassium rates, growth, productivity, onion, varieties.

INTRODUCTION

Onion, (*Allium cepa* L.) belongs to the Amaryllidaceae (Alliaceae) plant family. Worldwide, Onion is considered as an essential vegetable crop, attaining the second rank next to Tomato worldwide (Bekele, 2018). It has several health beneficial compounds and is commonly used in wide variety of dishes, soups, pickles, chutneys and kababs (Roy et al., 2016). It is a rich source of various health beneficial compounds including proteins, vitamins and carbohydrates, proteins, vitamins, minerals and fat (Job et al., 2016). Its mature bulb is generally used as salad, vegetable and spice round the year. It is generally known as a medicinal herb globally because of its curative and therapeutic properties (Zahid et al., 2008). It is well documented that several human health related issues including elevated cholesterol, heart associated diseases, anemia, diabetes, diarrhea, and cancer can be controlled through consumption of onion (Basit and Shera, 2008; Nicastro et al., 2015).



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The presence of sulfur compounds has enriched the onion with dermatological, antimicrobial and antitumor properties (Sarwar et al., 2011).

Onion is grown well relatively in cold season and under mild climate without extreme heat or cold or excessive rainfall (Shah et al., 2012). During vegetative growth it requires low temperature, however for bulb formation long photoperiod and high temperature are needed (Anjum et al., 2019). Onion is originated from Central Asia (Mallor et al., 2011). It is widely cultivated throughout the world, especially in Australia, Bangladesh, China, India, the Netherlands and Pakistan (Deshpande et al., 2013). In Pakistan, onions are extensively cultivated, with Sindh province being a major production area. However, recent reports indicate a significant decline in onion production in Sindh, attributed to various environmental factors. During the Year 2021-22, area under onion cultivation was decreased from 103,000 acres to 68,000 acres, displaying 34% decrease over the previous year (ICID Punjab, 2022).

Adequate nutrient management is a key element in agricultural aspects, exerting fundamental support for achieving high crop production (Malo et al., 2022). In present day agricultural practices, the main hurdle for growth and yield of crop lies in the soil nutrient status. Different plant species have varying nutritional needs which enlightens the use of suitable farming practices (Khan et al., 2022). Similarly, the most important factor for managing the onion production is fertilizer management which has a profound impact on yield of onions (Nira et al., 2023). Onion significantly responds well to the application of both organic and inorganic fertilizers (Gererufael et al., 2020). The formation of the onion bulb, its elongation along with the development of skin color and pungency is impacted by the presence of nitrogen, potassium, and sulfur (El-Morsy et al., 2016). Perfect balance of fertilizers produces a fine quality onion (Nira et al., 2023). Among NPK nutrients, local growers avoid using potash over their crops (Nabi et al., 2010). However, onion is potash loving crop, hence a great amount of nutrients specifically potassium should be maintained well at the topmost layer of the soil. For onion cultivation, a substantial dose of potash is often recommended due to its benefits, including enhanced carbohydrate production and transport, protein synthesis, pest and disease resistance, enzymatic functions, reduced stalk and stem breakage, extended shelf life, and improved bulb size and yield (Kumara et al., 2018; Pachauri et al., 2005). Similarly to the tuber and root crops, onion shows quick response to potash. Lower quantities of Potassium can decrease the onion production, its quality and shelf life. Soils having inadequate content of Potassium, generally fails to provide a satisfactory outcome (Engels et al., 2012; Hawkesford et al., 2012). Apart from nitrogen and phosphorus, Potassium is also an essential nutrient that is required in huge amounts and Onion erases it in huge quantities and intake it as the K^+ ion. Being highly valuable for the physiological and biochemical procedures of the onion, it mainly supports in photosynthesis, assimilation of nutrients, and managing the water stability of the plants leading to an increased yield and quality of onion (Marschner, 2012).

Onion is one of the important commercial crops of Pakistan, however, the yield of onion achieved in Pakistan is quite low as compared to rest of onion producing countries (Samra et al., 2017). Lack of adequate nutrients supply is one of the main factors which limit the bulb yield of onions (Kumara et al., 2018). Potassium is an important phytonutrient that plants require in large amounts for their optimum growth and development (Marrocos et al., 2017). The critical role of K in many physiological and biochemical processes in plants is well known, including photosynthesis, facilitating assimilation translocation, protein synthesis, maintaining water balance, and promoting enzyme activity (Marschner, 2012). Existing evidence shows that potassium has a highly beneficial impact on onion growth and bulb production (Nira et al., 2023; Bekele, 2018; Ali et al, 2007; Yadav et al. 2002). Vachhani and Patel (1993) recorded maximum leaves and bulb yield in onion by application of K from 100-150 kg ha⁻¹. Likewise, maximum bulb diameter, weight and dry matter was recorded by Gererufael et al. (2020). Positive nutritional effect of K was also observed by Ashraf et al. (2023) and registered more bulb production when plants were nourished under high K conditions. The Kaur et al. (2017) recorded the highest yield of onion by application of 100 kg ha⁻¹.

Onion is highly commercial crop of Sindh Province of Pakistan and plays a significant role in human nutrition. However, farmers ignore the use of chemical potassium to this important vegetable crop due to high cost of potassic fertilizers in the market. Moreover, there is a general understanding of the farmers that soils of Sindh province are rich in K and there is no need of its application to onion and other agricultural crops. However existing report indicated the deficiency of K in soils of Pakistan possibly due to continuous cropping, deforestation, cations exchanges and other possible reasons (Wakeel, 2014). In this context, it is mandatory to optimize the potassium nutrition management for quality production of onion. In the light of above discussion, the present research was executed to evaluate the growth and yield response of onion cultivars to different potassium application rates

MATERIALS AND METHODS

Experimental site

The current study was performed at the experimental area of Department of Horticulture, Sindh Agriculture University, Tandojam during 2021. The experimental site comes under sub-tropical climate and is divided into four distinct seasons, summer, autumn, winter and spring seasons. The average temperature ranged from 20-30 °C throughout the course of study.

Soil characteristics

Before plantation, the experimental soil was examined for its physico- chemical characteristics. The soil samples were taken at the depth of 10-15 cm. These samples were analyzed from department of soil Science, Sindh Agriculture University Tando Jam. The soil was sandy loam, moderately alkaline (pH 8.5) non-saline (EC=0.7 dSm⁻¹), organic matter (0.80%) available Potassium (120 mg kg⁻¹) and Nitrogen and Phosphorous contents were (0.040 % and 0.120 %), respectively.

Plant material

The seeds of four commercial varieties of onion including Nasarpuri, Phulkara, Thano bulla Khan and Ghotki were acquired from Husri Onion Research Station.

Experimental design

The trial was performed during winter season 2020-2021. Two factors were involved in the study, Factor A was the potassium rates that included K₁ = 0 kg ha⁻¹ (Control), K₂ = 50 kg ha⁻¹, K₃ = 75 kg ha⁻¹ and K₄ = 100 kg ha⁻¹, while Factor B was the onion varieties viz. Nasarpuri, Thano bulla khan, Phulkara and Ghotki. The experiment was laid out in Randomized Complete Block Design (RCBD) under three blocks with net plot size of 5x4 m (20 m²).

Land preparation

The soil was thoroughly prepared by ploughing and land leveling for even distribution of irrigation water. Dikes were prepared to separate sub-plots and feeder channels, and the road was prepared according to the work plan. After land preparation ridges of 60 cm wide were prepared.

Nursery raising and transplanting

Firstly, the seeds of four onion varieties (Nasarpuri, Phulkara, Thano bulla khan and Ghotki) were sown in the nursery. Before sowing, seeds were treated with the fungicide (Topsin M) to protect the seedlings from diseases. About six weeks old seedlings were transplanted on both sides of ridges by keeping the distance of 10 cm between plants and row to row distance was maintained at 30 cm.

Potassium application

Onion crop was nourished with four potassium rates that included 0, 50, 75 and 100 kg ha⁻¹. The source of K was Sulfate of Potash (SOP) that contains 50% K. All the K rates were applied in three split doses. One third of K was applied at sowing time and the remaining K was applied after 30 days of transplantation and bulb formation, respectively. The recommended doses of nitrogen and phosphorous at rate of 120 kg ha⁻¹ and 60 kg ha⁻¹ were applied to each plot.

Crop maintenance

All the essential cultural practices were followed according to requirement of the crop. The irrigation was done as per the requirement of the crop, while the regular weeding was carried out to clean the ridges.

Data recorded

The data of growth and yield associated traits of onion were recorded by selecting twenty randomly plants from each treatment in each replication. Days taken to maturity were examined by counting the days from plantation up to the plant maturity. Measurement the height of plant from the soil level to the tip of the tallest leaf was taken through using measuring scale. Leaves plant⁻¹ were measured through manual counting. Fresh weight of leaves and bulb was taken immediately using weighing balance. Scales were counted manually by carefully peeling off the outer layer of onion. Equatorial diameter, polar diameter and neck girth was measured by using vernier caliper.

Statistical Analysis

The analysis of variance (ANOVA) was applied to examine the obtained data of onion cultivars grown under different K rates applying a computer software Statistix 8.1 (Tallahassee Florida, USA). Mean values of varieties and K rates were separated by employing LSD test at 5% level of probability.

RESULTS

Days to maturation

Table 1 shows the comparative influence of different potassium rates and onion cultivars for days taken to attain

maturity. The interactive as well as the independent effect of both varieties and different potassium rates showed statistically significant difference for days to maturation of onion bulbs. Based on different potassium rates, the minimum days (102.72) were observed from $K_0 = 0 \text{ kg ha}^{-1}$ followed by $K_1 = 50 \text{ kg ha}^{-1}$ and $K_2 = 75 \text{ kg ha}^{-1}$ resulted (106.94 and 110.86 days) respectively. While, the maximum days to maturation (116.50 days) were seen under highest K rate (100 kg ha^{-1}). Among the varietal comparison, the Nasarpuri variety took minimum days (107.55) for maturation as compared to other varieties. Whereas the Ghotki variety took maximum days (111.33) for bulb maturation. On the interactive basis of both treatment and varieties, the minimum days (101.22) were obtained from $K_4 = 100 \text{ kg ha}^{-1}$ with Nasarpuri variety. The maximum days to maturation were counted (120.11 days) from Control with Ghotki variety.

Table 1. Days to maturation of onion varieties affected by K rates.

Treatments	Varieties				Mean
	Nasarpuri	Phulkara	Thano bulla khan	Ghotki	
$K_1 = 0 \text{ kg ha}^{-1}$ (control)	101.22 p	102.11 c	103.33 b	104.22 a	102.72 d
$K_2 = 50 \text{ kg ha}^{-1}$	105.55 l	106.55 g	107.22 f	108.44 e	106.94 c
$K_3 = 75 \text{ kg ha}^{-1}$	109.22 h	110.44 k	111.22 j	112.55 i	110.86 b
$K_4 = 100 \text{ kg ha}^{-1}$	114.22 p	115.44 o	116.22 n	120.11 m	116.50 a
Mean	107.55 d	108.64 c	109.50 b	111.33 a	

	Treatment	Variety	TxV
P-value	0.0000	0.0000	0.0000
SE	0.1126	0.1126	0.2252
LSD 0.05	0.2300	0.2300	0.4600

Plant height (cm)

The onion varieties exhibited a significant response to different potassium (K) rates, and there was also a significant interaction between the K rates and the varieties. Based on the mean of plant heights associated with different potassium rates, the tallest plants reaching 61.32 cm were observed with a potassium rate of K_4 (100 kg ha^{-1}) followed by K_3 (75 kg ha^{-1}) with a height of 56.78 cm, and K_2 (50 kg ha^{-1}) with a height of 48.20 cm (Table 2). The shorter plant height (35.29 cm) was observed from control (Table 2). Furthermore Table 2 shows the Nasarpuri variety had better plant height (53.38 cm) followed by Phulkara and Thano bulla khan. Whereas the Ghotki variety resulted minimum plant height (47.53 cm).

Table 2. Plant height (cm) of onion varieties affected by K rates

Treatments	Varieties				Mean
	Nasarpuri	Phulkara	Thano bulla khan	Ghotki	
$K_1 = 0 \text{ kg ha}^{-1}$ (control)	39.68 m	37.01 n	33.60 o	30.87 p	35.29 d
$K_2 = 50 \text{ kg ha}^{-1}$	51.96 i	49.43 j	46.89 k	44.52 l	48.20 c
$K_3 = 75 \text{ kg ha}^{-1}$	58.43 e	57.43 f	56.22 g	55.06 h	56.78 b
$K_4 = 100 \text{ kg ha}^{-1}$	63.44 a	61.70 b	60.48 c	59.68 d	61.32 a
Mean	53.38 a	51.39 b	49.30 c	47.53 d	

	Treatment	Variety	TxV
P-value	0.0000	0.0000	0.0000
SE	0.1399	0.1399	0.2799
LSD 0.05	0.2858	0.2858	0.5716

Leaves plant⁻¹

The leaves plant⁻¹ had statistically significant results affected by the different potassium rates and onion varieties as shown in Table 3. The comparative impact of both varieties and different potassium rates also had statistically significant difference for leaves plant⁻¹. On the basis of different potassium rates, the maximum leaves plant⁻¹ (10.33) were observed from $K_4 = 100 \text{ kg ha}^{-1}$ followed by $K_3 = 75 \text{ kg ha}^{-1}$ and $K_2 = 50 \text{ kg ha}^{-1}$ (8.33 and 6.00) respectively. The minimum leaves plant⁻¹ (4.88) were observed under Control. Among the varietal comparison the Nasarpuri variety

produced maximum leaves plant⁻¹ (8.55 g) as compared to other varieties. Whereas the Ghotki variety produced minimum leaves plant⁻¹ (7.22). On the basis of comparison of both treatment and varieties, the maximum leaves plant⁻¹ (11.55) was observed from K₄ = 100 kg ha⁻¹ with Nasarpuri variety. The minimum leaves plant⁻¹(4.22) were produced under Control in Ghotki variety.

Table 3. Leaves plant⁻¹ of onion varieties affected by K rates.

Treatments	Varieties				Mean
	Nasarpuri	Phulkara	Thano bulla khan	Ghotki	
K ₁ = 0 kg ha ⁻¹ (control)	5.5 m	5.22 n	4.55 o	4.22 p	4.88 d
K ₂ = 50 kg ha ⁻¹	7.55 i	7.22 j	6.55 k	6.22 l	6.00 c
K ₃ = 75 kg ha ⁻¹	9.550 e	9.22 f	8.33 g	8.22 h	8.33 b
K ₄ = 100 kg ha ⁻¹	11.55 a	11.20 b	10.55 c	10.22 d	10.33 a
Mean	8.550 a	8.22 b	7.55 c	7.22 d	

	Treatment	Variety	TxV
P-value	0.0000	0.0000	0.0000
SE	0.0696	0.0696	0.1391
LSD 0.05	0.1421	0.1421	0.2842

Leaves fresh weight (g)

The data regarding leaves fresh weight (g) as impacted by the varying potassium rates and onion varieties is presented in Table 4. The leaves fresh weight significantly differed by different potassium rates and onion varieties and their interactive impact. On the basis of different potassium rates, the maximum leaves fresh weight (29.393 g) was observed from K₄ = 100 kg ha⁻¹ followed by K₃ = 75 kg ha⁻¹ and K₂ = 50 kg ha⁻¹ (24.881 g and 19.527 g) respectively. The minimum leaves fresh weight (13.805 g) was seen under Control. Among the varietal comparison the leaves produced from Nasarpuri variety resulted in maximum fresh weight (24.187 g) as compared to other varieties. Whereas the Ghotki variety showed minimum leaves fresh weight (19.793 g). On the basis of comparison of both treatment and varieties, the maximum leaves fresh weight (32.370 g) was obtained from K₄ = 100 kg ha⁻¹ with Nasarpuri variety. The minimum leaves fresh weight (11.140 g) was obtained from Control with Ghotki variety.

Table 4. Leaves fresh weight (g) of onion varieties affected by K rates.

Treatments	Varieties				Mean
	Nasarpuri	Phulkara	Thano bulla khan	Ghotki	
K ₁ = 0 kg ha ⁻¹ (control)	16.357 m	14.497 n	13.227 o	11.140 p	13.805 d
K ₂ = 50 kg ha ⁻¹	21.620 i	20.193 j	18.803 k	17.490 l	19.527 c
K ₃ = 75 kg ha ⁻¹	26.400 e	25.440 f	24.360 g	23.323 h	24.881 b
K ₄ = 100 kg ha ⁻¹	32.370 a	29.580 b	28.400 c	27.220 d	29.393 a
Mean	24.187 a	22.427 b	21.197 c	19.793 d	

	Treatment	Variety	TxV
P-value	0.0000	0.0000	0.0000
SE	0.0606	0.0606	0.1212
LSD 0.05	0.1238	0.1238	0.2475

Dry leaves weight plant⁻¹

The data regarding leaves dry weight plant⁻¹ (g) as impacted by the varying potassium rates and onion varieties is present in Table 5. Dry leaves weight plant⁻¹ was significantly differed by different potassium rates and onion varieties and their interactive impact. On the basis of different potassium rates, the maximum dry leaves weight plant⁻¹ (10.08 g) were observed from K₄ = 100 kg ha⁻¹ followed by K₃ = 75 kg ha⁻¹ and K₂ = 50 kg ha⁻¹ resulted (7.512 g and 5.185 g) respectively. The minimum dry leaves weight plant⁻¹ (4.315 g) was observed in Control. Among the varietal comparison the Nasarpuri variety showed maximum dry leaves weight plant⁻¹ (7.667 g) as compared to other varieties. Whereas the Ghotki variety showed minimum dry leaves weight plant⁻¹ (6.276 g). On the basis of

comparison of both treatment and varieties, the maximum dry leaves weight plant⁻¹ (11.217 g) was obtained from K₄ = 100 kg ha⁻¹ with Nasarpuri variety. The minimum dry leaves weight plant⁻¹ (3.637 g) was observed under Control in Ghotki variety.

Table 5. Dry leaves weight plant⁻¹ of onion varieties affected by K rates.

Treatments	Varieties				Mean
	Nasarpuri	Phulkara	Thano bulla khan	Ghotki	
K ₁ = 0 kg ha ⁻¹ (control)	4.913 m	4.573 n	4.147 o	3.627 p	4.315 d
K ₂ = 50 kg ha ⁻¹	6.330 i	5.977 j	5.700 k	5.253 l	5.815 c
K ₃ = 75 kg ha ⁻¹	8.207 e	7.163 f	7.243 g	6.983 h	7.512 b
K ₄ = 100 kg ha ⁻¹	11.217 a	10.243 b	9.630 c	9.243 d	10.083 a
Mean	7.667 a	7.101 b	6.680 c	6.276 d	

	Treatment	Variety	TxV
P-value	0.0000	0.0000	0.0000
SE	0.0113	0.0113	0.0226
LSD 0.05	0.0231	0.0231	0.0461

Neck girth (cm)

Table 6 shows neck girth (cm) as influenced by different potassium rates and onion varieties. The single and comparative effect of both varieties and potassium rates showed statistically significant difference for neck girth (cm). On the basis of different potassium rates, the maximum neck girth (1.68 cm) was observed from K₄ = 100 kg ha⁻¹ followed by K₃ = 75 kg ha⁻¹ and K₂ = 50 kg ha⁻¹ (1.43 cm and 1.18 cm) respectively. The minimum neck girth (0.98 cm) was observed from Control. Among the varietal comparison the Nasarpuri variety imparted maximum neck girth (1.40 cm) as compared to other varieties. Whereas the Ghotki variety showed minimum neck girth (1.25 cm). On the basis of interaction, the maximum neck girth (1.78 cm) was observed from K₄ = 100 kg ha⁻¹ with Nasarpuri variety. The minimum neck girth (0.92 cm) was observed from Ghotki variety without the application of Potash.

Table 6. Neck grith (cm) of onion varieties affected by K rates.

Treatments	Varieties				Mean
	Nasarpuri	Phulkara	Thano bulla khan	Ghotki	
K ₁ = 0 kg ha ⁻¹ (control)	1.06 m	0.99 n	0.97 o	0.92 p	0.98 d
K ₂ = 50 kg ha ⁻¹	1.26 i	1.19 j	1.17 k	1.12 l	1.18 c
K ₃ = 75 kg ha ⁻¹	1.52 e	1.45 f	1.41 g	1.36 h	1.43 b
K ₄ = 100 kg ha ⁻¹	1.78 a	1.71 b	1.64 c	1.58 d	1.68 a
Mean	1.40 a	1.34 b	1.30 c	1.25 d	

	Treatment	Variety	TxV
P-value	0.0000	0.0000	0.0000
SE	3.2383	3.2383	6.4763
LSD 0.05	6.6130	6.6130	0.0132

Equatorial diameter of the bulb (mm)

Table 7 shows the Equatorial diameter of the bulb (mm) as influenced by different potassium rates and onion varieties. The single and comparative effect of both varieties and potassium rates showed statistically significant difference for bulb equatorial diameter. On the basis of different potassium rates, the maximum bulb equatorial diameter of the bulb (50.367 mm) was registered in K₄ = 100 kg ha⁻¹ followed by K₃ = 75 kg ha⁻¹ and K₂ = 50 kg ha⁻¹ resulted (45.165cm and 42.219 mm) respectively. The minimum equatorial diameter of the bulb (39.189 mm) was observed from Control. Among the varietal comparison the Nasarpuri attained maximum equatorial diameter of the bulb (45.639 mm) as compared to other varieties. Whereas the Ghotki variety attained minimum equatorial diameter of the bulb (42.976 mm). On the basis of comparison of both treatment and varieties, the maximum bulb equatorial diameter (52.597 mm) was recorded in K₄ = 100 kg ha⁻¹ with Nasarpuri variety. The lowest bulb equatorial diameter

(38.168 mm) was observed from Control with Ghotki variety.

Table 7. Equatorial diameter of the bulb (mm) of onion varieties affected by K rates.

Treatments	Varieties				Mean
	Nasarpuri	Phulkara	Thano bulla khan	Ghotki	
$K_1 = 0 \text{ kg ha}^{-1}$ (control)	40.293 m	39.293 n	38.880 o	38.168 p	39.189 d
$K_2 = 50 \text{ kg ha}^{-1}$	43.307 i	42.363 j	41.977 k	41.230 l	42.219 c
$K_3 = 75 \text{ kg ha}^{-1}$	46.233 e	45.317 f	44.880 g	44.230 h	45.165 b
$K_4 = 100 \text{ kg ha}^{-1}$	52.597 a	51.427 b	49.16 c	48.280 d	50.367 a
Mean	45.639 a	44.600 b	43.725 c	42.976 d	

	Treatment	Variety	TxV
P-value	0.0000	0.0000	0.0000
SE	0.0479	0.0479	0.0959
LSD 0.05	0.0479	0.0979	0.1958

Polar diameter of bulb (mm)

The data regarding Polar diameter of bulb is shown in the Table 8. The polar diameter of bulb is significantly influenced by the onion varieties as well as with different potassium rates. The comparative and the individual influence of varieties and different potassium rates was also found significant for polar diameter. On the basis of different potassium rates, the maximum polar diameter of bulb (46.98 mm) was observed from $K_4 = 100 \text{ kg ha}^{-1}$ followed by $K_3 = 75 \text{ kg ha}^{-1}$ and $K_2 = 50 \text{ kg ha}^{-1}$ (43.26 mm and 39.27 mm) respectively. The minimum polar diameter (36.07 mm) was observed in Control. Among the varietal comparison the Nasarpuri Variety showed greater polar diameter (43.11 mm g) as compared to other varieties. Whereas the Ghotki variety showed the least polar diameter (40.28 mm). Based on comparison of both treatment and varieties, the maximum polar diameter (49.61 mm) was observed from $K_4 = 100 \text{ kg ha}^{-1}$ with Nasarpuri variety. The minimum polar diameter (35.20 mm) was observed from Control with Ghotki variety.

Table 8. Polar diameter (mm) of onion varieties affected by K rates.

Treatments	Varieties				Mean
	Nasarpuri	Phulkara	Thano bulla khan	Ghotki	
$K_1 = 0 \text{ kg ha}^{-1}$ (control)	37.24 m	36.16 n	35.67 o	35.20 p	36.07 d
$K_2 = 50 \text{ kg ha}^{-1}$	41.44 i	38.91 j	38.53 k	38.22 l	39.27 c
$K_3 = 75 \text{ kg ha}^{-1}$	44.16 e	43.35 f	42.97 g	42.56 h	43.26 b
$K_4 = 100 \text{ kg ha}^{-1}$	49.61 a	47.50 b	45.65 c	45.15 d	46.98 a
Mean	43.11 a	41.48 b	40.28 c	40.28 d	

	Treatment	Variety	TxV
P-value	0.0000	0.0000	0.0000
SE	0.0486	0.0486	0.0972
LSD 0.05	0.0992	0.0992	0.1985

Number of scales bulb⁻¹

The data regarding the number of scales bulb⁻¹ is shown in the Table 9. The number of scales is significantly influenced by the onion varieties as well as with different potassium rates. The comparative and the individual influence of varieties and different potassium rates was also found significant for number of scales. On the basis of different potassium rates, more scales (25.82) in individual bulb was observed from $K_4 = 100 \text{ kg ha}^{-1}$ followed by $K_3 = 75 \text{ kg ha}^{-1}$ and $K_2 = 50 \text{ kg ha}^{-1}$ resulted (20.74 and 18.05) respectively. The minimum scales (15.16) in single bulb were observed from Control. Among the varietal comparison, the Nasarpuri variety showed maximum number of scales (21.49) as compared to other varieties. Whereas the Ghotki variety showed minimum number of scales (18.55). On the basis of comparison of both treatment and varieties, the maximum number of scales (28.88) was observed from $K_4 = 100 \text{ kg ha}^{-1}$ with Nasarpuri variety. The minimum number of scales (14.22) was observed from

control with Ghotki variety.

Table 9. Number of Scales of onion varieties affected by K rates.

Treatments	Varieties				Mean
	Nasarpuri	Phulkara	Thano bulla khan	Ghotki	
K ₁ = 0 kg ha ⁻¹ (control)	16.22 m	15.44 n	14.77 o	14.22 p	15.16 d
K ₂ = 50 kg ha ⁻¹	19.10 i	18.33 j	17.77 k	16.99 l	18.05 c
K ₃ = 75 kg ha ⁻¹	21.77 e	21.22 f	20.44 g	19.55 h	20.74 b
K ₄ = 100 kg ha ⁻¹	28.88 a	26.44 b	24.55 c	23.44 d	25.82 a
Mean	21.49 a	20.35 b	19.38 c	18.55 d	

	Treatment	Variety	TxV
P-value	0.0000	0.0000	0.0000
SE	0.0683	0.0683	0.1365
LSD 0.05	0.1394	0.1394	0.2788

Fresh weight of bulb (g)

The data regarding fresh bulb weight is shown in the Table 10. The fresh bulb weight is significantly influenced by the onion varieties as well as with different potassium rates. The comparative and the individual influence of varieties and different potassium rates was also found significant for fresh bulb weight. On the basis of different potassium rates, the maximum fresh weight of bulb (111.18 g) was observed from K₄ = 100 kg ha⁻¹ followed by K₃ = 75 kg ha⁻¹ and K₂ = 50 kg ha⁻¹ resulted (104.34 g and 97.20 g) respectively. The minimum fresh weight of bulb (92.72 g) was observed from Control. Among the varietal comparison the Nasarpuri variety resulted in maximum fresh weight of bulb (104.13 g) as compared to other varieties. Whereas the Ghotki variety resulted in minimum fresh weight of bulb (99.16). On the basis of comparison of both treatment and varieties, the maximum fresh weight of bulb (115.55 g) was observed from K₄ = 100 kg ha⁻¹ with Nasarpuri variety. The minimum fresh weight of bulb (90.92 g) was observed from Control with Ghotki variety.

Table 10. Fresh weight of bulb (g) of onion varieties affected by K rates.

Treatments	Varieties				Mean
	Nasarpuri	Phulkara	Thano bulla khan	Ghotki	
K ₁ = 0 kg ha ⁻¹ (control)	94.46 m	93.14 n	92.36 p	90.92 p	92.72 d
K ₂ = 50 kg ha ⁻¹	99.33 i	97.28 j	96.54 k	95.64 l	97.20 c
K ₃ = 75 kg ha ⁻¹	107.17 e	104.79 f	103.59 g	101.80 h	104.34 b
K ₄ = 100 kg ha ⁻¹	115.55 a	111.60 b	109.30 c	108.26 d	111.18 a
Mean	104.13 a	101.70 b	100.45 c	99.16 d	

	Treatment	Variety	TxV
P-value	0.0000	0.0000	0.0000
SE	0.1165	0.1165	0.2329
LSD 0.05	0.2378	0.2378	0.4757

DISCUSSION

Soil fertility is crucial for crop production, and farmers often use chemical fertilizers to enhance soil fertility and productivity. Potassium is a key nutrient that influences growth, yield, and quality of onion (Bajehbaj et al., 2009). Potassium is very essential for the greater yield of onion among other nutrients since it has ability of translocation of food, enhanced quality, and for increased number and size of bulbs (Islam et al., 2008). Thus, the optimum dose of potassium, sources of potassium and time of K application is essential for onion to attain its yield potential. The yield depends on yield components, which ultimately depends upon the growth attributes. The practical way of judging the efficiency of all the treatments in an experiment is to compare the significance of yield variations. Keeping these aspects in view we designed our study for evaluation of the response of onion varieties to K nutrition and optimizing the accurate dose of K for better growth and bulb production (Marrocos et al., 2017).

In the current research, the response of onion varieties to differing potash doses was screened under the field conditions. The outcomes of our study showed that there was significant nutritional effect on all traits of studied varieties. The taller plants were produced grown from increasing K supply. The plant height is one of main traits because whole plant architecture depends upon height of plants. The increase in plant height might be due to essential role of K in the photosynthetic activity in plants resultantly vigorous plants with better height were produced. The results of previous studies also advocated the findings of our study. Ashraf et al. (2023) reported that the varied K doses had significant impact on plant height of onion and also further reported that taller plants having height (45.46 cm) were produced when onion plantation was done at the highest rate of 95 kg ha⁻¹. Likewise, Islam et al., (2008) elaborates that the plant height of onion was significantly affected by varying doses of potash. Tallest plants were observed under 120 kg ha⁻¹ potassium and the shorter plants were recorded without the application of Potash. The study of Nabi et al. (2010) found maximum height of onion that were nourished with 75 and 100 kg K ha⁻¹ was applied. In our study Nasarpuri showed maximum plant height in comparison with its counterpart varieties under all K rates. The observed variation in height of varying cultivars is probably linked to their genetic composition as Kitila et al. (2022) reports indicate that plant height in different onion varieties is determined by genetic traits. Under specific environmental conditions, cultivars adjust their height based on their genetic makeup. The maximum neck girth and number of scales were found in plants nourished with higher K rate. In alliance with our study Nira et al., (2023) also found maximum neck diameter of onion when highest level of K was applied to the plants. This is further supported by our study, which highlights the positive role of potassium in promoting robust onion growth.

The large number of leaves, leaf fresh weight and dry weight were recorded from plants grown from Increasing K supply. The leaf is an important plant organ that manufacture whole plant food with the help of light and chlorophyll and directly translocate it down for onion bulb development. The increasing K supply to the soil might have enhanced the fertility of soil that allowed plants to grow vigorously resultantly heavier plants with more leaves were produced. Our findings are consistent with results of Islam et al. (2008) who found greatest number of leaves by application of K at 120 kg ha⁻¹. Furthermore, the study of Nabi et al., (2010) showed similar results for number of leaves where the maximum leaves plant⁻¹ (14.38) were recorded with K applied at 75 kg ha⁻¹, while the minimum leaves plant⁻¹ (10.63) were observed under control. Naher et al., (2017) reported that the maximum quantity of leaves (7.58) was obtained by the application of 120 kg ha⁻¹. Our findings are coherent with the study of Nira et al., (2023) where the highest dry and fresh leaf weight was measured when potash was applied in higher quantities. The better fresh leaf weight of onion plants was also reported by Behairy et al. (2015) by increasing supply of K @ 150 kg ha⁻¹.

Significantly greater fresh bulb weight with higher equatorial and polar diameter were recorded from increasing K supply as compared to rest of the K treatments. Bulb size is an essential trait which directly poses impact to the yield of onion. Onion is a potassium loving vegetable crop, the adequate supply of K might have influenced the protein synthesis, carbohydrate metabolism and ultimately translocation and storage food material in onion bulb. Besides, increase in bulb yield possibly due to increased uptake of nutrients, which might have enhanced the photosynthesis and translocation of photosynthates to the bulb, the storage organ of the onion which ultimately increased the bulb yield of onion. The earlier studies conducted by different researcher including (Kumara et al., 2018; Marrocos et al., 2017; Nira et al., 2023) also supports the results of our study. With regards to varieties, Nasarpuri produced heavier bulbs in comparison with other studied varieties across all K rates. These variations in bulb size and weight might be due to genetic potential of each variety in producing bulb weight (Abdissa et al., 2011; Khan et al., 2003). Anjum et al., (2019) also registered the greater bulb weight of Nasarpuri as compared to its counterpart variety.

Plant nourished with adequate K nutrition took more time to attain physiological maturity. This reflects that under starved nutritional conditions especially K bulb formation and development occurs earlier in onion. Moreover, this also revealed that in the absence of K, plants failed to complete its normal life cycle and attained physiological maturity earlier as compared to plants that were supplied adequate K nutrition.

In the present investigation, wide genetic variation was observed among varieties for all studies traits. However, the response of onion varieties to K nutrition was similar with regards to growth and bulb formation and development. All the onion varieties significantly showed better performance under adequate K conditions. The variety Nasarpuri performed well for all traits in comparison with counterpart varieties across the K nutrition. This might have associated with the different genetic makeup of varieties rather than application of K nutrition. It is also well documented that different cultivars evolves their own mechanism in capturing and utilization of nutrients. Our results are in accord with the findings of Kitila et al. (2022), who recorded varied performance of cultivars under different nutritional conditions. The study of Anjum et al., (2019) elaborates that the highest bulb weight was recorded in

cultivar Nasarpuri planted on ridges. Different varietal response of onion was also noted by Kahsay et al., (2014) while examining the different cultivars of onion by applying different row spacings. The different cultivar response for growth and yield attributes were also noted in other crop species including garlic (Lata et al., 2023; Etoh and Simon, 2002).

CONCLUSION

Increasing potassium (K) nutrition improved onion growth and bulb production. All varieties responded positively to K nutrition in terms of growth and bulb characteristics. Nasapuri and Phulkra showed superior performance across all K rates, likely due to their genetic traits. Therefore, it is concluded that adequate K fertilization is essential for optimal growth and profitable yield in onion

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CONFLICTS OF INTERESTS

The authors have declared no conflict of interest

AUTHORS CONTRIBUTION

Conceived and designed the study: NA Wahocho, Executed the study: M Ahmed: Analyzed the data: NA Wahocho, Contributed in Material and Method section: NN Memon, GM Jamro & MN Kandhro, Wrote the draft of manuscript: M Ahmed, Revised the draft: NA Wahocho & NN Memon

REFERENCES

- Abdissa, Y., Tekalign, T., Pant, L.M., 2011. Growth, bulb yield and quality of onion (*Allium cepa* L.) as influenced by nitrogen and phosphorus fertilization on vertisol. *African Journal of Agricultural Research*, 6(14): 3252-3258.
- Ali, M.K., Alam, M.F., Alam, M.N., Islam, M.S., Khandaker, S.M.A.T., 2007. Effect of Nitrogen and Potassium Level on Yield and Quality Seed Production of Onion. *Journal of Applied Sciences Research*, 3(12): 1889-1899.
- Anjum, M.A., Muhammad, H.M.D., Balal, R.M., Ahmad, R., 2019. Performance of two onion (*Allium cepa* L.) cultivars under two different planting systems in calcareous soil. *Journal of Horticultural Science and Technology*, 2(2): 54-59.
- Ashraf, S., Ul Hassan, M., Sajid, M., Anwar, A., Zaib, B., Anwar, S. 2023. Potential Of Onion Seed Production Under Different Potash Levels. *Journal of Xi'an Shiyou University, Natural Science Edition*.
- Bajehbaj, S.M.A., Farooq, M., Tabassum, R., 2009. Physiological and biochemical aspects of seed vigour enhancement treatments in fine onion. *Seed Science and Technology*, 33: 25-29.
- Basit, A., Shera, A.S., 2008. Prevalence of metabolic syndrome in Pakistan. *Metabolic Syndrome and Related Disorders*, 6(3): 171-175.
- Behairy, A.G., Asmaa, R.M., Shafik, M.R., Aisha, H.A., Magda, M.H., 2015. Growth, yield and bulb quality of onion plants (*Allium cepa* L.) as affected by foliar and soil application of potassium. *Middle East Journal of Agriculture Research*, 4(1): 60-66.
- Bekele, M., 2018. Effects of different levels of potassium fertilization on yield, quality and storage life of onion (*Allium cepa* L.) at Jimma, Southwestern Ethiopia. *Journal of Food Science and Nutrition*, 1(2): 32-39.
- Deshpande, A.N., Dhage, A.R., Bhalerao, V.P., Bansal, S.K., 2013. Potassium nutrition for improving yield and quality of onion. *Indian Journal of Fertilizers*, 9(10): 14-21.
- El-Morsy, A.E., El-Kassas, A.A.I., El-Tantawy, E.M., 2016. Onion plant growth and yield as affected by nitrogen, potassium and sulphur combinations under El-Arish region conditions. *Sinai Journal of Applied Science*, 5(3): 345-362.
- Engels, C., Kirkby, E.A., White, P., 2012. Mineral nutrition, yield and source-sink relationships. In: Marschner, P. (Ed.), *Marschner's Mineral Nutrition of Higher Plants* (3rd ed.). Elsevier Ltd., 85-97.
- Etoh, T., Simon, P., 2002. Diversity, fertility and seed production in garlic. In: Rabinowitch, H., Currah, L. (Eds.), *Allium Crop Science: Recent Advances*. CABI Publishing, Wallingford, UK. 101-118.
- Gererufael, L.A., Abraham, N.T., 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.
- Hawkesford, M., Horst, W., Kichey, T., Lambers, H., Schjoerring, J., Skrumsager, M.I., White, P., 2012. Functions of macronutrients. In: Marschner, P. (Ed.), *Marschner's Mineral Nutrition of Higher Plants* (3rd ed.). Elsevier Ltd., pp. 135-151.
- Industries, Commerce, Investment and Skill Development Department, Punjab Report., 2022. <https://icid.punjab.gov.pk/system/files/Quarterly%20Report%20March%202022.pdf>
- Islam, M.A., Shamsuddoha, A.T.M., Bhuiyan, M.S.I., Hasanuzzaman, M., 2008. Response of summer onion to potash and its application methods. *American-Eurasian Journal of Agronomy*, 1(1): 10-15.
- Job, M., Bhakar, S.R., Singh, P.K., Tiwari, G.S., Sharma, R.K., Lakhawat, S.S., Sharma, D., 2016. Evaluation of plastic mulch for changes in mechanical properties during onion cultivation. *International Journal of Science, Environment and Technology*, 5: 575-584.
- Kaur, A., Kaur, B., Sraw, P.K., Singh, K., 2017. Response of onion to applied potassium at farmer's scale field. *International Journal of Current Microbiology and Applied Sciences*, 6(7): 2491-2496.
- Kitila, C., Abraham, A., 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 & Agriculture*, 8(1): 1-11.
- Khan, M.R., Mostarin, T., Khatun, K., Sumon, M.M., Imtiaz, A.A., Samad, M.A., Khanom, A., Sumi, M.A., 2022. Influence of Phosphorus Fertilization and Seed Rates on Yield Components and Yield of Black Cumin (*Nigella sativa* L.). *Asian Journal of Advances in Agricultural Research*, 18(1): 38-50. DOI: <https://doi.org/10.9734/ajaar/2022/v18i130211>
- Khan, M.A., Hasan, M.K., Miah, M.A.J., Aalam, M.M., Masum, A.S.M.H. 2003. Effect of plant spacing on growth and yield of onion varieties. *Pakistan Journal of Biological Sciences*, 6: 1582-1585.
- Kahsay, Y., Belew, D., Abay, F., 2014. Effects of intra-row spacing on plant growth and yield of onion varieties (*Allium cepa* L.) at Aksum, Northern Ethiopia. *African Journal of Agricultural Research*, 9(10): 931-940.
- Kumara, B.R., Mansur, C.P., Chander, G., Wani, S.P., Allolli, T.B., Jagadeesh, S.L., Mesta, R.K., Satish, D., Meti, S., Reddy, G.S., 2018s. Effect of Potassium Levels, Sources and Time of Application on Yield of Onion (*Allium cepa* L.). *International Journal of Pure and Applied Bioscience*, 6(2): 540-549. DOI: <http://dx.doi.org/10.18782/2320-7051.6395>
- Mallor, C., Balcells, M., Mallor, F., Sales, E., 2011. Genetic variation for bulb size, soluble solids content and pungency in the Spanish sweet onion variety Fuentes de Ebro. Response to selection for low pungency. *Plant Breeding*, 130(1): 55-59.
- Malo, K., Khatun, K., Mostarin, T., Samad, M.A., Tania, M.M., Habiba, M.U., Touhidujjaman, M., 2022. Effect of Integrated Nutrient Management on Growth and Yield of Cucumber (*Cucumis sativus* L.) in Winter Season. *Journal of Global Agriculture and Ecology*, 13(3): 1-12. DOI: <https://doi.org/10.56557/jogae/2022/v13i37466>
- Marschner, P., 2012. *Marschner's Mineral Nutrition of Higher Plants* (3rd ed.). Academic Press, Elsevier.
- Marrocos, S.D.T., Grangeiro, L.C., Sousa, V.D.F.L.D., Ribeiro, R.M.P., Cordeiro, C.J., 2017. Potassium fertilization for optimization of onion production. *Revista Caatinga*, 31(2): 379-384.
- Nabi, G., Rab, A., Abbas, S.J., Farhatullah, M.F., Shah, I.H., 2010. Influence of different levels of potash on the quantity, quality and storage life of onion bulbs. *Pakistan Journal of Botany*, 42(3): 2151-2163.
- Naher, M.S., Brahma, S., Islam, M.A., Sarkar, M.B., Hasan, M.M., Fahim, A.H.F., 2017. Productivity of summer onion to different sources and levels of potash. *Bangladesh Agronomy Journal*, 20(1): 37-43.
- Nicastro, H.L., Ross, S.A., Milner, J.A., 2015. Garlic and onions: Their cancer prevention properties. *Cancer Prevention Research*, 8(3): 181-189.
- Nira, J.J., Mostarin, T., Khatun, K., Ferdousi, A.J., Hoque, S., Riad, R.I., Akter, M., 2023. Comparative Study of Three Varieties and Application Methods of Muriate of Potash Fertilizer on Growth and Yield of Onion. *Asian Journal of Agricultural and Horticultural Research*, 10(4): 475-485.
- Pachauri, S.P., Singh, V., Pachauri, C.P. (2005). Effect of FYM, nitrogen and potassium on growth, yield and quality of onion. *Annals of Plant and Soil Research*, 7(1): 54-56.
- Roy, A., Islam, A.S., Tabassum, R., 2016. Morphological features and yield evaluation of onion (*Allium cepa* L.) genotypes in acid soil. *International Journal of Plant Breeding and Genetics*, 10: 116-124.
- Samra, F.S., Farrukh, S., Waheed, A., Ahmed, N., Khan, N., Ali, S., Younis, M.A., 2017. Impact of potassium on the growth and yield-contributing attributes of onion (*Allium cepa* L.). *Asian Research Journal of Agriculture*,

7(3):1-4.

- Sarwar, M., Attitalla, I.H., Abdollahi, M., 2011. A review on the recent advances in pharmacological studies on medicinal plants: Animal studies are done but clinical studies need completing. *Asian Journal of Animal and Veterinary Advances*, 6: 867-883.
- Shah, S.T., Sajid, M., Alam, R., Rab, A., Mateen, A., Jan, I., Ali, A., Wahid, F., 2012. Comparative study of onion cultivars at Mardan, Khyber Pakhtunkhwa, Pakistan. *Sarhad Journal of Agriculture*, 28(3): 399-402.
- Statistix. 2006. *Statistics 8 User Guide*, version 1.0. Analytical software, P.O. Box 12185, Tallahassee FL 32317 USA; Copyright © 2006 by Analytical Software
- Vachhani, M.U., Patel, Z.G., 1993. Effect of nitrogen, phosphorus, and potash on bulb yield and quality of onion (*Allium cepa* L.). *Indian Journal of Agronomy*, 38: 333-334.
- Wakeel, A., 2014. Critical review of research on soil potassium and crops' response to potassium fertilizers in Pakistan: Perspectives and opportunities. *International Potash Institute*, 37: 16-21.
- Lata, K., Zubair, L., Wahocho, N.A, Noor-un-Nisa, M., Khalid, H.T., Waqas, A., Muzamil, F.J., Aftab, A.K., Safdar, A.W., 2023. Nitrogen nutrition affects the growth and bulb yield of garlic (*Allium sativum* L.). *Journal of Applied Research in Plant Sciences*, 4(1): 485-493.
- Yadav, R.L., Sen, N.L., Fageria, M.S., Dhaka, R.S., 2002. Effect of nitrogen and potassium fertilization on quality bulb production of onion. *Haryana Journal of Horticultural Sciences*, 31(3&4): 297-298.
- Zahid, H., Marwat, K.B., Shah, S.I.A., Arifullah, S.A., Khan, N.M., 2008. Evaluation of different herbicides for weed control in onion. *Sharad Journal of Agriculture*, 24(3): 453-456.