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Evaluating integrated use of potassium and mulching on growth and yield of onion

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ABSTRACT

The optimizing management practices including optimum potassium use and mulching approaches are pre-requisite for profitable onion production. The research study was carried out at the Onion Research Institute Husri, Hyderabad, Agricultural Research Center Tandojam aimed to evaluate the integrated use of potassium and mulching on onion growth and yield. The experiment involved the Nasarpuri onion variety, followed a three-replicated randomized complete block design (RCBD) with a factorial arrangement. The treatments included two factors. Factor-A represented potassium rates (kg K_2O ha^{-1}) (K_1= Control; 00, K_2= 40, K_3= 50, and K_4= 60), and Factor-B represented mulching (M_1= without mulching and M_2= With mulching). Data were collected for various parameters, including plant height; stem girth, bulb diameter, bulb weight, leaf weight, bulb yield, and potassium content in leaves and bulbs. The findings showed that plant height ranged from 33.17 to 44.80 cm, stem girth from 6.79 to 14.10 cm, bulb diameter from 45.17 to 67.00 cm, bulb weight from 10,796 to 29,126 kg ha^{-1}, leaf weight from 1,610 to 4,353 kg ha^{-1}, and the number of leaves per plant varied from 7.20 to 13.15. Additionally, potassium content in leaves ranged from 1.50% to 1.86%, and potassium content in bulbs varied from 1.14% to 1.35%. Notably, the combination of 60 Kg K_2O ha^{-1} with mulching resulted in the most favorable outcomes across various parameters. These results emphasize the importance of integrated potassium management and mulching techniques in enhancing onion growth, yield, and potassium uptake

Keywords: Potassium, mulching, growth, yield, onion

INTRODUCTION

Onions (*Allium cepa* L.) belongs to the Amaryllidaceous (Alliaceae) plant family and is cultivated worldwide under diverse climates (Danquah et al., 2022) Onion is rich in several health benefits compounds including vitamins, minerals, proteins, carbohydrates and dietary fiber. In Pakistan, onion yields per hectare are low (15-17 tons) compared to other onion-producing countries (Khokhar, 2019.). Several factors contribute to this low production, including poor varietal selection, fertilizer mismanagement, and inadequate cultural practices, such as planting density (Liliane & Charles, 2020). One critical factor affecting onion bulb yield is the availability of nutrients (Khokhar, 2019). Potassium (K) is well-recognized as a vital nutrient for vegetable crops growth (Mikkelsen, 2017). K is a major plant nutrient required in substantial amounts, primarily supplied through fertilizers (Manning, 2010). K plays essential roles in various physiological and biochemical processes within the plant, including photosynthesis, assimilate translocation, protein synthesis, water balance maintenance, and enzyme activity promotion. (Wang et al., 2013). Studies have emphasized the importance of K for onion yield and quality (Mozumder et al., 2007). Adequate K content in the bulb is crucial for storage quality (Abdissa et al., 2011). Deficiency of K in plant is evident through brown tips on older leaves and suboptimal bulb formation (Smallbon, 2018). Onions exhibit distinct bulb characteristics based on their varieties, varying in size, color, and shape (Havey, 2018). Beyond culinary use, onions are rich in nutrients, including vitamin C (a potent antioxidant), folate, and pyridoxine (essential for metabolism, red blood cells, and nerve function). Additionally, onions serve as a good source of potassium (Kim et al., 2023).

The yield of onions is significantly influenced by various cultural practices, with soil moisture conservation and optimal nutrient management especially nitrogen and potassium playing crucial roles (Khokhar, 2019). Achieving a

successful onion crop necessitates frequent irrigation, but in many onion-growing regions, irrigation facilities are not readily available. Furthermore, irrigation increases production costs. As an alternative to irrigation, artificial mulching using materials like rice straw, water hyacinth, and polythene sheets has been explored to conserve soil moisture (Perez, 2013).

Applying an appropriate quantity and source of K to onions during critical growth stages is essential for maintaining growth and quality (Ortolá & Knox, 2015). Onions remove significant amounts of nutrients from the soil, necessitating replenishment to maintain soil fertility. For achieving a bulb yield of 40 metric tons per hectare, optimal rates include 120 kg of nitrogen (N), 50 kg of phosphorus (P), and 160 kgs of K per hectare. Tekeste et al. (2018) observed higher onion yields and fresh bulb weights with the application of 150 kg of K_2O per hectare compared to other K levels. K plays a crucial role in plant growth, including photosynthesis enzyme activity, protein and carbohydrate synthesis, and resistance against pests and diseases (Sarker, 2020). In Pakistan, most soils contain relatively large amounts of total K as insoluble minerals, but only a small fraction is available to plants (Habib et al., 2014). Adequate K is essential for normal plant development, Symptoms of K deficiency include yellowish-white mottling, yellow and green discoloration between veins, and brown specks on leaf tips and margins (Kumar & Sharma, 2013).

Mulching serves as a valuable soil management tool, maintaining soil temperature, quality, and moisture while improving crop yield and water use efficiency (El-Beltagi et al., 2022). During experimental periods, mulching has been commonly employed to adapt to water scarcity, enhance soil water management, promote crop growth, and increase onion yield compared to control treatments (El–Metwally et al., 2022). In onion production, mulching practices are widespread, contributing to better growth and higher yields for most horticultural crops (Ghimire et al., 2024). The effectiveness of mulch lies in its ability to control weed growth, prevent soil runoff, conserve moisture, and reduce soil compaction caused by raindrops (Demo & Asefa, 2024). Different mulching materials exhibit varying degrees of control over these factors (Kader et al., 2017). The choice of mulching material also impacts the climate around the onion plants. Researchers have observed that temperature and moisture regimes in the soil are significantly influenced by mulching (Igbadun et al., 2012). Bulb development in onions is regulated by day length and temperature (Steer, 1980). Under favorable weather conditions, onion plants continue growing throughout winter, delaying bulb development until the temperature and day length exceed the minimum requirement. Some mulching materials, with distinct spectral properties, can increase soil temperature, thereby enhancing bulb development (Heißner et al., 2005). Overall, mulching reduces water loss through evaporation, leading to better moisture conservation in the soil (El-Beltagi et al., 2022). By adopting effective mulching practices, onion growers can optimize yield and improve crop quality. The present study was designed to investigate the integrated effects of K and mulching on onion growth and yield.

MATERIALS AND METHODS

Experimental details: The field experiment was conducted at Onion Research Institute Husri, Hyderabad, Agriculture Research Center) Tandojam. The experiment was laid out in a three-replicated Randomized Complete Block Design (RCBD) with factorial arrangements with a net plot size of 3x3.5 (10.5 m^2). Factor-A: Potassium rates (kg K_2O ha^{-1}) K_1= Control; 00, K_2= 40, K_3= 50 and K_4= 60. Factor-B: Mulching (M_1= without mulching and M_2= with mulching). Variety of onion used was Nasarpuri**.** For mulch application, banana leaves were collected from Tando Qaiser village near Tandojam. These leaves were used to mulch the crop at a depth of 2-5 cm for fifteen days, aiming to enhance seed germination.

Regarding fertilizer application, nitrogen (N) was applied at a rate of 120 kg ha^{-1} in three equal doses with a 30-day interval, using urea as a source of N. Additionally, 60 kg of phosphorus (P_2O_5) per hectare was applied at sowing time in the form of Di-ammonium phosphate (DAP) across all treatments. Potassium, in the form of sulfate of potash (SOP), was used according to the designed treatments during sowing.

Observations recorded: For taking observation 10 plants were selected randomly in each replication across all the treatments**.** Plant height was measured at ripening stage of the onion crop using measuring tape from nick of onion to top of the leaves of randomly selected plants from every treatments in centimeters. Stem girth was measured through the help of Vernier Calliper in mm in three points. First of all nick measure, second mid measure and third one head of stem measure and finally all these averaged. Number of leaves was counted from randomly selected plants in every treatment.Weight of leaves in grams of randomly selected plants for all treatments was recorded on digital weight balance and further calculated for kg ha^{-1}.For the measurement of bulb diameter in mm, Vernier Calliper was used to record diameter of bulb of randomly selected onion plants from all treatments. Bulb weight in grams was recorded from randomly selected plants of all treatments using digital balance further onion yield was calculated in kg ha^{-1}.

Soil sampling and analysis: Soil samples were evaluated for texture using the Bouyoucos method (1962). To measure particle size distribution, a dispersing agent was used with a 10% sodium hexametaphosphate solution. The soil suspension was left to settle for 8 to 12 hours, then transferred to a glass cylinder using a dispersion cup and mechanical stirrer. Distilled water was added to fill it up to the mark, and readings were taken after agitation and settling for 4 and 120 minutes, respectively. The temperature of the suspension was adjusted to 68°F, and textural class was determined based on these readings.

Soil-water extracts (1:2 ratio) were prepared to determine electrical conductivity (EC) and pH. The extracts were shaken on an orbital machine for 30 minutes at 180 rotations per minute. After filtration, the clear extract was used for pH measurement. Calibration was done using buffer solutions of pH 7.0 and 9.0. EC testing was performed after calibrating the equipment with standard potassium chloride at 25°C.

Organic matter content was assessed using the Walkley-Black method (Tahir & Jabbar, 1985). Soil was processed with potassium dichromate in the presence of sulfuric acid. The reduced dichromate was measured using ammonium sulfate titration. A mixture of 1 g of soil, 10 ml of 1N potassium dichromate solution, and concentrated sulfuric acid was used. The endpoint was indicated by a brilliant-green color.AB-DTPA (diethylenetriaminepentaacetic acid) was used to extract P and K from the soil (Eppley & Vosburgh, 1922). The extracted phosphorus reacted with a color solution, and the blue complex was measured using a spectrophotometer (Gee & Deitz, 1953). K in AB-DTPA extracts was quantified using a flame photometer (Meena, 2014).

Statistical analysis: The collected data were subjected to analysis of variance (ANOVA) technique using computer software Statistix Ver. 8.1 (Statistix, 2006). The least significant difference (LSD) test was applied to compare treatments superiority, where necessary.

RESULTS

Physico-chemical properties of soil: The soil was analyzed for its physico-chemical properties before planting onions, with the relevant data presented in Figure 1. At a depth of 0-20 cm, particle size analysis showed the soil contained 15% clay, 70% silt, and 15% sand, resulting in an overall silty loam texture. The soil was non-saline, with an electrical conductivity (EC) of 2.36 dS m^{-1}. The pH was moderately alkaline at 8.3. The soil had low organic matter content (0.62%) and low nitrogen content (0.112%). However, ABDTPA-extractable phosphorus (3.10 mg/kg) and potassium (112 mg/kg) were at medium levels.

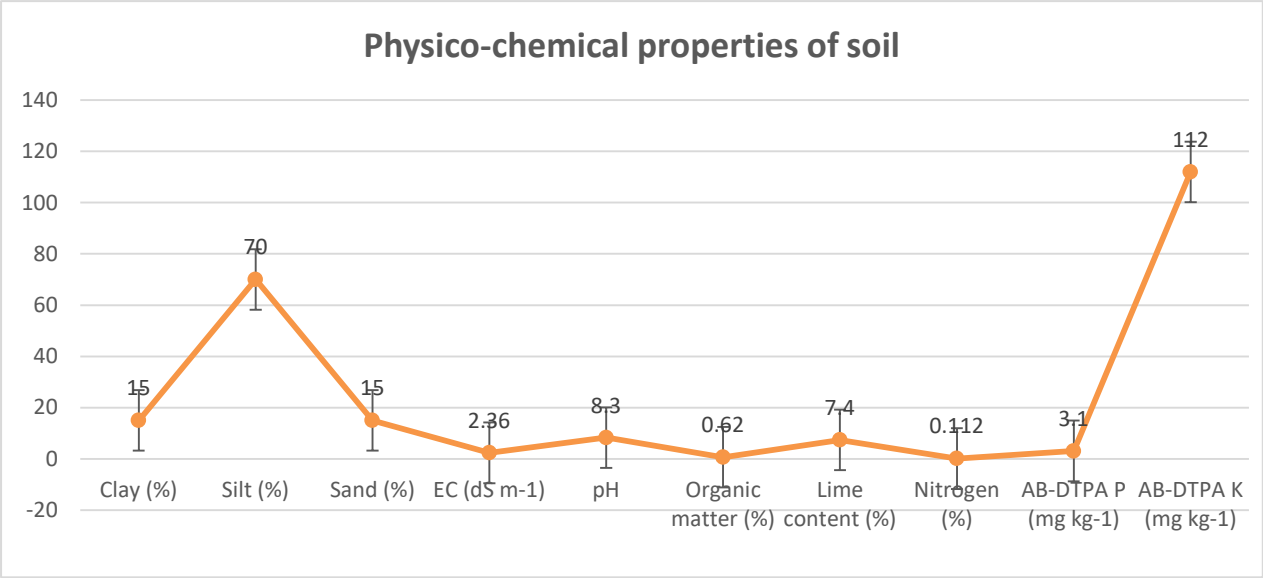

Figure 1 Physico-chemical properties of soil

Plant height (cm): The study examined the impact of potassium (K) and mulching on onion plant height. The analysis of variance revealed a significant effect of both K and mulching ($P < 0.05$) Table 1. The highest plant height (42.56 cm) occurred with an application rate of 60 kg K_2O per hectare, followed by 50 kg K_2O per hectare (40.53 cm) and 40 kg K_2O per hectare (38.67 cm), respectively. Conversely, the control group exhibited the lowest plant height (36.42 cm). Mulching significantly increased plant height (42.21 cm) in mulched plants, while non-mulched plants reached a minimum height of 36.89 cm. When considering the interaction between K rates and mulching, the maximum plant height (44.80 cm) was observed with 60 kg K_2O per hectare in conjunction with mulching, whereas the control group without mulching had a minimum height of 33.17 cm.

Table 1. Effect of potassium and mulching on plant height (cm)

Potassium rates (kg K_2O ha^{-1})	**Without mulching (M_1)**	**With mulching (M_2)**	**Mean**
Control (K_1)	33.17 e	39.67 bcd	36.42 C
40 (K_2)	36.03 de	41.30 abc	38.67 BC
50 (K_3)	38.00 cde	43.07 ab	40.53 AB
60 (K_4)	40.37 abcd	44.80 a	42.56 A
Mean	36.89 B	42.21 A	-
Variables	**Potassium (K)**	**Mulching (M)**	**K x M**

SE	1.6213	1.1464	2.2929
$LSD_{0.05}$	3.4774	2.4589	4.9177

Stem girth (mm): The study examined the impact of potassium (K) and mulching on onion stem girth. The analysis of variance revealed a significant effect of both K and mulching ($P < 0.05$) **Table 2**. Based on the mean of K treatments, the maximum stem girth (12.28 mm) occurred with an application rate of 60 kg K_2O per hectare, followed by 50 kg K_2O per hectare (11.27 mm) and 40 kg K_2O per hectare (10.20 mm), respectively. Conversely, the control group exhibited the lowest stem girth (8.68 mm). Mulching significantly increased stem girth (12.48 mm) in mulched plants, while non-mulched plants reached a minimum girth of 8.72 mm. The interaction analysis showed that the maximum stem girth (14.10 mm) occurred with 60 kg K_2O per hectare and mulched plants.

Table 2 Effect of potassium and mulching on stem girth (mm)

Potassium rates (kg K_2O ha^{-1})			**Mean**
	Without mulching (M_1)	**With mulching (M_2)**	
Control (K_1)	6.79 f	10.57 cd	**8.68 C**
40 (K_2)	8.41 e	11.99 bc	**10.20 B**
50 (K_3)	9.28 de	13.25 ab	**11.27 A**
60 (K_4)	10.41 d	14.10 a	**12.25 A**
Mean	**8.72 B**	**12.48 A**	-
Variables	**Potassium (K)**	**Mulching (M)**	**KxM**
SE	0.4941	0.3494	0.6987
$LSD_{(0.05)}$	1.0597	0.7493	1.4987

Number of leaves $plant^{-1}$: The study investigated the impact of potassium (K) and mulching on the number of leaves per onion plant (no. of leaves plant-1). The analysis of variance revealed a significant effect of both K and mulching ($P < 0.05$) **Table 3**. Based on the mean of K treatments, the maximum leaf count (14.63) occurred with an application rate of 60 kg K_2O per hectare, followed by 50 kg K_2O per hectare (13.00) and 40 kg K_2O per hectare (11.08), respectively. Conversely, the control group exhibited the lowest leaf count (8.28). Mulching significantly increased the leaf count (13.15) in mulched plants, while non-mulched plants had a minimum count of 10.35. The interaction analysis showed that the maximum leaf count (16.00) occurred with 60 kg K_2O per hectare and mulched plants.

Table 3 Effect of potassium and mulching on number of leaves $plant^{-1}$

Potassium rates (kg K_2O ha^{-1})			**Mean**
	Without mulching (M_1)	**With mulching (M_2)**	
Control (K_1)	7.20 f	9.37 e	**8.28 D**
40 (K_2)	9.20 e	12.96 c	**11.08 C**
50 (K_3)	11.73 d	14.27 b	**13.00 B**
60 (K_4)	13.27 bc	16.00 a	**14.63 A**
Mean	**10.35 B**	**13.15 A**	-
Variables	**Potassium (K)**	**Mulching (M)**	**KxM**
SE	0.3502	0.2476	0.4953
$LSD_{(0.05)}$	0.7511	0.5311	1.0622

Bulb diameter (mm): The study investigated the impact of potassium (K) and mulching on onion bulb diameter. The analysis of variance revealed a significant effect of both K and mulching ($P < 0.05$) **Table 4**. Based on the mean of K treatments, the maximum bulb diameter (62.18 mm) occurred with an application rate of 60 kg K_2O per hectare, followed by 50 kg K_2O per hectare (58.50 mm) and 40 kg K_2O per hectare (54.02 mm), respectively. Conversely, the control group exhibited the lowest bulb diameter (47.97 mm). Mulching significantly increased bulb diameter (59.20 mm) in mulched plants, while non-mulched plants had a minimum diameter of 52.13 mm. Regarding, the interaction between K rates and mulching, the maximum bulb diameter (67.00 mm) was observed with 60 kg K_2O per hectare and mulched plants

Table 4 Effect of potassium and mulching on bulb diameter (mm)

Potassium rates (kg K_2O ha^{-1})			**Mean**
	Without mulching (M_1)	**With mulching (M_2)**	
Control (K_1)	45.17 f	50.77 e	**47.97 D**
40 (K_2)	51.27 e	56.77 cd	**54.02 C**
50 (K_3)	54.73 d	62.27 b	**58.50 B**
60 (K_4)	57.37 c	67.00 a	**62.18 A**
Mean	**52.13 B**	**59.20 A**	-

Variables	**Potassium (K)**	**Mulching (M)**	**KxM**
SE	0.7917	0.5598	1.1196
$LSD_{(0.05)}$	1.6980	1.2006	2.4013

Bulb weight (Kg ha^{-1}): The study examined the impact of potassium (K) and mulching on onion bulb weight. The analysis of variance revealed a significant effect of both K and mulching **Table 5**. Among the K treatments, the highest bulb weight (26,533 kg ha^{-1}) occurred with 60 kg K2O per hectare, followed by 50 kg K2O per hectare (21,633 kg ha^{-1}) and 40 kg K2O per hectare (18,507 kg ha^{-1}). The control group had the lowest bulb weight (12,996 kg ha^{-1}). Mulching significantly increased bulb weight (21,718 kg ha^{-1}), while no mulching resulted in a lower weight (18,118 kg ha^{-1}). The interaction of 60 kg K2O per hectare and mulching produced the highest bulb weight (29,126 kg ha^{-1}), whereas the control group without mulching had the lowest weight (10,796 kg ha^{-1})

Table 5 Effect of potassium and mulching on bulb weight (kg ha^{-1})

Potassium rates (kg K_2O ha^{-1})			**Mean**
	Without mulching (M_1)	**With mulching (M_2)**	
Control (K_1)	10796 f	15196 e	**12996 D**
40 (K_2)	17459 d	19556 c	**18507 C**
50 (K_3)	20274 c	22993 b	**21633 B**
60 (K_4)	23941 b	29126 a	**26533 A**
Mean	**18118 B**	**21718 A**	-
Variables	**Potassium (K)**	**Mulching (M)**	**KxM**
SE	533.90	378.94	757.87
$LSD_{(0.05)}$	1149.4	812.74	1625.5

Weight of leaves: The study investigated the impact of potassium (K) and mulching on onion leaf weight. The analysis of variance revealed a significant effect of both K and mulching. Among the K treatments, the highest leaf weight (3,965 kg ha^{-1}) occurred with 60 kg K2O per hectare, followed by 50 kg K2O per hectare (3,402 kg ha^{-1}) and 40 kg K2O per hectare (2,715 kg ha^{-1}) Table 6. The control group had the lowest leaf weight (1,938 kg ha^{-1}). Mulching significantly increased leaf weight (3,276 kg ha^{-1}), while no mulching resulted in a lower weight (2,734 kg ha^{-1}). The interaction of 60 kg K2O per hectare and mulching produced the highest leaf weight (4,353 kg ha^{-1}), whereas the control group without mulching had the lowest weight (1,610 kg ha^{-1}).

Table 6 Effect of potassium and mulching on weight of leaves (kg ha^{-1})

Potassium rates (kg K_2O ha^{-1})			**Mean**
	Without mulching (M_1)	**With mulching (M_2)**	
Control (K_1)	1610 g	2266 f	**1938 D**
40 (K_2)	2561 e	2869 d	**2715 C**
50 (K_3)	3188 c	3616 b	**3402 B**
60 (K_4)	3578 b	4353 a	**3965 A**
Mean	**2734 B**	**3276 A**	-
Variables	**Potassium (K)**	**Mulching (M)**	**KxM**
SE	78.939	55.818	111.64
$LSD_{(0.05)}$	169.31	119.72	239.44

K content in bulb (%): The study examined the impact of potassium (K) and mulching on onion bulb potassium content. The analysis of variance revealed a significant effect of both K and mulching. Among the K treatments, the highest K content in bulbs (1.30%) occurred with 60 kg K2O per hectare, followed by 50 kg K2O per hectare (1.25%) and 40 kg K2O per hectare (1.22%) **Table 7**. The control group had the lowest K content in bulbs (1.19%). Mulching significantly increased K content in bulbs (1.29%) in mulched plants, whereas no mulching resulted in a lower K content (1.18%). The interaction of 60 kg K2O per hectare and mulching produced the highest K content in bulbs (1.35%), whereas the control group without mulching had the lowest content (1.14%)

Table 7 Effect of potassium and mulching on K content in bulb (%)

Potassium rates (kg K_2O ha^{-1})			**Mean**
	M1	**M2**	
Control	1.14 f	1.25 cd	**1.19 C**
40 kg K2O ha^{-1}	1.16 ef	1.27 c	**1.22 C**
50 kg K2O ha^{-1}	1.18 e	1.31 b	**1.25 B**
60 kg K 2Oha^{-1}	1.24 d	1.35 a	**1.30 A**
Mean	**1.18 B**	**1.29 A**	-
Variables	**Potassium (K)**	**Mulching (M)**	**KxM**
SE	0.0096	0.0068	0.0124

LSD $_{(0.05)}$	0.0188	0.0133	0.0266

K content in leaves (%): The results regarding potassium (K) levels in onion leaves, influenced by K application and mulching, are shown in **Table 8**, with the analysis of variance detailed in Appendix VII. The variance analysis indicated a significant effect ($P<0.05$) of both K application and mulching on K levels in the leaves. The interaction between K doses and mulching was also significant.The highest mean K level in leaves (1.76%) was recorded with 60 kg K2O ha^{-1}, followed by 50 kg K2O ha^{-1} and 40 kg K2O ha^{-1} (1.70% and 1.65%, respectively). The lowest K level (1.60%) was observed in the control group. Mulching significantly increased K levels in leaves to 1.78%, compared to 1.58% without mulching. The highest K level in leaves (1.86%) was found with 60 kg K2O ha^{-1} combined with mulching, while the lowest (1.50%) occurred in the control group without mulching.

Table 8 Effect of potassium and mulching on K content in leaves (%)

Potassium rates (kg K_2O ha^{-1})			**Mean**
	Without mulching (M_1)	**With mulching (M_2)**	
Control (K_1)	1.50 g	1.70 d	**1.60 D**
40 (K_2)	1.54 g	1.75 c	**1.65 C**
50 (K_3)	1.60 f	1.80 b	**1.70 B**
60 (K_4)	1.65 e	1.86 a	**1.76 A**
Mean	**1.58 B**	**1.78 A**	-
Variables	**Potassium (K)**	**Mulching (M)**	**KxM**
SE	0.0138	0.0106	0.0195
LSD $_{(0.05)}$	0.0296***	0,0209*	0.0419

DISCUSSION

The present study investigated the integrated effect of potassium and mulching on the growth and yield of onion. Substantial improvement was observed in growth and bulb related traits by use of potassium and mulching. Potassium nutrition together with mulching showed significant variation in growth and development of onion. Mulching alongside the K nutrition might have caused better water retention and conservation in the root zone during entire growth period of onion and it is well recognized that water has a significant effect on uptake and utilization of nutrient and photosynthesis which favoured the growth and development of crops that led to plants with better growth and bulb development. The highly favorable effect of mulch is also found by Islam et al. (2010) who described that mulch in combination with nitrogen and K revealed better results for growth and bulb related attributes in onion. In this study, potassium fertilization in combination with banana mulch improved the growth and development of onion. The favorable effect of increased K rate in enhancing the growth and productivity of onion was attributed to the fact that potassium played a key role in producing healthy and heavier bulbs. This also reflects that Potassium plays a vital role in the movement of carbohydrates synthesized during photosynthesis. It facilitates the translocation of these carbohydrates from the leaves, where they are produced, to storage organs like bulbs, tubers, or fruits. This ensures proper energy storage and supports the growth of plant structures critical for reproduction and final harvest The earlier studies have shown that adequate concentration of potassium not only enhances size and yield but also aids in better water use efficiency through improved activation of enzymes involved in bulb formation as well as plant metabolism (Mukhtar et al., 2024). This positive effect of potassium in increasing growth on the onion is in agreement with various studies conducted earlier (Islam et al., 2010; Khokhar et al. 2019). The outcomes of Luitel et al. (2024) revealed that onion plants which were fertilized with potassium with a close to 50-60 kg K_2O ha-1 had greater height and bulb weight than the control ones, which was quite in line with those outcomes of the current study. In the present study mulching with banana had highly desirable effect on the growth and bulb formation and development of onion. The positive effect of mulch in comparison with bare soil on onion growth and bulb development might be due to the fact that banana mulch might have depressed infiltration rate that led to reduction in leaching of nutrients, regulate temperature of soil, retained soil moisture, reduction of weed growth (Mohammed et al., 2019). Moreover, mulch also supplied organic matter to the soil after decomposition, enhanced the floral activity of the soil and provided favourable environmental conditions near the root zone of plants that positively contributed to overall growth and development of plants that eventually led to healthy growth of plants with higher bulb production (Islam et al., 2010). The favourable effect of mulch is found by Rahman et al. (2013) who underscored that plants gown under mulching environment revealed higher values for most of the parameters studied as compared to those not mulched. The maximum attained plant height, stem girth, bulb diameter and weight were registered in the plant that were grown under mulch. This reflected that mulching might have increased soil moisture retention and regulated temperature, besides reducing weed growth. Our findings are in line with Mutetwa and Mtaita, (2014); Rachel et al. (2018) who also found favourable effect of mulching in their studies on the growth and development of onion. The beneficial effect of mulching have also been noted in garlic by Islam et al. (2007); Karim et al. (2011); Mohammed et al. (2019) who reported that plants grown

under straw mulch attained increased plant height, with maximum leaves. Moreover plants cultivated under mulched condition also showed maximum fresh and dry weight of leaves. Likewise the findings of Abouziena et al. (2015) and Abd El-Mageed et al. (2016) are also in with our study who described that garlic crop grown under rice straw mulch showed maximum bulb yield which was significantly higher than the plants which were not grownup under bare soil. Maximum bulb weight and diameter was found in plots received with a combination of 60 kg K2O ha-1 with mulching possibly due to higher moisture content in plots that resulted in release of available nutrients for onion plants to uptake eventually led to better growth and bulb development. Interaction between potassium and mulching indicates the complementary effects on onion-growth. Potash enhances the regulation of nutrient and water in a plant, whereas mulching ensures adequate water and nutrient availability through preventing temperature fluctuation in temperature and water loss in soil. Our findings are consistent with Sarker (2020) who reported that Potassium application combined with mulching brought a positive impact on onion onion growth and development. Similar beneficial effect of potassium in combination with mulching was also found by Islam et al. (2010) in growth and bulb related traits in onion. The outcomes of other researchers including (Anisuzzaman et al., 2009; Rahman et al., 2013; Rachel et al., 2018: Ghimire et al., 2024) advocated the outcomes of our study with regards to positive effect of mulching on onion growth and bulb development. The potassium contents in the onion leaves and bulbs were also determined in this study. The results showed that the leaves had potassium values ranging between 1.50% to 1.86% whilst the bulbs stood between 1.14% to 1.35%. The highest content of potassium within the leaves and bulbs was found in plants fertilized with the highest applications of potassium (60 kg K_2O ha-1). This is also consistent with the physiological role of potassium as an enhancer of the plant's capacity to uptake and translocate nutrients. Jansson, (1980) explained the role of potassium in increasing the potassium concentration in the aerial and storage parts of the plant such as bulbs. Potassium acts as an activator of several enzymes that control the rate of photosynthesis as well as carbohydrate synthesis; hence, affecting both quality and quantity of bulbs at harvest. Furthermore, the higher potassium content in the bulbs of plants treated with potassium and mulching may have contributed to the better bulb size and weight observed in this study.

CONCLUSIONS

The current study underscored the significance of integrated potassium management and mulching for enhancing onion growth, yield, and potassium uptake. Notably, the combination of 60 kg K_2O per hectare with mulching revealed the most favorable outcomes across various parameters, including plant height, stem girth, bulb diameter, bulb weight, leaf weight, and potassium content in leaves and bulbs. These findings highlight the potential benefits of optimizing potassium application and implementing effective mulching practices in onion cultivation.

RECOMMENDATIONS

The results of current study demonstrated the beneficial effect of potassium in combination with banana mulch for better growth and bulb development of onion. Further should be focused on diverse crop species by applying other nutrient sources in combination with different organic mulches for efficient nutrient management and water conservation and use efficacy

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AUTHOR'S CONTRIBUTION

Designed the study and wrote the initial draft of the manuscript: B. Shah, K.H. Talpur, performed the study and collected data: Z. Shah and H. Sardar, Helped in data analysis: Azatullah, Provided technical help: H. Kakar, Assisted in assembling the data: G.N. Talpur, Assisted in data analysis: M.A. Wagan: Offered technical input and helped in writing of manuscript: K.H. Talpur, Assisted in review and editing of the manuscript: S.A. Wahocho

CONFLICTS OF INTEREST

The authors have declared no conflict of interest

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