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EFFECTS OF GENOTYPES AND MULCHING ON GROWTH AND YIELD OF ONION

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ABSTRACT

Selection of the right genotype and optimizing management practices are essential for higher crop productivity. In the area of onion cultivation, the correlation between onion genotypes and mulching remains a relatively unexplored terrain. To identify this association, an experiment was conducted at the Horticulture Development Resource Centre, Kaski, from November to April 2023. Structured in two factorial randomized complete block designs, the experiment featured five genotypes—AVON 1052, AVON 1103, Khumal 1, Khumal 2, and Red Creole (check variety)—and two mulching levels, namely black plastic mulch and control, with four replications. Significant variations were found among genotypes in response to mulching. Red Creole, Khumal 1, and AVON 1103 exhibited a significant difference in plant height and leaf number. AVON 1052, Khumal 2, and Khumal 1 showed a substantial divergence in average total bulb diameter with and without mulching. Furthermore, with the exception of Red Creole, other genotypes demonstrated a significant difference in total bulb yield, favoring mulching with black plastic. Khumal 2, produced a yield of 11.7 t ha^{-1} without mulching, attributed its success to larger bulb diameter, more leaves (8), and taller plants (66.8 cm), while Khumal 2 (16 t ha^{-1}) under mulching showed similar yielding potential as Red Creole. Ultimately, the recommendation of mulching in Khumal 2 was given owing to the bulb-splitting problem in Red Creole and indifferent yield in Khumal 2 as compared to Red Creole. This research shows how better onion types and using mulch can enhance onion production and promote agricultural sustainability in Nepal.

Keywords: Black polythene mulch, Bulb diameter, Microclimate, Soil moisture, Yield

1. INTRODUCTION

In the Alliaceae family, onion (*Allium cepa L.*) is one of the most important vegetable worldwide, including Nepal. It is a rich source of phosphorus, calcium, and carbohydrate. Along with these minerals, onion has several antibacterial and anti-fungal properties, that's why it has been used to prevent infection in wounds and burn from the very beginning (Luitel et al., 2021). Similarly, the sulfur volatiles from onion have been found to control Asian citrus psyllid (Mann et al., 2011) and the intercropping of onion and garlic acts as a good method of pest control (Debra & Misheck, 2014).

As per the global review of the area and production of major vegetable crops, onion ranks third in area and production (Board, 2015). According to the current market price, 417,000 metric tons of onions worth more than Rs. 25 billion are consumed in Nepal in a year. As per the data of the National Center for Potato, Vegetable and Spice Crop Development, 289,000

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tons of onions were produced in Nepal in the fiscal year 2020/21, while 129,000 metric tons had to be imported from abroad to meet the demand. In the same year, 11.5 tons of onions were exported from Nepal. Similarly, as per MoALD (2023), the area of onion is 13,189 ha, with its overall production of 166,904 mt, and yield of 12.65 mt ha^{-1}. As a result, the onion's overall GDP contribution to agriculture is 0.9473% (MoALD, 2023).

Many factors, including low yield and a small number of varieties, the lack of high-quality seed at the necessary planting time and location, bulb splitting, cultivars' poor adaptation to low input management conditions, and others, contribute to Nepal's lower onion productivity (12.65 mt ha^{-1}) than the global average (19.7 mt ha^{-1}) and neighboring countries (India: 31.69 mt ha^{-1}) (Srivastva et al., 2022). It says a lot about the status of onion cultivation in Nepal. Farmers cannot afford to pay high prices for seed every year and high input costs because the majority of imported cultivars on the market are hybrids and receptive to heavy inputs (Gautam et al., 2019) that's why the Nepalese farmers depend upon traditional onion cultivars which produce less per acre of land, limiting harvesting and making it challenging for farmers to make a livelihood. They have higher disease and insect susceptibility, leading to poorer yields and increased pesticide use (Luitel et al., 2021). They spoil quickly, have a lower shelf life, and produce inconsistent quality (Gyawali et al., 2022) inadequate approach to market and seasonal fluctuation of available vegetable creates difficulties in commercialization of off-season production. The current paper describes about what opportunities and importance do off-season farming has in Nepal and the constraints it has to encounter with. The cheap availability of labour, increasing interest of the government, and climatic suitability provide an opportunity for the farmers to make profitable income due to high prices during the off-season period which reduces the risk of failure of the farm, marketing risk, and maintains market equilibrium. Nevertheless, this cultivation system faces challenges of high post-harvest loss, poor implementation of policies, hijacked subsidies, inadequate irrigation facilities, and high pest infestation on-farm side and scarcity of cold storage, high transact cost, unmanaged collection, and market centers on the market side. Commercialization of off-season vegetable production can create a better environment for income improvement and maintain market equilibrium.

Onions are sensitive to drought stress, requiring regular watering for seed yield (Zayton, 2007). Throughout the growing season, the crop needs 350-500mm of water (FAO, 2023). Therefore, ensuring sufficient moisture, potentially achieved through irrigation or other ways, plays a crucial role in onion production. As such, mulching is a valuable technique that lowers the amount of soil moisture lost through evaporation (Mahajan et al., 2007). It lessens the need for irrigation, fosters the growth of roots, speeds up the development of crops, decreases the risk of weeds taking over, and encourages an earlier harvest of the crops (Ngouajio et al., 2008; Vavrina & Roka, 2000). Using polythene mulch raises the temperature of the soil and improves the effectiveness of applied nitrogen fertilizer by decreasing the loss of nutrients through leaching and evaporation (Kashi et al., 2004; Roy et al., 1990). Similarly, the use of black polythene mulch have also found to show the higher bulb diameter and single bulb yield than in control which ultimately increases the total bulb yield in onion (Rachel et al., 2018).

Thus, the objective of this study is to determine the effect of mulches on various genotypes of onion regarding their growth and yield in Pokhara Valley.

2. METHODOLOGY

2.1 EXPERIMENTAL SITE

The field trial was conducted at Horticulture Development Resource Centre (HDRC), Pokhara, situated at the latitude of 28°16'0.80" N and longitude of 83°58'6.64" E during the month of November to May of 2022. The lab works were carried out in the Horticulture lab of the Centre.

2.2 EXPERIMENTAL MATERIALS, DESIGN AND CULTURAL PRACTICES

The seeds of four onion genotypes, AVON 1052, AVON 1103, Khumal 1 and Khumal 2 were obtained from Horticulture Research Division of Nepal Agriculture Research Council (NARC), Khumaltar, Lalitpur. A standard check variety, Red Creole was obtained from the nearby market. Two factorial experiment was designed in randomized complete block with five genotypes and two mulching levels: with and without mulching, replicated four times.

The nursery bed was plowed, harrowed, and levelled before seed was sown on November 27, 2022. The field was ploughed three days before transplanting, and weeds and stubbles were incorporated. Transplantation was done on January 20, 2023, in forty plots with a hundred plant population in each plot and spacing 20×15 cm. FYM dose of 20 ton/ha and fertilizer rate of 240:180:180 kg NPK/ha were applied during transplanting. Full dose of FYM, Phosphorous, Potash and half dose of nitrogen were applied at the time of transplanting as basal dose and remaining half dose of Nitrogen was top dressed at 30 days after transplanting (DAT) and 60DAT. Black polythene of 30μ thickness was used as mulch, and irrigation was given immediately after transplantation. Weeding was conducted at 30, 45, and 60 days after transplanting. Regular observations were made on onion growth and development in different plots.

2.3 DATA COLLECTION AND ANALYSIS

The observations on different parameters such as plant height, number of leaves, bulb diameter, bulb thickness, root length, skin thickness, number of scales, and bulb yield were recorded. Ten plants from each plot were taken for the observation of data. The data on bulb diameter, bulb thickness, and skin thickness was taken using Vernier's caliper and the data on the plant height and number of leaves were taken on 30DAT, 60DAT, and 90DAT respectively. The plants were harvested after 131 days on the 1^{st} of May, 2023.

The data was then prepared for data analysis by arranging in Microsoft Excel and after that, the arranged data was subjected to an analysis to determine its normal distribution. For that purpose, Shapiro-Wilk test was used. Similarly two-factor ANOVA test was also done to identify the significance of the results and, the mean of different parameters was compared by least significant difference (LSD test) as described by Gomez and Gomez (1984); in R-studio 4.3.2.

3. RESULTS AND DISCUSSIONS

3.1 PLANT HEIGHT

Plant height varied among the different treatments. Red Creole had the tallest plants in both the control (no mulching) and mulched environments until 60 days after transplanting (60DAT). After that point, Red Creole's (74.6 ± 2.7[a] cm) plants grew rapidly, especially in the absence of mulching. Khumal 2 (66.8 ± 1.2[b] cm) closely followed Red Creole in terms of plant height in both conditions, surpassing the other types. Meanwhile, Khumal 1 (66.1±0.7[b] cm) showed better plant height than AVON 1103 (61.4 ±1.8[cde] cm) and AVON 1052 (58.4±3.0[def] cm) when mulching was used, but AVON 1103 (59.6±0.8[de] cm) exceeded AVON 1052 (57.4±0.7[ef] cm) and Khumal 1 (54.9±1.7[f] cm) when there was no mulching.

Red Creole plants benefited from mulching, achieving a maximum height, which may be because of its ability to optimally utilize the soil moisture that is conserved from mulching (Anisuzzaman et al., 2009).

According to Sarkar et al. (2019), higher soil moisture with lower soil temperature might be responsible for keeping the favorable growing microclimatic environment in the soil which might cause vigorous growth of a plant that ensures increased photosynthetic capacity by leaves and ultimately attain the maximum bulb development and plant height.

The plant height of different onion genotypes along the crop cycle grown under mulching and non- mulching has been represented in Figure 1.

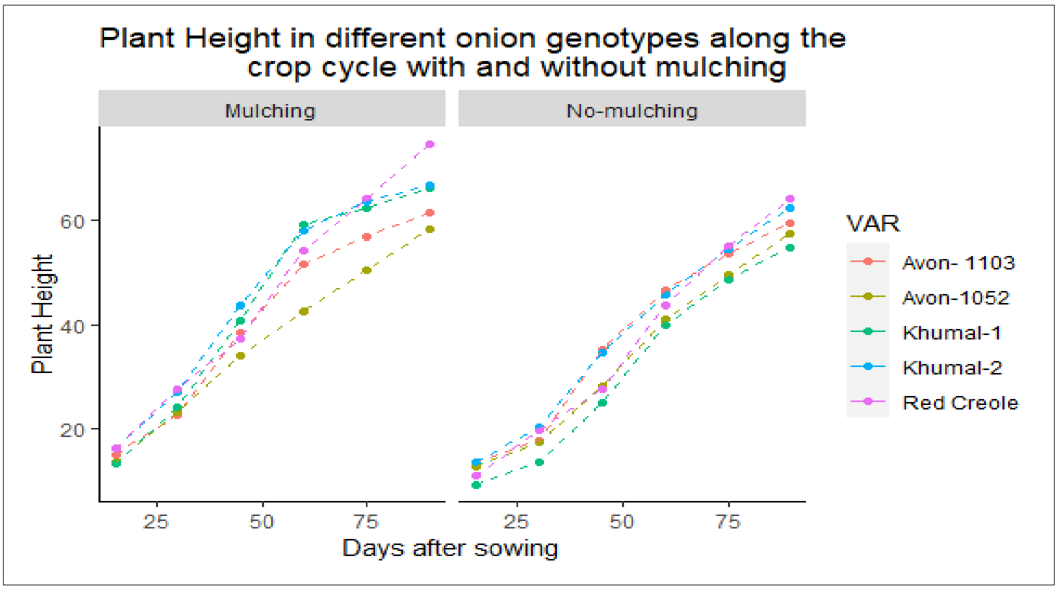

Figure 1. Plant height during different phases of growth in onion with mulching and without mulching

3.2 LEAF NUMBER

The leaf number showed significant differences when grown under different conditions of mulching. Red Creole (10.6±0.6[a]) showed the maximum number of leaves under mulching whereas Khumal 2 (7.7±0.2[cd]) surpasses Red Creole under non- mulching. Khumal 1 showed the highest leaf count(8.8±0.5[b]) under mulching up until 45 DAT after which its progress was slower than that of Red Creole. Under both conditions, AVON 1052 (7.7±0.2[cde] under mulch and 6.8±0.2[e] under non-mulch) was found to bear the least number of leaves.

The genetic make-up of the variety and its compatibility for various climatic and soil conditions may be the causes of the variations in leaf count (Gosai et al., 2018). The significant results on number of leaves were also reported from Singh (2017) and Gautam et al. (2019). In contrast, non-significant difference on the number of leaves between treatments were reported from Mitiku and Tadesse (2018).

Plants grown during the entire season under polythene film mulches slightly increased the vegetative growth stage of onion plant. Mulching with polythene films alter the microclimatic conditions of soil affecting the number of leaves (Sarkar et al., 2019). Ashrafuzzaman et al. (2011) stated that mulches provide suitable condition for producing a higher number of leaves in chilli and in onion.

The number of leaves in different onion genotypes along the crop cycle grown under mulching and non- mulching has be represented in Figure 2.

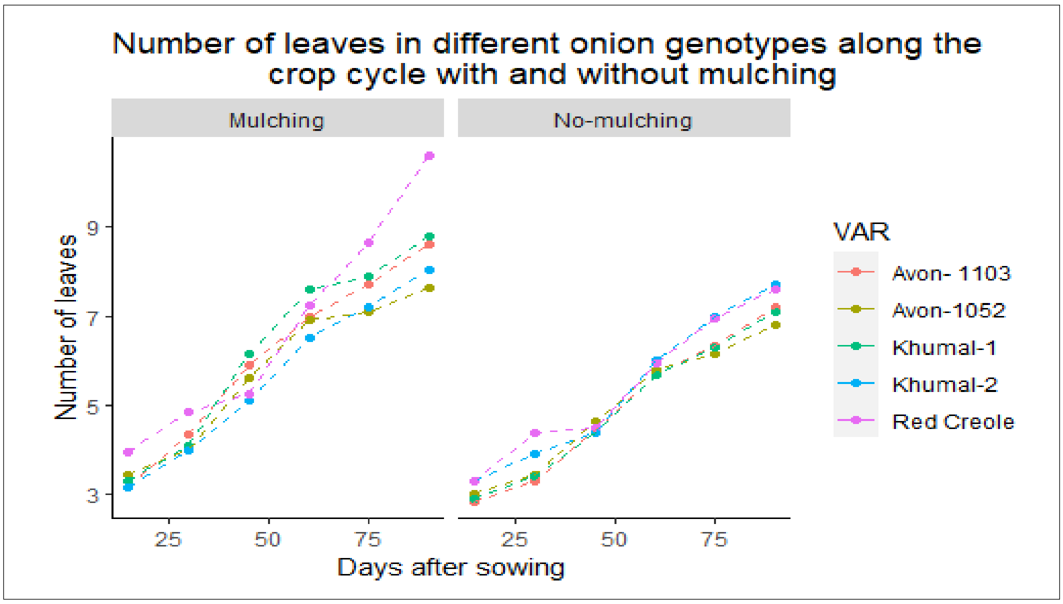

Figure 2. Number of leaves during different phases of growth in onion with mulching and without mulching

3.3 BULB DIAMETER (POLAR AND EQUATORIAL)

The analysis showed significant differences across genotype, mulch environment, and their interaction at both equatorial and polar bulb diameter. Among the genotypes, Khumal 2 and AVON 1103 produced plump bulbs matching the equatorial diameter of the standard variety Red Creole, while Khumal 1 and AVON 1052 had substantially lower equatorial bulb diameters than the standard check. In addition, Khumal 2 had significantly higher polar diameters than all the genotypes and the standard check Red Creole except Khumal 1, suggesting a large and long tapering shape of the bulbs in Khumal 2. The differences in the polar diameters were not as conspicuous as the equatorial diameter among the genotypes as shown in Table 1.

The equatorial and polar diameters as affected by the mulching environment, however, was very clear with bulbs produced under a mulched environment being larger($50.7±0.6^{a}$mm and $41.8±1.1^{a}$mm) exhibited by significantly higher equatorial and polar diameter respectively, compared to bulbs produced without mulching ($43.5±1.3^{b}$mm equatorial and $35.8±0.5^{b}$mm polar diameter). Red Creole ($49.6±0.6^{a}$mm) and Khumal 2 ($49.0±1.7^{a}$mm) has the largest equatorial diameter among all while AVON 1052 ($43.6±3.2^{c}$mm) shows the smallest equatorial diameter. Incase of polar diameter, Khumal 2 ($42.5±2.1^{a}$ mm) shows the largest diameter while AVON 1103 ($35.7±0.9^{c}$mm) shows the smallest diameter.

The interaction of the genotypes and the mulching environment showed that the equatorial bulb diameter in all the onion genotypes remained at par in the mulched environment and the differences among the genotypes in the equatorial bulb diameter as discussed above were observed only in the absence of mulching. In contrast, the polar diameter was different along the varieties when mulching was provided but remained unaffected without mulching. Khumal 2 ($47.9±0.9^{a}$ mm under mulch and $37±0.7^{cd}$ mm under non-mulch) and Khumal 1 ($44.3±0.9^{ab}$ mm under mulch and $34.9±0.3^{d}$ under non-mulch) produced bulbs with greater polar bulb diameter than other genotypes and the standard check variety Red Creole.

Higher polar diameter found in mulching of Khumal 2 represented by the long tapering bulb shape of the genotype, are overexpressed in an increased temperature and water-abundant environment. The higher number of scales and greater scale diameter in Khumal 2 can be attributed to their larger bulb size among all the genotypes. Similar trends of increase in bulb diameters across mulching environments are also reported by Mushtaq et al. (2013). As suggested by Abu-Gharbieh et al. (1991), mulching increases temperature, and water retention and reduces weed infestation to produce larger onion bulbs. The increase in bulb size can be further aggravated by increased nutrients (N, P, and K) availability under plastic mulches (Basnet et al., 2018)

3.4 NECK DIAMETER

The experiment conducted highlighted that there were no notable variations in neck diameter among the various onion genotypes. However, a significant contrast emerged in terms of neck diameter between two distinct management conditions: mulched and non-mulched. In this context, the non-mulched condition displayed the largest neck diameter ($1.3±0.04^{a}$). The interaction between genotypes and mulching also showed some impacts in the neck diameter.

Within the range of genotypes studied, with the exception of Khumal 1 and AVON 1103, there was an evident increase in neck diameter when they were cultivated without the application of mulch. AVON 1103 exhibited no notable variance in neck diameter whether grown with or without mulch while Khumal 1 demonstrated the smallest neck diameter when subjected to mulching. Notably, among all genotypes investigated, the reference variety, Red Creole, displayed a substantial difference in neck diameter; with largest observed in bulbs grown in the absence of mulch as shown in Table 1.

The primary reason for the greater neck diameter could be attributed to the increased presence of reserved nutrients within the larger bulbs, which was found to be Red Creole. This led to a higher leaf count, resulting in the production of a greater amount of nutrients. These nutrients were subsequently stored in the bulb, consequently leading to the observed larger neck diameter (Desta et al., 2021).

3.5 ROOT LENGTH

The present study has undertaken a comprehensive analysis, revealing noteworthy distinctions pertaining to genotypes and mulching conditions in relation to root growth parameters. The root length of the bulb was measured by taking the average length of five roots taken from the bottom end of the bulb by swiftly cutting with a sharp blade at the root top and measuring with a centimeter scale. Notably, among the genotypes studied, the Red Creole (11.7±0.6^{a} cm) genotype emerged as a standout performer in terms of root length, a statistically significant outcome that parallels the performance of Khumal 2 (10.7± 1.6^{a} cm). In contrast, the root length of AVON 1103 (4.1± 0.2^{e} cm) and Khumal 1 (4.4±0^{e} cm) was found to be notably limited under mulching. Upon closer examination of genotype interactions, it was observed that Khumal 2 (14.5± 1.2^{a} cm) exhibited the most extensive root diameter when grown without mulch. This finding contrasts with the mulched scenario of AVON 1103 (4.1± 0.2^{e} cm), which displayed the least root length as is shown in Table 1.

Table 1. Effect of onion genotypes and mulching on bulb diameter, neck diameter and root length of onion in Pokhara, 2023

Treatments	Bulb diameter (equatorial) (mm)	Bulb diameter(polar) (mm)	Neck Diameter (mm)	Root length (cm)
Factor A				
Red Creole	49.6±0.6^{a}	37.7±0.8^{bc}	1.2±0.1^{a}	11.7±0.6^{a}
AVON 1052	43.6±3.2^{c}	38.6^{bc}±1.6^{bc}	1.2±1.1^{ab}	6.5±0.4^{b}
Khumal 2	49.0±1.7^{a}	42.5±2.1^{a}	1.2±0.1^{a}	10.7±1.6^{a}
Khumal 1	44.9±1.8^{bc}	39.5±1.8^{ab}	1.1±0.1^{a}	6.1±0.7^{b}
AVON 1103	48.3±1.6^{ab}	35.7±0.9^{c}	1.2±0.04^{a}	6.0±0.8^{b}
LSD	3.6	3.6	0.1	1.4
CV%	7.5	9.1	9.3	16.1
p-value	<0.01	<0.001	NS	<0.001
Factor B				
Mulch	50.7±0.6^{a}	41.8±1.1^{a}	1.1±0.03^{b}	6.5±0.6^{b}
Non-Mulch	43.5±1.3^{b}	35.8±0.5^{b}	1.3±0.04^{a}	9.9±0.7^{a}
LSD	2.3	2.3	0.1	0.9
CV	7.5	9.1	9.3	16.1
p-value	<0.001	<0.001	<0.001	<0.001

Treatments		Bulb diameter (equatorial) (mm)	Bulb diameter(polar) (mm)	Neck Diameter (mm)	Root length (cm)
Combined effects of mulches and genotypes on the plant growth characters of onion					
Red Creole	Mulch	50.4±0.8[ab]	37.8±0.6[cd]	1.0±0.1[d]	11.5±1.1[b]
	Non- mulch	48.9±0.7[abc]	37.5±1.6[cd]	1.5±0.1[a]	12.0±0.8[b]
AVON 1052	Mulch	50.6±2.5[ab]	41.7±2.3[bc]	1.1±0.1[d]	5.5±0.2[de]
	Non- mulch	36.5±2.7[e]	35.5±0.5[d]	1.3 ±0.1[b]	7.5±0.2[c]
Khumal 2	Mulch	52.9±1.4[a]	47.9±0.9[a]	1.3±0.04[ab]	6.9±0.6[cd]
	Non- mulch	45.0±0.8[cd]	37.0±0.7[cd]	1.1±0.05[cd]	14.5±1.2[a]
Khumal 1	Mulch	49.0±0.6[abc]	44.3±0.9[ab]	0.9±0.01[d]	4.4±0.0[e]
	Non-mulch	40.9±1.8[de]	34.9±0.3[d]	1.3±0.06[b]	7.7±0.6[c]
AVON 1103	Mulch	50.6±1.2[ab]	37.2±0.7[cd]	1.3±0.04[b]	4.1±0.2[e]
	Non- mulch	45.9±2.8[bcd]	34.3±1.4[d]	1.2±0.07[bc]	8.0±0.7[c]
LSD		5.1	5.1	0.2	1.9
CV		7.5	9.1	9.3	16.1
p-value		<0.05	<0.001	<0.001	<0.001

From the analysis, it was found that the roots grown under non-mulching condition in all genotypes showed greater ability of soil penetration than that of mulched ones. As such, Khumal 2 showing the most extensive root diameter significantly higher than its mulched condition, maybe to make maximum use of available water from deep soil layers (Wang & Xing, 2016). Similarly, AVON1103 showing the smallest root diameter under mulched condition as compared to its non-mulched condition, maybe because of the implementation of plastic film mulching leading to an increase in soil water availability and soil temperature in the top soil itself, thereby limiting the necessity for further penetration of roots for water (Jia et al., 2018). Similar conclusions were also derived from the report of Gao et al. (2014) which related the increase in moisture in topsoil to restricting root growth under plastic film mulching.

3.6 NUMBER OF SCALES, SCALE DIAMETER

The conducted analysis reveals substantial variations among the genotypes concerning scale numbers. Notably, AVON 1103 exhibited the fewest scales, whereas the reference variety Red Creole and the genotypes AVON 1052, Khumal 2, and Khumal 1 demonstrated statistically comparable scale numbers. Furthermore, a notable disparity in scale numbers existed between the mulched and non-mulched genotypes, with the mulched genotype yielding greater number of scales, although their interaction yielded insignificant results.

Likewise, the investigation identified a significant distinction in scale diameter attributed to genotypic differences, mulching conditions, and their interaction. Remarkably, the mulch of AVON 1052 yielded the largest scale diameter than its non-mulch. In all genotypes, mulching favored the larger scale diameter except in the case of AVON 1103 where there was no significant difference between the scale diameter of mulched and non-mulched condition and had the least diameter than other genotypes which is shown in Table 2.

Table 2. Effect of onion genotypes and mulching on number of scales, scale diameter and bulb yield of onion in Pokhara, 2023

Treatments		**No. of scales**	**Scale diameter (mm)**	**Yield (t/ha)**
Factor A				
Red Creole		8.7±0.4[a]	0.3±0.03[c]	16.5±1.2[a]
AVON 1052		8.7±0.4[a]	0.9±0.04[a]	11.8 ±1.4[bc]
Khumal 2		8.7±0.4[a]	0.8±0.05[b]	13.9±0.9[b]
Khumal 1		8.7±0.4[a]	0.2±0.03[d]	11.40±1.7[c]
AVON 1103		5.8±0.3[b]	0.2±0.005[d]	12.3±0.9[bc]
LSD		0.6	0.04	2.1
CV%		7.7	7.5	15.4
p-value		<0.001	<0.001	<0.001
Factor B				
Mulch		8.9±0.2[a]	0.6±0.08[a]	15.7±0.6[a]
Non-Mulch		7.4±0.3[b]	0.4±0.06[b]	10.7±0.7[b]
LSD		0.4	0.02	1.3
CV		7.7	7.5	15.4
p-value		<0.01	<0.001	<0.001
Combined effects of mulches and genotypes on the plant growth characters of onion				
red Creole	Mulch	9.5±0.3[a]	0.4±2.4[e]	17.3±1.2[a]
	Non-mulch	8.0±0.4[b]	0.2±1.1[fg]	15.7±0.5[a]
AVON 1052	Mulch	9.5±0.3[a]	1.1±1.7[a]	14.8±0.8[a]
	Non-mulch	8.0±0.4[b]	0.8±0.5[c]	8.9±0.3[cd]
Khumal 2	Mulch	9.5±0.3[a]	1.0±0.8[b]	16.0±0.4[a]
	Non-mulch	8.0±0.4[b]	0.7±0.5[d]	11.7±0.2[bc]
Khumal 1	Mulch	9.5±0.3[a]	0.3±0.9[f]	15.7±0.4[a]
	Non-mulch	8.0±0.4[b]	0.2±0.7[g]	7.0±0.3[d]
AVON 1103	Mulch	6.5±0.3[c]	0.2±0.3[g]	14.6±0.2[ab]
	Non-mulch	5.3±0.2[c]	0.2±0.6[g]	9.9±0.3[cd]
LSD		0.9	0.05	2.9
CV		7.7	7.5	15.4
p-value		NS	<0.001	<0.05

Smith et al. (2017) conducted a comprehensive field experiment to assess the effects of different mulch types on onion growth and found that organic mulches led to an increase in the number of scales per bulb, attributing this effect to improved moisture retention and soil temperature moderation provided by the mulch. These favorable conditions are believed to promote better bulb development, leading to increased scales number.

In contrast, plastic film mulching has also been investigated by researchers like Brown and Johnson (2019), whose study highlighted that while plastic mulch had an impact on onion growth, the relationship with scale number was not universally consistent across all onion genotypes. This suggests that the response to mulching can be influenced by genetic factors and the interplay of various environmental conditions.

Regarding scale diameter, nutrient availability has been suggested as a contributing factor. Green et al. (2020) demonstrated that mulching with materials rich in nutrients could positively affect scale diameter. Nutrient-rich mulches may enhance the overall nutrient content in the soil, leading to larger and more developed onion scales.

3.7 BULB YIELD

The application of analysis of variance has unveiled highly significant variations in bulb yield across distinct genotypes and mulching conditions. Notably, the reference cultivar Red Creole exhibited the highest bulb yield. Following closely, the yield of Khumal 2 was statistically comparable to AVON 1103 and AVON 1052, while a significant difference was observed in the yield of Khumal 1 with the lowest yield among the others. This was found in contrast with report of Luitel et al. (2021) where AVON 1052 exhibited the highest bulb weight, followed by Red Creole and AVON 1103.

Furthermore, striking difference in the yield was observed between two management conditions: mulch and non- mulch with higher yield in mulching condition in all genotypes. In terms of interaction, when mulching is done all genotypes are able to yield as much as Red Creole but when there is no mulching Khumal 2 is better than other genotypes, while, Khumal 1 showed the most significant difference between mulching and non-mulching conditions with its non- mulch condition showing the least yield out of all as shown in Table 2.

The increase in yield when mulching can be attributed to the suppression of weeds that reduce the competition for uptake of nutrients (Mutetwa & Mtaita, 2014). Mulching is known to increase soil moisture and temperature significantly within the range of 0-25 cm soil depth (Jamil et al., 2005) which then help to release available nutrients for plant uptake that result in higher growth and development (Rachel et al., 2018). Under non- mulched condition, soil moisture percentage is less than the mulched that might hamper plant growth resulting in lower size of bulb, which, in turn results in low bulb yield.

The number and expansion of onion leaves is an important morphological process that contributes to the overall photosynthetic capacity of the plant. Photosynthesis is essential for producing carbohydrates, which are then transported to the bulb for growth. Plastic mulch can affect leaf expansion and number, as in case of Red Creole, by modifying microclimate conditions around the plant, such as temperature and humidity, potentially leading to variations in photosynthesis and, consequently, bulb yield (Shin et al., 1988). Similarly, Khumal 2 had loosely attached scales than Red Creole, which had compressed scales, leading to slightly larger bulb diameter in Khumal 2. This, combined with more number of scales were the reason for Red Creole to ultimately have higher bulb yield despite not having the highest bulb diameter. To conclude, the highest leaf number, maximum height of plant and larger bulb diameter in Red Creole led to its highest yield.

As such, the difference in yield between different genotypes under mulching and non-mulching has be shown in figure 3.

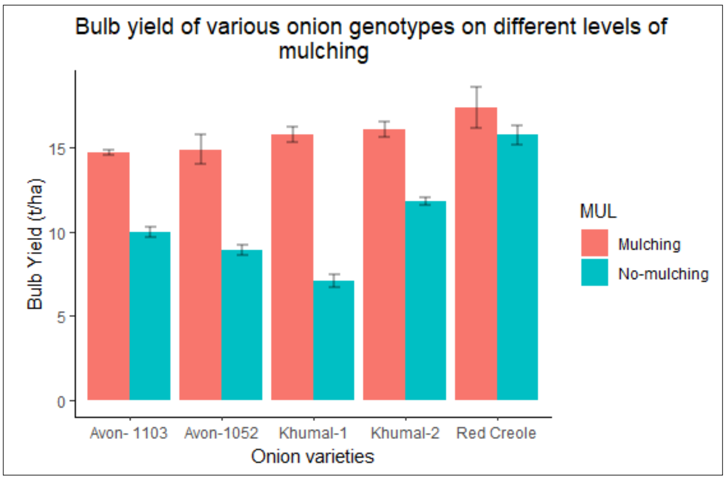

Figure 3. Bulb yield of various onion genotypes on different levels of mulching

CONCLUSION

In a controlled experimental investigation assessing the influence of mulching on the agronomic performance of onion cultivation, significant advantages associated with mulch application were found. Among a diverse range of onion genotypes evaluated, Khumal 2 demonstrated exceptional characteristics, showing a reduced incidence of bulb splitting and optimal utilization of soil moisture, thereby resulting in augmented bulb dimensions and overall increased bulb yield. This augmentation in yield was due to the development of a more expansive fresh mass within the plants, a pivotal factor in bulb initiation and maturation.

The employment of mulching provided conducive environmental conditions for onion growth, encompassing regulation of temperature and preservation of soil moisture. Specifically, the utilization of polyethylene mulch showed positive ramifications. Notably, enhancements were observed in leaf count and photosynthetic efficiency, along with stimulated root proliferation, from enhanced water and nutrient absorption efficiency. These synergistic effects collectively increased the metabolic activities throughout the growth and developmental phases of the plants.

Cumulatively, polyethylene mulching exerted a beneficial influence on soil microclimate modulation, vegetative growth promotion, and physiological vigor enhancement, surpassing the performance of non-mulched control counterparts.

Predicated upon these empirical insights, despite having a similar yield as Red Creole, Khumal 2 emerged as the most promising cultivar for adoption in the Pokhara valley. It was due to Red Creole showing bulb splitting problems in nearly 95% of the bulb population, which is not a desirable character for consumer and market preference. Nonetheless, a multi-year assessment is imperative to facilitate informed recommendations to farmers, incorporating comprehensive evaluations of additional parameters such as insect pest resistance, post-harvest attributes, and consumer preferences, among others.

DECLARATION

The authors declare no conflict of interest.

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