EFFECT OF DIFFERENT MULCHING MATERIALS ON GROWTH AND YIELD ATTRIBUTING CHARACTERS OF SUMMER SQUASH IN KANCHANPUR DISTRICT

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ABSTRACT

Mulching in the vegetable crop helps to conserve moisture, regulate temperature, avoid surface compaction, reduce runoff and erosion, improve soil structure, and manage weeds. To study the effect of different mulching materials on growth and yield attributing characters of summer squash, a field experiment was conducted at Kanchanpur district on summer squash during the summer season of 2023. The experiment was laid out in single factor Randomized Complete Block Design (RCBD) design with 4 replications and 5 treatments namely T1: control, T2: Plastic Mulching (silver on black plastic, black on top, silver on bottom), T3: rice straw, T4: sawdust and T5: mustard hulls in an area of 300m^2. "F1 Dollar plus" variety was used for the research. Growth and yield characteristics of summer squash were seen better with mulching and provided better results. The effect of different mulching materials on growth and yield attributing characters were found statistically significant except non-significant in a number of leaves at 15DAS. Plant height, number of leaves, and plant spreading were seen highest in treatment T2 and lowest in treatment T1 at 15DAS, 30DAS, 45DAS, and 60DAS. The moisture percentage is retained highest in treatment T3 and the lowest was recorded in treatment T1. The number of fruits per plant, fruit length, yield per plant, and yield were recorded as highest in T2 and lowest in T1. Yield was more than 3 times in treatment T2 and more than double in treatment T3 than in treatment T1. The findings of this research suggest plastic mulching especially silver on black plastic is a better tool for the production of summer squash in the research area compared to non-mulch conditions.

Keywords: *dollar plus, organic mulching, plastic mulching, summer squash*

INTRODUCTION

Summer squash (*Cucurbita pepo* L.) is a warm-season crop, primarily grown in the tropics, subtropics, and warm temperate zones worldwide (Regmi et al., 2021). It is a highly diverse species of the gourd family Cucurbitaceae and is commonly known as zucchini. It is also known as *Hariyo Farsi* in Nepal, Courgette in France, and Vegetable Marrow in the United Kingdom (Shrestha et al., 2022). Squash is divided into summer and winter varieties. Summer squash is harvested before the rind hardens and grows on bush-type plants, while fall and winter squash grow on sprawling vines. Squash plants produce yellow or orange flowers and green, white, or yellow fruit in various shapes and sizes with smooth or ridged skin. In Nepal, it was estimated that 2,768 ha of land is used for summer squash farming giving the production of 39,581 mt with a yield of 14.75 mt/ha (MoALD, 2023).

It is rich in carbohydrates, fiber, potassium, vitamin B, and vitamin C (Kumar & Sharma, 2018). Under the spring and summer climatic conditions in the mid-hills, summer squash has a high production potential. The sowing season begins in the final week of February and lasts until March and the crop is ready for harvest in June or July. It thrives in cool, humid climates and needs a temperature range of about 16 °C to 27 °C for growth and development (Chaurasia & Sachan, 2020).

Mulching has the added benefit of reducing the need for weeding in vegetables and fruit crops. Many different types of mulch materials such as plastic film, wooden fiber, paper, and living or dead plant matter have been researched. The ability of numerous novel mulch materials to reduce weed growth and increase crop yields still needs to be studied (Splawski et al., 2014). Black plastic mulch can give a harvest earlier by some 7-14 days, while clear plastic may advance the harvest date by 21 days in Watermelon (Rao et al., 2017). Under the plastic mulch, the soil remains friable, loose, and well-aerated. Mulching increases floral production by 3 to 4 times and boosts the quantity of blooms and fruits produced per plant (Karki et al., 2020).

Rice straw, rice husk, sawdust, and dried leaves are the examples of locally accessible materials that can be used scientifically to reduce weed growth, increase yields, and conserve moisture. As summer squash is cultivated during summer seasons, temperature is generally high, and high moisture loss occurs in the open field. Mulching in the vegetable crop helps to conserve moisture, regulate temperature, avoid surface compaction, reduce runoff and erosion, improve soil structure, and manage weeds. Squash producers in this area were unaware of mulching practices and their importance in production in the field.

High inputs and low output resulted in farmers quitting the cultivation of summer squash. Production of summer squash using mulching materials is negligible and in Kanchanpur district production is only limited to certain farmers for family consumption in a very small area although demand is high and this high demand is fulfilled by importing from India. Major issues with Summer squash production in the Kanchanpur district include agriculture automation, and poor soil and crop management methods (such as inadequate micronutrients, poor land preparation, late crop establishment, insect, diseases, and weed management). Based on the advantage of mulching in the production mentioned above, the present research was conducted to examine the impact of various mulching materials on summer squash growth and yield attributing characters.

METHODOLOGY

The experiment was conducted in a farmer's field at Gaujee, Bedkot municipality, Kanchanpur district of Sudurpaschim province. This district has a tropical climate with hot and dry summers, moderate rainfall, and cold winters. The mean annual temperature ranges between 43 ℃ and 3 ℃, and the highest amount of precipitation falls in July. The average yearly rainfall is 1771.5 mm. The experiment was laid out in a single factor Randomized complete block design with 4 replications and 5 treatments namely T1: Control (No mulching), T2: Silver on black plastic, T3: Rice straw, T4: Saw dust, T5: Mustard hulls. The study area covered a total of 300m^2, divided into 20 plots, each containing ten plants. The space between each replication and each plot was 1m and 0.5m respectively. Each plot had its own 10m^2 experimental area, with plants spaced 1 meter apart in rows that were also 1 meter apart. There were 2 rows of plants in each plot, with 5 plants in each row. There were all together 10 plants in each plot and 5 plants were randomly selected to record the data required for the experiment. The field was prepared by thorough plowing with a hand-power tiller, followed by cleaning to remove weeds and stones, making it suitable for sowing seeds. "F1 Dollar plus" variety of summer squash was used and sown in a plastic tray containing growing media of coco peat for refilling the dead plants or that cannot grow when shown directly. The recommended doses of well-decomposed FYM (1500 kg), Urea (12 kg), DAP (9 kg), and MOP (3kg) were applied. Full doses of FYM, DAP, MOP, and half doses of urea were applied as basal doses. In the 20 plots of 10m2, 589.7kg (2.95kg/pit) well-decomposed FYM, 4.72 kg (11.8gram/pit) urea, 3.53 kg (11.7gram/pit) DAP, and 1.18kg (5.9 gram/pit) MOP were applied as basal dose, and the remaining half dose of urea was applied after 25DAT. Plastic mulching was laid on the plots, and organic mulching was applied after sowing the seeds. Paddy straw was kept at a thickness of 5-7 cm, mustard hulls at a thickness of 3-4 cm, and sawdust at a thickness of 4-6 cm. The mulching materials included paddy straw, mustard hulls, and sawdust, with varying thicknesses. The seeds were shown into the pits of the experimental field, with two seeds per pit. The intercultural operations, such as watering, weeding, fertilization, and pesticide application, were carried out as per the requirement. Out of 10 plants in 2 rows in each plot, only 5 plants per plot were selected randomly. The randomly selected plants were tagged and different data were taken from those selected tagged plants in 15 DAS, 30 DAS 45 DAS, and 60 DAS. Plants were selected in a "Z" shape from different places in the plot.

The data gathered during the experiment were analyzed using statistical software packages such as Microsoft Office Excel and R-studio, and the analysis of variance was calculated using R-studio. The doe biological research package was used for analyses, and the obtained data were tabulated.

Observation record

Five randomly chosen plants from each plot were examined over the course of 15 DAS, 30 DAS, 45 DAS, and 60 DAS at different stages of crop duration.

Growth parameters

Plant height (cm)

Plant height was measured in cm by measuring it from the plant's base to its tip at different stages of crop growth and development with the help of measuring scale. It was measured from the randomly selected five plants from the net plot, recorded at 15-day intervals from 15 DAS to 60 DAS.

Number of leaves per plant

No. of leaves per plant was counted in five randomly selected plants within the net plot area. It was counted at 15-day intervals. Tagged Plant's leaves were counted at different stages of crop growth and development at 15, 30, 45, and 60 DAS respectively.

Plant spreading (cm)

Plant spreading was recorded in cm from left to right of plants at different stages of crop growth and development at 15-day intervals in 15 DAS, 30 DAS, 45 DAS, and 60 DAS. It was measured with the help of measuring tape.

Yield parameters

Fruit number per plant

It provides the data of number of summer squash fruits harvested from each selected plants. Total number of harvested fruits from each randomly selected plants were recorded by counting the total number of fruits harvested from each selected plants.

Fruit length (cm)

Fruits harvested at each picking were measured in cm from calyx base to fruit tip. The harvested fruits were measured with the help of a measuring scale and measuring tape. The total number of fruits harvested from the selected plants was measured and the average fruit length from that plant was calculated.

Yield of fruits per plant (kg)

Fruits from five randomly selected plants were harvested and the total weight of fruits recorded was divided by 5 to obtain average fruit yield (kg) per plant. The weight of the fruit was measured by hanging weighing balance.

Yield (mt/ha)

To calculate the yield, the net plot yield (from 5 randomly selected plants) was converted to total yield in mt/ha. The net plot yield was converted to hectare and the unit (kg) was also converted to metric tons to determine the total yield.

Other parameters

Soil moisture (%)

Samples were collected from the research area following the soil sampling procedure and sent to the soil testing laboratory for calculating soil moisture.
Soil moisture and soil moisture percentage were calculated by using the formula below:

Soil moisture = Weight of wet sample - Weight of dry sample.

$$\text{Soil moisture \%} = \frac{\text{Weight of wet sample - Weight of dry sample (soil moisture)}}{\text{Weight dry sample}} \times 100\%$$

RESULTS AND DISCUSSION

Plant height (cm)

Summer squash plant height was recorded at 15, 30, 45, and 60 days after sowing at various growth stages and was significantly affected by different mulching treatments.

At 15 days after sowing, the maximum plant height (13.65 cm) was recorded in plastic mulching followed by mustard hulls. The minimum plant height was recorded in treatment control (8.15 cm) and was statistically at par with rice straw and saw dust. Similarly, at 30 DAS, the maximum plant height (36.45 cm) was recorded in plastic mulching that was followed by rice straw and was statistically at par with mustard hulls and saw dust. The minimum plant height (22.73cm) at this stage was recorded in control. At 45 days after sowing the maximum plant height (61.95 cm) was recorded in plastic mulching followed by treatment rice straw, saw dust, mustard hulls. The minimum plant height (42.91 cm) was recorded in control. At 60 days after sowing, the maximum plant height (76.07 cm) was recorded in treatment plastic mulching followed by rice straw. The minimum plant height (46.70 cm) was recorded in control.

Mulching boosts soil warmth, controls soil moisture and nutrients by preventing soil evaporation and nutrient leaching, and has other benefits for vegetable development (Steinmetz et al., 2016).

Because plants grown under plastic mulch benefited from greater soil temperatures, a warmer micro-climate, and weed-free environments, the polythene mulched plots measured higher plant height (Shrestha et al., 2022). Because the mulch prevents leaching, fertilizer beneath it is used effectively and not wasted. Under the plastic mulch, the soil is still friable, loose, and well-aerated. Microbial activity is increased and roots have access to enough oxygen which improves the health of the plant. The variations in soil temperature beneath plastic mulch may be caused by various heating and heat transfer methods, as well as heat accumulation during the day and loss during the night (Parmar et al., 2013). The findings of this research were also similar to the findings by Regmi et al., (2021), Shrestha et al., (2022) and Chaurasia & Sachan, (2020) in summer squash and Awasthi et al., (2022) in Cucumber.

Table 1. Effect of mulching materials on plant height of summer squash

Treatment	Plant height (cm)			
	15 DAS	30 DAS	45 DAS	60 DAS
T1 (Control)	8.15[b]	22.73[b]	42.91[d]	46.70[d]
T2 (Plastic mulching)	13.65[a]	36.45[a]	61.95[a]	76.07[a]
T3 (Rice straw)	8.65[b]	26.01[b]	51.41[b]	55.39[b]
T4 (Sawdust)	8.30[b]	23.82[b]	47.88[bc]	49.12[cd]

T5 (Mustard hulls)	10.40^{ab}	25.89^{b}	46.35^{cd}	51.45^{c}
SEM (±)	1.20	2.75	1.14	1.05
LSD (0.05)	3.71	8.49	4.57	3.24
F-test	*	*	***	***
CV%	24.49	20.42	4.57	3.77
Grand mean	9.83	26.98	50.10	55.75

*Note: * significant at 5% level of significance, *** significant at 0.1% level of significance, SEM – Standard Error of Mean, CV – Coefficient of Variation, LSD – Least Significance Difference*

Number of leaves

The effect of different mulching materials on a number of leaves was statistically highly significant at 30 DAS, 45 DAS, and 60 DAS but it was found to be non-significant at 15 DAS as shown in Table (2).

The maximum number of leaves (14.70) was recorded in plastic mulching at 30 days after sowing which was followed by treatment mustard hulls and was statistically at par with sawdust, rice straw and control. At 45 days after sowing, the maximum number of leaves (29.20) was recorded in plastic mulching followed by treatment rice straw, saw dust and mustard hulls that were statistically at par with each other. The least count on leaves number (16.51) was recorded in control. The highest leaf count (37.95) was recorded in plastic mulching followed by rice straw at 60 days after sowing. Treatment T5 (mustard hulls) and T4 (sawdust) were at par during the leaf count at 60 DAS. The minimum number of leaves (20.81) was recorded in the control.

The increased moisture retention and availability, as well as improved nutrient absorption for healthy plant growth and development, resulted in the greatest number of leaves as compared to the control (Aniekwe & Anike, 2015). According to Chaurasia and Sachan, (2020), mulches may boost photosynthesis and other metabolic activities, resulting in improved growth characteristics. Plastic mulches absorb incoming solar energy and transport a significant portion of it to the soil, raising soil temperature and resulting in increased leaf growth. The development of microclimatic conditions under black polyethylene mulch might have created a suitable condition for increasing higher number of leaves per plant (Regmi et al., 2021). According to Rajablariani et al. (2012), the maximum number of leaves per plant was found in silver/black plastic mulching conditions. He determined that enhanced microclimatic conditions offered a good environment for plants to produce a greater number of leaves. These findings are in accordance with Shrestha et al. (2022), Akhter et al. (2018) and Chaurasia & Sachan (2020) in summer squash and Awasthi et al. (2022) in cucumber.

Table 2. Effect of mulching materials on number of leaves of summer squash

Treatment	Number of leaves			
	15 DAS	**30 DAS**	**45 DAS**	**60 DAS**
T1 (Control)	6.55	10.05[b]	16.51[c]	20.81[c]
T2 (Plastic mulching)	7.00	14.70[a]	29.20[a]	37.95[a]
T3 (Rice straw)	5.83	10.40[b]	21.60[b]	27.35[b]
T4 (Sawdust)	6.40	10.55[b]	19.56[b]	22.43[bc]
T5 (Mustard hulls)	6.25	10.75[b]	19.18[b]	22.35[bc]
SEM (±)	0.39	0.59	0.79	2.08
F-test	NS	***	***	***
LSD (0.05)	1.20	1.82	2.43	6.41
CV%	12.19	10.46	7.46	15.91
Grand mean	6.40	11.29	21.21	26.18

*Note: *** significant at 0.1% level of significance, NS – Non-Significant, SEM – Standard Error of Mean, CV – Coefficient of Variation, LSD – Least Significance Difference*

Plant spreading (cm)

Plant spreading was recorded in cm from left to right of plants at different stages of crop growth and development at 15-day intervals in 15 DAS, 30 DAS, 45 DAS, and 60 DAS. It was measured with the help of measuring tape. The effect of different mulching materials on plant spreading was statistically highly significant at 30 DAS, 45 DAS, and 60 DAS and significant at 15 DAS. Plant spread most in treatment Plastic mulch at 60 DAS and least in treatment Control at 15 DAS.

At 15 DAS plastic mulching produced a plant that spread the most (32.89 cm) followed by mustard hulls and sawdust which were at par with each other, the lowest spread of plants (21.62 cm) was found in control which was statistically similar to plants in rice straw. Likewise at 30 DAS plants spread the most (72.56 cm) in treatment plastic mulching followed by other treatments rice straw, mustard hulls, sawdust, and control which were at par to each other. Similarly at 45 DAS highest spread of plants was seen in plastic mulching (113.46 cm) followed by rice straw and then other treatments mustard hulls and sawdust which were at par with each other. Plants spread least in control with a spreading of 68.95 cm. At 60 DAS T2 (plastic mulching) produces a plant that spreads the most (129.10 cm) followed by plants in T3 (rice straw) and then other treatments T5 (mustard hulls), T4 (sawdust) and T1 (control) which were at par to each other.

Plastic mulches improve the CO_2 availability in the plant which ultimately led to higher rate of photosynthesis due to chimney effect. Black plastic mulch has an additional advantage that the absence of light within it did not allow photosynthesis under the film and therefore weed growth was depressed (Singh et al., 2005). Mulching enhances the soil's microclimate, which creates a favorable environment for nutrient and water absorption, resulting in increased cell division and cell elongation and, as a result, an increase in leaf canopy (Awasthi et al., 2022). The change in the light microenvironment caused by upwardly reflected light from silver mulches, which reduces the ratio of red to far-red light compared to black mulches, is considered to result in larger leaf area in plants growing on reflecting silver mulches over black plastic (Decoteau, 2007). The findings of this research are in line with findings of Regmi et al., (2021) and Shrestha et al. (2022) in Summer squash.

Table 3. Effect of mulching materials on plant spreading of summer squash

Treatment	Plant spreading (cm)			
	15 DAS	**30 DAS**	**45 DAS**	**60 DAS**
(T1) Control	21.62	44.14^{b}	68.95^{c}	76.66^{c}
(T2) Plastic mulching	32.80	72.56^{a}	113.46^{a}	129.10^{a}
(T3) Rice straw	21.75	51.43^{b}	92.90^{b}	103.63^{b}
(T4) Sawdust	24.35	47.41^{b}	72.50^{c}	77.48^{c}
(T5) Mustard hulls	25.90	50.64^{b}	71.98^{c}	84.58^{c}
SEM (±)	2.77	2.69	2.77	4.25
LSD (0.05)	8.54	8.29	8.54	13.10
F-test	NS	***	***	***
CV%	21.93	10.11	6.60	9.02
Grand mean	25.28	53.24	83.95	94.29

*Note: *** significant at 0.1% level of significance, NS– Non-Significant, SEM – Standard Error of Mean, CV – Coefficient of Variation, LSD – Least Significance Difference*

The data presented in Table 4 revealed that the moisture percentage in treatments was significantly influenced by mulching. The highest moisture percentage was retained in treatment rice straw (12.03%) followed by plastic mulching (8.89%). Treatments T5 (mustard hulls) and T4 (sawdust) were statistically at par and the lowest moisture was retained in treatment control (6.13%).

These mulches provide excellent insulation, water penetration, and weed control when applied lightly in the early season (Ranjan et al., 2017). Mulching reduces evaporation loss and adds to a suitable level of soil moisture at the root zone. The extended retention and availability of moisture also resulted in greater nutrient absorption, which resulted in the plants growing at a faster pace than the control (Reddy et al., 2022). The present study proved the findings of previous works by Rajput & Singh (1970) which state that Straw mulch preserved soil moisture to an extent of 55% greater than the control in Cotton.

Table 4. Effect of mulching materials on soil moisture percentage (%) of summer squash

Treatment	Moisture Percentage (%)
T1 (Control)	6.13^{c}
T2 (Plastic mulching)	8.89^{b}
T3 (Rice straw)	12.03^{a}
T4 (Sawdust)	8.02^{bc}
T5 (Mustard hulls)	8.49^{bc}
SEM (±)	0.78
LSD (0.05)	2.43
F-test	**
CV%	18.10
Grand mean	8.71

*Note: ** significant at 1% level of significance, SEM – Standard Error of Mean, CV – Coefficient of Variation, LSD – Least Significance Difference*

Number of fruits per plant

The analyzed data in Table 5 revealed that the number of fruits per plant was significantly influenced by mulching. The highest fruits per plant were recorded in T2 i.e. plastic mulching (5.45) followed by rice straw and mustard hulls which were statistically similar to each other. The lowest number of fruits per plant was found in control (2.81) and saw dust (2.85) which were at par with each other.

These findings were as with the findings of Chaurasia and Sachan (2020) which states, that it was black plastic mulch that produced the most fruits per plant. Fruit harvesting was also higher in organic mulched plots than in un-mulched plots. The yield increase under organic mulch could be due to their ability to minimize soil temperature fluctuations, increase water holding capacity, smother weed populations, and create ideal conditions for plant growth and development. Favorable soil temperature, moisture conditions, and pest-disease control consistently promoted fruit set in watermelon more than other mulch and no mulch (Parmar et al., 2013). According to Kumar and Sharma, (2018), plastic mulch produced the best results for several fruits per plant, whereas the control produced the lowest results. The current study findings could be explained by the effect of improved soil microclimate, weed-free environment, low evaporation, and higher moisture availability in the root zone, which resulted in better nutrient uptake by plants, resulting in early and better vegetative growth, which then enhanced the photosynthesis rate and translocation of synthesized food from leaves to fruits, resulting in early harvesting and an increased number of fruits per plant under black plastic mulch. The treatment with silver on black plastic mulch produced the most female flowers per plant, whereas the control produced the fewest. When compared to other mulched treatments, the male-female ratio was considerably greater for the control (Karki et al., 2020). The highest number of fruits per plant was observed in black plastic mulch (Thakur et al., 2020). These findings are in accordance with Shrestha et al. (2022), Regmi et al. (2021), Reddy et al. (2022), and Akhter et al. (2018) in summer squash.

Table 5. Effect of mulching materials on average number of fruits per plant of summer squash

Treatment	Number of fruits per plant
T1 (Control)	2.81[c]
T2 (Plastic mulching)	5.45[a]
T3 (Rice straw)	4.15[b]
T4 (Sawdust)	2.85[c]
T5 (Mustard hulls)	4.00[b]
SEM (±)	0.32
LSD (0.05)	1.01
F-test	***
CV%	17.06
Grand mean	3.85

*Note: *** significant at 0.1% level of significance, SEM – Standard Error of Mean, CV – Coefficient of Variation, LSD – Least Significance Difference*

Fruit length (cm)

Fruits length was recorded highest in plastic mulching (37.70 cm) followed rice straw (33.00 cm). Fruits with the lowest length were recorded from treatment control (26.16 cm) as shown in Table 6.

Mulching treatments and organic additions had a substantial impact on fruit length, diameter, quantity of fruits, and weight (Youssef et al., 2021). According to Akhter et al., (2018), statistically significant variation was recorded in terms of length of fruit due to different mulching, and maximum fruit length was recorded from treatment used as black plastic and minimum fruit length was observed from treatment used as control. According to the researchers, plants grown in polyethylene mulch produce larger fruit and have a greater fruit yield per plant because of improved plant growth caused by a favorable hydro-thermal regime of the soil and a completely weed-free environment. The findings of the study are in close agreement with Regmi et al. (2021) in summer squash and Thakur et al. (2020) in okra that states: the length of the fruit is determined by the duration between blooming and fruit maturity. Fruit picking at short intervals might be the cause of shortened fruit length. Rapid fruit growth and elongation in black plastic mulch and white plastic mulch due to favorable soil environment from optimum soil moisture, soil temperature, and accessible plant nutrients may be the explanation for comparably long fruits in plastic mulched plots.

Table 6. Effect of mulching materials on fruit length of summer squash

Treatment	Average fruit length (Cm)
T1 (Control)	26.16^{c}
T2 (Plastic mulching)	37.70^{a}
T3 (Rice straw)	33.00^{ab}
T4 (Sawdust)	29.83^{bc}
T5 (Mustard hulls)	26.67^{c}
SEM (±)	1.59
LSD (0.05)	4.92
F-test	**
CV%	10.42
Grand mean	30.67

*Note: ** significant at 1% level of significance, SEM – Standard Error of Mean, CV – Coefficient of Variation, LSD – Least Significance Difference*

Yield (mt/ha)

The effect of different mulching materials on the yield of summer squash was significant in different treatments as shown in Table 7. The highest yield was recorded from treatment T2 ie. Plastic mulching (76.71 mt/ha) followed by rice straw (53.80 mt/ha). The yield on mustard hulls and sawdust was found to be statistically similar to each other. The lowest yield was recorded in control (20.70 mt/ha). The maximum yield was recorded from the black polythene treatment and the minimum yield was recorded in the control condition (Akhter et al., 2018). The yield of tomatoes significantly increased in mulches over without mulch (Islam et al., 2020).

According to Khan (2016), plastic mulch minimizes evaporation, fertilizer leaching, and soil compaction, increases soil temperature, and produces few weeds, especially black plastic mulch, these features result in a well-developed root system of the plant, excellent soil moisture, and nutrient retention within the root zone, which ultimately results in better yields from crops. Watermelon yield was greater in plants mulched with silver on black plastic, compared to other mulch and no mulch (Parmar et al., 2013). Mulching enhances the soil's microclimate by providing a favorable environment for nutrition and water uptake, resulting in superior branch features, the number of flowers, fruits, fruit size, and overall yield in the plant (Awasthi et al., 2022). Black plastic mulch affects the nitrate leaching which is indirectly related to the yield (Singh & Kamal, 2012). Black plastic mulch plots had as much as 48.45 percent higher yield than un-mulched plots (Chaurasia & Sachan, 2020). Observations in this research are similar to the observations reported by Regmi et al. (2021), Reddy et al. (2022), Kumar & Sharma, (2018), and Shrestha et al. (2022) in summer squash and Mahadeen, (2014) in okra and summer squash.

Table 7. Effect of mulching materials on yield of summer squash

Treatment	Yield (mt/ha)
T1 (Control)	20.70^{c}
T2 (Plastic mulching)	76.71^{a}
T3 (Rice straw)	53.80^{ab}
T4 (Sawdust)	37.67^{bc}
T5 (Mustard hulls)	40.12^{bc}
SEM (±)	8.18
LSD (0.05)	25.23
F-test	**
CV%	35.75
Grand mean	45.80

*Note: ** significant at 1% level of significance, SEM – Standard Error of Mean, CV – Coefficient of Variation, LSD – Least Significance Difference*

CONCLUSION

The experiment brought some important information about the effect of mulching materials on growth and yield attributing characteristics of summer squash. Summer squash was seen better in growth and yield with mulching and provided better results. Among the different mulches, plastic mulch was found to be superior in growth performance and yield characteristics of summer squash. The study suggests that the use of plastic mulches in summer squash cultivation yields better outcomes than no mulch circumstances, i.e. control. Among organic and inorganic mulches, inorganic mulches (plastic mulches) performed better than organic mulches. The use of plastic mulch, specifically silver on black (black at the top and silver at the bottom), is a superior tool for improving summer squash production by altering the soil environment for better crop stand and greater yield. The findings of this research suggest plastic mulching is a better tool for the production of summer squash in the research area compared to non-mulch conditions. Along with plastic mulching, organic mulching can also be used if plastic mulching cannot be afforded.

Organic mulches are readily accessible on farms, these include crop residue, plant waste compost, and other organic materials. Because they are low-priced materials, the cost of mulching is low. Organic mulch provides farmers with a more advantageous position. As a result, there is a lot of space for organic mulching materials to be used in crop production while conserving natural resources like soil and water. Mulching reduces evaporation loss and adds to a suitable level of soil moisture at the root zone. Being environmentally friendly and adding valuable nutrients to the soil, organic material mulching enhances soil nutrients, maintains ideal soil temperature, slows evaporation from the soil surface, inhibits weed development, and prevents soil erosion. It enhances all soil qualities, including physical, chemical, and biological aspects. Thus, both inorganic and organic mulching have the potential to keep the soil wet, boost water efficiency, and improve output while also producing high-quality fruits. Hence, the study concludes mulching to be an effective, environmentally friendly, and non-toxic way to increase summer squash growth, yield, and profitability.

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