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EFFECTS OF MULCHING MATERIALS ON GROWTH AND YIELD OF BRINJAL

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ABSTRACT

Brinjal; a valuable vegetable, is susceptible to weeds and moisture stress that can hinder growth and yield. Mulching might be a good option to control weeds and moisture to enhance growth and yield. So, an experiment was conducted with five treatments viz. black silver coated mulch (BSCM; 100 gauge), black polythene mulch (BPM; 300 gauge), straw mulch (8 t ha^{-1}), corrugated fiber box mulch (CFBM), and an unmulch group replicated for four times in randomized complete block design at Horticulture Research Station, Pokhara in 2022. Results revealed that BSCM showed the highest marketable yield (23.78 t ha^{-1}) which was statistically similar to straw mulch (20.44 t ha^{-1}) and BPM (19.64 t ha^{-1}) and the lowest (12.1 t ha^{-1}) was observed in the unmulch (12.1 t ha^{-1}). Plant height (134.1 cm), primary root length (40.95 cm), and secondary root numbers (23.25) were observed significantly higher in BPM which was statistically similar ($p>0.05$) with BSCM and straw mulch. The number of branches (7.325), the fruit length (23.2 cm), and fruit diameter (2.5 cm) were found higher in BSCM. Findings suggested that applying different types of mulching materials can effectively enhance the growth and yield of brinjal.

Keywords: Black plastics, Black silver, Brinjal, Pokhara Lurkee, Yield

1. INTRODUCTION

Brinjal, scientifically known as *Solanum melongena* L., is a significant vegetable in the Solanaceae family and is one of the most important vegetable crops predominately grown extensively in tropical and sub-tropical areas throughout the world. It is primarily grown for its unripe fruits, which are used in various culinary preparations, pickling, and dehydrated food industries. Additionally, brinjals are known for their medicinal properties and are particularly rich in vitamin A, making them beneficial for diabetic patients. Although brinjals are technically perennial plants, they are commercially grown as annual crops (Joshi, 2003).

The yield of brinjals in Asia stands at 34.15 t/ha, covering an area of 17,18,049 ha (FAO, 2022). In Nepal, the statistics for brinjal cultivation are 11,292 ha in area, with a total production of 149,075 t, and a productivity of 13.20 t/ha. In the Kaski district of Nepal, brinjal are grown on 125 ha, yielding 2,136 t of produce with a productivity of 17.08 t/ha (MoALD, 2023). The low productivity of brinjal in Nepal is attributed to various biotic and abiotic factors, as well as the absence of suitable cultivars (Joshi, 2003).

Brinjal crops face daily reductions in yield due to the influence of biotic and abiotic factors. Insect pests, such as aphids, brinjal fruit, and shoot borers, are known to affect the crop (Gallo et al., 1988). Other factors like high temperatures, excessive soil humidity, salinity, water stress, and weed competition can lead to significant yield reduction (Attna et al.,

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2023). Weed interference alone has been reported to cause annual crop losses of up to 70%, with a 45% annual loss in sole brinjal crops (Marahatta, 2018). To mitigate these factors, mulching, particularly plastic mulch, has been found effective (Patil et al., 2013). Plastic mulches provide benefits such as weed control, temperature regulation, and reduced salinity, resulting in decreased water loss from the soil (Atta et al., 2023).

Water is a crucial resource in agriculture, and there is often a disparity between the available water and the water required for crop irrigation. Innovative irrigation techniques such as mulching can improve water use efficiency by storing a maximum amount of water in the root zone while minimizing deep percolation losses (El-Beltagi et al., 2022).

In agriculture, two main types of mulches are used: organic mulch, consisting of natural materials like straw, newspaper, dry leaves, sawdust, and compost, and inorganic mulch, which includes materials like plastic mulch, synthetic mulch, and polyethylene film (Memon et al., 2017). Studies have shown a substantial increase in brinjal yield when mulched with materials such as transparent foil (28.3% increase), polyethylene film (15.9% increase), and black polypropylene textile mulch (11.6% increase) compared to conventional cultivation methods (Sowinska et al., 2016). Plastic mulch, in particular, offers advantages like weed control, temperature regulation, and reduced salinity, resulting in less water loss from the soil. Various types of mulches, such as plastic sheets and biodegradable films, are used by farmers to promote plant growth and enhance crop yield.

Research has demonstrated that mulching positively impacts crop growth, yield, and overall cropping outcomes for brinjal cultivation (Ashworth & Harrison, 1983). Grafted brinjals with a 25µ plastic mulch thickness have been found to yield higher produce (Rajasekar et al., 2017). Plastic mulch has been shown to enhance fruit to mature earlier, and higher quality of vegetable crops (Raina et al., 1999; Bharadwaj, 2013).

2. MATERIALS AND METHODS

The experiment was carried out in the vegetable research unit of Horticulture Research Station, Malepatan, Pokhara, Kaski district in western Nepal from February to July 2022. The region lies at the latitude and longitude of 28°13’6.8” and 83°58’27.72” respectively, and a height of 848 meters above sea level. The station has a subtropical humid climate. The soils have a sandy loam texture and are deep and well-drained. The region has an average monthly minimum and maximum temperatures between 13.37 °C in February and 30.64 °C in June and receives a total average rainfall of 74.7 and an average RH was 72.38% within the cultivation period (HRS, 2023).

For the experiment, Pokhara Lurkee brinjal variety was selected. The experiment was laid out in a randomized complete block design (RCBD) with five numbers of treatments (black silver coated mulch (100 gauge), black polythene mulch (300 gauge), straw mulch @ 8 t/ha, corrugated fiber box mulch, control (no mulch) group with four replications. All treatments involved transplanting the brinjal seedling into a raised seedbed. On the last week of February 2022, a nursery bed of 2m long and 1m wide with decomposed FYM (5 kg/m^2) and vermicompost (1 kg/m^2) was mixed with soil, and the elevated nursery bed (15–20 cm) was thoroughly prepared. The seeds were planted in rows at a shallow depth and a distance of 10 cm, 5 cm apart. After that, finely sieved leaf mold was lightly sprinkled on top of the rows of seeds. Seedlings developed after 40 days, which were 10 to 15 cm tall and had three to four leaves, were prepared for transplantation. The plot was supplied with 25 ton/ha farm yard manure and 5 ton/ha vermicompost as basal dose at the time of preparation, and seedlings were transplanted on the field on April 3, 2022. The plot size was 7.4 m^2 and had 60 cm × 60 cm spacing.

Five plants from each plot were taken as sample plants and an average of those was taken as final data from each plot. Growth parameters, assessed at 75 days after transplanting (DAT) and at final harvest, encompassed various aspects of plant development. Plant height was measured with measuring tape from the ground surface to the tip of the plants while stretching. The number of leaves per plant was counted, with only healthy leaves being considered. Leaf area was determined by measuring the length from apex to bale and breadth at three positions on each of five leaves from a single sample plant, multiplying the length and breadth of each leaf to obtain the leaf area. Similarly, the number of branches was recorded, taking into account only healthy branches. After the final harvest, primary root length was measured by uprooting five sample plants and utilizing a measuring tape. Additionally, the number of secondary roots was counted from the same set of uprooted plants.

For yield parameters, measurements were taken to evaluate fruit production. The number of fruits per plant was determined by counting the fruits on five sample plants. Fruit length was gauged by placing a rope alongside the fruit and measuring it with a meter scale. Fruit diameter was measured at three positions on each fruit per sample plant using a digital vernier caliper, with the average diameter calculated thereafter. Fruit yield per plant was obtained by weighing the harvested fruits from all plots using a machine. Moreover, marketable yield per hectare was computed by removing diseased and unsuitable fruits for human consumption and weighing the remainder from each plot using the same weighing machine. After the final data was obtained it was inserted into MS-Excel and analysis of variance (ANOVA) was performed on the data using GENSTAT 15th Edition after ensuring that they met all of the ANOVA assumptions. Duncan's multiple range test (DMRT) was employed to separate the means. The least significant difference (LSD) test at a 5% level of significance was used to assess the significant differences between the types (Gomez & Gomez, 1984).

3. RESULTS

3.1 GROWTH PARAMETER

Plant height

There was a significant difference between the plant height of brinjals with different mulching materials at a p-value of 0.014. Brinjals mulched with black polythene (134.1 cm) had the tallest plant height and brinjals with control (110.6 cm) had the smallest plant height. However, brinjals with straw mulch (121.4 cm) and brinjals with black silver coated mulch (127.5) were statistically at par with both brinjals mulched with black polythene and control. Brinjals mulched with corrugated fiber box shows the same result as that of control which has a lower mean value than brinjals mulched with black polythene, black silver, and straw.

Number of leaves per plant

The effect of mulching materials on brinjal's number of leaves per plant differed significantly at a p-value of 0.017. The highest number of leaves per plant was observed with brinjals mulched with black silver (187.8) which was statistically at par with brinjals mulched with black polythene (178), corrugated fiber box (153.8), and straw (170). The lowest number of leaves per plant was observed in control (110.1).

Leaf area

Leaf area (measured in cm^2) for the different mulching materials was found to be significantly different. Brinjals mulched with black silver had the highest leaf area (401.0 cm^2) as the lowest leaf area was found in control (268.3 cm^2) and was statistically at par with brinjals mulched with corrugated fiber box.

Number of branches

Mulching materials had a significant effect on number of branches. More branch number was found on brinjals mulched with black silver (7.3) and was statistically similar to brinjals mulched with black polythene (6.9) and corrugated fiber box (6.4). Control (5.4) had a smaller number of branches and was statistically at par with brinjals mulched with both straw (6.2) and corrugated fiber box (6.4).

Primary root length

The effect of mulching materials on brinjal's primary root length differed significantly at a p-value of 0.008. The longest primary root was found in brinjals mulched with black silver (41.30 cm) and was statistically at par with all other mulching materials except control (32.80 cm).

Secondary root numbers

The mulching materials significantly impacted the brinjal's secondary root number. More secondary root number was found on brinjals mulched with black silver (25.70) and was significantly at par with brinjals mulched with black polythene (23.25), straw (22.40) & corrugated fiber box (21.75), and fewer secondary root numbers were recorded in control (17.65).

Days to 50% flowering

Days to 50% flowering in brinjals were significantly influenced by the mulching materials. The shortest duration to reach 50% flowering was observed in mulched with black silver (42.75 days), which was statistically different from all other treatments. Black polyethylene (46.0 days) and straw mulch (47.25 days) also showed relatively shorter durations, and they were not significantly different from each other. Corrugated fiber box mulch had a longer duration of 50% flowering (48.75 days), but it was still shorter compared to the control (54.50 days).

Table 1. Effect of mulching materials on plant height, number of leaves per plant, leaf area, number of branches, primary root length, secondary root numbers, and days to 50% flowering of brinjal cultivated at HRS, Malepatan during cropping season 2022

Mulching Materials (Treatments)	**Plant height (cm)**	**Number of leaves per plant**	**Leaf area (cm^2)**	**Number of branches**	**Primary root length (cm)**	**Secondary root numbers**	**Days to 50% flowering (Days)**
Black polythene (300 gauge) mulch	134.1^{a}	178.0^{a}	366.2^{b}	6.925^{ab}	40.95^{a}	23.25^{a}	46.0^{c}
Black silver (100 gauge) mulch	127.5^{ab}	187.8^{a}	401.0^{a}	7.325^{a}	41.30^{a}	25.70^{a}	42.75^{d}
Corrugated fiber box mulch	113.6^{bc}	153.8^{a}	292.5^{cd}	6.4^{b}	39.40^{a}	21.75^{a}	48.75^{b}
Straw mulch	121.4^{abc}	170.0^{a}	318.8^{c}	6.250^{b}	40.17^{a}	22.40^{a}	47.25^{bc}
Control (no mulch)	110.6^{c}	109.1^{b}	268.3^{d}	5.450^{c}	32.80^{b}	17.65^{b}	54.50^{a}
Grand Mean	121.4	159.9	329.4	6.47	38.92	22.14	47.85
p-value	0.014	0.017	<0.001	0.001	0.008	0.01	<0.001
$LSD_{(0.05)}$	13.52	43.71	28.78	0.770	4.482	3.991	2.332
CV (%)	7.2	17.7	5.7	7.3	7.5	11.6	3.2

Note: LSD= Least Significant Difference, CV= Coefficient of Variation, means in column with the same superscript is not significantly different by DMRT ($p<0.05$).

3.2 YIELD PARAMETERS

Number of fruits per plant

The average number of fruits produced by each plant for the various mulching materials was not significantly different from one another, but the highest number of fruits per plant was found to be in brinjals mulched with straw mulch (42.8), and the lowest number of fruits per plant was found in brinjals mulched with black polythene (30.4).

Fruit length

Mulching materials had a significant effect on brinjal fruit length. Brinjals mulched with black silver had the highest fruit length (23.3 cm) and it is statistically at par with brinjals mulched with straw (20.2 cm), corrugated fiber box (19.3 cm), and black polythene (18.5 cm). The fruit length of the control (17.1 cm) was found to lowest as compared to brinjals with other mulches.

Fruit diameter

There was a significant difference in the fruit diameter of brinjals with different mulching materials. Brinjals mulched with black silver had the largest fruit diameter (2.5 cm), while brinjals in control (no mulch) (2.2 cm) had the smallest fruit diameter. However, brinjals mulched with straw (2.1) were statistically at par with brinjals mulched with black silver, control black polythene (2.15), and corrugated fiber box (2.1).

Fruit yield/plant

The mulching materials significantly impacted the fruit yield per plant of brinjal. The highest fruit yield/plant (0.856 kg) was observed in brinjals mulched with black silver which was statistically at par with brinjals mulched with black polythene (0.707 kg), straw (0.736 kg), and corrugated fiber box (0.655 kg). The lowest fruit yield/plant was found in the control (0.438 kg).

Marketable yield

There was a significant difference between the marketable yield of brinjals on different mulching materials used. Brinjals mulched with black polythene (19.6 t/ha) had the highest marketable yield, while those mulched with black silver (23.7 t/ha) were statistically at par with brinjals mulched with straw (20.4 t/ha) whereas control (12.1 t/ha) had the lowest marketable yield.

Table 2. Effect of mulching materials on fruit length, fruit diameter, number of fruits per plant, fruit yield/plant, and marketable yield of brinjal cultivated at HRS, Malepatan, Nepal during cropping season 2022

Mulching Materials (Treatments)	**Fruit length (cm)**	**Fruit diameter (cm)**	**Number of fruits per plant**	**Fruit yield/ plant (kg)**	**Marketable Yield (ton/ ha)**
Black polythene (300 gauge) mulch	18.5[b]	2.15[b]	30.35[b]	0.707[a]	19.64[ab]
Black silver (100 gauge) mulch	23.3[a]	2.56[a]	32.05[ab]	0.856[a]	23.78[a]
Corrugated fiber box mulch	19.3[b]	2.16[b]	35.25[ab]	0.655[ab]	18.19[b]
Straw mulch	20.2[ab]	2.27[b]	42.75[a]	0.736[a]	20.44[ab]
Control (no mulch)	17.1[b]	2.06[b]	34[ab]	0.438[b]	12.17[c]
Grand Mean	19.7	2.2	34.9	0.678	18.8
p-value	0.019	0.016	0.150	0.001	0.001
$LSD_{(0.05)}$	3.3	0.273	-	0.156	4.335
CV (%)	11.2	7.9	10.2	14.9	14.9

Note: LSD= Least Significant Difference, CV= Coefficient of Variation, means in column with same superscript is not significantly different by DMRT ($p<0.05$).

4. DISCUSSION

The utilization of mulching materials in brinjal cultivation has demonstrated a significant impact on various growth parameters and ultimately on fruit yield. Ashrafuzzaman et al. (2011) noted that mulching enhanced plant height, primarily attributed to the improved availability of soil moisture and optimal soil temperature. In addition, the conducive microclimate created by mulches facilitated increased leaf area by providing an environment favorable for cell expansion and elongation, as reported by Li et al. (2004). This, in turn, contributed to a higher number of leaves per plant, as observed in the work of Joshi et al. (2019). The research also highlights that the choice of mulching material can influence the vegetative and fruiting characteristics of brinjal plants. Plastic mulch, as shown by

Mahadeen (2014), significantly increased all growth parameters, and ultimately fruit length, diameter, number of fruits and leaves, fruit yield per plant, and marketable yield due to the improvement in moisture conservation and availability in the soil. Similar results were also shown by Mcmillen (2013) due to better moisture conservation and reduced evaporation rates. Furthermore, weed control, facilitated by mulches, as advocated by Viradiya (2013), has a profound impact on yield as it reduces competition for nutrients, space, and light, leading to higher marketable yields. Some free-flying insects need light from the sun to maintain their horizontal orientation while they are in the air; however, when light from the ground enters their body, they are unable to carry on with their regular flight pattern. The typical orientation of flight is disrupted by the light reflection from below when the ground is covered with black silver-coated plastics contributing to higher marketable yield (Shimoda & Honda, 2013). Overall, mulching materials offer an effective means to optimize brinjal cultivation, enhancing plant growth, fruit development, and yield, with silver plastic mulch emerging as a promising choice for improved results.

5. CONCLUSION

In conclusion, the study conducted at the Horticulture Research Station in Malepatan, Nepal, during the 2022 cropping season underscores the significant impact of various mulching materials on brinjal growth and yield. Among the mulching materials tested, black polythene mulch resulted in the tallest plants, while black silver coated mulch demonstrated superior performance in terms of leaf number, leaf area, branches, primary root length, and secondary root numbers. Remarkably, brinjals with black silver-coated mulch produced the longest fruit length and largest fruit diameter. It also achieved the highest fruit yield per plant and marketable yield, followed by straw mulch. Choosing the right mulching material is crucial for successful brinjal cultivation, offering advantages like moisture retention, temperature control, microclimate optimization, and weed suppression, all leading to improved growth and yield. Notably, black silver-coated mulch stands out as a promising choice due to its positive impact on various growth and yield parameters. Further research and field trials are needed to fine-tune these techniques to suit various agricultural contexts, promoting sustainable and efficient brinjal cultivation.

DECLARATION

The authors declare no conflict of interest.

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