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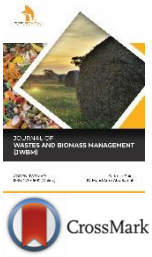

RESEARCH ARTICLE

EFFICACY OF DIFFERENT MULCHING MATERIALS ON PERFORMANCE AND YIELD OF OKRA IN MAHOTTARI, NEPAL

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ABSTRACT

The efficacy of different organic and inorganic mulches in modulating the environment, growth, performance, and yield of okra [*Abelmoschus esculentus (L.)*] was compared in the field experiment in Matihani, Mahottari from 2078 Falgun to 2079 Ashad. Okra (variety SVOK 5151) was direct seeded in single rows. The experiment consisted of 5 treatments as follows: control, black plastic mulch, rice straw, wheat st, raw, and sawdust with four replications designed in RCBD. Seed germination significantly differed with the type of mulching material used. The highest seed germination percentage was recorded from the black plastic mulch plot and the lowest seed germination percentage was recorded from the control plot. The highest plant height was recorded from black plastic mulch at 20, 35, 50, and 65 DAS than that of other treatments. Black plastic mulch enhanced the number of leaves per plant than that of other treatments. Black plastic mulch enhanced the early flowering of okra leading to increased early and total yield of okra in comparison to bare soil. Vegetative attributes and yield-related attributes were found to be significantly better and higher in crops with plastic mulch rather than organic mulches. The highest productivity (30.93 Mg ha^{-1}) was recorded from black plastic mulch followed by rice straw (24.71 Mg ha^{-1}). Okra productivity with the highest net return and the highest benefit-cost ratio was obtained from black plastic mulching. The highest B: C ratio (3.23) and lowest B: C ratio (1.75) were calculated from the control plot. Because of these findings, it is believed that plastic culture has positive effects on the growth and yield of vegetables. The use of plastic mulch is an absolute tool for promoting vegetable production in Matihani. Further studies need to be performed to have a better understanding of the effects of vegetable crops grown with organic and plastic mulches.

KEYWORDS

Okra, Mulching, Yield

1. INTRODUCTION

Nepal, a developing nation heavily reliant on agriculture, particularly in the Terai region, constitutes a significant portion of its GDP, contributing around 34% (AICC, 2078). Additionally, approximately 68% of the population depends on agriculture as their primary income source (MoALD, 2078). Within the agricultural sector, vegetable production stands out as a promising occupation for rural households to generate income. Nepal boasts a substantial vegetable area of 281,132 hectares and a production of 3,962,383 metric tons, contributing 16.67% to the country's GDP (MoALD, 2021).

The country's varied agroecological conditions make it advantageous for nutrition, income generation, and overall economic development (USAID/ANSAB, 2011). Vegetables, such as cauliflower, cabbage, okra (also known as Lady's finger), green beans, eggplants, cucumbers, and others, play a vital role in providing a balanced diet and strengthening the population's health and the nation's economy. Okra, in particular, is a highly nutritious vegetable, rich in vitamins C and K, protein, antioxidants, and polyphenols that contribute to various health benefits (Natalie Rizzo, 2019). It also plays a role in cholesterol reduction, gastrointestinal health, and metabolic disorder control (Mariem et al., 2020).

Globally, okra production amounts to approximately 9.96 million tons, with India being the largest producer at 6.18 million tons, followed by Nigeria with 1.82 million tons (FAOSTAT, 2020). In Nepal, okra production is notable, with the Terai region leading in production (Nepal Vegetable Crop Survey, 2009-10). In the 2020/21 season, the country produced 110,565 metric tons of okra on 9,584 hectares, with a productivity of 11.54 tons per hectare (MoAD, 2020/21). Various okra varieties are cultivated in Nepal, with the hybrid SVOK5151 being a popular choice in Mahottari (MoAD, 2020/21).

The yield of okra is influenced by several factors, including spacing, nutrient and irrigation management, and mulching (Khanal et al., 2020). Among these factors, mulching plays a significant role in conserving soil moisture, reducing temperature extremes, and enhancing crop yield (Rathore et al., 2013). Mulching can be achieved using locally available materials like rice straw, sawdust, and dried leaves, as well as commercial plastic mulch options with varying thicknesses.

2. MATERIALS AND METHODS

2.1 Experimental Site

The study was conducted in the field of Mr. Ashok Mandal at Bhagwati tole, Matihani Municipality (ward no. 6), Mahottari district. The study site is located in the southeast 5 km away from the district headquarters, Jaleshwor. Mahottari district has a total area of 1,002 km2 with a total population of 705,838 (Census Report, 2021). The experiment was carried out from 5th April to July 18. The geographical location of the site is situated at an elevation of 90 m above sea level, the latitude 26.36° North

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and 85.50° East. (Soil Management Directorate,2020).

2.2 Experimental Details

The experiment was conducted at Bhagwati tole, Matihani, Mahottari during the spring-summer season starting from April 5 to July 18. The experiment was laid out in one factorial RCBD design with 5 treatments and each replication was treatment was replicated 4 times. SVOK5151 hybrid variety of okra was selected for the experimental purpose. The plant could be 120 to 130 cm tall, erect, and well branched, producing fruit length up to 15 to 20 cm having 5 rushes and lush green color. The variety was brought from the local market of Tulsiyahi, Dhanusha. Black plastic mulch, rice straw, wheat straw, and sawdust were used as plastic mulching materials. The thickness of the black plastic mulch was 350 gauge. Mulching materials were evenly sprayed over the respective plots after the field preparation and then sowing was done at the distance calculated. One ton of decomposed FYM and recommended doses of Urea, DAP, and MOP @ 6kg/rop, 4kg/rop, and 2kg/rop respectively (Krishi Diary, 2078) were applied. The full dose of phosphorus and potassium and 1/3rd of N was applied as basal in all plots at the time of seed sowing. The remaining 1/3rd dose of N was placed between the rows of standing crops 4 weeks after sowing. And the remaining 1/3rd was applied at flowering and fruiting.

2.3 Experimental Unit

Each plot measures 2.5 m in length and 1.7 m in breadth. The R-R distance between crops was 50cm and the P-P distance was 30 cm. The individual plot area was 4.25 m^2 with 5 rows and 5 plants per row giving a total of 25 plants in each plot. The distance between the blocks of replication was 0.75 m and within the treatments was 0.60 m. Out of 5 rows, 2 rows were taken as border plants and the data were recorded from the sample plants selected within the remaining 3 rows. The outer border was at a distance of 1 m from the plot.

2.4 Observations And Measurements Taken

Five plants were randomly selected excluding the border plants and were tagged accordingly for recording the observations. The first observations were recorded at 20 DAS and the later recordings were done at an interval of 15 days till the time of the last harvest. Plant height was measured from the base of the plant to the tip of the apical or flower tip. For the number of leaves per plant, fully developed fresh leaves attached to the plants while recording the data were counted and taken under measurements. In yield and yield parameters, the number of fruits per plant, average fruit length (cm), average fruit weight (g), yield per plant (g), and productivity (Mg ha^{-1}) were recorded.

2.5 Field Preparation, Layout, And Seed Sowing

The field was ploughed by using a tractor followed by harrowing. Then the field was divided into 20 plots with each plot size with 2.5 m length and 1.7 m breadth in the appropriate layout of RCBD design. Measuring tape, pegs, and ropes were used to carry the layout of the field. Okra seeds were soaked in water 24 hours before sowing time. 3 seeds per hill were sown in the field at a distance of 50 cm R-R distance and 30 cm P-P distance. Thinning of an extra 2 plants was done after satisfactory growth leaving one behind. The okra seeds were sown on 5th April 2022.

2.6 Irrigation, Weeding, Disease And Pest Management And Harvesting

Irrigation was given one day before and after sowing. Further application of irrigation was done as per the requirement of the plants and to maintain optimum moisture of the soil. Two weeding were done manually at 25 and 50 DAS. The field was monitored regularly and appropriate disease and pest management strategies were implemented in case of disease and pest emergence. Harvesting was done manually in more than 10 pickings. The fruit was harvested at the appropriate stage of maturity.

2.7 Statistical Analysis

The data collected during the experiment was analyzed using the statistical package Microsoft Excel and R-studio. Duncan's Multiple Range Test (DMRT) and Least Significant Difference (LSD) tests were used for the mean separation. Graphs were prepared using MS Excel.

3. Results and Discussion

3.1 Seed Germination

Differences in seed germination were observed based on the type of mulching material used (see Table 2). The black plastic mulch plot yielded the highest seed germination percentage at 89.01%, while the control plot had the lowest germination rate at 68%. Following the black plastic mulch, rice straw mulch exhibited a seed germination rate of 83.26%. In general, plastic mulch resulted in higher seed germination rates, followed by plant-based mulches such as rice straw, wheat straw, and sawdust, with the control plot showing the lowest seed germination. The enhanced germination in the presence of plastic mulch can be attributed to its positive impact on the soil environment, as noted by (Lamont et al.,1999). The plastic mulch raised soil temperature by absorbing and transmitting solar radiation, as reported by (Dalorima et al.,2014). Additionally, the black polythene mulch plots retained higher soil moisture content compared to non-mulched plots, which can be attributed to reduced evaporation losses from the soil surface, in line with (Mamkagh et al.,2009). The use of various mulches, including sawdust, straw mulch, and polythene, in vegetable production increased soil temperature and conserved soil moisture, as suggested by (Patel et al.,2019). In mulched conditions, summer vegetable crop seedlings, such as okra and squash, emerged earlier than in non-mulched conditions, as observed by (Mahadeen ,2014). Soil moisture deficiency can impede seed germination in arid and semiarid regions, as discussed by (Sharma,1998). The higher germination rates in mulched conditions may be attributed to the availability of adequate soil moisture and optimal temperatures. Conversely, the lowest germination in the control plot could be attributed to reduced soil moisture availability due to excess evaporation losses caused by the absence of mulching materials.

Table 1: Effect of mulching material on germination of okra at Matihani, Mahottari, Nepal, 2022

Treatments	Germination (%)
Black plastic mulch	89.01^{a}
Rice straw mulch	83.26^{b}
Wheat straw mulch	79.49^{bc}
Saw dust mulch	75.66^{c}
Control	68.00^{d}
LSD (0.05)	4.49
SEM (±)	0.65
F-probability	***
CV%	3.68
Grand mean	79.09

Means followed by the same letter in a column are not significantly different at a 5% level of significance of DMRT

3.2 Plant Height (cm)

The choice of mulching materials had a significant impact on plant height at various stages of growth (20, 35, 50, and 65 days after sowing - DAS). Black plastic mulch consistently resulted in the tallest plants at each stage. For example, at 20 DAS, the highest plant height (15.46 cm) was achieved with black plastic mulch, while the control plot had the smallest plant height (9.37 cm) (Table 3). The plant height was consistently higher with black plastic mulch compared to other treatments at 20, 35, 50, and 65 DAS. At 35 DAS, black plastic mulch produced the tallest plants (44.36 cm), whereas rice straw mulch resulted in the smallest plants (30.49 cm) (Table 3). Similarly, at 50 DAS, the tallest plants (73.23 cm) were observed with black plastic mulch, while the smallest plants (47.81 cm) were seen with rice straw mulch (Table 3). At 65 DAS, the tallest plants (119.7 cm) were found in the black plastic mulch treatment, whereas the control plot had the smallest plants (90.85 cm) (Table 3).

Mulching plays a crucial role in facilitating root penetration by creating a favorable environment through increased soil moisture and organic matter content (Ravinder et al., 1997). The elevated temperature promotes plant growth (Ravinder et al., 1997). Mulching enhances soil moisture, which in turn benefits root development and nutrient accessibility for crop roots (Mamkagh, 2009). Plastic mulch creates a salt-free zone around plant roots, further promoting root growth. Additionally, mulching reduces soil compaction, which is conducive to proper root growth and distribution (Singh and Sarkar, 2020).

Table 2: Effect of mulching material on plant height of okra at Matihani, Mahottari, Nepal, 2022

Treatments	Plant height(cm)			
	20 DAS	35 DAS	50 DAS	65 DAS
Black plastic mulch	15.46[a]	44.36[a]	73.23[a]	119.70[a]
Rice straw mulch	10.25[b]	30.49[c]	47.81[b]	99.98[bc]
Wheat straw mulch	10.98[b]	34.83[bc]	51.84[b]	99.93[bc]
Saw dust mulch	10.88[b]	35.89[b]	68.16[a]	110.50[ab]
Control	9.37[b]	31.34[bc]	50.08[b]	90.75[c]
LSD (0.05)	1.922	5.24	8.53	16.88
SEM (±)	0.28	0.76	1.24	2.45
F-probability	***	***	***	*
CV %	10.96	9.61	9.5	10.53
Grand mean	11.39	35.38	58.22	104.07

Means followed by the same letter in a column are not significantly different at a 5% level of significance of DMRT

3.3 Number of Leaves Per Plant

The number of leaves per plant was significantly affected by the mulching materials used at 20, 35, and 65 DAS but it was not significant at 50 DAS (Table 4). The highest number of leaves per plant was recorded in the black plastic mulch at 20 DAS (6.83), 35 DAS (21.98), and 65 DAS (60.30) as in Table 4. The lowest number of leaves per plant was recorded from wheat straw mulch at 20 DAS (5.75) and 50 DAS. The number of leaves per plant was significantly lowest recorded from the control plot at 35 DAS (14.31). The lowest number of leaves per plant was recorded from rice straw mulch at 65 DAS (52.69).

The increased number of leaves per okra plant during all growth stages when using black plastic mulch may be attributed to the elevated soil temperatures necessary for optimal leaf development (Gopi et al., 2018). Black plastic mulches absorb incoming soil radiation and subsequently transmit a substantial portion of this energy to the soil, thereby enhancing soil temperatures, which are conducive to increased leaf production. The heightened soil temperatures beneath the plastic mulch can also be attributed to reduced evaporation and greater microbial activity in this environment (Sanders, 2002).

Table 3: Effect of mulching material on the number of leaves per plant of okra at Matihani, Mahottari, Nepal, 2022

Treatments	Number of leaves per plant			
	20 DAS	35 DAS	50 DAS	65 DAS
Black plastic mulch	6.83[a]	21.98[a]	34.50	60.31[a]
Rice straw mulch	5.83[b]	15.66[b]	32.16	52.69[bc]
Wheat straw mulch	5.75[b]	14.92[b]	26.80	50.12[c]
Saw dust mulch	6.00[b]	17.66[ab]	33.33	56.84[ab]
Control	5.89[b]	14.31[b]	33.75	55.78[ab]
LSD (0.05)	0.53	5.17	9.06	5.57
SEM (±)	0.08	0.75	1.32	0.81
F-probability	**	*	NS	*
CV %	5.67	19.91	18.32	6.55
Grand mean	6.06	16.85	32.11	55.15

Means followed by the same letter in a column are not significantly different at a 5% level of significance of DMRT

3.4 Days To Flowering

The mulching material had a significant impact on the number of days it took for flowering to occur. The control plot had the most extended time for flowering, with an average of 43.23 days, while the rice straw mulch resulted in slightly fewer days for flowering, averaging 40.51 days. The earliest flowering, at an average of 38.98 days, was observed in plots using black plastic mulch. It's worth noting that flowering occurred earlier in the mulched conditions, as reported by (Mahadeen,2014). Furthermore, when black plastic mulch was used in combination with three times tillage, the time to emergence was significantly reduced. In an experiment conducted by (Mamkagh,2009), it was observed that about 50% flowering occurred 3-6 days earlier in plots mulched with black polythene.

Table 4: Effect of mulching material on Days to flowering of okra at Matihani, Mahottari, Nepal, 2022

Table 1: Effect of mulching material on germination of okra at Matihani, Mahottari, Nepal, 2022

Treatments	Days to flowering
Black plastic mulch	38.98b
Rice straw mulch	40.51b
Wheat straw mulch	39.48b
Saw dust mulch	39.06b
Control	43.23a
LSD (0.05)	1.89
SEM (±)	0.27
F-probability	**
CV (%)	3.05
Grand mean	40.25

Means followed by the same letter in a column are not significantly different at a 5% level of significance of DMRT

3.5 Number of fruits per plant, Average fruit length (cm), Average fruit weight (g), yield per plant (g), and Productivity (Mg ha-1)

The choice of mulching materials had a significant impact on the number of fruits per plant. The highest number of fruits per plant was observed when using black plastic mulch (24.53), while the lowest was recorded with sawdust mulch (19.79) (Table 5). The increased number of pickings and early fruit set on black plastic mulch could explain the higher yield, which is consistent with findings by (Duzyaman,1997). Similarly, (Olabode et al.,2007) reported that plastic mulch resulted in a higher number of fruits per plant compared to wood shaving mulch.

Fruit length was also affected by the different treatments, with the longest average fruit length (15.86 cm) observed in plots with black plastic mulch, followed by rice straw mulch (12.56 cm), while the shortest average fruit length (10.48 cm) was found in sawdust mulch. The time from flowering to fruit maturity played a role in determining fruit length, and more frequent harvesting likely resulted in shorter fruits. The favorable soil conditions created by black plastic mulch, including optimal soil moisture, temperature, and nutrient availability, contributed to longer fruits.

Average fruit weight did not show a significant difference among the treatments. The highest fruit weight (18.90 g) was recorded with black plastic mulch, while the lowest fruit weight (14.20 g) was observed in plots with wheat straw mulch.

Yield per plant varied significantly between the treatments. The highest yield per plant (463.91 g) was obtained from black plastic mulch, followed by rice straw mulch (370.68 g). Sawdust mulch had the lowest yield per plant (298.89 g), which was statistically similar to that of wheat straw and the control plot. The increased yield in plastic mulched plots could be attributed to higher nutrient concentration and uptake, as reported by (Hundal et al.,2000) in tomato. Factors such as CO2 concentration and assimilation also played a role in promoting growth and yield in plastic mulch (Kim et al., 2016).

Overall, the use of polythene mulch created a favorable soil environment that led to higher branches, leaves, flowers, average weight, and fruit production per hectare (Mamkagh, 2009). The retention of moisture, higher temperature, and increased soil microorganism activity contributed to the increment in yield in plastic mulch (A. Singh & Sarkar, 2020). Similar results regarding maximum yield per plant in okra under plastic mulch were reported by various studies (Ham et al., 1993; Lourduraj et al., 1997; Sanders et al., 2002; Sannigrahi et al., 2002; Khambal et al., 2009), and the highest number of fruits per plant, fruit length, average fruit weight, and yield per plant were observed with black plastic mulch compared to the control (Bhutia et al., 2017).

Okra productivity was significantly influenced by the mulching materials used. The highest productivity (30.93 Mg ha-1) was achieved with black plastic mulch, followed by rice straw mulch (24.71 Mg ha-1). The lowest okra productivity (19.92 Mg ha-1) was associated with sawdust mulch. There was no statistically significant difference between the productivity

of wheat straw mulch (20.81 Mg ha-1), sawdust mulch (19.92 Mg ha-1), and the control plot (21.06 Mg ha-1). The increased productivity with black plastic mulch can be attributed to factors such as the number of pickings, number of fruits per plant (24.53), and yield per plant (463.91 g). (Puria et al.,2022) also reported higher okra yields with polythene mulch compared to bare soil, emphasizing the role of black mulch in reducing weeds and fertilizer leaching.

Additionally, suggested that the higher yield with plastic mulch is due to the accumulation of a higher CO2 concentration and increased CO2 assimilation (Kim et al.,2016). Has a noted that mulches help conserve soil moisture, improve soil nutrient levels, suppress weed growth, and ultimately enhance crop yield and quality (Tanveer et al.,2022). The ambient temperature provided by plastic mulch significantly contributed to higher yield and productivity in the plastic mulching plot (Fawibe et al., 2022).

Table 5: Effect of mulching material on yield parameters and productivity of okra at Matihani, Mahottari, Nepal, 2022

Treatments	Number of fruits per plant	Average fruit length (cm)	Average fruit weight (g)	Yield per plant (g)	Productivity (Mg ha^{-1})
Black plastic mulch	24.53^{a}	15.86^{a}	18.90	463.91^{a}	30.93^{a}
Rice straw mulch	21.63^{ab}	12.56^{ab}	16.92	370.68^{ab}	24.71^{ab}
Wheat straw mulch	22.01^{ab}	12.14^{b}	14.20	312.78^{b}	20.81^{b}
Saw dust mulch	19.79^{b}	10.48^{b}	15.10	298.83^{b}	19.92^{b}
Control	20.82^{b}	11.54^{b}	15.17	315.83^{b}	21.06^{b}
LSD (0.05)	2.56	3.42	1.07	108.49	7.23
SEM (±)	0.37	0.16	0.62	15.75	1.05
F-probability	*	*	NS	*	*
CV %	7.62	17.75	4.33	20.02	20.02
Grand mean	21.76	12.52	16.06	351.68	23.45

Means followed by the same letter in a column are not significantly different at a 5% level of significance of DMRT

3.6 Economics Of Different Mulching Materials Using Different Mulching Materials

The economic analysis of okra production was carried out by adding the general cost of cultivation with an additional cost for the treatment (mulching materials). Also, the benefit-cost ratio was calculated using the available parameters. The highest cost of cultivation (N.Rs. 287550) was expended on black plastic mulching the and lowest (N.Rs. 178550) was expended on wheat straw. The highest net return (N.Rs. 640350) was gained from sawdust mulch. Benefit-cost analysis was also performed. The highest B: C (3.23) was obtained from black plastic mulch and the lowest B: C (1.75) was obtained from sawdust mulch. Thus, okra cultivation using black plastic mulch is profitable at Matihani, Mahottari.

Table 6: Economics of okra production using different mulching materials at Matihani, Mahottari, Nepal 2022

Treatments	Total cost of cultivation (NRs 000 ha^{-1})	Gross return (NRs 000 ha^{-1})	Net return (NRs 000 ha^{-1})	B: C ratio
Black plastic mulch	287.55	927.90	640.35	3.23
Rice straw mulch	188.55	494.20	305.65	2.62
Wheat straw mulch	178.55	416.20	237.65	2.33
Saw dust mulch	189.55	398.40	208.85	2.10
Control	180.85	315.90	135.05	1.75

Means followed by the same letter in a column are not significantly different at a 5% level of significance of DMRT

4. Conclusions

A field experiment was conducted to evaluate the effectiveness of different mulching materials on okra productivity in Matihani, Mahottari, Nepal in 2022. There were five treatments (black plastic mulch, rice straw mulch, wheat straw mulch, sawdust mulch and control). Each treatment was replicated in a randomized complete block (RCBD) design four times. The data was observed in seed germination, plant height, number of leaves per plant, days to flowering, average fruit length, average fruit weight, number of fruits per plant, yield per plant, and productivity. The data obtained were analyzed using R-Studio. The highest seed germination percentage (89.01) was recorded from the black plastic mulch plot and the lowest germination percentage (68.00) was recorded from the control plot. The seed germination in a plot with black plastic mulch was followed by the rice straw mulch (83.26). The highest plant height was recorded from black plastic mulch at each stage. The highest plant was significantly higher in black plastic mulches at 20, 35, 50, and 65 DAS than that of other treatments. The highest number of leaves per plant was observed in the black plastic mulch at 20 DAS (6.83), 35 DAS (21.98), and 65 DAS (60.31). The lowest number of leaves per plant was recorded from wheat straw at 20 DAS (5.75) and 65 DAS. Similarly, the lowest number of leaves per plant was recorded from the control plot at 35 DAS (14.31). The earlier flowering was recorded from black plastic mulch (38.98 days) followed by sawdust mulch (39.06 days). The delayed flowering was observed from the control plot (43.23 days). Significantly highest number of fruits per plant (24.53) was observed in black plastic mulch and the lowest number of fruits per plant (19.79) was recorded from sawdust mulch. The highest fruit length (15.86 cm) was recorded from black plastic mulch followed by rice straw mulch (12.56 cm). The highest fruit weight (18.90) was recorded from black plastic mulch and the lowest fruit weight was recorded from wheat straw mulch. The highest yield per plant (463.91 g) was recorded from black plastic mulch which is statistically at par with the rice straw mulch (370.68 g). The lowest yield per plant (298.83 g) was recorded from sawdust mulch. The highest productivity (30.93 Mg ha^{-1}) was recorded from black plastic mulch. The lowest okra productivity (19.92 Mg ha^{-1}) was recorded from sawdust mulch. Statically there was no difference between the productivity of sawdust, wheat straw, rice straw, and control plot. Similarly, the highest B: C ratio was obtained from okra production using black plastic mulch (3.23), and the lowest B: C ratio was calculated from the control plot (1.75). The black plastic mulch is more beneficial for the growth and yield of okra by modifying the soil environment for a better crop stand and higher production. The highest okra productivity with the highest net return and highest benefit-cost ratio was obtained from black plastic mulch though the cost of production was also highest in black plastic mulch.

Author's Contribution

Bhagawan Lal Chaudhary planned the research, did experiments, collected, data, and prepared the manuscript. Safal Adhikari, Pankaj Karki Dholi, and Pratibha Khatiwada analyzed the data, critically revised it, and did the finalization of the manuscript.

Conflict of Interest

The authors declare that there is no conflict of interest with the present publication.

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