



RESEARCH ARTICLE

EFFECT OF DIFFERENT MULCH MATERIALS ON POTATO PRODUCTION AND SOIL PROPERTIES IN EAST RUKUM, LUMBINI PROVINCE, NEPAL

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ARTICLE DETAILS

Article History:

Received 19 March 2025
Revised 22 March 2025
Accepted 26 April 2025
Available online 23 May 2025

ABSTRACT

Mulching, which covers the soil surface, preserves moisture, suppresses weeds, and improves soil health, has a major role in crop yield and quality. A field experiment conducted from March to July 2024 investigated the response of potatoes to various mulching methods in Dhakalbara, Sisne Rural Municipality, aiming to identify the most suitable mulching materials for potato cultivation. The (Local) potato variety was used, and the performance was observed. The experiment utilized a single factorial RCBD with 6 treatments: T1 (Black Plastic), T2 (Sawdust), T3 (Mustard Straw), T4 (Control), T5 (Khar), and T6 (Asuro/*Justicia adhatoda*), with four replications. Germination was highest in Khar. Plant height was greatest in Khar at 45 DAS and in Asuro at 60 and 75 DAS, whereas leaf numbers were highest in Asuro at 45, 60, and 75 DAS. Asuro significantly boosted potato production and quality. Results showed the highest yield in Asuro, followed by Khar. Mulching practices improved soil available phosphorus, potassium, moisture, organic matter, and nitrogen, but not pH levels. Moisture content, particularly with Khar (39%), significantly enhanced soil capacity for crop growth. Organic matter content was highest in Khar, indicating its pronounced effect. Locally available Khar could be the best to improve soil properties for potato cultivation. For East Rukum, the best mulching materials for potato production and soil properties are Asuro, followed by Khar.

KEYWORDS

Mulching, Potato, Soil properties, Performance

1. INTRODUCTION

Solanum tuberosum L., or potato, is the most essential non-cereal food crop and the world's fourth most important crop. It is a significant, stable crop in Nepal's hills. The crop ranks sixth in area, second in production, and first in productivity (MoALD, 2020). Nepal's potato cultivation spans 197,037 hectares, yielding 13.13 metric tons per hectare and a total production of 2,586,287 metric tons (Chauhan et al., 2022). In Lumbini Province, potato cultivation covers 21,010 m², producing 3,16,950 tons with a yield of 15.09 tons per hectare (MoALD, 2022).

Mulch is a layer of organic or inorganic materials spread over the ground, natural or man-made. Mulching serves various ecological purposes, such as soil enrichment and conservation, pest control, and crop yield promotion (Bharati et al., 2020). The higher germination, height, flowering, and physiological maturity in mulch treatments were due to increased soil temperature (Bhatta et al., 2020). Mulching treatments increased yield and yield attributing characteristics of potatoes (Timilsina et al., 2022). In the case of potato cultivation and soil enhancement, using organic mulch materials is significant (Bhattarai et al., 2009). Soil parameters such as pH, Cation exchange capacity, Nitrogen, Available phosphorus, Potassium, and Organic mulch are higher under the mulching treatments (Bishwakarma et al., 2022). Mulching practices are vital for solving irrigation and weed problems in potato farming (Aryal et al., 2023). Organic mulch can support raising soil organic matter content by involving materials in the soil (Timilsina et al., 2022).

Despite the growing demand for vegetables in Nepal, their productivity is less than that of the global average. Potatoes also play an essential role in future food security. Since potatoes are a cool-season root crop, they require high irrigation and fertilization at every phase of their growth,

thus being a heavy-feeder crop. In Rukum East, the organic farming concept brings difficulties in fulfilling the entire fertilizer needed for production improvement. Rukum East farmers face several problems, such as drought, poor quality seed, a lack of fertilizer, a shortage of farm workers, and pests. Several farmers do not have information regarding the possible advantages of mulching for potato production.

While Nepalese farmers apply various mulch materials, they lack comprehensive guidance on which options would be most beneficial. Hence, this study aimed to assess how different mulch materials affect potato yield, yield-related characteristics, and soil properties in Rukum East, Nepal.

2. MATERIALS AND METHODS

The research experiment was conducted at Sisne Rural Municipality-6, Dhakalbara, Rukum (east). The elevation of the site is 1568 masl. DHM (Department of Hydrology and Metrology) indicates the latitude and longitude of Rukumkot are 28.61280306 and 82.62066389. Rukum East is subtropical to temperate in climate. The experiment was conducted in a Randomized Complete Block Design with 6 treatments, each replicated 4 times. The plot size was 4m² (2m×2m) with a spacing of 50 cm between rows and 25 cm within rows. A plot has 4 hills with 8 potato tubers in each row, making 32 plants in each plot. The total population of the plant becomes 768 in a whole field. The local variety of potato tuber collected from Maring Multipurpose Cooperative Limited of Bhume-2, East Rukum, was planted in March for experimentation, and harvesting was done in July of each year. In black polythene mulches, holes were punched for planting tubers, and sides were sealed with earth. The crop was grown under rainfed conditions. The full recommended dose, 20 ton/ha farmyard manure, was applied uniformly during land preparation at the time of

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Website:
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DOI:
10.26480/ppsc.02.2025.79.83

planting. Chemical fertilizers were not used as the site area consists of 100% organic farming practices. The experiments received uniform cultural management practices throughout crop growth. The necessary data for growth, yield, and yield parameters were recorded and analyzed by using data analysis software like Microsoft Excel and R-studio. Post-harvest soil samples were collected and analyzed for the pH, Moisture %, total N, available phosphorus, exchangeable potassium, and organic matter using the standard lab method at the soil laboratory of the Directorate of Agriculture Research, Banke, Khajura, Nepal.

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3. RESULTS AND DISCUSSION

Table 1: Effects of different mulching materials on the number of tuber germination, plant height, and number of leaves of potatoes in East Rukum, 2024

Treatments	Tuber germination		Plant height (cm)			Number of leaves		
	15 DAS	30 DAS	45DAS	60DAS	75 DAS	45 DAS	60 DAS	75 DAS
Black plastic	16.25	22.25	31.19	50.39 ^b	53.18 ^c	37.15	92.45	102.95
Sawdust	15.25	28.50	33.07	50.40 ^b	51.64 ^c	36.05	58.20	68.00
Mustard straw	18.75	28.75	40.54	60.93 ^{ab}	71.83 ^{ab}	36.60	84.20	97.10
No mulching	13.75	24.75	32.66	52.33 ^b	59.52 ^{bc}	33.20	90.05	104.10
Khar	22.50	30.00	41.55	62.15 ^{ab}	63.50 ^{abc}	43.10	85.45	99.60
Asuro	22.25	28.75	39.40	68.26 ^a	78.76 ^a	60.20	121.55	134.95
SEM(±)	4.22	2.76	3.42	4.14 ^a	5.00	4.60	13.32	15.61
LSD (α=0.05)	12.72	8.34	10.31	12.5	15.1	13.87	40.17	47.07
CV	46.52	20.37	18.8	14.4	15.9	22.43	30.07	30.89
F value (α=0.05)	NS	NS	NS	*	*	**	.	NS
Grand mean	18.125	27.166	36.4	57.41	63.07	41.05	88.65	101.12

SEm means standard error of mean, LSD means least significant difference, CV means coefficient of variation, NS represents not significant, * represents significant at 5% level of probability and ** represents significant at 1% level of probability

The experiment revealed that the germination of potato tubers on the 15th day after sowing was statistically similar among all the treatments. However, in field conditions, germination was higher in the Khar among all treatments. The emergence percentage of potatoes was recorded as significantly higher in mulch practices than in those without mulch practices (Timilsina et al., 2022).

The research showed the plant height at each of these three dates (45, 60, and 75 days), was statistically similar at 45 DAS days and significantly different at 60 and 75 DAS (Table 1). The highest height was observed for

the Khar mulch (41.55 cm) at 45 days. At 60 and 75 days, the highest height was observed in Asuro which was 68.26 cm and 78.76 cm. The enhanced plant height in mulched plants could be due to mulched improved soil moisture and optimum soil temperature (Joshi et al., 2020).

The difference in average leaf number was significant among mulches and non-mulch conditions in 45 and 60 days (Table 1), but in 75 days, the result was statistically similar among the treatments. The highest number of leaves was observed for the Asuro mulch at 45, 60, and 75 days after sowing, which were 60.20, 121.55, and 134.95. This study is supported, Microclimate conditions improved by mulching, which might have provided a suitable condition for producing a high number of leaves in the plants (Rajablariani, 2012).

Table 2: Effect of different mulching materials on the number of tubers in East Rukum, 2024

Mulching	Tuber number/plant	Tuber number/plot
Black plastic	23.10 ^a	739.2 ^a
Sawdust	16.05 ^c	513.6 ^c
Mustard straw	18.55 ^{bc}	593.6 ^{bc}
No mulching	20.70 ^{ab}	662.4 ^{ab}
Khar	21.23 ^{ab}	679.2 ^{ab}
Asuro	22.83 ^a	730.4 ^a
SEM(±)	0.98	31.36
LSD (α=0.05)	2.95	94.52
CV	9.60	9.60
F value (α=0.05)	**	**
Grand mean	20.41	653.07

SEm means standard error of the mean, LSD means least significant difference, CV means coefficient of variation, and ** represents significant at a 1% level of probability

The overall tuber number per plant and tuber number per plot were significantly different (Table 2). The highest number of tuber was observed in the treatment of Black polythene (23.10) followed by Asuro

(22.83) and khar (21.23). The tuber number in the treatment of Black polythene was at par with Control, Khar, and Asuro treatments. The Black polythene (739.2) has the highest number of tubers per plot as compared to other treatments. Similar findings were also reported in potatoes, who found that the mulching treatments increased tuber yields of potatoes, with significantly higher yields from commercial mulch paper having a black color outside and a silver color inside (Timilsina et al., 2022).

Table 3: Effect of different mulching materials on yield of tuber in East Rukum, 2024

Mulching	Tuber yield in kg/plant	Tuber yield in kg/plot	Tuber yield in kg/ha
Black plastic	0.29 ^e	9.36 ^e	2340.22 ^e
Sawdust	0.27 ^f	8.69 ^f	2174.56 ^f
Mustard straw	0.31 ^d	9.87 ^d	2466.54 ^d

Table 3 (cont): Effect of different mulching materials on yield of tuber in East Rukum, 2024

No mulching	0.34 ^c	10.95 ^c	2738.10 ^c
Khar	0.36 ^b	11.59 ^b	2897.24 ^b
Asuro	0.41 ^a	13.34 ^a	3335.94 ^a
SEM(±)	0.0036	0.12	28.99
LSD (α=0.05)	0.01	0.35	87.39
CV	2.18	2.18	2.18
F value (α=0.05)	***	***	***
Grand mean	0.33	10.63	2658.7

SEm means standard error of the mean, LSD means least significant difference, CV means coefficient of variation, *** means significant at 0.1 % level of probability

The overall mean yield of tubers was significantly different (Table 3). The average yield per plant in Asuro (0.41kg) mulching was the highest among all the other treatments. Similarly, the Yield per plot or the Yield per

hectare was also found to have a highly significant effect by various mulching and non-mulching conditions. The result revealed that the highest yield per plot was obtained in Asuro (13.34kg) followed by khar (11.59kg). Timilsina et al. (2022) support this study by revealing that mulching materials increased potato production compared to no mulch in the field.

Table 4: Effect of different mulching materials on grading of tuber number (large, medium, and small) in East Rukum, 2024

Mulching	Small size tuber number/plot (<25g)	Medium-sized tuber number/plot (25-50g)	Large size tuber number/plot (>50g)
Black plastic	651.2 ^a	96.00 ^d	32.00 ^c
Sawdust	392.0 ^e	113.07 ^c	36.00 ^c
Mustard straw	467.2 ^{cd}	113.20 ^c	53.33 ^b
No mulching	506.4 ^c	130.00 ^b	63.00 ^a
Khar	459.2 ^d	128.35 ^b	48.74 ^b
Asuro	565.6 ^b	168.53 ^a	37.21 ^c
SEM(±)	14.59	2.19	2.53
LSD (α=0.05)	43.99	6.60	7.64
CV	5.76	3.51	11.25
F value (α=0.05)	***	***	***
Grand mean	506.93	124.86	45.05

SEm means standard error of mean, LSD means least significant difference, CV means coefficient of variation, *** means significant at 0.1 % level of probability

There was a highly significant difference in several tubers at all grading levels by using the various mulches and non-mulch conditions (Table 4). In the case of tuber size less than 25g per plant, the highest number of such

small-sized tubers was observed in the treatment of Black polythene (651.2), followed by the Asuro treatment (565.6). In medium-sized tuber grading, the highest tuber number was obtained in Asuro mulch (168.53). Likewise, In Oversized tuber grading, the highest number of tubers was observed in the Control (63), which was a significant difference from other treatments.

Table 5: Effect of different mulching materials on grading of tuber weight (large, medium, and small) in East Rukum, 2024

Mulching	Small tuber weight in kg/plot (<25g)	Medium-sized tuber weight in kg/plot (25-50g)	Large tuber weight in kg/plot (>50g)
Black plastic	5.71	3.15	1.82
Sawdust	3.74	3.94	2.34
Mustard straw	4.81	3.94	3.40
No mulching	5.08	4.36	3.43
Khar	5.15	4.54	3.32
Asuro	5.83	5.81	2.24
SEM(±)	0.17	0.33	0.21
LSD (α=0.05)	0.518	1.002	0.644
CV	6.81	15.49	15.49
F value (α=0.05)	***	**	***
Grand mean	5.05	4.29	2.76

SEm means standard error of the mean, LSD means least significant difference, CV means coefficient of variation, ** means significant at a 1% level of probability, and *** means significant at a 0.1 % level of probability

There was a highly significant difference in the weight of tubers at all grading levels by using the various mulches and non-mulch conditions (Table 5). In the case of tuber size less than 25g per plant, the highest

weight of such small-sized tubers was observed in the treatment Asuro (5.83 kg), followed by the Black polythene treatment (5.71). In medium-sized tuber grading, the highest tuber weight was obtained in Asuro mulch (5.81 kg), followed by Khar (4.54 kg). Likewise, In Oversized tuber grading, the highest weight of the tuber was observed in Control (3.43), which was statistically similar to Mustard straw (3.40) and Khar (3.32).

Table 6: Effect of different mulching materials on tuber number with different diameters in East Rukum, 2024

Mulching	Tuber number/plot (<25mm)	Tuber number/plot (25 to 35mm)	Tuber number/plot (35 to 55mm)
Black plastic	376.00 ^a	334.00 ^{abc}	56.00 ^d
Sawdust	224.00 ^c	262.36 ^d	48.00 ^d
Mustard straw	228.87 ^c	307.15 ^{cd}	80.00 ^{ab}
No mulching	240.00 ^c	379.15 ^{ab}	71.15 ^{bc}
Khar	233.60 ^c	331.20 ^{bc}	68.70 ^e
Asuro	294.40	382.40 ^a	90.31 ^a
SEM(±)	9.413	16.674	3.522
LSD ($\alpha=0.05$)	28.37	50.26	10.62
CV	7.07	10.02	10.20
F value	***	**	***
Grand mean	266.1458	332.71	69.03

SEm means standard error of the mean, LSD means least significant difference, CV means coefficient of variation, ** means significant at a 1% level of probability, and *** means significant at a 0.1 % level of probability

There was a significant difference in the diameter of tubers in using the various mulches and non-mulch treatments (Table 6). For tubers with a diameter of less than 25mm, highest number of tubers was observed in

Black polythene (376) followed by Asuro (294.4). Similarly, for a tuber with a size of 25 to 35mm and 35 to 55mm, the highest number of tuber was found in Asuro 382.4 and 90.31. A similar study is supported by Ibarra-Jiménez et al. (2011), which found that black plastic mulches were observed to have increased soil temperature, inhibited weed competition, improved nutrient uptake, and improved soil moisture regimes, resulting in larger tuber size.

Table 7: Effect of different mulching materials on tuber weight with different diameters in East Rukum, 2024

Mulching	Tuber weight in kg/plot (<25mm)	Tuber weight in kg/plot (25 to 35mm)	Tuber weight in kg/plot (35 to 55mm)
Black plastic	1.76 ^a	6.48 ^b	2.82 ^c
Sawdust	1.02 ^b	5.89 ^b	2.88 ^c
Mustard straw	1.12 ^b	6.10 ^b	4.16 ^{ab}
No mulching	1.12 ^b	7.50 ^a	3.88 ^c
Khar	1.22 ^b	6.44 ^b	3.91 ^{ab}
Asuro	1.76 ^a	8.29 ^a	4.55 ^a
SEM(±)	0.019	0.304	0.221
LSD ($\alpha=0.05$)	0.33	0.92	0.66
CV	16.31	8.95	11.93
F value	***	***	***
Grand mean	1.33	6.79	3.70

SEm means standard error of the mean, LSD means least significant difference, CV means coefficient of variation, *** means significant at 0.1 % level of probability

There was great variation in tuber diameter with the various mulching and non-mulching treatments (Table 7). For a tuber having a diameter less

than 25mm, the highest tuber weight was observed in Black polythene and Asuro with a weight of 1.76 kg, which was statistically similar, and was followed by Khar (1.22 kg). Similarly, for the tubers having a diameter between 25 to 35mm and 35 to 55mm, the study observed that the maximum weight of the tuber was realized in Asuro which was 8.29 kg and 4.55 kg.

Table 8: Effect of different mulching materials on Nitrogen, Phosphorus, Potassium, Organic Matter, pH, and moisture in soil after potato harvesting in East Rukum, 2024

Mulching	Nitrogen (%)	Phosphorus (kg/ha)	Potassium (kg/ha)	Organic Matter (%)	pH	Moisture(%)
Black plastic	0.14 ^{bc}	173.5 ^c	488.8 ^e	2.8 ^{cd}	7.5	30.4 ^c
Sawdust	0.15 ^b	161.6 ^d	482.8 ^f	3.09 ^b	8.0	30.4 ^c
Mustard straw	0.15 ^{bc}	221.3 ^a	632.7 ^b	3.0 ^{bc}	8.0	33.7 ^b
No Mulching	0.15 ^{bc}	161.6 ^d	536.8 ^d	2.96 ^a	7.8	27.2 ^d
Khar	0.19 ^a	219.3 ^a	554.7 ^c	3.99 ^a	7.7	39 ^a
Asuro	0.14 ^c	214.1 ^b	698.7 ^a	2.71 ^d	7.8	30.4 ^c
SEM(±)	0.0046	0.94	1.12	0.07	0.16	0.82
LSD ($\alpha=0.05$)	0.014	2.82	3.37	0.21	0.49	2.47
CV	5.99	0.97	0.39	4.56	4.18	5.14
F value	***	***	***	***	NS	***
Grand mean	0.15	191.9	565.75	3.09	7.8	31.86

SEm means standard error of the mean, LSD means least significant difference, CV means coefficient of variation, NS represents not significant, *** means significant at 0.1 % level of probability

After harvesting the potato, soil sampling from each treatment was done and analyzed at the soil laboratory of NARC khajura, Banke. The result showed that Nitrogen, Phosphorus, Potassium, Organic matter, and Moisture differ significantly from one treatment to another, whereas pH has no significant effect on soil reaction. The research shows that the pH levels of the treatments were statistically similar and overall alkaline (≥ 7.5), which is beneficial for many crops but may lead to the lockout of nutrients for others if not controlled. Sawdust and Mustard have the highest PH of 8, which was statistically similar, i.e., more alkaline condition, while Black Plastic is neutral at 7.5. Khar has the highest moisture content (39%), and this indicates that it can effectively enhance water-holding capacity in the soil. Control has less moisture content (27.21%) than the rest of the treatments. Overall improvement in moisture retention, especially with Khar, indicates that the treatments can enhance the capacity of soil to hold water, which is pivotal for plant growth. All the treatments have medium nitrogen content, with the highest being Khar (0.19). This indicates that none of the treatments enhanced nitrogen content compared to the control. Asuro and Black plastic contained the lowest nitrogen content. The Nitrogen content in the soil mulched using Black plastic was statistically not different from other treatments except for Khar. All the treatments produced a very significant difference in the available phosphorus contents. Mustard has the maximum available phosphorus content (221.3), then Khar (219.3), which means that it can increase phosphorus availability to a greater extent than the other treatments. A highly significant difference in the K2O content of soil was observed. Asuro had the maximum K2O content (698.7), then mustard (632.7). The K2O content without mulch condition was higher than the Black Polythene sheet and Sawdust mulching. This shows that Mustard, Asuro, and Khar mulch treatment can be particularly useful for enhancing potassium availability in the soil. Organic matter content across treatments was typically in the medium category, and Khar content was the highest (3.99), followed by Sawdust (3.09) and Mustard straw (3.0), which were statistically similar to others. This was supported, whose results showed that in potato utilization and soil enrichment, utilizing organic sources as mulching materials is a remunerative method of mulching (Bhattarai et al., 2009).

4. CONCLUSION

Mulching is a practice of covering soil with different organic and inorganic materials have proven crucial role in crop production. This study showed that Asuro, followed by Khar and Black plastic, was found to be the best mulching material. Mulching practices significantly improve the Phosphorus, Potassium, Moisture, OM, and Nitrogen in the soil, but there is not any significant change in the PH level. Mulching with locally available Khar could be the best practice to increase soil properties for potato cultivation.

ACKNOWLEDGMENT

We thank the Prime Minister Agriculture Modernization Project, Project Implementation Unit, Potato Zone, Rukum East, and Agriculture and Forestry University, Rampur, Nepal, for their unwavering support and direction throughout the research period.

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