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Research Article

Effect of plastic mulches on growth and yield of potato (*Solanum tuberosum* L.) in Dadeldhura, Nepal

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ABSTRACT
A field experiment was conducted from February to June, 2020 at Bhatkanda, Dadeldhura, Nepal to assess the effectiveness of plastic mulches in potato production. The experiment was laid out in Randomized Complete Block Design (RCBD) with four replications comprising of five treatments viz: T1: white plastic mulch (white on black colored), T2: silver plastic mulch (silver on black colored), T3: perforated black plastic mulch, T4: black plastic mulch and T5: control (without mulch). Results revealed that the black plastic mulch significantly increased the rate of emergence while perforated black plastic exhibited highest values of all other studied growth parameters, yield components and quality parameters. The highest marketable tuber yield was obtained in perforated black plastic (6.05 kg/m^2) followed by silver plastic (5.62 kg/m^2), white plastic (5.46 kg/m^2), black plastic (5.14 kg/m^2) and lowest marketable tuber yield was obtained in control condition (4.07 kg/m^2). Similarly, temperature difference between controlled and mulched condition at 15 cm depth of soil was observed up to 2.8°C with its highest value in black plastic mulch and lowest in control condition. The perforated black plastic mulch was found most economical with maximum value of net return (NRs. 1904.31 thousands/ha) and B: C ratio (5.83). This study concludes that the use of perforated black plastic mulch is most economical with optimum plant growth and yield, producing best quality potatoes under climatic condition of Dadeldhura, Nepal.

Keywords: Plastic mulching, potato, perforated black plastic mulch, yield

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INTRODUCTION
Potato (*Solanum tuberosum* L.), belonging to Solanaceae family is one of the most important vegetable crops having a balanced diet. It is commercial non-cereal produce of Nepal and an important source of income for the farmers (Upadhyay et al., 2020). It is used as subsidiary food as part of vegetables in Terai region, whereas as staple food in Hill and Mountain Regions of Nepal (Subedi et al., 2019). It contains water 75 to 80%, carbohydrates 16 to 20%, crude protein 2.5 to 3.2%, true protein 1.2 to 2.2%, mineral matter 0.8 to 1.2%,

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crude fats 0.1 to 0.2%, crude fiber 0.6% and different vitamins (Reddy et al., 2018). Being cool season crop, potato grows well in certain areas having cool climatic regime but the sprout development rate depends on temperature of soil (Samy & EI-Zohiri, 2013). The optimum temperature of soil for initiating tubers is 16-19°C (Khan et al., 2011). Development of tuber decreases as soil temperatures increases above 20°C and growth of tuber practically stops at soil temperatures above 30°C (Samy & EI-Zohiri, 2013). The reason for its potentiality and wider adaptability to grow year-round, its importance is constantly increasing.

Potato is the major cash crop of Nepal that ranks fifth in terms of area coverage (193,997 ha), second in quantity of production (3,112,947 t) and first in productivity (16.05 t ha^{-1}) as compared with that of main staple food crops rice, maize, wheat and finger millet (MoALD, 2019). It accounts for about 6.57 and 2.17% of Agricultural Gross Domestic Product (AGDP) and Gross Domestic Product (GDP) of nation respectively (Gairhe et al., 2017). Nepal is one of the top twenty countries where potato contributes substantially for human diet (Subedi et al., 2019). Province 1 constitutes the highest production volume of 30.44% of national production with the highest productivity of 17.92 t ha^{-1} in Bagmati province (MoALD, 2018/19). In Dadeldhura district, potato is cultivated in 1,154 ha area producing 16,169 t with average productivity of 14.01 t ha^{-1}, which is lower than both attainable yield and national average (16.05 t ha^{-1}) (MoALD, 2019).

Mulching is one of the improved cultivation practices to increase yield and productivity of potato to its maximum. According to Singh and Ahmed (2008), mulching shows significant influence on growth and yield of potato. Mulching promotes soil water infiltration and crop water availability which helps to improve soil biodiversity and environmental benefits (Memon *et al.*, 2017). Mulches function as cover crop and reduce tillage operations that have some ecological advantages over conventional land preparation tasks causing minimum alterations in soil environment (Ahmed et al., 2017). This contributes to higher water use efficiency by plants, higher yields and greater economic benefit. Mulching with black plastic film increases tuber yield by 16% as compared to no mulch (Kang et al., 2003). Bharati *et al.* (2020) also reported enhanced emergence, plant height and number of stems of potato increases with black plastic mulching. Orzolek et al. (1993) reported that increased soil temperature especially during early spring by polyethene mulch helps to reduce weed population as well as reduces insect pest's population favoring higher crop yield and efficient use of soil nutrients. Mulching cut off crop irrigation requirement by reducing the rate of soil water evaporation up to 50% (Hatfield, 2001).

Farmers of the study area are facing the problem of irrigation water due to scarce water resources. Limited water available for plant is lost due to evaporation from soil surface due to lack of suitable cultivation practices like mulching. In absence of mulching practices, nutrient runoff takes place from bare soil surface due to excessive rainfall and results in loss of mineral nutrients which are vital for plant growth and development. Weed and pest problem on other hand causes substantial loss in yield and quality of crop contributing to lower yield of potato. Due to all these, current productivity of potato in Dadeldhura district is unable to meet the ever-increasing demand of potato in the market. To overcome this, improvement of cultivation practices like mulching is easiest and best option. Mulching technique being an important step towards higher agricultural production and sustainable use of resources, it's vital to consider the use of proper mulching materials that are beneficial to soil and its biodiversity. According to NRCS (2012), use of properly undecomposed and different

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organic mulch materials without considerations of their C:N ratio results in nutrients immobilization in soil that hinders plant growth and development. Field trials performed in Dadeldhura district by Joshi et al. (2020) and Bharati *et al*. (2020) have proved plastic mulching as the best mulching material for potato cultivation. But there is still a research gap in finding the best and effective plastic mulch among various plastic mulches available in the market. So, the research was conducted to find out best and effective type of plastic mulch assessing the effect of different types of plastic mulches on growth and yield of potato and on its soil environment.

MATERIALS AND METHODS

Experimental site

The experiment was carried out in farmer's field at Bhatkanda -1, Dadeldhura, Province no.7, Nepal. It is situated in the humid sub-tropical region having elevation 1,745masl. The site is located in mid hills at 29°14'57.32'' N latitude and 80°38'2.06'' E longitude.

Climatic condition during experimentation

The meteorological data for cropping season were taken from the regional department of hydrology and meteorological station, Dadeldhura from February (3rd week) to June (4th week) in 2020. The average maximum temperature was observed 25.8°C which ranged from 17.8°C to 31.8°C whereas the average minimum temperature was observed 12.5°C which ranged from 6.2°C to 19°C. The total rainfall and average humidity during the experimentation were 86.7mm and 56.6% respectively.

Crop Management

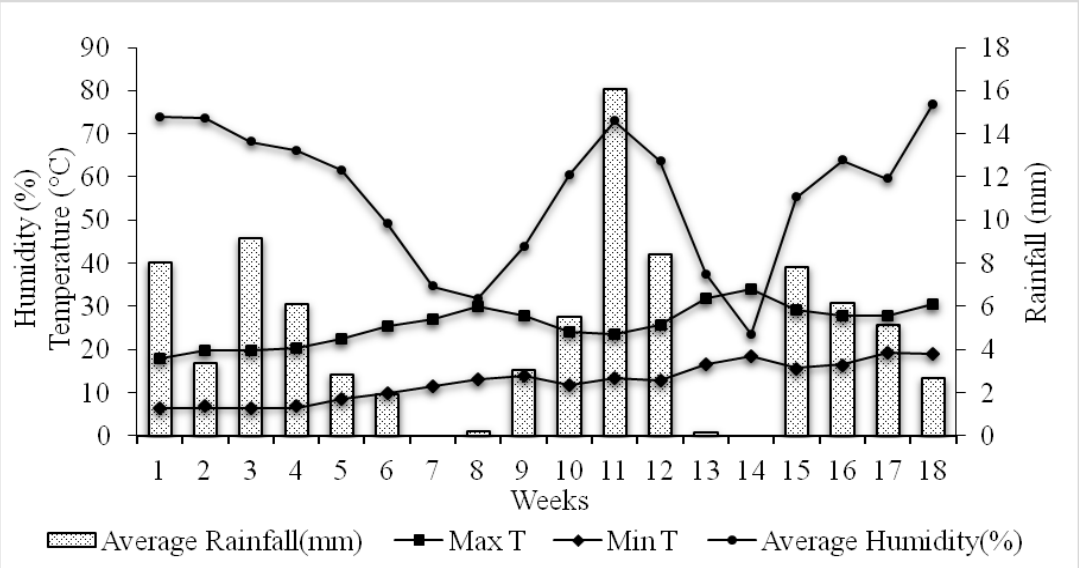

Figure 1: Weather condition during experimentation period in Dadeldhura in 2020

Finely graded medium sized seed tubers (40-50 gm per seed tuber) of Desiree variety of potato were sown on 25th February, 2020 with 60*25 cm spacing. Before sowing, one deep plowing and 3 light plowing followed by harrowing was done for field preparation. The recommended dose of fertilizers for Desiree variety of potato FYM @20 ton/ha, N: P_2O_5: K_2O @ 140:220:100 kg/ha were applied. All the above-mentioned fertilizer doses were

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incorporated into the field before sowing. Due to mulches on the field, full dose of nitrogen was given as the basal dose at the time of sowing.

Experimental Design

The experiment was laid out in Randomized Complete Block Design (RCBD) with 4 replications and five treatments viz:

T_1 = White Plastic Mulching (White on black colored plastic)
T_2 = Silver Plastic Mulching (Silver on black colored plastic)
T_3 = Perforated Black Plastic Mulching (Uniform perforations made on plastic film by sack needle of 3mm diameter)
T_4 = Black Plastic Mulching
T_5 = Control (without mulch)

The individual plot size was 3.6 x 1 m^2 with 6 rows per plot and 4 plants per row.

Data collection

Randomly selected 5 plants from each plot excluding border plants were used to measure various growth and yield parameters. Data regarding economics were taken and calculated using standard technique.

Statistical analysis

ANOVA was computed and the means were compared by using Duncan's multiple Range Test (DMRT) at 5% level of significance (Gomez & Gomez, 1984; Shrestha, 2019).

RESULTS AND DISCUSSION

Effect of plastic mulches on plant growth parameters

Days to 90% emergence, 50% flowering and 90% physiological maturity were significantly influenced by plastic mulching (Table 1). Black plastic took lowest number of day for attaining 90% emergence followed by perforated black plastic. Similarly, days for 50% flowering and 90% maturity were lowest in perforated black plastic which was statistically similar with black plastic mulch for 50% flowering. Whereas, the highest days for 90% emergence, 50% flowering and 90% physiological maturity were observed in control condition. These results are in accordance with those of Ping, Xuejun, & Xing (1994) and Mahmood M. M., Farooq, Hussain, & Sher (2002). The quicker germination, flowering and physiological maturity in mulched condition was due to increase in soil temperature by use of different plastic mulches. Black polyethylene mulch can increase soil temperature up to 9-degree Celsius which stimulates quicker germination (Kumari, 2012). According to Azad (2015), mulching reduces the day to harvest because of earlier physiological maturity in mulched condition.

An appraisal of data (Table 2) revealed that the maximum plant height of potato was measured in black plastic (21.49 cm) at 45 DAP which was statistically similar with perforated black plastic and silver plastic. However, maximum plant height of 38.89 cm was recorded in perforated black plastic mulch at 60 DAP, which was statistically at par with silver plastic and black plastic. Significantly minimum plant height was recorded in control plot as there was no any mulch used. Ahmed, Mahmud, Hossain, Zaman, and Halder (2017) also reported higher plant height of potato in black polythene mulch over white polythene. The higher plant height in perforated black plastic mulch might be due to the reason that perforations over the plastic film allows air to pass through it and hence increases oxygen

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availability around root zone of plant contributing to better growth of shoot. Plastic mulches contribute to better availability of soil moisture and optimum soil temperature for better plant growth and development.

Table 1: Days to 90% emergence, 50% flowering and 90% physiological maturity (Haulm senescence) of potato plant as influenced by plastic mulches at Dadeldhura, Nepal in 2020

Treatments	Days to 90% Emergence	Days to 50% Flowering	Days to 90% Physiological maturity
White plastic	37.50^{d}	75.00^{c}	100.75^{c}
Silver plastic	34.75^{c}	74.00^{b}	100.00^{bc}
Perforated black plastic	30.75^{b}	70.50^{a}	98.50^{a}
Black plastic	29.50^{a}	70.75^{a}	99.00^{ab}
Control	40.75^{e}	76.50^{d}	101.25^{c}
F-test	**	**	**
LSD (0.05)	0.81	0.813	1.25
SEm (±)	0.26	0.30	0.41
CV,%	1.51	0.72	0.81
Grand Mean	34.65	73.35	99.90

*Means followed by the same letter(s) in a column are not significantly different by DMRT at 5% level of significance. ns= Non-significant, *=significant at 5% probability level, **= significant at 1% probability level*

Table 2: Plant height (cm) of potato as influenced by using different types of plastic mulches at Dadeldhura, Nepal in 2020.

Treatments	Plant height (cm)		
	45DAP	60DAP	75DAP
White plastic	16.17^{b}	33.16^{bc}	59.28
Silver plastic	20.33^{a}	37.39^{ab}	61.55
Perforated black plastic	20.4^{a}	38.89^{a}	64.46
Black plastic	21.49^{a}	37.33^{ab}	60.10
Control	12.15^{c}	29.17^{c}	55.20
F-test	**	**	ns
LSD(0.05)	2.56	5.06	ns
SEm (±)	0.83	1.64	2.8
CV, %	9.15	9.33	9.29
Grand Mean	18.107	35.19	60.118

*DAP= Days after planting, Means followed by the same letter(s) in a column are not significantly different by DMRT at 5% level of significance. ns= Non-significant, *=significant at 5% probability level, **= significant at 1% probability level*

Number of leaves of plants per hill was found to be statistically superior in plastic mulches as compared to control plots (Table 3). However, among different plastic mulches, the number of leaves per hill was found comparable with each other except at 45 DAP, when white plastic mulch resulted lower number of leaves per hill (39) than other plastic mulches. Maximum number of leaves per hill was recorded in black plastic (77) at 45 DAP and in perforated black plastic at 60 DAP (268) and 75 DAP (427). Nitrogen and phosphorus content as well as nutrient uptake is significantly higher in mulched plots as compared to that of un-mulched plots which is necessary for proper vegetative growth of plant (Hundal et al., 2000). The number of main stems per hill were found insignificant among the treatments.

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Table 3: Number of leaves of potato plants as influenced by using different types of plastic mulches at Dadeldhura, Nepal in 2020.

Treatments	Average number of leaves per hill		
	45DAP	60DAP	75DAP
White plastic	39.65[b]	201.75[ab]	362.15[a]
Silver plastic	72.80[a]	262.55[a]	394.70[a]
Perforated black plastic	66.25[a]	268.55[a]	427.40[a]
Black plastic	77.45[a]	256.45[a]	362.00[a]
Control	34.35[b]	132.95[b]	229.45[b]
F-test	**	**	*
LSD (0.05)	24.61	74.42	109.26
SEm (±)	7.99	24.15	35.46
CV, %	27.5	21.52	19.97
Grand Mean	58.1	224.45	355.14

*DAP= Days after planting, Means followed by the same letter(s) in a column are not significantly different by DMRT at 5% level of significance. ns= Non-significant, *=significant at 5% probability level, **= significant at 1% probability level*

Plastic mulches had insignificant effect on stem diameter at 60 DAP but had significant effect at 75 DAP (Table 4). At 75DAP stem diameter was observed highest in perforated black plastic (15.3mm) which was significantly at par with silver plastic (14.45mm) and white plastic (14.33mm). Plastic mulching results in lower weed population enhancing nutrient availability to the plants as well as optimizes the soil temperature for crop growth and development. Perforated pores over plastic films provides aeriation in root zone of plant and hence contribute to better growth and development of plant. The lowest value of stem diameter was observed in control condition (12.24).

Table 4: Stem diameter (mm) of potato plants as influenced by using different types of plastic mulching as treatment at Dadeldhura, Nepal in 2020.

Treatments	Stem diameter (mm)	
	60DAP	75DAP
White plastic	11.47	14.33[ab]
Silver plastic	11.88	14.45[ab]
Perforated black plastic	12.58	15.30[a]
Black plastic	11.98	13.46[bc]
Control	10.94	12.24[c]
F-test	ns	**
LSD (0.05)	2.54	1.43
SEm (±)	0.37	0.47
CV, %	6.23	6.70
Grand Mean	11.80	13.96

*Means followed by the same letter(s) in a column are not significantly different by DMRT at 5% level of significance. ns= Non-significant, *=significant at 5% probability level, **= significant at 1% probability level, DAP = Days after planting*
Note: stem diameter was measured using calibrated Vernier Caliper

Effect of plastic mulches on yield and yield parameters

Significantly maximum number of tubers per hill (10.10) and average tuber yield per hill (925.20g) were found in perforated black plastic mulch (Table 5). It was observed that perforated black plastic mulch, white plastic, silver plastic and black plastic had 36.49%, 23%, 12.2% and 7.43% higher numbers of tubers per hill than control condition. Whereas,

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average tuber weight was found maximum in black plastic mulch (107.13g) which was statistically similar with other plastic mulches. The minimum average tuber weight was recorded in control condition (61.7g).

Table 5: Average number of tubers per hill, average tuber yield per hill (g) and average weight of individual tuber (Average tuber yield per hill/average tuber number per hill) of potato plants as influenced by different plastic mulches at Dadeldhura, Nepal in 2020.

Treatments	Average number of tubers per hill	Average tuber yield per hill(g)	Average tuber weight(g)
White plastic	9.10^{ab}	793.20^{a}	89.26^{a}
Silver plastic	8.30^{b}	879.50^{a}	105.55^{a}
Perforated black plastic	10.10^{a}	925.20^{a}	92.60^{a}
Black plastic	7.95^{b}	844.80^{a}	107.13^{a}
Control	7.40^{b}	452.50^{b}	61.70^{b}
F-test	*	**	**
LSD (0.05)	1.70	151.00	18.91
SEm (±)	0.60	49.00	6.14
CV, %	12.84	12.60	13.45
Grand Mean	8.57	779.04	91.24

*Means followed by the same letter(s) in a column are not significantly different by DMRT at 5% level of significance. ns= Non-significant, *=significant at 5% probability level, **= significant at 1% probability level*

Highly significant difference was found in marketable tuber number, unmarketable tuber number and total tuber number per meter square in mulched condition as compared to without mulch (Table 6). Significantly maximum marketable tuber number per m^2 was observed in perforated black plastic mulch (67) which was statistically similar with white plastic (65). Whereas the lowest number of marketable seed tuber per m^2 was found in control condition (40). Similarly, maximum unmarketable tuber number per m^2 (15) was recorded in control plots. The total tuber number per meter square was found significantly maximum in perforated black plastic mulch (71) followed by white plastic (68), black plastic (64), silver plastic (63) and Control (56). Tuber number was observed highest in mulch condition than that of un-mulched as mulching help to regulate the temperature, maintain proper environmental condition which is in accordance with the finding of (Hochmuth, 2018). Kadar, Senge, Mojid, & Onishi, (2017) also recorded higher marketable seed tuber number and total tuber number per square meter in perforated black plastic.

Tuber yield of potato was significantly influenced by the treatments (Table 7). The marketable tuber yield was observed significantly higher in perforated black plastic mulch (6.05 kg/m^2) which was statistically similar to silver plastic mulch (5.62 kg/m^2) and white plastic mulch (5.46 kg/m^2). The unmarketable tuber yield was recorded maximum in control condition (80 g/m^2) and minimum in silver plastic (50 g/m^2). Significantly maximum total tuber yield was obtained in perforated black plastic mulch (6.08 kg/m^2) followed by silver plastic (5.67 kg/m^2), white plastic (5.49 kg/m^2) and black plastic (5.17 kg/m^2). The minimum total tuber yield was obtained in control plots (4.15 kg/m^2). Generally, higher yield in plastic mulches is accompanied with the lower weed incidence, lower insect pest damage and reduced soil water evaporation (Orzolek et al., 1993). However, non- perforated plastic mulching reduces the effective rainfall by preventing infiltration, but in case of perforated plastic mulching, effective rainfall is increased by 9% through enhanced infiltration, both type of plastic controlling the soil temperature (Kadar et al.,2017). Thus, the results are in

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accordance with the findings of Kadar et al. (2017) that they also observed the highest seed yield of soybean in perforated plastic mulch. They explained the reason behind this was due to effective utilization of rain water by increasing moisture extraction ratio in deeper layers of soil that helped to increase total readily available soil moisture for plant growth and yield. In addition, perforations made over plastic film helps in aeriation of root zone and evaporation of excess water around the plants thereby enhancing the growth of tuber. Comparatively lesser yield in black plastic than other plastic mulches might be due to excessive rainfall and higher temperature during tuberization and tuber growth (Figure 1). Kapoor (2012) also reported that silver and white coloured plastic mulches proved superior in tuber yield of potato than black colored plastic mulch.

Table 6: Marketable seed tuber number (Healthy tubers of diameter>25mm), Unmarketable tuber number (Undersized tubers with diameter <25mm, diseased, deformed and insect attacked) and Total tuber number per square meter of potato as influenced by different plastic mulches at Dadeldhura, Nepal in 2020.

Treatments	Marketable tuber number/m^2	Unmarketable tuber number/m^2	Total tuber number /m^2
White plastic	65.75^{a}	2.50^{b}	68.25^{ab}
Silver plastic	57.75^{b}	5.25^{b}	63.00^{b}
Perforated black plastic	67.50^{a}	4.25^{b}	71.75^{a}
Black plastic	61.00^{ab}	3.50^{b}	64.50^{b}
Control	40.25^{c}	15.75^{a}	56.00^{c}
F-test	**	**	**
LSD (0.05)	6.27	2.86	5.88
SEm (±)	2.04	0.93	1.91
CV, %	6.96	29.70	5.9
Grand Mean	58.45	6.25	64.7

*Means followed by the same letter(s) in a column are not significantly different by DMRT at 5% level of significance. ns= Non-significant, *=significant at 5% probability level, **= significant at 1% probability level*

The number of under sized tubers and small sized tubers per m^2 were found significantly higher in control condition (11 and 21) but found statistically indifferent among different plastic mulches (Table 8). Highest number of medium sized tubers per m^2 were observed in white plastic mulch (49) which was statistically at par with perforated black plastic mulch (45). The lowest number of medium sized tubers was observed in control condition (34). Whereas, the number of large sized tubers were found significantly higher in all plastic mulches than in control plot. The higher number of medium sized tubers in white plastic mulch and large sized tubers in silver plastic mulch was due to the light that is reflected from white and silver plastic mulches which results in deposition of more photosynthate into the tubers (Matheny, 1992). Higher number of large sized tubers in black plastic was due to raised soil temperature by black plastic, less weed competition, better nutrient uptake, and better soil moisture regimes (Luis et al., 2011). Higher number of medium and large sized tubers in perforated black mulch was due to better moisture availability, proper aeration along with optimal temperature in root zone of plant (Kadar et al., 2017).

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Table 7: Marketable seed tuber yield (Healthy tubers of diameter >25mm), Unmarketable tuber yield (Undersized tubers having diameter <25mm, diseased, deformed and insect attacked) and Total tuber yield in kg per square meter of potato plants as influenced by different types of plastic mulches at Dadeldhura, Nepal in 2020.

Treatments	Marketable tuber yield (kg/m^2)	Unmarketable tuber yield (kg/m^2)	Total tuber yield (kg/m^2)
White plastic	5.46^{ab}	0.02^{b}	5.48^{ab}
Silver plastic	5.62^{ab}	0.05^{b}	5.67^{ab}
Perforated black plastic	6.05^{a}	0.03^{b}	6.08^{a}
Black plastic	5.14^{b}	0.03^{b}	5.17^{b}
Control	4.07^{c}	0.08^{a}	4.15^{c}
F-test	**	**	**
LSD (0.05)	0.81	0.02	0.80
SEm (±)	0.26	0.01	0.26
CV, %	10.00	38.61	9.83
Grand Mean	5.27	0.04	5.31

*Means followed by the same letter(s) in a column are not significantly different by DMRT at 5% level of significance. ns= Non-significant, *=significant at 5% probability level, **= significant at 1% probability level*

Table 8: Grades of harvested potato tubers on the basis of size as influenced by different plastic mulches at Dadeldhura, Nepal in 2020

Treatments	Undersized tubers/m^2 (<25mm)	Small sized tubers/m^2 (25-35mm)	Medium sized tubers/m^2 (35-55mm)	Large sized tubers/m^2 (>55mm)
White plastic	2.50^{b}	9.25^{b}	49.00^{a}	6.25^{a}
Silver plastic	5.75^{b}	9.00^{b}	39.00^{c}	7.25^{a}
Perforated black plastic	3.75^{b}	7.25^{b}	45.75^{ab}	8.50^{a}
Black plastic	3.25^{b}	7.25^{b}	40.75^{bc}	7.25^{a}
Control	11.00^{a}	21.75^{a}	34.75^{c}	1.00^{b}
F-test	**	**	**	**
LSD (0.05)	3.30	5.06	6.11	3.7
SEm (±)	1.06	1.64	1.98	1.19
CV, %	40.22	30.10	9.50	39.32
Grand Mean	5.25	10.90	41.85	6.05

*Means followed by the same letter(s) in a column are not significantly different by DMRT at 5% level of significance. ns= Non-significant, *=significant at 5% probability level, **= significant at 1% probability level*

Soil temperature

Average soil temperature at 15 cm depth during the experimental period was significantly affected by different plastic mulches (Table). Results indicated that soil temperature at 15 cm depth was significantly higher in black plastic mulch at first (17.61ºC), second (18.51ºC) and third month (19.84ºC) of planting. Lowest value of soil temperature was observed in control condition (15.63ºC, 15.76ºC, 18.24ºC) at first, second and third month of planting respectively. And soil temperature of other treatments lied between them. The lower soil temperature in white and silver plastic than black plastic was due to the higher reflection of light radiation by white and silver plastic mulch that prevents higher temperature buildup under plastic and in the root zone of plant (Manganelli, 2017). Lower temperature in perforated black plastic mulch than black plastic might be due to aeration through perforations made over plastic film.

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Table 9: Soil temperature (in degree Celsius) as influenced by plastic mulches at Dadeldhura, Nepal in 2020.

Treatments	Soil temperature in first month of planting (ºC)	Soil temperature in second month of planting (ºC)	Soil temperature in third month of planting (ºC)
White plastic	15.75^{c}	17.49^{c}	18.84^{c}
Silver plastic	16.62^{b}	17.09^{d}	19.60^{b}
Perforated black plastic	16.85^{b}	17.743^{b}	19.69^{b}
Black plastic	17.61^{a}	18.51^{a}	19.84^{a}
Control	15.63^{c}	15.76^{e}	18.24^{d}
F-test	**	**	**
LSD (0.05)	0.40	0.24	0.09
SEm (±)	0.12	0.08	0.03
CV, %	1.43	0.90	0.31
Grand Mean	16.49	17.32	19.24

*Means followed by the same letter(s) in a column are not significantly different by DMRT at 5% level of significance. ns= Non-significant, *=significant at 5% probability level, **= significant at 1% probability level*

Economic analysis

Economic analysis of data (Table 10) revealed that significantly maximum gross return (NRs. 2076.13 thousands/ha) and net return (NRs. 1683.13 thousands/ha) were obtained in perforated black plastic mulch which were statistically at par with white plastic and silver plastic mulch. The minimum gross return and net profit were obtained in control plot. The highest B:C ratio was obtained in perforated black plastic mulch (5.83) which was statistically at par with silver plastic (5.44) and white plastic (5.29). These were followed by black plastic mulch (4.97) and control plot (4.24).

Table 10: Economics of potato production as influenced by plastic mulches at Dadeldhura, Nepal in 2020.

Treatments	Total Cost of Cultivation (NRs.)	Gross Return (NRs.)	Net Return (NRs.)	B:C Ratio
White plastic	393000	2076130^{ab}	1683130^{ab}	5.29^{ab}
Silver plastic	393000	2136360^{ab}	1743360^{ab}	5.44^{ab}
Perforated black plastic	394400	2298715^{a}	1904315^{a}	5.83^{a}
Black plastic	393000	1952250^{b}	1559250^{b}	4.97^{bc}
Control	365000	1546600^{c}	1181600^{c}	4.24^{c}
F-test	-	**	**	**
LSD (0.05)	-	308442.50	308442.50	0.78
SEm (±)	-	100101.20	100101.20	0.25
CV, %	-	10.00	12.40	9.89
Grand Mean	387680	2002011	1614331	5.15

*Means followed by the same letter(s) in a column are not significantly different by DMRT at 5% level of significance. ns= Non-significant, *=significant at 5% probability level, **= significant at 1% probability level,*
NRs.= Nepali Rupees, Local market price of potato = NRs.38/kg

CONCLUSION

Based on the result of this experiment, it would be better to use perforated black plastic mulch for optimum growth and yield of potato production in agro-climatic conditions of Dadeldhura. Furthermore, it is suggested to conduct multi-location and multi-seasonal trials on this aspect to achieve more accurate results.

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Authors' Contributions

M. Bhatta designed the research plan, conducted experiment and prepared manuscript. B. Shrestha, A. R. Devkota, K. R. Joshi, S. Bhattarai and U. Dhakal helped for conduciton the experiment, data recording and preparing this manuscript.

Conflict of Interest

The authors declare that there are no conflicts of interest regarding publication of this manuscript.

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