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RESEARCH ARTICLE

EFFECT OF DIFFERENT MULCHING ON YIELD AND YIELD ATTRIBUTES OF POTATO IN DADELDHURA DISTRICT, NEPAL

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ABSTRACT

A study on "Effect of different mulching materials on yield and yield attributes of potato in Dadeldhura, District" was conducted from March to June, 2019 in Tadibata, the commanding area of potato superzone, Dadeldhura to detect the effective mulching materials for potato. Lack of irrigation and labor shortage along with high weed infestation were the problem found in the potato production in farmers level .To find out the efficiency of different mulching materials, a field experiment was conducted in RCBD design with five treatments: T1: Control, T2: Saw dust, T3: Rice straw, T4: Black plastic and T5: Rice husk and were replicated four times to find the best mulching materials that can help the farmers to improve their production practice. The data on plant height, aerial stem number, canopy and number of leaves were taken at 45, 60 and 75 days after planting (DAP) and the data on grading, diameter, dry weight were taken after harvesting of potato. After the data collection, data entry was done is MS- Excel and analysis was done by using R-studio software. From the experiment it was found that the highest tuber yield was obtained in black plastic (3.33 kg/m2) which was followed by rice straw (2.74 kg/m2) , saw dust (2.63 kg/m2), rice husk (2.55kg/m2) and lowest tuber yield was obtained in control condition (2.39 kg/m2). Similarly, the soil temperature was influenced by the use of mulching material as compared to the bare soil with highest soil temperature being recorded in black plastic and lowest recorded in control condition. In case of economics, the highest B: C ratio was found in black plastic (2.01) and minimum found in rice husk (1.64). Thus, black plastic is the most effective mulching material for the high production of potato in Dadeldhura.

KEYWORDS

Potato, Temperature, Mulch, Tuber, Yield.

1. INTRODUCTION

Potato (Solanum tuberosum L.) is the first non-cereal food crops and fourth most important crops in the world after wheat, rice and maize and is considered as the major crops in the hilly region of Nepal. It is also considered as the major cash crops that are grown to satisfy the food demand and to improve the living standard of the farmers (Shijie, 2011). It consists of high starch (16.1/100 g), vitamin C (17.1 mg/100 g), protein (2.1/100 g), potassium (443 mg/100 g) and essential amino acids and it is considered as the nutrient rich food. Potato is a major food- security crop that can substitute for cereal crop considering its high yield and great nutritive value (Zhang, 2017). Potato is native to Peru and Chile in the Andes Mountains of South America as well as the alpine zone with an elevation of 3000-4000 m in Mexico (Ahmed, 2017).

Mulching also has some disadvantages by the continuous use of plastic mulch over an entire growing season it may reduce crop yield due to prolonged higher temperature (Zhou, 2009; Dong, 2014). It is the more time consuming and labor intensive for the installation of mulching in the main field (Dong, 2014). The ability to suppress weeds by various plant species sown as living mulches is presented in the literature and ranges widely from 34 to 96%. Mulching can be done by organic materials like straw, husk, cover crop etc. or by inorganic black or silver plastic that provide one or more ecological services such as enriching or protecting the soil or preventing pest attack or for enhancement of the production of crop. Potato is harvested twice a year in this area of the country. Certain cultural practices can be imposed or modified to increase the yields such as the use of improved hybrid varieties, use of modern techniques like irrigation, and higher plant populations which are tedious along with being expensive.

In Nepal potato is cultivated in the 18,587-hectare area producing 2,591,686 tons and yield of 13,943 kg per hectare (MOAD2016/17). Various factors affect the productivity of potato in Nepal. In such situations use of mulching can be cheap way to increase potential yield. Farmers are not aware about the potential benefits from use of mulching on plants. Although the initial cost is high but it gives service for longer period of time. Diseases, insects, weeds and others pests causes the substantial loss in the yield and quality of the crop yearly which can be controlled by the use of proper mulching method and proper management of the field. As,

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the geographical situation of this area is not plain the irrigation becomes a major factor for decrease in the yield of the potato. In such scenario mulching of potato can be highly significant for conserving the moisture.

An important step in substituting the problems of irrigation and weed infestation in potato cultivation is through the use of proper mulching techniques. Mulch plays an important role in the high production of the potato. Soil water does not escape from under plastic mulch. Plant growth on mulch is often higher as compared on bare soil. Farmers are not aware about these benefits of the mulches. Mulching techniques is widely practiced on the wide range of the vegetables while its application has been limited to the potato production. As, the potato is the one of the major staple crops of this region its demand is always high. So, to meet its increasing demand from potato-based industries it is necessary to use various techniques like mulching to reduce the import of potato from the other country.

2. Materials and Methods

2.1 Experimental site

The research experiment entitled "Effect of different planting depth and mulching on yield and yield attributes of potato in Dadeldhura district, Nepal "was carried out at Dadeldhura district Nepal during 2018-2019.The study site is located at 28º59"N to 29º26"N latitude and 80º12" to 80º47" longitude in the humid sub-tropical zone with elevation of 17, 45masl.

2.1.1 Climatic condition at experimental site

The data regarding the maximum and minimum temperature, rainfall, relative humidity and bright sunshine during the experiment period of 3.5 month from March to June 2019 was recorded from the Department of Hydrology and Meteorology, Dadeldhura. The average relative humidity was found 54.22% during the experiment. Similarly, the average maximum temperature was 23.53ºc which ranged from 13.70-33.10ºc whereas the average minimum temperature was 12.09ºc which ranged from 1.30-17.70ºc. The average precipitation of 1.09mm with100.6 mm rainfall was observed in the experimental field. The average bright sunshine of 8.07 hundredths of an hour with total 742.0 hundredths of an hour was observed in the experimental area.

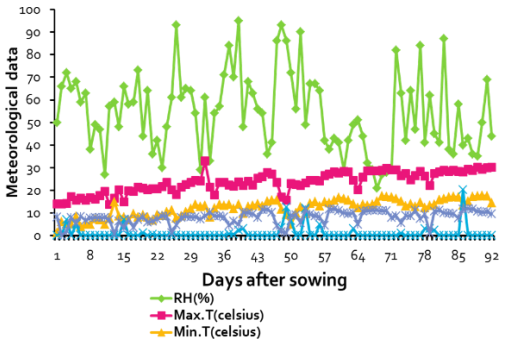

Figure 1: Meteorological parameters (Relative humidity, Maximum Temperature, Minimum Temperature, Rainfall, Bright Sunshine) during the crop duration at experimental site

2.2 Experimental design, layout and methodology

The field experiment was carried out on RCBD with four replication and five treatment in total land area of 131.2m2(16.4m*8m) at Tadibata (Bhatkada) farm of Dadeldhura, district. Each replication consists of five treatment plot each of area 3.6m*1m that were placed through randomization. The Desiree cultivar of potato was taken for the experimental study of our research project. The Desiree variety of potato was sown on March 1, 2019. Crop geometry was maintained of 60*20 cm. Plot size was 3.6*1 m2 where 6 rows with 5 plants/ row was planted.

The soil was made harrowed until completely free of weed roots. About three ploughing, along with the harrowing, was done before the soil would reach a suitable condition: soft, well-drained and well-aerated. Ridge and furrow will be made on the field and black-plastic mulch (silver color on underside) will be used to cover the ridges. For Desiree variety of potato the recommended dose of fertilizers is used i.e, FYM: 1500kg/ropani, Urea: 7kg/ropani,DAP: 11 kg/ropani and MOP: 5 kg/ropani. All the fertilizers according to above doses were incorporated into the field before sowing. Due to mulches on the field, all the doses of nitrogen were given as the basal dose at the time of sowing.

Table 1: Different treatment and their abbreviation used in the experiment

S.N.	Treatment	Abbreviation
1.	Control	T_1
2.	Saw dust	T_2
3.	Rice straw	T_3
4.	Black polythene	T_4
5.	Rice husk	T_5

2.3 Data collection and analysis

The five plants were tagged randomly from each plot for the collection of data. The data regarding to plant height, canopy, leaves number and aerial stem per plant were taken at 45, 60 and 75 days after planting as well as other data of tuber number. Yield, marketable tuber and unmarketable tuber were also taken. The data collected were entered in MS-Excel and then analyzed by using R studio software. The means were compared by using Duncan's Multiple Range test (DMRT) at 5% level of significance.

3. Result and Discussion

3.1 Effects of different types of mulching on 90% germination

Table 2: Effect of different treatments on 90 percentage germination after sowing of potato

Treatments	Days to 90 % germination
Rice straw	37.25^{b}
Saw dust	36.50^{b}
Rice husk	35.75^{b}
Black plastic	30.75a
Control	40.00c
Grand mean	36
CV	4.85
LSD	2.69***
SEM(±)	0.87

A perusal of the data revealed that the days to germination was significantly influenced by mulching. In case of black plastic quicker germination was observed as compared to control condition and other mulching materials. In case of black plastic to get 90 percent of germination it took (30.75 days). The days to germination for rice husk was found at (37.25 days) which was significantly at par with saw dust (36.50 days) and rice straw (37.25 days).The highest days for 90 percent germination was observed in control condition (40 days). The quicker germination in mulch condition was due to increase in soil temperature by the application of mulching material as compared to control condition.

3.2 Effect of different types of mulching on plant height and canopy length

Table 3: Effect of different treatment on plant height and canopy length at different days after planting

Treatments	Plant height(cm)			Canopy(cm)		
	45 DAP	60DAP	75DAP	45 DAP	60DAP	75DAP
Rice straw	22.31^{b}	32.85^{b}	36.52^{b}	36.800^{ab}	46.550^{ab}	53.375
Saw dust	20.65^{b}	33.05^{b}	36.27^{b}	35.775^{ab}	44.900^{bc}	51.550
Rice husk	22.55^{b}	33.52^{b}	36.25^{b}	35.425^{b}	43.725^{bc}	52.325
Black plastic	28.15^{a}	38.15^{a}	38.20^{a}	38.850^{a}	50.475^{a}	55.325
Control	15.79^{c}	27.93^{c}	36.20^{b}	31.025^{c}	40.925^{c}	49.300
Grand mean	21.9	33.1	36.7	35.6	45.3	52.4
CV	11.9	7.64	1.32	5.74	7.55	6.33
LSD	4.02^{***}	3.9^{**}	0.744^{***}	3.15^{**}	5.27^{*}	5.11^{NS}
SEM(±)	1.30	1.26	0.24	1.02	1.70	1.65

(Means with the same letter do not differ significantly at p=0.05 by DMRT. CV =Coefficient of variation. LSD=least significant difference, SEM=Standard error of mean. DAP= Days after planting). Plant height is one of yield attributing parameter. Plant height was found significantly higher in black plastic (28.15, 38.15 and 38.20) which was found significantly at par with the rice straw (22.31, 32.85, 36.52) and at 45, 60 and 75 DAP respectively. The plant height of rice straw (22.31, 32.85, 36.52) was found significantly at par with saw dust (20.65, 33.05, 36.27) and rice husk (22.55, 33.52, 36.25) at 45, 60 and 75 DAP respectively. The increased plant height in mulched plants was possibly due to better availability of soil moisture and optimum soil temperature provided by the mulches. Changes in the plant height of potato have been observed by using different mulches and plastic mulch increased the plant height than other mulches. Similar result with application of black plastic in plant height was reported by the research carried (Ahmed, 2017).

CANOPY:

Canopy length is another important parameter, in which tuber yield depends to certain extent. At 45 DAP the canopy was found significantly high in black plastic (38.85) which was found significantly at par with the rice straw (36.80) and saw dust (35.75) respectively at 45 DAP. The lowest canopy was found in control condition (31.02) at 45 DAP. At 60 DAP the canopy was found significantly higher in black plastic (50.47) which was found statistically significant at par with the rice straw (46.55) while the smallest canopy was found in control condition (40.92). At 75 DAP no significant result was observed in all treatment while the highest canopy was observed in black plastic (55.32) and lowest canopy was found in control condition (49.30).

Mulch materials created favorable condition for the growth of plant. Such response was mainly due to the physiochemical and biological improvement occurred in the soil including favorable temperature and moisture regimes, nutrient availability and microbial activity in mulch condition. Among the different mulch materials black polythene was more effective, which ensured maximum vegetative growth with maximum foliage coverage.

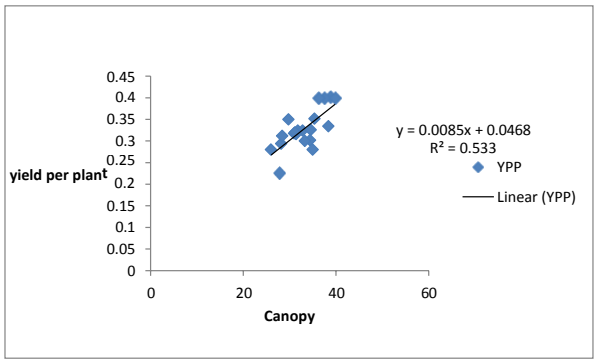

Figure 2: Relationship between Canopy coverage at 60 DAP and yield per plant at Tadibata, Dadeldhura

3.3 Effect of different mulching on the aerial stem per plant

Table 4: Effect of different treatment on aerial stem per plant

Treatments	Aerial stem number
Rice straw	5.70^{ab}
Saw dust	5.50^{abc}
Rice husk	5.40^{bc}
Black plastic	6.17^{a}
Control	4.87^{c}
Grand mean	5.53
CV	9.09
LSD	0.774*
SEM(±)	0.25

Aerial stem number per plant is one of the major contributing on the yield attributes of the potato. The numbers of aerial stems per plants were found highest in black plastic as compared to the other mulching materials and control conditions. In case of black plastic, the number of aerial stems per plant found was 6.17 which was statistically at par with rice straw (5.70) and saw dust (5.50). The lowest number of aerial stems was found in control condition (4.87). The mulching condition produced significantly higher number of aerial stems per plant as compared to the control condition (no use of any mulch) and in case of mulching material highest number of aerial stems per plant was found in black plastic mulch. Mulch materials created favorable condition for the growth of plant which leads to production of maximum number of main stems per hill. The mulching treatment increased tuber yields of potato, with significantly higher tuber yields for full mulching than no mulching at Munsigonj. These could be attributed to the higher temperature and humidity under mulched during the early development. As a result, mulching led to the higher emergence rate and strong seedling, accordingly increased the stems and branches per plant, leading to a greater number of tubers in tuber initiation (Ahmed, 2017).

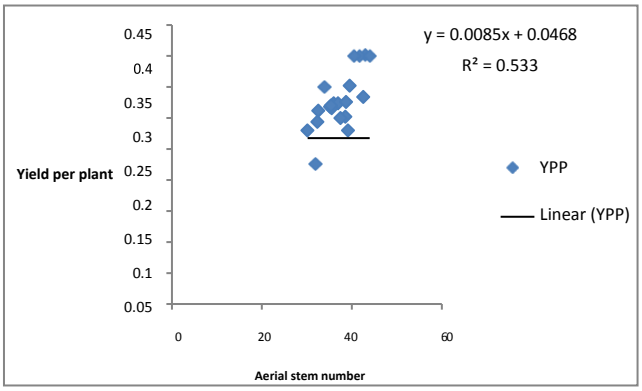

Figure 3: Relationship between Aerial stem numbers at 60 DAP and yield per plant at Tadibata, Dadeldhura

3.4 Effect of different types of mulching on leaves number

Table 5: Effect of different treatment on leaf number

Treatments	No of leaves		
	45 DAP	60DAP	75DAP
Rice straw	35.15^{ab}	67.400^{ab}	60.500
Saw dust	33.60^{b}	64.100^{abc}	55.250
Rice husk	32.17^{bc}	58.38^{bc}	53.450
Black plastic	38.52^{a}	71.600^{a}	61.750
Control	28.95^{c}	53.85^{c}	53.425
Grand mean	33.7	63.07	56.9
CV	8.18	11.8	13.9
LSD	4.24**	11.4*	12.1^{NS}
SE(±)	1.34	3.70	3.94

Number of leaves is one of the major yields attributing parameter. Number of leaves per plant was found significantly higher in mulch condition as compared to control condition. At 45 DAP the highest number of leaves was found higher in black plastic (38.52) which was statistically at par with rice straw (35.15) and lowest number of leaves was found in control condition (28.95). AT 60 DAP the number of leaves was found higher in black plastic (71.60) which was statistically at par with rice straw (67.40) and saw dust (64.10) while the lowest number of leaves per plant was found in control condition (71.60). At 75 DAP no significant difference was found in number of leaves in mulch and control condition. In case of mulching, it helps to reduce the evaporation and maintain proper moisture content due to which maximum number of leaves is found at mulching as compared to un-mulching. Similar result with maximum number of leaves in mulching as compared to un-mulching was reported (Dong, 2014).

Table 6: Effect of different treatment on diameter of tuber

TREATMENT	UMS(<1cm)	MRS (1-2.5cm)	MRST (2.6-3.5cm)	MT(>3.5cm)
Rice straw	1.35^{bc}	7.75^{ab}	3.80^{ab}	2.025^{b}
Saw dust	1.70^{b}	7.00^{bc}	3.15^{bc}	1.850^{b}
Rice husk	1.87^{ab}	6.65^{bc}	2.75^{bc}	1.750^{b}
Black plastic	0.75^{c}	8.80^{a}	4.80^{a}	3.075^{a}
Control	2.35^{a}	5.75^{c}	2.25^{c}	1.575^{b}
Grand mean	1.6	7.19	3.35	2.06
CV	24.5	15.7	21.3	15.2
LSD	0.605**	1.74*	1.1**	0.482***
SE(±)	0.19	0.56	0.35	0.15

Means with the same letter do not differ significantly at p=0.05 by DMRT. CV =Coefficient of variation. LSD=least significant difference, SEM=Standard error of mean. DAP= Days after planting (UMS indicates "Unmarketable seed", MRS indicates "Marketable seed" used for tuber, MRST indicate "Marketable seed for tuber as well as for seed purpose" and MT indicate "Marketable tuber" used for consumption only). The Unmarketable seeds per plant were found significantly different in mulch and control condition. The lowest numbers of unmarketable seed were found in black plastic (0.75) which was statistically at par with rice straw (1.35) while the highest numbers of unmarketable seed were found in control condition (2.35).In case of Marketable seed used for tuber the highest number of tubers per plant the highest number of tubers per plant was found in was found in black plastic (8.80) which was significantly at par with rice straw (7.75) and lowest number were found in control condition(5.75).

The number of marketable tubers and seeds per plant were found significantly higher in black plastic (4.80) which was statistically at par with rice straw (3.80) and lowest number were found in control condition (2.25). In case of marketable tuber significant difference was found between mulched and control condition. In case of black plastic, the numbers of marketable tuber per pant were found (3.07) as compared to the control condition (1.57). Similarly, the marketable tubers in rice straw was found (2.02) which was statistically at par with saw dust(1.85) and rice husk (1.75). Mulch materials created favorable condition for the growth of plant. Such response was mainly due to the physiochemical and biological improvement occurred in the soil including favorable temperature and moisture regimes, nutrient availability and microbial activity in mulch condition. Among the different mulch materials black polythene was more effective, which ensured maximum vegetative growth. The above results are in accordance with the findings of (Ahmed, 2017).

3.5 Effect of different types of mulching on yield of tube

Table 7: Effect of different treatment on yield of tuber

Treatments	TUBER YIELD (kg/m2)
Rice straw	2.74^{b}
Saw dust	2.63^{b}
Rice husk	2.55^{b}
Black plastic	3.33^{a}
Control	2.39^{b}
Grand mean	2.73
CV	8.77
LSD	0.36**
SEM(±)	0.11

Mulch materials showed significant difference on yield per meter square of potato. The maximum (3.33 kg) yield per meter square was recorded from black plastic while the lowest yield was recorded in control condition (2.39) which was statistically at par with rice straw (2.74), saw dust (2.63) and rice husk (2.55). Mulch materials created favorable condition for the growth of plant which leads to the production of maximum yield per hectare. Mulch application resulted in a significant decrease in soil temperature in the root zone and the conservation of soil moisture. The number and weight of tubers and tuber yield in the mulch treatment were significantly greater than on plots without mulching. Similar result with application of black plastic was reported (Farrag, 2016).

3.6 Effect of different types of mulching on number of tubers

Table 8: Effect of different treatments on number of tubers

Treatments	Tuber No (number/m^2)
Rice straw	101.62^{b}
Saw dust	99.96^{b}
Rice husk	102.87^{b}
Black plastic	125.15^{a}
Control	93.29^{b}
Grand mean	105
CV	11.7
LSD	18.9*
SEM(±)	6.14

Statistically significant difference was recorded due to different mulch materials on number of tubers per meter square of potato. The maximum (125.15) number of tubers per plant was found in black plastic. The minimum number (93.29) was found in control condition which was statistically at par with rice straw (101.62), rice husk (102.87) and saw dust (99.96) Mulch materials created favorable condition for the growth of plant which leads to the production of maximum vegetative growth with maximum number of tubers per hill. Plots covered with black polyethylene mulch recorded significantly higher average number of tubers per square meter and statistically superior to no mulch and other mulching.

3.7 Effect of different types of mulching on grading of tubers

Table 9: Effect of different treatment on grading of tuber (large, medium and small)

Treatments	**LST (>50gm)/plant**	**MST(25-50gm)/plant**	**SST (<25gm)/plant**
Rice straw	4.25^{b}	4.30^{b}	4.05^{bc}
Saw dust	3.80^{bc}	4.22^{b}	4.90^{ab}
Rice husk	3.46^{c}	4.00^{bc}	5.15^{ab}
Black plastic	5.50^{a}	4.65^{a}	3.25^{c}
Control	3.22^{c}	3.88^{c}	5.85^{a}
Grand mean	4.05	4.21	4.64
CV	10	4.67	21.5
LSD	0.624***	0.303**	1.54*
SEM(±)	0.2	0.09	0.49

Mulching produces a significant difference in tuber weight per plant as compared to the control condition. In case of large of large size tubers(>50gm) the maximum number of large tubers were found in black plastic (5.50) while the minimum number were found in control condition (3.22) which was statistically at par with rice straw (4.25) and saw dust (3.80). Medium sized tuber (25 -50 gm) were found significantly higher in mulch condition as compared to the control condition. In black plastic the maximum numbers of medium sized tubers per plant were found (4.65).The minimum number of medium sized tubers were found in control condition was found in control condition (3.88) which was statistically at par with rice husk (4.00).

The number of medium sized tubers in rice straw was found (4.30) which was significantly at par with saw dust (4.22) and rice husk (4.00). Small sized tubers (<25 gm) numbers per plant were found significantly higher in control condition as compared to the mulch condition. The highest numbers of small sized tubers were found in control condition (5.85) which was statistically at par with rice husk (5.15) and saw dust (4.90). The minimum numbers of small sized tubers were found in black plastic (3.25). The higher yield of large sized tubers and medium sized tubers with mulch was due to the less resistance by soil and more up take of water and nutrients which might have led to better development and growth of individual tuber and hence large sized potato (Zhao, 2012). The results were more pronounced in case of black polyethylene mulch compared to other mulches and control condition because of more soil moisture and nutrient retention due to lesser weed competition.

3.8 Effect of different mulching materials on soil temperature

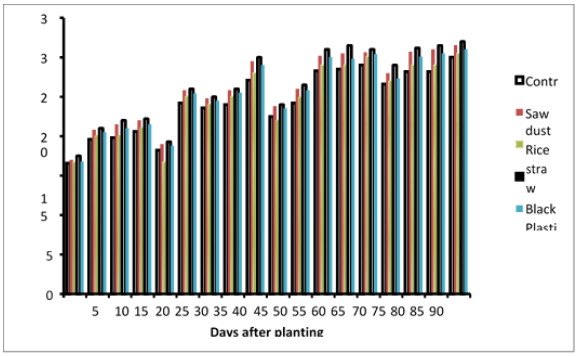

Figure 4: Effect of different mulching material on soil temperature

Average soil temperature at 15 cm depth during the experimental period (Figure 6) was affected by the mulching type and materials applied. Results indicated that the type of mulch improved the soil temperature following the order of Black plastic > Saw dust > Rice husk > Rice straw > Control. The soil temperature under the different mulches is affected by the type of material employed and the temperatures registered in bare soil are always lower than under mulch treatments. Applying the black plastic mulch increased soil temperature by 1.5 -2.47 C° as compared to other mulching materials and bare soils. These findings are in agreement with many other field studies (Singh, 2012; Moursy, 2015; Li, 2018; Kumari, 2012; Simsek, 2017; Xing, 2012; Yaghi, 2013). The warmer soil temperatures can quicken seedling emergence and growth to achieve the desired population structure at an earlier growth stage which maximize the absorption of solar radiation and enhance the yield (Zhou, 2009; Li, 2018). Furthermore, elevated soil temperature can be lethal for nematode and soil borne pathogens as well as many weed seeds before its germination through solarization (Singh, 2012).

4. Conclusion

- Black polyethylene mulch was found to be more suitable mulching material compared to saw dust, rice straw, rice husk, mulch for potato crop.
- The maximum yield was obtained from black plastic which was followed by rice straw, saw dust, rice husk and control condition.
- The soil temperature was found maximum in black plastic followed by saw dust, rice husk, rice straw and control condition.
- The production of potato with the use of black plastic was found economical.

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