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Evaluation of Different Organic and Inorganic Mulches for the Growth and Yield Characteristics of Potato (*Solanum tuberosum* L.) under Tarai Region of Uttarakhand, India

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A B S T R A C T

Potato (*Solanum tuberosum L.*, 2n= 4x= 48) is one of the major food crops of the world which can supplement the food needs of any country in a substantial manner. It is a perennial plant of the Solanaceae or nightshade family, commonly grown for its starchy tuber content. Mulching plays a very important role in the potato production. It has numerous advantages, it reduces labour required in cultivation and does not harm the crop. Mulching is done to improve the soil structure, it conserves the soil by slowing the evaporation rate, regulates the temperature and provides a more unified appearance to the field. The present investigation was undertaken for the "Evaluation of different organic and inorganic mulches for the growth and yield characteristics of potato (*Solanum tuberosum* L.) under tarai region of uttarakhand". The experiment was conducted in randomized block design with three replications. The experiment comprised of 1 treatment of inorganic mulch [Black polyethylene mulch (25µ)], 4 treatments of organic mulches (Sugarcane dry leaves of 2.5 cm thickness, sugarcane dry leaves of 5.0 cm thickness, paddy straw mulch of 2.5 cm thickness, paddy straw mulch of 5.0 cm thickness) and control (without mulch) treatment. The results concluded that sugarcane dry leaves mulch of 5.0 cm thickness was found most effective and more beneficial than rest of the treatment for growth and yield of potato while the minimum values of the same was found under control (without mulch) treatment. The positive response of various organic mulches on growth, yield attributes and total yield may be due to the fact that mulch treatments provide a congenial environment for proper plant growth which ultimately improves these parameters.

Introduction

Potato (*Solanum tuberosum L.*, 2n= 4x= 48) are the world's most widely grown tuber crops, and the fourth largest crop in terms of fresh produce (after rice, wheat, and maize) but this ranking is inflated due to the high water content of fresh potatoes relative to that of other crops. It is an important food crop of subtropical and temperate countries and provides staple food stuff for millions of people in many parts of the world. It is grown in India as a vegetable crop alone or mixed with other vegetables. As a cash crop, it is the

most efficient producer of food per unit area and time. In India, the *aloo* is not primarily a rural staple but a cash crop that provides significant income for farmers, the value of the 2005 harvest was estimated to be $3.6 billion and exports were about 80,000 tonnes. As a food, it is one of the cheapest sources of carbohydrate and furnish appreciable amount of vitamin B1 and C as well as some minerals. It is a rich source of energy (81 kcal/ 100 g).

Mulching plays a very important role in the potato production. The word mulching was derived from the German word *Mulsch* which means soft and beginning to decay. Mulching has numerous advantages, it reduces labour required in cultivation, since emerging and small weeds perish under their dark barrier. It also reduces the requirement for tillage and the use of weed-control chemicals. It does not harm the crop and can be either organic or inorganic in nature.

Mulching is done to improve the soil structure, it conserves the soil by slowing the evaporation rate, it regulates the temperature and provides a more unified appearance to the field. There are three different types of mulches which are being used by the farmers such as organic, inorganic, and chemical. Paddy straw, sugarcane dry leaves and dry grass are used as organic mulches, even a couch potato can grow a good potato crop with very little efforts. By using straw and a little soil preparation up front, it's easy to grow an admirable crop in a limited space.

These materials are lightweight and easy to apply Mulching also helps in faster plant emergence; early canopy development of potato plants and higher marketable and total tuber yield (Mohammad *et al.,* 2002). Therefore, mulching practices in potato may be an important resource management tool in improving water use efficiency in potato production. In view of these an experiment was undertaken for higher tuber productivity.

Materials and Methods

The experiment was carried out during *rabi* season under locally available mulch materials using organic and inorganic materials along with control i.e. without mulch or traditional practice (Table 1). The trail was conducted at Vegetable Research Centre, G.B. Pant University of Agriculture and Technology, Pantnagar, district Udham Singh Nagar, Uttarakhand during the rabi season.

Disease free, medium sized (25 to 50g) and well sprouted tubers were selected. The seed tubers were treated with Boric acid (3%) for 15 minutes before planting. The treated tubers were planted in furrows and covered by soil by making ridges. The distances between row to row and plant to plant were kept 60 cm and 20 cm, respectively. Mulch materials were applied in each plot after one month of planting. The 2.5 cm and 5.0 cm thick layer of paddy straw and sugarcane dry leaves mulch material were used as mulch. The control plots were left without any mulch i.e. traditional practice.

The observations were recorded under growth and yield parameters like Emergence Percent, Plant height, Number of haulm per hill, number of leaves per hill, diameter of haulm per hill, Tuber yield, Average tuber weight, grade wise number of tuber per hill, grade wise yield of tuber per hill (kg) etc. (Table 2).

The data recorded during the course of experiment were statistically analyzed using randomized block design. Valid conclusions were drawn by performing analysis of variance. To evaluate the significance of the difference between means of two treatments, critical difference (at 5% level of

significance) was calculated using following formula:

$$CD = \sqrt{2 \times EMS \div r \times t}$$

Where,

CD = critical difference
t = table value of 't' at error degree of freedom
r = number of replications
EMS = error mean square

Results and Discussion

Evaluation of different organic and inorganic mulches for plant growth characters

Mulching with organic and inorganic material showed significant effect on the percent sprout emergence at 30 days after planting (Table 3). The mulching with paddy straw of 2.5 cm thickness and sugarcane dry leaves of 5.0 cm thickness showed improvement over control treatment (without mulch). It might be probably due to the food material already stored in the seed tuber, which gave initial boost to the emerging plants; improvement in emergence due to mulching may attributed to the early increase in temperature. It has also been confirmed by the findings of The finding is fully supported by zhao 2012 and Sadawarti *et al.,* (2013). The effect of different mulches varied differently from one stage to another with respect to plant height. At 45 days stage, paddy straw mulch of 2.5 cm thickness came out to be significantly superior in producing the tallest plant as compared to other treatments (Table 4). At 60, 75 and at haulm cutting stage the tallest plant was found with paddy straw mulch of 5 cm thickness. This might be due to the fact that mulch treatments provide a congenial environment for proper plant growth. The beneficial effects of mulching in increasing plant height have also been reported by Kar and Kumar (2007) and Dash *et al.,* (2018). Similar observations on plant height of potato have been reported by Aulakh and Sur (1999) and Hedau and Kumar (2002) dvorak *et al.,* (2009). Mulch of 5 cm thickness applied in the form of paddy straw gave maximum number of leaves per hill at 45 days but it was recorded with sugarcane dry leaves mulch at 60, 75 day and at haulm cutting stage (Table 5). The minimum number of leaves was observed in control (without mulch) treatment.

This difference in number of leaves might be attributed to the fact that the organic mulches had more favourable environment which resulted in more number of haulms which ultimately increase the number of leaves per hill. Similar findings were also reported by Ram and Singh (1992), Hallidri (2001) and Singh and Ahmed (2008). Diameter of haulms increased with the advancement of crop growth, irrespective of the treatment. The maximum rate of increase was recorded between 45 to 75 day stage and slight decrease was noticed at haulm cutting stage, might be due to maturity of the crop. Maximum diameter of haulms per hill at all the stages was recorded with sugarcane dry leaves mulch of 5.0 cm thickness. Significant increase in the diameter of haulms might be on account of improved environmental condition such as temperature and moisture due to the application of organic mulches.

Treatments differed significantly with respect to number of tubers per hill. It is obvious from the Table 6 that there was a slight increase in number of tubers per hill under mulched plot. Maximum number of tubers per hill (8.68) was recorded under sugarcane dry leaves mulch of 5.0 cm thickness which was at par with paddy straw mulch of 2.5 cm thickness and black polyethylene (25µ) mulch. The minimum number of tubers was recorded under control (without mulch) plot.

Evaluation of different organic and inorganic mulches for yield and yield attributes

Treatments differed significantly with respect to number of tubers per hill. It is obvious from the Table 6 that there was a slight increase in number of tubers per hill under mulched plot (Table 6). Maximum number of tubers per hill (8.68) was recorded under sugarcane dry leaves mulch of 5.0 cm thickness which was at par with paddy straw mulch of 2.5 cm thickness and black polyethylene (25µ) mulch. The minimum number of tubers was recorded under control (without mulch) plot. The effect of organic and inorganic mulch with respect to the yield of tubers per hill was found significant. The maximum tuber yield per hill was recorded in sugarcane dry leaves mulch of 5 cm thickness.

It was noticed that all the organic mulch treatments increased tuber yield per hill as compared to inorganic mulch (black polyethylene) and control (without mulch). It was observed that the maximum tuber weight was recorded in sugarcane dry leaves mulch of 5.0 cm thickness which was at par with sugarcane dry leaves mulch of 2.5 cm thickness, paddy straw mulch of 2.5 and 5 cm thickness. The minimum tuber weight was recorded black polyethylene mulch. Such a result has been supported by the findings of Sadawarti *et al.,* (2013). Kumar *et al.,* (2003) has also suggested that potato leaves close their stomata at relatively low soil moisture regime leading to faster decrease in photosynthesis and transpiration rate than other field crops leading to lower yields which has also been reflected in the present study. Mulching also resulted in higher tuber yield in all the yield categories over no mulching. Such beneficial effects of mulching have been demonstrated in the results achieved by Kar and Kumar (2007).

The differences due to different treatments on grade wise number of tubers were significant during the investigation. Maximum numbers of 'A', 'B', 'C' and 'D' grade tubers were recorded in sugarcane dry leaves mulch of 5.0 cm thickness, black polyethylene mulch, control treatment (without mulch) and sugarcane dry leaves mulch of 2.5 cm thickness, respectively (Table 7).

The yield of 'A', 'B', 'C' and 'D' grade tubers were recorded maximum in sugarcane dry leaves mulch of 5.0 cm thickness, sugarcane dry leaves mulch of 2.5 cm thickness, paddy straw mulch of 5.0 cm thickness and sugarcane dry leaves mulch of 2.5 cm thickness, respectively (Table 8).

Table.1 Treatment details

S.No.	Treatments	Symbols
1	Black polyethylene mulch (25µ)	T_1
2	Sugarcane dry leaves mulch (2.5cm)	T_2
3	Sugarcane dry leaves mulch (5.0 cm)	T_3
4	Paddy straw mulch (2.5 cm)	T_4
5	Paddy straw mulch (5.0 cm)	T_5
6	Control (without mulch)	T_6

Table.2 Trail details

Sr. No	Items	Details
1	Total number of treatments	06
2	Number of replications	03
3	Number of plots	18
4	Number of rows per replication	5
5	Number of tubers planted per row	15
6	Number of tubers planted per plot	75
7	Gross plot size	4.2m× 3.6m
8	Net plot size	3.6m×3.6m
9	Spacing	60× 20 m^2
10	Main irrigated channel	1m
11	Sub-irrigated channel	0.75 m
12	Variety	K.Jawahar

Table.3 Evaluation of different organic and inorganic mulches for emergence percent of potato

Mulch treatment	Emergence Percent at 30 DAP
Black polyethylene (25µ)	87.35
Sugarcane dry leaves (2.5cm thickness)	88.23
Sugarcane dry leaves (5cm thickness)	87.40
Paddy straw (2.5cm thickness)	88.15
Paddy straw (5cm thickness)	87.15
Control (without mulch)	86.78
S.Em.±	0.06
C.D. at 5%	0.19

Table.4 Evaluation of different organic and inorganic mulches for plant height and number of haulm per hill at various growth stages (cm)

Mulch treatment	Plant height (cm)				Number of haulm per hill			
	45 DAP	60DAP	75 DAP	At haulm cutting	45 DAP	60DAP	75 DAP	At haulm cutting
Black polyethylene (25µ)	47.29	50.25	51.10	52.30	6.99	6.99	6.99	**4.67**
Sugarcane dry leaves (2.5cm thickness)	47.45	50.36	51.18	52.27	7.00	7.00	7.00	**7.00**
Sugarcane dry leaves (5cm thickness)	47.46	50.32	51.10	50.39	5.00	5.00	5.00	**6.67**
Paddy straw (2.5cm thickness)	47.89	51.11	51.17	51.47	6.31	6.31	6.31	**5.66**
Paddy straw (5cm thickness)	47.78	52.12	51.50	52.34	8.00	8.00	8.00	**5.30**
Control (without mulch)	46.54	50.02	51.18	52.29	4.67	4.67	4.67	**3.33**
S.Em.±	0.21	0.22	0.28	0.16	0.52	0.52	0.52	**0.32**
C.D. at 5%	**0.65**	**0.69**	**0.88**	**0.53**	**1.66**	**1.66**	**1.66**	**1.05**

Table.5 Evaluation of different organic and inorganic mulches for number of leaves per hill and Diameter of haulms of potato

Mulch treatment	Number of leaves				Diameter of haulms			
	45 DAP	60DAP	75 DAP	At haulm cutting	45 DAP	60DAP	75 DAP	At haulm cutting
Black polyethylene (25µ)	66.66	64.11	51.66	41.77	8.08	8.79	9.42	**9.52**
Sugarcane dry leaves (2.5cm thickness)	68.66	64.44	60.66	51.11	8.82	9.00	9.79	**9.59**
Sugarcane dry leaves (5cm thickness)	57.77	67.43	55.65	46.66	8.91	9.22	9.88	**9.89**
Paddy straw (2.5cm thickness)	62.66	57.33	60.55	48.11	8.34	8.47	9.64	**9.59**
Paddy straw (5cm thickness)	70.00	66.22	40.44	47.00	8.37	8.52	9.47	**9.48**
Control (without mulch)	45.00	42.55	45.00	36.55	7.94	8.37	9.13	**9.41**
S.Em.±	6.18	5.50	9.18	4.74	0.14	0.12	0.15	**0.87**
C.D. at 5%	**19.46**	**17.35**	**28.92**	**14.94**	**0.45**	**0.36**	**0.46**	**0.28**

Table.6 Evaluation of different organic and inorganic mulches for Number of tuber/hill, Tuber yield /hill (kg), Average tuber weight (g) and Total tuber yield (q/ha) of potato

Mulch treatment	Number of tuber/hill	Tuber yield /hill (kg)	Average tuber weight (g)	Total tuber yield (q/ha)
Black polyethylene (25µ)	8.27	0.272	33.69	**249.24**
Sugarcane dry leaves (2.5cm thickness)	7.48	0.339	43.75	**251.17**
Sugarcane dry leaves (5cm thickness)	8.68	0.348	45.72	**279.11**
Paddy straw (2.5cm thickness)	8.45	0.324	43.71	**232.49**
Paddy straw (5cm thickness)	7.38	0.317	43.36	**230.03**
Control (without mulch)	7.30	0.280	35.33	**206.53**
S.Em.±	0.19	0.105	1.04	**0.42**
C.D. at 5%	**0.61**	**0.331**	**3.28**	**1.32**

Table.7 Evaluation of different organic and inorganic mulches for grade wise number of tuber per hill

Mulch treatment	Grade A	Grade B	Grade C	Grade D
Black polyethylene (25µ)	34.00	145.00	168.00	180.00
Sugarcane dry leaves (2.5cm thickness)	45.33	107.33	170.0	189.00
Sugarcane dry leaves (5cm thickness)	47.00	127.00	171.00	178.00
Paddy straw (2.5cm thickness)	46.00	119.67	155.00	145.00
Paddy straw (5cm thickness)	39.00	132.00	152.00	152.33
Control (without mulch)	30.33	105.33	182.00	187.33
S.Em.±	0.17	0.25	0.24	0.17
C.D. at 5%	0.54	0.79	0.79	0.54

Table.8 Evaluation of different organic and inorganic mulches for grade wise yield of tuber per hill (kg)

Mulch treatment	Grade A	Grade B	Grade C	Grade D
Black polyethylene (25µ)	5.73	10.66	7.67	2.64
Sugarcane dry leaves (2.5cm thickness)	7.28	12.67	8.00	3.09
Sugarcane dry leaves (5cm thickness)	7.42	11.92	8.07	2.80
Paddy straw (2.5cm thickness)	7.26	11.73	7.13	2.66
Paddy straw (5cm thickness)	4.97	12.33	9.33	2.67
Control (without mulch)	5.73	9.75	9.27	2.91
S.Em.±	0.12	0.28	0.23	0.55
C.D. at 5%	0.38	0.43	0.73	0.17

The total tuber yield varied from 206.5 to 279.1 q/ha. and was higher in sugarcane dry leaves mulch of 5.0 cm thickness (279.11q/ha) followed by sugarcane dry leaves mulch of 2.5 cm thickness (251.17q/ha) whereas, control (without mulch) treatment yielded minimum tuber yield (206.53q/ha) which was 35% low than the yield obtained in sugarcane dry mulch of 5 cm thickness. Progressive increase in these parameters owing to mulching may attributed that mulching provide congenial environment for tuber development by maintaining soil temperature and conserving soil moisture.

Hence concluded that the critical analysis of data revealed that paddy straw mulch of 2.5 cm thickness gave tallest plant but at par with all the treatments except the control treatment (without mulch) that also have the shortest plant at 45 day stage.

The total tuber yield varied from 206.5 to 279.1 q/ha. Total yield of potato tuber was recorded higher in sugarcane dry leaves mulch of 5.0 cm thickness (279.11q/ha) followed by sugarcane dry leaves mulch of 2.5 cm thickness (251.17q/ha). control (without mulch) treatment yielded minimum tuber yield (206.53q/ha) which was 35 per cent low than the yield obtained in sugarcane dry mulch of 5 cm thickness. The effect of different mulches varied differently from one stage to another in respect to plant height. At 45 day stage, paddy straw mulch of 2.5 cm thickness came out to be significantly superior in producing the tallest plant as compared to other treatments. At 60, 75 and

at haulm cutting stage the tallest plant was found with paddy straw mulch of 5 cm thickness. Number of haulms per hill at 45, 60 and 75 day stage was significantly higher with paddy straw mulch of 5 cm thickness. It might be due to the fact that paddy straw mulch provides more favourable temperature which resulted in more number of haulms per hill. The total tuber yield varied from 206.5 to 279.1 q/ha. and was recorded higher in sugarcane dry leaves mulch of 5.0 cm thickness (279.11q/ha) followed by sugarcane dry leaves mulch of 2.5 cm thickness (251.17q/ha) whereas, control (without mulch) treatment yielded minimum tuber yield (206.53q/ha) which was 35 per cent low than the yield obtained in sugarcane dry mulch of 5 cm thickness.

On the basis of observations it could be possible to conclude that mulching with sugarcane dry leaves of 5.0 cm thickness were most effective for better growth and yield of potato. Mulches showed significant effect on growth parameters viz., percent emergence (30 DAP), plant height, number of leaves, number and diameter of haulms per hill at various stages, Maximum values in all the parameters mentioned were obtained during investigation. Mulching with organic and inorganic material showed significant effect on the percent sprout emergence at 30 days after planting. The mulching with paddy straw of 2.5 cm thickness and sugarcane dry leaves of 5.0 cm thickness showed improvement over control treatment (without mulch). The effect of different mulches varied differently from one stage to another in respect to plant height. At 45 day stage, paddy straw mulch of 2.5 cm thickness came out to be significantly superior in producing the tallest plant as compared to other treatments. At 60, 75 and at haulm cutting stage the tallest plant was found with paddy straw mulch of 5 cm thickness. Number of haulms per hill at 45, 60 and 75 day stage was significantly higher with paddy straw mulch of 5 cm thickness. It might be due to the fact that paddy straw mulch provides more favourable temperature which resulted in more number of haulms per hill. Mulch of 5 cm thickness applied in the form of paddy straw gave maximum number of leaves per hill at 45 days but it was recorded with sugarcane dry leaves mulch at 60, 75 day and at haulm cutting stage. The minimum number of leaves was observed in control (without mulch) treatment. Diameter of haulms increased with the advancement of crop growth, irrespective of the treatment. Maximum diameter of haulms par hill at all the stages was recorded with sugarcane dry leaves mulch of 5.0 cm thickness. The total tuber yield varied from 206.5 to 279.1 q/ha. and was recorded higher in sugarcane dry leaves mulch of 5.0 cm thickness (279.11q/ha) followed by sugarcane dry leaves mulch of 2.5 cm thickness (251.17q/ha) whereas, control (without mulch) treatment yielded minimum tuber yield (206.53q/ha) which was 35% low than the yield obtained in sugarcane dry mulch of 5 cm thickness.

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