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Effect of different mulch materials on growth and yield attributing traits in broccoli (*Brassica oleracea* var. *italica* L.)

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Abstract

A field experiment was conducted at Vegetable Research and Demonstration Block, RLBCAU, Jhansi during November 2018 to March 2019. The experiment consisted of six treatments, viz. T₀ = Control (without mulch), T₁ = Clear plastic, T₂ = Black plastic, T₃ = Red plastic, T₄ = Green Leaves and T₅ = Dry Grass was laid out in randomized block design with four replications. Maximum number of leaves (15.45), leaf length (53.28 cm), leaf breadth (23.10 cm), number of spears (7.25), average spear weight (32.46 g), head polar diameter (11.64 cm), head equatorial diameter (10.92 cm), head weight (496.19g), yield 16.65 t/ha and TSS (11.98°Brix) and minimum days to head harvest (63.70), were observed in T₂ (Black mulch) followed by T₃ (Red mulch) in comparison to T₀ (Control/without mulch). So, it can be concluded that black plastic mulch is suitable for broccoli cultivation during winter season in Bundelkhand region of Uttar Pradesh.

Keywords: Mulch, broccoli, growth and yield attributes, Bundelkhand

Introduction

Broccoli (*Brassica oleracea* var. *italica* L.) is an important Cole crop of Brassicaceae family. It is a minor vegetable crop of India and rarely cultivated in Bundelkhand region. There are three classes of broccoli, i.e. green, purple and white, among them green type broccoli is the most popular (Shoemaker, 1962) [17]. Sprouting broccoli contains more vitamins and minerals than those of other Cole crops (Nonnecke 1989) [11]. Broccoli is a nutritionally important crop grown all over the world and it is a floral vegetable with an important nutritional value due to its content of vitamins, antioxidants, glucosinolates and anticarcinogenic compounds (Parente *et al.*, 2013; Lemoine *et al.*, 2010; Chuanphongpanich *et al.*, 2006) [12, 9, 2]. Therefore, it can be met up some degree of vitamin A and vitamin C requirement and can contribute to solve malnutrition problem in Bundelkhand region. Due to low production of vegetables, the present per capita consumption is only about 230g but it is about 70 g with potato. It is an alarming situation for vegetable consumption in India. Hence, a large-scale production of broccoli can help to increase vegetable consumption.

Broccoli can be grown on a wide range of soil types, ranging from light sand to heavy loam or even clay that are well supplied with organic matter (Katayal, 1994) [8]. Successful production of broccoli depends on various factors. Fertilizer and moisture management are the most important factors, which assured crop production. Broccoli is cultivated in India during the winter season when rainfall is scanty. It requires 250-300 mm water during transplanting, growing period and curd formation stage (Rashid, 1976) [14]. In most of the time irrigation increases the cost of production resulting in unprofitable production of broccoli and make growers frustrated. Mulching can minimize the requirement of water and helps in retaining moisture (Amal *et al.* 1990) [1]. Mulches also reduce the water loss from the soil by evaporation and reduce the irrigation requirements (Vanderwerken *et al.* 1988 and Amal *et al.* 1990) [19, 1]. In addition, plastic mulch increases temperature of soil, accelerated plant height, early growth, early yield, and bring satisfactory weed control without any application of herbicides (Najafabadi *et al.*, 2012) [10]. Mulching system also causes an increase in fruit soluble solids content, total sugar, fructose, glucose, ascorbic acid, citric acid contents, flavonoid contents and antioxidant capacities (Wang *et al.*, 2002) [20]. Therefore, mulching may be helpful in conserving soil moisture of the preceding season and may be exploited to produce broccoli successfully particularly where rainfall and irrigation facilities are scarce.

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Considering the above circumstances, this work was undertaken to study the effect of different mulching materials on growth and yield of broccoli.

Materials and Methods

Experimental Site: The experimental area is located at (24° 11'N latitude and 78° 17' E longitude), Jhansi, Uttar Pradesh, India. The region lies in agro-eco region-4, Northern Plain and Central Highlands, hot semi- arid eco region with alluvium-derived soil. Mean annual rain-fall of the region is 960 mm with an average of 52 rainy days per year. Most of the rainfall is received during monsoon period which begins in the last week of June (26th Standard Meteorological Week [SMW]) and remains active till the first week of September. Mean maximum temperature ranges from 47.4 °C (June) to 23.5 °C (January) and mean minimum temperature from 27.2 °C (June) to 4.1 °C (December). May and June are the hottest months. The maximum recorded temperature on a particular day often touches 47–48 °C during summer. Red soils occurred at elevated spots and were shallow, gravelly and light textured. Black soils were situated in comparatively low-lying areas and were fine textured.

Experimental Layout and Design: The experiment was laid out in randomized block design with four replications using

six levels of mulching, viz. control (without mulch), black plastic, clear/transparent plastic mulch, red plastic, green leaves, dry grasses and one variety of broccoli (Palam Smruddhi). The size of the each plot was 5m ×5m. The distance maintained between two blocks and two plots were 1 m and 0.5 m respectively. The plots were raised up to 15 cm. Four weeks old healthy seedlings of uniform size (10-15 cm) transplanted at the spacing of 60 cm × 50 cm in the experimental plots. Recommended dose of fertilizer (100-80-60 kg ha⁻¹ NPK) in the form of Urea, SSP and MOP were applied to grow the crop. The experimental plots were thoroughly cultivated and levelled so as to minimize such protrusions as clods, stubble, and stones in the area and to prevent the tearing of polythene sheeting. Slight irrigation has given prior to laying of the polythene sheeting to make soil surface more uniform and to increase the moisture content. Mulches were laid in the plots at the time of transplanting. Plastic sheets (black, clear, red) with small opening which was made for maintaining proper plant to plant and row to row distance before placing over the plots. Two edges of polythene sheets inserted in the furrows. Hand hoeing operation was done periodically in control plots. Intercultural operations were done as per the requirement. The fresh water green leaves and dry grasses were chopped into small pieces (5 cm) and sun dried for two days.



Fig 1: Experimental field view

The thickness of green leaves and dried grasses mulch materials were maintained at 5 cm approximately. Harvesting was initiated when the buds of the head became firm and tight before flowering. The data pertaining to following characters were recorded from ten plants randomly selected from each plot except yield of curds which was recorded plot wise. Days to first harvest, number of leaves, leaf length, leaf breadth, number of spears, average spear weight, head polar diameter, head equatorial diameter, head weight, yield and TSS were

measured. The mean values of all the treatments were calculated and analyses of variance for all the characters were performed by the F-test (variance ratio). The significance of the difference among the treatment combinations of means was estimated by least significance difference (LSD) at 5% level of probability.

Results and Discussion

From Tables 1-2 and Figures 2-5 shows that the data

pertaining to different growth characters at different stages revealed significant variations among the different treatments under study.

In the present study, three inorganic mulch *i.e.* clear plastic, black plastic and red plastic mulch, two organic mulch with green leaves and dry grasses were used and control (without mulch). Days to first harvesting ranged from 63.70 days to 73.10 days among the treatments. Earliest (63.70) days to harvest was observed with black plastic mulch followed by Red plastic mulch 64.05 while maximum days taken for harvest was observed in control (without mulch). Among the treatments number of leaves was ranged from 11.83 to 15.45. Maximum number of leaves were recorded with black plastic mulch (15.45) followed by Red plastic mulch (14.30). Leaf length was ranged between 43.18 - 53.28 cm and maximum 53.28 cm was recorded with black plastic mulch followed by

red mulch 50.95 cm. Whereas, minimum 43.18cm recorded in control (without mulch). Maximum leaf breadth was observed with black plastic mulch (23.10 cm) followed by red mulch (20.53 cm) whereas, minimum 17.48 cm was recorded in control (without mulch).

Maximum number of spear 7.25 was recorded with black plastic mulch followed by red mulch 6.35 whereas, minimum 5.05 was recorded in control (without mulch). Average spear weight (g) was ranged from 24.81 to 32.46. Heaviest spear was recorded with black mulch 32.46g followed by red 29.06 g. Head polar diameter recorded maximum 11.64 cm with black mulch followed by red mulch 10.36 cm while minimum 8.35 cm was recorded in control without mulch. Maximum head polar diameter 11.64 cm was recorded with black plastic mulch followed by red mulch 10.36 cm whereas, minimum 7.18 cm was recorded in control (without mulch).

Table 1: Effect of different mulching materials on growth characters in broccoli

Treatments	Days to first harvest	Number of leaves	Leaf length (cm)	Leaf breadth (cm)	Number of spear
T ₀ :- Control (without mulch)	73.10	11.83	43.18	17.48	5.05
T ₁ :- Clear plastic	68.73	13.70	49.95	19.70	5.98
T ₂ :- Black plastic	63.70	15.45	53.28	23.10	7.25
T ₃ :- Red plastic	64.05	14.30	50.95	20.53	6.35
T ₄ :- Green Leaves	65.60	13.30	44.85	19.55	5.63
T ₅ :- Dry Grasses	67.30	12.85	46.05	20.43	5.68
Mean	67.08	13.57	48.04	20.13	5.99
S.Em ±	1.25	0.53	0.54	0.39	0.34
CD (0.05)	3.86	1.62	1.78	1.32	1.03

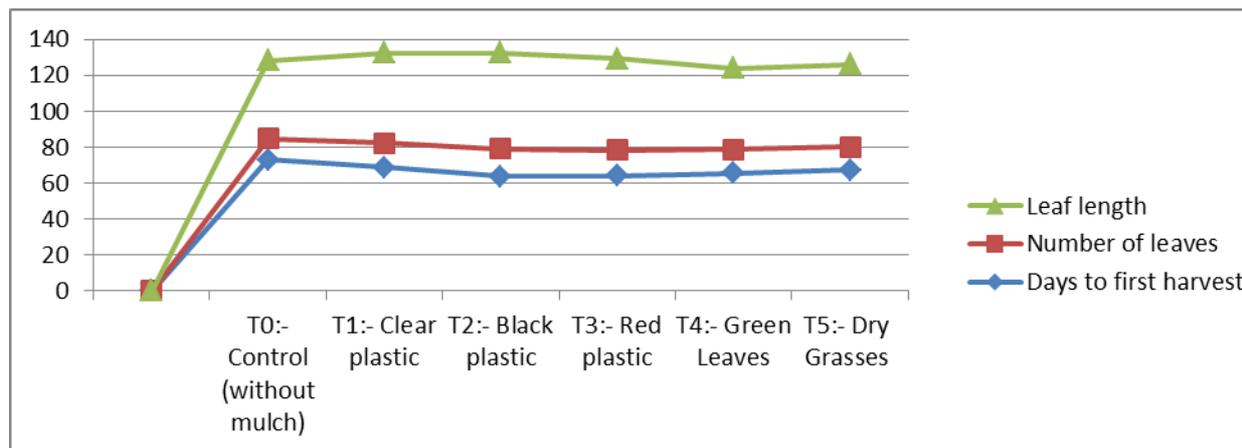


Fig 2: Effect of different mulching materials on leaf length, number of leaves and days to first harvest in broccoli

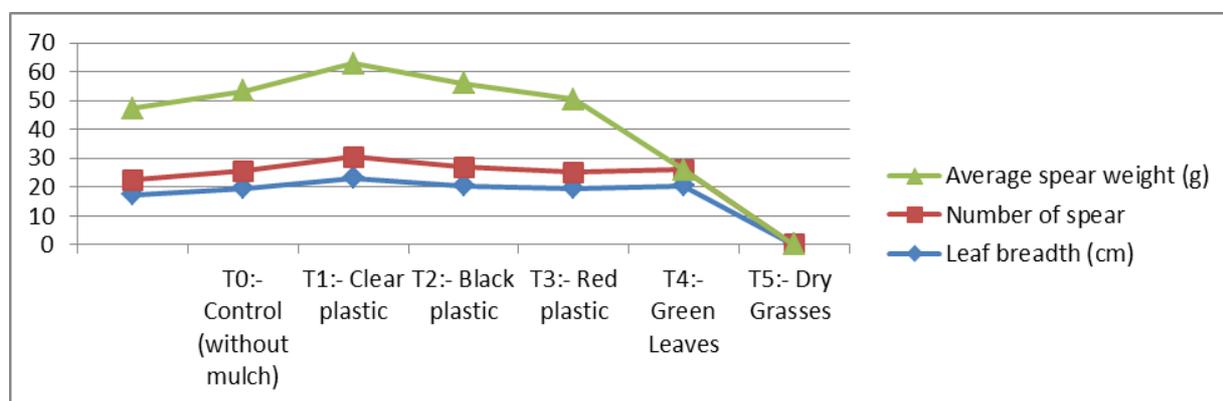


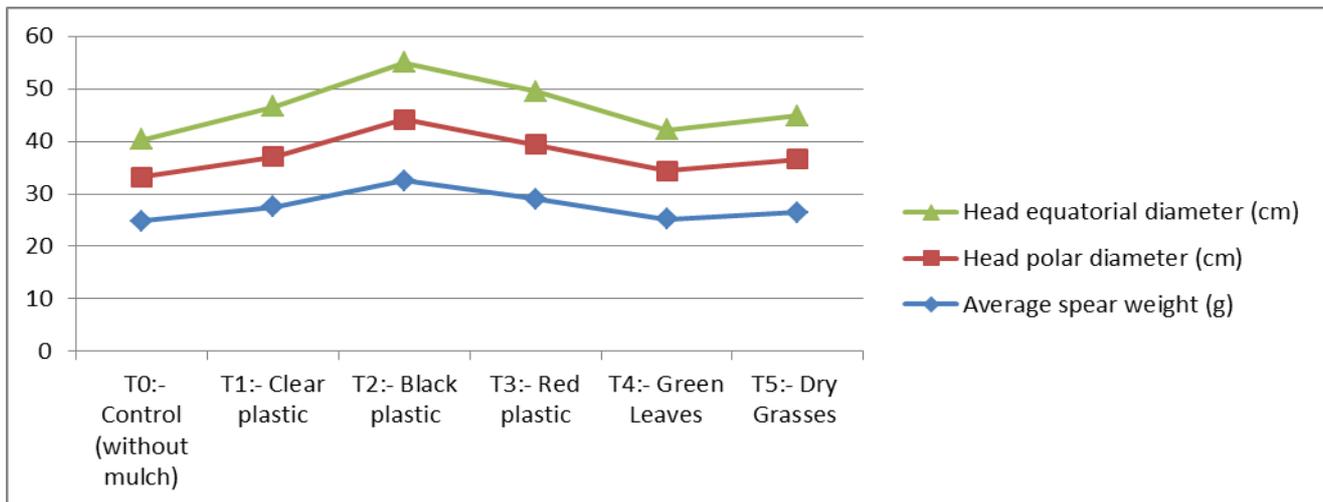
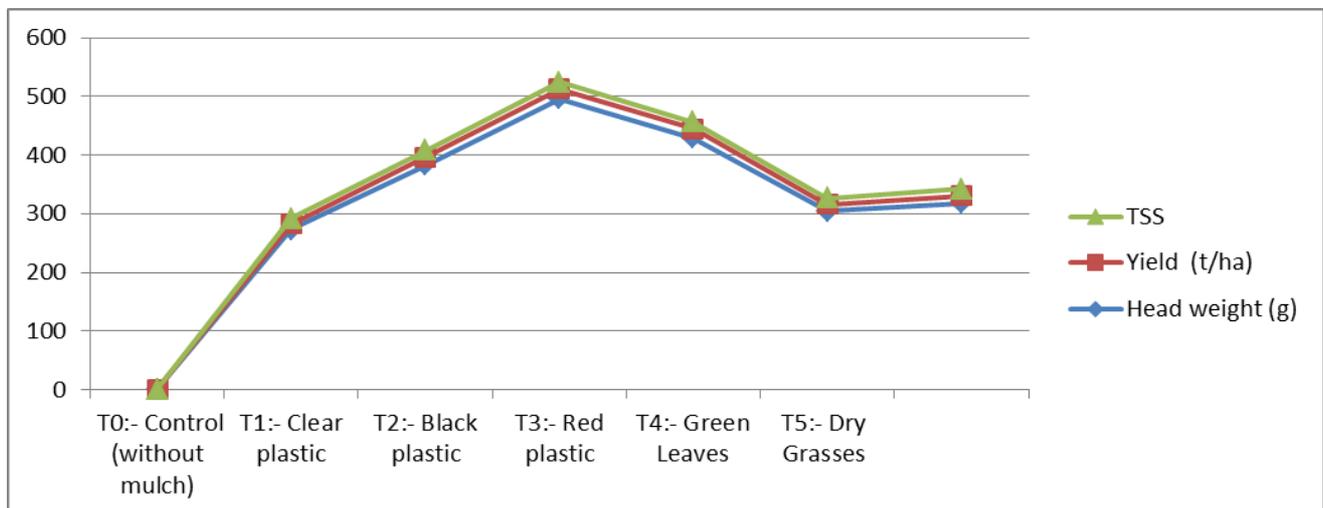
Fig 3: Effect of different mulching materials on average spear weight, number of spear and leaf breadth in broccoli

Head equatorial diameter was ranged from 7.18 to 10.92 cm. maximum 10.92 cm equatorial diameter was observed in black mulch followed by red mulch 10.03 cm. Minimum 7.18

cm equatorial diameter was recorded in the treatment without mulch.

Table 2: Effect of different mulching materials on yield attributing traits in broccoli

Treatments	Average spear weight (g)	Head polar diameter (cm)	Head equatorial diameter (cm)	Head weight (g)	Yield (t/ha)	TSS (^o Brix)
T ₀ : Control (without mulch)	24.81	8.35	7.18	272.43	10.18	9.13
T ₁ : Clear plastic	27.52	9.55	9.48	383.25	13.43	10.98
T ₂ : Black plastic	32.46	11.64	10.92	496.19	16.65	11.98
T ₃ : Red plastic	29.06	10.36	10.03	429.28	15.83	11.30
T ₄ : Green Leaves	25.15	9.19	7.84	304.08	11.73	10.50
T ₅ : Dry Grasses	26.41	10.16	8.27	317.93	12.83	10.90
Mean	27.57	9.87	8.95	367.19	13.44	10.80
S.Em ±	1.16	0.56	0.58	10.88	1.01	0.41
CD (0.05)	3.45	1.85	1.86	33.56	3.12	1.13

**Fig. 4:** Effect of different mulching materials on head equatorial diameter, head polar diameter and average spear weight characters in broccoli**Fig. 5:** Effect of different mulching materials on TSS, head weight and yield in broccoli

The head weight was ranged from 272.43 to 496.19 g. maximum head weight was recorded with black mulch (496.19 g) followed by red mulch 429.28 g while minimum 272.43 g head weight was observed in control treatment. Highest Yield 16.65 t/ha was recorded with the treatment-2 (black mulch) which was followed by 15.83 t/ha with T₃ (red mulch). Lowest yield 10.18 t/ha was observed in control (without mulch). Maximum 11.98 (Brix) amounts of total soluble solids (^oBrix) was recorded in black mulch treatment followed by red mulch 11.30 (^oBrix). Lowest TSS 9.13 (^oBrix) was observed with control treatment (without mulch).

Discussion

The heaviest broccoli heads were harvested from the beds

covered with black plastic mulch at the time of harvesting. This confirmed the well-known facts that mulching has beneficial effects once the soil is warm enough (Johnson *et al.* 2004) [6], and that the soil temperatures determine the growth and development of the crop plants, and consequently the final yield of cabbage (Singh and Mir 2005) [18]. Similarly, it has been confirmed several times that Cole group, as well as many other vegetables, produce higher yields when grown through sheets of black polyethylene (Pulgar *et al.* 2001) [13]. Soils covered with organic mulches are not as warm as soils covered with black polyethylene (Johnson *et al.* 2004) [7]. In addition, soils covered with black polyethylene retain water longer than soils under organic mulches (Schonbeck and Evanylo 1998) [16]. The advantages of growing vegetables

through black polyethylene are that the polyethylene prevents the growth of weeds and diminishes the leaching of nitrates (Hembry and Davies 1994). The results indicate that applying black polyethylene to the soil helps to buffer against low night temperatures in December-January. The lower soil temperatures that are produced under organic mulches appear to be the main reason for the lower yields of broccoli.

It is observed that growing broccoli through black plastic mulch produced the highest crop yields. The advantage of using polyethylene was most apparent when the polyethylene was applied at the start of the experiment. Hence, if the spring is cold and wet, the use of black polyethylene is strongly recommended. It is obvious that black polyethylene mulch is a good way of retaining moisture in the soil.

Conclusion

Application of mulch enhanced the growth and yield of broccoli in comparison to control and application of black plastic mulch may be considered as best treatment followed by red plastic mulch in terms of growth and yield in broccoli. However, the study needs to be further evaluated on large fields and another two to three seasons.

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