

Effect of different mulch colors on the yield of cabbage in the cold arid region of Ladakh (UT), India

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ABSTRACT

Mulching is a protective covering of the soil surface and offers immense benefits in the vegetable production system in terms of yield, quality, earliness, weed infestation, water use efficiency, and drudgery reduction. Using colored plastic mulches is mainly focused on modifying the radiation budget and decreasing soil water loss. Besides, it helps to regulate soil temperature, plant growth, quality, and weed infestation. Therefore, an effort has been made to study the impact of different colors of mulch on the yield of cabbage under cold arid conditions. The results revealed that different colors of mulch significantly influenced the growth parameters of cabbage viz., yield/plot, Net head weight (Kg), Gross head weight (Kg), No. of non-wrapped leaves (g), Weight of non-wrapper leaves (g), and dry weight of weeds(g) overrun-mulched. For days to head formation was significantly earlier in black mulched who took (91 days) followed by blue mulched (93 days) as compared to un mulched which took a maximum number of days (106). Weed infestation in cabbage was significantly reduced under black mulch than control.

Key words: Yield of cabbage, Weed infestation, Ladakh mulching

Introduction

Ladakh, being a cold arid, high-altitude region of India has an extremely harsh climate and a short agriculture season. The high wind velocity, extreme temperature (-25 to 30 °C), very low precipitation (80 and 300 mm mostly in the form of snow), and low soil moisture content (20 to 40 %) directly affect the overall physiology of plant growth. Therefore, this abiotic stress during the growing season results in decreased and unsustainable crop yields. Under such agro-climatic conditions, mulches have a significant effect on preventing drought stress, protecting from frost injury, improving soil chemical, physical, biological properties, disease control, and enhancing crop productivities (Amare and Desta, 2021; Franquera, 2015). The development of polyeth-

ylene (PE) as a plastic film in 1938 and its introduction as a plastic mulch for vegetable crop production started in ancient times (Lightfoot, 1994) in the 1950s significantly enhances commercial crop production (Lamont, 2017). Nowadays, the plastic colors mulch viz. Black, white, green, brown, red, silver, and blue are used in different crops and their impact is quantified by many researchers in different crops (Gordon *et al.*, 2010). The application of black plastic mulch film is becoming popular and very good results have been achieved particularly in arid and semi-arid regions (Bhardwaj *et al.*, 2011). Therefore, increasing production mulching can be the solution to many problems as it can increase soil temperature, especially in early spring, enhances moisture conservation, increases crop yields, and leads to more efficient use of soil nutrients. Under Ladakh conditions,

there is a lack of manpower during the peak growing season for weeding and this technology can play a huge role in drudgery reduction. Black and brown plastic mulches are effective in increasing root zone temperature (RTZ). Increasing the root zone temperature with plastic mulches is highly required in areas with cold climatic conditions (Orozco, 1994). It is eminent that using colored plastic mulches enhances the temperature of the soil. There is a higher soil temperature by colored plastic mulches than bare land (Franquera, 2011). Hence, under prevailing drought and water scarcity conditions as in the cold-arid region of Ladakh, the conservation of soil moisture and ensuring its availability to crops are of vital importance. Therefore mulching plays a very important role in the overall production of vegetables in this cold arid condition.

Cabbage (*Brassica oleracea* L. var *capitata*) is one of the important and commercially grown cole crops in the summer season in Ladakh. It has a good shelf life; therefore it can be stored for a longer duration for winter consumption. The area under cabbage constitutes 3.3 % out of the total 10,319 ha of agricultural land in Leh district (Stobdan *et al.*, 2017). It is a rich source of vitamins C and K helps in preventing certain types of cancer due to the presence of antioxidants and anti-inflammatory qualities (WebMD, 2020). The main sugars found in cabbage are fructose (1.45-2.16g/100g) and glucose (1.67-3.51g/100g) with trace amounts of sucrose (U.S Dept. Agriculture, 2018).

However, no research work on the impact of color plastic mulching has been reported in this region. Considering the importance of polythene mulching in various vegetable crops, the current study aimed to investigate the effect of different mulching materials on the growth, yield, and quality of cabbage under Ladakh conditions.

Materials and Methods

The field experiment was conducted at Precision farming development center, HMAARI, SKUAST-K, Leh during summer for two consecutive years 2015 and 2016. The experimental farm is situated at 3319m AMSL latitude 33058.551' NS and longitude 77041.995' EW at an altitude of 3319m AMSL. The climate of the area is typically dried temperate with extreme fluctuation in the temperature (Fig. 1) and the soil is sandy loam. The experimental design was a Randomized Block Design with three replications.

There were a total of six treatments of different colors mulch materials viz., black mulch (T1), green mulch (T2), blue mulch (T3), red mulch (T4), silver mulch (T5), and control (T6). The nursery was sown in an underground structure (trench) in the 2nd week of March. The lines are covered with a fine mixture of sand, soil, and compost in the ratio of 1:1:1. Light irrigation was given immediately after transplanting. Thereafter covered with plastic mulch to conserve the soil moisture, early germination and to prevent the growth of weeds. Regular monitoring was done for disease incidence. The field was prepared by thorough ploughing, planking and applied with the required quantity of well-decomposed FYM @ 20t/ha and fertilizer (150:60:60 kg/ha) before mulching. After that, the field was leveled and divided into plots/beds of convenient size (10m²), and polythene sheets were laid by pressing the sides with soil so that it may not blow off by strong winds. Small round holes were cut with the help of a scissor at the spacing of 30 cm x 45 cm. Seedlings were transplanted in the 1st week of May into the holes in the evening hours to facilitate proper establishment.

The data were recorded on net head weight (kg), gross head weight (kg), Average head size (cm), number of non-wrapper leaves(g), stalk length (cm), dry wt. of weeds (g/m²), days to head initiation and quality parameters like head compactness were recorded on five randomly plants from each replication and subjected to statistical analysis of variance technique as described by Panse and Sukhatme (1985).

Results and Discussion

Vegetative growth parameters

The results revealed that different types of plastic colors mulch significantly influenced the growth parameters of cabbage viz., Net head weight (Kg), Gross head weight (Kg), No. of non-wrapper leaves (g), Weight of non-wrapper leaves (g), and dry weight of weeds(g) over not mulched. For days to head formation was significantly earlier in black mulched which took (91 days) followed by blue mulched (93 days) and red is at par with silver mulch. Whereas unmulched which took a maximum number of days (106). This may be due to increased temperature under mulch conditions and moisture content stimulates root growth which leads to greater plant growth. It was also reported that improving the micro-climate around plants using col-

ored plastic mulching increases cell expansion and elongation which can increase the growth and development of plants (Franquera, 2015). Similar results were reported in black and silver plastics mulches in enhancing leaf area increasing the rate of photosynthesis, plant yield, and quality (Arancibia, 2008; Ruíz Machuc, 2015). Applications of polyethylene films as mulch have shortened the growing season and enhanced earliness and yield in different vegetable crops (Goreta *et al.*, 2005; McCann *et al.*, 2007).

Weed infestation

The results indicated that the effect of different mulching materials on weed infestation (Table 3) of cabbage was significantly reduced under black mulch than control. The unmulch plot had relatively the highest weed infestation (28.87g) compared to the other treatments. Among all the treatments black mulch recorded minimum weed infestation (8.57g/m²) followed by silver (9.77g/m²) which is at par with blue mulch (10.77g/m²). This might be because the black plastic film does not allow the sunlight to pass through onto the soil. Therefore Photosynthesis does not take place in the absence of sunlight below black film hence, it arrests weed growth. The findings were also obtained by Ossom *et al.* (2001) also

observed significant differences in weed control between mulched and unmulched plots in eggplant. Colored plastic mulches have a significant effect on weed control (Franquera, 2011). Plastic mulch reduced weed dry matter by 63.8% compared with an un-mulched land (Mahajan, 2007) black plastic mulch showed decreased weed dry weights by 91.3% and 94.7% and the lowest weed dry weight was recorded in black plastic (Ashrafuzzaman *et al.*, 2011; Rajablarjani, 2014).

Regarding Stalk, length was recorded maximum in silver mulch (6.05 cm) which is at par with black (6.03) and the minimum was recorded by no mulch (3.72 cm).

Table 3. Effect of mulch color on weed infestation (kg/m²)

Treatments	Fresh wt. of weeds (g)	Dry wt. of weeds (g)
M1 (Black)	27.33	8.57
M2(Green)	174.67	20.47
M3(Blue)	69.33	10.77
M4(Red)	74.33	14.33
M5(Silver)	52.33	9.77
M6(Control)	129.33	28.87
CD _{0.05}	6.24	2.37

Table 1. Effect of mulch color on earliness in cabbage

Treatments	Days to head formation	No. of non-wrapper leaves	Weight of non-wrapper leaves (g)	Stalk length (cm)
M1 (Black)	91	17.55	414.00	6.03
M2 (Green)	101	16.00	330.55	5.53
M3 (Blue)	93	17.00	380.55	3.72
M4 (Red)	98	17.33	366.67	5.49
M5 (Silver)	99	15.67	361.33	6.05
M6 (Control)	106	15.00	272.56	3.95
Mean	98	16.43	354.27	5.13
CD _{0.05}	5.6	2.27	135.53	2.16

Table 2. Effect of mulch color on yield and quality in cabbage

Treatments	Yield (kg/plot)	Marketable wt /plant (Kg)	Gross wt/plant (Kg)	Average head size (cm)	Head compactness (Z value)
M1 (Black)	75.40	1.68	2.14	15.00	45.06
M2(Green)	59.52	1.33	2.00	14.66	42.92
M3(Blue)	67.23	1.50	2.02	14.53	44.17
M4(Red)	51.48	1.15	1.64	13.50	48.67
M5(Silver)	64.22	1.43	1.98	13.50	57.61
M6(Control)	41.43	0.94	1.40	11.51	61.62
Mean	59.88	1.29	1.86	13.78	50.01
CD _{0.05}	0.83	0.43	0.51	NS	13.45

Yield and quality

The results revealed that there was a significant difference in yield and its attributing traits. Black polyethylene mulch was found to have a significantly better effect on yield/plot, net head weight and gross head weight followed by blue polyethylene mulch than other mulching materials tried (Table 2). The results revealed that there was a significant difference in yield/plot, gross head weight and net head weight of cabbage between all the treatments.

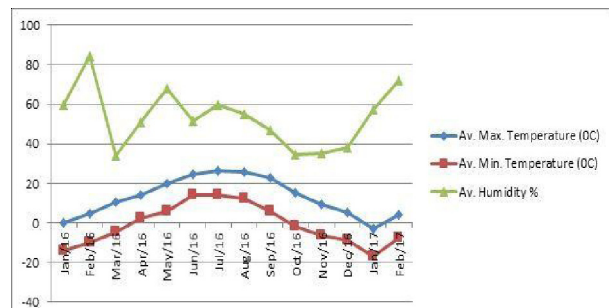


Fig. 1. Agro Climatic meteorological data (2016) under open conditions

Source : AMFU (2016)

Black mulch recorded maximum yield/plot (75.40kg) followed by blue (67.23 kg), silver (64.22kg) as compared to control (41.43kg). The increase yield in black plastic mulch is due to favourable soil condition and restricting weed growth (Dale, 2000). This impact is associated with the impact of plastic mulching on improvement of the microclimate and root zone temperature of plants which increases activities of cell expansion and cell enlargement. Furthermore, the active involvement of the enzymes in enhancing growth development also increased the yield of plants (Torres, 2016). Similarly net head weight and gross head weight of (1.68 kg/plant and 2.14 kg/plant) followed by blue mulch (1.50 kg/plant) and silver mulch (1.43 kg/plant) respectively. Whereas no mulch showed minimum net head weight and gross head weight of 0.94 kg/plant and 1.40 kg/plant. This might have been influenced by favorable soil temperature, moisture conservation, and weed control as influenced by black mulch. Matsoukis and Gasparatos (2015) reported that Variation in color of plastic mulches affects spectral balance, quality, and quantity of light that affects many plant growth and developmental patterns including the yield of plants. The impact is associated with the impact of plastic mulching on the improvement of the micro-

climate and root zone temperature of plants which increases activities of cell expansion and cell enlargement. Furthermore, the active involvement of the enzymes in enhancing growth development also increased the yield of plants (Li *et al.*, 2004). Shah Jahan *et al.* 2018 also obtained a higher yield in black mulch than blue, white, and un-mulched in lettuce. RuizMachuca *et al.*, 2015 also observed similar results in potato. The beneficial effect of polyethylene mulch on early harvest and higher yield was also found for watermelon (Romic *et al.*, 2003), zucchini (Walters, 2003), tomato, and pepper (Hutton and Handley, 2007).

Head compactness and average head size are important quality parameters in cabbage that have a direct effect on the yield of cabbage. Head size was recorded maximum in black mulch (15 cm) and the minimum was found in no mulch (11.51cm).

Conclusion

The results of this study exhibited the significant effect of black plastic mulch on earliness, plant growth, higher net weight/plant, and minimum weed infestation than other treatments. Under this cold arid condition of Ladakh, it is recommended to use black plastic mulch during summer to minimize the drudgery reduction, water saving technology and to enhance the yield of cabbage.

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Conflict of Interest

This study was funded by NCPAH (National committee for plasticulture application in Horticulture at Precision farming development center, High Mountain Arid Agriculture Research Institute (HMAARI), SKUAST-K, Stakna Leh.

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