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Effect of Different Type of Mulches on Soil Properties and Weed Control Efficiency in Cauliflower Var. Pusa Snowball K-1

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present experiment was conducted during winter 2021-22 at Polytechnic in Horticulture, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Paria, Gujarat, India to study the effect of different type of mulches on soil properties and weed control efficiency in cauliflower var. Pusa Snowball K-1. The experiment was laid out in Randomized Block Design (RBD) with three replications and nine treatments *viz.*, T_1- Black polyethylene mulch, T_2- Silver polyethylene mulch, T_3- Red polyethylene mulch, T_4- Silver black polyethylene mulch, T_5- White polyethylene mulch, T_6- Paddy straw mulch (10 t ha^{-1}), T_7- Sugarcane trash (10 t ha^{-1}), T_8- Farmer's practice (Two hand weeding with flood irrigation) and T_9- Control (No mulch). The study revealed that the black polyethylene mulch had a positive impact on soil properties and weed control efficiency in cauliflower var. Pusa Snowball K-1. Black polyethylene mulch (T_1) recorded maximum

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soil temperature (32.70 °C, 32.33 °C, 29.86 °C, 27.93 °C, 27.73 °C, 31.70 °C and 33.93 °C) and soil moisture content (23.65 %, 22.60 %, 20.98 %, 22.26 %, 21.55 %, 20.65 % and 22.46 %) at 15, 30, 45, 60, 75, 90 and 105 DATP, respectively. The highest weed control efficiency (97.26 %) was also recorded by black polyethylene mulch (T_1) among the all treatments.

Keywords: Black polyethylene mulch; soil temperature; soil moisture content; weed control.

1. INTRODUCTION

Vegetables play an important role in food and nutritional security of ever-growing population of the world. They are potential source of vitamins, minerals and dietary fibers. The '*Cole crops'* are one of the most popular group of vegetables grown during winter season in India. "The *'Cole'* group of vegetables includes cabbage, cauliflower, knol-khol, broccoli, brussels sprout and kale. Among cole crops, Cauliflower (*Brassica oleracea* var. *botrytis* L.) is an important vegetable crop, belongs to family Cruciferae. It is cultivated for its attractive curd which is used as a vegetable, soup and pickling. Cauliflower fresh curd is highly nutritive and contains moisture 90.8 g, protein 2.6 g, fat 0.4 g, minerals 1.0 g, fiber 1.2 g, carbohydrates 4.0 g, energy 30 kcal, calcium 33 mg, phosphorus 57 mg, iron 1.5 mg, carotene 30 mg, thiamine 0.04 mg, riboflavin 0.10 mg, niacin 1.0 mg and vitamin-C 56 mg per 100 g of an edible portion" [1]. "Cauliflower is the extremely sensitive to unfavourable conditions such as hot weather, drought or too low temperature, which often result into formation of premature heads or curds" [2]. "Cauliflower can be grown on any good soil but a fairly deep loamy soil is desirable. It grows well when the optimum pH of the soil is between 6.0 and 6.5" [3].

Among the various stresses of agriculture in India, weeds are the major problem by contributing 33 % of total loss. Weeds interfere with crop plants severely and affect the growth, yield and quality of crops as well as increasing the cost of cultivation. In arid and semi-arid environments of the tropics and subtropics, moisture, temperature, precipitation and other soil factors are the limiting factors in crop production. Lower root zone temperature, high rate of evaporation and insufficient rainfall determine cropping systems. Availability of water is the one of the most common limiting factor for the growth of most of crops, especially in arid and semi-arid regions. Water is one of the necessities of plants life in which all their processes during their lifecycle depends on. Mulching is one of the important cultivation practices, which provides the opportunity to control the weeds, minimizing the temperature fluctuations, reducing the soil evaporation, conserve the soil moisture as well as increasing the crop yield and income of the farmers.

The practice of applying mulch for the production of vegetables is thousands of years old. Mulching is a non-chemical agricultural cropping technique that involves placing organic or synthetic materials on soil around plants to provide a more favourable environment for growth and production. Mulches are either organic or inorganic in nature. "Organic mulches are the mulch that is derived from plant and animal materials. Commonly available organic mulches include leaves, grass clippings, peat moss, bark chips, rice straw, compost, sugarcane trash, animal manures and inorganic mulches include polyethylene films, aluminium foils, stones, pebbles, etc. The use of organic mulches not only conserves the soil moisture, but also increases the soil nutrients through organic matter addition" [4]. Organic mulches are produced as wastes in several forms, biodegradable in nature, economical to marginal farmers and are available locally free of cost or in cheaper rate.

On the other hand, plastic mulches have also gain acceptance in agriculture. Various types of coloured plastic mulches have been utilized in the farming community with different formulations for a different purpose. Different coloured plastic mulches impact the crop production in different ways. Previously black, clear and white plastic mulches were utilized for vegetable farming. The plastic colours known today are mainly, black, white, green, brown, red, yellow, silver and blue. These colours are formulated with their role in light absorption and crop physiology. "Plastic or polyethylene mulches have the properties of moderating the hydrothermal regimes of microclimate of crops, show positive effects on weed control, prevention of soil dryness and crusting, water saving by preventing evaporation from surface, prevention of soil erosion and reduction of nutrient loss by leaching" [5]. "In addition, plastic mulch also accelerates plant

height, early growth and bring satisfactory weed control without any application of herbicides" [6].

Therefore, mulching can help to regulate the soil temperature, protect the root of a plant from heat, check evaporation, conserve soil moisture, suppress weed growth and modify soil micro climate. Considering the above circumstances, this work was undertaken to study the effect of different type of mulches on soil properties and weed control efficiency in cauliflower var. Pusa Snowball K-1.

2. MATERIALS AND METHODS

The present investigation was carried out at Polytechnic in Horticulture, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Paria, Gujarat, India during the winter season, 2021-22. Geographically, it is situated on 22º 35' North latitude and 72º 35' East longitude at an elevation of 16.10 m above Mean Sea Level. According to agro-climatic zones of India, Polytechnic in Horticulture, ACHF, Paria falls in South Gujarat Heavy Rainfall zone-I and Agro-Ecological Situation-II (AES-II), which is typically characterized by humid and warm monsoon with heavy rainfall, moderately cold winter and fairly hot summer. The average rainfall of this region is 1500 to 2000 mm which is normally received from first fortnight of June to September end. The soil of experimental field was deep black having pH 7.4, EC 0.43 dS m^{-1}, medium in nitrogen and phosphorus and sufficient in potash content.

The experiment was laid out in a Randomized Block Design (RBD) including three replications and nine treatments *viz.*, T_1- Black polyethylene mulch, T_2- Silver polyethylene mulch, T_3- Red polyethylene mulch, T_4- Silver black polyethylene mulch, T_5- White polyethylene mulch, T_6- Paddy straw mulch (10 t ha^{-1}), T_7- Sugarcane trash (10 t ha^{-1}), T_8- Farmer's practice (Two hand weeding with flood irrigation) and T_9- Control (No mulch). The thickness of the all plastic mulches was 50 micron. The size of each plot was 3.60 m × 3.15 m. The distance maintained between two blocks and two plots were 1 m and 0.5 m, respectively.

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. Mulches were spread in plot before a day of transplanting as per treatment. Plastic mulch was laid by cutting into pieces of 4 m × 4 m to cover the plot area. For the seedling, transplanting holes were made in plastic at 60 cm × 45 cm spacing. After that, all sides of the mulch sheet were anchored at 15 cm depth of soil. Paddy straw and sugarcane trash were spread in the plot after the transplanting of seedlings. About one month old seedlings of cauliflower were used for transplanting. All the cultural and plant protection operations were followed to raise healthy crop. The irrigation was given by drip system except treatment T_8 (Farmer's practice: Two hand weeding with flood irrigation). Two hand weedings were done only in treatment T_8 (Farmer's practice) and no any weeding was done during entire cropping period in the treatments of different mulches (T_1, T_2, T_3, T_4, T_5, T_6, T_7) and control weedy check (T_9).

The data were recorded on soil temperature, soil moisture content and weed control efficiency. Collected data were statistically analyzed by the method described by [7]. The method of analysis of variance for experiment for Randomized Block Design (RBD) was used. The data, collected for all the characters involved under study were subjected to the statistical scrutiny (analysis) for proper interpretation. The treatment differences were tested by employing "F" test at five per cent level of significance on the basis of null hypothesis. The appropriate standard errors (S.Em±) were calculated in each case and the Critical Difference (C.D.) at five per cent level of probability was worked out to compare the two treatment means, where the treatment effects were found significant under "F" test. The percentage coefficient of variation (C.V. %) was also worked out for all the cases to understand variability in the experimental material.

2.1 Soil Temperature (ºC)

Soil temperature was recorded with the use of soil thermometers at 0-15 cm depth. It was recorded at 15 days interval (15, 30, 45, 60, 75, 90 and 105 DATP) in each treatment and expressed in degree Celsius (ºC).

2.2 Soil Moisture Content (%)

Soil moisture content was also determined at 15 days interval (15, 30, 45, 60, 75, 90 and 105 DATP) in each treatment at 0-15 cm depth by gravimetric method [8]. Samples were dried in oven at 105°C until constant weight. It was estimated in percentage by using following formula:

$$\text{Moisture content (\%)} = \frac{W_1 - W_2}{W_1} \times 100$$

Where,

W_1 = Weight of moist soil (g)
W_2 = Weight of oven dry soil (g)

2.3 Weed Control Efficiency (%)

It was recorded at the time of curd harvest from each treatment plot. Weeds were collected and dried in oven at 65° ± 5 °C to a constant dry weight from each plot. Treatment T_9 (No mulch) was used as weedy check plot. Weed control efficiency indicates the percentage reduction in weed population under treated plot in comparison to untreated plot. The dry weight of weed from each plot was used for calculating the weed control efficiency by following formula:

$$\text{WCE (\%)} = \frac{DMC - DMT}{DMC} \times 100$$

Where,

DMC = Dry matter of weed in control plot (g)
DMT = Dry matter of weed in treatment plot (g)

3. RESULTS AND DISCUSSION

3.1 Soil Temperature (ºC)

The data recorded on soil temperature (0-15 cm depth) are presented in Fig. 1. The different mulches had positive impact on soil temperature at 15, 30, 45, 60, 75, 90 and 105 DATP. The soil temperature was obtained higher under the plastic mulches than the other treatments of mulching. Based on data, the highest soil temperature at 15 DATP (32.70°C), 30 DATP (32.33°C), 45 DATP (29.86°C), 60 DATP (27.93°C), 75 DATP (27.73°C), 90 DATP (31.70°C) and 105 DATP (33.93°C) was recorded in treatment T_1 (Black polyethylene mulch) followed by treatment T_4 (Silver black polyethylene mulch). While, treatment T_9 (Control) recorded the lower soil temperatures among the all treatments at all the growth stages. The unmulched plots had the lowest soil temperature (about 1-3.8 °C lower) at different times since planting compared to plastic film mulched plots. The mulching with plastic film raises soil surface temperature by altering the thermal balance [9]. Black coloured mulches recorded warmer soil temperatures as compared to lighter coloured mulches [10]. Black plastic mulch absorbs comparatively large amount of incoming radiation that traps the radiant energy and penetrates into the soil which warm up the soil. Similar findings were confirmed with [11] in cauliflower, [12] in broccoli, [13] in okra and [14] in brinjal.

3.2 Soil Moisture Content (%)

The mean data on soil moisture content (%) of 0-15 cm depth recorded at 15 days interval are presented in Table 1. The perusal of data revealed that soil moisture content (%) was significantly affected by different mulch treatments during different growth stages. The maximum soil moisture content at 15 DATP (23.65 %), 30 DATP (22.60 %), 45 DATP (20.98 %), 60 DATP (22.26 %), 75 DATP (21.55 %), 90 DATP (20.65 %) and 105 DATP (22.46 %) was recorded in treatment T_1 (Black polyethylene mulch) followed by treatment T_4 (Silver black polyethylene mulch). The lowest soil moisture content was recorded in the control plot (T_9). As compared to other mulches, plastic mulches are completely impermeable to water; it therefore prevents direct evaporation of moisture from the soil and thus limits the water losses and soil erosion over the surface. In this manner it plays a positive role in water conservation [15]. The black polyethylene mulch favourably influences the soil moisture regime by controlling evaporation from the soil surface and facilitates condensation of soil water at night due to temperature reversals. Less moisture depletion under the black mulch was a result of prevention of contact between the soil and dry air which reduced water loss into the atmosphere through evaporation. Similar results were observed by [11] in cauliflower, [12] in broccoli and [16] in summer squash and tomato.

3.2 Weed Control Efficiency (%)

The data related to weed control efficiency (%) as influenced by different type of mulches are graphically illustrated in Fig. 2. The collected data showed that the mulching of soil significantly influenced the weed growth. Among various treatments, the highest weed control efficiency (97.26 %) was recorded by treatment T_1 (Black polyethylene mulch) followed by treatment T_4 (Silver black polyethylene mulch). However, treatment T_8 (Farmer's practice) noted the lowest weed control efficiency as compared to all the mulch treatments. The obtained result might be due to the fact that polyethylene sheet

acts as a barrier between sunlight and soil further leads to a reduction in the weed growth [17]. Black polyethylene mulch excludes the light and due to lack of photosynthesis, weeds are remarkably suppressed. It also raises soil temperature at all depths which reduced weed density as well as weed biomass production as compared to weedy check. The present results are in accordance with [18,19] in cauliflower and [20] in cucumber.

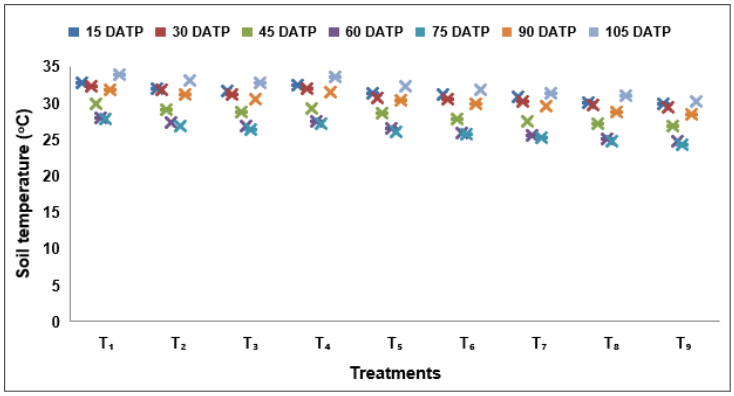

Fig 1. Effect of different type of mulches on soil temperature (ºC) (0-15 cm depth) of cauliflower var. Pusa Snowball K-1 at 15 days interval

Table 1. Effect of different type of mulches on soil moisture content (%) (0-15 cm depth) of cauliflower var. Pusa Snowball K-1 at 15 days interval

Treatments	Soil moisture content (%) (0-15 cm depth)						
	15 DATP	30 DATP	45 DATP	60 DATP	75 DATP	90 DATP	105 DATP
T_1: Black polyethylene mulch	23.65	22.60	20.98	22.26	21.55	20.65	22.46
T_2: Silver polyethylene mulch	22.40	21.10	19.54	21.18	20.12	19.80	21.16
T_3: Red polyethylene mulch	20.54	19.23	17.90	19.30	18.78	18.26	19.84
T_4: Silver black polyethylene mulch	22.88	21.84	20.36	21.98	20.84	20.30	21.77
T_5: White polyethylene mulch	21.33	20.15	18.88	20.85	19.81	19.38	20.55
T_6: Paddy straw mulch	19.26	18.48	17.47	19.10	18.44	17.70	19.15
T_7: Sugarcane trash	18.72	17.80	16.92	18.26	17.70	17.18	18.42
T_8: Farmer's practice	17.19	16.32	15.64	17.51	17.16	16.42	17.65
T_9: Control (No mulch)	16.70	15.75	14.97	16.35	16.45	15.73	16.38
S.Em±	0.88	0.86	0.77	0.81	0.79	0.75	0.81
C.D. at 5%	2.66	2.60	2.31	2.43	2.38	2.25	2.43
C.V. %	7.57	7.81	7.41	7.15	7.26	7.08	7.12

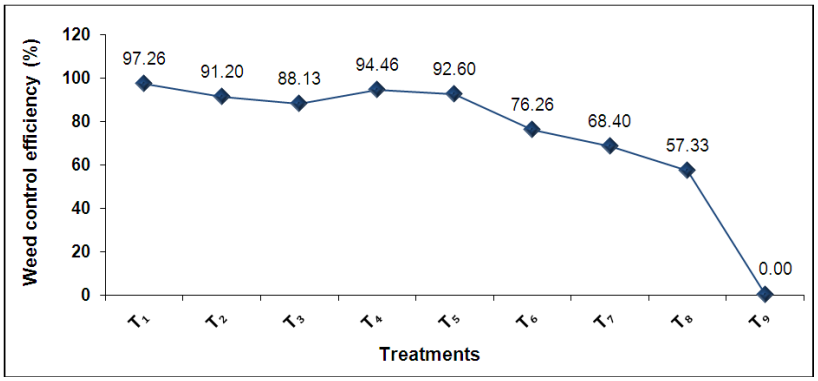

Fig. 2 Effect of different type of mulches on weed control efficiency (%) of cauliflower var. Pusa Snowball K-1

4. CONCLUSION

The effect of different type of mulches on soil properties and weed control efficiency in cauliflower var. Pusa Snowball K-1 was evaluated in this study. Based on the results obtained from the present investigation, it can be concluded that application of different mulches positively influenced the soil properties and control the weed growth in cauliflower field. The use of black polyethylene mulch was found very effective and recorded maximum soil temperature and soil moisture content among the all treatments during the entire growing season of cauliflower. The highest weed control efficiency was also achieved by black polyethylene mulch, which leads to an increase in growth, yield and quality of cauliflower. Therefore, the cultivation of cauliflower using plastic mulches could bring an ample scope for controlling weeds and enhancing production potential.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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