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Diksha Thakur
Lovely Professional
University, Phagwara,
Jalandhar, Punjab, India

Effect of mulching on cruciferous vegetable crop production: A review

Diksha Thakur

Abstract

Mulching is ancient technique which is used to conserve soil moisture, helps in reducing weed growth, moderate soil temperature and reduce salinity. This technique act as a boon for the agriculture and horticulture crops not only for increasing the growth and yield but also act as a method to conserve soil and water. This technique helps in protecting the roots of the plants from heat and cold. It is mainly used in fruit orchard, flower, vegetable production, nurseries and forest. Black plastic mulch is mostly used in agriculture whereas the transparent or clear plastic mulch is used in some areas to increased soil warming characteristics. Some Research has reveals that white or aluminum reflective mulch helps to repels aphids which are spread through virus diseases in vine crops such as squash. It is act as boon increasing horticultural crop production in dry lands.

Keywords: Conserve, mulching, protecting, salinity, vegetable crop

Introduction

Cruciferous vegetables belongs to family Brassicaceae (also called Cruciferae) with many genera, species, and cultivars being grown for food production such as cauliflower, cabbage, kale, garden cress, bok choy, broccoli, Brussels sprouts, and similar green leaf vegetables. Most common cruciferous vegetables which are eaten by people, known in North America as cole crops and in the UK, Ireland and Australia as brassicas. Cruciferous vegetables are one of the dominant food crops worldwide. They are rich in vitamin C and soluble fiber and contain multiple nutrients and phytochemicals. The word mulch derived from the German word “molsch” which means soft to decay, that referred to the use of straw and leaves by gardeners or farmers to spread over the ground as mulch (Jacks *et al.* 1955). In agriculture or horticulture mulch are used for various reasons but in arid and semi-arid regions water conservation and erosion control are the most important objectives. Mulch are also used for other points like soil temperature modification, weed control, soil conservation and add plant nutrients upon decomposition of organic mulch, soil structure improvement, helps in increases of quality and yield of crop. Soil deterioration has been reduced with the help of Mulching by preventing the runoff and soil loss, reduced the weed growth water evaporation, helps in conserving soil moisture, control of temperature fluctuations, helps in the improvement of physical, chemical and biological properties of soil, adds nutrients upon decomposition to the soil and ultimately leads to the enhancement of the crops growth and yield (Dilip Kumar *et al.* 1990) ^[4]. (Van Derwerken and Wilcox, 1988) ^[24]. Mulch is effective against soil erosion, weed problems, and minimize water vapor loss and nutrient loss.

Types of mulches

There are two types of mulches:

1. **Live mulch:** It is a method which gives useful effect on soil, environment and plant canopy of vegetable crops. Living cover is used as a mulch to put over the crop in this method. Mostly Legume crops are used as a live crop. Koota and Sowinska (2013) ^[12] states that live mulches are more suitable with perennial crops like rhubarb or another crop which having long vegetation duration and also those which are grown after transplants such as leek, cabbage, sweet corn, stake tomato, pepper etc. The main advantage of live mulch is:
 - Suppress weed growth.
 - Reduced the infestation due to insect and diseases.

Corresponding Author:
Diksha Thakur
Lovely Professional
University, Phagwara,
Jalandhar, Punjab, India

- Prevent from soil erosion and degradation.

2. Dead mulch: These are 2 types:

a) **Organic mulches:** Organic mulches are obtained from decomposed parts of plant and animals. Organic mulch can perform all the function which is done by other mulches also except early season soil warming. Lekasi *et al.* (2001) ^[14] states that management practices was done in cabbage crop in both seasons followed the order of fertilized + weeded > banana mulched + weeded > plastic mulch > weeded > banana mulched > un-mulched + un-weeded gave results that when hand weeding gave yield increased by 9.3 tones/ha (fresh weight), when banana mulch and hand weeding increasing the yield up to 12.5 tones/ha. When banana mulch is used then the earthworm population increases leads to no reduction in the weed control and not helps in conserving soil moisture. When plastic mulches used to increase the temperature up to 14.9% tonnes/hectare also control weed and conserve soil moisture.

Inorganic mulches: These are mostly used create barrier

from weeds to main crop grown in an area. It does not add nutrients benefits to soil like organic mulches. These are usually man made materials like plastic films, stone etc. Plastic mulches provides many benefits such as increases yield, improves quality, control weed, diseases and pest infestation. This also helps in saving water efficiency by installing drip irrigation. Selection of mulch usually depends on the factor like which type of crop grown, season of which the crop to be grown, intercropping etc. (Iyenger *et al.* 2011). Different types of plastic mulches are:

- Black mulches.
- Clear or transparent mulches.
- Two sided colour mulches.
 - Yellow and Black.
 - White and Black.
 - Silver and Black.
 - Red and Black
- Degradable mulches.
 - Bio-degradable.
 - Photo-degradable.

Table 1: Types of plastic mulches and their uses

S. No.	Colour of plastic mulch	Uses
1	Black mulch	Reduced Weed. Mainly used in plain area to keep soil temperature less during summer season. Upward movement of salt is reduced and also controls water movement.
2	Clear or transparent	Used for soil solarization by disinfecting the soil which will helps in the reduction of soil borne diseases and reduced the occurrence of some weeds. Mainly used in hilly areas for raising soil temperature during winter time and deposit more salts on soil surface.
3	White mulch	Used in the summer seasons helps to reduced soil temperature
4	Yellow or black	Used as an attractant to attracts certain insects and thus acts as trap mulch for them, also prevents disease infestation.
5	Silver or black	Used as a repellent mulches to repels the insect like aphids and thrips and also cool the soil temperature.

Selection of mulch

The selection of mulches mainly depends upon the factors ecological situations and primary and secondary aspects as given under:

- Rainy season- Perforated mulch
- Orchard and plantation- Thicker mulch
- Soil solarization- Thin transparent film
- Weed control through- Transparent film solarization
- Weed control - Black film cropped land
- Sandy soil- Black film
- Saline water- Use Black film
- Summer cropped land- White film
- Insect repellent- Silver colour film
- Early germination- Thinner film

The major functions and action perform by mulch are

1. **Moisture conservation:** The reason of less soil moisture under the mulch was leads to the prevention of the contact between the soil and dry air, due to water loss in the atmosphere through evaporation. Kosterna (2014) ^[13] states that soil mulching was the one of the methods which produces positively effects on soil moisture and structure, reduce the effects of erosion, and help to decrease fluctuations of soil temperature. Soil temperature at a depth of 10 cm in covered plots was higher than in plot without cover. Soil temperature in the plots without straw, irrespective of whether a

- covering was used, was higher than in plots with straw.
- Soil Temperature:** The green house effects that traps the little radiant energy and penetrates into soil this leads to increase the temperature under plastic mulch. In summer the heat is transferred into solar radiation became less or reduced, in the winter seasons the roots are protected from the cold air. (Park *et al.* 1987) ^[17] states that the higher soil temperature was found in the transparent plastic mulch as comparison to blue and black plastic mulch. The polythene mulches let to pass through some of the radiation but normally it acts as barriers against outgoing thermal radiation.
- Weed control:** It is a plant grown out of place, unwanted plant, or a plant that is a pest in that it interferes with crop or livestock production. It reduces the crop production, yield and reduces the market value of the produce in the end. With the help of mulching yield of the crop is increased and quality is improved and weed growth is also controlled. Most effective mulch that suppresses the weed growth is organic mulch. Díaz *et al.* (2012) studied the effects of tillage, cover crop and mulch on weed control and yield of organic broccoli. Weed control over the season was 84.8 and 71.6% for the conventional tillage and no-till, respectively. Among cover crops, pearl millet tended to provide the highest weed control. Wheat straw and plastic film mulch both had higher levels of weed

control compared to un-mulched soil.

4. **Enhance growth, development, yield of plants and quality of fruits:** Rahman *et al.* (1989) ^[19] studied that the effect of different source of nutrients and mulching on the growth and yield of cabbage. The experiment contains four levels of nutrients and three mulching. Sources of nutrients had significant effect on most of the parameters which were studied. The plants which were received organic + inorganic fertilizers produced the highest (79.01 t ha⁻¹) marketable yield, whereas plants having no fertilizer gave yield of 30.65 t ha⁻¹. Mulching had no noticeable effect on harvest index, but had marked effect on rest of the parameters studied. The highest marketable yield (70.24 t ha⁻¹) was with the use of black polythene sheet mulch produced and the lowest (45.13 t ha⁻¹) was observed without mulch. The highest marketable yield (97.83 t ha⁻¹) of cabbage was observed with treatment combination of organic + inorganic fertilizers with black polythene sheet mulch. William (1993) ^[25] observed that vegetables like cole crops, muskmelon, watermelon, squash, capsicum, brinjal, okra are successfully grown as a crop under plastic mulches which helps in increasing the yield and quality of these crops. Jaiswal *et al.* (1997) ^[10] reported that when carrots are cultivated with use of any mulch materials then yield increases by 34.6 % as compared with non-mulching. This indicates that mulching is effective method when used in carrots field. Pulgar *et al.* (1999) ^[18] found that there is increase in the yield of Chinese cabbage (*Brassica pekinensis* (Lour) Rupr. Cv. Nagaoka 50) when semi-forcing mulches (polyethylene: T₁ and polypropylene: T₂) are used as compared to uncovered plants (T₀). They also taken seven sample and determine: N, P, S, NH₄⁺, NO₂⁻, Cl⁻, SO₄²⁻, Ca, Mg, Na and K. From yield and analytical value optimum foliage range were calculated. At the end proves that the T₁ and T₂ are more effective than T₀ because of well uptake of micronutrients. Islam *et al.* (2002) ^[6] studied the growth and yield of cabbage cv. Atlas-70 is improved with the help of irrigation and mulching. When black plastic mulch are used the highest gross yield is obtained (71.85 kg/plot) followed by water hyacinth mulch (65.99 kg/plot). Marketable yield when irrigated (85.85 t/ha) in 15 days interval and with black mulch & water hyacinth is (103.01 t/ha) and (90.99 t/ha) whereas there is lower marketable yield with non-mulching and irrigated plots (control) is (38.87 t/ha). Sarker *et al.* (2003) ^[21] studies that in cabbage field the black polythene sheet mulch gave good marketable yield (70.24 t/ha) as compared to un-mulched (45.13 t/ha). Tiwari *et al.* (2003) ^[22] states that when black plastic mulch (PM) of 25µm thick used in cabbage field with the help of three levels drip irrigation which applied at the rate of 100% (VD), 80% (VD) AND 60% (VD). With drip irrigation two organic mulches are used i.e. rice husk & straw. When black plastic used with drip irrigation (VD + PM) give high yield 111.72 t/ha as compared 106.68 t/ha (VD). Moniruzzaman *et al.* (2007) ^[16] conducted an experiment on cauliflower with irrigation at 7 days interval and black polythene mulch on marketable yield. When black polythene mulch are used with irrigation after 7 days intervals give high curd yield upto 30.38 t/ha and 29.40 t/ha as compared to the curd

yield obtained from un-mulched field i.e. 10.50 t/ha and 10.04 t/ha. When mango leaves are used with irrigation at 14 days interval have cost ration 6.51% with same mulch. Salim *et al.* (2008) ^[20] reported that on cauliflower use of mulches give positive effect on yield and yield attributes. When cauliflower variety i.e. Snow Crown was grown with the help of mulch give high marketable yield i.e. 35.16% than without mulch (31.32%). Due to mulching the net returns of the varieties Snow Crown, Poushali, and IPSA-1 comes to be 97800, 41040, and 30840 respectively. Filippi *et al.* (2009) studied that two biodegradable mulches with different irrigation system (drip irrigation, spray irrigation without irrigation) are used in cauliflower (*Brassica oleracea* var. botrytis L.) comparing them to a tradition Idpe film and soil. In Idpe type of film the plant growth and production is good. Kashyap *et al.* (2009) ^[11] checked that when black polythene mulch with drip irrigation is applied in broccoli contribute to yield parameter i.e. head diameter (20.25), head weight (603.50g) were observed. There is low water use efficiency in furrow system i.e. 0.59 t/ha cm as compared to black polythene mulch with drip irrigation at 60% EPR (Evaporation replenishment rate) which is having high efficiency 4.11 t/ha cm. With black polythene sheet with 120% water efficiency give high cost ratio 5.73. Wahome *et al.* (2009) ^[26] observed that when two type of mulch [organic mulch (grass) and inorganic mulch (black polythene)] are used with three irrigation regimes on cabbage provide effects on growth, yield and quality. Observations were recorded that when cabbage plants are mulch their height becomes short. When black plastic mulch with 10 mPa irrigated gave highest yield (118.7 t/ha). When three mulching material are used give no variation on plant height, no. of leaves, root and shoot dry mass, yield and head diameter. Vezquez *et al.* (2010) reported that with the help of black plastic mulch the yield of cauliflower is not significantly affected. The crop residue is increased when nitrogen is applied in excess amount after using black mulch. So there is more chance of nitrogen leaching. Carvolho *et al.* (2011) founded that production of cabbage can be influenced with the help of irrigation and mulching. They concluded that when mulch is applied and irrigation is done at an interval of 48 hours moisture loss also reduces and yield is also increased. Diaz-Pere *et al.* (2012) ^[3] states that in broccoli the yield and weed growth were affected with the help of tillage cover crops and mulch material. They was seen that the wheat straw and plastic mulch gave highest yield and also control the weeds growth as compared to uncovered soil surface. Wheat straw also improves the florets and marketable yield, increases the no. of florets. Mitra and Mandal (2013) ^[15] reported that in green gram (*Vigna radiata*), rape seed (*Brassica campestris* var. yellow sarson) and rice (*Oryza sativa*) the fertility is improved with the help of mulching under rainfed uplant ecosystem. The organic and inorganic mulches, paddy straw give higher yield in rape seed and green gram. Therefore ultimately the organic and inorganic mulches help in improving the soil fertility as well as yield. Jasim and Timmen (2014) ^[9] conducted a Factorial field experiment in year 2012/2013 on broccoli to study the effect of soil mulch

(mulch and without mulch) and some fertilizers (control, sulfur, organic and high potash fertilizer) on H₂O₂ content and the activity of catalase (CAT), superoxide dismutase (SOD), and glutathione (GSH) oxidative enzymes of broccoli leaves and flowers. They concluded that while using mulch, fertilizer treatment and the interaction between mulch and high potash treatment showed a significant increase in CAT and SOD activity. With the use of high potash and sulfur supplementation led to a significant increase in broccoli antioxidants both in leaves and flowers respectively. They concluded that with the use mulch and high potash treatment helps the plant to tolerate salt stress condition by increasing antioxidant mechanisms.

5. **Disease and Insect-pest control:** Mulch act as protective layer between soil and crop due to this soil borne diseases will not occur. It also acts as a barrier from adult insect so that they do not lay egg inside soil. Burgio *et al.* (2014) [1] studied the effect of cover crops on pest/beneficial dynamics and to test the potential of living mulch on enhancing biological control against insect pests on three crops: cauliflower, leek and artichoke. The results was obtained in italy on cauliflower, indicated that the living mulch did not affect the infestation of the cabbage butterfly, *Pieris brassicae*. A very high level of parasitization against cabbage butterfly was detected either in the living mulch crop (88%) or in the sole one (63%).

Conclusion

Mulching is the method which helps in increasing the yield, improves the quality, reduced weed infestation, and improves soil structure. This also helps in the use of weedicides, thus prevents environmental pollution and provides organic food. Living mulch technology has been provides benefit both short and long term productivity by improving soil physical ,biological and chemical properties, suppress weeds growth and, if the live mulch is a legume helps in transferring symbiotically fixed nitrogen to the cash crop. Organic mulches increase soil organic matter content by adding nutrient to it, improve long-term soil fertility, and strengthen soil biological activity. Plastic mulches produce directly impact the microclimate around the plant by modifying the radiation comes from the sun budget then on the surface and also helps in decreasing the soil water loss. Colored plastic mulch is mostly used for commercial production but black is mostly used in vegetables. Colored mulch affects the soil temperature and surface temperature. It is very effective and affordable but concern related to this is disposal issues. Upon burning or dumping or recycling the plastic is not economically feasible option due to occurrence of climate change. So to overcome this type of problems now a day's bio-degradable or photo-degradable films are became popular.

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