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Mulching: Its effect on fruit productivity and soil health: A review

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Abstract

The demand for healthy horticultural crops has increased globally as a result of globalization and increased health awareness. Farmers have to grow more and higher-quality fruits in order to compete in the international market due to rising demand for fruits and market competition. Mulching is one of the effective methods that can assist horticultural growers in increasing production while maintaining high quality. This paper is a review of various researches done in mulching to mitigate the moisture losses and effects of mulching in enhancing yield and quality of fruits. Black polythene mulch performs best in preventing evaporational losses among inorganic mulches. Paddy straws in organic mulches lead to better fruit physio-chemical characteristics. This paper reviews the different researches published on mulching and its effects along with the discussion on the opportunities they are providing for problem solving in agriculture.

Keywords: Mulching, yield, organic and inorganic

1. Introduction

Mulching is the process or practice of covering the soil/ground in order to improve plant growth, development, and crop production efficiency. Mulch is a scientific word that means "soil coating." Mulch is most likely derived from the German word "molsch," which means "soft to rot," and apparently refers to gardeners spreading straw and leaves over the ground as mulch (Jacks *et. al.*, 1955)^[1].

Mulching prevents runoff and soil degradation, decreases weed infestation, and controls water evaporation, both of which help to prevent soil deterioration. It improves the physical, chemical, and biological properties of soil, as well as the growth and yield, by retaining soil moisture and assisting in the regulation of temperature fluctuations. It also adds nutrients to the soil (Patil *et. al.*, 2013)^[4]. Mulches have been found to be helpful in increasing water retention in soil and its availability by reducing evaporation losses and alleviating the harmful effects of water stress on soil and plants (Singh *et. al.*, 2014). Mulches not only preserve soil moisture but also have a variety of other benefits, such as reducing water loss by evaporation and suppressing severe temperature fluctuations, resulting in more retained soil moisture and soil fertility maintenance. The main objectives of mulching are to prevent water loss by evaporation, to prevent soil erosion, to control weeds, to minimize fertilizer leaching, to encourage soil fertility, and to improve the yield and quality fruit crops. As a result, mulching is beneficial to the preservation of our underground resources. For sustainable crop production, water resources, soil, and the environment must all be considered (Kaur *et. al.*, 2017)^[7].

There are two types of mulches basically organic which can be decomposed later and enhance the soil properties and inorganic which cannot be decomposed but can be used for more period of time. Organic mulches include hay, straw, tree leaves, bark shreds, saw dust, compost, biodegradable paper, manure, groundnut hulls etc. They have the ability to easily decay due to the presence of insects, slugs, and cutworms that eat them, allowing them to degrade quickly while also adding organic matter and nutrients to the soil. Inorganic mulches are rocks and gravel, polyethylene, LDPE, HDPE, black polyethylene mulch, crushed stone, marble chips, pebbles, ground rubber etc. They perform various actions like weed control, moisture conservation, soil conservation, soil temperature, soil solarization (with transparent plastic mulch controls disease pest) etc (Telkar *et. al.*, 2017)^[8].

2. Effects of Mulching on Vegetative Growth

Different mulches had a large impact on plant height, canopy diameter, number of leaves, leaf size (average length of leaflet), and leaf petiole length in the experiments (Deb *et. al.*, 2014)

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^[20]. Budling development and nutrient uptake in aonla seedling was maximum when the pits of plants were filled by straw and covered by black polythene mulch in a ring basin system previous year on degraded sloppy lands (Negi *et al.*, 2013) ^[12]. The watermelon growth parameters such as the number of branches per vine, the main vine length, along with the nodes per vine were more as compared to unmulched. Silver on black plastic mulch resulted in a higher number of branches per vine than the other mulching treatments (Parmar *et al.*, 2013) ^[14].

In terms of plant height, rootstock, growth, scion girth, and plant weight, different types of organic mulches influenced the growth of NA-7 aonla. Paddy straw mulch showed the greatest increase in plant height, rootstock, growth, scion girth, and plant spread, followed by maize straw. The rise in plant growth may be attributed to increased soil moisture, nutrients, and mild evaporation from the soil surface (Singh *et al.*, 2010) ^[5]. In an experiment conducted in guava the plant height, basal girth and canopy spread were maximum in paddy straw mulching and minimum in unmulched plants (Das *et al.*, 2010) ^[16].

Mulching improved plant vegetative growth and flowering, according to the findings. Black polyethylene mulched plants had the highest plant height, spread, number of leaves, and flowers per plant (Ali *et al.*, 2007) ^[18]. Experiment conducted in apple showed that dry grass and black polythene mulches were found effective in generating maximum annual extension growth as compared to unmulched (Pande *et al.*, 2005) ^[5]. On most of the vegetative growth parameters of strawberry, there was a significant impact of different mulches. Among the various mulches used in the experiment, inorganic mulches had a distinct advantage over organic mulches (Deb *et al.*, 2014) ^[20]. Plants treated with paddy straw mulch produced the most runners per plant, while plants not treated with paddy straw mulch produced the fewest runners (Kaur *et al.*, 2017) ^[7].

3. Effects of Mulching on Yield

Yield in Aonla is increased by the application of organic and inorganic mulches. Physical characters like fruit weight, breadth, and length are more in mulched plants as compared to the unmulched hence increasing the productivity. Among organic mulches paddy straw has been found effective in enhancing the yield (Singh *et al.*, 2014). Different organic mulches had a major impact on the fruit yield and yield-attributing parameters of NA7 aonla. Fruit yield was higher in plants treated with different mulches than in plants that were not. Mulching with paddy straw resulted in the most rapid growth and increased yield. Paddy straw produced the highest fruit yield, maize straw came in second while control came in last (Singh *et al.*, 2010) ^[5]. When opposed to no mulch, the yield under black polyethylene was more than double. Favorably changed hydrothermal conditions increased nutrient availability, which aided plant growth under black polyethylene mulch, resulting in the highest fruit yield per plant (Kaur *et al.*, 2017) ^[21].

In comparison to the other treatments, the 3 layers of rice straw followed by 2 layers of rice straw treatment resulted in a substantial increase in navel orange yield (Abdelraouf *et al.*, 2020) ^[17]. Mulching greatly increased the number of fruits produced by the plants. The fruit set of the highest quality was registered by the paddy straw mulch and minimum was in control (Das *et al.*, 2010) ^[16]. The soil cover treatment with black polythene resulted in the most fruits per plant, while the

control had the fewest. It is clear that all of the mulching treatments improved fruit yield substantially over the control (Das *et al.*, 2010) ^[16]. The tree receiving the dry grass mulch had the highest final fruit retention and yield, while the tree receiving clean cultivation had the lowest final fruit yield and maximum fruit drop (Pande *et al.*, 2005) ^[5]. The highest yield per plant was recorded in plastic mulch, followed by straw mulch. The lowest yield per plant was recorded in control (Sagar *et al.*, 2019) ^[23].

4. Effects of Mulching on plant physical parameters

Mulching has an impact on fruit size because it improves moisture availability and conserves nutrients in the soil during fruit production. Under unmulched fruits, moisture stress conditions created during fruit production leads to poor growth.

The increase in fruit volume is strongly associated with fruit size, which can be attributed to increased fruit size as a result of enhanced cell division and cell elongation (Pande *et al.*, 2005) ^[19].

In watermelon the highest fruit length was observed under silver on black mulch due to more favourable soil moisture, which resulted in higher uptake of nutrition for better fruit growth, as well as a reduction in evaporation losses caused by mulches covering the soil surface (Parmar *et al.*, 2013) ^[14]. Different experiments in aonla shown that, mulching enhanced the fruit size, fruit weight and pulp weight along with stone weight, pulp: stone ratio. Among all mulches black polythene mulch showed best results. Hence the application of black polythene is the most appropriate mulching treatment for aonla under rainfed conditions, according to the results (Iqbal *et al.*, 2015) ^[2]. Among organic and inorganic mulches fruit weight, fruit length, fruit diameter, fruit volume, fresh weight of pulp, and dry weight of pulp were all substantially increased by black polythene mulch (Iqbal *et al.*, 2015) ^[2]. Fruit length and fruit width in strawberry were found to be substantially higher under black polythene than in all other treatments. More plant growth and production under black polythene mulch was attributed to better nutrient absorption due to the microclimatic conditions (Bakshi *et al.*, 2014) ^[15].

In an experiment conducted, different organic mulching techniques were used including paddy straw, saw dust and maize straw. The mulches affected the fruit quality attributes to a greater extent than the control. Fruits with the highest weight and diameter were under paddy mulch (Singh *et al.*, 2010) ^[5]. The guava fruits with the highest length and diameter were provided by plants with paddy straw mulch. The average fruit weight showed considerable variation due to different mulching treatments (Das *et al.*, 2010) ^[16]. Black polyethylene mulch increased the number of fruits per plant, average weight and size (length and width), and fruit yield. For most of the parameters, however, the effect of black polyethylene mulch was statistically comparable to paddy straw and sugarcane garbage (Ali *et al.*, 2007) ^[18].

Organic mulching combined with a drip irrigation schedule increased mango growth and bearing, according to the results of the experiments (Kumar *et al.*, 2017) ^[8]. In the treatment with black polyethylene mulch, the maximum plant height, number of leaves per plant, leaf area, number of flowers, number of fruits, and fruit set percent were reported (Kaur *et al.*, 2017) ^[21]. Due to organic mulching + 75 percent PER, fruit quality attributes such as fresh fruit weight, fruit dry weight, and pulp weight were at their peak (Kumar *et al.*, 2008) ^[22].

5. Effects of mulching on biochemical parameters

Mulching in aonla also encourage the leaf nutrient content (N, P, K, Ca and Mg) along with the all over growth and development in fruit. FYM mulch shows better performance in increasing the leaf nutrient content (Shukla *et. al.*, 2000). Studies in aonla have shown that the usable nitrogen content in soil was increased by paddy straw mulch, but it was comparable to saw dust mulch. In comparison to the other mulches, the control had the lowest usable nitrogen. The application of various mulching treatments resulted in significant improvements in soil P, K, Ca, and Mg content (Bakshi *et. al.*, 2015) [11].

Mulching also increased the chemical compositions of fruits as compared to the control. Paddy straw mulch, accompanied by dry leaves, was found to be the most effective in growing the total soluble solids content of fruits among the mulching treatments. The mulching treatments have had a major impact on reducing the acidity of the fruits, with white polythene having the lowest acidity and control having the highest (Das *et. al.*, 2010) [16].

In an experiment conducted with organic mulches including paddy straw, maize straw and grasses, paddy straw had the highest TSS, total phenols and vitamin C. Maize straw and grasses had the lowest TSS, total phenols, and vitamin C (Singh *et. al.*, 2010) [5]. The application of black polythene mulch resulted in the highest TSS, total sugars, ascorbic acid, and crude protein in an experiment conducted in strawberry (Bakshi *et. al.*, 2014) [15]. In the experiment conducted in watermelon the treatment with silver on black polythene mulch had the highest TSS, reducing sugars, total sugar, and non-reducing sugar of all of the mulching treatments and minimum was in control (Parmar *et. al.*, 2013) [14].

With the mulching procedures, the TSS (total sugars and ascorbic acid) increased, but the effect under control was non-significant. Paddy straw produced the best results, closely followed by sugarcane trash (Ali *et. al.*, 2007) [18].

6. Effects of mulching on soil

Organic mulches affect the soil chemistry. The pH of the organic material will eventually cause the soil pH to rise or fall. When organic mulches are used, the physical structure of the soil is altered. Aeration is increased in clay soils, which provides a better atmosphere for root development.

Organic mulches improve soil quality by enriching organic matter after decomposition, loosening the soil, improving soil structure and root growth, reducing soil compactness and oxidation of organic carbon, increasing water infiltration, and increasing the soil's water keeping ability. Mulch organic matter is a source of plant nutrients and provides an optimal habitat for the proper growth and production of soil flora and fauna. Among the various types of mulches used in aonla at Gujarat, paddy straw mulches have shown favourable and encouraging results in terms of soil quality, soil microbial and earthworm population, growth and yield of aonla with high-quality fruits under dryland conditions (Singh *et. al.*, 2014).

It has been seen that different organic mulches enhance the soil organic carbon and nutrients. Among them FYM shows significant result in increasing the organic carbon content of soil along with nitrogen, phosphorous and potassium content. Maize mulch helps in reducing the pH and EC of the soil (Kumar 2014) [10]. When organic and inorganic mulches applied in aonla, mulching treatments promoted tree development, inhibited weed growth, decreased moisture evaporation, and controlled soil temperature. Paddy Straws

and sugarcane trash decompose over time and thus helps in improving the soil fertility. Mulching treatments promoted tree development, inhibited weed growth, decreased moisture evaporation, and controlled soil temperature. Black polyethylene is very costly per tree basin and hectare, and it also does not introduce any humus into the soil. In contrast, paddy straw, which is readily available locally, performed better, followed by sugarcane trash mulch (Rao *et. al.*, 1998) [6].

Paddy straw mulch substantially increased soil organic carbon content, while being comparable to grass mulch. The control had the lowest soil organic carbon, of all the other treatments (Bakshi *et. al.*, 2015) [11]. This impact may be due to the fact that surface-applied organic mulches added nutrients and carbonaceous material after decomposition to the soil, resulting in a significant rise in the organic carbon content of the soil.

7. Conclusion

In present scenario, the demand for fruits and fruit products has been increasing day by day due to their various nutritional qualities. Mulching plays an efficient role for enhancing yield and other quality parameters. The vegetative growth including shoot and root development is highly affected by use of mulches in fruit crops. Organic mulches improve the soil structure, pH, texture, EC, NPK content and organic carbon content. Paddy straw and FYM among organic mulch resulted in high TSS, vitamin, total phenol content and also fruit diameter, size and volume. Black polythene on the other hand shows the best results among inorganic mulches followed by white polythene mulch. The black polythene mulch has shown significant increase in bud development, vegetative growth, fruit size, weight and pulp to stone ratio. Despite all uses plastic mulches cause environmental pollution and to mitigate those organic mulches can be used hence improving the soil quality.

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