

Performance of Mechanical Plastic Mulch Laying Practices: A Review

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Abstract: The plastic mulch applications in the agriculture are based on type, source and degradability. There is increasing interest in the use of plastic mulching for fruit and vegetable crops in the Agriculture field. Globally the mulching area has increased about 50 per cent since 1991. Mulching can make effective change to increase horticulture crop production in the water scarcity regions. Plastic mulching using black polyethylene paper is recommended for vegetables and has advantage for earliness production, better fruit quality and greater total yield. Here we review the use of mechanical mulch laying practices in agriculture. Major topics discussed are (1) history of plastic mulching, (2) benefit of plastic mulching, (3) effect of plastic mulching and (4) application of plastic mulching. Manual or mechanical techniques are used for mulch-laying among that mechanical mulching practices has greater efficiency and uniformity which reduces human efforts.

Key words: mulching, History of mulching, benefits of mulching, Effects of plastic mulch, Application of plastic mulch.

Date of Submission: 27-02-2018

Date of acceptance 14-03-2018

I. Introduction

Agriculture is the most important sector of Indian Economy. Agriculture sector accounts for 18 per cent of India's gross domestic product (GDP) and provides employment to 50 per cent of the countries workforce. India has emerged as the second largest producer of fruits and vegetables in the world. Formerly agriculture was more dependent on the nature and all the operations were carried out manually, however new technologies have been developed to increase the production and productivity of crops.

Konkan region is the part of Western Ghat of Maharashtra having warm and humid climate with assured rainfall. Geographically it is hilly region with long coastal sea shore 720 km. The hilly terrain receives heavy rainfall ranging from 2000 – 4000 mm per annum. The total geographical area of the region is 2.95 million ha, out of which 0.95 million ha. have been brought under cultivation of different crops. Net sown area is 0.839 million ha. The climatic conditions are suitable for growing various fruit and vegetable crops. As concerned with the mechanization point of view Konkan is the most backward region in the state of Maharashtra. The Konkan region and the Sahyadri range having same basalts give rise to the brick-red lateritic soil, which are productive under a forest- cover (shahare 2016).

Under Konkan condition, low temperature and lack of irrigation facilities during post rainy season are the major constraints for crop production. In recent years some useful techniques have been evolved to minimize water loss through evaporation such as use of different plastic mulches or any other organic material available on farm (Game *et al.* 2017).

Farmers and agriculturists are use mulching as a method of improving the condition of agricultural soils by covering the surface with different kinds of materials. Improvement of the soil physical environment contributes to better plant production (Vendenberg and Tiessen 1972, Chakraborty *et al.* 2008). Covering the ground with mulch may add organic matter to the soil, reduce weed growth and reduce erosion (Bot and Benites 2005). Therefore, several kind of organic mulches are widely used to control weeds and to enhance plant health (Tiquia 2002).

The conservation farming is nothing but the organic farming wherein all the biodegradable organic wastes are re-used as mulches and also nutrient recycling. It is helpful and advantageous in crop production (Govindappa 2015). The restoration of soil health and addition of plant nutrient to the soil and improvement of the microbial population and also the organic carbon content. There is an increasing interest in the use of plastic mulching for protected cultivation. (Jouet 2001), Mulching area has increased at least 50 per cent globally since 1991. Mulches affect the plant micro climate, modifying the energy balance of the environment and decreasing

the soil water loss (Tarara 2000). As the result of these changes, and depending on the type of mulch and on the specific environmental conditions, crop growth improves.

Mulching with organic or inorganic materials aims to cover soils and forms a physical barrier to limit soil water evaporation, control weeds, maintain a good soil structure, and protect crops from soil contamination. Natural mulches are those derived from animal and plant materials. If properly used, they can offer all the benefits of other types of mulches. Natural mulches help in maintaining soil organic matter and tilth (Tindall *et al.* 1991) and provide food and shelter for earthworms and other desirable soil biota (Doran 1980).

In the recent years the use of plastic mulch has dramatically increased. Plastic mulches have widely replaced them and are very common practice in vegetable production (Jenni *et al.* 2004, Moreno and Moreno 2008). The most common materials used as a mulch cover are manufactured plastics, essentially black polyethylene. These plastics are produced from petroleum derivatives, which are non-renewable resources; they are not degradable, and thus persist and pollute the environment for very long periods. Therefore, after the crop harvest, the plastics have to be removed from the field and transported to an authorized landfill. As an alternative to the disposal inconvenience associated with non-degradable mulch films, photodegradable plastic mulches were developed by adding additives to promote controlled degradation (Bonora and De Corte, 2003).

Availability of low cost biodegradable mulch which can be mixed into soil after the growing period would eliminate the problems of collecting and disposing of used mulch material. To be a viable alternative, biodegradable mulch film should perform comparably or at least satisfactory to polyethylene mulch film in crop production regarding easy mechanized laying, weather resistance decay resistance and ability to prevent weed growth (Beaurepaire 2013, Querrini 2013). This review surveys the research on applications of plastic mulches and assesses the possibilities for the use of paper materials to solve the problems of the immense use of plastics in agriculture and its environmental impact.

History of Mulching

While mulching with the organic matter was already used in ancient agriculture, there is also a long history of lithic (stone) mulches. More than thousand years ago, in both old and new worlds, farmers used lithic material to mulch their dry land field to avoid drought and to improve crop yield. Stones, gravel, pebbles, volcanic ash and cinder as well as other lithic materials have been used. The method not only reduces evaporation but also decreases wind erosion and surface runoff from fields (Lightfoot 1996). Also traditionally the farmers used organic materials such as dry leaf, paddy straw, paddy husk, jowar trash, saw dust, dry grass, dry sugarcane leaves, coconut husk, dry coconut leaves and paper for mulching.

Plastics are man-made long-chain polymeric molecules (Scott 1999). The word plastic comes from the Greek word "plastikos," which means "able to be molded into different shapes" (Joel 1995). According to the American Society for Plastics, plasticulture is "the use of plastic in agriculture," which includes but is not limited to plastic mulch films, drip irrigation tape, row covers, low tunnels, high tunnels, silage bags, hay bale wraps, and plastic trays and pots used in transplant and bedding plant production (Lamont and Orzolek 2004). Plasticulture is the technology of the use of plastics in the agricultural sector. Tar-coated paper mulches began to be used in the late 1800s, long before polyethylene was available (Rivise 1929). British scientist has made polyethylene as sheet film in 1938 (Masey 1972). The earliest method using organic and inorganic materials to modify the microclimate of crop was mulching (Jaworski *et al.* 1974).

These developments during the early 1950s gave rise to a new system of vegetable production known worldwide as plasticulture. The largest volumes of agricultural plastics used today are in the form of plastic films. Plastics were first introduced on a commercial scale in 1939 (Byrdson 1970). These include polyethylene, polyvinyl chloride, and ethylene vinyl acetate. Polyethylene plastic is made from polyethylene resin, which is in the form of pellets. The pellets are heated and processed into bendable sheets of plastic film. The widespread use of polyethylene (the principal type of plastic used today) is due to easy processibility, excellent chemical resistance, high durability, flexibility, and freedom from odor and toxicity (Clarke 1987; Garnaud 1974). The most commonly used mulch films include low-density polyethylene, linear low-density polyethylene, and high-density polyethylene (Fleck-Arnold 2000). This study reported the most commonly used plastics in different application and approximately 66.5 per cent of agricultural plastics are used for nursery containers, 28.8 per cent for various types of plastic films. (Hussain and hamid 2003) reported that global plastic consumption in the agriculture and related areas accounted for 2.48 million tons of plastics annually.

In 1999, for example, over 30 million acres of agricultural land were covered with the plastic mulch, and the figure has been increased significantly since (Miles *et al.* 2005). It is estimated that 1 million tons of mulch film is used worldwide every year in agriculture (Halley *et al.* 2001).

Benefits of Plastic Mulching

The main benefits of mulching are early crop production, higher yields, better product quality, more efficient water use, reduced leaching of fertilizers, reduced soil and wind erosion, reduced herbicide application

for weed control, and others related to pest and disease management (Lamont, 1996). Some of these benefits are especially relevant in organic farming. Crops from the Solanaceae (tomato, eggplant, and pepper) and Cucurbitaceae (melons, watermelons, squash, cucumber) families, strawberries, green beans, asparagus, and salads, among others, have shown significant gains when cultivated with mulch (Witter and Castilla, 1995).

It is used to cover soil surface around the plants to create congenial condition for the plant growth. Polyethylene mulches are widely used in the cultivation of vegetables. Temperature moderation and salinity reduction are the desirable effects of plastic mulching. It also exerts decisive effects of earliness, yield and quality of crop (Raina *et al.* 1999; Bharadwaj 2013).

The benefits of polyethylene mulch to crop production are well documented and include greater root growth and nutrient uptake (Wein *et al.* 1993), earlier ripening and a higher yield of fruit (Abdul-Baki *et al.* 1992), and improved fruit quality and a lower incidence of viral diseases (Singh 1992) than plants grown without mulch.

Effects of Plastic Mulch

Paper mulches have been used for several horticultural crops. Mulch can modify soil temperature (Abdul-Baki *et al.* 1992). Under the waxed coated mulch the average soil temperature was higher than using kraft paper (Coolong 2010). Soil temperature is affected by colour of mulching paper (Schonbeck and Evanylo 1998) attributed the reduced drytime soil heating of black paper or kraft paper that was lighter coloured but fairly opaque to the reflection of solar radiation (Chakraborty *et al.* 2008) founded that increased soil temperature under mulch did not increased yield, and attribute d this lack of effect to the soil temperature. (Hooda *et al.* 1999 and Rajbir 2005) reported higher temperatures with the use of different mulches. Mulch regulates soil temperature, creates suitable condition for germination, improve soil moisture (Patil and Basad 1972).

Mulching helps to conserve soil moisture content, also it modifies physical environment of soil, which helps in appropriate growth of crops (Chakraborty 2008, 2010). The positive effects of plastic mulching on the soil water content are assuredly dependant on the climate. The effects of mulching on soil moisture depend on precipitation and climatic factors. Mulching favorably influences soil-moisture regime by controlling surface evaporation rate; in summer, mulching conserves soil moisture by reducing the evaporation rate. Mulches improve soil-moisture retention capacity as well as soil structure and suppress weed growth (Mutetwa and Mtaita 2014).

Paper mulching resist the growth of unwanted weeds ultimately the insect population will decrease which grow on leaves of weed. Also mulching paper create obstacle between soil insect and crop, this position helps to proper and insect free growth of plant (Freeman 1929, Jenni *et al.* 2004) .

Mulching may increase yield and also improve yield quality. Particularly in conditions where nutrients and organic matter in soils are scare, organic mulch application has increased the yield and reduced its yearly variation (Cadavid 1998).

Applications of Plastic Mulch

The application of plastic mulching in agriculture, called plasticulture, has increased dramatically throughout the world since 2000 (Kyrikou and Briassoulis 2007). Plastic is now used in all types of climate, seasons and soils for its numerous benefits, in addition to enhancing soil temperature (Kasirajan and Ngouajio 2012). Various inorganic mulching materials were applied under different methods such as flat, ridge or ridge furrow and tried with different plastic colors and thicknesses.

Placing the film between the vegetables that are planted in row spacing is not entirely satisfactory at present since a large area is left in between the plants and thus the mulching effect of the film is highly reduced (Menn 1960). The present most popular method of using plastic mulch for mulching purposes in vegetable production is laying the film down over a soil area by special mulch laying machine that can be attached to any tractor and covering up the ends of the film with soil which the machine does by disc type operation and making holes in the film and planting the seed or transplant in the man-made holes. This is presently the most popular application of the mulching.

Plastic mulching needs proper installation soil preparation, fertilization, bed shape and width, irrigation, contact and anchoring, wind brakes etc. such factors should must be taken into consideration. Also during mulching method of planting which may be mechanical or manual taken into consideration (Maughan and Drost 2016).

In commercial applications, mulch is typically laid down by machine. There are basically three operations involved in applying the mulch such as bedding the soil, pressing the bed, laying the plastic mulch, drip tube and fumigation (William and Lamout). These can be accomplished as separate operations or in combination. The plastic mulch is generally 4 or 5 feet wide, 1.25 to 1.50 mm thick and comes in 2400 feet rolls. For single row crops such as tomatoes, cucumbers, muskmelons, honeydews, watermelons, and pumpkins the drip tube should be placed 4 to 5 inches from the center of the bed and 1 to 2 inches deep with the emitter

facing upward. For double row crops like summer squash, okra, eggplant, pappars, beans, peas, lettuce and sweet corn, the the drip tube is directly placed on the centre of the bed and burries 2 to 3 inches deep. For 5 feet row centers there are 8,712 linear feet of row per acre, so grower would require about 3.5 rolls of plastic mulch per acre. For 6 feet centers, 3 rolls of plastic mulch will be required (Sanders 2001).

Plastic mulch is mechanical laying on a soil bed without tearing if the tear strength was > 800 kN and tensile strength > 3 kN m⁻¹ (Korpela *et al.* 2014). Paper mulches with the lower tear and tensile strengths could be laid on flat soil without noteworthy tearing, but when laid on the soil bed, they tore so badly that laying interrupted constantly and due to many tears much was vulnerable for further tearing caused by wind. Tearing started mostly from planting holes. Round planting holes would perhaps prevent wind tearing, but a more advanced tool than a simple edge would be needed for doing planting holes or they should be done advance. An conclusion was made that the mulch must have a certain strength in order to stand the stress of mechanical laying and this strength is needed later on to prevent tears caused by wind (Ahokas *et al.* 2014).

II. Conclusion

This review has covered the major concerns about the plastic mulch application in the Agriculture like its type, source and degradability. There is increasing interest in the use of plastic mulching for fruit and vegetable crops in the Agriculture field. Globally the mulching area has increased about 50 per cent since 1991. Mulching can make effective change to increase horticulture crop production in the water scarcity regions. Plastic mulching using black polyethylene paper is recommended for vegetables and has advantageous for earliness production, better fruit quality and greater total yield. Manual or mechanical techniques are used for mulch laying among that mechanical mulching practices has greater efficiency and uniformity which reduces human efforts. Mulching maintains moisture content level of soil also it helps in weed and insect control.

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Mr. A.V. Rangbhal "Performance of Mechanical Plastic Mulch Laying Practices: A Review" *International Journal of Engineering Science Invention (IJESI)*, vol. 07, no. 03, 2018, pp42-46