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Effect of mulching on soil and water conservation -A review

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ABSTRACT

The need to increase food production and improve the quality of our environment has prompted a search for materials to control wind and water erosion. This paper is a review of research and development associated with application, methods, and amounts of mulch types-crop residues, chemical soil stabilizers, and feedlot wastes (manure)-required to control wind erosion. An effective wind erosion control treatment is one that can resist a 38.0 m/s wind as measured at 15.2 m. Mulching has becomes an important practice in modern field production. Mulch paper reduces the application of chemical fertilizer and herbicide, weed control and maintain the land temperature. This article reviews the published research on mulches and discusses the opportunities that they solving the problem in agriculture.

Key words: Conservation, Mulching, Plastic mulch, Soil properties, Weeds.

India has made immense development in agriculture and food security. It began with the decision to adopt superior yielding, disease resistant wheat varieties in combination with better farming knowledge to improve productivity. Development of irrigation schemes, copious use of fertilizers and pesticides, use of high yielding varieties made the green revolution possible. The word mulch has been probably derived from the German word "*molsch*" means soft to decay, which apparently referred to the use of straw and leaves by gardeners as a spread over the ground as mulch (Jacks *et al.,* 1955). Mulches are used for various reasons in agriculture but water conservation and erosion control are the most important objectives particularly in arid and semi-arid regions. Mulching is the process or practice of covering the soil/ground to make more favourable conditions for plant growth, development and efficient crop production. Mulch technical term means 'covering of soil'. While natural mulches such as leaf, straw, dead leaves and compost have been used for centuries, during the last 60 years the advent of synthetic materials has altered the methods and benefits of mulching. The research as well as field data available on effect of synthetic mulches make a vast volume of useful literature. When 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. The suppression of evaporation also has a supplementary effect; it prevents the rise of water containing salt, which is important in countries with high salt content water resources. Thus, it facilitates more retention of soil moisture and helps in control of temperature fluctuations, improves physical, chemical and biological properties of soil, as it adds nutrients to the soil and ultimately enhances the growth and yield of crops (Dilip Kumar *et al.,* 1990). In addition mulch can effectively minimize water vapour loss, soil erosion, weed problems and nutrient loss (Van Derwerken and Wilcox, 1988).

Mulching in improve soil health: Knowledge of the physical properties of soil is essential for defining and/or improving soil health to achieve optimal productivity for each soil/climatic condition. This envisages that for increasing crop production, soil must be maintained in such a physical condition so as to allow adequate crop growth. Unless the soil physical environment is maintained at its optimum level, the genetic yield potential of a crop cannot be realized even when all the other requirements are fulfilled. No doubt, if these soils are managed properly for good physical health, the yield potential of different crops can be increased significantly.

Soil temperature: Soil temperature under plastic film is usually high and also it is based on the color of the plastic mulches. The black plastic-film mulched plots had significantly lower soil temperature (1 to 2.80 C) than the clear plastic-film mulched plots. Because much of the solar energy absorbed by black plastic-film mulch is lost to the atmosphere through radiation and forced convection (Schales and Sheldrake,1963). Anikwe *et al.*, (2007) observed that the unmulched plots had the lowest soil temperature (about 1-3.80 C lower) at different times since planting compared to plastic film mulched plots. Among different mulching techniques plastic film mulching increases soil surface temperature by influencing the heat balance and thus increased the soil temperature and it also positively influenced the crop emergence (Aniekwe *et al.*, 2004).

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Soil water content: The black polyethylene mulch maintained high soil water contents compared to the control (no mulch) and the bare soil treatments (Li *et al.*, (2001). Improvement of the water use efficiency by better utilization of soil water appears to be the best way to increase grain yield in the semiarid areas (Zhao *et al.*, 1995). The main methods of increasing the water use efficiency include reducing soil water evaporation, and exploiting deep soil water so as to support shoot biomass accumulation and optimize the dry matter allocation by selectively increasing the reproduction (Li *et al.*, 1997, 2000; Li and Zhao, 1997). The plastic film mulch was promoted root growth and that more roots were distributed in mid- and deep-soil, so that the plant can uptake water from the deep soil and increase the grain yield (Kwabiah, 2004).

Nutrient availability: The decomposition of organic residues under plastic mulch adds organic acids to the soil resulting in low soil pH, which may increases the bioavailability of micronutrients (Mn, Zn, Cu, and Fe). This was also evident from the increased Fe and Zn content in soil under plastic mulch (Tisdale *et al.*, 1990). The mineral N content (NO3 and NH4+) in soil is high due to mineralization of organic N with time, thereby; it increases the availability of soil nitrogen. Breakdown of organic material release soluble nutrients like NO3, NH4+, Ca2+, Mg2+, K+ and fulvic acid to the soil intern increases the soil nutrient availability under plastic mulch.

Crop growth parameters: Plastic mulch induces the early crop emergence, so that it increased the biomass production at early stages of the crop growth. Li *et al.*, (1999) reported that plastic film mulching leads to earlier seedling emergence and earlier spike differentiation, which help to develop more spikelets and more grains per spike in wheat. The improvement in soil moisture and topsoil temperature under plastic mulch hastened seedling emergence by 8 days on average in wheat. Plants in mulching treatments entered the maturation phase sooner and their maturation period was longer. This change is favorable to partition assimilate that is stored in vegetative organs, thus facilitating development of the reproductive organs of wheat plants. It increases the duration of reproductive period so the yield will be maximized (Li, *et al.*, 2004).

Effect of mulching on weed control: The principle aim of mulching is to cut off the light to the weeds and to suppress their growth . Since every type of the mulch covers soil and performs physical pressure to the weeds.

Biodegradable mulches: Carrubba and Militello, (2013) presented some environmentally friendly techniques for weed management, which proved to be efficient to increase seed yields of coriander, fennel and psyllium. Although biodegradable films used in experiment positively affected yields, they were not capable to suppress weeds. Organic agriculture also uses some degradable inorganic materials, such as gravel, which has been used as mulch from almost forty years now (Fairborn, 1973). Besides the thickness of this mulch, the gravel different grain size is also examined (Qiu, *et.al*, 2014). Wang *et al.* 2014 investigated implementation of gravel-sand mulches in watermelon production and reported how it influences the soil temperature. There are reports on application of many other organic mulches, such as composted pine bark in *Allium aflatunense* (Laskowska *et.al,* 2012) or pine bark mulch in *Salvia splendens* (Blażewicz-Woźniak *et.al,* 2011). Sawdust was recommended as effective mulch for acid-loving plants, such as calla (Wright and Burge 2010) or blueberries (Haynes and Swift 1986). Straw and other organic mulches, similarly to composting process, decompose over time through mineralization process, thus forming humus. Apart from its primary use as organic fertilizers, compost positively contribute to the soil structure and is frequently used for production of various substrates and mulches (Matković, *et.al*, 2015).

Non-biodegradable film mulches: Different polypropylene (PP) black films were tested for efficiency in weed control and the results proved significant increase in the plants height (Fontana, *et.al* 2006). Normally, black and other film colours are used in a cultivation of strawberry and watermelon, since they need higher soil temperatures for attaining desired sweetness. Polara and Viradiya (2013) presented superior yield and quality features of watermelon produced on silver-black PE film, although it is quite known that conventional PE films create a big trouble to the environmental. With regard to this, Costa *et al.* (2014) compared efficacy of PE film with five biodegradable films and proved no significant differences in productivity and quality of strawberry.

Mulching advantages and disadvantages: The influence of different mulch types on crop yield might be positive or negative, related totheir weed suppression effect. Many researchers proved positive effects of mulching on crop growth and the obtained yield quantities and qualities (Ramakrishna, *et.al,* 2005). Regardless the colour, non-biodegradable PP and PE films mulches proved to be the most efficient in preventing of germination of seeds of the most weeds and their further growth, though they are also helpful in preventing loss of the moisture from the soil and in balancing of its temperature (Momirović, *et.al*, 2010). Their application frequently bring about many other benefits, such as reduction of the run-offs, increase in rain water penetration, control of erosion, correction of the chemical balance of the soil and reduction of pest and disease damages. However, they also have some environmental disadvantages, related to the removal and handling of their waste (Briassoulis 2006).

Mulches and insect pest and disease management: Polyethylene mulches have been used to potential decrease in insect and disease pests (Lamont, 1993). The influence of mulches on plant microclimate and energy balance is a function of transmittance, absorbance, and reflectance of solar radiation (Ham *et al.*, 1993; Lamont, 2005; Tarara, 2000). Host-seeking behavior of thrips can be disrupted by incorporating ultraviolet reflectance, thereby reducing thrips numbers on and around host plants (Brown and Brown, 1992; Kirk, 1997; Kring and Schuster, 1992; Scott *et al.*, 1989; Stavisky *et al.*, 2002). The use of highly ultraviolet-reflective aluminized mulch as a bed covering provides this reflectance to disrupt initial flights of thrips into a field (Brown and Brown, 1992; Kring and Schuster, 1992; Scott *et al.*, 1989).

Soil preparation and preplant fertilization: The soil should be deep plowed or disked at least one month before bed preparation. Incorporate crop residues well. Remove all trash, rocks or clods from the field that may hinder the application of the plastic. Preplant fertilizers can be broadcast and incorporated into the beds as they are formed. Good soil moisture (60 to 80% of field capacity) is necessary to make firm, smooth beds (Granberry, 1994). It is important that the bed be firm, so the soil doesn't settle.

Mulch application: Plastic mulch is most efficient when used in conjunction with drip irrigation. A drip tube can be applied on the soil surface under the mulch or buried two inches to three inches beneath the soil surface. Burial reduces the chance for movement of the tube and for damage that causes leaks. Either way, the tube must be installed prior to the mulch. For spring planting, the mulch should be applied at least seven days ahead of planting to allow time for soil warming. Soil fumigation can also be accomplished during mulch application. Fumigation is a specialized operation. Make plans well ahead of time to allow for equipment readiness as well as necessary waiting periods between treatment and planting. Apply the mulch properly to realize all of the potential benefits for your money. The plastic should be in continuous contact with the soil, i.e. the bed should be uniform with no dish shapes to hold the mulch off the soil. Space between the soil and the mulch interferes with heat transfer and pre-vents the soil from warming as quickly and thoroughly. The edges of the mulch should be secured with a generous amount of soil. However, do not apply more soil than is need-ed, as this makes the mulch more difficult to remove.

Planting: The crop should be planted in the middle of the bed. Transplants or direct-seeded vegetables can be planted directly through the plastic with a machine or by hand. Starter fertilizer solutions generally are applied to transplants to promote early growth. Fertilize plants midseason by injecting appropriate soluble fertilizers through the drip line.

Culture and management: Plastic mulch does not eliminate the need for good cul-tural practices. On the contrary, more intensive management is needed to ensure utilization of the mulch to its greatest advantage. Crops should be observed regularly for insect build up under the plastic around plant openings. If the mulch loosens after installation and flaps in the wind, apply a shovel of soil in the middle of the plastic at regular intervals down the row to stabilize the mulch. This can prevent the mulch from blowing off the row or damaging transplants. Establish and follow a good integrated pest control management program for the particular crop. Use good judgment to assess the nutrition status of the plants and act accordingly.

Removal: After the plastic has served its purpose, i.e. produced at least one and preferably two or more crops, it must be removed from the field. The plastic should be removed as soon as possible after use ceases. Do not allow the plastic to become overgrown with weeds prior to removal. The plastic must be removed after the growing season. Do not disc plastic under. Machines are available commercially for plastic removal, but they can be expensive. In most cases, the plastic must be removed by hand and disposed of in a landfill.

CONCLUSION

In the present scenario of globalization and health consciousness demand for horticultural crops has increased world over. Under plastic mulch, soil properties like soil temperature, moisture content, bulk density, aggregate stability and nutrient availability improved. Plant growth and yield are also positively influenced by the plastic mulch due to the modification of soil microclimate. Even though it has many advantages, high initial cost, removal and disposal of plastic materials are some of the limitations experienced by the farmers. To overcome these limitations photo and biodegradable plastic mulches can be effectively used for sustaining the productivity as well as controlling environmental pollution due to the use of plastics.

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