TEMPERATURE INFLUENCE AND MULCHING EFFECT ON PARASITIC PLANTS AND GRAPEVINE

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Abstract. Temperature of soil is one of the most important factors that can affect the good development of the plant. The functional activity of the plant can be affected to the same extent at low and high temperatures of the soil. Mulch is a protective layer, placed on the surface of the soil, around the plant to prevent moisture evaporation. In general, mulch is often used to maintain optimum soil temperature because mulches modify hydrothermal regime, recycles plant nutrients, promote crop development and increase yields. The mulching materials are classified into several categories: organic materials which contain plant products and animal wastes, synthetic materials which are based on petroleum products and special materials based on polymer films. During the time, several research has been made to identify the impact of the mulch on soil and weeds, withal different types of mulch materials and their characteristics. The research has shown that the application of weed mulch at talessing, conserved more water, reduced soil temperature, increased volumetric heat capacity and thermal conductivity. It is concluded that mulch increased the heat conservation and keep the favorable temperature for vineyard soil.

Keywords: mulch, hydrothermal condition, soil temperature, mulching materials, vineyard

INTRODUCTION

The English word ‘mulch’ is derived from the German word “molsch”, which means soft or beginning to decay (Jacks et al., 1955). Any material spread over the soil to assist soil and water conservation, and increase the productivity of soil is called mulch (P. Pramanik, Bandyopadhyay, Bhaduri, Bhattacharyya and Aggarwal, 2015). Mulches are defined as materials that are applied to soil surface, as opposed to materials that are incorporated into the soil profile (Chalker-Scott, 2007). Mulch is a layer of varied material separating the soil surface from the atmosphere (Acharya et al., 2005) and mulching is the artificial application of mulch, practiced to obtain beneficial changes in the soil environment (Pramanik et al., 2015). In nature, the mulch may be organic or synthetic (Kamal and Singh, 2011).

MULCHES AND TEMPERATURE ON SOIL IMPACTS

Mulches conserve soil moisture by retarding evaporation (Hillel 1982), but effects on soil temperature vary depending on the composition and optical properties of the mulch (Ham et al. 1993). Mulches are known to increase soil temperature since the solar energy passes through the mulch and heats the air and soil beneath the mulch directly and then the heat is trapped by the “greenhouse effect” (Hu et al., 1995).
According to research of Aggarwal et al. from 1998, about application of weed mulch at 1q/ha at talessing, conserved 1.5-2 cm more water, reduced soil temperature by 4-5 degrees at 5 cm and 2-4 degrees at the 15 cm, increased volumetric heat capacity and thermal conductivity. It is concluded that mulch increased the heat conservation and keep the favorable temperature for vineyard soil.

Among the various environmental factors, temperature is probably the most important (Likatas et al., 1986). Soil temperature is a measure of the intensity of heat in soil. Soil temperature is affected by heat exchange with air or the atmosphere heat flow in soil and consumption or production of heat in soil (Ramakrishna et al. 2006). Soil thermal regimes can be modified by using different kinds of mulches.

Thermal regime of a soil depends on radiant energy incident at the soil surface, heat flux into the soil as determined by soil thermal characteristics and heat exchange between the soil and air (P. Pramanik et al., 2015).

In 2005, Achaeya et al., said that mulches acting as physical barriers for the loss of vapour to the atmosphere. In addition, combination of optimum soil temperature and soil moisture favour microbial activity (Kaschuk et al., 2010), and supplied more substrates for microbial biomass by increasing plant root growth (Yao et al. 2011) under mulching. Mulches modify soil hydrothermal regimes in crop root zone, conserve soil moisture, keep down weeds and promote soil productivity (Pramanik et al., 2015).

Modifications of hydrothermal regimes by application of mulches or by adopting suitable management practice can result in enhancing crop production (Pramanik et al., 2015).

Soil temperature is one of the most important factors that affect the soil heat storage, soil heat flux, soil water flux, seed emergence, nutrient transformation, transport, uptake and plant growth. The functional activity of plant roots can be affected both at low and high soil temperatures. Most of the plant responses alter with changing temperature, with lower and upper threshold values and a prominent optimum (Pollock, 1990). Favorable soil temperature for the growth of nitrogen fixing bacteria generally ranges from 20 to 25°C. The optimum soil temperature varies from 15-27°C for wheat, 25-30°C for sorghum and rice, and 25-35°C for corn crop (Oswal, 1993).

**MULCHING MATERIALS AND METHODS**

The mulching materials are broadly classified into three main groups: organic materials (plant products, animal wastes), synthetic materials and special materials. The organic mulching materials are derived from organic substances such as agricultural wastes (straw, stalks), wood industrial wastes (sawdust), processing residues (rice husks) and animal wastes (cow during, manure). The inorganic mulching materials include polyethylene plastic films, which are petroleum based products (Gill, 2014), and synthetic polymers (Kyrikou and Briassoulis, 2007). There are also other types of organic and inorganic mulching materials (SSSA, 2007; Mbah et al., 2010). Adhikari et al. (2016) and Yang et al. (2015) described several new types of biodegradable and photodegradable plastic films as ecological materials, and proposed sprayable and biodegradable polymer films for easy application and versatility.
Based on the constituents of mulch, the different mulch types are:

a) **Synthetic mulch** - such as stone or plastics, or geotextiles tend to stay in place. Main disadvantages when it is used in the garden: can migrate down into the soil in time and making future digging difficult, light-colored stones can reflect heat onto plants and scorching sensitive plants, stones also can be thrown by lawn mowers, potentially causing injury and these type of mulches do not contribute organic matter to the soil (Pramanik et al., 2015).

Plastic mulches are highly effective in moisture conservation and in alleviating sub optimal temperature conditions (Yi et al., 2011). In 1989, Wolfe et al., observed that clear polyethylene mulch increased soil temperature more than black mulch, but black polyethylene mulch increased air temperature more than clear mulch beneath tomato and cucumber crops and in 1986, Liakata et al., reported that black and reflective mulches may reduce the diurnal amplitude of soil temperature and always reduce the radiant heat gain by the soil; where as transparent mulches resulted in a relatively large net radiation at the soil surface (Pramanik et al., 2015).

In 2011, Kamal and Singh, have demonstrated that the highest soil temperature occurred under black polyethylene which was 2.2 – 3.4 °C more than the bare soil. In general, this effect was more evident during the early crop season when tomato plants shaded less soil surface area. Black plastic mulches are more effective in increasing soil temperature due to absorption of greater net radiation under the mulch compared to bare soil (Pramanik et al., 2015).

In 1972, Kiss observed that black polyethylene transmitted 20-40% of the thermal radiation compared to transparent polyethylene which transmitted about 75%. Additionally greenhouse gas like N\textsubscript{2}O was also found to reduce under ridge furrow mulching system as mulches acted as a physical barrier to the gas from soil to the atmosphere (Gan et al. 2012).

In 2011, Sultana et al. affirmed the thermal transmission efficiency might have resulted in better heat conservation under the black mulch during the night because of the higher temperature differences between the phases of the day, but the positive part of black polyethylene mulch was found superior for lettuce (Sultana et al., 2011), and okra and squash (Mahadeen 2014).

**Organic mulch** – the organic mulch comes from plants or vegetable waste. This decomposition adds organic matter to soil and helps in improving water and nutrients retention capacity of soil and promotes the growth of healthier plants.

Main benefits are the organic mulches decompose and become a part of the soil, but the disadvantage are the organic mulches will have to be replenished from time to time (P. Pramanik et al., 2015).

Organic mulch can be: **Stubble mulch** - they reduce evaporation, thereby increasing water content in the soil. A few good examples of this are dry grass, wheat, and gram stalks. Stubble mulching is a system of farming primarily developed in the arid and semiarid areas. Stubble mulching is demonstrated to be of practical value in reducing soil erosion by wind and water and in resisting surface runoff. Under some conditions, the practice of stubble mulching may reduce soil losses from intense rains to only a portion of those occurring with plowing (Mc Calla and Army, 1961 and
Surface application of wheat straw at 7.5 tonnes/ha reduced the maximum soil temperature from 37.1 to 28.6°C in Brazil (Bragagnolo and Mielniczuk, 1990).

In 1985, Tomar and Verma reported that the mulching of paddy straw at 5 or 10 tonnes/ha reduced fluctuations in soil temperature and delayed all growth stages of early and late sown wheat and according to research of Aggarwal et al. (1998), about application of weed mulch at 1 q/ha at tasseling, coinciding with time of recession of monsoon, conserved 1.5-2 cm more water, reduced temperature by 4-5°C at 5 cm and 2-4°C at the 15 cm soil depth, increased volumetric heat capacity by 0.01-0.02 calories/cm°C and thermal conductivity by $1^2 \times 10^{-3}$ calories/cm/sec/°C and, thus, checked diurnal temperature and evaporation both in ridge and flat-bed treatments.

In 2007, research of Sarkar and Singh shown that soil temperature decreased with the decrease in ploughing depth at 07:00 but increased at 14:00, and soil dust and straw mulching increased soil temperature over the un-mulched condition at 07:00 but decreased it at 14:00, and the impact of tillage depths and mulching on soil temperature lasted for 75 days after sowing of barley and they concluded that the application of straw mulch can lower maximum soil temperature due to the interception of incoming solar radiation.

Another organic mulch can be: Vertical mulch – which are used on arid areas, where are extreme rain and resulting severe soil erosion. To prevent this, are being used trenches which are dug all across in between the crop lines so as to absorb the excess of water and redistribute around the area. Vertical mulch can provide 3 to 4 years of consistent service. (Pramanik et al., 2015).

![Mulching Conceptual Framework](Source: M.A. Kader et al., 2017)

**WEEDS CONTROL OF THERMAL MULCHING**
Weeds are plants that are not desirable in the fields of agricultural plants. They are competing with the plants, planted for crops, for water, nutrients, light and space. If
they are not properly controlled, they can reduce the quality and quantity of the yield in the vineyard. In addition, weeds can be hosts of several pathogens and pests, and make problems during the harvest (M.A. Kader, 2017).

CONCLUSIONS

The weed control and ensuring the thermal, water and solar regime of the soil can be achieved with the mulching materials. Mulching materials and methods depend on the soil type, hydric regime, planting culture, nitrogen plant needs and sun exposure time. Main benefit are the organic mulches decompose and become a part of the soil, but it should be controled time to time due to decomposition. This research has shown that the application of weed mulch at talessing, conserved more water, reduced soil temperature, increased volumetric heat capacity and thermal conductivity.

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