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Elucidating the Role of Different Mulching Materials on the Growth Performance of Hot Pepper (*Capsicum annum*)

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ABSTRACT

Hot pepper (*Capsicum annum* L.) is one of the commercially cultivated crops in most part of the world. It can be consumed both in the green states as well as matured. It is important crop in Ethiopia and high value cash crop, the production of which is generally confined to areas were water is often limiting. However, the yield of the crop in the dry season is limited attributing to the soil moisture stress in spite of the maximum sun light intensities. Therefore, the present experiment was conducted in 2014 cropping season at JUCAVM research site under irrigation to determine the effect of different types of mulches on the germination and growth performance of local hot pepper. The experiment had four treatments: Dry banana leaves, dry Vetivar-grass, plastic and bare plot laid out using Randomized Complete Block Design (RCBD) each replicated three times. Data was collected on seedling emergency and growth performance of hot pepper. The results indicated that using different mulches did not show any significant difference on germination and growth performance of hot pepper. This result gives us two conclusion lines: the first line is telling us that using any type of mulching material do not have unique implication on the growth performance of hot pepper. The other one is telling us that it might be because of uncontrolled environmental factors like heavy rain, snow in our experimental site. Likewise, the time for data collection also was early. However, the plastic mulches showed higher mean value in plant height, seedling emergency and number of plant. From this study, it is clear that even though the different mulching materials have no statistically significant differences on the growth performance of hot pepper still the plastic mulch showed better performance on seedling emergency, plant height and number of branch per plant under JUCAVM research site condition.

Key words: Mulching, seeding emergency, Ethiopia, hot pepper, JUCAVM

INTRODUCTION

Hot paper (*Capsicum annum*) is new world crop that belongs to the Solonaceae family (Poulos, 1993). The five domesticated species are *C. annuum* L., *C. frutescence*, *C. Chinese* jacq, *C. baccatum* var. *Pendulum* L., *C. pubescens R.* and *P. capsicum*. These plants are dicotyledonous woody shrub with erect, sometimes prostrate growth habit which may vary certain characters according to species. According to Greenleaf (1986) and Poulos (1993) all cultivated capsicum species are diploid and have the same chromosome number of 2n = 2x = 24. Capsicum fruits are consumed as fresh, dried or processed as vegetable and as spice or condiments (Geleta, 1998). The nutritional value of hot pepper merits special attention because it is rich source of vitamin A, C and

E. Both hot and sweet paper contains more vitamins C than any other vegetable crops (Poulos, 1993) oleoresin of paprika and capsicum is the two important extracts of pepper.

The most popular range of its color strength is from 40,000 to 80,000 color units (Poulos, 1993). Capsicum oleoresin is prepared from the most pungent, small fruiting chilies in addition to their use as food, condiments and ornamentals in the garden. Pepper are also used as medicine (Bosland and Votava, 2000). Peppers are one of the most widely used of all remedies. At present, it is the most recommended topical medication for arthritis (Bosland and Votava, 2000).

Hot pepper is one of the major vegetable crops produced in Ethiopia. Ethiopia is one of a few market developing countries that have been producing paprika and capsicum oleoresins for export (Geleta, 1998). This is because of its widely use in Ethiopia diet. Hot pepper is an important traditional crop mainly valued for its pungency and color. It is extensively grown in most parts of the country with the major production areas concentrated at altitude of 1400-1900 m.a.s.1. (Geleta, 1998). The central (eastern and western shewa), western and North western (Wollegea and Gojam) and northern parts of the country are the potential pepper producing areas.

Even though, the total yield gained from hot pepper is still remain low as compared to the national yield. Thus, there are a number of constraints that hinder the production and productivity of the crop. Among these lack improved varieties for different agro ecology, adverse environmental factories and agronomic practices such as fertilization, irrigation, cultivation, weeding, disease and insect pest and effect of mulching materials. Many researchers have been revealed that lack of appropriate agronomic practices has been a limiting factor and farmers are complaining of difficulty in management activities for different varieties to obtain the potential yield. Therefore, evaluation and selection of different mulching materials under Jimma condition will improve production and productivity of the crop which has great contribution for increment of the national average yield.

Mulching materials have effects on the seedling emergence and growth performance of hot pepper by affecting soil temperature, moisture soil structure and weed emergence. These all factors affect on germination percentage, growth performance like number of leaf per plant, height and plant size and leaf diameter of stem (Bosland and Votava, 2000).

STATEMENTS OF PROBLEMS

Knowing the effect of different mulching materials is very important because most of the time producers of hot pepper (*Capsicum*) do not consider about effect of mulch. The mulching materials have different capacity to transparent light intensity which has effect on the germination and growth performance of hot pepper. Even though, a very little information is available regarding the influences of different types of mulches on the growth of hot pepper. All of the information is not published on scientific journals. Most of them are from the farmers view point. Therefore, this study was undertaken to pick out the best mulch materials for hot pepper seedling emergence and growth performance. The objective of present study is to elucidate the effect of different mulching materials on the seedling emergence and growth performance of hot pepper.

Nutrient composition of hot pepper fruit: Hot pepper processed as vegetable and as spice or condiments (Geleta, 1998). The anti oxidant vitamins A, C and E are present in high concentration in hot pepper (Bosland and Votava, 2000). Both hot pepper and sweet pepper contain more vitamin C than any other vegetable crops (Poulos, 1993). Hot pepper produce high amount of vitamin C, pro vitamin A, E, P, B_1 (thiamine), B_2 (riboflavin) and B_3 hot pepper has significant role in the human diet. They are consumed as fresh or dried. Bosland and Votava (2000) summarized that one

medium green sweet pepper (1488) has 30 calories; 7 g of total carbohydrate which is 2% of the Recommended Daily Allowance (RDA) for adults and 2g of dietary fiber which is 8% of the RDA; 4 g of sugar; and 1 g of protein. It also provides 8% of the RDA of vitamin A, 180% of vitamin C, 2% of calcium and 2% of iron (Poulos, 1993).

Agro ecological requirement: Pepper can grow in a wide range of climate and soil condition in Ethiopia, though, it is warm season crop (Geleta, 1998). It does best with a long, frost free season to produce high yield of quality fruit. Rabinowitch and Brewster (1990) indicated that elevation up to 2000 m.a.s.l. is suitable for most cultivar. Plants are preferable to slightly acidic soils with pH 5.5-6.6 and 600-750 mm per annum rain fall is adequate with high temperatures.

Use of organic mulches in vegetable production: Mulching is one of the simplest and most beneficial practices used in the garden. Mulch is a simply a protective layer of material that is spread on top of soil. It is used for retain moisture, reduce erosion, suppress weed growth, seed germination and provide nutrients up on decay.

Mulches can be either organic such as; grass clipping, straw, bark chips and similar materials or inorganic such as stones, brick chips and plastics.

Since beginning of civilization man has developed technology to increase the efficiency of food production. The use of organic and plastic mulches in commercial vegetable production is one of those traditional techniques that have been used since 1950. Mulching with plant residues and synthetic material is a well established technique for increasing profitability of many horticultural crops (Iqbal, 2009). A favorable soil, water and plant relationship is created by placing mulch over the soil surface. The micro climate surrounding the plant and soil is significantly affected by mulch i.e., thermodynamic environment, moisture, root zone, erosion, physical, chemical and biological properties of soil the incidence of pests and diseases, crop growth and yield (Iqbal, 2009).

In addition the decline in soil organic matter content and the resultant loss on soil productivity is considered as one of the major problems in maintaining soil fertility in the tropics. The additions of organic materials such as crop residues play a key role in the recycling of nutrients. Crop residues returned to the soil can maintain or enhances soil quality and productivity through favorable effects on soil properties and life support process.

Effect of organic mulches on soil moisture: Water is essential for growth and development. It is also a major cost in agricultural systems. The success of many agricultural farms rises on conservative and efficient use of water. Moisture retention is undoubtedly the most common reason for which mulch is applied to soil. Mulch is used to protect soil from direct exposure to the sun which would evaporate moisture from the soil surface and cause drying of the soil profile. The protective inter face established by the mulch stops rain drop splash by absorbing the impact energy of the rain hence reducing soil surface crust formation. The mulch also slows soil surface run off allowing a long infiltration time. These features results in improved water infiltration rates and higher soil moisture. An auxiliary benefit of mulch reducing soil splash is the decreased need for additional cleaning berries to process the herb foliage (Barker, 1990).

Organic mulches have been shown to improve the moisture retention of soil. This extended water holding capacity which the plants enable to survive during low rain fall periods (Iqbal *et al.*, 2009). Aiyelaagbe and Fawusi (1986) reported mulched plots maintained a high soil water potential regime of 0-20 bar during the watering cycles. Whereas on bare (un-mulched) plots, soil moisture

was rapidly depleted to 0.64 bar soil water potential. According to Cook *et al.* (2006) report the control treatment (no mulch) had the lowest water content than mulched plots with wheat and soybean straw.

Similarly due to the evaporation reducing property of the surface place straw layer, mulching reduced soil water loss as compared to un-mulched control (Pervaiz *et al.*, 2009).

Effect of organic mulches on soil properties: Organic mulches improve the condition of the soil. Since organic mulches are derived from plant material decomposition do occur and several important effects on the soil and on plant growth will be apparent to growers. Mulches after the structure of the soil which usually increases root growth. The addition of such mulches as leaves, sphagnum peat moss or shredded bark to the soil brings an all most immediate effect (Williams, 1997). Aeration is improved in clay soils and the water holding capacity is increased in sandy soils. If not already decomposed, mulch will promote granulation or the clinging together of soil particles (Williams, 1997).

During decomposition of organic material soil micro organisms secrete a sticky substance that plays an important role in soil granulation. This process is particularly important in heavy soil types. Cultivating the soil when it is too wet destroys good structure. When mulches are used cultivation is reduced or eliminated. Soil structure is also harmed by walking through the garden when the soil is wet. Mulches however, serve as a cushion and those minimize the damage. In addition soil structure is not disturbed by pelting rains (Williams, 1997). Organic mulching decreases bulk density of the surface soil. Soil pH (acidity or alkalinity) may be somewhat affected by the use of organic mulches. Acid sphagnum peat usually lowers the pH. Most other organic mulches raise the pH slightly making the soil reaction move alkaline. Oak leaves may be acid when fresh but as decomposition progresses the net result is an alkaline reaction (Williams, 1997). Shashidhar *et al.* (2009) indicated that effects of mulches on soil pH were significant. Among the different mulches higher soil pH were recorded in silk worm bed waste mulched plot (Shashidhar *et al.*, 2009).

Organic carbon content of soil was found to significantly high in all mulched plots over the control (Shashidhar *et al.*, 2009) since organic mulches are composed of plant materials they add small amount of nutrients to the soil through the decomposition.

These amounts have little effect on the nutrient level in the soil and should not be considered a substitute for fertilizers. If quickly decaying organic mulches such as fresh leaves, wood chips and straw are used a considerable amount of nitrogen is taken from the soil by the micro organisms decomposing the organic matters. This reduces the nitrogen reserves in the root zone of the growing plant. If additions of nitrogenous fertilizer are not made regularly, a nitrogen deficiency may result (Williams, 1997).

Organic mulches serve as food for many micro organisms in the soil. These organisms are necessary for maintaining and promoting soil granulation. Mulch also helps to keep the soil temperature constant so that the activity of the micro organisms can continue at an even rate (Williams, 1997). Recent studies showed that mulched plots significantly increased the bacteria, fungal and actinomycetes colonies compared to non mulched plots (Shashidhar *et al.*, 2009).

Effect of organic mulches on weed: Weed control in crop is a difficult, time consuming and expensive task. Organic mulches have the potential to alter soil temperature, crop water use,

improve crop quality and reduces weed competition. Ramakrishna *et al.* (2006) indicated that poly ethylene and straw mulched plots compared to the chemical and mulched plots showed significantly the least weed infestation also the un-mulched plots showed a greater diversity of weed species than the mulched plot.

Effect of organic mulches on plant growth and yield: Organic or inorganic soil mulches influence the crop in number of ways. Organic mulches can offer a barrier against weed, moisture loss, nutrient loss, erosion, insect and disease injury while encouraging plant establishment and an earlier crop of potentially higher quality (Mugalla *et al.*, 1996). The combined effect of soil temperature, soil moisture and weed suppration not only work to improve crop growth but they facilitate hand picking and lead to high yield and increased fruit size (Scheerens and Brenneman, 1994).

Tan *et al.* (2009) observed higher number of primary branches under straw mulch relative to the bare plot on bottle gourd. Aiyelaagbe and Fawusi (1986) studied show that the growth and yield response of hot pepper to mulching and reported plant height canopy diameter, leaf area per plant, number of fruits per plant and total fruit dry weight under organic mulches with saw dust, dry grass and maize crop were higher than bare plot.

Mulching significantly resulted in tallest plant and give higher yield per plant in garlic (Islam *et al.*, 2007). Umar *et al.* (2000) observed significant effect of mulching on leaf number per plant in onions. Islam *et al.* (2007) reported higher number of leaves on mulched plot over the bare plot in onion.

MATERIALS AND METHODS

Description of experimental site or area: The experiment was conducted under field condition at Jimma University College of Agriculture and Veterinary Medicine research field in the year 2014 under irrigation. JUCAVM is geographically located at 346 km South West of Addis Ababa at about 7°33'N latitude, 36°, 57' longitude and at an altitude of 1710 meter above sea level. The mean maximum and minimum temperature are 26.8 and 11.4°C, respectively and the mean maximum and minimum relative humilities are 91.4 and 39.92%, respectively. The mean annual rainfall of the area is 1500 mm (BPEDORS, 2000).

Experimental design treatments: The experiment was carried out in Random Complete Block Design (RCBD) with three replication and four treatments. Four different mulching materials were used as treatments. These are: dry Vetiver grass, dry Banana leaves, plastic mulch and control. The inter and intra row spacing was 30 and 10 cm, respectively. Data was taken starting from week as hot pepper seeds started to germinate. Three plants were randomly selected and tagged from each plot for data measurement. From these plants, the following data was collected: Seedling emergency, plant height (cm), stem width (cm) and leaf number and No. of branch.

Statistical analysis: The raw data was analyzed using JMP statistical software version-7.

RESULTS AND DISCUSSION

As can be realized from all figures below all of the parameters were non significant. Warner and Zandstra (2004) found similar finding showing that none of the mulches increased early yield

compared to bare soil. However, plastic mulching had higher mean values for seedling emergency, plant height and number of branches per plant. The plastic film is fixed over wet soil to trap solar heat which kills weeds and soil pathogens. Clear plastic is believed to achieve higher soil temperatures. This happens because much of the incident radiation is absorbed by colored films and does not pass through the soil. The placement of the mulch is important to raise temperature. The least mean value was recorded in Vetiver grass for seedling emergency, plant height, stem width and No. of branches per plant. This might be due to the photogenic effect, heavy rain damage to the leaves and finally led to major damage on the plant. Similarly (Mochiah *et al.*, 2012) showed that mulch may provide a better refuge for the disease causing agents that can later on cause considerable damage to our plants. Some of the advantages of mulches are earlier yield, increased water retention, inhibition of weeds, reduced fertilizer leaching, decreased soil compaction, fruit protection from soil deposits (from splash) and soil (Hatutale, 2010).

Growth parameters

Seedling emergency: Seedling emergency was a non significantly different (p = 0.392). Even if there is no significant difference between the treatments, still the hot pepper plants treated with plastic mulch showed the largest mean seedling emergency compared to others (Fig. 1). Use of plastic mulch to achieve earlier and larger yields of commercial vegetables is increasing. The plastic mulch like the other mulching materials is believed to check the evapotranspiration from the root zone of the crops.

Plant height: There is no significant difference among the different mulching types on the plant height. Similarly, Mochiah *et al.* (2012) observed non significant differences among the mulched plots (straw mulch, plastic mulch and live-mulch of cowpea plant) on plant heights. But plastic mulches still showed higher mean value (Fig. 2). Sky Red and Maha hot pepper hybrids mulched with black plastic showed significantly better vegetative growth (plant height, leaf area etc.,) and fruit yield (Iqbal, 2009). Our finding is in contrary to the finding of (Dzomeku *et al.*, 2009) where they indicated that straw mulch enhanced plant height and increased fruit number and fruit yield in both pepper and tomato.

Stem width: There was no significant difference (Fig. 3). However, the mean stem width in the control plot was relatively higher.

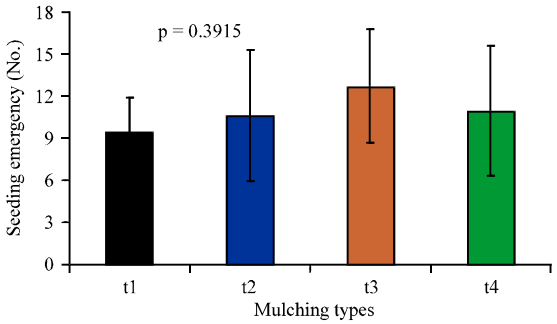

Fig. 1: Effect of mulching types on seedling emergency of hot pepper, t1: Dry Vetivar grass, t2: Dry Banana leaf, t3: Plastic Mulching and t4: Control. Data are Mean±SE

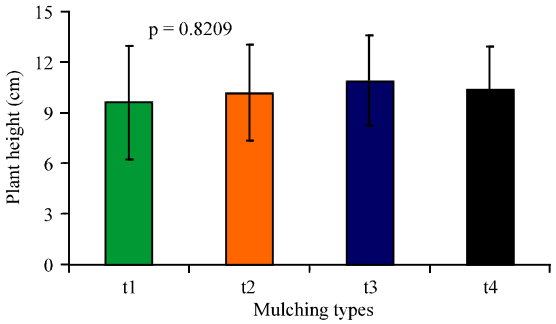

Fig. 2: Effect of different mulching types on plant height, t1: Dry Vetivar grass, t2: Dry banana leaf, t3: Plastic and t4: Control. Data are Mean±SE

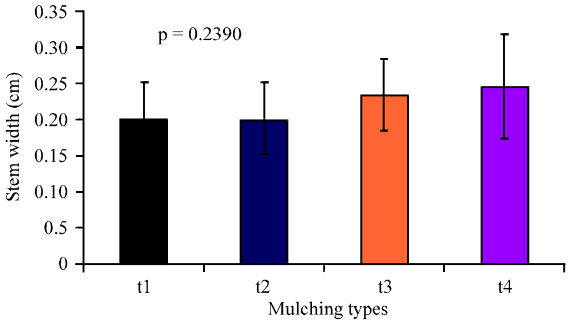

Fig. 3: Effect of different Mulching types on stem width of hot pepper t1: Dry Vetivar grass, t2: Dry banana leaf, t3: Plastic and t4: Control. Data are Mean±SE

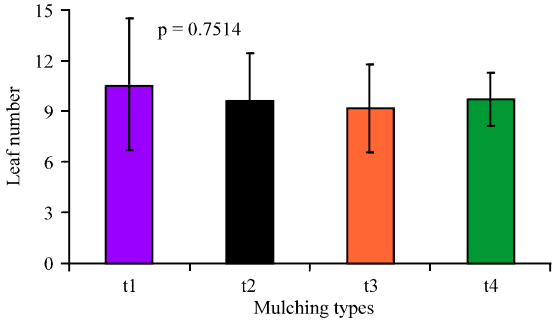

Fig. 4: Effect of different Mulching types on leaves number per plant of hot t1: Dry Vetivar grass, t2: Dry banana leaf, t3: Plastic and t4: Control. Data are Mean±SE

Leaf number per plant: According to analysis of variance, there was no significant difference among different type of mulch application on the number of leaves per plant of hot pepper (Fig. 4). In spite of the statistically insignificance, considerably high No. of leave per plant were obtained in the dry vetivarv grass. Organic carbon content of soil was found to significantly high in all mulched plots over the control (Shashidhar *et al.*, 2009). Since organic mulches are composed of plant materials, they add small amount of nutrients to the soil through the decomposition.

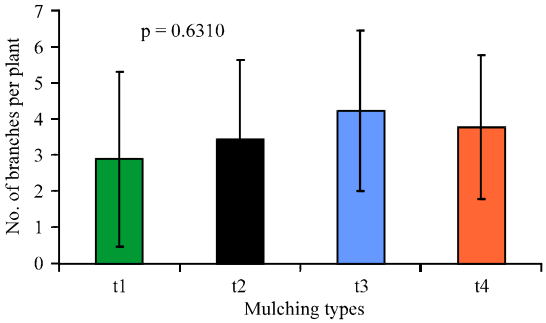

Fig. 5: Effect of mulching types on number of braches per plant t1: Dry Vetivar grass, t2: Dry banana leaf, t3: Plastic and t4: Control. Data are Mean±SE

Number of branch per plant: Number of branches per plant was non significant among the different mulching types. But plastic mulching had higher number of branches per plant (Fig. 5). Numbers of primary branches were better in tomato plants treated with plastic mulching (Ashrafuzzaman *et al*., 2011).

CONCLUSION

The hot pepper (*Capsicum annum* L.) is the important crop and the high value cash crop which production is confined to areas where water is limited. In order to peruse the study, the hot pepper (*Capsicum annum* L.) were grown on 15 plots laid out in randomized complete block design receiving four types of mulches as a treatment; dry banana leaves, dry vetivar grass, plastic mulches and bare plot under irrigation condition with application of fertilizer through side dressing. In this study effect of different mulches on the germination and growth of hot pepper was investigated. From our experiment we conclude that the difference in mulching types did not affect the growth and development of hot pepper prominently. A slight promising difference was realized in the plastic mulching as the mean values for seedling emergency, plant height and number of branches per plant were considerably higher than the other treatments.

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