

EFFECT OF MULCH ON SOIL PROPERTIES AND YIELD OF GROUNDNUT PLANTS EXPOSED TO TEMPERATURE STRESS

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INTRODUCTION

Groundnut (*Arachis hypogaea* L) is an important cash crop grown in the dry zone of Sri Lanka. Heat and/or drought-induced stresses are the major environmental factors that limit pod yields of groundnut. The optimum day/night temperature for vegetative and reproductive growth and development in groundnut ranges from 25/25° C (Wood, 1968) to 30/26 °C (Cox, 1979) and from 25/20 ° C (Wood, 1968) to 26/22 ° C (Cox, 1979), respectively. However, due to global warming, temperature in the globe is predicted to increase in the coming years and therefore it is imperative to find adaptation measures to cultivate groundnut as it plays a major role in the rural economy of Sri Lanka (De Silva et al, 2007). The main aim of this paper is to quantify the effects of high air temperature on nodulation and pod yield of groundnut and to identify the best mulch which contributed to reduce high temperature effects on groundnut.

METHODOLOGY

This study was conducted during the period October 2010 to April 2013 in temperature regulated poly tunnels constructed in the agricultural field of the Open University of Sri Lanka, Nawala, Nugegoda. One set of polytunnels was maintained at 32°C maximum temperature. Another set of polytunnels was maintained at 34°C. The temperature inside the polytunnels was set by a thermostat. Groundnut (Walawe) seeds were planted in pots filled with compost and reddish brown earth soil mixture (1 plant/ pot in 30 cm i.e. and 45 cm deep pots). Three types of mulches were used (coir dust, straw and saw dust) along with a control no mulch (15% of mulch). The plants were maintained without water stress by applying water to keep the soil moisture at field capacity level throughout the growing season, according to the findings of a previous study (Gunawardhana *et al*, 2011).

Data Collection and Analysis

The experimental design used was a Completely Randomized Design (CRD) with factorial treatment structure. Temperature and mulches were taken as factors. Analysis of covariance (ANCOVA) of the results was performed using General Linear Model procedure of Mini tab (Software Version 17). Standard error bars were developed using the maximum and minimum values of the mean values. The yield was collected at the end of 4 months after planting. The average of five replicates was taken as yield per plant. Air-dried plant weights and pod weight were measured using a digital balance. Physical and chemical parameters of the soil were estimated viz. pH by direct method (electronic pH meter), EC (measured using the conductivity meter), organic matter (determined using the ASTM D2974-Standard test method for organic matter), and moisture percentage and bulk density (estimated using the gravimetric method).

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RESULTS AND DISCUSSION

Effect of Mulch on Soil Properties

Soil pH

Average soil pH among the treatments ranged from 6.5 - 7.24 (Figure 1). Generally, plants mulched with saw dust and straw maintained significantly higher pH values than the others ($p < 0.05$). An important characteristic of coir dust is its low biodegradation. Coir dust consists of lignin, cellulose and hemicelluloses. About 90% is organic matter and the carbon nitrogen ratio is extremely high (>130) according to Van Mele (1997). The low pH of coir dust offers an extra protection against biodegradation, and many microorganisms do not survive once the pH is low. Slow biodegradation of organic mulches have been given more consideration, especially in tropical countries like Sri Lanka where fast mineralization of the humic substances and runoff with intensive rainfall are problems. Further, coir dust has a good cation exchange capacity (CEC) of 50 meq/100g dry matter (Van Mele, 1997) therefore; it improves the nutrient binding capacity of the low fertile soils. In addition, studies have shown that up to 70% of the nitrogen applied is often lost through leaching and application of a mixture of coir dust strongly reduces the nitrogen leaching by slowly releasing the nutrient (Vidhana Arachchi and Somasiri, 1997).

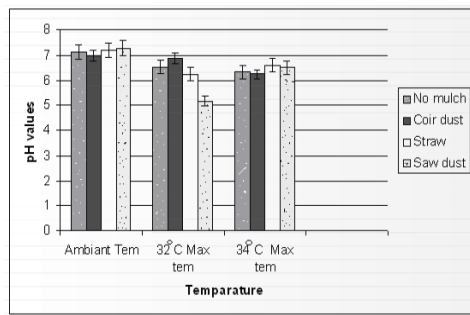


Figure 1: Effect of mulch on Soil pH

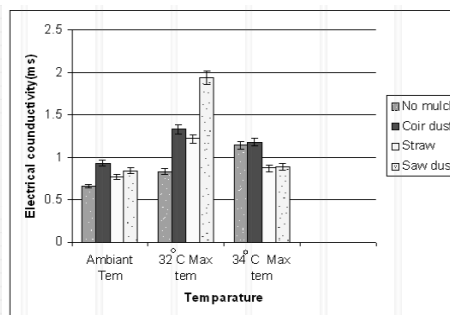


Figure 2: Effect of mulch on Soil EC.

Soil electrical conductivity (EC)

Average soil EC among the treatments ranged from 0.66 -2.22(ds/m) (Figure 2). The results showed a significant difference with temperature. There was a significant variation between coir and other mulches. It was found that a agricultural management practices can change the characteristics of the soil surface and influence the hydrothermal properties of the soil. For example, mulching can affect the temperature and moisture content of the soil (Li *et al.*, 1999). The highest EC was reported from the coir dust mulched treatment. EC proportionally increased with the moisture content. Straw mulching systems can conserve soil water and reduce temperature because they reduce soil disturbance and increase residue accumulation at the soil surface (Zhang *et al.*, 2009).

Organic matter content

Average soil organic matter content among the treatments ranged from 6.04-7.9% (Figure 3). (Initial stage organic matter content of the soil 4.5%) Organic matter is a key component of soils affecting their physical, chemical and biological properties and is important as a source of energy and nutrient elements for soil ecosystem. Maintenance of sufficient levels of organic matter in soils is prerequisite for sustainable and high production of crops according to Arafat (1994). Some of the properties influenced by organic matter include soil structure, soil compressibility and shear strength. In addition, it also affects the water holding capacity, nutrient contributions, and biological activity, water and air infiltration rates. Research findings indicate the vital role of bio-organic fertilization in releasing of available nutrient

elements more to be absorbed by plant roots and this in turn increase dry matter content in the different peanut and lentil plant organs (Saber and Kabesh, 1990).

Moisture content

The average soil moisture among the treatments ranged from 19.08-23.8% (Figure 4). Plants mulched with coir, straw and saw showed higher moisture content. Manure and mulch can be used in soil and water conservation, since their appropriate use in soil treatment will reduce soil erosion. Fertile soil also produces higher yielding crops through this mulching treatment (Robert 1987). One of the most important characteristics of coir dust is the high water retention capacity. Coir dust can store up to 8 times its dry weight on water. By applying a 15 cm thick coir dust mulch layer around coconut seedlings in Sri Lanka, irrigation could be reduced by 40-55% during dry season. In a pineapple coconut intercrop during dry season the top soil layer had a moisture content of 49% under coir dust mulch compared to 10% under a sandy ridge of the same height. The water retention is not too strong as plant available water stored in coir dust mulch is about 50%, compared to 10% in organic sandy soils and 23% in organic loamy sand soils according to the recent studies carried out by students of the University of Gent and the College of Gent, Belgium at the Coconut Research Institute of Sri Lanka (Van Mele, 1997).

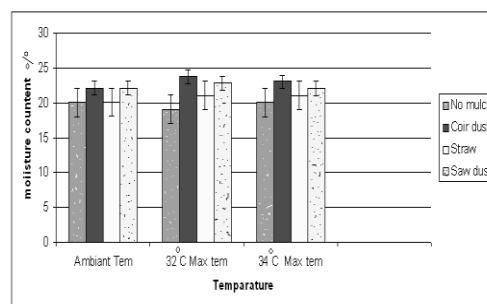
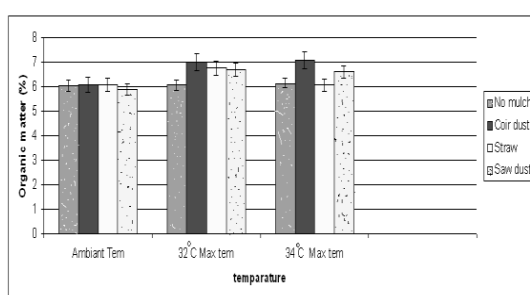


Figure 3: Effect of mulch on Organic matter **Figure 4: Effect of mulch on soil moisture**

Yield of Groundnut

The results indicate the effect of individual mulches on yield (Figure 5). Pod yield reduced proportionately with the temperature. When the temperature increased pod yield reduced as the optimum air temperature for growth and development of groundnut is between 25⁰ C and 30⁰ C (Williams and Boote, 1995). It has been shown, for example, that the numbers of pegs and pods were reduced by 33% by exposure to a day temperature of 35⁰ C compared with 30⁰C (Ketrting, 1984). The results of this study agree with the findings of Ketrting (1984) as the number of pegs and pods were reduced in treatment exposed to 34⁰ C maximum temperature. The highest pod yield was obtained in coir dust mulch in all three temperature treatments. (p<0.05)

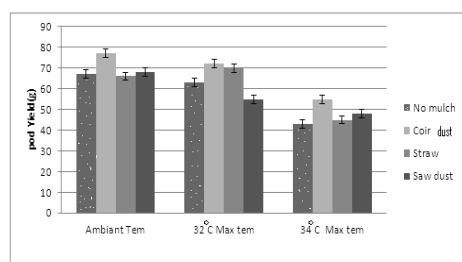


Figure 5: Effect of mulch on average pod yield

CONCLUSIONS

When considering the effect of mulch on soil properties, coir dust mulch treatment has the lowest pH compared to the other mulches which give protection against biodegradation. This is because most of the microorganisms do not survive in low pH. Coir dust mulch treated soil has the highest electrical conductivity and highest moisture content as electrical conductivity increases with increased moisture content. Coir dust mulch has very good water retention capacity, which will be advantageous in drought conditions. Furthermore, the study showed that the coir dust mulch has the highest organic matter content which is essential for plant nutrient availability, growth and yield. However, coir dust mulch has significantly higher yield even in all three temperature treatments. Coir dust mulch also performed well in plants exposed to heat stress compared to saw dust mulch. Even though there is temperature stress to plants due to global warming, by applying adequate water without water stress along with coir dust mulch, yield could be obtained without significant reduction. The findings of this study will help the farmers in dry zone to cope with temperature stress in coming years due to climate change.

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