IMPACT OF MULCHING ON SOIL PROPERTIES TO COPE WITH TEMPERATURE STRESS BY MAIZE PLANTS (*ZEA MAYS L.*)

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INTRODUCTION

Global warming, driven by the rising of greenhouse gases especially CO_2 in the Earth's atmosphere, could cause many changes to the ecosystems of the world. One of the most important is a long-term shift or alteration in the climate termed as "Climate Change". Temperature and precipitation are the most important climatic parameters for crop growth. Therefore, scientists have used available climatic data and information into several large-scale models on the atmosphere. These models are used to predict changes in temperature, precipitation, radiation, like climatic variables caused by increased greenhouse gases in the atmosphere. Temperature increase during 1961 to 1990 has been reported for Colombo as 0.0164°C per year and Anuradapura 0.0364°C per year (Fernando and Chandrapala 1995). The average annual temperature for 2050 using General Circulation Model (HadCM3) predicts an increase by 1.6°C (A2 scenario) and 1.2°C (B2 scenario). The highest mean temperature predicted for Anuradhapura was 2.1°C (A2), 1.6°C (B2). During the southwest monsoon period (May to September) the overall increase in mean annual air temperature across the island is predicted to increase by 1.6°C (A1) and 1.2°C (B2) (De Silva,*et al* 2007). Further the Northeast monsoon rainfall is also predicted to be decreased.

Maize is one of the main crops widely cultivated in the dry zone of Sri Lanka. Mulching can affect the temperature and moisture content of the soil. Mulching increased soil moisture, organic matter contents leading to a suitable environment for root penetration. The soil organic matter is increased due to decomposition of applied mulch. Applications of crop residue mulches increase soil organic carbon contents.

Therefore this paper analyses the impact of mulch on soil properties by analyzing the growth and yield of Maize plants grown under temperature and water stress.

MATERIALS AND METHODS

This study was conducted from October 2010 to December of 2012 in two temperature regulated poly tunnels constructed in the agricultural field of the Open University of Sri Lanka, Nawala, and Nugegoda. One was maintained at 32°C maximum temperature and the other at 34°C(Temperature was maintained by using temperature regulating sensors) .The cultivar sampath of maize was used for testing and Maize seeds were directly planted in individual diameter of 45cm plastic pots(each pot contains one plant). The pots were filled with a compost and reddish brown earth soil mixture. Plants were grown under 3 different conditions as indicated in Table 01.Management of the crop, cultural practices and fertilizing were done according to the recommendations of the Department of Agriculture. All the plants were watered to the field capacity level (determined using pressure plate apparatus) of the soil in order to avoid

water stress. The experimental design was Completely Randomized Design (CRD) with factorial treatment structure. Temperature and mulches were taken as factors. Physiological and morphological parameters of Maize were investigated during the growing and reproductive periods.

Plant height was measured at weekly intervals10 WAP. Yield was collected two times during the growing season and the average of two pluckings was taken as yield per plant. Soil moisture content under different mulches was measured within 3 -10 cm depth, at 10 WAP using the gravimetric method. Soil pH was measured using an electronic pH meter whereas the electrical conductivity using the conductivity meter, ASTM D 2974 Ignition method was used to determine the Organic Matter content in the soil using a Muffle furnace. Soil P and K Content were determined spectrophotometrically. All extraction runs and analyses were carried out in duplicate and in randomized order with the mean values being reported. Analysis of variance (ANOVA) of the results was performed using General Linear Model procedure of SPSS (Software Version 19). Multiple comparison of the various means were carried out by LSD (Least Significant Difference) test at P = 0.05 and p = 0.01.

Table 01: Three environment conditions maintained for the experiment

Condition	***Major Specifications***
Condition 1 – Poly Tunnel	34^0C Poly tunnel • Three types of mulches on soil – **coir dust (M1) /straw (M2)/sawdust (M3)/No mulch(M0)**
Condition 2 – Poly Tunnel	32^0C Poly tunnel • Three types of mulches on soil – **coir dust (M1) /straw (M2)/sawdust (M3)/No mulch(M0)**
Condition 3 – Open Space	Ambient temperature • Three types of mulches on the soil – **coir dust (M1) /straw (M2)/sawdust (M3)/No mulch(M0)**

RESULTS AND DISCUSSION

Pod yield

The pod yield is the most important character when considering the economic importance of this crop. Coir dust mulch showed a significantly high yield compared to the other mulches under all three temperature conditions (Table 02).Higher air temperatures will also be felt in the soil, where warmer conditions are likely to speed the natural decomposition of organic matter and to increase the rates of other soil processes that affect fertility. Further, when temperature exceeds the optimum for biological processes, crops often respond negatively with a steep drop in net growth and yield (Cynthia Rosenzweig and Daniel Hillel 1995). It shows that coir dust mulch resist temperature stress on maize yield.

Soil pH

Average soil pH among the treatments ranged from 6.5 -7.24 (Table 02). Generally, plants mulched with saw dust maintained significantly higher pH values than the others. Soil pH was lower in soils mulched with coir and straw than no mulch and saw dust.

Soil electrical conductivity

Average soil EC among the treatments ranged from 9 -11.6 (Table 02). Generally, 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(Cynthia Rosenzweig and Danial Hillel 1995)The highest EC was reported from coir dust mulch treatment. EC is proportionally increased with the moisture content. Coir dust mulch treatment increases the soil moisture content in soil according to the retardation factor.

Organic matter content

The highest organic matter content was reported from saw dust in 34°C and in ambient temperature treatments. In 32°C temperature condition, dust showed the highest organic matter content. The lowest organic matter content was shown by no mulch condition under all temperature conditions (Table02).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 a prerequisite for sustainable and high production of crops according to Arafat (1994).

Table 02: Variations of Crop and soil characters among the treatments (10WAP)

Treatments	Yield/plant (g)	pH	EC (ds/m)	Organic matter (%)	Soil moisture (%)	K (ppm)	P (mg/kg)
Ambient tem-no mulch	**81**	**6.6**	**9.9**	**3.1**	**20**	**149**	**17.5**
Ambient tem-coir	**142**	**6.5**	**10.7**	**3.8**	**25**	**165**	**21.5**
Ambient tem-straw	**114**	**6.4**	**9.9**	**3.4**	**22**	**151**	**17**
Ambient tem-saw dust	**101**	**6.7**	**9.6**	**3.3**	**24**	**166**	**21**
32 ° c max tem-no mulch	**95**	**6.7**	**9.8**	**2.8**	**19**	**160**	**19**
32 ° c max tem-coir	**135**	**6.5**	**11.7**	**3.9**	**23**	**177**	**23**
32 ° c max tem-straw	**107**	**6.5**	**9.9**	**3.5**	**24**	**161**	**20**
32 ° c max tem-saw dust	**106**	**7.2**	**9.6**	**4.2**	**22**	**170**	**22**
34 ° c max tem-no mulch	**104**	**6.9**	**11.5**	**2.5**	**17**	**140**	**17.5**
34 ° c max tem-coir	**124**	**6.5**	**11.7**	**4.8**	**23**	**159**	**22.5**
34 ° c max tem-straw	**88**	**6.6**	**9.8**	**3.5**	**21**	**158**	**19**
34 ° c max tem-saw dust	**95**	**6.7**	**9.2**	**3.2**	**24**	**156**	**21**

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 indicates the vital role of bio-organic fertilization in more release of available nutrient elements to be absorbed by plant roots and this in turn increase dry matter content in the different peanut and lentil plant organs.

Moisture content

Average soil moisture among the treatments ranged from 18%-25%. According to the results there was no significant difference with temperature. Significant variation was shown between coir dust and no mulch condition. The highest moisture percentage was reported from coir dust and saw dust mulched treatment followed by saw dust mulched treatments and lowest moisture percentage was shown from no mulch condition. Therefore mulching will help to maintain the high moisture content.

Soil Phosphorus content

Average soil phosphorus among the treatments ranged from 17 – 23 mg/kg (Table 02). According to the results there is no significant difference among the mulches. Significant variation was shown between coir dust and no mulch condition. The highest soil phosphorus content was reported from coir dust and saw dust mulched soil in ambient temperature condition. In temperature stress (32°C) condition coir dust mulched soil showed the highest soil phosphorus and lowest soil phosphorus content was shown from no mulch condition.

Soil potassium content

Average soil potassium content among the treatments ranged from 140-178 (ppm)(Table 02). According to the results there is no significant difference with temperature. Significant variation was shown between coir dust and no mulch condition. The highest soil potassium content was reported from coir dust mulched treatment and lowest soil potassium content was shown from no mulch condition. Tree-based mulches influence soil potassium and plant growth. Growth and fruit yields were associated with K availability in the soil and potassium content proportionally increased with the yield.

CONCLUSION

Results showed that higher temperature stress in natural environment either due to global warming or any other conditions could be reduced by using mulches. According to this temperature simulated field study the adverse effects on soil due to high temperature stress of 32-34°C could be reduced by using mulches and maize performed well without significant yield reduction in coir dust mulch grown under stressful temperatures, by applying adequate water without water stress. This study is in progress and these results will be confirmed after conducting the research for another growing season. These three mulches could be easily available for farmers. Therefore the adverse effects on soil due to high temperature stress could be minimized by using mulch such as saw dust or coir dust and could ensure food security in Sri Lanka. Findings of this study will help the farmers in the dry zone to cope with temperature stress in the coming years due to climate change.

REFERENCES

Cynthia Rosenzweig and Daniel Hillel (1995). Potential Impacts of Climate Change on Agriculture and Food Supply, The nature and Implications of environmental Changes Consequences Vol. 1, No. 2

De Silva, C. S. Weatherhead, E.K., Knox, J.W., Rodriguez-Diaz, J.A., (2007). Predicting the impacts of climate change—A case study of paddy irrigation water requirements in Sri Lanka. Agricultural Water Management, 93(1): 19-29, October

Fernando, T.K and L. Chandrapala, 1995. Climate variability in SriLanka- A study on Trends on air temperature, rainfall and thunder activity. Proceedings of international symposium on climate and life in Asia – Pacific, April 10-13, 1995, Brunai.

Arafat, S. M. (1994). Evaluation of sugar cane filter mud on improving soil characteristics and water melon yield. Egypt. J. App. Sci., 9:287.