IMPACT OF MULCH ON GROWTH PARAMETERS OF TOMATO (*SOLANUM LYCOPERSICUM*-VARIETY THILINA) PLANTS EXPOSED TO HIGH TEMPERATURE AND WATER STRESS

P.T.N.Dishani[1] and C.S de Silva

Department of Agricultural and Plantation Engineering, Faculty of Engineering Technology, The Open University of Sri Lanka, Nawala, Sri Lanka

INTRODUCTION

Studies in Sri Lanka based on HadCM3 general circulation model has revealed that the temperature will increase in the coming years and in 2050s the highest temperature increase by 2^0 C is predicted in Anuradhapura compared to the baseline temperature during the period of 1961-1990. Further the rainfall during northeast monsoon is predicted to decrease in the dry zone area. Therefore, the decrease in rainfall and increase in temperature will increase the evapotranspiration and soil moisture deficits. Accordingly, agricultural activities in the dry zone may be affected by predicted climate change in Sri Lanka (De Silva et al., 2007). A significant change in climate on a global scale will impact agriculture and consequently affect the world's food supply. Climate change per se is not necessarily harmful; it is the problems that arise from extreme events that are difficult to predict (FAO 2001). More erratic rainfall patterns and unpredictable high temperature spells will consequently reduce crop productivity. Temperature stress is becoming the major concern for plant scientists worldwide due to the changing climate. The difficulty of climate change is further compounded considering its precisely projecting potential agricultural impacts. Temperature stress has devastating effects on plant growth and metabolism, as these processes have optimum temperature limits in every plant species. Water deficit often limits the crop growth and development. The plant is sensitive to water stress. Plant seedlings cannot withstand either water deficit or excess soil moisture while older plants can withstand deficit or excess water. To improve the productivity of crops where either water deficiency or excess frequently occurs, proper water management is necessary (Hale and Orcutt, 1987). The conservation of soil moisture may help in preventing the loss of water through evaporation from the soil facilitating maximum utilization of moisture by the plants. Mulching is a method by which soil moisture can be conserved (Sandal and Acharya, 1997). Mulching stimulates the microbial activity in soil through improvement of soil agro-physical properties.

This study intends to identify a suitable mulch to mitigate consequences of higher temperature and water stress by evaluating the growth parameters of Tomato (*Solanum lycopersicum*) variety Thilina. Tomato is one of the most widely cultivated crops through the year both during *yala* and *maha* seasons. In a previous study the tomato plants grown under temperature and water stress were not successful as the plants were unable to cope with higher temperature and water stress effects (Gunawardana et al, 2011).

MATERIAL AND METHODS

Growing conditions

The research is planned to identify effect of mulch on temperature and water stress due to climatic changes on dry zone vegetables with the most popular variety of Tomato. First season (1st) study was conducted during December 2012 and an experiment was set up in the agricultural field poly tunnels of Open University at Nawala, Nugegoda.

[1] Principal author: disha2007sl@yahoo.com

Nursery management was initiated on 18th December in 2012 and Tomato seedlings were transplanted (28th December 2012) into individual plastic pots (1 plant/ pot in 30 cm i.e. and 45 cm deep pots). The pots were filled with a compost and sandy loam soil mixture and the two mulching treatments namely coir dust, saw dust with control treatment was unmulched (no mulch) were arranged in a complete randomized design. Two mulches were added for 5cm thickness until the surface of the compacted soil was within 1.5 cm of the rim. Initial height of the Tomato seedlings was 12 cm. These Tomato plants were grown at 3 different conditions as indicated in the Table1.

A two factor factorial experiment was carried out under three replicates. Pots are arranged according to the complete randomized design (CRD), resulting in a total of 54 pot-grown plants. Temperature and mulches were taken as factors. Physiological and morphological parameters of Tomato were investigated during the growing and reproductive periods. Analysis of variance (ANOVA) of the result was performed using the statistical program Minitab (version 14, Minitab Inc.), followed by (P = 0.05).

Table 01.Three different environment at condition of the experiment.

No	Environmental conditions
Condition 1 – Open Top Poly tunnel	Temperature of 32 ^{0}C (i). Providing adequate water to fill the field capacity for Tomato plants in mulching pots. (ii). Providing water to fill only the 50% of the field capacity for Tomato plants in mulching pots.
Condition 2 – Open Top Poly tunnel	Temperature of 34 ^{0}C (i). Providing adequate water to fill the field capacity for Tomato plants in mulching pots. (ii). Providing water to fill only the 50% of the field capacity Tomato plants in mulching pots.
Condition 3 – Open space	Ambient temperature [AT^{0}C] (i). Providing adequate water to fill the field capacity for Tomato plants in mulching pots. (ii). Providing water to fill only the 50% of the field capacity for Tomato plants in mulching pots.

RESULT AND DISCUSSION

Temperature and water stress on morphological parameters of Tomato

Plant height

Plant height was measured from 30 Days after Transplanting (DAT) to 105 DAT at 15 days interval. As shown in Figure. 1, the plant height varied significantly due to different mulches and temperature at different growth stages and increased with plant age. Coir mulch in 34°C maximum temperature treatment showed the superior performance in plant height than the control without mulched, indicating mulches had positive effect on the growth and development of Tomato. The increased plant height in mulched plants may be possibly due to better availability of soil moisture and by reducing the effect of higher temperature.

Leaf area

The mulches had a significant effect on the leaf area of the plant. The leaf area continually increased with plant age. All the mulches had a positive effect on generating and retaining higher leaf area per plant. The highest leaf area per plant was observed in saw dust mulch in no water stress treatment of 32°C maximum temperature. Control treatment without mulch always showed the lowest leaf area per plant in all temperature treatments. Favorable weather condition and moisture of the soil are the important parameters affecting the leaf area of plant. It was reported that mulched Tomato plants had more leaf area and branches than that of plants without mulch, which supported the present results.

Temperature and water stress on physiological parameters of Tomato

Leaf chlorophyll content

Chlorophyll concentration has been known as an index for evaluating source strength thus, its decrease under drought stress can be regarded as a non-stomatal limiting factor. There are reports showing the decrease in chlorophyll under drought stress (Kulshreshta et al., 1987). The effect of mulch on leaf chlorophyll content is presented in Figure 04. Results revealed that the no water stress plants have more chlorophyll content than the water stressed plant in all three temperature conditions. The saw dust mulched plants at 32°C temperature showed significantly higher chlorophyll content.

Figure. 01. Effect of mulching on average plant height.

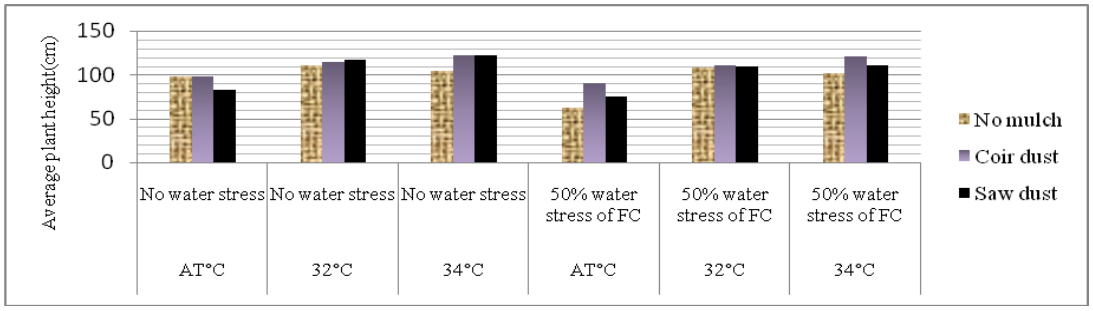
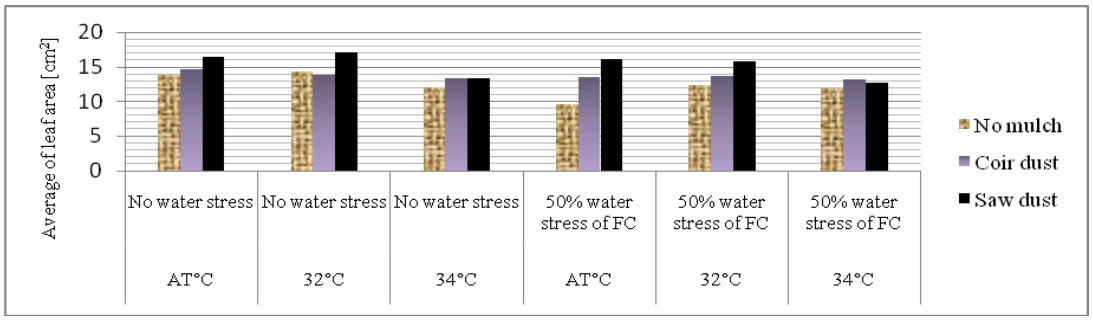


Figure.02. Effect of mulching on the average leaf area.



Relative Water Content (RWC)

Measurements of water content expressed on a tissue fresh or dry mass basis have been mostly replaced by measurements based on the maximum amount of water a tissue can hold. These measurements are referred to as Relative Water Content (Barrs, 1968). These results show that organic surface mulches can improve internal water status. Generally RWC of the plants maintained without water stress is higher than the water stressed plants. However RWC is significantly higher in coir dust and saw dust mulches in higher temperatures.

Figure.03 Effect of mulch on average chlorophyll content

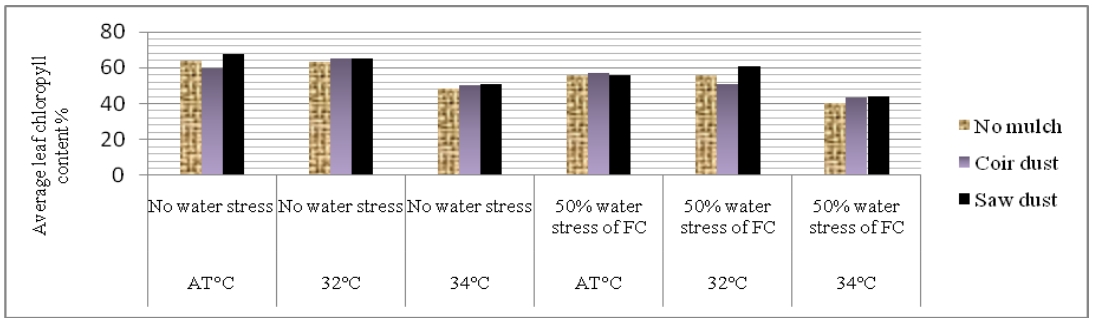
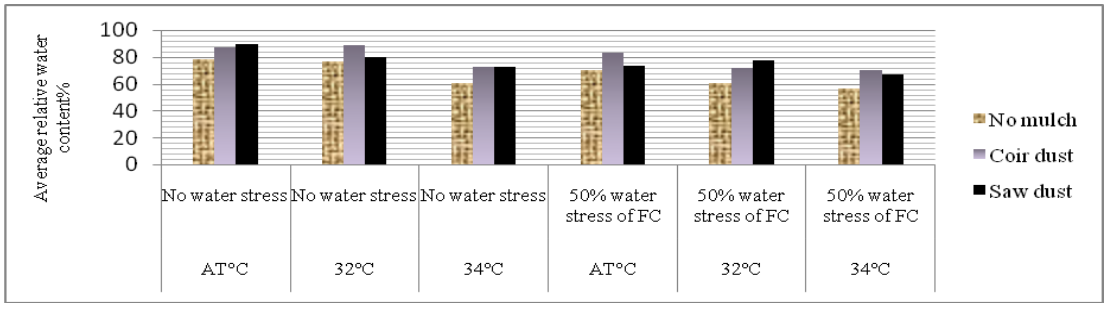


Figure.04. Effect of mulch on average relative water content



CONCLUSION

According to the results, there is significant effect of mulch on growth parameters of Tomato plants exposed to water and temperature stresses. Higher temperature treatments with saw dust mulch showed significantly higher plant height. Higher leaf area was shown on 32^0C with no water stress condition. The water stress resulted in significant decreases in chlorophyll content and the leaf relative water content. (Kirnak et al., 2001) showed that the total chlorophyll content in high water stress was reduced by 55% compared to the control which agrees with present results. Water and temperature stress in combination had severe negative effects on growth parameters as compared to the mulched treatments. According to high temperature stress of 32-34^{0}C could minimized by using mulches such as saw dust and coir dust. There were significant good growth parameters under saw dust mulch in maximum temperature of 32^0C and under coir mulch in 34^0C maximum temperature. Agronomic management practices like mulching will help the crop to adjust to the climatic change in Sri Lanka.

REFERENCES

Barrs, H.D.(1968). Determination of water deficits in plant tissue. In:KOZLOWSKI, T.T. (Ed) Water deficits and plant growth. NewYork, Academic Press, 1968. v.1, p.235-368.

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

FAO (2001) Climate variability and change: A challenge for sustainable agricultural production. Committee on Agriculture, Sixteenth Session Report, 26-30 March, 2001. Rome, Italy.

Gunawardana, M.D.M.,De Silva, C.S. and Gunasekara, H.K.L.K (2011).Impact of temperature and water stressdue to global warming on growth and yield of tomato (*Lycopersicon esculentum).*OUSL Annual Academic sessions-2011 proceeding .Pp 6-10The Open University of Sri Lanka, Nawala, Nugegoda.

Hale, M. G. and D. M. Orcutt. 1987. The physiology of plants under stress. Wiley-Inter Sci., New York.

Kulshreshta, S., D. P. Mishra, and R. K., Gupta. 1987.Changes in content of cholorophyll, proteins and lipids in whole choloplast and chloroplast membrane fractions at different leaf water potentials in drought resistant and sensitive genotypes of wheat. Photosynthetica, 21(1): 65-70.

Kirnak H, Kaya C, Tas I, Higgs D (2001). The influence of water deficit on vegetative growth, physiology, fruit yield and quality in eggplants. Bulgarian J. Plant Physiol., 27(3–4): 34–46.

Sandal, S. K. and Acharya, C. L. (1997), Effect of tillage on moisture conservation, soil physical conditions, seedling emergence and grain yield of rainfed maize (Zea mays L.) and wheat (Triticum aestivum). Indian J. Agric. Sci., 67, 227-231.