IMPACT OF MULCH ON YIELD AND QUALITY PARAMETERS 0F T0MATO (*Solanum lycopersicum*-variety Thilina) PLANTS EXPOSED TO HIGH TEMPERATURE AND WATER STRESS

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INTRODUCTION

Agricultural crops are affected by climate change due to the relationship between crop development, growth, yield, CO_2 atmospheric concentration and climate conditions. Temperature related extreme indices have increased over most locations in Sri Lanka. Annual average rainfall over Sri Lanka has been decreasing for the last 57 years at a rate of about 7 mm per year. The coefficient of variation of rainfall distribution between 1931 and 1960 is greater during the Northeast monsoon and Second inter monsoon period (*Maha* Season) when compared to the period from 1961 – 1990. Southwest monsoon rainfall has not shown any significant change during these two periods. However variability has decreased during 1961-1990 compared to 1931-1960 period. When temperature exceeds the optimum for biological processes, crops often respond negatively with a steep drop in net growth and yield (Chynthia Rosen Zweig and Hillel, 1995). Some reports show that an increase in temperature by a single degree above normal can lead to a significant reduction in growth and yield (Pastori and Foyer, 2002). Yield is positively related to the amount of incoming solar radiation intercepted by the plants in a long season crop. Shading reduces the fruit size (Kinet & Peet, 1997), and low light intensities combined with low temperatures cause deterioration of fruit taste caused by a decrease in sugar content (Rylski et al., 1994). Termination of growth of small fruits is sometimes induced by high temperatures and high light conditions. Tomato is one of the major fruit vegetables in the world. In Sri Lanka it is annually cultivated in more than 220ha, producing approximated 3400metric tons. However, the average productivity of Tomato in Sri Lanka (2 metric tons/ha) is much lower than the world average as the seasonal weather changes adversely affect average productivity. In the meantime, a shortage in the month of peak rain fall (May and November) and a production glut in the month of harvesting (March to May and September to October) lead to a dichotomy in the distribution of annual Tomato production. Protect culture is a remedy for environmental problems of crops cultivation. However, seasonal weather changes adversely affect indoor grown plants. Protected (indoor) culture is predominately used in temperature regions. In Sri Lanka, commercial growers of ornamental plant or vegetable crop use different types of indoor structure and agronomic management practices which provide protection at a different level.

This study intends to identify a suitable mulch to mitigate consequences of higher temperature stress on soil by evaluating the yield parameters of Tomato [*solanum lycopersicum*] variety Thilina as it is widely cultivated throughout the year both *yala* and *maha* seasons. Plants cultivated without mulch under higher temperature and water stress were unsuccessful with very low yield (Gunawardana et al, 2013).

MATERIAL AND METHODS

Growing conditions - The research is planned to identify effect of mulch on plants' exposure to temperature and water stress due to climatic changes on one of the dry zone vegetables

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with most popular variety of Tomato. The study was conducted during December 2012 and an experiment was set up in the agricultural field poly tunnels of the Open University at Nawala, Nugegoda. Nursery management was initiated on 23rd December in 2012 and tomato seedlings were transplanted (18th December 2013) 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 without mulch (no mulch) were arranged in a complete randomized design. Two mulches were added up to 5 cm thickness until the surface of the compacted mulch and soil was within 1.5 cm of the rim. Initial height of the Tomato seedlings was 12 cm. This Tomato plants were grown at 3 different conditions as indicated in the Table 01.

The experimental design was Completely Randomized Design (CRD) with factorial treatment structure. Stress and mulches were taken as factors, resulting in a total of 54 pot-grown plants yield and quality parameters of Tomato were investigated during the fruit ripening stage. All extraction runs and analyses were carried out at least 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 Minitab (Software Version 14). Significant differences specified were all at $p < 0.05$.

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

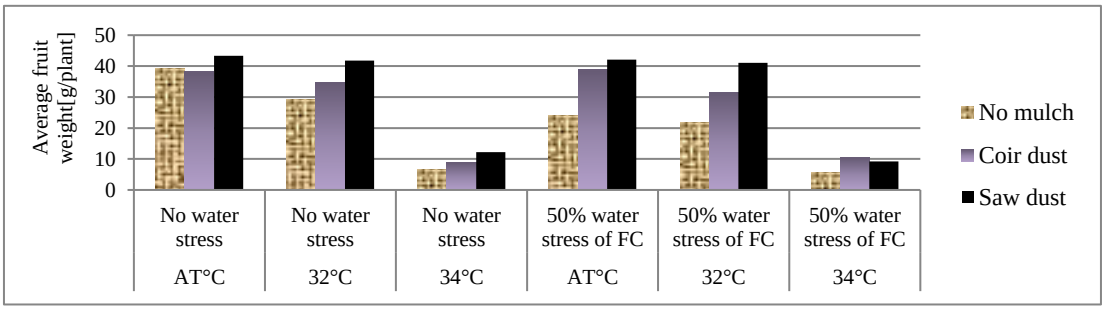
No	*Environmental conditions*
Condition 1 – *Poly tunnels*	Temperature 32°C (i). Providing adequate water to fill the field capacity for Tomato plants in mulching pots. (ii). Providing water to fill only the 50% of the field capacity for Tomato plants in mulching pots.
Condition 2 – *Poly tunnels*	Ambient temperature 34°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°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.

RESULTS AND DISCUSSION

Fruit weight

Fruit weight decreased with increase in temperature irrespective of water availability. Plants grown in an ambient temperature without a water stress showed the highest fruits weight (Figure 01). Fruit weight statistics showed that there is significantly higher ($p<0.05$) impact in outdoor ambient temperature compared to 32°C and 34°C temperature ranges inside the poly tunnel. High temperatures however often result in smaller fruits. But significant results were presented on saw dust mulching in 32°C temperature. In the case of dry matter of the fruit the maximum weight was observed at the 34°C temperature with water stress and no mulched condition. Even the combined effect of high temperature and water stress had a remarkable effect on the fruit weight of Tomato compared to the other treatments. Sawdust mulch performed well in both water stressed and no water stress condition irrespective of temperature. However fruit weight was lowest in 34°C treatments.

Figure 01. Effect of treatments on average fruit weight.



Soluble solids content (SSC)

SSC of Tomato tested ranged from 6.43 to 11.06 °Brix. SSC increased with increased temperature irrespective of water availability. However, 34°C maximum temperatures showed the highest SSC irrespective of water availability. May (1993) observe that low water stress resulted in maximum yield of Tomato raw product with best viscosity and soluble solids. High water stress caused lower yield, highest soluble solids and poorer viscosity. Soluble solids were highest in no mulch and no water stress condition.

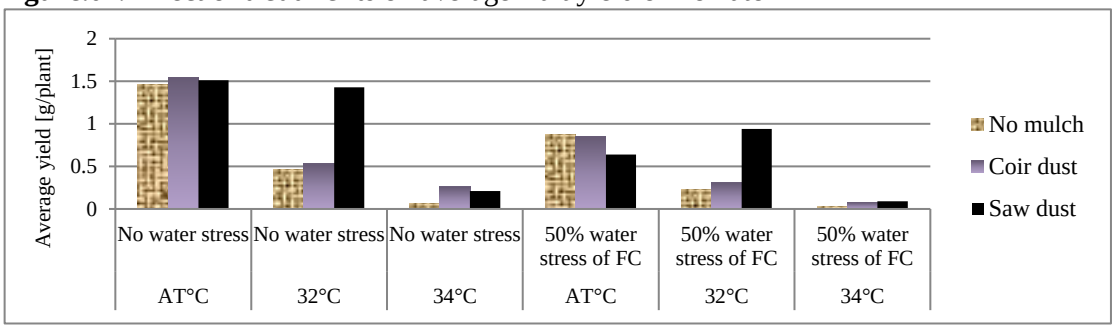
Firmness

Fruit firmness is determined by a number of factors including cell wall structure and cuticle properties. Flesh firmness is a characteristic used to indicate fruit quality. During Tomato ripening, remodeling and degradation of the cell wall is intimately involved in softening (Matas et al., 2009). Tomato has been identified that have a global effect on ripening and texture. The effects of humidity and temperature on firmness of Tomato were studied to discriminate between the effect on the biochemical process of cell wall breakdown and the effect on the physical process of water loss. Average firmness of fruit among the treatments increased with increase in temperature. It was also observed that no mulch conditions has the highest firmness followed by saw dust and coir dust Coir mulch and saw dust mulch presented significant effect ($p < 0.05$) on tomato fruit firmness. Firmness is one of the important factors determining market quality and consumer acceptance of tomatoes.

Fruit yield

According to the results the average yield decreased with increase in temperature (Figure 02). Results showed that the highest mean yield (1.55kg/ plant) in plant grown in outdoor ambient temperature without water stress with coir dust mulch followed by saw dust mulch. The potential yield range of Tomato with the application of recommended chemical fertilizer was 20 to 30 t/ha (Department of Agriculture Crop recommendation – Technogide). Therefore, above yield of Tomato in ambient temperature (outdoor condition) without water stress is in the potential yield range of Tomato. Although the vegetative growth is higher in the controlled environment condition, at 32^0C temperature and saw dust mulch, the yield was in significant value (1.43kg/plant) and with water stresses it was further reduced to (0.94kg/plant). Meanwhile the yield obtained at 34^0C temperature and coir mulch with no water stress was 0.26kg/plant. But in the previous research without mulching showed only 0.16kg/ plant was obtained at 34^0C with no water stress (Gunawardena et al, 2011). This study proves that the yield can be improved with mulching even if the temperature increased up to 34^0C due to global warming if the plants are maintained with no water stress.

Figure.02. Effect of treatments on average fruit yield of Tomato



CONCLUSION

According to the results, there is significant effect of individual stress of water, mulching and temperature and in combination effect on yield parameters such as fruit firmness, fruit SSC, fruit weight, fruit yield etc. The fruit firmness and SSC increased with increase in temperature. But the average fruit weight and average yield per plant decrease with increase in temperature. According to the results there is not much difference between the water stress and no water stress treatment as the mulching has resisted the effect of temperature by conserving more moisture in the soil. Mulch and water stress; two way interactions were significant ($p < 0.05$) 32^0C and 34^0C temperatures in SSC. Fruit weight had significant ($p < 0.05$) value in two way interactions of 34^0C. Therefore the yield per plant has improved with coir dust mulch compared to the previous study without mulch at 34°C maximum temperature. The findings of this study could be an adaptation measure for farmers growing tomato if the temperature increases due to global warming. This study will be continued to reconfirm the findings.

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