# IMPACT OF MULCHES ON PHYSIOLOGICAL PARAMETERS OF TOMATO (*Solanum lycopersicum* - variety Thilina) AT DIFFERENT GROWTH STAGES 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. In particular, further reduction in existing limited water resources, combined with an increase in temperature, may result in a higher impact on agricultural crops.

Annual mean air temperature anomalies have shown significant increasing trends in Sri Lanka. The rate of increase of mean air temperature for the1961-1990 period is in the order of 0.016˚C per year. Annual mean maximum air temperatures have shown increasing trends in almost all stations, with the maximum rate of increase about 0.021˚C per year in Puttalam. Night-time annual mean minimum air temperatures have also shown increasing trends with higher gradients. The maximum rate of increase of night-time annual mean minimum air temperature is reported to be about 0.02˚C per year in Nuwara-Eliya.

Environmental stress is the primary cause of crop losses worldwide, which reduces average yields for most major crops by more than 50% (Boyer 1982). The tropical vegetable production environment is a mixture of conditions that varies with season and region. Climatic changes influence the severity of environmental stress imposed on vegetable crops. Moreover, increasing temperatures, reduced irrigation water availability, flooding, and salinity are major limiting factors in sustaining and increasing vegetable productivity.
Tomatoes are very sensitive to water deficits during and immediately after transplanting, at flowering and during fruit development (Nuruddin, 2001). Kirnak et al. (2001) have found that water stress results in significant decreases in chlorophyll content, electrolyte leakage, leaf relative water content and vegetative growth.

## METHODOLOGY

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

Nursery management was initiated and tomato seedlings were transplanted into individual plastic pots (1 plant/ pot in 30 cm diameter and 45 cm deep pots). The pots were filled with compost and sandy loam soil mixture, and the two mulching treatments of coir dust and saw dust with control treatment (no mulch) were arranged in a completely randomized design.

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Two mulches were added until the surface of the compacted soil was within 1.5 cm of the brim. The tomato plants were grown under 3 different conditions, as indicated in Table1.

The experiment consisted of two factor factorial design was carried out, which included three replicates. Pots were arranged according to a complete randomized design (CRD). Water stress and mulches were taken as treatment factors. The physiological parameters of the tomato (Leaf Relative Water Content (LRWC) and Leaf chlorophyll content (LCC)) were investigated during the Vegetative stage (end of transplanting stage to flowering), the Reproductive growth stage (until first full size mature green fruit) and the Ripening stage (color changing of fruit). An analysis of variance (ANOVA) of the result was performed using the statistical program Minitab (version 14, Minitab Inc.) at $P<0.05$.

**Table 1. Three different environmental conditions imposed**

| ***Condition No*** | ***Environmental conditions*** |
|---|---|
| **Condition 1 – *Poly tunnel 1*** | Ambient temperature 32 $^0$C<br>(i). Providing adequate water to reach the substratum in mulched pots.<br>(ii). Providing water to fill only up to 50% of the substratum in mulched pots. |
| **Condition 2 – *Poly tunnel 2*** | Ambient temperature 34 $^0$C<br>(i). Providing adequate water to reach the substratum in mulched pots.<br>(ii). Providing water to fill only up to 50% of the substratum in mulched pots. |
| ***Condition 3 – Open space*** | Ambient temperature (AT$^0$C)<br>(i). Providing adequate water to reach the substratum in mulched pots.<br>(ii). Providing water to fill only up to 50% of the substratum in mulched pots. |

## RESULTS AND DISCUSSION

### The Leaf Relative Water Content (LRWC) at different growth stages

The LRWC was measured at three different growth stages. The LRWC varied significantly due to different mulches and water stress at AT$^0$C in the vegetative growth stage. Mulching treatments demonstrated superior performance related to the LRWC than the control without mulch, at three different temperatures. Saw dust mulch had a positive effect from water stress conditions at 34$^0$C temperature. The three different growth stages showed positive effects with mulching conditions at temperature variations and water stress conditions.

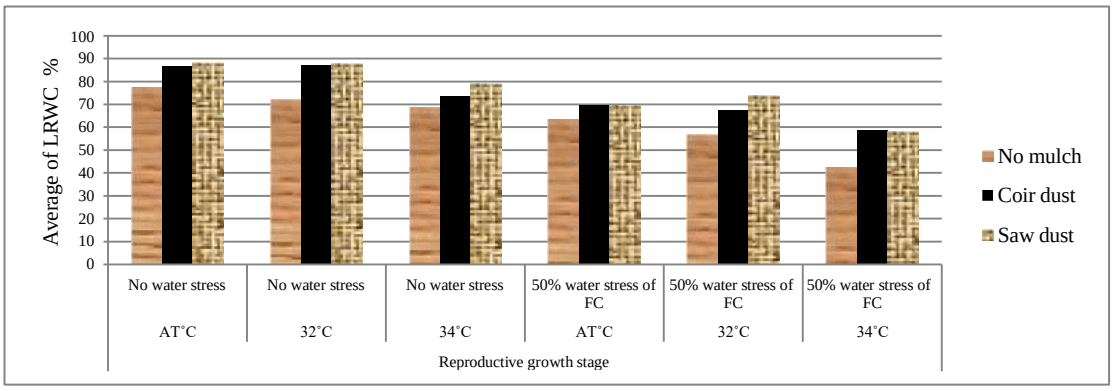


**Figure 01. The effect of mulch and water stress on LRWC in the Reproductive stage**

The lowest LRWC was reported in the without mulch crop at 34 $^0$C in the reproductive stage (Figure.01). However, the LRWC demonstrated decreasing function at 32$^0$C and 34 $^0$C in the Ripening stage (Figure 02), but the saw dust and coir mulch treatments showed good LRWC conditions in higher temperatures. Therefore, mulching helps to maintain the LRWC, and consequently increases the yield of tomato.

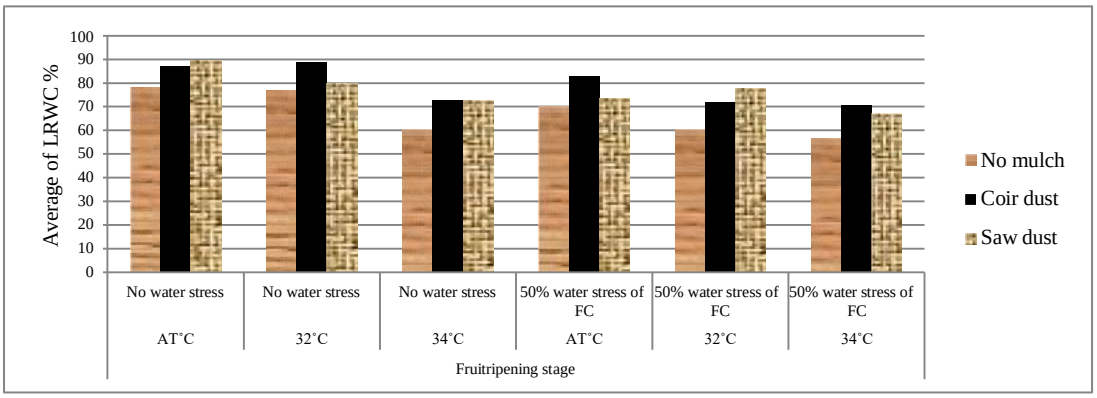


**Figure 02. The effect of mulch and water stress on average LRWC at the Ripening stage**

**The Leaf chlorophyll content (LCC) at different growth stages**

The water stress resulted in significant decreases in LCC. There are reports showing the decrease in chlorophyll under drought stress (Kulshreshta et al., 1987). The effect of mulch and water stress on the LCC in the vegetative stage demonstrated that the no water stress plants have more LCC than water stressed plants in all three temperature conditions.

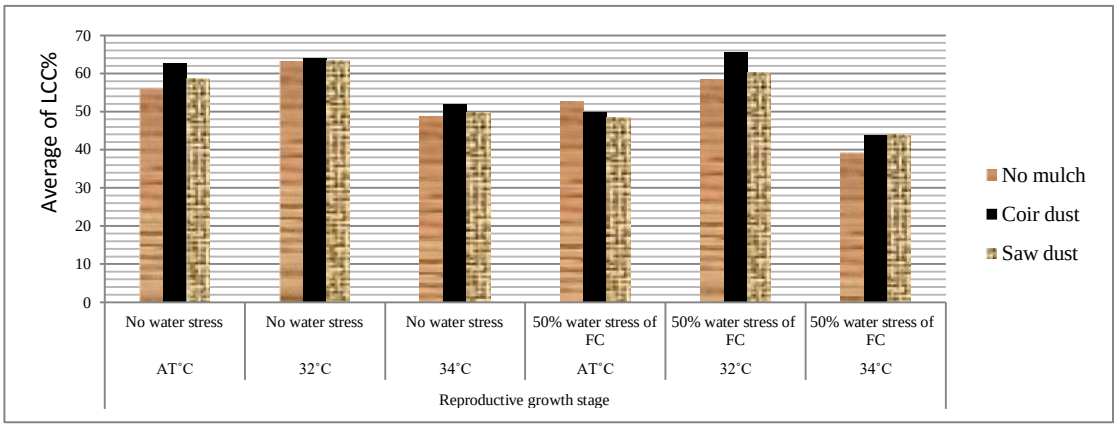


**Figure 03. The effect of mulch and water stress on average LCC at the Reproductive stage**

The coir and saw dust mulched plants at 32°C temperature showed significantly higher LCC even at the water stressed condition of the Reproductive stage compared with that of the no mulch treatments (Figure 03). However, at the Ripening stage, saw dust mulched plants showed higher LCC and also a higher yield (Figure 04). Kirnak et al., 2001 demonstrated that the total LCC in high water stress was reduced by 55% compared to the control which agrees with present results.

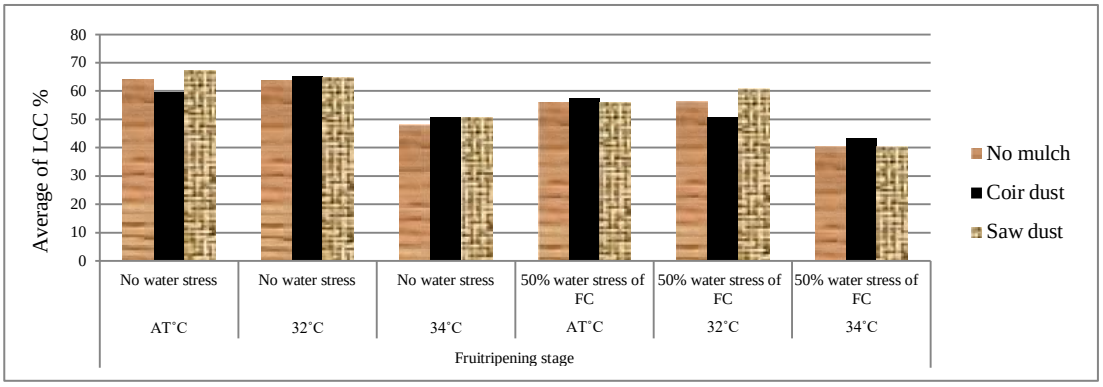


**Figure 04. The effect of mulch and water stress on average LCC at the Ripening stage**

## CONCLUSION

According to the results, there is a significant effect from mulch at the different growth stages of Tomato plants that are exposed to water and temperature stresses. The water stress resulted in significant decreases in LCC and the LRWC. Water and temperature stress, in combination, had severe negative effects during the growth stages as compared with the mulched treatments. Results showed a significant effect on LCC at 32°C and 34°C during the Reproductive and Ripening stages ($p < 0.05$). The two way interaction (mulch*water stress) showed a significant effect on LCC ($p < 0.05$). LRWC showed a significant effect of 34°C in the Reproductive stage. Mulched plants showed a higher water and LCC compared with the no mulch treatment under water and temperature stress, and therefore, the yield of tomato was improved. The findings of this study will help farmers in the dry zone to maintain their tomato cultivation as required. Agronomic management practices, such as mulching for suitable crop growth at the different growth stages, could be adopted to adjust to the climatic changes in Sri Lanka.

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