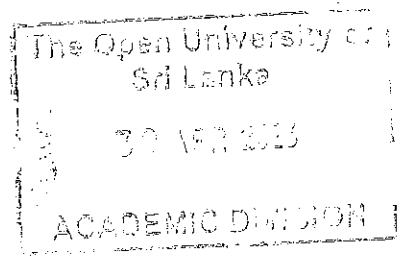


IDENTIFICATION OF A SUITABLE  
IRRIGATION INTERVAL USING A SUPER  
ABSORBENT POLYMER (SAP) TO  
COMBAT WATER STRESS ON SELECTED  
CROP PLANTS EXPOSED TO INDUCED  
TEMPERATURE STRESS

Thesis submitted to  
The Open University of Sri Lanka  
For the award of degree of  
Master of Philosophy



June, 2022



K.G.A.I. Rasanjali

M.Phil/NAT.SC/2019/02

# Identification of a suitable irrigation interval using a Super Absorbent Polymer (SAP) to combat water stress on selected crop plants exposed to induced temperature stress

## ABSTRACT

The human population is growing exponentially day by day. Meeting the needs of this growing population has become a challenge. Among those needs, meeting the demand for food is paramount. Crop cultivation is one of the main ways to meet the demand for food. But at present, due to various reasons, the crop yield are adversely affected. Among these reasons, adverse changes in climatic factors are the main ones. Climatic factors such as, temperature and rainfall greatly affect the crop. At present, global warming is showing a rapidly increasing pattern. Rising temperature creates stress on crops and as a result, the crop yield is reduced. According to various types of global climatic variation predicted models, rainfall shows a declining pattern. Many farmers all around the world are suffering due to low amount and frequency of rainfall. Water has become one of the limiting factors available for farmers to cultivate their crops. Therefore, it is very important to use adaptation technologies in crop fields to mitigate the adverse effect of increasing temperature and limited amount of water on crop growth and yield. Various countries use different types of technology to overcome the impact of heat stress and water stress on crop growth and yield. Application of Super Absorbent Polymers (SAPs) is one of the modern technologies which can be used to overcome the negative influence of increased temperature and limited amount of water to plant. This

technology is popular in many countries, especially in Middle east countries, India and Pakistan etc., However, this technology is new to Sri Lanka. Therefore, one of the reasons of conducting this research is to disseminate this technology to Sri Lanka through research papers on the use of Super Absorbent Polymer. This study was conducted at the Open University of Sri Lanka, Nawala during the period of 2019 to 2021. In this study it will be hypothesized that SAPs could reduce the magnitude of yield penalty of chilli, tomato and cabbage imposed by high temperature and water stress condition. Experimental design consisted with three factors, i.e. temperature conditions, irrigation intervals and application of Super Absorbent Polymers. Treatments were arranged in Complete Randomized Design (CRD) with three replicates. Temperature conditions were used as ambient temperature condition (32–33<sup>0</sup>C), increased temperature condition (35- 36 <sup>0</sup>C). Three irrigation intervals were used as three days, five days and eight days. Third factor (application of SAPs) was used as two levels (2g of super absorbent polymer per pot and not applied super absorbent polymer). There are various kind of super absorbent polymers and in this study, organic-based super absorbent polymer which is named as Zeba (corn starch is the main ingredient) was used. The experiments were repeated thrice to replicate the treatment effects. Growth and yield parameters of selected crops (tomato – variety Thilina, chilli – variety MI2, cabbage – variety Exotic F1) were collected and Statistical analysis of the data (ANOVA) was performed using Three-Factor Factorial Design and compared for the significance by using a Revised Least Significant Difference (LSD) test at p=0.05. Apart from this field trials another study was done to predict the yield responses of Chilli, Cabbage and Tomato for year 2040, 2050 and 2060 by using crop simulation model CROPGRO of DSSAT (Decision Support

System for Agricultural Transfer) version 4.5. According to the results of the field study, Zeba positively influences to mitigate the adverse effect of increased temperature and water stress condition imposed by longer irrigation interval. Under ambient temperature condition, treatment with Zeba, three days irrigation interval shown the highest yield of chilli, tomato and cabbage. However, yield of such crops were not significantly different from the treatments with five days irrigation and eight days irrigation interval under ambient temperature condition with Zeba. Therefore, due to the no significant difference, treatment with Zeba, eight days irrigation interval can be named as the bestcost-effective treatment to cultivate with limited amount of water under ambient temperature condition. Under increased temperature condition, treatment with Zeba, three days irrigation interval has shown the highest yield of all three crops. However, it is not significantly different from the treatment of five days irrigation interval, with Zeba under increased temperature condition. Therefore, under increased temperature condition, irrigation interval can be extended up to five days when plants treated with Zeba. Treatments with Zeba have shown higher moisture content than treatments without Zeba either at the ambient temperature or increased temperature condition. After the calibration of CROPGRO of DSSAT, the simulated values shown by the model are matched with the observed values of tomato, cabbage, chilli growth and yield. Therefore, this model can be used to future yield prediction. Predicted climatic data under the scenario RCP8.5 for Colombo area has clearly shown that there are changes of climatic conditions in mid- centuries than present conditions. According to the forecasted weather data, both maximum and minimum air temperatures in Colombo area will be increased and the rainfall will be decreased than present conditions. Fresh weight of chilli pods per plant

will be reduced approximately 40% in 2050 and 2060 than 2020. Fresh weight of tomato fruits per plant will be reduced approximately 40% - 53% in 2050 and 2060 than 2020. Cabbage fresh weight of head will be reduced approximately 40% in mid-centuries than present yield with increasing temperature and decreasing rainfall. According to predicted temperature, in 2060 temperature will be approximately reached to 36 °C. In this study, 36°C temperature has been given to one set of tomato, chilli and cabbage plant in a polytunnel with application of Zeba. According to the field data and simulated data, application of Zeba under increased temperature condition, will increase the yield of chilli, tomato and cabbage respectively from 37.9%, 65.7% and 37.9% than the simulated yield in 2060. Therefore, it can be concluded that Super Absorbent Polymers have a positive influence to mitigate the effect of increased temperature and water stress condition on crop growth and yield of tomato, chilli and cabbage. However, further studies should be carried out covering various areas of Sri Lanka to finalize a recommendation.

**Key words:** Temperature stress, Water stress, Soil moisture, Yield, DSSAT