Shahid Chamran University of Ahvaz
Irrigation Sciences and Engineering (JISE) **Vol. 42, No. 2, Summer 2019, p. 105-118**

EXTENDED ABSTRACT

Scheduling Maize Irrigation by Crop Water Stress Index (CWSI) in North of Isfahan

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Received: 16 May 2017 Revised: 23 September 2017 Accepted: 25 September 2017

Keywords: Deficit İrrigation, Leaf Surface Temperature, Total Available Water, Soil Water Deficit.
DOI: 10.22055/jise.2017.22038.1579

İntroduction

Nowadays, the world is facing increasing population and demand for food as well as shortage of fresh water supplies (Mangus et al., 2016). Deficit irrigation (DI) and urban wastewater utilization are two management solutions for the purpose of reducing fresh water consumption in agriculture. Due to the shortage of irrigation water resources and the increase of the area under cultivation, farmers in the northern part of Isfahan (viz., Borkhar), Iran, employ these two strategies. Precise irrigation planning could be of help in preventing water stress and optimum performance in plants. Water stress is considered one of the most important plant stresses, which is the most common and limiting factor for yield (Jackson et al., 1981; Scherrer et al., 2011; Zia et al., 2013).

Since 1970, canopy temperature has been accepted as an indicator of water stress because plants under stress close their stomata for preserving water and reducing stomatal conduction, decreasing transpiration, and increasing leaf temperature (Ballester et al., 2013).

One of the most reliable indicators is the crop water stress index (CWSI). Several studies have been conducted on irrigation scheduling using leaf surface temperature measurements. (Candogan et al., 2013; Orta et al., 2003). The difference in air temperature and leaf area was calculated from the difference in vapour pressure for different irrigation treatments in soybean and watermelon plants. Also, sorghum was studied by O’Shaughnessy et al. (2010) in different irrigation systems and the crop water stress index (CWSI) was calculated.

Mangus et al. (2016) examined the water stress index of corn in four stages of plant growth; their results showed that in the third stage of corn growth (i.e., in the flowering stage), the surface temperature of the leaf was higher and that the plant used the most energy for cob growth and thus shrinking transpiration from the plant. Based on the aforementioned studies, this study sought to compute the water stress index (CWSI) under irrigation treatments in the climate of North Isfahan in order to identify the irrigation time.

Methodology

This study was carried out in Borkhar, north of Isfahan, Iran, during the crop year of 2013. The area is located at 32° 47’ and 51° 45’ longitude and latitude. The altitude of the area is 1950 m. The weather condition of Borkhar is warm and dry, the moisture content in the air is an average of 35%, and the maximum evapotranspiration (ETO) is 7 mm day-1.

This study was conducted with five irrigation treatments, where the amount of Total Available Water (TAW) was 37, 63, 75, 87, 100%, respectively, in four replications.

Single Cross maize 701 (SC-701) was selected as an appropriate plant. The growth period of corn was 125 days. It was planted in the crop year 2013, June 27, and was harvested in October 29. Regarding the pilot study and the measurement of parameters, each was done in an area of 500 m^2 in the farm. The maize crops were cultivated within 0.75 m between rows and 12 cm between the bushes. When the plants leaves reached a level that could be measured, data collection was started. Measurements were done between two irrigations (on sunny days) every hour from 8 a.m. to 6 p.m. Relative humidity (RH), air temperature (Ta), and leaf area temperature (TL) were measured near the leaf area and Soil Moisture (SM) was measured at the level of the plant shadow. The Vapour Pressure Deficit (VPD) was determined using air temperature and relative humidity (Monteith and Unsworth, 2013).

Results and Discussion

The data indicated the position of the upper base lines under each treatment and showed that by increasing water stress, the upper and lower base lines were displaced. As a result of increasing water stress from T5 to T1, the linear gradient tilt (Tl-Ta) and VPD fell below the baseline from +0.2046 to -1.3529. On the other hand, as a result of increasing water stress from T5 to T1, the tensile base line rose from 1.3 to 5.

The CWSI was calculated on the basis of the lower and upper base line equations and the value of CWSI was calculated on the day after irrigation under each treatment. By increasing the acceptable drainage from 37% to 100%, the CWSI increased from 0.07 to 0.44.

The CWSI was calculated on the basis of the lower and upper base line equations and the value of CWSI was calculated on the day before irrigation under each treatment. As a result of increasing drainage volumes from 37% to 100%, the CWSI increased from 0.12 to 0.46.

Conclusions

In this study, the CWSI was calculated in the days before irrigation in T1, T2, T3, T4 and T5 treatments, and its values were 0.12, 0.21, 0.24, 0.30 and 0.46, respectively. The results also showed that with soil moisture change from 100 to 37 percent, the CWSI was about 3.5 times higher. Accordingly, the CWSI can be used to plan irrigation. Comparison of yield of treatments showed that the best irrigation time is based on T3 treatment when the CWSI is less than 0.24. In addition, it maintains optimum performance of water saving in irrigation. Therefore, the CWSI can be used to plan irrigation.

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