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Research Article

WATER PRODUCTIVITY OF *RABI* MAIZE INFLUENCED BY DIFFERENT DRIP IRRIGATION TREATMENTS

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Abstract- A field experiment was conducted at Water Technology Centre, college farm, College of Agriculture, Rajendranagar, Professor Jayashankar Telangana State Agricultural University, Hyderabad during *rabi* 2015-16 to study the effect of different irrigation levels i.e., surface irrigation at 0.6 IW/CPE ratio (T_1) , 0.8 IW/CPE ratio (T_2) , 1.0 IW/CPE ratio (T_3), 1.2 IW/CPE ratio (T_4), drip irrigation at 0.6 Epan (T_5) , drip irrigation at 0.8 Epan (T_6) , drip irrigation at1.0 Epan (T_7) and drip irrigation at 1.2 Epan (T_8) on the water productivity of maize crop in semiarid tropical climate. The results of the study revealed that the water productivity obtained with 0.6 Epan was highest (1.34 kg m^{-3}) with consumption of 3130 m^3 of water, while the lowest was observed in surface irrigation scheduled at 1.0 and 1.2 IW/CPE ratio (0.84 and 0.84 kg m^{-3}) which consumed 4670 and 5170 m^3 of water, respectively.

Keywords- Drip Irrigation, Surface irrigation, Water Productivity and *rabi* maize.

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Introduction

Maize (*Zea mays* L.) is an important food and fodder crop among cereals which occupies third rank after wheat and rice in the world. Because of its expanded use in the agro-industries and increased potential yield when compared to other major food crops, it is credited as "Queen of the Cereals" [1]. Globally maize is cultivated in an area of 177 million hectares with a production and productivity of 989 and 5.5 metric t ha^{-1}, respectively [2]. In India, the maize occupies an area of 6.29 million hectare with a production of 10.30 million tonnes and average productivity of 16.4 q ha^{-1}. In Telangana state, the total cropped area is 7.52 lakh ha with production and productivity of 35.25 lakh tonnes and 4.69 t ha^{-1} respectively [3]. Among the major maize producing states, Telangana state had highest contribution of 13% of the total Indian maize production.

Water is the most important and critical input for agriculture and the demand for efficient use of irrigation water for crops is intensifying in view of changing climate. Irrigation water supplies are decreasing day to day and are facing scarcity in many areas of the world. Some of the reasons for this decrease include extended drought periods, decline in groundwater levels and diversion of water from irrigation to environmental uses. Therefore, shortage of water coupled with increasing population growth necessitates protocols enhance water productivity in agriculture. With the ever increasing demand of irrigation water and its cost leading to increase in water scarcity. This situation is forcing farmers to consider the options of deficit-irrigating crops like corn or growing alternative crops that require less irrigation water, but that are generally less profitable. Deficit irrigation (DI) has been widely investigated as a valuable strategy where water is the limiting factor in crop cultivation in arid and semiarid regions [4][5.In future coming years there is a need to increase the food production by using of less amount of water.

Materials and Methods

The field experiment was carried out during *rabi* season, 2015-16 with DEKLAB SUPER 900 M hybrid at Water Technology Center, College farm, College of Agriculture, Rajendranagar, Professor Jayashankar Telangana State Agricultural University, Hyderabad on a sandy clay loam soil, alkaline in reaction and non-saline, low in available nitrogen, high in available phosphorous and available potassium, medium in organic carbon content, with field capacity and permanent wilting point of 18.1 and 10.13 per cent, respectively with a total available soil moisture 68.8 mm in 60 cm depth of soil. The soil infiltration rate (3.2 cm h^{-1}) was moderate. The recommended dose of fertilizer 200-80-80 kg NPK ha-1, and the entire dose of P was applied as basal for surface irrigated plots N and K were applied in 3 and 2 splits. In drip irrigated plots, N and K were applied as fertigation in 9 and 3 splits of equal doses in 7 days interval in drip irrigated plots. The experiment was conducted in a randomized block design with eight treatments in three replications. The treatments comprises of surface and drip irrigation schedules based on Epan *viz.,* surface irrigation at 0.6 IW/CPE ratio (T_1) , 0.8 IW/CPE ratio (T_2) , 1.0 IW/CPE ratio (T_3), 1.2 IW/CPE ratio (T_4), drip irrigation at 0.6 Epan (T_5) , 0.8 Epan (T_6) , 1.0 Epan (T_7) and 1.2 Epan (T_8). The data was analyzed statistically and N, P and K were estimated by following standard procedures. Maize crop was sown on 5th October 2015with a spacing of 60 X 20 cm in surface irrigation, 80 X 15 cm in drip irrigation treatments. Irrigations were scheduled as per the treatments by taking in to decennial average evaporation data obtained from agro met cell of Agricultural research Institute, Rajendranagar, Hyderabad. Aqua Crop is a windows-based software programme which is designed to simulate yield, biomass and water productivity responses of field crops to various degrees of water availability. The model works on the combined data input fed through user interface and the production potential can be generated by taking in to considerations of soil (per cent of sand, clay, loam), weather (air temperature, reference evapo-transpiration and rainfall), crop (initial, final and rate of change in percent canopy cover, biomass water productivity, harvest index, typical management conditions such as irrigation dates and amounts, sowing and harvest dates, etc.)

Results and Discussions

Amount of water applied

The data pertaining to amount of water applied to *rabi* maize was presented in [Table-1]. The amount of irrigation water applied among the irrigation treatment ranges between 296.30 in drip irrigation at 0.6 Epan to 550 mm surface irrigation at 1.2 IW/CPE ratio. The amount of irrigation water applied was 300, 350, 450, 500, 296.3, 378.4, 460.5 and 542.6 mm respectively among the treatments. The total water consumed including effective rainfall 17 mm was 317, 367, 467 and 567 mm in surface irrigation in 0.6, 0.8, 1.0 and 1.2 IW/CPE ratio, respectively. Whereas, in drip irrigation it was 313, 395, 477 and 559 mm in 0.6, 0.8, 1.0 and 1.2 Epan, respectively.

Water productivity (kg ha $^{-1}$ mm $^{-1}$) under field conditions

Water productivity of drip irrigated *rabi* maize varied among different treatments, Perusal of the data reveals that the drip irrigation scheduled at 0.6 Epan recorded highest water productivity (13.4kg ha $^{-1}$mm^{-1}) closely followed by drip irrigation scheduled at 0.8 Epan (11.2 kg ha $^{-1}$mm^{-1}). Though the grain yield is realized at higher level of drip irrigation i.e., 1.0 and 1.2 Epan, but the water productivity realized was less (10.7 and 8.8 kg ha $^{-1}$mm $^{-1}$) when compared to lower levels of drip irrigation schedules. With the Increase in irrigation level, the water productivity decreases gradually [6] [Table-1and Fig-1].

Lower water productivity (7.71 kg ha^{-1}mm^{-1}) was observed among surface irrigation at 1.2 IW/CPE ratios. Further, all the surface irrigation regimes recorded comparatively lower water productivity (8.40 to 9.10 kg ha^{-1}mm^{-1}), compared to drip irrigation treatments. The reason for lower water productivity might be due to the water stress experienced by the crop with low leaf water content and high leaf water potential and also due to drastic reduction in the yield of grain and fodder due to moisture stress during its crop growth period. Similar results were reported by [7,8].

A decrease of 36 % in water productivity was found in surface irrigation at 0.6 IW/CPE than drip irrigation at 0.6 Epan. Similarly, decrease of 18 %, was seen under surface irrigation at 0.8 IW/CPE compared to drip irrigation at 0.8 Epan. 21 % decrease was observed under surface irrigation at 1.0 IW/CPE and drip irrigation at 1.0 Epan. 12 % decrease was observed under surface irrigation at 1.2 IW/CPE ratio and drip irrigation at 1.2 Epan, respectively.

Table-1 *Irrigation, total water consumed, and water productivity of rabi maize as influenced by different drip irrigation treatments*

Treatment	Irrigation water applied (mm)	Total water consumed (mm)	Total water consumed (m^3)	WP (kg m^{-3})	Grain yield (kg ha^{-1})
T_1 -Surface irrigation at 0.6 IW/CPE ratio	300	317	3170	8.51	2711
T_2 -Surface irrigation at 0.8 IW/CPE ratio	350	367	3670	9.10	3362
T_3 -Surface irrigation at 1.0 IW/CPE ratio	450	467	4670	8.40	3954
T_4 -Surface irrigation at 1.2 IW/CPE ratio	550	567	5670	7.71	4373
T_5-Drip irrigation at 0.6 Epan	296.30	313.0	3130	13.4	4115
T_6 -Drip irrigation at 0.8 Epan	378.4	395.4	3954	11.2	4465
T_7 -Drip irrigation at 1.0 Epan	460.5	477.5	4775	10.7	5130
T_8 –Drip irrigation at 1.2 Epan	542.6	559.6	5596	8.88	4946
SEm±					124

Water productivity under AquaCrop model

The results of prediction error between measured and simulated water productivity by Aqua Crop model are presented in [Table-2]. From the table, it is observed that, among all the treatments, the minimum and maximum prediction errors (Pe) are recorded in 1.2 Epan and 0.6 IW/CPE ratio accounting 10.2 % and 25.9 % under drip and surface irrigation, respectively. On the other hand, the prediction error for remaining treatments was 21.0 % (1.0 Epan) followed by 15.2 % (0.8 Epan), 14.2 % (1.2IW/CPE), 14.0 (0.6 Epan), 13.1 % (1.0 IW/CPE), 11.0 % (0.8 IW/CPE) and 10.2 % (1.2 Epan). The results of simulated water productivity by AquaCrop are in quite agreement with the measured data. However, the prediction errors generated for water productivity are quite higher than grain yield and biomass. The present results are in line with the [9].

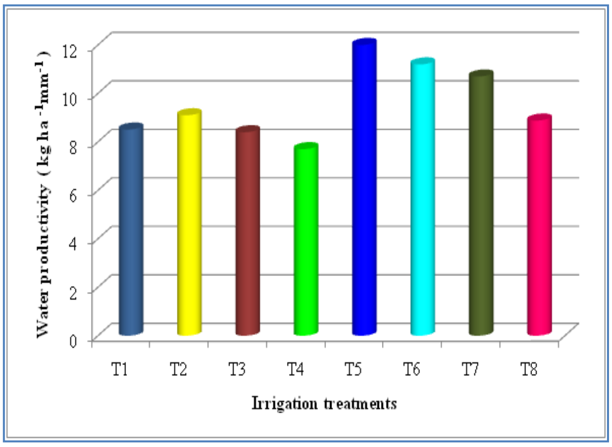

Fig-1 Water productivity (kg ha^{-1} mm^{-1}) of maize as influenced different irrigation regimes

Table-2 *Measured and simulated water productivity of AquaCrop model during rabi 2015-16*

Treatments	WP (Kg ha $^{-1}$ mm^{-1})		
T_1 -Surface irrigation at 0.6 IW/CPE ratio	8.5	10.7	25.9
T_2 -Surface irrigation at 0.8 IW/CPE ratio	9.1	10.1	11.0
T_3 -Surface irrigation at 1.0 IW/CPE ratio	8.4	9.5	13.1
T_4 -Surface irrigation at 1.2 IW/CPE ratio	7.7	8.8	14.2
T_5-Drip irrigation at 0.6 Epan	13.4	15.3	14.0
T_6 -Drip irrigation at 0.8 Epan	11.2	12.9	15.2
T_7 -Drip irrigation at 1.0 Epan	10.5	12.7	21.0
T_8 –Drip irrigation at 1.2 Epan	8.8	9.7	10.2

Conclusion

Water productivity of different irrigation treatments for *rabi* maize varied among different treatments and significantly higher water productivity was recorded with drip irrigation scheduled at 0.6 Epan recorded highest water productivity (1.34 kg m^{-3}) which consumed 3130 m^3 of water respectively later on drip irrigation scheduled at 0.8 Epan followed by drip irrigation scheduled at 1.0 Epan. While the lowest water productivity was observed in surface irrigation scheduled at 1.0 and 1.2 IW/CPE ratio (0.84 and 0.84 kg m^{-3}) which consumed 4670 and 5170m^3 of water, respectively. The Aqua Crop model predictions for water productivity were in line with the measured data corroborated data.

Abbreviations: Water productivity (wp), Prediction errors (Pe), Deficit irrigation (DI) and Pan Evaporation (Epan)

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Conflict of Interest: None declared

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