

Yield and Yield Attributes of Maize (*Zea mays* L.) as Influenced by Different Surface and Drip Irrigation Levels

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Abstract A field experiment was conducted during *rabi* 2015-16 to study the effect of different irrigation levels, 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 at 1.0 Epan (T_7) and drip irrigation at 1.2 Epan (T_8) on yield and yield attributes of maize. The results revealed that drip irrigation scheduled at 1.0 Epan recorded higher growth, yield and its attributes, compared to other surface and drip irrigation treatments except at drip irrigation scheduled at 1.2 Epan.

Keywords Drip irrigation, Surface irrigation, IW/CPE, Epan, Maize grain yield.

Introduction

Maize (*Zea mays* L.) a miracle crop, is grown over a wide range of climatic conditions in semi arid and sub tropics for food and fodder crop, which occupies third rank after wheat and rice in the world among the cereals. Because of its expanded use in the agro-industries and increased potential yield when compared to other major food crops like wheat and rice, it is credited as Queen of the Cereals. The critical stage of irrigation to maize is flowering and grain filling stages and any reduction in soil moisture at these stages will considerably reduce the grain yield [1]. In India, the maize occupies an area of 6.29 million hectare, while in Telangana state, the total cropped area is 7.52 lakh ha [2]. Water is increasing becoming scarce because of erratic distribution of monsoons and uncontrolled exploitation of ground water. The ever increasing demand for irrigation water and its cost, leading to emphasize on the development of suitable methods of irrigation that maximize the water use efficiency. In arid and semiarid regions, search for sustainable methods to increase the crop water productivity is gaining importance [3]. Maize responds well to irrigation. In general maize is irrigated by furrow or check basin, where the irrigation frequency seldom exceeds 50% (Drip/sprinkler) and tends to waste water, nutrients, energy and may cause soil degradation by water logging and salinization, particularly where drainage is poor. However with the use of micro irrigation systems the application efficiency can be increased up to 90 % [4, 5]. The limited water resources in the area and the cost of pumping irrigation water are the most important factors that force many farm-

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Table 1. Yield attributes of maize as influenced by different irrigation regimes.

Irrigation scheduling treatments	No. of cobs plant ⁻¹	Cob weight (g plant ⁻¹)	Grain weight (g plant ⁻¹)	Number of grains cob ⁻¹	Test weight (g)	Shelling (%)
T ₁ - Surface irrigation at 0.6 IW/CPE ratio	1.37	96.13	60.37	284.73	27.17	62.80
T ₂ - Surface irrigation at 0.8 IW/CPE ratio	1.42	102.59	67.67	292.07	27.33	65.96
T ₃ - Surface irrigation at 1.0 IW/CPE ratio	1.44	117.62	75.63	315.93	28.03	64.30
T ₄ - Surface irrigation at 1.2 IW/CPE ratio	1.52	143.0	97.40	369.07	29.23	70.15
T ₅ - Drip irrigation at 0.6 Epan	1.45	126.77	82.07	345.0	28.50	68.11
T ₆ - Drip irrigation at 0.8 Epan	1.49	142.10	95.50	372.53	29.13	67.20
T ₇ - Drip irrigation at 1.0 Epan	1.54	198.53	144.53	485.80	30.90	72.80
T ₈ - Drip irrigation at 1.2 Epan	1.53	190.97	138.97	447.13	30.73	72.77
SEM ±	0.04	4.76	4.95	25.36	0.23	2.1
CD (<i>p</i> = 0.5)	NS	14.43	15.01	76.93	0.69	NS

ers to reduce irrigation in many arid and semi-arid regions. Keeping the above facts in view, the present study was conducted to maximize the net returns with application of limited quantity 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 phosphorus and available potassium, medium in organic carbon content, with field capacity and permanent wilting point of 18.1 and 10.13%, respectively having total available soil moisture 68.8 mm in 60 cm depth of soil. The soil infiltration rate (3.2 cm h⁻¹) was moderate. A total rainfall of 23.3 mm was received in 5 rainy days during the entire crop growth period. The mean weekly maximum and minimum temperatures ranged from 28.6 to 33.4 °C and 11.1 to 21.1 °C, respectively. The recommended dose of fertilizer 200-80-80 kg NPK ha⁻¹, 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

(T₁), 0.8 IW/CPE ratio (T₂), 1.0 IW/CPE ratio (T₃), 1.2 IW/CPE ratio (T₄), drip irrigation at 0.6 Epan (T₅), 0.8 Epan (T₆), 1.0 Epan (T₇) and 1.2 Epan (T₈). The data was analyzed statistically and N, P and K were estimated by following standard procedures. Maize crop was sown on October 5th with a spacing of 60 × 20 cm in surface irrigation, 80 × 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.

Results and Discussion

The number of cobs plant⁻¹ in maize was not significantly affected by different surface and drip irrigation schedules. Grain, cob weight and test weight of maize (198.53, 144.53 and 30.90 g plant⁻¹, respectively) were higher at drip irrigation scheduling at 1.0 Epan and differ significantly with rest of the irrigation scheduling except with drip irrigation scheduled at 1.2 Epan. The increase in cob, grain and test weight of maize with increased irrigation frequency might be due to better growth of crop, efficient dry matter partitioning and translocation in to the sink under no moisture stress as a result of continuous moisture supply in the root zone under frequent irrigations leading to the formation of large sized grains. On the other hand, surface irrigation scheduled at 0.6 IW/CPE ratio produced significantly lowest grain, cob and test weights (96.13, 60.37 and 27.17 g plant⁻¹), closely followed by surface irrigation scheduled at 0.8 IW/CPE ratio (Table

Table 2. Grain yield (kg ha⁻¹), straw yield (kg ha⁻¹) and harvest index (%) of maize as influenced by different irrigation regimes.

Treatments	Grain yield kg ha ⁻¹	Straw yield kg ha ⁻¹	III
T ₁ - Surface irrigation at 0.6 IW/CPE ratio	2711	7190	27.38
T ₂ - Surface irrigation at 0.8 IW/CPE ratio	3362	8160	29.17
T ₃ - Surface irrigation at 1.0 IW/CPE ratio	3954	9343	29.73
T ₄ - Surface irrigation at 1.2 IW/CPE ratio	4373	9666	31.14
T ₅ - Drip irrigation at 0.6 Epan	4115	9463	30.30
T ₆ - Drip irrigation at 0.8 Epan	4465	10016	30.83
T ₇ - Drip irrigation at 1.0 Epan	5130	11093	31.62
T ₈ - Drip irrigation at 1.2 Epan	4946	10936	31.14
SEm ±	124	269	
CD (<i>p</i> = 0.05)	378	817	

1). Lower cob and grain weight might be due to persistence of drought stress at different growth stages of the crop that could be ascribed to the impairment of many metabolic and physiological processes within the plants. Water stress led to slower pollen and filament development which might have decreased filament fertility, resulting in the reduction of cob weight. No. of grains cob⁻¹ was recorded at 1.0 Epan (485) which was significantly differed from rest of surface and drip irrigation schedules except with drip irrigation at 1.2 Epan. Lowest no. of grains cob⁻¹ (284) was observed in surface irrigation at 0.6 IW/CPE ratio, which significantly differed from the rest of surface and drip irrigation treatments except with surface irrigation of 0.8 IW/CPE ratio. The increase in number of grains per cob might be due to lower bareness of the cobs under higher irrigation regimes, which facilitated for better pollination, consequent to better filling of cobs under optimum moisture availability.

Among the surface and drip irrigation treatments, cob, grain and test weight plant⁻¹ realized at surface irrigation 1.0 IW/CPE ratio was on par with the drip irrigation at 0.6 Epan. The cob, grain and test weight resulted from surface irrigation at 1.2 IW/CPE ratio was on par with the drip irrigation 0.8 Epan. Shelling percentage of maize was not significantly influenced by different irrigation schedules [6–9].

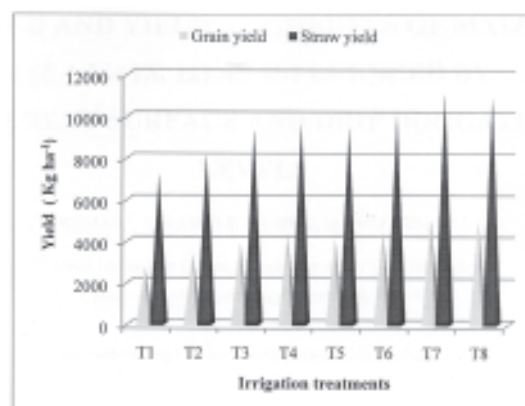


Fig. 1. Grain yield and straw yield (kg ha⁻¹) of maize as influenced by different irrigation regimes.

The maize grain and straw yield realized with drip irrigation scheduled at 1.0 Epan was higher (5130 and 11093 kg ha⁻¹) and differed significantly with rest of the irrigation schedules except with grain yield obtained at 1.2 Epan. Where in, the grain yield (4946 and 10936 kg ha⁻¹) realized in drip irrigation scheduling at 1.2 Epan was found to be at par with the grain yield obtained with drip irrigation at 1.0 Epan. This might be due to maintaining adequate soil moisture in the root zone depth throughout the crop growth period which facilitated in better uptake of water and nutrients having beneficial effect on growth viz., plant height and LAI which favored more production and translocation of photosynthates to the sink there by high dry matter production and yield contributing factors viz., no. of cobs per plant, shelling per cent, cob weight, grain weight and test weight, resulted in high grain yield.

The lower grain and straw yield was revealed under 0.6 IW/CPE ratio (2711 and 7190 kg ha⁻¹) which was significantly differed from rest of surface and drip irrigation treatments. This might be due to moisture stress as a results of deficit irrigation scheduling practiced during the entire growth period which resulted in lower leaf area there by lesser photosynthesis might have occurred that ultimately resulted in lower yield and yield attributes.

Among the surface and drip irrigation treat-

ments, grain and straw yield realized at surface irrigation at 1.0 IW/CPE ratio was on par with the drip irrigation at 0.6 Epan. Similarly, grain yield noticed in surface irrigation at 1.2 IW/CPE ratio was on par with the drip irrigation at 0.6 Epan and 0.8 Epan treatments, respectively [8–14]. The reason being higher grain and straw yield in drip irrigation under sufficiently irrigated regime can be attributed to the adequate turgidity which must have prevailed inside the plant, thereby helping in significantly better growth and development of the crop.

A decrease of 34% and 24% was found in surface irrigation at 0.6 IW/CPE than drip irrigation at 0.6 Epan in grain and straw yield. Similarly, decrease of 24%, 22% and 11% grain yield were observed between surface irrigation at 0.8 IW/CPE and drip irrigation at 0.8 Epan, surface irrigation at 1.0 IW/CPE and drip irrigation at 1.0 Epan and surface irrigation at 1.2 IW/CPE ratio and drip irrigation at 1.2 Epan respectively, where drip irrigation treatments were found superior over surface irrigation treatments. Similarly, decrease of 18%, 15.5% and 11.61% straw yield were observed between surface irrigation at 0.8 IW/CPE (8160 kg ha⁻¹) and drip irrigation at 0.8 Epan (10016 kg ha⁻¹), surface irrigation at 1.0 IW/CPE (9343 kg ha⁻¹) and drip irrigation at 1.0 Epan (11093 kg ha⁻¹) and surface irrigation at 1.2 IW/CPE ratio (9666 kg ha⁻¹) and drip irrigation at 1.2 Epan (10936 kg ha⁻¹) respectively, where drip irrigation treatments were found superior over surface irrigation treatments (Table 2 and Fig. 1).

Higher harvest index (31.62%) was observed under drip irrigation scheduled at 1.0 Epan closely followed by drip irrigation equivalent to 100% pan evaporation (31.14%). Lower harvest index was observed in surface irrigation scheduled 0.6 IW/CPE ratio (27.38%) in maize crop [15].

Conclusion

Drip irrigation scheduled at 1.0 Epan recorded higher yield and its attributes, compared to other surface and drip irrigation treatments except at drip irrigation scheduled at 1.2 Epan. With the application of equal amount of irrigation water to drip and surface irrigation treatments drip irrigated treatments recorded

higher values in all aspects. Surface irrigation scheduled at 0.6 IW/CPE was inferior in terms of growth, yield and yield attributes, compared to rest of the treatments.

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