

Comparison of Crop Water Requirements of Maize Varieties Under Irrigated Condition in Semi-Arid Environment

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Abstract

A field study was conducted to find the crop water requirements of four maize varieties under irrigated condition on clay loam soil at the research farm of The University of Agriculture Peshawar, Pakistan during July–October, 2012. Objective of the study was to compare the crop water requirements of maize using two traditional varieties i.e. Azam (V₁) and Jalal (V₂) and two hybrid 3025W (V₃) and 30K08(V₄) replicated four times in a randomized complete block design. Soil moisture was determined by gravimetric method, actual evapotranspiration (ET_a) was worked out by field water balance taking into account soil moisture, rainfall, and irrigation water applied. ET_a of traditional maize variety V₁ was found lower and higher for hybrid maize variety V₄. Seasonal ET_a of selected maize varieties V₂, V₃ and V₄ were 3, 24 and 34 % higher as compared to V₁. ET_a of V₁ varied between 2.7 to 4.8 mm d⁻¹, for V₂ between 2.6 to 5.2 mm d⁻¹, for V₃ between 3.3 to 6.2 mm d⁻¹ and for V₄ between 3.4 to 6.5 mm d⁻¹. The seasonal ET_a of selected varieties V₁, V₂, V₃ and V₄ was found 411, 422, 512 and 550 mm, respectively. Results showed that ET_a of hybrid varieties was higher as compared to traditional varieties. ET_a was found statistically significant ($P \leq 0.05$) for the selected maize varieties.

Keywords: Actual evapotranspiration, crop water requirement.

INTRODUCTION

Maize is the 2nd most important crop after wheat in Khyber Pakhtunkhwa and Pakistan. Maize being the highest yielding cereal crop in the world is of significant importance for countries like Pakistan. In Pakistan, it is planted on about 43% cropped area with the production of 461,000 tons and average grain yield of 3671 kg ha⁻¹ and 37% in Khyber Pakhtunkhwa, produce 101,515 tons and average grain yield of 2984 kg ha⁻¹ (Govt. of Pakistan, 2010). For better production a medium matured maize crop requires between 500 to 800 mm of water depending on environment (FAO, 2012). Maize crop is a C₄ plant, which is more capable to use CO₂, solar radiation, water and N in photosynthesis as compared to C₃ crops. Crop water requirement (CWR) of maize is about twice than C₃ crops grown at the similar places. Different maize cultivars have varying water requirement and crop water use efficiencies (Asare et al, 2011). Also irrigation water requirement differ statistically among all the hybrids (Maria, 2009). For normal growth and development of maize, it's maximum and even yields and high class, it is essential to keep optimal soil moisture in the root zone during the growing period. For determination of optimal irrigation requirements of crops, it is important to determine the actual evapotranspiration of the crop. Crop water requirement is mainly dependent on the supply of water from the soil, the demand of water by the crop, and the manner in which the crop is able to use the limited water supply. Crops usually differ for their water demand and this is an important subject of concern. Thus, knowledge of actual evapotranspiration use was helpful in planning the most efficient and economical use of available irrigation supplies and to fix realistic targets of crop acreage and production and conserving more water.

A study was undertaken to determine actual evapotranspiration, of traditional and hybrid maize varieties in Peshawar valley which is essential for effective water management practices.

MATERIALS AND METHODS

A field study was conducted for comparison of crop water requirement of traditional vs hybrid maize varieties at the research farm of The University of Agriculture Peshawar, during Kharif 2012. The research site is located at 34 N, 76 E and altitude of 450 m from the mean seas level.

Experimental Design: The experiment consisted of four varieties Azam (V₁), Jalal (V₂), Hybrid-3025W (V₃) and Hybrid 30K08(V₄) laid out in Randomized Complete Block Design with four replications. The experimental field was divided into 16 subplots of 4 m x 20 m, where plant to plant and row to row distance was kept 0.2 and 0.70 m, respectively.

Crop Sowing: Maize crop was sown at recommended seed rate of 28 kg ha⁻¹ in rows in the last week of June, 2012 by hand hoe. Weeds were removed manually when required to save losses of available soil moisture and nutrients from the soil. The textural class of the research plot soil was Clay Loam with the maximum infiltration rate of 8 mm hr⁻¹. Fertilizer (N:P:K) was applied at the rate of 160:80:0 kg ha⁻¹, respectively.

Actual Evapotranspiration (ET_a): Actual evapotranspiration (ET_a) or CWR of maize was determined by water balance equation. The difference in moisture content was added to the rainfall, the depth of irrigation applied and

dividing this by the number of days between successive samplings. The following equation was used to determine ETa:

$$ETa = \frac{I+P-Drz(\theta_f-\theta_i)}{\Delta t}$$

Where,

ETa = Actual evapotranspiration between two successive samplings (mm d⁻¹)

I = Depth of irrigation (mm)

P = Precipitation between the sampling periods (mm)

Drz = Depth of root zone (mm)

θ_f = Soil moisture content at the time of second sampling (% by vol.)

θ_i = Soil moisture content at the time of first sampling (% by vol.)

Δt = Time interval between samplings (days).

Runoff and deep percolation was assumed to be negligible throughout the growing season, because field is banded and irrigation was applied according to crop requirement.

Determination of Soil Moisture Content: The moisture content of the soil was determined by gravimetric method. The irrigation was applied at 55% depletion of available water (FAO, 2012). Subsequent irrigations were applied to the respective plots, when soil moisture reached to critical moisture level.

RESULTS AND DISCUSSIONS

Actual Evapotranspiration (ETa): ETa of traditional and hybrid maize varieties are given in Figure 1. Maize variety V₁, ETa was found to be lower and hybrid variety V₄ was found to be higher. Comparison of seasonal ETa of selected maize varieties showed that V₂, V₃ and V₄ had 3, 24 and 34 % higher values compared to V₁. Similar results were found by Piccinni et al. (2009) who reported that seasonal ETa of maize ranged from 441 to 641 mm. Similarly, Tariq et al. (2003) reported that ETa of maize was 451 mm during the study period. According to Ruzsanyi (1987), ETa of medium maturity maize hybrids ranged from 430 to 545 mm for the whole growing season. Similarly, length of growing season also increases the ETa as hybrid varieties take relatively greater number of days to harvesting than traditional maize varieties. The stage wise comparison showed gradual increase in ETa from crop initial stage to mid stage and then started decline till crop harvest.

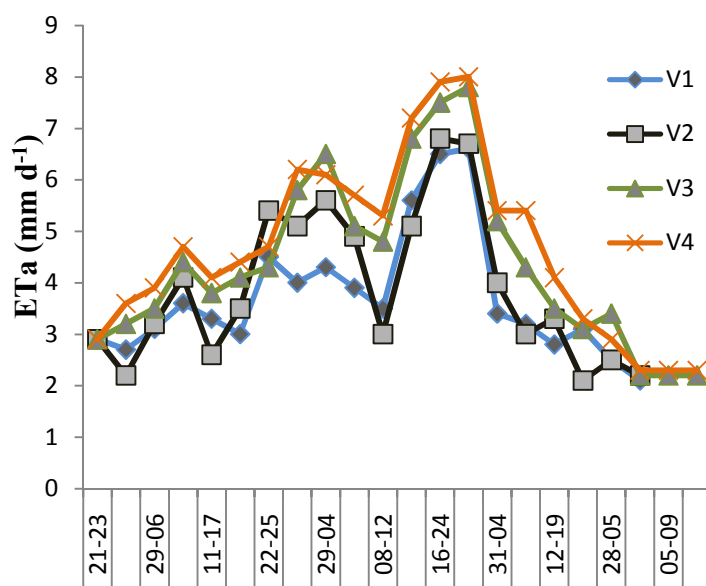


Figure 1. Actual evapotranspiration (ETa) of selected maize varieties

The FAO reported values for ETa were different than present study. The reason might be the differences in the climatic conditions of the research areas.

Table 1. Stage wise actual evapotranspiration (ETa) of selected maize varieties.

Varieties/Stages	Initial	Developmental	Mid-Season	Late Season
 mm d ⁻¹			
V ₁	3.1	3.7	4.8	2.7
V ₂	3.1	4.2	5.2	2.6
V ₃	3.5	4.5	6.2	3.3
V ₄	3.8	4.9	6.5	3.4

Table 2. Analysis of variance of ETa/CWR of selected maize varieties

Varieties	Crop Water Requirement
V ₁	410.75c
V ₂	421.50c
V ₃	512.25b
V ₄	549.75a
Significance	*
LSD 5%	9.60

Mean value of same category followed by different letters are significantly different from each other at $P \leq 0.5$ using LSD test.

ns = Non significant, * = Significant, ** = Highly significant

Conclusions

- Actual evapotranspiration (ETa) for V₁, V₂, V₃, and V₄ were 411, 422, 512 and 550 mm when all the varieties were irrigated according to recommended MAD (55%). Comparison of ETa showed significant difference between all the varieties.

Recommendations

- FAO reported CWR values of a crop are generalized one for a wide range of climate therefore, CWR value of each crop variety should be investigated and used.

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