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Determination of Corn Consumption Water at Lysimeter Method and Comparing with Pan Evaporation Method in Blochestan Area

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Abstract

Irrigation is an increasingly important practice for sustainable agriculture in the Midlist region, as well as in other semi-arid environments of southern Iran. Evapotranspiration (ET) of corn hybrids were measured and compared in 2003 and 2004 under lysimeters at Iranshahr Research Station in the Blochestan of Iran, and studied differences in growth, yield and water use efficiency (WUE). In both years, corn was planted in July and harvested in October in two different fields of 1000m^2 each, containing drainage lysimeters to directly measure ET. Irrigation differentiation was made upon crop evapotranspiration measured on the lysimeters, water was then applied at 100 and 60% of ET. Full irrigation treatment (I-100) was managed for high productivity, whereas deficit irrigation treatment (I-60) was maintained at 60% of field capacity. Water stress was applied continuously during the growing cycle. The analysis revealed that SC 704 hybrid is suitable variety for southern of Iran, because WUE of this hybrid %4.4 higher than SC604, While water using of this variety is %2.03 more than SC604. Meanwhile yield and yield components (1000 w, number of row per ear) and plant height are %6.73, %8.39, %11.11 and %5.11 higher than SC604 respectively. On the other hand cob percentage of SC604 as a negative parameters is %10 more than SC 704. In the meantime seed depth of SC604 is other recorded parameter which %5.88 more than SC 704.

Keywords

Corn (*Zea Maize*), Consumption Water, Lysimeter, Pan Evaporation, Hybrid

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1. Introduction

1.1. Overview

In Midlist region, submitted to arid and semi-arid climate, water is a limiting factor for profitable agriculture, in terms both of overall amount and intermittence and/or irregularity of rainfall events throughout crops' growing season. In this context, irrigation (full or supplementary) of the crops is needed for providing best level of production. However, water is becoming a scarce natural resource and agriculture represents the major water consumption at global scale, thus, proper irrigation scheduling has to be employed by the producers for exploring water saving measures.

The misuse of water due to either low efficiency of irrigation or inadequate irrigation scheduling can lead to loss of water, resulting in higher production costs and negative environmental impacts. Matching water supply and demand are essential for productivity and sustainability in any irrigation scheme. Moreover, knowledge of crop-water requirements is crucial for water resources management and planning in order to improve water-use efficiency [6], [7].

Crop-water requirements vary during the growing period,

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mainly due to variation in crop canopy and climatic conditions, and related to both cropping technique and irrigation methods. About 99% of the water uptake by plants from soil is lost as evapotranspiration (ET), so, it can be stated that the measurement of actual crop evapotranspiration (ETc) on a daily scale for the whole vegetative cycle is equal to the water requirement of the given crop. Evapotranspiration is defined as the water lost as vapour by an unsaturated vegetative surface and it is the sum of evaporation from soil and transpiration by plants. In order to avoid the underestimation or overestimation of crop water consumption, knowledge of the exact water loss through actual evapotranspiration is necessary for sustainable development and environmentally sound water management in the Mediterranean region. However, overestimation of water consumption is very common practice in this region [15], causing both wastes of water and negative impacts on economic, social and environmental levels [7].

Corn has been reported in the literature to have high irrigation requirements [18], [13], [4], [9], [16]. The scarce and year-to-year variability of rain in the Bekaa Valley makes it necessary to efficiently use water for irrigation of corn. However, more significant is the higher evapotranspiration of fully irrigated corn in this region where the advection effect is considerable compared to other sites in the country [1].

The influence of water application on corn yield has been discussed in reviews by [12]. Corn dry matter and grain yield increased significantly by irrigation [20]. However, corn has been reported to be very sensitive to drought [3], [10].

In this region, irrigation water supplies are mainly from groundwater sources that are being depleted.

Understanding the relationship between growths of corn hybrids and water consumption for each area would aid the improvement of growth conditions and crop yield and would provide useful tools for future genetic engineering. Research in the late 1980s demonstrated that yields can be raised two to three-fold by using available improved varieties and appropriate agronomic techniques. But these findings need to be refined, improved and tested for local climatic, soil and crop conditions [11].

These include in the aspects of to what extent irrigation for different cultivars affect the yield of corn. In addition, no comprehensive database is available for water consumption of corn hybrids in south of Iran. Thus, studies are still needed to improve understanding of the effects of different irrigation on corn hybrids. Hence, the present study was designed with the following objectives:

1.2. Objectives

1. To study the growth and yield characteristics of summer corn (Zea mays L.) as well as of different corn hybrids.
2. To determine levels of corn water conception.
3. To compare lysimeter method and comparing with pan evaporation method corn.

2. Materials and Methods

The field experiments were conducted for two years in 2003 and 2004 at Iranshahr agricultural research station, southern Iran (27°N 12.00′ 60°E 37.00′, 51m altitude).

The experiment consisted of 18 treatments outlined as follows:

Each plot comprised of four raised beds of 50 meters length – and plants were harvested at the physiological maturity stage.

The usual agricultural planting were done. During the growth the usual notes were taken (Figure 3).

The land was plowed to a depth of 20-25 cm followed by harrowing before planting. During the growth the usual notes were taken. Data were analyzed using the analysis of variance (ANOVA) procedure with of [14] by means between the treatments were compared using LSD Test at $P<0.05$.

2.1. Soil Media: Properties and Preparation

The soil was analyzed for physical and chemical properties (Table 1). Soil was analyzed for total nitrogen following Kjeldahl method [8], and soil organic carbon (OC) was determined according to Walkley and Black [19]. Available phosphorus was determined by Molybdenum Blue method [5]. Leaching method using one N neutral ammonium acetate solution was used for exchangeable K, Ca, Mg and Na determination [18].

Table 1. Physical and chemical properties of the experimental soil media.

Soil Properties	Analytical value
Sand (%)	54.43
Silt (%)	7.00
Clay (%)	38.47
Textural class	Sandy loam
FC (% w/w)	14.4
PWP (% w/w)	10.8
Saturated (% w/w)	27
(pH)	7.44
SAR	14.3
EC (dS m^{-1})	2.3
Organic matter (%)	5.39
Total N (%)	0.528
Available P (mg kg^{-1})	2.09
Na^{+}	32.5
Cl^{-}	14.1
CO_3H^{-}	4.3
$Mg^{2+}+Ca^{2+}$	10.4
Available Fe (mg kg^{-1})	4.9
Available Mn (mg kg^{-1})	2.8
Available Cu (mg kg^{-1})	4.3
Available Zn (mg kg^{-1})	2.7

Each meter square of soil was also thoroughly mixed with 60

g of $CaCO_3$, 10 g of complete fertilizer (15% N, 15% P_2O_5, 15% K_2O), 1 g of triple super phosphate (45% P_2O_5) and 2.4 g of urea (46% N). Soil field capacity (FC) and permanent wilting point (PWP) were measured before and after completion at the experiment. Soil moisture was determined by gravimetric method [2].

The flowchart and template of applied lysimeter are shown at the figures 1 and 2.

2.2. Transpiration and Evaporation Equation and Climatically

For determination of potential transpiration and evaporation, fallowing equation used;

$ETP=P+ I+ d_8- D$

ETP=Potential transpiration and evaporation (mm)

P=prispation amount (mm)

I=Irrigation amount (mm)

d_8=drainage amount (mm)

D= amount (mm)

3. Results and Discussion

3.1. Simple Effects

The results of comparing hybrids of corn (Tables 3 & 4) showed, both of the corn hybrids were significantly different ($P<0.05$) between lysimetrs. The yield of SC 604 had been less than SC 704, also water use efficiency of SC 604 had been less than SC 704.

The analysis revealed that SC 704 hybrid is suitable variety for southern of Iran, because WUE of this hybrid %4.4 higher than SC604, While water using of this variety is %2.03 more than SC604. Meanwhile yield and yield components (1000 w, number of row per ear) and plant height are %6.73, %8.39, %11.11 and %5.11 higher than SC604 respectively. On the other hand cob percentage of SC604 as a negative parameters is %10 more than SC 704. In the meantime seed depth of SC604 is other recorded parameter which %5.88 more than SC 704.

Table 2. Climatically data at Agricultural Research Station of Iranshahr during the growth period of corn.

	Precipitation		Mean temperature (c)		Mean of maximum temperature (c)		Mean of minimum temperature (c)		Evaporation (mm)		Mean of Relative humidity (%)	
Month	Y1	Y2	Y1	Y2	Y1	Y2	Y1	Y2	Y1	Y2	Y1	Y2
May	34.6	33.8	20.7	27.2	26.9	28.4	24.6	13	148.9	95.2	66.5	74.8
June	20.2	10.5	24	35.1	39.4	38.9	18.6	18.3	170.3	181.6	65.4	60.6
July	24.4	32	27.5	28.3	42.1	43.9	22.9	22.8	213.6	225.7	61.7	65.4
Agust	16.3	19	29.3	29.2	45.1	44	23.6	24.4	247.4	213.3	59	64.9

Y1: 2004 Y2: 2005

3.2. Combination Effects

Interaction of lysimetr 1×SC 704 with 42.75 Ton ha^{-1} was the maximum yield harvested from inside the lysimetr. Combination of lysimetr× SC 604 with 26.81 Ton ha^{-1} produced the lowest yield (Table 3).

Corn yield fell by 19.7% under medium and 37.7% under low irigation; the application of late mature variety, increased yield significantly evapotranspiration of SC 704 corn during two years experiments and periods of 133 and 138 days was 849 and 914 mm. while evapotranspiration of SC 604 corn during two years experiments and periods of 124 and 130 days was 831 and 896 mm. Similarly,

Grain yield, 1000 Kernel weight, number of seed row per ear, number of seed per row and plant height were higher for SC704 hybrid, compared to SC604 hybrid and overhand cob percentage and seed depth were maximum amount for SC604 hybrid (Table 4).

In order to find the most suitable planting date for more producing silage corn hybrids, the field experiments were conducted for two years at agricultural research station Iranshahr in 2004-2005. The cultivars were sown at three planting dates from 16 July with 15 days interval. The experimental was laid out in a split plot randomized complete block design arranged with four replications. The main plots were planting date and the sub-plot consisted of varieties. The harvesting areas for early matured, mid matured and later matured varieties were 10.08, 9.27 and 8.48, respectively. The usual agricultural planting were done. During the growth the usual notes were taken.

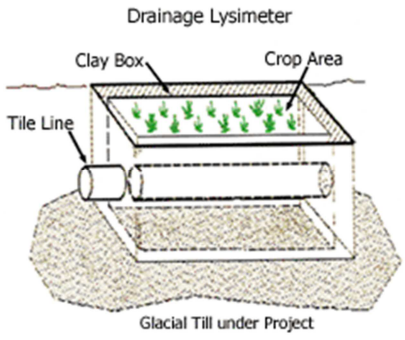

Figure 1. Template of applied drainage lysimeter.

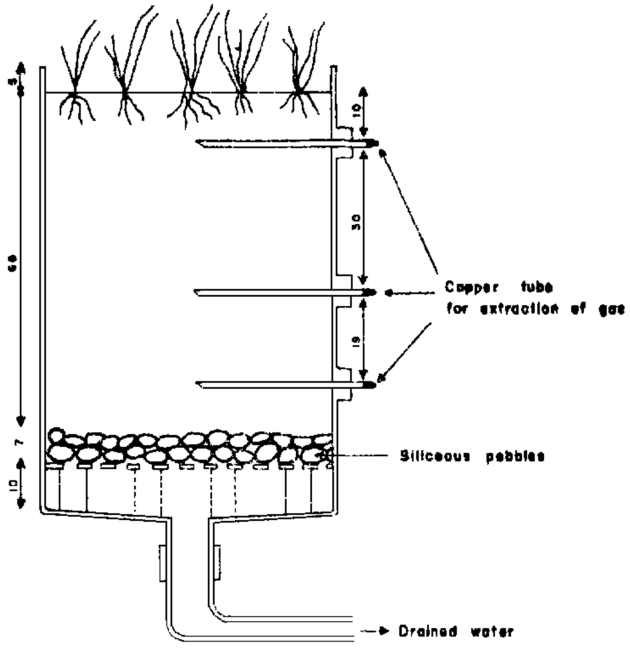

Figure 2. Flowchart of lysimeter at the field in southern of Iran.

Figure 3. General picture from lysimeter field in southern of Iran.

The analysis revealed that late variety single cross 711 with 42.75 Ton ha^{-1} had the highest yield on August 1 planting date and single cross 301 on July 16 planting date produced the lowest yield (26.81 Ton ha^{-1}).

The water conception, grain yield and water use efficiency (WUE) for two varieties of SC 704 and SC 604corns were different during two years experiment.

Table 3. Studied treats of corns.

Year	Location	Grain yield (Ton ha^{-1})	1000 Kernel weight (gr)	Cob Percentage	Number of seed row per ear	Number of seed per row	Moisture percentage	Seed depth (mm)	Plant height (cm)
2001	lysimeter 1*	13.9	298	15.9	16	26	17.4	2.6	180
	Around	13	290	17.6	14	20	18	2.2	178
2001	lysimeter 2*	14.2	324	14.8	18	29	14	2.1	196
	Around	13.1	318	20	16	29	17.3	2.2	192
2002	lysimeter 1	13.5	302	16.4	16	27	14.8	2.4	191
	Around	12.2	296	17.9	14	21	16.4	2.4	190
2002	lysimeter 2	15.4	331`	15.6	18	30	19	2.3	195
	Around	13.7	325	18.2	14	28	15.8	2.2	192

*In the lysimetr number 1 corn of SC604 planted.
*In the lysimeter number 2 corn of SC704 planted.

Table 4. Comparing water conception factors (m^3ha^{-1}), grain yield ($kgha^{-1}$) and water use efficiency (WUE) for two varieties of SC 704 and SC 604corns during two years experiment.

Variety	Factor	Replication		Means
		1	2	
SC 604	Using water	8312	8960	8636
	Grain yield	13450	12850	13150
	WUE	1.62	1.43	1.52
SC 704	Using water	8490	9140	8815
	Grain yield	13650	14550	14100
	WUE	1.60	1.59	1.599

Considering above table it can be concluded; The yield of SC 604 had been less than SC 704, also water use efficiency of SC 604 had been less than SC 704.

4. Conclusions

The resulting groundwater contamination from intensive cereal production has become a major concern for long-term farmland efficiency and environmental sustainability in southern Iran. In the water scarcity condition, using enough irrigation and appropriate corn hybrid are the best strategies to improve water productivity. The water use efficiency of corn also will be increase.

It would be more appropriate practice both for minimizing nitrate leaching and sustainable corn production under the arid and semiarid conditions of southern Iran.

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