WATER CONSUMPTION OF IRRIGATED AND UNIRRIGATED MAIZE CROP AND IRRIGATION INFLUENCE ON YIELDS OBTAINED IN DIFFERENT AREAS FROM ROMANIA

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Abstract

The paper shows the determination of water consumption by crop which can be made by direct methods in special locations and indirectly by adjusting the values of reference evapotranspiration (ET_0) with Kc transformation coefficients. Irrigation determined an increase in total water consumption by 45%, the relative differences compared with unirrigated variants recorded between 1976-2014 were between 9 and 145%. The moderate sub-humid zone of Crisurilor Plain, under circumstances of optimum water regime irrigation has led to obtain an yield gain of 78% during 1976-2014 .Using irrigation determined to obtain a higher level of total nitrogen in seeds (1, 70%) in comparison with unirrigated variant (1.42%). That means higher protein content per unit area. In this case the protein content was 1311.52 kg / ha in irrigated variant, compared to 556.94 kg / ha under unirrigated variant. Relative differences of the maize yield registered in different regions of Romania were 177% at the Valu lui Traian, Braila 86%, 70% Caracal, 49% in Baneasa-Giurgiu, 37% in Cluj-Napoca and 19% in Podu Iloaiei.

Key words: irrigation, maize, water consumption, yield

INTRODUCTION

Maize crop occupies third place in importance between cultivated plants around the globe.

This position, in terms of agriculture, is motivated by a number of features, such as: - an higher yield capacity about 50% higher than other cereals; has great ecological plasticity, which enables a wide area of distribution, giving high yields and relatively constant, less influenced by climatic irregularities; maize is a good preceding for most crops; supports monoculture several years; it has a coefficient of propagating large (l 50-400); with later seeding in the spring allows for better scheduling of soil tillage; culture is mechanized 100%; harvesting is done without the danger of shaking; had good efficiency using organic and mineral fertilizers and irrigation; their possibilities of yield efficiency are varied etc (Ionescu Şişeşti., 1986) . From 100 kg grain can be obtained: 77 kg flour or 63 kg starch, 44 l alcohol, 71 kg of glucose, 1.8 to 2.7 l oil and 3.6 kg pomaces (Bîlteanu, 2001).

In human nutrition from beans "germinated" by dry milling are obtained: corn flour, corn flakes, baby food, artificial milk etc .; by wet milling (grain with embryo) provided with the goods listed and fructose syrup (for diabetics), beer, coffee substitutes, lozenges glazed pastes etc. Through different treatments after wet milling are obtained starch, glucose, dextrose, whiskey, gasohol, etc. drugs.

In feeding maize had a nutritive value of 1.17 to 1.30 nutrient units, at 1 kg beans. From cobs were obtained: furfural, feed for ruminants, soaps; vitamins etc. or used as fuel. Husk is used for plaiting or foraging. Stems, stalks are used as feed or in the manufacture of pulp and chipboard (Muresan, et al.,1992).

Total green plant can be used for the production of fuels (methanol, ethanol) or silage during the milk-grain wax, it ensures a particularly valuable feed.

After Borcean (2003) Crisurilor Plain is situated in first zone of favorability for maize, since the amount of temperatures biologically active is 1400-1600ºC and soils are fertile.

Water demand of maize increases as plants forward in growth, maximum power consumption registered before earing and early ripening wax phase (Domuta, 2010). Soil moisture during this period ensures fertilization and grain formation, migration of substances from the leaves to the grain treated, supplies the plant in the best conditions with minerals. After ripe wax, requirements of maize for water are significantly reduced, leading role in full ripening returning to temperature (Muntean 2003, 2008, 2011).

Previously quoted author considers that the critical period for maize lasts around 50 days, peak demand registered at the appearance of male inflorescence. F. Angelini (1965) (quoted by Bîlteanu 2001), considered as critical early blossoming period and the ten days that follow.

MATERIAL AND METHOD

The methods and processes used throughout time in irrigation scheduling have been designed specifically for this purpose or have been taken from other areas, some adaptations (Grumeza et al., 1989). Irrigation scheduling take into account relationships from soil-water -plant-atmosphere system (Brejea, 2009, 2014). In choosing the irrigation scheduling is envisaged the type of fitting used in irrigation, the application of irrigation (in Romania using watering rotation), the crop structure, the technical-organizational characteristics (system size and irrigation sectors, size of fields occupied by crops, beneficiaries, etc.) and efficiency considerations, not least economic ones (Borza, 2007, 2010).

Determination of water consumption of plants can be done by direct methods, in special locations and indirectly by adjusting the values of reference evapotranspiration (ET0) with transformation coefficients Kc (Domuta 2003, 2005, 2009).

RESULTS AND DISCUSSION

The influence of irrigation on maize water consumption

Ensuring the maintaining of water reserve between easily available water content and field capacity on watering depth through irrigation is accomplished using conditions for increases of values of daily water consumption, the higher relative difference (77%) was registered in August.

Values of optimal daily consumption of water at maize is different.

In April the highest optimum water consumption by maize was registered in Baneasa-Giurgiu (22 m^3/ha/day) in May at Oradea (30 m^3/ha/day), in June at Marculesti (43 m^3/ha/day) in July at Marculesti and in Oradea (61 m^3/ha/day), in August at Marculesti (54 m^3/ha/day) and in September at Marculesti and Braila (28 m^3/ha/day) (Table 1).

Table 1.

Average of daily water consumption (m^3/ha/day) of maize crop in different areas from Romania

Area	Place	Variant	Month					
			IV	V	VI	VII	VIII	IX
Crisurilor Plain	Oradea (1976-2014)	Unirigated	15	26	36	40	27	16
		Irrigated	18	30	42	61	48	27
North Moldova	Podu Iloaiei	Irrigated	15	25	39	51	38	19
Baraganului Plain	Braila	Irrigated	16	19	41	58	51	28
Dobrogea	Valu lui Traian	Irrigated	13	21	34	58	49	21
Baraganului Plain	Marculesti	Irrigated	14	22	40	61	54	28
Burnasului Plain	Băneasa Giurgiu	Irrigated	22	28	43	58	43	27
Olteniei Plain	Caracal	Irrigated	18	26	39	59	42	24
Transilvaniei Highland	Cluj Napoca	Irrigated	17	26	34	39	31	22

Irrigation determined an increase of total water consumption by 45%, relative differences in comparison with unirigated variant registered between 1976-2014 were about 9 and 145%. Irrigation has covered 37.7% of total water consumption, the range of irrigation ratio is between 7.4% (in 2001) and 61.2% (in 2000) (table 2).

Table 2.

Total water consumption of irrigated and unirrigated maize crop and sources of coverage, Oradea 1976-2014

Variant	Sources of coverage							
	m³/ha	Int. of variation %	Water reserve (Ri-Rf) m³/ha	Pv		Σm		
				m³/ha	Int. of variation %	m³/ha	Intervalle of variation	
							%	%
1.Unirrigated	4343	100	1064	3279	1125-5538	-	-	-
2. Irrigated	6300	109-245	536	3279	1125-5538	2452	39	7.4-61.2

Ri-Rf = Initial resserve – final resserve;
Pv = rainfalls from vegetation period ;
Σm = irrigation ratio

Most of the water consumption of maize is provided by the soil layer between 0 and 75 cm, which is the depth of watering of preluvosoil from Oradea (Domuta C., 1995). Since June, maize consumes from soil layer between 75 and 150 cm, 0.2 m^3/ha/day under irrigation and 0.3 m^3/ha/day in conditions without irrigation; in July it was registered the highest values(9.7 m^3/ha/day under irrigation and 10.3 m^3/ha/day in conditions without irrigation) of water consumption from 75-150 cm depth. In August values are lower (6.4 m^3/ha/day or 7.1 m^3/ha/day) because in September, they are 4.6 m^3/ha/day for irrigation variant and 3.5 m^3/ha/day in unirrigated.

Between the total water consumption and yield there is a direct link of different forms depending on the pedoclimatic area. This highlights the opportunity of irrigation as a mean measure of providing a better water consumption (Grumeza et al., 1989). In terms of Oradea for the period 1987-2014 was quantified the correlation shown in Figure 1.

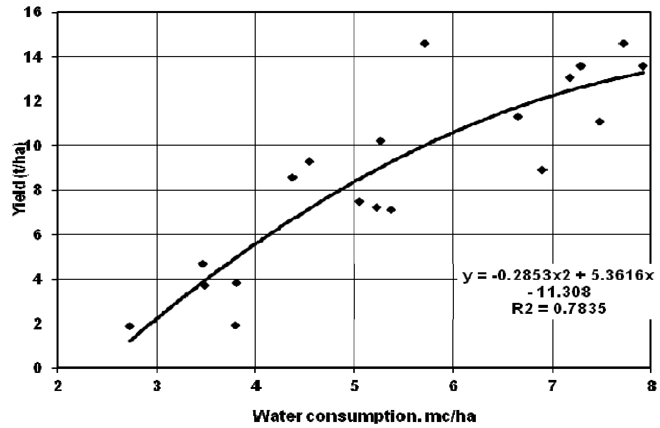

Figure 1. Correlation between water consumption-yield at maize crop from Crisurilor Plain , 1987-2014

The influence of irrigation on leaf turgescence and on plant nutrition

As a result of using irrigation overall level of turgidity of the leaves is higher. Differences turgidity is registered throughout the irrigation period and thereafter until harvest. These differences are more pronounced at harvest. The differences are greater at midLSDe leafs and especially of the basal leafs, high turgescent and, consequently, photosynthetic activity of the basal leaves extending in dry years more than a month, as shown by the results obtained by Domuta (2003).

Analysis of total nitrogen content from leaves carried by Domuta (1995) found higher levels of it under irrigation conditions. The largest amount of total nitrogen in leaves was registered with 2-3 weeks before earings, both under unirrigation and irrigation conditions. Also was registered the biggest difference between the two variants.

Irrigation has led to a better nitrogen translocation so that its content in the grain is higher than the content from the strain, unlike the variant umirrigated in which total nitrogen content is higher in bark than the grains.

The phosphorus content of the leaves at irrigated maize was higher in the whole growing season; the biggest difference compared with unirrigated variant was registered in August.

As the nitrogen and the phosphorus content is higher in grain than in strain under irrigation conditions, unlike in the unirrigated variant in which phosphorous content was higher in the strain than in the grains.

It can be said that by using irrigation the maize nutrition has improved and the content of grains in total nitrogen and phosphorus were higher in beans than in the stem, comparison with unirrigated maize where the content in these items was lower in the grain than the stalk. We believe that irrigation improved the translocation of nitrogen and phosphorus in grains.

Regarding the dynamic of content in mobile potassium in plants, it was found that the level from irrigated variant was lower than unirrigated variant. The explanation is that irrigation water used has a higher content of Ca^{2+} and Mg^{2+}, the coordinator of this book, giving low level of potassium in plants due to the antagonism of Ca and K.

The influence of irrigation on maize yield

In the moderate wet area from Crisurilor Plain, in the conditions of optimum regime of water supply the irrigation has determined the obtaining of an yield gain of 78% during 1976-2014. The average difference and the differences registered during the years were highly statistically significant (table 3).

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Influence of irrigation on level and yield constant at maize crop Oradea 1976-2014

Variant	Yield				Standard deviation	
	Average		Intervalle of variation		kg/ha	%
	kg/ha	%	kg/ha	%		
Unirrigated	6870	100	1510-11840	100	3271	100
Irrigated	12232	178	7850-16480	107-912	1879	57.4
LSD 5% 370 ; LSD 1% 490 ; LSD 0.1% 720 ;						

The variation interval of relative differences in Oradea was between 7and 812%.

Standard deviation expresses the degree of dispersion of values around the average. The calculation of this indicator for these data show constant improvement of yield under irrigation, standard deviation values being lower than the 42.6% in unirrigation conditions. In climate conditions with a worst rainfall regime for maize crop is expected that the differences between the values of this indicator under irrigation and unirrigation conditions to be even higher.

As disclosed previously, the use of irrigation determined to obtain a higher level of total nitrogen in grains (1.70%) compared to unirrigated crop (1.42%). That means higher protein content per unit area. In this case the protein content was 1311.52 kg / ha in irrigated variant, compared to 556.94 kg / ha in unirrigated variant.

The relative differences between maize yield registered in different areas of Romania were 177% at Valu lui Traian, 86% in Braila, 70% at Caracal, 49% in Baneasa-Giurgiu, 37% to Cluj-Napoca and 19% Podu Iloaiei (table 4).

Table 4.

Irrigation influence on maize yield in different areas from Romania

Area	Place	Variant	Yield		Diference	
			Kg/ha	%	Kg/ha	%
North Moldova	Podu Iloaiei	Unirrigted	8600	100	-	-
		Irrigated	10200	119	1600	19
Baraganului Plain	Valu lui Traian	Unirrigted	4200	100	-	-
		Irrigated	11600	277	7400	177
Dobrogea	Braila	Unirrigted	3750	100	-	-
		Irrigated	6960	186	3210	86
Baraganului Plain	Marculesti	Unirrigted	4060	100	-	-
		Irrigated	6500	160	2440	60
Burnasului Plain	Băneasa Giurgiu	Unirrigted	5500	100	-	-
		Irrigated	13700	149	8200	49
Olteniei Plain	Caracal	Unirrigted	6600	100	-	-
		Irrigated	11233	170	4600	70
Transilvaniei Highland	Cluj-Napoca	Unirrigted	7300	100	-	-
		Irrigated	10000	137	2700	37

Obtaining of yield differences presented above was achieved in the conditions of maintaining water reserve between easily available water content and field capacity. In the condition of half reduced irrigation ratio but respecting the optimal number of watering, maize was the crop that reacted most powerful from 10 cultures studied, the yield decreased to 66.4% from variant correctly irrigated (Domuta, 1995). Results the importance that have to be given to size of irrigation ratio contained in the bulletins for irrigation scheduling, preventing harvest losses and negative financial results.

CONCLUSIONS

Irrigation scheduling represent all the measures that have the main objective the establishing of irrigation application. There are direct and indirect method for determination of irrigation scheduling. Indirect methods are based on the link between water consumption by crop and reference evapotranspiration (ET_0) with Kc transformation coefficients. Water consumption of crop is determined in the field of soil water balance.

The research were carried out in the different area from Romania.

Ensuring the maintaining of water reserve between easily available water content and field capacity on watering depth through irrigation is accomplished using conditions for increases of values of daily water consumption, the higher relative difference (77%) was registered in August in the all areas.

As a result of using irrigation over all level of turgidity of the leaves is higher. Differences of turgidity is registered throughout the irrigation period and thereafter until harvest.

In the moderate wet area from Crisurilor Plain, in the conditions of optimum regime of water supply the irrigation has determined the obtaining of an yield gain of 78% during 1976-2014. The average difference and the differences registered during the years were highly statistically significant

Correlations statistically assured quantified for the period 1987-2014 sustain the need for irrigation in a certain area, in this case the Crisurilor Plain. And in other areas of Romania were quantified direct correlation, too.

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