RESEARCHES REGARDING TO SUBBASURANCE WITH WATER A PREMISE FOR AN OPTIMUM IRRIGATION SCHEDULING OF MAIZE CROP FROM CRISURILOR PLAIN

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Abstract

Research results obtained show the necessity of maize irrigation from Crisurilor Plain, because are obtained yield gain statistically assured and increased of protein content in maize grains. Decadal determinations of soil moisture show that in all three years studied in depth watering of 0 - 75 cm water reserve fell below the easily available water content so in the unirrigated conditions was registered the pedological drought phenomenon. Number of days with pedological drought in irrigated maize crop was 61 days in 2012, 64 days in 2013. To maintain water reserve between the easily available water content and field capacity on the depth of watering (0-75 cm) at maize crop were necessary irrigation rates with values by 2800 m3 / ha in 2012 and 3320 m3 / ha in 2013; the highest yields of maize 13500 kg / ha in 2012 and 12410 kg / ha in 2013 were obtained in variant without irrigation suspension and the smallest in variant with irrigation (4700 kg / ha in 2012 and 3860 kg / ha in 2013). Suspension of irrigation in the seasons of irrigations determined yield losses statistically assured both in 2012 and 2013. An exception were made in June of 2012, when there was no need for irrigations. The content in protein of maize grain from optimally irrigated variant versus unirrigated variant increased, suspending irrigation in July and August determined the decreasing highly statistically significant of protein content compared to variant optimally supplied with water.

Keywords: irrigation, easily available water content, drought, maize, yield, protein

INTRODUCTION

The problem of the correctly irrigation scheduling torque application was and is a major concern of specialists. For this depends the important measure to obtain the expected yield and the prevention of negative phenomena in the evolution of soil and groundwater (Grumeza N. et al., 1989).

The methods and procedures used during time during in the irrigation schedule was designed specifically for this purpose or have been taken from other areas, some adaptations. Irrigation scheduling methods considering the soil-water -plant-climate relationships. For choosing the method of irrigation scheduling is takes into account the type of fitting used in the irrigation system, the application of irrigations (in Romania using rotating watering), crop structrure, technical and organizational characteristics (size system and irrigation sectors, sizes of fields occupied, beneficiaries, etc.) and efficiency considerations, not least the economic ones.

Grumeza N. (1989) classifies the methods of irrigation scheduling into the following groups:

- Method of extrapolation of data on soil water reserve from control plots;

- Methods based on the relations between water consumption of plants and reference evapotranspiration determined by evaporimeters, climate formulas, lysimeters etc .;

- Methods based on the use of physiological indexes.

I believe that the methods of irrigation scheduling can be grouped as follows:

Direct methods:

Based on the control of soil moisture by:

- Gravimetric method;
- Tensiometry method;
- Neutron method;

Based on physiological indicators of plant;

Indirect methods

- Based on the link between water consumption of plants and reference evapotranspiration ETo;

MATERIAL AND METHOD

The research was conducted in 2012 and 2013 at Agricultural Research and Development Station Oradea on a preluvosoil. Experimental variants studied were: V 1 - Without irrigation suspending;

V2 - Irrigation suspending in May (4-9 leaves)
V3 - Irrigation suspending in June (10-18 leaves)
V4 - Irrigation suspending in July
V5 - Irrigation suspending in August (Filling grains)
V6 - Unirrigated

Proper management of soil water regime in variant without irrigation suspending was based on the decade determination of soil moisture with irrigation whenever the soil water reserve on depth of 0-75 cm reached below the easily available water content. Simultaneously, and in variants with irrigation suspending was determined the soil moisture. Method of determination used was gravimetric method. Soil water reserve was determined by the formula:

$Ra = U \times DA \times H$

In which:

Ra = soil water reserve; m^3/ha;
U = soil moisture %;
DA = bulk density; g/m^3;
H = depth, cm.

Yield results and results regarding of protein content were calculated by the method of variance analysis (Domuta C., 2006).

RESULTS AND DISCUSSION

Pedological drought in maize crop

At unirrigated maize, pedological drought (decreasing of water reserves on watering depth below the easily available water content) registered in irrigation season totaled a number of 61 days in 2012 and a total of 64 days in 2013 (table 1). Most days with pedological drought occurred in August 2012 as well in 2013. The suspending of irrigation in different months of the irrigation season causes apparition of pedological drought also in these months (Table 1, Table 2).

Table 1

Number of days with pedolgical drought in maize, in different water assurance variants, in the condition from Oradea 2012

Variant	Month					IV-VIII
	IV	V	VI	VII	VIII	
1. Without irrigation suspending	0	0	0	0	0	0
2. Irrigation suspending in May (4-9 leaves)	0	10	0	0	0	10
3. Irrigation suspending in June (10-18 leaves)	0	0	0	0	0	0
4. Irrigation suspending in July	0	0	0	20	6	26
5. Irrigation suspending in August (Filling grains)	0	0	0	0	31	31
6. Unirrigated	0	10	0	20	31	61

Table 2

Number of days with pedolgical drought in maize, in different water assurance variants, in the condition from Oradea 2013

Variant	Month					IV-VIII
	IV	V	VI	VII	VIII	
1. Without irrigation suspending	0	0	0	0	0	0
2. Irrigation suspending in May (4-9 leaves)	0	0	0	0	0	0
3. Irrigation suspending in June (10-18 leaves)	0	0	8	0	0	8
4. Irrigation suspending in July	0	0	0	15	7	22
5. Irrigation suspending in August (Filling grains)	0	0	0	0	31	31
6. Unirrigated	0	0	8	15	31	64

Both in 2012 and in 2013 on the irrigation depth (0-75 cm) water reserve decreased below the wilting point (strong pedological drought), the phenomenon was registered in August 2012 (10 days) and in July (10 days) and in 2013 in August (15 days).(Table 3).

Table 3

Number of days with strong pedological drought registered in unirrigated maize crop in the conditions from Oradea, 2012-2013

Year	IV	V	VI	VII	VIII	IV-VIII
2012	0	0	0	0	10	10
2013	0	0	0	10	15	25

In 2012, the optimum irrigation regime of maize crop consisted an irrigation rate with value of 2800 m³ /ha. The highest monthly irrigation rate was used in August 1200 m³ / ha. Suspending irrigation in different months of the irrigation season at maize determined the decreasing of irrigation rate (Table 4).

In 2013, the optimum irrigation regime of maize crop prezented an irrigation rate irrigation with value of 3200 m³ / ha applied in 8 irrigation. In the variants with irrigation suspending in different months of the vegetation period of maize crop, monthly irrigation rate value decreased (Table 5)

Table 4

Water regime of maize crop in different variants of water assurance in the conditions from Oradea, 2012

Variant	V		VI		VII		VIII		Total	
	∑m	n	∑m	n	∑m	n	∑m	n	∑m	n
1. Without irrigation suspending	800	2			800	2	1200	3	2800	7
2. Irrigation suspending in May (vegetative growth)					800	2	1200	3	2000	5
3. Irrigation suspending in June (flowering)	800	2			800	2	1200	3	2800	7
4. Irrigation suspending in July (flowering – filling grains)	800	2					1200	3	2000	5
5. Irrigation suspending in August (Filling grains)			600	2			600	2	1200	4

Table 5

Water regime of maize crop in different variants of water assurance in the conditions from Oradea, 2013

Variant	**V**		**VI**		**VII**		**VIII**		**Total**	
	∑m	**n**	**∑m**	**n**	**∑m**	**n**	**∑m**	**n**	**∑m**	**n**
1. Without irrigation suspending			800	2	1200	3	1200	3	3200	8
2. Irrigation suspending in May (vegetative growth)			800	2	1200	3	1200	3	3200	8
3. Irrigation suspending in June (flowering)					1200	3	1200	3	2400	6
4. Irrigation suspending in July (flowering – filling grains)			800	2			1200	3	2000	5
5. Irrigation suspending in August (Filling grains)			800	2	1200	3			2000	5

Influence of irrigation on yield level at maize crop

Optimum supply of water to the maize crop through irrigation determined the obtaining of an yield of 13500 kg / ha in 2012. The irrigation suspending in the irrigation season determined yield losses statistically very significant. In unirrigated variant, the difference from the variant optimum irrigated was 65% (8720 kg / ha) (Table 6).

In 2013 the yield from the variant without irrigation suspending in the irrigation seasons of maize was 12500 kg / ha. This year suspension of irrigation determined yield losses very significant statistically in all cases. In unirrigation conditions, yield registered (3860 kg / ha) represents 45% of the optimum supplied with water through irrigation (Table 7).

Table 6

Suspending irrigation influence in different month of vegetation period on yield in maize crop, in the conditions from Oradea 2012

Variant	Yield		Difference		Statistic semnif.
	kg/ha	%	kg/ha	%	
1. Without irrigation suspending	13500	100	-	-	Mt
2. Irrigation suspending in May (4-9 leaves)	11560	86	-1940	-14	000
3. Irrigation suspending in June (10-18 leaves)	13370	99	-130	-1	-
4. Irrigation suspending in July	7460	55	-6040	-45	000
5. Irrigation suspending in August (Filling grains)	6980	52	-6520	-48	000
6. Unirrigated	4780	35	8720	65	000
LSD 5% 210, LSD 1% 330, LSD 0,1% 640					

Table 7

Suspending irrigation influence in different month of vegetation period on yield in maize crop, in the conditions from Oradea 2013

Variant	Yield		Difference		Statistic semnif.
	kg/ha	%	kg/ha	%	
1. Without irrigation suspending	12500	100	-	-	Mt
2. Irrigation suspending in May (4-9 leaves)	12410	99	-90	-1	-
3. Irrigation suspending in June (10-18 leaves)	10250	81,8	-2275	-18,2	000
4. Irrigation suspending in July	9010	73	-3400	-27	000
5. Irrigation suspending in August (Filling grains)	9100	72,8	-3400	-27,2	000
6. Unirrigated	3860	31,1	-8640	-68,9	000
LSD 5% 190, LSD 1% 310, LSD 0,1% 570					

Influence of irrigation on protein content at maize grains

In 2012, the highest protein content of maize grains (11,12%) was determined in variant without suspending irrigation in the irrigation season of maize crop. In the maize growing season, suspending irrigation determined a lower protein content, so that by suspending irrigation in August the difference to optimally irrigated variant registered a difference of 28,6%. In unirrigation condition difference increased to 37,0%. Except for the difference registered in variant with irrigation suspending in May which was statistically distinct significant, in all other variants were registered differences statistically significant (Table 8).

Table 8

Suspending irrigation influence in different month of vegetation period on protein content of maize crop, in the conditions from Oradea 2012

Variant	Protein content		Difference		Statistic semnif.
	%	%	%	%	
1. Without irrigation suspending	11,12	100	-	-	Mt
2. Irrigation suspending in May (4-9 leaves)	10,44	93,9	-0,67	-6,1	-
3. Irrigation suspending in June (10-18 leaves)	10,60	95	-0,52	-5	-
4. Irrigation suspending in July	8,39	75,4	-2,73	-24,6	000
5. Irrigation suspending in August (Filling grains)	7,93	71,4	-3,19	-28,6	000
6. Unirrigated	7,00	63,0	-4,12	-37,0	000
LSD 5%= 0,81; LSD 1% = 1,56; LSD 0,1%= 2,63					

Table 9

Suspending irrigation influence in different month of vegetation period on protein content of maize crop, in the conditions from Oradea 2013

Variant	Protein content		Difference		Statistic semnif.
	%	%	%	%	
1. Without irrigation suspending	11,38	100	-	-	Mt
2. Irrigation suspending in May (4-9 leaves)	10,94	96,1	-0,44	-3,9	-
3. Irrigation suspending in June (10-18 leaves)	9,50	83,5	-1,88	-16,5	00
4. Irrigation suspending in July	9,19	80,8	-2,19	-19,2	000
5. Irrigation suspending in August (Filling grains)	7,94	69,8	-3,44	-30,2	000
6. Unirrigated	6,75	59,4	-5,13	-40,6	000
LSD 5% = 0,50; LSD 1% = 1,06; LSD 0,1% = 2,00					

In 2013, under optimal water supply was registered the highest protein content of 11,38%. By suspending irrigation in May there was a slight decrease (3,9%) in protein content of grains; in variant with suspending

irrigation in June, decreasing of protein content (16,5%) was statistically distinct significant, and by suspending irrigation in July and August decreasing of protein content was highly statistically significant (19,2% and 30,3%), and in unirrigated variant was determined lowest protein content (6,75%) with 40,6% less than optimally approximated variant (Tble 9).

CONCLUSIONS

The research was conducted in 2012 and 2013 at Agricultural Research and Development Station Oradea on a preluvosoil and the results obtained led to the following conclusions:

- Decadal determinations of soil moisture show that in all three years studied in depth watering of 0 -75 cm water reserve fell below the easily available water content so in the unirrigated conditions was registered the pedological drought phenomenon. Number of days with pedological drought in irrigated maize crop was 61 days in 2012, 64 days in 2013.
- To maintain water reserve between the easily available water content and field capacity on the depth of watering (0-75 cm) at maize crop were necessary irrigation rates with values by 2800 m^3 / ha in 2012 and 3320 m^3 / ha in 2013;
- The highest yields of maize 13500 kg / ha in 2012 and 12410 kg / ha in 2013 were obtained in variant without irrigation suspension and the smallest in variant with irrigation (4700 kg / ha in 2012 and 3860 kg / ha in 2013). Suspension of irrigation in the seasons of irrigations determined yield losses statistically assured both in 2012 and 2013. An exception was made in June of 2012, when there was no need for irrigations.
- The content in protein of maize grain from optimally irrigated variant versus unirrigated variant increased, suspending irrigation in July and August determined the decreasing highly statistically significant of protein content compared to variant optimally supplied with water.
- Research results obtained argue the necessity of irrigation in maize crop from Crisurilor Plain because are obtaining yield gains statistically assured and increased of protein content in maize grains. However, the results reflect the need for optimal supply with water because suspending irrigation in the irrigation season of maize causes loss of yield and decrease in protein content. This means that an optimum irrigation scheduling is very important.

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