ESTABLISHING THE OPTIMUM REGIME FOR IRRIGATION AT BARLEY AND TWO ROWED BARLEY IN NORTHERN BĂRĂGAN AREA

Daniela COADĂ (NENCIU)[1], Cătălina Ionela PREPELIȚĂ (POPOVICI), Adriana Mihaela TOTOLEA (HUȚANU), D.BUCUR
University of Agronomical Sciences and Veterinary Medicine in –Iași
Corresponding author: dana_nenciu2006@yahoo.com

Abstract. *The expansion of the areas cultivated with barley in the irrigated area of Northern Bărăgan imposes the knowledge of the water consumption and the optimum regime for irrigation, aspect less presented in the research literature. In the present paper there are presented the results of the researches performed in the Northern Bărăgan area, where, at present, it is cultivated the biggest part from the ploughland. The researches were performed in the years 2016-2020 at "Famagrion SRL" Commercial Company, under the representative field conditions of the dry steppe from Bărăgan. It was used the recommended technology fir this area. The differentiation of the experimental modalities was made taking into account the maintenance of the moisture of the soil between the water capacity from the field and certain minimum limit values in relation to the accessible moisture of the plants (available water, the interval of the active moisture), at the developing depth of the main mass of roots. The management of the irrigation system (application of the watering) was based on the moisture measurements from the soil carried out decadal in three repeated intervals for each modality. These measurements allowed the calculation of the water consumption through the balance method. For the calculation of the water consumption, it was taken into account the total of the rainfall amount. The results obtained certify the opportunity of irrigating these plants in order to ensure the moisture and compliance of the requirements regarding the water consumption for establishing the increased productions, both on normal soils and those affected by the salinization processe..*

***Key words*:** interval ofactive moisture, available water, norms of irrigation, average productions

INTRODUCTION

The extension of the cultivated areas with barley in the irrigated area of Baraganul Nord requires the knowledge of water consumption and the optimal irrigation regime, an aspect presented as little as possible in the specialized literature. Irrigation at 50% of the active humidity range (I.U.A.) is recommended. It is shown that spring watering is preferable for straw cereals, as autumn supply watering up to 1.5 m depth ensures a significant increase in soil moisture in spring and summer. It is considered to show the importance of these plants on the soils affected by salinity where they hold the share in the structure of the crops during the intensive improvement through field plants.

This paper presents the results of research conducted in the North Baragan area, where most of the arable land is currently cultivated. In the eastern part of the county, in most localities the share of arable land in the total agricultural land is at least 90%. Overall, in all localities in

Brăila the arable land occupies an important share (minimum 70%). The only exception is the city of Făurei where the arable land owns between 40% and 50% of the agricultural land. In this city, forests and other forest vegetation occupy a larger area than in other localities. The extension of the cultivated areas with barley in the irrigated area of Baraganul Nord requires the knowledge of water consumption and the optimal irrigation regime, an aspect presented as little as possible in the specialized literature. Irrigation at 50% of the active humidity range (I.U.A.) is recommended. It is shown that spring watering is preferable for straw cereals, as autumn supply watering up to 1.5 m depth ensures a significant increase in soil moisture in spring and summer. The importance of these plants on the soils affected by salinity is taken into account, where they hold the weight in the structure of the crops during the intensive improvement through field plants.

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MATERIALS AND METHODS

The researches were carried out in the years 2016-2020 in Braila county, instead. The union with "Famagrion SRL" Commercial Company, Traian, Corbu, Lacu Sarat, in the field conditions representative of the dry steppe area of Baragan.

Work was done on chernozem cambic. The mineral material on which these soils were formed consists of loess and loessoid deposits with a loamy to loamy-sandy texture in the depth of the soil profile and with groundwater at 2.5-3.5 m (critical depth) and on affected soils of salting processes being improved.

The recommended technology was used for this area. The differentiation of the experimental variants was made taking into account the maintenance of soil moisture between the water capacity in the field and certain minimum limit values compared to the accessible humidity of plants (useful water, active humidity range), at the depth of development of the main root mass. The management of the irrigation regime (watering application) was based on the soil moisture determinations performed decadal in three repetitions in the field for each variant.

These determinations also allowed the calculation of water consumption by the balance method. In the calculation of water consumption, the total atmospheric precipitation was taken into account .

RESULTS AND DISCUSSION

The obtained results attest to the opportunity to irrigate these plants to ensure humidity and meet water requirements in order to establish high yields, both on normal soils and those affected by salting processes.

Data on the climatic situation and soil moisture illustrate the fact that each year in variable time intervals, due to low atmospheric precipitation, there have been decreases below 50% even below 25% of water accessible to plants in the area of root system development, especially with a depth of 0-51 cm, either in autumn, in spring or in autumn and spring. As a

result, in natural conditions without irrigation, the vegetation of the plants and the level of production are considerably influenced. Tables 1, 3, 6, 7 present the production results and the irrigation regime applied to the most significant variants for the practice of agricultural units, and tables 2, 4, 5 show the corresponding water consumption, its sources of coverage and aspects on the capitalization of water by plants in different conditions of ensuring soil moisture.

1. Barley grown on chernozem

The obtained productions (table 1) show every year increases compared to non-irrigated to the irrigated variants. The highest increases were registered in the years with droughts in autumn and spring, when the non-irrigated version had the lowest productions. In fact, the production of the non-irrigated variant, in general, reflects the soil moisture conditions, and the increases brought by irrigation were up to 7.4 t / ha - 12% in 2016 and reached the maximum values of 4.54 t / ha and 250 respectively. % in the very dry year 2017.

Table 1

Influence of the irrigation system on the winter crops on vermic chernozem

with the groundwater at depth of 2.5-3.0 m

Variant	Yield of standard grains t/ha					
	2016	2017	2018	2019	2020	Average
Non-irrigated	5.94	1.75	4.97	1.96	5.20	3.96
Irrigated at 50% I.U.A. autumn + vegetation with differentiated norms on depths la 50% I.U.A.	6.68	6.29	6.62	5.80	8.0	6.68
Irrigated at 50% I.U.A. only autumn for sunrise and in vegetation the first phases	5.94	3.74	6.49	3.21	6.15	5.10
Irrigated at 50% I.U.A. only in vegetation	6.68	3.86	5.27	3.73	7.10	5.33
Irrigated at 50% I.U.A. (h = 0.75m)	-	5.87	-	5.72	--	-
Irrigated at 50% I.U.A. the last watering inspected it	-	5.59	-	4.95	-	-
Irrigated at 50% I.U.A. last watering on filling	-	4.59	-	4.33	-	-
Irrigated at 50% I.U.A. at inspection-fruiting + autumn for sunrise	-	5.28	-	4.80	6.85	-
Irrigated at 50% I.U.A. to inspected-fruiting	-	2.71	-	3.71	-	-
Irrigated at 70% I.U.A.	-	-	-	4.75	-	-

The drought in the area specific to the area makes sowing irrigation particularly efficient. During the five-year research period, in four autumn barley did not find optimal humidity conditions for sunrise, which lasted in the windows of positive temperatures from winter to spring. In such situations, sowing irrigation gave the guarantee of the harvest, made the plants able to benefit from the spring moisture, entering the winter with good vegetation, and in dry springs to be able to capitalize efficiently the irrigation during the vegetation. Compared to non-irrigation, average production increases of 1.14t / ha were obtained, which means 1727 kg brought by each m^3 irrigation water. The increases were between 0 and 1.99 t / ha, respectively, up to 2500 kg for each m^3 irrigation water.

The high frequency of spring droughts leads to the depletion of moisture reserve during vegetation, especially in May in the inspected-fruiting phases, or even to the filling and less frequently in the grain filling phase. In three out of five years, the blight took place when the soil moisture accessible to plants was below 50% and even below 25%. Following tables 1 and 3, the efficiency of irrigation is found in such situations.

The largest productions with a good capitalization of the water are noticed in the irrigated variants for sowing in dry autumns and during the vegetation, in spring. There is the irrigated variant at 50% accessible humidity with differentiated norms on depths depending on the development of the root system, the possibility to use the reserve water from the deeper layers and the production of plant fall. In this variant, applying smaller quantities of irrigation water, productions equal to those from the irrigated variant at 50% accessible humidity for plants were achieved, with watering norms calculated for 75-80 cm, the variant according to which the landscaping arrangements are designed. irrigation and which is the basis of watering warning. The last watering was applied during grain formation, as the need for irrigation after this phase occurs only in cases of prolonged drought with heat, in cases when no watering was applied until these phases, and may damage the crop if it causes the plants to fall. Also, irrigation at a high humidity ceiling, at 70% of the useful water, does not ensure satisfactory production as it leads to the fall of plants. Interruption of irrigation before the grain formation phase is also not recommended in dry years, although barley best exploits irrigation until these phases. The application of watering until inspected decreased the harvest by 7.0 - 8.5 t / ha and the application of watering only until the filling phase can decrease the production by 1.47 - 1.70 t / ha in the years when the following phases take place in unsatisfactory humidity conditions. , below 50% humidity accessible to plants.

Note the inefficiency or reduced efficiency and irrigation at 50% humidity accessible only during the vegetation without irrigation at sowing in dry autumns.

Regarding the efficiency of irrigation applied during the vegetation in good conditions of sunrise in autumn, it was found that watering at the ceiling of 50% humidity accessible to plants until the beginning of grain formation with differentiated norms, led to obtaining the highest production increases 0.74 - 2.55 t / ha (table 2), compared to the irrigated sowing variant. It returned 1,057 - 1,707 kg of grain increase per cubic meter of irrigation water, with a total consumption of 0.59 - 0.81m^3 water for the production of one kg of grains. In this variant, the lowest water consumption was achieved to obtain one kg of grains: 0.74 m^3/ kg.

Table 2

Water consumption by the plants on vermic chernozem in the period 2016-2020

Variant	Yield growth due tu irrigation, kg/ha		Yield growth due to irrigation water), kg/ m^3		Water consumption m^3/kg grains	
	Average	Limits	Average	Limits	Average	Limits
Non-irrigated	Martor		Martor		0.94	0.50-1.45
Irrigated at 50% I.U.A. autumn + in vegetation with differentiated norms	27.1	7.4-45.4	1.291	1.057-1.707	0.74	0.59-0.81
Irrigated at 50% I.U.A. only autumn	11.4	0.0-19.9	1.727	0.0-2.500	0.77	0.53-1.04
Irrigated at 50% I.U.A. only during the vegetation period	13.6	3.0-21.1	0.966	0.400-1.416	0.86	0.49-1.10

The observations on the main elements of productivity (table 3) show an increase in the number of fertile ears and the number of stems compared to non-irrigated to the irrigated variants at sowing in dry autumns. In the irrigated variants, the vegetative apparatus was richer, the straw production being higher by 70-120% compared to the non-irrigated one in the dry years. Also, the height of the plants increased compared to the non-irrigated one by 20-25 cm. The mass of 1000 grains was favorably influenced by irrigation in years with drought during grain formation-filling and therefore favorable if there was a decrease in plants and excessive irrigation at 70% accessible humidity, or with norms greater than 40-50mm

Table 3

Influence of the irrigation system on the main productivity elemnts in barley on vermic chernozem in two typical droughty years, 2017-2018

Variant	Number ears/ m^2		Number stems/ m^2		M.M.B	Straw yield	Plant height at harvesting
	Total	Small %	20-25 VI	1-10 IV	-g-	-t/ha-	-cm-
Non-irrigated	534	37	0-196	278-367	39.0-40.8	3.7	40
Irrigated at 50% I.U.A.	762	16	440-503	473-895	39.6-42.6	5.9	61
Irrigated at 70% I.U.A.	776	14	440-503	473-895	36.6-39.0	6.0	65

In the irrigated variant at 50% humidity accessible to plants with sowing waterings and during vegetation until inspected - the beginning of grain formation with differentiated norms, the irrigation regime consisted of average irrigation norms of 200 mm, respectively 70-300 mm distributed in 1 - 5 waterings depending on the annual climatic conditions, applied in autumn to sowing 0.80 mm in 1-2 waterings, in April 0.120 mm, in May 50-170 mm and up to 50 mm in June.

Tables 4 and 5 present the results of research on water consumption. In the period 2016-2020 the total water consumption was about 500mm, with variations from 457 to 537 mm. In the natural conditions of the area, the main source of its coverage is the precipitation that falls during the vegetation. They can cover on average around 70% of the total evapotranspiration with variations from 45% to over 85% of the total consumption. From the soil reserve (the difference between the initial reserve and the final soil moisture reserve) can cover only a maximum of 2-5% of the total evapotranspiration. The result is a deficit of 15-55% of the total water consumption to be covered by irrigation, which occurs in autumn at sowing and in April, May, June with a maximum peak in May when the water consumption of the plants reaches the maximum values.

Table 4

Water consumption and sources for winter crops on vermic chernozem in the period 2016-2020

Variant	Total water consumption, mm		Sources of average water consumption, %			
	Average	Limits	Rainfals		irrigations	
			Average	Limits	Average	Limits
Non-irrigated	339	207-457	94	82-100	-	-
Irrigated at 50% I.U.A. autumn + in vegetation with differentiated norms	494	457-537	70	45-85	30	15-55
Irrigated at 50% I.U.A. only autumn	377	297-462	84	65-100	14	0-35
Irrigated at 50% I.U.A. only during the vegetation period	426	350-501	74	55-93	26	7-45

Table 5

Dynamics of average daily water consumption during the period 2016-2020

Month	Water consumption, mm			
	Optium irrigation		Non- irrigated	
	Average	Limits	Average	Limits
October	1.9	1.0-2.6	1.0	0.8-2.6
November	0.8	0.5-1.2	0.7	0.4-1.2
Winter	0.7	0.2-1.0	0.4	0.0-0.6
March	1.2	0.2-1.8	0.8	0.0-1.8
April	3.1	1.7-5.0	2.7	0.9-5.0
May	4.5	4.0-5.0	2.7	0.7-4.0
June	3.0	2.3-4.3	2.5	1.2-3.2

2. Spring barley grown on chernozem

Spring barley, considered for the North Baragan area as an intervention crop, to compensate for extreme cases of calamity of autumn cereals, achieves very different productions depending on the variety (table 6). For the Xanadu variety, the maximum production was 4.29-5.11 t / ha, the irrigated variant was made at the ceiling of 50% of the accessible humidity with increases of 0.30-1.51 t / ha compared to non-irrigated.

Table 6

Influence of the irrigation system on the yield of two-row summer barley on vermic chernozem with groundwater at a depth of 2.5-3.0 m

Variant	Grain yield, t/ha				Difference		Difference of rate, mm						
	2016	2019	2020	Average	t/ha	%	Number of annual irrigations				Monthly		
	Tunika	Xanadu					2016	2019	2020	Average	IV	V	VI
Non-irrigated	1.70	3.67	3.50	2.95	Martor		-	-	-	-	-	-	-
Irrigated at 50% I.U.A.	2.04	4.29	5.11	3.8	0.85	2.9	50/1	50/1	210/6	100/1-3	-	50-210	-
Irrigated at 50% I.U.A. last heard the inspected			4.60						140/2				
Irrigated at 50% I.U.A. last watering on filling			4.00						75/1				
Irrigated at 30% I.U.A.			3.90						90/1				

Irrigation at a lower ceiling of soil moisture, or interruption of irrigation at the stage of inspection or spreading in dry years, reduces production by 0.51-1.21 t / ha.

From these indicative researches results the efficiency of barley irrigation with average irrigation norms of about 100 mm, respectively 50-210 mm distributed in 1-3 waterings, especially in May.

3. Barley and barley on soils affected by salting

The results of the researches on soils affected by salting processes in the process of improvement in North Baraganul, presented synthetically in table 7, lead to the conclusion of a minimum ceiling of the optimal soil moisture higher than normal soils. The best results were obtained at the ceiling of 60-70% of the accessible humidity.

At the end of the first stage of soil improvement, yields of 5.20 t / ha for autumn barley, 3.92 t / ha for spring barley (Xanadu variety) and 2.2 t / ha for spring barley (Tunika variety) could be obtained in the first years of improvement.

On these soils, which usually have a groundwater intake, maintaining the soil moisture between the ceiling of 60-70% accessible moisture of water in the field is ensured with more and more frequent watering norms compared to normal soils. In such irrigation conditions it also has an ameliorating role, contributing to the washing of salts and maintaining a low concentration in the area of the roots. On saline soils, non-irrigated crops are more strongly affected than on normal soils, as the lack of moisture is complicated by the increase in salt concentration so that production is greatly reduced. Thus, for barley and barley in the very dry year 2016, yields lower than half were obtained compared to those on normal soils in case it was irrigated only in autumn without watering during the vegetation period.

Table 7

Influence of irrigation on the yields achieved on salty soils that are in course of melioration

Variant	Gain in yield	Irrigation rate, mm					
	t/ha	Average years/no ofirrigations	Limits	Autumn at sowing	monthly		
					IV	V	VI
I.	Wet groundwater saline medium soil, stage I of improvement, Lacu Sarat, average 2016-2020- Xanadu						
-non-irrigated	1.49	-	-		-	-	-
-irrigated at 50% I.U.A.	1.85	72/1-2	40-95	60-120	-	0-60	0-55
-irrigated at 70% I.U.A.	2.20	85/3-4			1-55	30-55	0-55
II.	Medium salinized soil at the end of the first stage of improvement, Corbu, 2016-2018						
-irrigated barley Xanadu irrigated 60-70% I.U.A..	3.92	140/3-4	120-160	-	0-50	80-120	40-90
-autumn barley irrigated at 60-70% I.U.A.	5.20	190/4-5	140-240	40-60	0-50	60-120	40-60
III.	Medium saline soil at the beginning of breeding. Traian, 2020						
Irrigated spring barley Xanadu 60-70% I.U.A.	3.01	280/4		-	-	140/2	140/2
IV.	Moderately-strongly salinized soil in the improvement stage. Traian, 2016-2020						
Laverda autumn barley irrigated only in autumn for sunrise	1.50	50/1		50/1			
Andra autumn barley irrigated only in autumn for sunrise	1.60	50/1		50/1			

The presented results allow to establish for the elements of the irrigation regime the following values: for spring barley irrigation norm of 6-160 mm distributed in 3-4 waterings in April, May, June, and for autumn crops norms of 140-240 mm distributed in 4-5 waterings in autumn for sowing to ensure the emergence and vegetation in the first phases and during the vegetation in April, May, June.

The researches draw attention to the fact that both normal and salted soils require the observance of the minimum ceiling, especially in the 0-50 cm layer, and the application of

watering to be done depending on the reaction of the plants. After inspecting the grain formation, in case the plants fall, the irrigation will be interrupted.

CONCLUSIONS

- The research carried out in the years 2016-2020 attests the opportunity to irrigate barley and barley in the dry steppe area of the Romanian Camia, in order to stabilize the high productions.

- Under natural conditions, the production level is considerably affected by drought in two stages: specific to the area in autumn sowing and frequently in spring when inspected-fruiting, when the soil moisture is exhausted and insufficient rainfall does not meet the water needs of plants.

- The total water consumption for autumn crops is around 500 mm, covered mostly by atmospheric precipitation during vegetation, with an average deficit of 30% to be covered by irrigation.

- During the vegetation the average diurnal water consumption registers values of 1.5-2.6 mm in October during sunrise and vegetation in the first phases, in autumn crops, 3.1-4.7 mm on average in April, May, June, with maximum in May he inspected the beginning of grain formation. In the non-irrigated area, an average deficit of 0.7 mm was reported in October, 2.2 mm in May and 0.6 mm in April and June.

- The minimum ceiling of the optimal soil moisture at the development depth of the main root mass is 50% useful water, which must be provided from sowing to the beginning of grain formation on normal soils and 60-70% on soils affected by salting processes. in the process of amelioration where more frequent and low watering irrigations are applied, the irrigation having an ameliorating role.

- On normal irrigation soils necessary for barley, they have average values of 200 mm, respectively 70-300 mm distributed in 1-5 waterings depending on the annual climatic conditions. Watering application: autumn to sowing 40-50 mm and in April to May, norms of 60-70 mm. Exceptionally, in the very dry years, autumn, it returns with another watering of 40-50 mm and in the period of filling the grains, on the heat, if it does not cause the plants to fall. For spring barley, average irrigation norms around 100mm, with variations from 50 to 210 mm distributed in 1-3 waterings, with weight in May.

- On the soils affected by plowing, in the process of improvement, the irrigation norms have values of 140-240 mm for the autumn crops distributed in 4-5 waterings and norms of 60-160 mm, for the spring barley, distributed in 2-4 udari.

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