INFLUENCE OF THE IRRIGATION ON WATER CONSUMPTION AND YIELD IN WINTER WHEAT AT ORADEA AND IN DIFFERENT REGIONS OF ROMANIA

Brejea Radu*, Domuța Cristian, Gîtea Manuel, Jude Eugen, Cenușa Nicolae

*University of Oradea, Faculty of Environmental Protection, 26 Gen. Magheru St., 410048 Oradea; Romania, e-mail: rbrejea@yahoo.com

Abstract

The paper presents the results of research realized in the field of soil water balance in representative areas for irrigation in Romania. In April the highest optimum water daily consumption of winter wheat was registered in Plain Burnasului at Baneasa Giurgiu, 38m^3 / ha and the lowest at Braila in Bărăganului Plain. In May the highest water consumption was registered at Valu Traian in Dobrogea, and the lowest daily water consumption was registered at Podu Iloaiei, Valu lui Traian and Mărculeşti. In June, the highest value of optimum water consumption was recorded at Oradea, and the lowest at Podul Iloaiei; in localities Oradea, Braila, Baneasa- Giurgiu and Caracal were recorded the maximum daily water consumption of winter wheat. Using irrigation in the conditions of maintaining of soil water reserve on watering depth between easily available water content and field capacity causes a substantial improvement in daily water consumption of winter wheat. Thus, under the moderately sub-humid zone of Crisurilor Plain during 1976-2014 average values of water consumption were higher than in unirrigation conditions with 19% -56%, pointing out that the maximum difference was registered in the last month vegetation, plant leaves maintaining the activity over a longer period of time.

Key words*:* irrigation, winter wheat, soil water reserve, daily water consumption, yield

INTRODUCTION

Research on the anatomical and physiological particularities leads to highlighting winter wheat crop irrigation regime and irrigation influence on the quantity and accessibility of water in the soil, the microclimate, water consumption, yield and water use efficiency. (Canarache, 2001, Bîlteanu, 2003, Domuța 2009, 2012, Jude, 2012)

The amount of water absorbed by the seeds of winter wheat sprout is 44-50% by dry weight.(Stepănescu, Mate, 1972) Rising of winter wheat takes place under optimum conditions when soil moisture is 70-80% of field capacity of the soil. (Brejea, 2009, 2010, 2014) Plants from sowing to emergence grow in humid conditions are poor little with narrow leaflets with embryonic stem underdeveloped, with small quantities of carbohydrates. These plants undergoing with difficulty to adverse winter conditions. Spring adequate moisture conditions can not eliminate water deficiency during rising and next steps. They are maintained throughout the

vegetation period with repercussions on yield capacity (Bîlteanu, 2003, Borza, Stanciu, 2010, Borza, 2014, Domuța, 2010).

Anghel et al. (1960) (quoted by Domuța, 2010) consider that it is wrong to believe that deficiency of water for growing, winter wheat seeds in dry soil preserves its germination ability and capacity to pierce. It is considered that in such conditions, seeds germinate losses are 25-28%. During earing requirements of winter wheat to moisture increasing since at this stage of vegetation occurs an intense growth, forming shoots, leaves and new roots.

In spring winter winter wheat starts early vegetation and use a period soil moisture reserves accumulated during the winter. As it developed the vegetation winter wheat requirements for moisture grows. Insufficient humidity in this period has influence on elongation and on the process of organogenesis straw, ear formed under such conditions having a smaller number of fertile ears. (Borza, Stanciu, 2010)

Insufficient soil water during earing, fertilization, grain filling determine loss of yield. In this period the deficiency of soil water accompanied by atmospheric drought and high temperatures creates an imbalance in the water cycle in the plant (Jitereanu, 1995). Level of perspiration exceeds the level of absorption and metabolism of the plant including the transport of assimilated leaf to grain. Sharp rising of temperature and currents of warm air causes the same imbalance in plant metabolism, even if the soil is well supplied with water, registered the phenomenon of "physiological drought" (Domuța 2000, 2012, 2014). As a result, the grain growth stops, waste water, wrinkles, and if it occurs earlier at the top of the ear grains do not form. Loss of water by grain and pucker is called "shriveled".

Ceapoiu (1984) estimated that the winter wheat growth stages have excess moisture requirements and these are (in order of importance):

- Appearance of primordial ears, formation and differentiation of primordial floral when is deciding the number of ears fertile flowers from ears;
- Pollination and fertilization, when drought installation reduces stigma receptivity, reduce pollen activity and decreasing of pollen grain viability;
- Formation and grain filling when water deficiency impedes the deposit reserve of substances in seeds. Grains remain shriveled, light, low in starch and protein, rich in cellulose, with poor baking properties;
- Formation of primordial which give the brothers. Lack of moisture reduces the number of brothers;
- Strawing. Rich vegetative growth (elongation of stems, leaf growth, root system development) requires a large amount of water.

MATERIAL AND METHOD

ICITID Baneasa Giurgiu had a strong network of research with fields in soil water balance located in all regions of interest for irrigation in Romania. These experiences aimed substantiation opportunity for irrigation in these areas. In the immediate vicinity were placed points or stations warning splashing provided with Bac evaporimetre and meteorological instrumentation allowed to determine coefficients Kc for converting reference evapotranspiration Bac (or Piche) in optimum water consumption of plants, coefficients Kc are used in irrigation scheduling. (Domuța, 2010)

To show the influence of irrigation on water consumption and yield were chosen following fields of water balance in soil: Oradea (Crisurilor Plain) Podu Iloaiei (Northern Moldova), Braila and Mărculeşti (Baragan Plain), Baneasa-Giurgiu (Burnasului Plain), Caracal (Olteniei Plain), Cluj-Napoca (Transylvania Plateau).

Irrigation regime will be leading so as to ensure the maintenance of the water supply between the easily available water content and field capacity to the depth of 0-75 cm in Constanta and North Bărăgan and on depth of 0-50 cm in the other areas.

In Oradea, the average of irrigation rates used during the 1976-2014 in winter wheat crop was 1490 m^3/ha; average scheme of application was as follows:

IV	V	VI	VII
1/2	1	11/2	0

The variation interval of values of irrigation ratio was between 0 in (1978) and 4080 m^3/ha (2000).

Water consumption was determined through soil water balance method, balance depth being 0-150 cm. (grumeza etal., 1983, Grumeza, Kleps, 2005, Ionescu Șișești, 1986)

Winter wheat yields were obtained in compliance with the rigors of experimental technique.

RESULTS AND DISCUSSION

The influence of irrigation on water consumption of winter wheat

Using irrigation in the conditions of maintaining of water reserve on the watering depth between easily available water content and field capacity causes a substantial improvement in daily water consumption of winter

wheat. Thus, under the moderately sub-humid zone of Crisurilor Plain during 1976-2014 average values of water consumption were higher than in unirrigation conditions with 19% -56%, pointing out that the maximum difference was registered in the last month of vegetation, plant leaves maintaining the activity over a longer period of time (table 1).

Table 1.

The average daily water consumption (m^3/ha/day) in the winter wheat in the Crișurilor Plain and in different areas of Romania

Area	Place	Variant	Month		
			IV	V	VI
Crisurilor Plain	Oradea	Unirrigated	26	33	17
		Irrigated	31	45	20
Moldova de nord	Podu Iloaiei	Irrigated	27	43	-
Baraganului Plain	Braila	Irrigated	23	42	-
Dobrogea	Valu lui Traian	Irrigated	30	48	-
Baraganului Plain	Marculesti	Irrigated	28	44	-
Burnasului Plain	Băneasa Giurgiu	Irrigated	38	41	-
Olteniei Plain	Caracal	Irrigated	29	41	-
Transilvaniei Plateau	Cluj Napoca	Irrigated	-	-	-

In April the highest optimum water daily consumption of winter wheat was registered in Plain Burnasului at Baneasa Giurgiu, 38m^3 / ha and the lowest at Braila in Bărăganului Plain. In May the highest water consumption was registered at Valu Traian in Dobrogea, and the lowest daily water consumption was registered at Podu Iloaiei, Valu lui Traian and Mărculeşti. In June, the highest value of optimum water consumption was recorded at Oradea, and the lowest at Podul Iloaiei; in localities Oradea, Braila, Baneasa- Giurgiu and Caracal were recorded the maximum daily water consumption of winter wheat.

In terms of Oradea in the period 1976-2014, total water consumption of irrigated winter wheat was higher than the unirrigated with values between 3% and 103%, irrigation participating in its coverage with 34.4%, variation interval from 0 to 54% (table 2).

Between water consumption and yield of winter wheat there is a direct link by different forms depending on climatic conditions (Grumeza et al., 1989). In terms of Oradea, this link had a polynomial form statistically very significant.

Table 2.

Total water consumption of irrigated and unirrigated winter wheat and the covering sources, Oradea 1976-2014

Variant	Total water consumption			Covering sources of the water consuption					
	m^3/ha	%	Int. of variation %	Ri-Rf m^3/ha	Precipitation from vegetation period		Σm		
					m^3/ha	Int. of variation %	m^3/ha	Int. of variation	
								m^3/ha	%
Unirrigated	3160	100	100	806	2354	38-108	-	-	-
Irrigated	4329	137	103-203	485	2354	22-88	1490	0-4080	0-54

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

The influence of irrigation on winter wheat yield

Using irrigation in the conditions of maintaining water reserve between the easily available water content and field capacity obtaining gain yields highly statistically significant in all years studied. In Oradea in the period 1976-2014, the yield obtained was higher than unirrigation conditions with 38.5% , variations interval is between 5 and 121%.

Besides the higher level of yield under irrigation conditions, the degree of stability of winter wheat yield has improved significantly, so that the degree of dispersion of yield around the average under irrigation conditions decreased with 30.8% compared to unirrigated variant (Table 3).

Differences of the level and stability of yield were registered in the conditions of maintaining the water reserve on irrigation depth between easily available water content and field capacity throughout the irrigation season.

Failure in follow this conditions determines obtaining of a lower yield performance. Thus, respecting the optimal number of irrigation applications, but reducing the irrigation ratio halfway was obtained winter wheat yield which represents only 77.8% from yield of irrigated variant full time. This underlines the necessity to respect the number of irrigation application and irrigation ratio set (Domuta, 1995).

Table 3

Influence of the irrigation on level and stability of winter wheat yield in the conditions of Crisurilor Plain, Oradea 1976-2014

Variant	Yield				Standard deviation	
	Average		Interval of variation			
	Kg/ha	%	Kg/ha	%	Kg/ha	%
Unirrigated	4620	100	2736-7100	100	922	100
Irrigated	6399	138,5	3993-8300	105-221	642	69,2

LSD 5% 230; LSD 1% 370; LSD 0,1% 630;

The higher relative difference between the yield of irrigated winter wheat and the unirrigated winter wheat was determined at Valu lui Traian (61%), followed by Braila (55%), Mărculeşti (50%), Baneasa Giurgiu (47%), Caracal (22%) and Podu Iloaiei. The higher absolute yield of winter wheat crop was obtained at Valu lui Traian (6100 kg/ha) and lowest at Podu Iloaiei (4600 kg / ha) (Table 4).

Table 4

Influence of the irrigation on winter wheat yield in different areas from Romania

Area	Place	Variant	Yield		Difference	
			Kg/ha	%	Kg/ha	%
North Moldova	Podu Iloaiei	Unirrigated	3800	100	-	-
		Irrigated	4600	121	800	21
Dobrogea	Valu lui Traian	Unirrigated	3800	100	-	-
		Irrigated	6100	161	2300	61
Baraganului Plain	Braila	Unirrigated	3900	100	-	-
		Irrigated	5300	155	1400	55
Baraganului Plain	Marculesti	Unirrigated	3000	100	-	-
		Irrigated	4500	150	1500	50
Burnasului Plain	Băneasa Giurgiu	Unirrigated	3200	-	-	-
		Irrigated	4700	147	1500	47
Olteniei Plain	Caracal	Unirrigated	4400	100	-	-
		Irrigated	5500	122	1100	22

CONCLUSIONS

Research conducted in the field of soil water balance from Oradea and in the other representative irrigation areas of Romania led to the following conclusions:

❖ In April the highest optimum water daily consumption of winter wheat was registered in Plain Burnasului at Baneasa Giurgiu, 38m^3/ha and the lowest at Braila in Bărăganului Plain. In May the highest water consumption was registered at Valu Traian in Dobrogea, and the lowest daily water consumption was registered at Podu Iloaiei, Valu lui Traian and Mărculeşti. In June, the highest value of optimum water consumption was recorded at Oradea, and the lowest at Podul Iloaiei; in localities Oradea,

Braila, Baneasa- Giurgiu and Caracal were recorded the maximum daily water consumption of winter wheat;

❖ Using irrigation in the conditions of maintaining of water reserve on the watering depth between easily available water content and field capacity causes a substantial improvement in daily water consumption of winter wheat. Thus, under the moderately sub-humid zone of Crisurilor Plain during 1976-2014 average values of water consumption were higher than in unirrigated conditions with 19%-56%, the maximum difference was registered in the last month of vegetation, plant leaves maintaining the activity over a longer period of time;

❖ In terms of Oradea in the period 1976-2014, total water consumption of irrigated winter wheat was higher than the unirrigated with values between 3% and 103%, irrigation participating in its coverage with 34.4%, variation interval from 0 to 54%;

❖ Using irrigation in the conditions of maintaining the soil water reserve between the easily available water content and field capacity obtaining the yield gains highly statistically significant were obtained in all years studied. In Oradea in the period 1976-2014, the yields obtained were higher than the yield obtained in unirrigated conditions with 38.5%; variations interval is between 5 and 121%;

❖ Besides the higher level of yield under irrigation conditions, the degree of stability of winter wheat yield has improved significantly, so that the degree of dispersion of yield around the average under irrigation conditions decreased with 30.8% compared to unirrigated variant;

Differences between water consumption of irrigated and unirrigated winter wheat crop, yield differences statistically assured, higher yield stability sustain the necessity for irrigation in all six areas studied in Romania.

REFERENCES

1. Bîlteanu Gh., 2003, Fitotehnie vol I. Ed. Ceres, Bucureşti
2. Borcean I., David Gh., Borcean A., 2006, Tehnici de cultură şi protecţie a plantelor tehnice Ed. De Vest
3. Borza I., Stanciu A., 2010, Fitotehnie, Editura Universităţii din Oradea
4. Borza I., Domuţa C., Şandor M., Domuţa Cr., Brejea R., Jude E., Albu R., 2014 The Irrigation Influence on Main Parameters of the Soil-Water-Plant-Atmophere in Winter Wheat from Crisurilor Plain, Analele Universităţii din Oradea, Fascicula Protecţia Mediului Vol XXIII Anul 19, ISSN 1224-6255, pp. 31-36
5. Budoi Gh., Penescu A., 1996, Agrotehnică. Ed. Ceres, Bucureşti
6. Brejea R., 2009, Tehnologii de protecţie sau refacere a solurilor, Ed. Universităţii din Oradea
7. Brejea R., 2010**,** Ştiinţa solului: îndrumător de lucrări practice, Ed. Universităţii din Oradea
8. Brejea R., Domuţa C., 2011, Practicum de pedologie. Ed. Universitatii din Oradea

9. Brejea, R., 2014, Tehnologii de protecţia solului. Oradea. Ed. Universităţii din Oradea
10. Cazacu, E., et al. 1989, Irigaţii. Bucureşti. Ed. Ceres Bucureşti
11. Ceapoiu, N., 1974, Grâul. Editura Ceres Bucureşti
12. Canarache A., 2001, Utilizarea eficientă a resurselor funciare din agricultură. În vol. „Cercetarea ştiinţifică în sprijinul redresării şi relansării agriculturii şi silviculturii româneşti. Ed. Ceres. Bucureşti.
13. Colibaş I., Colibaş Maria, Tirpe Gheorghe, 2000, Solurile brune luvice, caracterizare şi ameliorare, Ed. Mirton, Timişoara.
14. Domuţa C., 1995, Contribuţii la stabilirea consumului de apă al principalelor culturi din Câmpia Crişurilor. Teză de doctorat, Academia de Ştiinţe Agricole şi Silvice „Gheorghe Ionescu Şişeşti" Bucureşti
15. Domuţa C. şi colab., 2000, Irigarea culturilor. Ed. Universităţii din Oradea.
16. Domuţa C. 2003, Oportunitatea irigaţiilor în Câmpia Crişurilor. Ed. Universităţii din Oradea
17. Domuţa C., 2005, Practicum de irigarea culturilor şi agrotehnică. Ed. Universităţii din Oradea
18. Domuţa C., coord., 2009, Irigaţiile în Câmpia Crişurilor. Ed. Universităţii din Oradea.
19. Domuţa C., 2009, Irigarea culturilor. Ed. Universităţii din Oradea.
20. Domuţa C. (coord), 2012, 50 de ani de cercetări agricole în Oradea. Ed. Universităţii din Oradea
21. Domuţa C., Domuţa Cr. (coord), 2014, Cercetări privind irigaţiile în Câmpia Crişurilor (1976-2014) Ed. Universităţii din Oradea.
22. Domuţa Cr., C. Domuţa, 2010, Materii prime vegetale. Ed. Universităţii din Oradea.
23. Grumeza N. şi colab., 1989, Prognoza şi programarea aplicării udărilor în sistemele de irigaţii. Editura Ceres, Bucureşti.
24. Grumeza N., Klepş Cr., 2005, Amenajările de irigaţii. Editura Ceres, Bucureşti
25. Ionescu Şişeşti, Vl., 1986, Irigarea culturilor. Bucureşti. Editura Ceres
26. Jitereanu G., 1995, Ingineria conservării solului şi apei. Curs. Ed. Univ. Agronomice şi de Medicină Veterinară, Iaşi.
27. Jude E., 2012, Ecologie generală, Ed. Universităţii din Oradea
28. Stepănescu E., Mate E., 1972, Irigaţiile – mijloc de sporire a producţiilor la principalele culturi, în vol SCAZ Oradea zece ani de activitate în sprijinul producţiei. Red. de prop. agr. Bucureşti