THE INFLUENCE OF THE FORERUNNER PLANT AND THE IRRIGATION ON SOME QUALITY INDICATORS OF THE WHEAT PLANT (*Triticum aestivum* L.) IN THEIR GROWTH CONDITIONS ON THE ACID SOILS IN THE NORTH-WESTERN ROMANIA

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Abstract: The paper sustains the importance of the forerunner plant concerning the quality of the wheat (*Triticum aestivum* L.) and is based on the research carried out during 2006-2008 on a long term trial placed on the brown luvic (acid soils) from Oradea in 1990. In non-irrigating and irrigating conditions as well the smallest protein, wet gluten and dry gluten values were obtained in wheat mono-crop; the values increased in the forerunner plant, wheat-maize and the biggest values were registered in the forerunner plant, wheat-maize-soybean.

Keywords: forerunner plant, quality, irrigated, non-irrigated, water regime, mono-crop, protein, wet gluten, dry gluten.

INTRODUCTION

The importance of the forerunner plant for the wheat culture is known since Ancient History, the Romans even had a law that forbid the cultivation of wheat after wheat [7, 10]. In irrigation conditions, the importance of the forerunner plant increases both due to its complex influence, and due to the influence of irrigation on the physical and chemical features of the soil [2]

The research carried out in this field has pointed out the fact that the quality feature is conditioned by the cultivated species and hybrid, the climatic movement of the culture year and last but not least by the technology applied to the agricultural plants. In order to justify some aspects, with implications influencing the quality of the obtained production, we make some references to specialty literature, where [12, 13]), we underline the importance of nitrogen in the growth of the protein content, wet and dry gluten and on the improvement of the quality indices of the gluten. The authors mention also the role of the improving plant on the quality indices for wheat [6].

The role of the forerunner plant and especially that of the fertilization with nitrogen on the quality of wheat, materialized in a higher content of protein and wet and dry gluten indifferent to the degree of soil's fertilization on which the cultivated species had been experimented [8, 14].

The quality of the production is a feature connected to a series of physical and chemical characteristics of the plants that offer a positive note to the applied agro technical measures for its correlation with the production obtained on the surface unit [5].

The quality of yield is influenced by many factors. Protein accumulation in the grains is influenced by wheat type, cultivar, climate conditions, natural fertility of the soil, nitrogen doses used, irrigation [1, 4]. The gluten content of the wheat grain is influenced first of all by the climatic conditions [3].

The influence of crop's rotation and irrigation in the protein and gluten content is presented in some of the authors' papers [5, 11]. This study is important given the fact that the aridization tendencies of the climate are obvious, and a part of The Western Plain that is extended until the sands area in Valea lui Mihai is considered to be "transfer area to desertification". It is a radical change of perception of the realities of the area given the fact that 30-40 years ago, there mainly research was regarding the temporary excess of moisture. Subsequently, the correct concept regarding the succession *moisture excess-deficit* appeared, the moisture excess manifesting itself in the cold months (X-III) and sometimes in the first months of the warm period. Long-term research carried out at the Agricultural Research-Development Station Oradea has pointed out the fact that in the second part of the warm period the phenomenon of pedological drought is manifested [9].

The theoretical and practical importance of this study consists in the fact that each year was pointed out the presence of accentuated pedological drought, as well as the statistically very significant connections between these indicators and water consumption, the quantity and quality of the productions (the content of protein, wet and dry gluten) [15].

MATERIALS AND METHODS

The paper is based on the research obtained on a long term trial with forerunner plant, placed in 1990 carried out at the Agricultural Research-Development Station Oradea on acid soil. The research was carried out during 2006-2008.

On ploughing depth, the soil is low acid (pH=6.8), low humus content (1.75%), phosphorus (22.0 ppm) and potassium (845.4 ppm) has medium values; the hydro stability of macro aggregates has high and bulk density (1.44 g/cm^3) is high, too [9].

The investigated experimental factors were:

Factor A: forerunner plant

a_1 = wheat, mono-crop; (*Triticum aestivum* L., 'Dropia' cultivar);

a_2 = wheat (*Triticum aestivum* L., 'Dropia' cultivar) – maize (*Zea mays* L., HT Elan)

a_3 = wheat, (*Triticum aestivum* L., 'Dropia' cultivar) – maize (*Zea mays* L., HT Elan) – soybean (*Glycine hispida* L., 'Biloxi' cultivar).

Factor B : water regime

b_1 = non-irrigated;

b_2 = irrigated

The experience was set up using the block method. The surface of the experiment parcels = 50 m^2. The number of repetitions = 4, during 2006-2009.

- *forerunner plant:* monoculture wheat, maize in a two-year rotation and soybean in a three-year rotation;

- *species of wheat used*: Dropia, created by the Institute of Agricultural Research-Development Fundulea (Romania), and acknowledged in 1993. Is an early species with a short coleoptile, average union, semi-dwarf (85-90 cm). It is a species resistant to wintering, falling, mildew and Septoria and the kernel is resistant to fusariosis, rust and Helmintosporiosis. It is a species which tolerates scorching heat and drought. The mass of 1000 grains is 43-48 g. The species production potential is average, and the quality is very good. It is a species cultivated only on plains.

Knowing the dependence between bread quality and protein substances, and especially in comparison with the quantity and quality of the gluten, the most frequent analyses refer to the determination of the protein content or to the *determination of the percent of wet or dry gluten*, as well as to *its quality*. The content of wet or dry gluten of flour gives a very approximate indication of the flour quality. This is the reason why it is necessary to determine the quality of the gluten because the features of flour panification are connected to it. Wet and dry gluten were determined with common methods used in panification, at the Agricultural Research-Development Station Oradea: *Berliner method*, *Pelshenke method, Zeleny method* (sedimentation method), *Chopin method.*

In order to determine the *protein content*, we used the classical Kjeldhal method. *The raw protein (RP)* was calculated with the relation: RP = Nt x 5.7% where: Nt = total nitrogen.

The total nitrogen (Nt) in the grains was determined by using the Kjeldahl method in the laboratory.

The *moisture* of the grains at harvesting was determined using the moisture meter.

The *main production* was calculated at the STAS moisture of 14.5%.

RESULTS

The results obtained after the carried out research are presented next. In Table 1 are presented the results obtained regarding the influence of the forerunner plant and of the irrigation on the protein content of wheat grains in the period 2006-2008.

The experimental results regarding the influence of the forerunner plant and of irrigation on the content of wet gluten for wheat grains during 2006-2008, are presented in Table 2.

Table 1. Influence of the forerunner plant and irrigation on the protein content of the wheat grains, Oradea 2006-2008.

Forerunner plant	Water regime				Average on the forerunner plant
	Non-irrigated		Irrigated		
	Protein				
-	%	%	%	%	-
1.Wheat – monocrop	7.98	100	7.73	100	7.86^{Mt}
2.Wheat – maize	10.7	135	10.45	135	10.56^{**}
3.Wheat – maize – soybean	13.02	164	12.93	167	12.98^{***}
4.Average on the water regime	10.27^{Mt}	100	9.73	98.1	-
-	Crop ration	Water regime	Water regime x Crop rotation	Crop rotation x Water regime	-
LSD 5%	1.17	0.73	1.4	1.43	
LSD 1%	2.16	1.46	2.6	2.73	
LSD 0.1%	3.96	2.96	4.8	4.43	

Note: 1.– unsignificant = under 1.17; * significant = 1.17-2.16; ** significantly different = 2.16-3.96; *** very significant = over 3.96;
2. – unsignificant = under 0.73; * significant = 0.73-1.46; ** significantly different = 1.46-2.96; *** very significant = over 2.96.

Table 2. Influence of the forerunner plant and irrigation on wet gluten content of the wheat grains, Oradea 2006-2008.

Forerunner plant	Water regime				Average on the forerunner plant
	Non-irrigated		Irrigated		
	Wet gluten				
-	%	%	%	%	-
1.Wheat – monocrop	21.1	100	20.5	100	20.8^{Mt}
2.Wheat – maize	28.2	134	27.5	134	27.85^{***}
3.Wheat – maize – soybean	33.7	160	32.6	159	33.15^{***}
4.Average on the water regime	27.7^{Mt}	100	26.9	96.9	-
-	Crop rotation	Water regime	Water regime x Crop rotation	Crop rotation x Water regime	-
LSD 5%	1.42	0.75	1.70	1.63	
LSD 1%	2.40	1.45	3.03	2.96	
LSD 0.1%	4.46	3.41	5.24	5.05	

Note: 1. – unsignificant = under 1.42; *significant =1.42-2.40; ** significantly different =2.40-4.46; *** very significant = over 4.46;
2. – unsignificant = under 0.75; * significant 0.75-1.45; ** significantly different = 1.45-3.41; *** very significant = over 3.41.

The data regarding the influence of the forerunner plant and of irrigation on the content of dry gluten of wheat grains for the interval 2006-2008, are presented in Table 3.

Table 3. Influence of the forerunner plant and irrigation on the dry gluten content of the wheat grains, Oradea 2006-2008.

Forerunner plant	Water regime				Average on the forerunner plant
	Non-irrigated		Irrigated		
	Protein				
-	%	%	%	%	-
1.Wheat – mono-crop	10.01	100	9.58	100	9.80^{Mt}
2.Wheat – maize	12.20	122	11.53	120	11.87^{***}
3.Wheat – maize – soybean	13.88	139	13.38	140	13.59^{***}
4.Average on the water regime	12.03^{Mt}	100	11.49	95.6	-
-	Crop rotation	Water regime	Water regime x Crop rotation	Crop rotation x Water regime	-
LSD 5%	0.91	0.65	1.18	1.14	
LSD 1%	1.56	1.16	2.12	1.90	
LSD 0.1%	2.49	2.14	3.95	3.48	

Note: 1. – unsignificant = under 0.91; significant = 0.91-1.56; ** significantly different = 1.56-2.49; *** very significant = over 2.49;
2. – unsignificant = under 0.65; *significant = 0.65-1.16; ** significantly different = 1.16-2.14; *** very significant = over 2.14.

DISCUSSION

The influence of the forerunner plant on the protein content of the wheat grains. Both in non-irrigated and irrigated conditions, the forerunner plant have influenced the protein content of the wheat yield. There were specific situations studied for every year.

The protein content of the wheat grains determined in the wheat – mono-crop in 2006 was of 9.1% in non-irrigated conditions and 9.0% in irrigated conditions. The values determined in the wheat–maize forerunner plant, 11.0% and 10.9% were bigger than the values from wheat mono-crop. The biggest values of the protein content were registered in the wheat-maize-soybean forerunner plant, respectively 13.8% in dry condition and 13.7% on irrigated soil; in comparison with mono-crop the differences, are of 4.7% both in non-irrigated and irrigation conditions is very statistically significant.

In the year 2008, the smallest values of the protein content were again registered in the mono-crop of wheat: 71% in non-irrigated and 6.9% in irrigated conditions. In the wheat-maize crop rotation the values increased with 45% and 46% and in the wheat-maize-soybean, forerunner plant with 73% in non-irrigated and 77% respectively.

The average of the researched period, the smallest values of the protein content of the wheat grains were registered in mono-crop, 7.98% in non-irrigated and 7.73% in irrigation conditions. In the wheat-maize crop rotation the values of the protein content (10.7% and 10.45%) increased significantly different in comparison with mono-crop. The biggest values of the protein content were obtained in the wheat-maize-soybean crop rotation, 13.02% in non-irrigated and 12.93% in irrigated conditions (Table 1).

In 2007 in wheat-mono-crop, the content of the wet gluten from grains was 21.3% in non-irrigation conditions and 21% in irrigation conditions. The registered differences in the wheat-maize and wheat-maize – soybean forerunner plant were very significant from the statistical point of view, 31% and 61% in non-irrigation conditions, 30% and 57% in irrigation conditions respectively.

The influence of the forerunner plant on wet gluten content of the wheat grains. The forerunner plant influenced the wet gluten content of the wheat grain very much. Every year the smallest contents were obtained in wheat mono-crop in both non-irrigated and irrigated conditions.

The year 2006 was the year with the biggest drought and the values of the gluten were the biggest too. In wheat mono-crop, the values of the gluten were 22.6% in non-irrigated conditions and 21.9% in irrigation conditions. The values registered in the wheat-maize crop rotation (29.9% and 29.0%) and in the wheat-maize-soybean forerunner plant (36.1% and 33.8%) statistically was significantly bigger than the values registered in the wheat – mono-crop (Table 1).

In 2007 in wheat-mono-crop, the content of the wet gluten from grains was 21.3% in non-irrigation conditions and 21% in irrigation conditions. Differences registered in the wheat-maize and wheat-maize – soybean forerunner plant were statistically very important, 31% and 61% in non-irrigation conditions, 30% and 57% in irrigation conditions respectively.

In the year 2008, the smallest values of the wet gluten were registered in the wheat mono-crop, 19.9% in non-irrigated conditions and 19.5% in irrigated conditions; in the wheat-maize crop rotation the values increased with 36% and 37% in the wheat-maize-soybean crop rotation with 59% and 62%.

The average data of the period 2006-2008 show that the smallest content of the grain wet gluten was registered in mono-crop. In wheat-maize and wheat-maize-soybean forerunner plant were registered important statistical differences in comparison with wheat-mono-crop: 34% and 60% in non-irrigation conditions, 34% and 55% in irrigation conditions, respectively (Table 2).

Influence of the forerunner plant and irrigation on the dry gluten content of the wheat grains. In 2006 the values of the dry gluten content from wheat grains for mono-crop were of 10.8%, in non-irrigated and

10.3% in irrigation conditions. The differences registered in wheat-maize crop rotation were noteworthy from a statistical point of view, 19% in non-irrigation conditions and 17.0% in irrigation conditions. In the wheat-maize-soybean crop rotation the results were significantly different: 35% on non-irrigated conditions and 39% on irrigated land (Table 2).

The dry gluten content of the wheat grains in 2007 in the mono-crop was 9.8% in non-irrigated conditions and 9.3% in irrigated conditions. The statistically substantial differences vs. wheat-mono-crop registered in the wheat-maize-soybean forerunner plant have been similarly significant from a statistical point of view with the differences registered in 2006: significant and significantly different; the biggest values, 13.7% in non-irrigated conditions and 13.0% in irrigated conditions, were registered in wheat-maize-soybean crop rotation.

In the year 2008, the smallest values of the dry gluten were registered in the wheat – mono-crop, 9.5% in non-irrigated conditions and 9.3% on irrigated land. In the wheat-maize crop rotation the values of the dry gluten increase with 23.0% in both irrigated and non-irrigated conditions and in the wheat-maize-soybean crop rotation with 38.0% and 39.0% respectively.

The average of the researched period, the values of the dry gluten content of the wheat grains from mono-crop were of 10.01% in non-irrigated conditions and 9.58% in irrigation conditions. The values, registered in wheat-maize forerunner plant were bigger from an important statistical point of view: (12.20% and 11.53%) and in the wheat-maize-soybean forerunner plant were registered the biggest values (13.88% and 13.38%) and differences significantly different in comparison with wheat-mono-crop (Table 3).

During 2006-2008 both in non-irrigation and irrigation conditions the smallest values of the protein, wet gluten and dry gluten were obtained in wheat mono-crop in comparison with wheat mono-crop, in the wheat-maize crop rotation the differences were very significant statistically in comparison with the wheat mono-crop were registered every year in the wheat-maize-soybean crop rotation in all three parameters of the wheat yield quality analysed.

Irrigation determined the obtaining of smaller protein values, wet and dry gluten in the wheat grains in comparison with non-irrigation variants from all the crop rotations.

REFERENCES

[1] Ardelean, I., (2006): Contribution in the known and modification of the crop rotation influence on quantity and quality of the winter wheat yield cropped on the acid soils from North-Western Romania. Doctoral thesis, U.S.A.M.V. Cluj-Napoca, Romania [in Romanian], 220 p.

[2] Ardelean, I., (2007): Asolamentele şi calitatea producţiei de grâu. Universităţii din Oradea Press, 190 p.

[3] Bandici, G.E., (1997): Contribuţii la stabilirea influenţei premergătoarei şi a fertilizării asupra dinamicii acumulării biomasei, la grâul de toamnă, cultivat pe soluri cu exces temporar de umiditate, în centrul Câmpiei de Vest a României. Doctoral thesis, U.S.A.M.V. Cluj-Napoca, Romania [in Romanian], 250 p.

[4] Bandici, G.E., Domuţa, C., Ardelean, I., (2003): The influence of the forerunner plant, fertilisation level and climatic conditions on the total wet and dry gluten content of winter wheat seeds cultivated on brown luvic soils in the Western Plain of Romania. Lucrari ştiinţifice USAMVB., B, Bucharest, vol. XLV, pp. 281-284.

[5] Bandici, G.E., Guş, P., (2001): Dinamica acumulării de biomasă la grâul de toamnă. University of Oradea Press, 107 p.

[6] Boldea, E., (1986): Însuşirile de panificaţie a unor soiuri de grâu raionate şi linii de perspectivă. Probleme Agricole, 7: 27-32.

[7] Budoi, G., Penescu, A., (1996): Agrotehnică. Ceres Press, Bucharest, 375 p.

[8] Dincă, D., (1971): Influenţa rotaţiei asupra producţiei, valorificării îngrăşămintelor şi calităţii biologice a recoltelor de grâu şi porumb pe solul brun roşcat de pădure. Probleme agricole, 9: 56-59, 70.

[9] Domuţa, C., (2005): Irrigation of cultures. Universităţii din Oradea Press, Oradea, 330 p.

[10]Guş P., şi colab., 1998 – Agrotehnica . Editura Risoprint. Cluj – Napoca, 380 p.

[11] Hera, C., (1986a): Influenţa fertilizării asupra unor indici calitativi ai recoltelor de grâu. Probleme de agrofitotehnie teoretica si aplicata, 8(2): 71-76, 190.

[12] Hera, C., (1986b): Influenţa unor factori tehnologici asupra calităţii grâului. Cereale şi plante tehnice, 7: 47-52, 100.

[13] Munteanu, L.S., Cernea, S., Morar, G., Duta, M., Vârban, D., Muntean, S., (2008): Fitotehnie. AcademicPres Printing House, Cluj-Napoca, pp. 83-135.

[14] Oproiu, E., Cernescu, L., (1970): Influenţa îngrăşămintelor chimice asupra calităţii grâului. Probleme agricole, 9: 33-38, 70.

[15] Zăhan, P., Zăhan, R., (1989): Cercetări privind acumularea biomasei vegetale radiculare şi calitatea recoltei obţinute, sub influenţa plantei premergătoare şi a fertilizării la grâul cultivat pe soluri podzolice cu exces temporar de umiditate din Câmpia de Vest a ţării (II). Probleme de agrofitotehnie teoretică şi aplicată, 11(1): 237-240, 300.

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