

## WHEAT WATER CONSUMPTION AND WATER USE EFFICIENCY UNDER THE CROP ROTATION AND FERTILIZERS INFLUENCE

Ioana BORZA<sup>1</sup>

**Abstract.** *The paper is based on the results researches obtained during 2009 – 2011 in Oradea. In the crop rotation of 4 years with clover in comparison with wheat – maize crop, the yield gains statistically assured were obtained both in the variants with organic fertilization and in the variant with organic + chemical fertilization. The use of the mixture lupin + oat in this crop rotation determined to obtain yield gains in comparison with variants with lupin, pure crop as green manure; yield obtained using lupin + oat were close to the yield from variant with manure 25 t/ha. Meliorative crop rotation and fertilization determined the improve of the water use efficiency in comparison with the controls; water use efficiency from variants with lupin + oat was bigger than water use efficiency obtained in the variant with lupin, too.*

**Key words:** crop rotation, green manure, water use efficiency, wheat.

### 1. Introduction

In the sustainable agriculture system, the crop rotation is the central pivot and organic fertilization is one of the most components [1,6, 9]. Green manure can occupied a very important place between the organic fertilizer types but the correct use are need consist of the mixture between lupin and oat (rye) and rape. [5, 7]. The use of the lupin in pure crop due the small C/N rapport determines, explosive microbiological processes and intense humus mineralization and finally the decrease of the soil humus reserve. [8, 10]

### 2. Materials and methods

The researches were carried out in Oradea, Western Romania, on eroded preluvosoil with slope of 8°. On ploughing land the pH value is of 6.2, humus content is of 2.1, mobile phosphorus is of 34.1 ppm and mobile potassium content is of 209.2 ppm. Structure degree is of 55.8% and field capacity (24.3%) and wilting point (9.1%) have median value.

Research period was 2009 – 2011, experimental dispositive includes three factors: Factor A: crop rotation: a1 : wheat – maize; a2 : oat + clover – clover – wheat –

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<sup>1</sup> Lecturer, PhD, University of Oradea, Faculty of Environmental Protection, 26 Gen. Magheru St., 410048 Oradea; Romania, e-mail: [borzaioanamarina@yahoo.com](mailto:borzaioanamarina@yahoo.com)

maize

Factor B: organic fertilization: b1 : control; b2: manure, 25 t/ha; b3 : manure, 50 t/ha; b4 : lupin; b5 : lupin + oat

Factor C: annual fertilization: c1: N<sub>0</sub>P<sub>0</sub>; c2: N<sub>90</sub>P<sub>60</sub>K<sub>60</sub>

Number of repetition used: 4. Surface of the experiment plot: 300 m<sup>2</sup>.

Sowing rate: 200 kg/ha in lupin pure crop and lupin 100 kg/ha and oat 80 kg/ha in the mixture.

The harvesting was made in the flowering stage of the lupin. After harvesting the green manure was kept like mulch on the soil surface. After 10 days the plough land of 25 cm depth was made. The maize was cropped in the first year after organic fertilization.

Water use efficiency was established dividing the wheat yield to water consumption. Wheat water consumption was established using the soil water balance method; balance depth used was 0 – 150 cm. [2,3,4]

### 3. Results and discussions

#### Influence of crop rotation on wheat yield

The average of the yield on the period 2009 – 2011 emphasizes bigger yields in the crop rotation with clover both in the background N<sub>0</sub>P<sub>0</sub> (4944 kg/ha vs. 3944 kg/ha, 25.3%) both in the background N<sub>90</sub>P<sub>60</sub>K<sub>60</sub> (6092 kg/ha vs. 5562 kg/ha).

**Table 1.** Influence of the crop rotation and fertilization on wheat yield, Oradea 2009– 2011

Organic fertilization	Chemical fertilization							
	N <sub>0</sub> P <sub>0</sub>				N <sub>90</sub> P <sub>60</sub> K <sub>60</sub>			
	2009	2010	2011	Average	2009	2010	2011	Average
Wheat – maize								
1. Control	2740	3010	3580	3110	4010	4690	5010	4570
2. Manure 25 t/ha	3890	3850	4320	4020	5320	5720	6190	5740
3. Manure 50 t/ha	5020	4580	5030	4880	6280	6440	6760	6490
4. Lupin	3690	3420	3840	3650	4960	5130	5530	5210
5. Lupin + oat	4080	3810	4290	4060	5620	5700	6080	5800
Average	3884	3734	4212	3944	5238	5536	5914	5562
Oat + clover – clover – wheat – maize								
1. Control	3640	4010	4520	4060	5020	5330	5840	5400
2. Manure 25 t/ha	4760	5030	5570	5120	5980	6090	6460	6180
3. Manure 50 t/ha	5620	5710	6240	5860	6390	6890	7100	6790
4. Lupin	4210	4540	5010	4590	5720	5680	6010	5800
5. Lupin + oat	4800	4990	5480	5090	6320	6170	6390	6290
Average	4606	4856	5364	4944	5886	6032	6360	6092

	Organic fertilization		Chemical fertilization		Chemical fertilization x Organic fertilization		Organic fertilization x Chemical fertilization	
	a1	a2	a1	a2	a1	a2	a1	a2
LSD 5%	140	150	160	110	230	210	200	190
LSD 1%	250	290	230	208	310	420	350	360
LSD 0.1%	590	470	310	390	420	730	560	580

The relative differences between yield registered in the researched crop rotation during the years were of 18.6% ( $N_0P_0$ ) and of 12.4% ( $N_{90}P_{60}K_{60}$ ) in 2009, of 30.0% ( $N_0P_0$ ) and of 9.0% ( $N_{90}P_{60}K_{60}$ ) in 2010, of 27.3% ( $N_0P_0$ ) and of 7.5% ( $N_{90}P_{60}K_{60}$ ) in 2011 (table 1).

#### Influence of crop rotation on wheat yield

All the organic fertilization variant determined to obtain very significant yield gain in comparison with control both in crop rotation wheat – maize and in crop rotation oat + clover – clover – wheat – maize. The biggest yields were obtained in the variant with manure 50 t/ha.

In the variant with lupin + oat, an yields bigger than yields obtained in the variants with lupin were obtained 410 kg/ha in the crop rotation wheat – maize and 500 kg/ha in the crop rotation oat + clover – clover – wheat – maize. The yield obtained in the variants with lupin + oat are very closed to the yields obtained in the variant with manure 25 t/ha.

Chemical fertilization applied on organic background determined the increase of the yields with 28.3% in crop rotation wheat – maize and with 23.3% in crop rotation oat + clover – clover – wheat – maize.

#### Influence of the crop rotation and organic fertilization on wheat water consumption

All the years, in the crop rotation with clover, a bigger quantity of rainfall was storied during the cold period. The same phenomenon was registered in the variant with organic fertilization in comparison with the control. In these conditions the values of the wheat water consumption are bigger in the variants from crop rotation with clover and from organic fertilization. (Table 2)

**Table 2.** Influence of the crop rotation and organic fertilization on wheat water consumption, Oradea 2009 – 2011

Variant of organic fertilization	Crop rotation					
	Wheat – maize			Oat + clover – clover – wheat – maize		
	2009	2010	2011	2009	2010	2011
1. Control	3670	3820	4250	4020	4210	4520
2. Manure 25 t/ha	3810	3980	4420	4200	4400	4660
3. Manure 50 t/ha	3960	4210	4760	4420	4580	4880
4. Lupin	3680	3850	4310	4100	4290	4530
5. Lupin + oat	3780	3930	4400	4180	4350	4700
Average	3780	3958	4436	4184	4366	4658

#### Influence of the crop rotation and organic fertilization on water use efficiency in wheat

In the background  $N_0P_0$  in average on the studied period, in the crop rotation oat + clover – clover – wheat – maize the wheat quantity obtained on 1 m<sup>3</sup> was bigger than the value obtained in wheat – maize crop rotation with 44.3% (1.40 kg/m<sup>3</sup> vs. 0.97 kg/m<sup>3</sup>). The same situation was registered in the background  $N_{90}P_{60}K_{60}$ ,

(1.38 kg/m<sup>3</sup> vs. 1.25 kg/m<sup>3</sup>) but the relative difference (10.4%) is smaller.

The green manure represented by mixture lupin and oat determined to obtain a water use efficiency bigger than the values obtained in the variant with lupin both in crop rotation wheat – maize and oat + clover – clover – wheat – maize; the same situation was registered in the background N<sub>0</sub>P<sub>0</sub> and N<sub>90</sub>P<sub>60</sub>K<sub>60</sub>. Generally the water use efficiency obtained in the variant with lupin + oat like green manure was very closed to water use efficiency obtained in the variant with manure, 25 t/ha.

**Table 3.** Influence of the crop rotation and fertilization on water use efficiency in wheat, Oradea 2009 – 2011

Variant of organic fertilization	Crop rotation							
	Wheat - maize				Oat + clover – clover – wheat – maize			
	2009	2010	2011	Average	2009	2010	2011	Average
N <sub>0</sub> P <sub>0</sub>								
1. Control	0.75	0.79	0.84	0.79	1.25	1.31	1.39	1.32
2. Manure 25 t/ha	1.12	0.97	0.98	0.99	1.42	1.38	1.47	1.42
3. Manure 50 t/ha	1.27	1.09	1.06	1.13	1.45	1.50	1.45	1.47
4. Lupin	1.00	0.89	0.89	0.93	1.40	1.32	1.33	1.35
5. Lupin + oat	1.08	0.97	0.98	1.01	1.51	1.42	1.36	1.43
Average	1.02	0.94	0.97	0.97	1.41	1.39	1.40	1.40
N <sub>90</sub> P <sub>60</sub> K <sub>60</sub>								
1. Control	1.00	1.11	1.11	1.07	1.25	1.27	1.29	1.27
2. Manure 25 t/ha	1.27	1.30	1.33	1.30	1.42	1.38	1.39	1.40
3. Manure 50 t/ha	1.32	1.41	1.39	1.37	1.45	1.50	1.45	1.47
4. Lupin	1.15	1.20	1.22	1.19	1.40	1.32	1.33	1.35
5. Lupin + oat	1.28	1.31	1.29	1.29	1.51	1.42	1.36	1.43
Average	1.20	1.27	1.27	1.25	1.41	1.38	1.36	1.38

## Conclusions

The researches carried out during 2009-2011 in Agricultural Research and Development Station Oradea determined the following conclusions:

- (1)The yields wheat obtained in the crop rotation oat + clover – clover – wheat – maize were bigger than yields obtained in the wheat – maize crop rotation both in N<sub>0</sub>P<sub>0</sub> background and in N<sub>90</sub>P<sub>60</sub>K<sub>60</sub> background.
- (2)Organic fertilization (manure 25 t/ha, manure 50 t/ha, lupin, lupin + oat) but especially organic fertilization associated with annual background N<sub>90</sub>P<sub>60</sub>K<sub>60</sub> determined to obtain very significant yield gains in comparison with control.
- (3)The use green manure composed by lupin + oat (applied for maize) determined yield gains bigger than green manure composed by lupin like pure crop. The yields gains were registered in the twice crop rotation studied.
- (4)In the crop rotation with clover the rainfall storages in the cold period were bigger than in the crop rotation wheat – maize; the same situation, was registered

in the variants with organic fertilization. Due the values of wheat water consumption increased.

(5) Water use efficiency values obtained in the crop rotation with clover were bigger than in the crop rotation wheat – maize; the values registered in the background  $N_{90}P_{60}K_{60}$  were bigger than the values obtained in the background  $N_0P_0$ . In the variant with lupin + oat like green manure the water use efficiency had bigger values than in the variant with lupin.

The results research emphasizes the importance of the crop rotation in wheat crop and recomands to use of the green manure like mixture beetween lupin and oat and not like lupin pure crop.

## References

- [1] Budoï Gh., Penescu A., 1996, Agrotehnica. Ed. Ceres, pg. 427 – 432.
- [2] Brejea R., 2009, Tehnologii de protecție sau refacere a solurilor. Editura Universității din Oradea, p. 78-92
- [3] Brejea R., 2010, Știința solului – îndrumător de lucrări practice. Editura Universității din Oradea, p. 84-105
- [4] Borza Ioana Maria, Alina Ștefania Stanciu, 2010, Fitotehnie. Editura Universității din Oradea, p. 332-352
- [5] Domuța C. 2005, Agrotehnica terenurilor în pantă din nord – vestul României. Ed. Universității Oradea, pg. 96 – 117.
- [6] Domuța C., 2006 Agrotehnica diferențiată. Ed. Universității Oradea, pg. 377 – 442.
- [7] Domuța C. (coord), 2008, Asolamentele în Câmpia Crișurilor, Ed. Universității Oradea,
- [8] Eliade Gh., Ghinea L., Ștefanic Gh., Bazele biologice ale fertilității solului. Ed. Ceres, 1983, pg. 127 – 130.
- [9] Guș P., Lăzureanu A., Sândoiu D., Jităreanu G., Stancu I., Agrotehnica. Ed. Risoprint 1998, pg. 496 – 499.
- [10] Samuel A. D., Drăgan – Bularda M., Domuța C., 2006, The effect of green manure on enzymatic activities in a brown luvic soil. Studia Universitas Babeș – Bolyai, Biologia, L I, pg.83–93.