INFLUENCE OF CROP ROTATION AND GREEN MANURE ON WHEAT YIELD IN THE CONDITIONS OF THE ERODED SOILS OF BIHOR (ROMANIA)

INFLUENȚA ASOLAMENTULUI ŞI A ÎNGRĂŞĂMINTELOR VERZI ASUPRA PRODUCȚIEI DE GRÂU ÎN CONDIȚIILE SOLURILOR ERODATE DIN BIHOR (ROMANIA)

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Abstract: *The paper is based on the results researches obtained during 2004 – 2006 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 lupine + oat in this crop rotation determined to obtain yield gains in comparison with variants with lupine, pure crop as green manure; yield obtained using lupine + 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 lupine + oat was bigger than water use efficiency obtained in the variant with lupine, too.*

Rezumat: *Lucrarea prezintă rezultate de cercetare obținute în perioada 2004 – 2006 la Oradea. În asolamentul de 4 ani cu trifoi s-au obținut sporuri de producție asigurate statistic față de asolamentul grâu – porumb, atât în condițiile fertilizării organice, cât şi a fertilizării organice minerale. În aceste asolamente folosirea amestecului lupin + ovăz, ca îngrăşământ verde, a determinat obținerea de sporuri de producție față de varianta cu lupin cultură pură. Producțiile obținute în varianta cu lupin + ovăz au fost apropiate de producțiile obținute în varianta fertilizată cu 25 t/ha gunoi de grajd. Asolamentul ameliorativ, fertilizarea organică şi fertilizarea organică minerală au determinat îmbunătățirea eficienței valorificării apei consumate comparativ cu variantele martor; în variantele cu lupin + ovăz s-a obținut de asemenea o eficiență a valorificării apei mai mare decât în varianta cu lupin.*

Key words*: crop rotation, green manure, yield, wheat.*
Cuvinte cheie: *asolament, îngrăşământ verde, producție, grâu.*

INTRODUCTION

In the sustainable agriculture system, the crop rotation is the central pivot and organic fertilization is one of the most components (Budoi and Penescu, 1998; Gus and al, 1998; Domuța, 2006). Green manure can occupy a very important place between the organic fertilizer types but the correct use it needs consist of the mixture between lupine and oat (rye) and rape. (Domuța, 1999, 2005) The use of the lupine 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. (Eliade and al, 1983, Samuel and al, 2006)

MATERIAL AND METHOD

The researches were carried out in Oradea, Western Romania, on erosioned 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 2004 – 2006 but the experiment is in the second cycle of the researches. Experimental trial includes three factors: factor A: crop rotation. a1: wheat – maize; a2: oat + clover – clover – wheat – maize. Factor B: organic fertilization. b1: control; b2: manure, 25 t/ha; b3: manure, 50 t/ha; b4: lupine; b5: lupine + oat. Factor C: annual fertilization. c1: N_0P; c2: $N_{90}P_{60}K_{60}$. Number of repetition used: 4. Surface of the experiment plot: 300 m^2. Total surface of the experiment: 6000 m^2.

Green manure was produced in 2001, 2002 and 2003 like main crop. Sowing rate: 200 kg/ha in lupine pure crop and lupine 100 kg/ha and oat 80 kg/ha in the mixture.

The harvesting was made in the flowering stage of the lupine. 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 driving the wheat yield to water consumption. Wheat water consumption was established using the soil water balance method; balance depth used was 0 – 150 cm.

RESULTS AND DISCUSSION

Influence of crop rotation on wheat yield

The average of the yield on the period 2004 – 2006 emphasizes bigger yields in the crop rotation with clover both in the background N_0P_0 (4944 kg/ha vs. 3944 kg/ha, 25.3%) both in the background $N_{90}P_{60}K_{60}$ (6092 kg/ha vs. 5562 kg/ha). 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 2004, of 30.0% (N_0P_0) and of 9.0% ($N_{90}P_{60}K_{60}$) in 2005, of 27.3% (N_0P_0) and of 7.5% ($N_{90}P_{60}K_{60}$) in 2006 (table 1).

Table 1

Influence of the crop rotation and fertilization on wheat yield, Oradea 2004 – 2006

Organic fertilization	Chemical fertilization							
	N_0P_0				$N_{90}P_{60}K_{60}$			
	2004	2005	2006	Average	2004	2005	2006	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. Lupine	3690	3420	3840	3650	4960	5130	5530	5210
5. Lupine + 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. Lupine	4210	4540	5010	4590	5720	5680	6010	5800
5. Lupine + 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
DL 5%	140	150	160	110	230	210	200	190
DL 1%	250	290	230	208	310	420	350	360
DL 0.1%	590	470	310	390	420	730	560	580

Influence of crop rotation on wheat yield

The entire 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 lupine + oat, a yields bigger than yields obtained in the variants with lupine 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 lupine + oat are much 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 2004 – 2006

Variant of organic fertilization	Crop rotation					
	Wheat - maize			Oat + clover – clover – wheat - maize		
	2004	2005	2006	2004	2005	2006
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. Lupine	3680	3850	4310	4100	4290	4530
5. Lupine + 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^3 was bigger than the value obtained in wheat – maize crop rotation with 44.3% (1.40 kg/m^3 vs. 0.97 kg/m^3). The same situation was registered in the background $N_{90}P_{60}K_{60}$, (1.38 kg/m^3 vs. 1.25 kg/m^3) but the relative difference (10.4%0) is smaller (*table 3).*

Table 3

Influence of the crop rotation and fertilization on water use efficiency in wheat, Oradea 2004 – 2006

Variant of organic fertilization	Crop rotation							
	Wheat - maize				Oat + clover – clover – wheat – maize			
	2004	2005	2006	Average	2004	2005	2006	Average
N_0P_0								
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. Lupine	1.00	0.89	0.89	0.93	1.40	1.32	1.33	1.35
5. Lupine + 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
$N_{90}P_{60}K_{60}$								
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. Lupine	1.15	1.20	1.22	1.19	1.40	1.32	1.33	1.35
5. Lupine + 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

The green manure represented by mixture lupine and oat determined to obtain a water use efficiency bigger than the values obtained in the variant with lupine both in crop rotation wheat – maize and oat + clover – clover – wheat – maize; the same situation was registered in the background N_0P_0 and $N_{90}P_{60}K_{60}$. Generally the water use efficiency obtained in the variant with lupine + oat like green manure was very closed to water use efficiency obtained in the variant with manure, 25 t/ha.

CONCLUSIONS

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_0P_0 background and in $N_{90}P_{60}K_{60}$ background.

Organic fertilization (manure 25 t/ha, manure 50 t/ha, lupine, lupine + oat) but especially organic fertilization associated with annual background $N_{90}P_{60}K_{60}$ determined to obtained very significant yield gains in comparison with control.

The use green manure composed by lupine + oat (applied for maize) determined yield gains bigger than green manure composed by lupine like pure crop. The yields gains were registered in the twice crop rotation studied.

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.

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 lupine + oat like green manure the water use efficiency had bigger values than in the variant with lupine.

The paper emphasizes the importance of the crop rotation in wheat crop and recommends using of the green manure like mixture between lupine and oat and not liking lupine pure crop.

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