GREEN MANURE AND MANURE INFLUENCE ON THE MAIN PHYSICAL AND CHEMICAL PROPERTIES OF THE SOIL FROM ORADEA IN THE SUSTAINABLE CONTEXT

Domuta Cristian*, Domuta Cornel*, Ciobanu Gheorghe*, Sandor Maria*, Borza Ioana*, Vuscan Adrian*

* University of Oradea, Faculty of Environmental Protection, Gen.Magheru St., No.26, 410048, Oradea, Romania, e-mail: cristian_domuta@yahoo.com

Abstract

The paper is based on the research results carried out in a long term trial placed on the Agricultural Research and Development Station in 1999. The soil from research field is erosioned one, with 10% slope. Two components of the sustainabile agrciculture system were studied crop ratation and organic fertilization. Crop rotation studied: winter wheat – maize; oat + clover – maize – winter wheat - maize. The variants with organic fertilization studied: control (without fertilization), Lupinus angustifolius, Lupinus angustifolius + oat + rape; vetch + oat + ryegrass; manure, 25 t/hectare; manure, 50 t/hectare. In 2013, the soil samples after winter wheat from the first crop rotation were prelevated. Results research regarding the soil physical properties … indicate an improvement of the structure degree in the all variants with organic fertilization; the exception is variant with Lupinus angustifolius, green manure; all the other physical properties studied were improved in the all the variant studied: the values of the bulk density and penetration rezistance decreased and total porosity and hydraulic conductivity incresead. The laboratory analysis emphasize the increases of the mineral nitrogen content in all the studied variants. The pH values where a little bigger than the value of the control but the differences are unsignificant statistically; the mobile phosphorus and potassium content of the soil increased but the differences in comparison with the control where unsignificant statistically; only the difference from variant with manure 50 t/hectare are statistically significant.

Key words: green manure, Lupinus angustifolius, oat, rape, vetch, ryegrass, manure.

INTRODUCTION

Sustainable agriculture system is based on the following component: crop rotations (central pivot), large structure of crops, organic fertilizers use, chemical fertilizers use in moderate doses correctly soil tillage, integrated management of the plant protection, resources conservation, the use of the farms interne, resources integration between field crop branch and horticulture or zootechnical branch rural sustainable development (Budoi, Penescu, 1996; Domuţa, 2005, 2006; Ciobanu, 2003, 2011; Samuel, 2006). Organic fertilization is difficult to realize because the quantities of the manure produced by farms are small and don't provide an optimum fertilization; the green manure use was stimulated by European Union but establishing the harvest period in March, the use of the rape is encouraged and not the use of the leguminous, the plants, which can fixe the small quantity (180-220 kg/hectare) from enormous nitrogen quantity from

atmosphere (200.000-300.000 tones/hectare). One of the most known leguminous was used like green manure is the lupin; the problem of the priming effect produced by the use of the lupin in pure crop was solved by Roger (1976) using the mixture vetch + oat (rye) + ryegrass. Vetch is very known like excellent fodder and Domuţa Cornel starting the research using the mixture lupin +oat, lupin + oat + rape, lupin + rye and the mixture of the lupin determined better results than the mixture of vetch.

MATERIAL AND METHOD

The research was carried on erosioned soil with slope of 10% at Agricultural Research and Development Station Oradea. In 1999 was placed the experiment with tree factors: Factor A: crop rotation, with a_1 = winter wheat – maize; a_2 = oat + clover – clover – maize – winter wheat – maize. Factor B: organic fertilization with b_1 = control, without fertilizers; b_2 = *Lupinus angustifolius*; b_3 = *Lupinus angustifolius* + oat + rap; b_4 = vetch + oat + ryegrass; b_5 = manure, 25 t/hectare; b_6 = manure, 50 t/hectare. Factor C: annual chemical fertilization: c_1 = N_0P_0; c_2 = $N_{120}P_{90}$. Number of repetition used: 4. The lot surface: 100 m^2.

In 2013, after winter wheat harvesting, a soil profile was made in the first crop rotation and the cylinders with soil were prelivated for determination in the laboratory, of the bulk density (BD), hydraulic conductivity and penetration resistance (IPR); the cylinders were prelivated on a 0 - 10 cm depth and 10 – 20 cm depth and the averages on the 0 – 20 cm are presented in the papers. Other soil samples were prelivated on 0 – 20 cm depth for determination the structure degree, mineral nitrogen, ph, mobile phosphorus, mobile potassium.

Physical properties of the soil were determined in the laboratory by specifical methods: Cseratzki method (the sieves with diameters = 5 mm, 2 mm; 1 mm, 0.25 mm) for structure degree, laboratory installation for hydraulic conductivity determination, penetrometer for laboratory. Total porositiy (TP) was determined using the formula (Canarache, 1990):

$$TP = \left(1 - \frac{BD}{D}\right) 100$$

In which: D = density = 2.65 g/cm^3;
BD = bulk density.

Soil reaction was determined by potentiometer method; mobile phosphorus and mobile potassium were determined by Egner – Rhiem – Domingo method. Four repetition were realized for every physical and chemical parameters and the research results were interpreted by variance analysis method (Brejea, 2010, 2011; Domuţa, Brejea, 2010).

RESULTS AND DISCUSSION

Structure degree

The smallest value of the structure degree was determined in the variant without organic fertilization, 54.70%; the result obtained in the variant *Lupinus angustifolius* like green manure is very close, 54.50%. In the variant with the mixture *Lupinus angustifolius*+ oat +rape, the structure degree increase significant statistically in comparison with control, the increase is significant statistically, in the variant with manure 25 t/hectare. In the variant with vetch + oat + ryegrass was registered an increase of the control but insignificant statistically. The biggest structure degree, 64.26%, was registered in the variant with manure, 50 t/hectare; the difference (18%) in comparison with the control is distingue significant statistically (Table 1).

Table 1

The influence of the green manure and manure on structure degree of the erosioned soil from Oradea, 2013

Variant	Structure degree		Difference %	Statistically significant
	Val %	%		
1. Control	54.70	100	-	Control
2. Lupinus angustifolius	54.50	99	-1	-
3. Lupinus angustifolius + oat + rape	58.80	108	8	X
4. Vitch + oat + ryegrass	57.98	106	6	-
5. Manure, 25 t/hectare	60.30	110	10	X
6. Manure, 50 t/hectare	64.26	118	18	xx

LSD 5% 3,96%, LSD 1% 6,02%, LSD 0,1% 13,56%

Bulk density

All the variant with organic fertilization determined the decrease of the bulk density values in comparison with the control (1,529/cm^3). The decreases are very significant statistically in the variant with manure 50 t/hectare (-14%), distingue significant statistically in the variants with manure 25 t/hectare (Table 2).

Table 2

The influence of the green manure and manure on bulk density (BD) of the erosioned soil from Oradea, 2003

Variant	BD		Difference	Statistically significant
	g/cm3	%		
1. Control	1.52	100	-	Control
2. Lupinus angustifolius	1.0	92	-8	0
3. Lupinus angustifolius + oat + rape	1.35	88	-12	00
4. Vetch + oat + ryegrass	1.36	89	-11	00
5. Manure, 25 t/hectare	1.34	88	-12	00
6. Manure, 50 t/hectare	1.30	86	-14	000

LSD 5% 0.10, LSD 1% 0.15, LSD 0.1% 021

Total porosity

Calculating the total porosity values the smallest value was obtained in the control, 43%. The difference registered in the variant with *Lupinus angustifolius* (9%) is unsignificant statistically. In the variant with manure 50 t/hectare a difference of 19% distinguish significant statistically. Was registered the differences of 14% registered in the variants with *Lupinus angustifolius* + oat + rape and vetch + oat + ryegrass and difference of 16% are significant statistically only (Table 3).

Table 3

The influence of the green manure and manure on total porosity (TP) of the erosioned soil from Oradea, 2013

Variant	TP		Difference (%)	Statisticaly Significant
	%	%		
1. Control	43	100	-	Control
2. Lupinus angustifolius	47	109	9	-
3. Lupinus angustifolius + oat + rape	49	114	14	x
4. Vetch + oat + ryegrass	49	114	14	X
5. Manure, 25 t/hectare	50	116	13	X
6. Manure, 50 t/hectare	51	119	19	xx

LSD 5% 4,5 LSD 1% 7,5 LSD 0,1% 11,0

Penetration rezistance

The biggest value of the penetration rezistance 25.0 kgf/cm^2, was registered in the control; In the all variants with organic fertilization, the values of penetration rezistance decreased; the differences were distingue significant statistically. The biggest difference – 38% - was registered in the variant with manure 50 t/hectare (Table 4).

Table 4

The influence of the green manure and manure on penetration rezistance (PR) of the erosioned soil from Oradea,

Variant	PR		Difference (%)	Statisticaly significant
	Kg/cm^2	%		
1. Control	25.0	100	-	Control
2. Lupinus angustifolius	19.8	79	-21	00
3. Lupinus angustifolius + oat + rape	18.9	76	-24	00
4. Vetch + oat + ryegrass	19.0	76	-24	00
5. Manure, 25 t/hectare	18.0	72	-28	00
6. Manure, 50 t/hectare	15.4	62	-38	00

LSD 5% 3,5 LSD 1% 6,3 LSD 0,1% 1130

Soil reaction

The value of the pH determined in the control was of 6.3. The values determined in the studies variants are very close and to control but the difference are unsignificat statistically (Table 5).

Table 5

The influence of the green manure and manure on hydraulic conductivity (HC) of the erosioned soil from Oradea,2 013

Variant	HC		Difference (%)	Statisticaly significant
	mm/h	%		
1. Control	13.30	100	-	Control
2. Lupinus angustifolius	15.58	117	17	-
3. Lupinus angustifolius + oat + rape	16.47	124	24	-
4. Vetch + oat + ryegrass	16.40	123	23	*
5. Manure, 25 t/hectare	17.26	129	29	*
6. Manure, 50 t/hectare	19.86	149	49	**

LSD 5% 2,70 LSD 1% 4,72 LSD 0,1% 7,29

Mineral nitrogen

The value of the N – NO_3 determined in the control was of 0,70 ppm. The difference registered in the variant with *Lupinus angustifolius* (64%) with vetch + oat + ryegrass; with manure 25 t/hectare, with manure 50 t/hectare are distingue significant bigger. In the variant with *Lupinus angustifolius* + oat + rape the difference are very significant statistically. The differences registered in the variant with manure are distingue significant (Table 6).

Table 6

The influence of the green manure and manure on the pH of the erosioned soil from Oradea, 2013

Variant	pH		Difference	Statistically significant
	Value	%		
1. Control	6.30	100	-	Control
2. Lupinus angustifolius	6.29	99	-1	-
3. Lupinus angustifolius + oat + rape	6.32	101	+1	-
4. Vetch + oat + ryegrass	6.31	101	+1	-
5. Manure, 25 t/hectare	6.39	102	+2	-
6. Manure, 50 t/hectare	6.42	103	+3	-

LSD 5% 0.13, LSD 1% 0.24, LSD 0.1% 0.40

The N – NH_4 content is bigger than N – NO_3 content in the all variants. In the control was registered the smallest value, 2.6 ppm. In the all variants with organic fertilization the N-NH_3 the content were very significant bigger.

The content of N – NO_3 + NH from the control is of 3.16 ppm. The values of the N – NO_3 + NH_4 from the all variants with organic fertilization are bigger than the value determined in the control; organic fertilization determined the differences very significant statistically; the biggest difference, 94%, was registered in the variant with *Lupinus angustifolius* + oat + rape (Table 7).

Table 7

The influence of the green manure and manure on the N – NO3+ N – NH4 of the erosioned soil from Oradea, 2013

Variant	N – NO3			N – NH4			N – NO3 + NH4		
	ppm	%	Statistically significant	ppm	%	Statistically significant	ppm	%	Statistically significant
1. Control	0.70	100	Control	2.46	100	Control	3.16	100	Control
2. Lupinus angustifolius	1.15	164	**	3.82	153	***	4.97	157	***
3. Lupinus angustifolius + oat + rape	1.20	172	***	4.94	201	***	6.14	194	***
4. Vetch +oat ryegrass	1.17	167	**	4.40	179	***	5.57	176	***
5. Manure, 25 t/hectare	0.90	129	**	3.40	138	**	4.30	136	***
6. Manure, 50 t/hectare	1.13	162	**	3.70	150	***	4.83	153	***

LSD 5% 0,17 LSD 5% 0,60 LSD 5% 0,23
LSD 1% 0,28 LSD 1% 0,64 LSD 1% 0,46
LSD 0,1% 0,51 LSD 0,1% 1,12 LSD 0,1% 0,81

Mobile phosphorus

The mobile phosphorus is median in the control (34.6 ppm) and good in the others variants. The differences registered in comparison, with the control are insignificant statistically, the exception is the value (43.1 ppm) determined in the variant with manure 50t/hectare (Table 8).

Table 8

The influence of the green manure and manure on mobile phosphorus (PAL) content of erosioned soil from Oradea, 2013

Variant	PAL		Difference	Statistically significant
	ppm	%		
1. Control	34.6	100	-	Control
2. Lupinus angustifolius	37.8	109	9	-
3. Lupinus angustifolius + oat + rape	39.0	113	13	-
4. Vetch + oat + ryegrass	38.8	112	12	-
5. Manure, 25 t/hectare	39.4	114	14	-
6. Manure, 50 t/hectare	43.1	125	25	*

LSD 5% 7.8, LSD 1% 12.6, LSD 0,1% 21.3

Mobile potassium

The smallest content of the mobile potassium was registered in the control, 196.2 ppm. The differences registered in the variants with green manure and in the variant with manure 27 t/hectare are insignificant statistically; the difference registered ion the variant with manure 50t/hectare is distingue significant (Table 9).

Table 9

The influence of the green manure and manure on mobile potassium (KAL content of the prelucosoil from Oradea, 2013

Variant	KAL		Difference	Statistically significant
	ppm	%		
1. Control	192.2	100	-	Control
2. Lupinus angustifolius	199.3	102	2	-
3. Lupinus angustifolius + oat + rape	204.7	104	4	-
4. Vetch + oat + ryegrass	205.0	105	5	-
5. Manure, 25 t/hectare	207.6	106	6	-
6. Manure, 50 t/hectare	215.6	110	10	xx

LSD 5% 13.2, LSD 1% 18.4, LSD 0.1% 27.8

CONCLUSIONS

Results research regarding the green manure and manure influence on physical and chemical properties of the erosioned soil were obtained in a long term trial placed at Agricultural Research and Development Station Oradea in 1999 and there were the following conclusions:

- Soil structure degree increase in comparison with the control in the variants with green manures (*Lupinus angustifolius* + oat + rape; vetch + oat + ryegrass) and manure 25 t/hectare and 50 t/hectare respectively. The exception is the variant with *Lupinus angustifolius* due to the small C/N report.
- Bulk density and penetration resistance decreased in comparison with the control in the all variant studied; the differences in comparison with the control are statistically assured the best values were registered in the variant with manure 50t/ha.
- Total porosity and hydraulic conductivity increased in comparison with the values determined in the control; the differences are statistically assured. Both total porosity and hydraulic conductivity registered an exception: the variant with *Lupinus angustifolius.*
- Regarding the pH value didn't determinate the differences statistically assured in the variants with organic fertilization in comparison with the control.
- The $N\text{-}NO_3$ + NH_4 content are bigger in the variant with green manure in comparison with the manure. In comparison with the value determinate in the control, 3.16 ppm, in the all variants studied were registered the differences very significant statistically.
- Mobile phosphorus and potassium content increased in the all variants studied in comparison with the control but only the differences determined in the variant with manure 50t/hectare are statistically assured.

Results research emphasize an improvement of the physical and chemical properties of the soil using green manure and manure and because the lupine is easier acceptably by the farmers, the results obtained

recommend for erosioned soils is the mixture *Lupinus angustifolius* + oat + rape; This mixture determined better properties of the soil in this comparison with the mixture vetch + oat + ryegrass.

REFERENCES

1. Bica A., Curilă M., Curilă S., 2013, The Method of Successive Interpolations Solving Initial Value Problems for Second Order Functional Differential Equations, Fixed Point Theory, Volume: 14, Issue: 1, p. 67-90, ISSN 1583-5022
2. Bica A., Curilă M., Curilă S., 2012, About a numerical method of succesive interpolations for functional Hammerstein integral equations, Journal of Computational Analysis and Applied Mathematics, vol. 236, Issue: 7, p. 2005-2024, ISSN 0377-0427
3. Bica A., Curilă M., Curilă S., 2006, Optimal Piecewise Smooth Interpolation of Experimental Data, ICCCC 2006, International Journal of Computers, Communications & Control, p. 74-79, ISSN 1841-9836
4. Brejea R., 2009, Tehnologii de protecţie sau refacere a solurilor. Editura Universităţii din Oradea
5. Brejea R, 2010, Ştiinţa solului – îndrumător de lucrări practice, Editura Universităţii din Oradea.
6. Brejea R, 2011, Practicum de pedologie, Editura Universităţii din Oradea.
7. Brejea R . 2011 Practicum de Tehnologii de Protecţie a Solurilor. Editura Universităţii din Oradea
8. Budoi Gh., Penescu A., 1996, Agrotehnică, Ed. Ceres, Bucureşti.
9. Canarache A., 1990, Fizica solurilor agricole. Ed. Ceres, Bucureşti.
10. Ciobanu Gh., 2003, Agrochimie. Editura Universităţii din Oradea.
11. Ciobanu Gh., 2011, Practicum de agrochimie, Editura Universităţii din Oradea.
12. Curilă M., Curilă S., Bica Al., Tăut A. O., 2008, Agricultural Remote Sensing Images Analysis With Blind Source Separation Technique, 6th International scientific symposium "Natural resources and sustainable development", Journal of Agricultural Sciences, Acta Agraria Debrecensis, pp. 227-232, ISSN 1588-8363, Debrecen.
13. Domuţa C., 2005, Agrotehnica terenurilor în pantă din nord-vestul României, Editura Universităţii din Oradea.
14. Domuţa C., et al., 2005, Influenţa eroziunii asupra hidrostabilităţii macrostructurii solului în condiţiile de la Oradea, Analele Universităţii din Oradea, Fascicula Agricultură-Horticultură, Vol XI, Anul II, Editura Universităţii din Oradea.
15. Domuţa C. et al., 2006, Modifications of the soil structure under the erosion and crops influence in the condition from NorthWestern Romania, Buletin USAMV Cluj-Napoca 63.
16. Domuţa C. et al., 2007, Influence of crop rotation and green manure on wheat yield in the conditions of the eroded soils of Bihor (Romania), Analele USAMVB Timisoara, Lucrări ştiinţifice Facultatea de Agricultura, vol. XXXIX, Editura Agroprint, Timisoara.
17. Domuţa C., Brejea R., 2010, Eroziunea terenurilor în pantă din nord-vestul României, Editura Universităţii din Oradea.
18. Domuţa C., Brejea R., 2011, Eroziunea terenurilor în panta din Bihor, Editura Universităţii din Oradea.
19. Samuel A.D., Drăgan-Bularda M., Domuţa C., 2006, The effect of green manure on enzymatic activities in a brown luvic soil, Studia Universitatis Babeş-Bolyai, Biologia, LI, 1.