RESEARCHES ON THE EVOLUTION OF SOIL MAIN CHEMICAL INDICATORS UNDER THE INFLUENCE OF DIFFERENT CROPS, SOIL WATER EROSION AND FERTILIZATION ON TYPICAL LUVOSOIL FROM EXPERIMENTAL FIELD PREAJBA, GORJ COUNTY

Bălan Mihaela
University of Craiova, Faculty of Agronomy

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ABSTRACT

The researches that have been made during three years of experimentation at Experimental Field for Pasture of Preajba, Gorj County, on a slope typical luvosoi that undergoes surface water erosion process, has a low nitrogen and phosphorus supply and a very low potassium supply have shown that fertilization has had indirect beneficial effects os soil protection against soil water erosion. Also, there was emphasized the fact that the intensity and duration of rainfall, on one hand, and fertilizer application, on the other hand, as well as low soil reaction act in opposite senses, the first ones conducting to the losing of nutrients from the soil and the others (fertilizers and soil reaction), to the accumulation of nutrients into the soil by anthropic contribution and by slowing the physiological activity of plants, and, consequently, by lowing the nutrient consumption.

The evolution of the chemical features of the soil by experimented treatments under the influence of erosion and fertilizers is influenced by the quantity and intensity of rainfall, by the mass of the eroded soil, the nature of the crop, the phase of the crop, with repercussions on the intensity of nutrient uptake, the fertilizer rates and their rates, the activity of soil microorganisms which, in turn, dependent of temperature, the aeration degree of soil and by the pH of soil suspension of water.

INTRODUCTION

The soil is one of the most important natural resources for human survival and wellbeing. Moreover, this resource is fragile and can undergo degradation processes such that the mankind must take in account the promotion of optimal usage of soil, the maintaining and improving the soil productivity and the conservation of soil resources.

The soil chemical features (soil reaction, the basses saturation degree, humus and nutrients contents) directly influence the soil quality.

Among processes that affect the soil quality, erosion is one of the highest interests both through damages it determines as well as by surfaces affected by it. The soil erosion has begun along with slope soils or sandy soils cultivation. The populace pressure on terrains has determined the intensification of soil erosion or desertification and the migration of population toward other territories. In other cases there were practiced systems of agriculture that determined the setup of population on the same territory during centuries or, even, millennia.

The water from rainfall in its dynamics slowly removes, in variable quantities, the shallow layer of soil from slope terrains, such way that under the influence of time, the whole coverage of fertile soil is removed and the sterile bedrock is brought to surface. This form of soil erosion is very dangerous because it is hard to observe and it can conducts to irreparable loss of humus horizon and nutrients.

MATERIAL AND METHOD

The experiment has been located at the Experimental Field for Pastures that belongs to Tg. Jiu town, Preajba locality. The experimental treatments have been tried on a typical luvosoil with 10-12% slope on terrace alluvial deposits as parental materials, where the water table is at 5-10 m depth, with natural vegetation represented by pasture with acidic species. The soil is characterized by a soil profile of Ao, AE, El, Bt_1, BC, C type.

The soil profiles have been made after Perieni model and consisted of setting up 3 experiments with 3 crops (corn, natural pasture and sown pasture), with three treatments and 3 replications, after isolated block method in order to determine both the eroded soil quantity and the quantity of nutrients that are lost along with the eroded soil.

With the natural pasture the former vegetation has been racked and then there were applied fertilizers, at the beginning of the vegetation period, in April. With the corn crop, there were made tillage by a tiller, then the soil was manually leveled and there was sown $PR_{38}A_{79}$ early corn hybrid at 6-7 cm depth and 70 cm between rows, at a plant density of 40,000-50,000 plants per hectare. Immediately after sowing there were applied complex fertilizers. For the sown pasture, during April the seedbed was prepared by tiller, then it was manually leveled and there was sown a mixture of grasses and pulses of 60% to 40% proportion in the following way: Dactylis glomerata 20% (210 g.), Lolium perene 20% (228 g.), Phleum pretense 20% (228 g.), Trifolium pratense 15% (120 gr.), Lotus corniculatus 25% (282 gr.). just after sowing there were applied different fertilizer rates. With all three crops, all treatments have been fertilized in the same way, with the same types and rates of fertilizers: V1 – not fertilized control; V2 - $N_{60}P_{60}K_{60}$ using $N_{15}P_{15}K_{15}$ complex fertilizer - 2.5kg/plot; V3 - $N_{100}P_{90}K_{60}$ using $N_{15}P_{15}K_{15}$ complex fertilizer - 2.5kg/plot + NH_4NO_3 (34,5% N a.i.) - 0.73 kg/plot +Ca $(H_2PO_4)2\times CaSO_4$(20% P_2O_5)- 0.94Kg/plot. In order to observe the dynamics of nutrients and to correlate the loss of nutrients there were taken soil samples each year of experimentation and at the end of the vegetation period in the following way:

- with the natural and sown pasture – 2 soil samples for each plot, by soil drill probe (one from the first half of the plot and the second one from the second half of the plot), each sample consisting of 10 randomized individual drillings;

- with the corn crop – two soil samples with the soil drill probe from each plot(one from the first half of the plot and the second one from the second half of the plot), each sample consisting of 10 randomized individual drillings;

RESULTS AND DISCUSSIONS

After three years of experimentation, the researched treatments have influenced the following chemical soil features: pH, humus content, total nitrogen, soluble phosphorus, and soluble potassium. The modifications were recorded between the first year of experimentation and the third one under the influence of fertilization and the nature of the crops.

The soil reaction

The variations of pH water suspensions are written in table 1. From these data we can notice the following:

- for control treatment, the pH value has decreased by 0.7% with the corn crop, by 1.7% for natural pasture and it remained constant with the case of sown pasture;

- for the treatments fertilized by N60P60K60 there was recorded a decrease of pH by 0.7% with the corn crop, it remained constant with the sown pasture and it decreased by 1.8% with the natural pasture;

- for the treatments fertilized by N100P90K60 there was recorded a decrease by 0.7%, by 0.5% with sown pasture and by 0.4% with natural pasture.

The decreasing of the pH values is attributed by physiological reaction of fertilizers that were applied.

From the experimental data obtained within the three years of experimentation there were noticed that with the case of the same crop and the same fertilizer rates there appear pH differences and nutrients content. These variations are due to:

- soil unevenness over the soil profile;
- soil micro relief (small dips, small ridges) which determines low accumulation of organic material or fertilizers;
- uneven soil erosion as well as accumulated materials brought by wind from upper part of the slope, including the plateau;
- analytical laboratory errors.

Table 1

The variation of the initial and final soil reaction values of the water soil suspension for different crops

Treatment	Soil reaction. pH units		The variation of the soil reaction %	The variation interval of soil reaction
	Initial values	Initial values		
Corn $N_0P_0K_0$ Mt A	5,07	5,00	-1,38	4,8 – 5,17
Corn $N_0P_0K_0$ Mt B	5,08	5,07	-0,20	
Corn $N_{60}P_{60}K_{60}$ A	5,05	5,03	-0,40	
Corn $N_{60}P_{60}K_{60}$ B	5,09	5,04	-0,98	
Corn $N_{100}P_{90}K_{60}$ A	5,12	5,07	-0,98	
Corn $N_{100}P_{90}K_{60}$ B	4,95	4,93	-0,40	
Natural pasture $N_0P_0K_0$ Mt A	4,95	4,88	-1,41	4,82 – 5,11
Natural pasture $N_0P_0K_0$ Mt B	5,07	4,96	-2,17	
Natural pasture $N_{60}P_{60}K_{60}$ A	5,00	4,91	-1,80	
Natural pasture $N_{60}P_{60}K_{60}$ B	5,07	4,98	-1,78	
Natural pasture $N_{100}P_{90}K_{60}$ A	4,91	4,93	0,41	
Natural pasture $N_{100}P_{90}K_{60}$ B	4,96	4,92	-0,81	
Sown pasture $N_0P_0K_0$ Mt A	4,90	4,95	1,02	4,85 – 5,10
Sown pasture $N_0P_0K_0$ Mt B	5,00	5,00	0,00	
Sown pasture $N_{60}P_{60}K_{60}$ A	4,95	4,87	-1,62	
Sown pasture $N_{60}P_{60}K_{60}$ B	4,97	5,03	1,21	
Sown pasture $N_{100}P_{90}K_{60}$ A	4,85	4,85	0,00	
Sown pasture $N_{100}P_{90}K_{60}$ B	4,95	4,89	-1,21	

The humus content

The variation of the humus content is presented in the table 2. From these data there results the following aspects:

- with the controll treatments there are recorded a high decreasing of the humus content by 2-3% with the corn crop, average decreasing with sown pasture, of 0.5% and low decreasing with natural pasture, by 0.15%;
- with the fertilized treatments the experimental data indicates a maintaining of the humus content with the case of $N_{60}P_{60}K_{60}$ rate and a slight increase, by 1% of the humus content with the case of $N_{100}P_{60}K_{60}$ rate due to manure aplication.

There, also, can be noticed that the humus content values decreases in the following order: natural pasture – sown pasture – corn. These variations can be explained by at least two causes: soil erosion that increases in uppward order (so, the humus is less conserved) and the cropping, reffering to the crop and sown pasture. The agricultural practice has confirmed that cropping determine the loss of humus. The humus formed and accumulated in reducing environment. By cropping, because of tillage, the air porosity increases and the same happen with the ogixen content of the soil. As a consequence the reductive character of the soil environment shifts to an oxidative one and that brigs about the convertion of the soil humus in mineral elements by the action of soil microorganisms. This way there can be explained why under the natural pasture, in comparison with other crops, the humus content has had the highest levels.

Table 2

The variation of the soil humus content between initial and final data of the experiment, for different crops

Treatment	Humus content, %		The variation of the humus content, %	The variation interval of the humus content
	Initial	Final		
Corn $N_0P_0K_0$ Mt A	2,46	2,41	-2,03	2,43 – 2,61
Corn $N_0P_0K_0$ Mt B	2,48	2,40	-3,23	
Corn $N_{60}P_{60}K_{60}$ A	2,47	2,45	-0,81	
Corn $N_{60}P_{60}K_{60}$ B	2,42	2,44	0,83	
Corn $N_{100}P_{90}K_{60}$ A	2,51	2,46	-1,99	
Corn $N_{100}P_{90}K_{60}$ B	2,45	2,48	1,22	
Natural pasture $N_0P_0K_0$ Mt A	3,10	3,12	0,65	3,04 – 3,21
Natural pasture $N_0P_0K_0$ Mt B	3,11	3,10	-0,32	
Natural pasture $N_{60}P_{60}K_{60}$ A	3,08	3,09	0,32	
Natural pasture $N_{60}P_{60}K_{60}$ B	3,10	3,08	-0,65	
Natural pasture $N_{100}P_{90}K_{60}$ A	3,13	3,14	0,32	
Natural pasture $N_{100}P_{90}K_{60}$ B	3,09	3,11	0,65	
Sown pasture $N_0P_0K_0$ Mt A	2,82	2,81	-0,35	2,73 – 2,87
Sown pasture $N_0P_0K_0$ Mt B	2,82	2,80	-0,71	
Sown pasture $N_{60}P_{60}K_{60}$ A	2,77	2,79	0,72	
Sown pasture $N_{60}P_{60}K_{60}$ B	2,87	2,78	-3,14	
Sown pasture $N_{100}P_{90}K_{60}$ A	2,79	2,82	1,08	
Sown pasture $N_{100}P_{90}K_{60}$ B	2,80	2,83	1,07	

The total nitrogen content

The data on total nitrogen content are presented in the table 3.

The variations of the total nitrogen are almost identical with the humus variations and this phenomenon is explainable by the fact that 92-98% from total nitrogen of soil from arable layer is in humus. This way:

- with the control treatment there is recorded a decreasing of the total nitrogen content, higher for the corn crop (about 2-3%) and lower for the other crops (0-0.7%);
- with the treatments fertilized by $N_{60}P_{60}K_{60}$ there is recorded no increase of the total nitrogen, higher for natural pasture (about 0.8%) and lower for sown pasture (about 0.7%) and corn (about 0.5%).

Table 3

The variation of the total nitrogen content of the soil between initial and final data of the experiment, for different crops

Treatment	Total nitrogen content, %		The variation of the total nitrogen content, %	The variation interval of the total nitrogen content %
	Initial	Final		
Corn $N_0P_0K_0$ Mt A	0,095	0,093	-2,11	0,093 – 0,111
Corn $N_0P_0K_0$ Mt B	0,098	0,095	-3,06	
Corn $N_{60}P_{60}K_{60}$ A	0,101	0,102	0,99	
Corn $N_{60}P_{60}K_{60}$ B	0,104	0,105	0,96	
Corn $N_{100}P_{90}K_{60}$ A	0,107	0,106	-0,93	
Corn $N_{100}P_{90}K_{60}$ B	0,105	0,107	1,90	
Natural pasture $N_0P_0K_0$ Mt A	0,135	0,136	0,74	0,133 – 0,141
Natural pasture $N_0P_0K_0$ Mt B	0,136	0,135	-0,74	
Natural pasture $N_{60}P_{60}K_{60}$ A	0,133	0,133	0,00	
Natural pasture $N_{60}P_{60}K_{60}$ B	0,135	0,134	-0,74	
Natural pasture $N_{100}P_{90}K_{60}$ A	0,137	0,138	0,73	
Natural pasture $N_{100}P_{90}K_{60}$ B	0,134	0,135	0,75	
Sown pasture $N_0P_0K_0$ Mt A	0,124	0,122	-1,61	0,121 – 0,127
Sown pasture $N_0P_0K_0$ Mt B	0,124	0,124	0,00	
Sown pasture $N_{60}P_{60}K_{60}$ A	0,122	0,123	0,82	
Sown pasture $N_{60}P_{60}K_{60}$ B	0,125	0,125	0,00	
Sown pasture $N_{100}P_{90}K_{60}$ A	0,123	0,124	0,81	
Sown pasture $N_{100}P_{90}K_{60}$ B	0,124	0,125	0,81	

The soluble phosphorus content

The analytical values are presented in the table 4 and from these data there can be noticed the following aspects:

- with the control treatment, for corn crop there is recorded a decrease of the soluble phosphorus content by 1.7% and for the other crops, an increase by 0.15%with the sown pasture and by 0.11% with natural pasture;
- with the treatment fertilized by $N_{60}P_{60}K_{60}$ there is recorded, for the corn crop, a decrease of the soluble phosphorus by 1.8%, an increase by 0.6% with the sown pasture and an increase by 0.3% for the natural pasture;
- with the treatments fertilized by $N_{100}P_{90}K_{60}$ there is recorded a decrease of the soluble phosphorus content by 0.11% for the corn crop, an increase by 2.2% with the sown pasture and an increase by 2.6% for the natural pasture.

The relatively high variations of the soluble phosphorus content are due to the high variation of the phosphorus content on the soil profile, the highest concentrations being recorded in the shallow layer that is exposed to erosion as well as the precipitation of the phosphorus ion because of high concentration of aluminum, forming low soluble components called aluminum phosphates.

Table 4

The variation of the soluble phosphorus content from the soil between initial and final values for different crops

Treatment	The soluble phosphorus content, ppm		The variation of the soluble phosphorus content, %	The variation interval of the soluble phosphorus, ppm
	Initial	Final		
Corn $N_0P_0K_0$ Mt A	8,25	8,15	-1,21	8,25 – 10,40
Corn $N_0P_0K_0$ Mt B	8,32	8,13	-2,28	
Corn $N_{60}P_{60}K_{60}$ A	8,40	8,23	-2,02	
Corn $N_{60}P_{60}K_{60}$ B	9,01	8,86	-1,66	
Corn $N_{100}P_{90}K_{60}$ A	8,70	8,69	-0,11	
Corn $N_{100}P_{90}K_{60}$ B	9,15	9,14	-0,11	
Natural pasture $N_0P_0K_0$ Mt A	8,38	8,39	0,12	8,5 – 12,41
Natural pasture $N_0P_0K_0$ Mt B	8,75	8,76	0,11	
Natural pasture $N_{60}P_{60}K_{60}$ A	9,13	9,18	0,55	
Natural pasture $N_{60}P_{60}K_{60}$ B	8,90	8,98	0,90	
Natural pasture $N_{100}P_{90}K_{60}$ A	10,15	10,33	1,77	
Natural pasture $N_{100}P_{90}K_{60}$ B	9,40	9,72	3,40	
Sown pasture $N_0P_0K_0$ Mt A	9,20	9,21	0,11	8,13 – 11,02
Sown pasture $N_0P_0K_0$ Mt B	9,40	9,42	0,21	
Sown pasture $N_{60}P_{60}K_{60}$ A	10,23	10,29	0,59	
Sown pasture $N_{60}P_{60}K_{60}$ B	9,11	9,18	0,77	
Sown pasture $N_{100}P_{90}K_{60}$ A	8,70	8,85	1,72	
Sown pasture $N_{100}P_{90}K_{60}$ B	8,13	8,35	2,71	

The variation of the soluble potassium content

The soluble potassium concentrations from the soil are written in the table 5; from these data there can be observed the following:

- the control treatment records a decrease of the soluble potassium by 4% for the corn crop, a decrease of 0.2% for the sown crop and a slight increase by 0.2% for the natural pasture;

- with the treatments fertilized by $N_{60}P_{60}K_{60}$ there is recorded a decrease of the soluble potassium content by about 2% for the corn crop, an increase by 0.5% for the sown crop and an increase of about 1% for the natural pasture;

- for the treatments fertilized by $N_{100}P_{90}K_{60}$ there was recorded an increased by).4% for the corn crop, by 1.3% for the sown pasture and by 2% for the natural pasture.

The decreasing of the soluble potassium content is determined by the compensation of the potassium loss by fertilizer application.

Table 5

The variation of the soluble potassium content from the soil between initial and final values for different crops

Treatment	The soluble potassium content, ppm		The variation of the soluble potassium content %	The variation interval of the soluble potassium, ppm
	Initial	Final		
Corn $N_0P_0K_0$ Mt A	50,55	48,53	-4,00	48,22 – 53,58
Corn $N_0P_0K_0$ Mt B	50,98	48,94	-4,00	
Corn $N_{60}P_{60}K_{60}$ A	49,75	48,26	-2,99	
Corn $N_{60}P_{60}K_{60}$ B	49,58	48,64	-1,90	
Corn $N_{100}P_{90}K_{60}$ A	49,40	49,42	0,04	
Corn $N_{100}P_{90}K_{60}$ B	49,21	49,54	0,67	
Natural pasture $N_0P_0K_0$ Mt A	46,85	47,23	0,81	46,10 – 48,16
Natural pasture $N_0P_0K_0$ Mt B	46,48	46,25	-0,49	
Natural pasture $N_{60}P_{60}K_{60}$ A	46,45	46,81	0,78	
Natural pasture $N_{60}P_{60}K_{60}$ B	46,33	46,95	1,34	
Natural pasture $N_{100}P_{90}K_{60}$ A	46,18	46,78	1,30	
Natural pasture $N_{100}P_{90}K_{60}$ B	46,50	47,73	2,65	
Sown pasture $N_0P_0K_0$ Mt A	48,72	48,65	-0,14	48,05 – 51,73
Sown pasture $N_0P_0K_0$ Mt B	48,55	48,40	-0,31	
Sown pasture $N_{60}P_{60}K_{60}$ A	49,20	49,84	1,30	
Sown pasture $N_{60}P_{60}K_{60}$ B	49,35	50,00	1,32	
Sown pasture $N_{100}P_{90}K_{60}$ A	49,70	50,35	1,31	
Sown pasture $N_{100}P_{90}K_{60}$ B	48,84	49,70	1,76	

CONCLUSIONS

Taking account of the inertia of the main chemical soil indicators and their tendency to oppose to the external factors, there can be said that that short term experiments, on a low slope versant supply only approximated data of the tendency of evolution of the chemical parameters under the influence of soil water erosion and fertilization.

This tendency is to lower the humus content and the total nitrogen content for the corn crop and sown pasture yet by a slight increase of it with the case of natural pasture, of decreasing of the phosphorus concentration and, less with potassium and of decreasing with the case of pH of the water suspension of soil.

The evolution of the chemical features of the soil by experimented treatments under the influence of erosion and fertilizers is influenced by the quantity and intensity of rainfall, by the mass of the eroded soil, the nature of the crop, the phase of the crop, with repercussions on the intensity of nutrient uptake, the fertilizer rates and their rates, the activity of soil microorganisms which, in turn, dependent of temperature, the aeration degree of soil and by the pH of soil suspension of water.

The chemical indicators have varied during time in narrow interval of values, maintaining the homeostasis of the soil as an ecological system.

Intensity and duration of rainfall, on one hand, and fertilizer application, on the other hand, as well as low soil reaction act in opposite senses, the first ones conducting to the losing of nutrients from the soil and the others (fertilizers and soil reaction), to the accumulation of nutrients into the soil by anthropic contribution and by slowing the physiological activity of plants, and, consequently, by lowing the nutrient consumption.

BIBLIOGRAPHY

1**. Bălan Mihaela**, 2010. *Starea de calitate a unor soluri erodate din Județul Gorj*. *Teză de doctorat, Facultatea de Agricultură a Universității din Craiova.*

2. **Bălan Mihaela**, **Craioveanu Ghe**., **Carigoiu Violeta**, 2011. *Aspecte privind eroziunea solurilor din Județul Gorj. Ed. Universitaria, Craiova.*

3. **Borlan Z**., **Hera C**., **Dornescu D**., **Kurtinecz P**., **Rusu M**., **Buzdugan I**., **Tănase Gh.**, 1994. *Fertilitatea şi fertilizarea solurilor. Editura Ceres, Bucureşti.*

4. **Florea N**., 2004. *Degradarea, protecţia şi ameliorarea solurilor şi terenurilor. Ed. SNRSS, Bucureşti.*

5. **Moţoc M**., 1982. *Unele probleme privind folosirea intensivă a terenurilor arabile situate pe pante. Prod. veget. – cereale şi plante tehnice, nr. 10, Bucureşti.*

6. **C. Popescu**,2005. *Researches on the fertility of the degraded solis from the minning zone of Rovinari, district Gorj and ecological measures for their cropping. Simpozion ştiinţific internaţional, Analele Universităţii din Craiova Seria Biologie, Horticultură, Tehnologia prelucrări produselor agricole, Ingineria Mediului, pg.233-236, ISSN 1435-1275.*

7. **Popescu C**., 2009. *Researches on the structure of the preluvosoils from the southern part on the Getic Piemont thatwas used log term as arable., Buletin of Universitu of Agricultural and Veterinary medicine Cluj Napoca, Vol 66 (I),ISSUE 1 /2009, pag. 552, ISBN 1843-5246*