METHODS FOR MITIGATION THE NUTRIENT LOSSES ON SLOPE SOILS

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Abstract: *On slopes soils there take place important nutrient losses that inflict pollution of surface waters. The most lost nutrient is nitrogen yet the phosphorus from soluble fertilizers is also lost. These nutrients reach into surface waters where determine eutrophication phenomenon. In order to implement the objectives of Water Frame Directive 2000/60/CE there have been searched methods for mitigation the nutrient pollution from slope soils. These methods are: - the using of organic – mineral fertilizers (L120) instead of soluble phosphorus fertilizers (superphosphates); - buffer strips at the bottom of the slope;- filtering materials for water from creeks. The applying of these methods have contributed to the reduction of the nutrient losses (nitrogen and phosphorus) from slope soils with values ranging between 38-41% by applying organic – mineral fertilizer and by 52-64% when buffer strips were installed. The using of straw ballots as filtering materials for creek water has determined the reduction of nutrient losses by 72%. This way, the using of organic – mineral fertilizer on lignite base (L-120) has determined the diminishing of phosphorus losses on slope soils due to bonding phosphorus from this fertilizer in an organic – mineral matrix that speeds up the retrogradation and solubilisation processes of phosphorus. The using of grass buffer strips of 10 m wide on level curves at the bottom of the slope along Preajba creek has determined an obvious decreasing of the eroded soil quantity, of humus and nutrient losses due to better retention by root system and its higher density. Straw ballots across the course of a creek are a good filter for running waters. The straw action is similar with soil colloidal complex, they retain chemical ions from water like: NO3, NH4, K, PO4, etc. By using straw ballots there can be avoided the eutrophication phenomenon of the surface waters. The using of crops like natural and sown pasture as well as cereals could be a method to mitigate nutrient losses on slopes. Wide row crops should be avoided as much as possible.*

Key words**:** *slope, nutrient losses, Water Frame Directive, nitrogen, phosphorus*

INTRODUCTION

Nutrient losses from soils are close related to the erosion phenomenon because large quantities of nutrients are lost along with the solid material transported as a result of erosion agents. The ways these nutrients are lost are:

- eroded soil that contribute to the movement of the nutrients and humus on the versants and their accumulation at the base of it in lowlands or lakes in function of the transport power of the erosion agents along with the transported material;
- nutrient losses along with the surface runoff water, these losses are proportional with the nutrient solubility and quantity;
- the leaching of nutrients into the soil profile by water (Filiche, 2011).

These soil and nutrient losses have an outstanding impact on the environment, namely: decreasing the soil productivity because of humus and nutrient losses, lakes warping (Cojocaru, 1995), plants uprooting or plant covering with sediments that conduct to the decreasing of the yield, surface water and running water depreciation by their pollution, eutrophication phenomenon.

The eutrophication of the surface waters and the contamination of the ground waters as a result of massive applying of fertilizer and surface runoff as well as of leaching into ground water has a major impact on ecosystems across many Europeans countries. The Water Frame Directive (WFD) 2000/60/EC assumes the improvement of the surface and ground

waters. This aspect will determine a drastic reduction of the nutrient losses from farming activity that will imply a long term implications on sustainability of agricultural ecosystems.

In order to reduce nutrient losses from farming activity at European level there was established the COST Program, Action 869 entitled: Mitigation options for nutrient reductions in surface waters and ground waters. The main objective of the Action COST 869 has been the scientifically evaluation of the suitability and the cost of different options for mitigation of nutrient losses into ground waters and surface waters at the scale of river basins as well as their limits (Ana Maria Dodocioiu, 2012).

In order to implement this program in Romania we have made researches at the Research Center for Pastures Preajba Gorj with the goal of finding some measures for reducing nutrient losses.

MATERIAL AND METHODS

At the Research Centre for Pastures Preajba Gorj there have been established field experiments on the albic luvic soil on a 6% slope on standard plots for erosion research with the dimension of 4/25 m.

The experiment was located at 355 m altitude on the fifth terrace of Jiu River that has an herbaceous acidophile – xerophile vegetation. The soil on the experiment has the following profile: At, Ao, El (A), EBw, Btw1, Btw2, BC, CR.

The physical features of this soil are unfavorable in relation with water, the bulk density is high, the air porousity is low, the wilting point and the available water capacity are high, the water permeability is low. It is a low favorable soil for crops, its fertility decreasing with the eluviation degree.

The soil reaction is moderate acid (pH=5.29 – 5.46), moderate supplied by nitrogen (Total Nitrogen = 0.17%), very poor in soluble phosphates for plants, middle supplied by available potassium.

On the standard plots for erosion research there has been established an experiment with 6 treatments in three replications: sown pasture (control), sown pasture fertilized with N162P81K80 (superphosphate), sown pasture fertilized by L120 organic – mineral fertilizer, corn, unfertilized (control), corn N162P81K80, corn fertilized by L120 organic – mineral fertilizer.

The organic – mineral fertilizer L120 has the lignite coal as a base and it contains polymeric acids, ureo – aldehydical polymers and salts of the sulphuric acid or phosphoric acid used for activating the coal. In this type of fertilizer the nitrogen is linked by ions either as ammonium humates or amidic polymer or as salt of ammonium sulphate, the phosphorus is as ammonium phosphates and the potassium as ionitic form (Dorneanu, 2010).

The nutrients are present as different forms in an organic – mineral matrix that slows and prolongs the hydrolysis, amonification and nitrification processes of nitrogen compounds hasting the retrogradation processes of available phosphates as calcium superior phosphates for plants (Preda, 2010).

Annually, there has been quantified the phosphorus losses, within the 2009-2011 period, in function of the 6 treatments and the rainfall as well as of the fertilizers that have been applied at the same rate of P81. Also, there has been researched the effect of the buffer strips on the retaining major nutrients on the slope and there were tried several materials as filter for nutrients as straw ballots for purifying the water in nearby creek.

RESULTS AND DISCUSSIONS

The reduction of the nutrient losses using the organic – mineral fertilizer L120

The using of the organic – mineral fertilizer L120 at P81 rate has emphasized, during all three years of the experiment, the obvious decreasing of the lost quantity of phosphorus. The data on this issue, during 2009-2011 period are presented below.

Table 1

The phosphorus losses from the stagnic luvosoil from Preajba Gorj in function of the crop and the applied fertilizers (average 2009-2011)

Treatment	Annual rainfall (mm)	Runoff m^3/ha	Eroded soil t/ha	Lost Phosphorus Kg/ha
Sown pasture (control)	565 mm	572.5	2.68	0.32
Sown pasture N162P81K80		546.8	2.33	0.26
Sown pasture L120		549.6	2.32	0.18
Corn, not fertilized		744.9	5.37	0.65
Corn N162P81K80		792.6	5.15	0.51
Corn L120		734.2	5.17	0.32

The data comprised in this table shows that, on average for three years of experimentation with the sown pasture that was not fertilized, in the conditions of 565 mm rainfall the runoff from the slope of 6% at Preajba research Station there were lost 572.5 m^3/ha water ant there were eroded 2.68 t/ha soil and the phosphorus quantity that was lost was of 0.32 kg/ha.

When fertilizing with N162P81K80 the runoff water quantity was less, the same with the phosphorus that was 0.26 kg/ha due to more intense growth of the pasture and better covering of the soil as well as much more consumption by the plants of soil phosphorus.

When L120 organic – mineral fertilizer is applied on the soil the phosphorus quantity that is lost from the soil is even lower due to better retention in the soil of this nutrient, in comparison with conventional superphosphate fertilizer.

With the corn crop the runoff water is lower than with sown pasture, of 744.9 – 792.6 m^3/ha and 5.15 – 5.37 t/ha/yr. The lost phosphorus quantity has been of 0.65 kg/ha/yr with the not fertilized control and of 0.51 kg/ha/yr with N162P81K80 and it decreases to 0.32 kg/ha/yr when apply L120 organic – mineral fertilizer. So, this fertilizer contributes to the decrease of the phosphorus losses on slope soils.

The using of buffer strips in order to reduce nutrients losses

Buffer strips are permanently put with herbs or by natural vegetation. They have an important role in preventing runoff processes and nutrient losses as well as the accumulation of soil sediments. They are placed along slope lines or at the base of the slope (Chardon, 2010).

At Preajba Research Station there were established buffer strips of natural vegetation at the base of the slope along Preajba creek with 10 m width formed of the following species: Agrostis capillaris, Festuca rubra, Cynosurus cristatus, Lollium perenne, Anthoxanthus odoratum and Trifolium arvense.

In 2010 there were quantified the soil quantities of soil and nutrients that were lost on slopes without and with buffer strips. The results are presented in the table below.

Table 2

The soil and nutrient losses when using buffer strips near Preajba creek

Specification	Liquid runoff m^3/ha	Erosion, soil t/ha	Humus Kg/ha	N Kg/ha	P Kg/ha	K Kg/ha
No buffer strips	674.2	0.783	111.2	2.94	0.114	0.59
With buffer strips	326.3	0.286	14.5	1.22	0.053	0.34

There can be observed that the using of buffer strips contributes to the reduction of the humus and N,P,K losses from the soil.

When no buffer strips are established there were the following losses: 674.2 m^3/ha liquid runoffs, 0.783 t/ha soil, 111.2 kg humus, 0.114 kg/ha P and 0.59 kg/ha K while the using of buffer strips these losses decreased almost by half, reaching 326.3 m^3/ha liquid runoffs, 0.286 t/ha eroded soil, 14.5 kg/ha humus, 1.22 kg N, 0.053 kg P and 0.34 kg K.

The using of different materials for filtering runoff water

For this goal there have been used straw ballots that have been placed across the Balasan creek. There have been determined the main nutrients before and after the crossing over the barrier filter and after several time periods. The results are presented in the table 3.

From these data there can be emphasized that straw ballots are an efficient mean for filtering waters when placed across the creek. This way, after an hour of filtering, the nutrient content of water filtered by the straw ballots has been almost the same. After 6 hours the nutrient content of the water after passing through straw ballots begins to decrease from 1.85 to 1.61 mg/l N-NH4; from 10.65 mg/l to 9.52 N – NO3; from 0.155 mg/l to 0.140 mg/l N – NO2; from 8.81 mg/l to 8.04 total nitrogen; from 0.114 to 0.119 mg/l P – PO4; from 0.119 mg/l to 0.110 total P; from 96.3 mg/l to 27.1 Ca and so on.

Table 3

The soil and nutrient losses when using buffer strips near Preajba creek

Nutrients	Normal values mg/l	Before filtering	Values after time filtering of				
			1 hour	6 h	24 h	48 h	96 h
N – NH4	0.4	1.82	1.85	1.61	1.03	0.56	0.38
N – NO3	1.0	10.65	10.66	9.52	6.33	4.11	2.77
N – NO3	0.01	0.154	0.155	0.140	0.076	0.034	0.016
Total N	1.5	8.81	8.82	8.04	5.11	2.37	1.12
P – PO4	0.1	0.119	0.119	0.114	0.080	0.06	0.040
Total P	0.015	0.21	0.22	0.13	0.06	0.02	0.013
Ca^{2+}	50	96.3	96.5	81.3	62.6	41.5	36.2
Mg^{2+}	12	29.0	29.0	27.1	21.3	15.2	10.4
K^{+}	12	13.6	13.5	11.8	6.5	4.2	3.7

The decreasing of the nutrient cont from the water of Balasan creek has been accentuated after 24, 48 and 96 hours, when the content is approaching normal values of 2.77 mg N – NO3 mg/l, 0.016 mg N – NO2 mg/l, 1.12 mg/l total N, 0.04 mg/l P-PO4, 0.013 mg/l total P, 36.2 mg/l Ca, 10.4 mg/l Mg and 3.7 mg/l K.

There results that the using of straw ballots is an important mean for reducing pollution of running waters.

CONCLUSIONS

The experiments carried out with different means for reducing nutrient losses on slope soils have emphasized the following issues:

- the using of organic – mineral fertilizer on lignite base L120 has conducted to the diminishing of the phosphorus losses on slope soils due linking the phosphorus from this fertilizer into an organic – mineral matrix that slows haste the retrogradation processes of phosphorus insolubilisation;

- the using of buffer strips of 10 m width located on the slope lines and at the base of the slope along Preajba creek has determined an evident decreasing of the eroded soil, of the humus quantity and nutrient losses per hectare;

- the using of straw ballots as filter for running water has contributed to purifying the water course of Balasan creek 6 to 10 times.

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