RATIONAL APPLICATION OF FERTILIZERS TO SUPPORT THE PROCESSES OF RECULTIVATION AND ECOLOGICAL RESTORATION OF STERIL DUMPS IN MEHEDINTI COUNTY

Mihail SUSINSKI, Marian DOBRE, Gabriel BĂDESCU, Cristian VASILE

University of Craiova, Faculty of Agronomy

Coressponding author: gabrielbadescu3000@gmail.com

Abstract

Soil represents the upper layer of the Earth's crust, consisting of a complex mixture of mineral particles, organic matter, water, air, and microbial communities and living organisms, which interact to support the biological, chemical, and physical processes essential to ecosystems.

The use of soil as a medium for the storage and disposal of liquid and solid waste raises a series of significant environmental issues. Among the factors contributing to waste generation and soil degradation are mining activities, particularly lignite extraction, which affects the structure and fertility of soils.

Lignite mining, whether in open-pit mines or at the surface, represents the most aggressive form of soil degradation. It leads to the inversion and mixing of geological soil layers, nutrient migration, and landscape degradation, with waste dumps replacing productive land.

The areas affected by lignite extraction in Romania amount to over 26,200 hectares, with Gorj County ranking first (~14,505 ha), followed by Vâlcea (~2,166 ha) and Mehedinți (~586 ha). These areas are mainly occupied by tailings dumps, composed of a homogeneous mixture of geological deposits depending on the exploitation zone, which have a significant environmental impact.

Under these conditions, the recultivation of tailings dumps becomes an essential necessity, also requiring detailed research aimed at identifying the most appropriate, efficient, and cost-effective solutions for their ecological restoration.

Key words: steril dumps, fertilizers, underground water, soil

INTRODUCTION

Open-pit coal mining is carried out exclusively through surface works, which consist of removing the overburden, the layers of earth covering the coal seam, followed by the extraction of lignite.

The mining technology chosen for open-pit lignite excavation involves a continuous flow of excavation, transport, and dumping using high-capacity equipment.

The layers above the coal (consisting of clay, sand, gravel, and soil) form material that is worthless from a mining point of view and are conventionally referred to as "overburden."

The dumps are generally made up of heterogeneous rocks lacking the nutrients necessary for plant growth and development, so they cannot be considered soil.

In the process of open-pit mining, the soil factor has disappeared, even though sometimes the fertile horizon has been selectively stripped to be used for covering in order to reduce the improvement period.

MATERIAL AND METHOD

With a view to the ecological reconstruction of the waste dumps at the Husnicioara – Mehedinţi quarry, we set up an experimental site on these dumps, with the main objective of introducing crops using chemical and organic fertilizers.

To this end, experiments were conducted with a variety of crops and different doses of fertilizers, as follows:

Corn	Sunflower
Mt nefert.	Mt. nefert.
N64	N64
N100	N100
N136	N136
N136P80	N136P64
N136P80K80	N136P64K80

These doses were applied on a background of 25 t/ha manure and without manure.

The soil on which these experiments were conducted consists of different lithological materials mixed heterogeneously, forming psammic entiantrosol. This soil has a profile consisting of 4 lithological layers: S1...S4, with a sandy texture and coal inclusions, having the physical (Table 1) and chemical (Table 2) properties

Table 1.Physical properties of the psammic entiantrosol at Husnicioara

Profile No.	No. of layers	Layers (cm)	Coarse sand (%)	Fine sand (%)	Dust (%)	Physical clay (%)	Colloidal clay (%)	Texture
1	S_1	0-23	21,5	75,3	0,3	3,0	2,9	N
	S_2	23-37	39,3	51,9	3,2	7,6	5,6	NL
	S_3	37-62	45,5	47,3	4,0	7,1	3,2	N
	S_4	62-128	30,9	62,1	3,7	5,4	3,3	N
2	S_1	0-25	70,0	21,0	7,0	3,9	2,0	NL
	S_2	25-50	44,8	30,4	16,6	10,2	8,2	LN
	S_3	50-75	46,2	28,3	17,4	12,2	8,1	LN-LA
	S_4	75-150	50,0	26,8	16,6	9,0	6,6	LN

Table 2.Chemical properties of the psamic entiantrosol from Husnicioara

Profile No.	Depth (cm)	pH	$CaCO_3$ (%)	Humus (%)	Nt (%)	P (ppm)	K (ppm)
1	0-23	8,7	4,8	0,40	0,16	6,96	44,86
	23-37	8,9	4,8	0,50	0,16	4,52	39,95
	37-62	9,0	3,2	0,40	0,20	5,09	33,24
	62-128	8,0	2,4	0,40	0,08	11,09	33,21
2	0-25	8,1	3,9	0,40	0,16	14,05	42,44
	25-50	7,9	4,0	0,20	0,08	11,98	49,50
	50-75	8,2	4,2	0,30	0,11	15,93	50,85
	75-150	8,2	4,2	0,30	0,12	13,03	30,31

The soil is very poor in nitrogen, phosphorus, and potassium, creating conditions unsuitable for plant growth and development. The soil rating is 10.5, which places it in class V of suitability.

RESULTS AND DISCUSSIONS

a) Following the use of chemical fertilizers

Table 3.Average corn grain production with different doses of mineral fertilizers on agricultural land with 25 t/ha manure (kg/ha)

Applied fertilization	Production (kg/ha)	Relative production (%)	Difference (kg/ha)		Meaning	
			From the control	From the average	From the control	From the average
Unfertilized	1068	100	39,4	0	-	000
N_{64}	1822	170,5	67,2	754	x	0
N_{100}	2210	206,9	81,5	1142	xx	0
N_{136}	2682	251,1	98,9	1614	xxx	-
$N_{136}P_{80}$	3802	355,9	140,2	2734	xxx	xx
$N_{136}P_{80}K_{80}$	4064	380,5	149,8	2996	xxx	xx
Average X	2712	253,9	100	1644	xxx	-

DL 5% = 689
DL 1% = 896
DL 0,1% = 1191

Table 4.Influence of chemical and organic fertilizers on sunflower production (kg/ha)

Option	Production (kg/ha)	Relative value (%)		Difference (kg/ha)		Meaning	
		From the control	From the average	From the control	From the average	From the control	From the average
Unfertilized	263	100	44,0	0	-308	-	000
N_{64}	496	188,6	86,8	233	-75	xxx	0
N_{100}	577	219,4	101,0	314	6	xxx	-
N_{136}	587	223,2	102,8	324	11	xxx	-
$N_{136}P_{64}$	650	247,2	113,8	387	79	xxx	x
$N_{136}P_{64}K_{80}$	853	324,3	149,9	590	282	xxx	xxx
Average X	571	217,1	100	308	0	xxx	-

DL 5% = 67
DL 1% = 89
DL 0,1% = 119

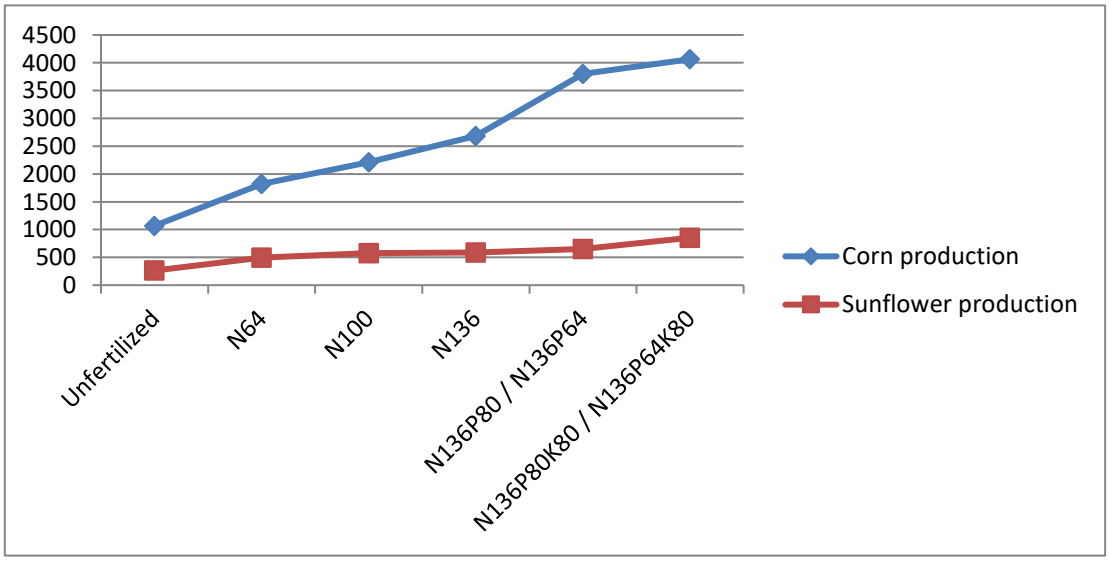

Figure 1.Corn and sunflower production depending on fertilizer doses applied

Table 5.Influence of compost fertilization on corn grain production (kg/ha)

Applied fertilization	Production (kg/ha)	Relative value (%)	Absolute difference	Meaning
Unfertilized	914	100	-	-
10t/ha	2600	284	+1686	xxx
20t/ha	3325	364	+2411	xxx
30t/ha	3793	415	+2879	xxx

DL 5% = 519
DL 1% = 653
DL 0,1% = 1050

Table 6.Influence of compost fertilization on sunflower production (kg/ha)

Applied fertilization	Production (kg/ha)	Relative value (%)	Absolute difference	Meaning
Unfertilized	619	100	-	-
10t/ha	708	114	+89	-
20t/ha	1058	171	+439	xx
30t/ha	1167	188	+548	xxx

DL 5% = 201
DL 1% = 304
DL 0,1% = 486

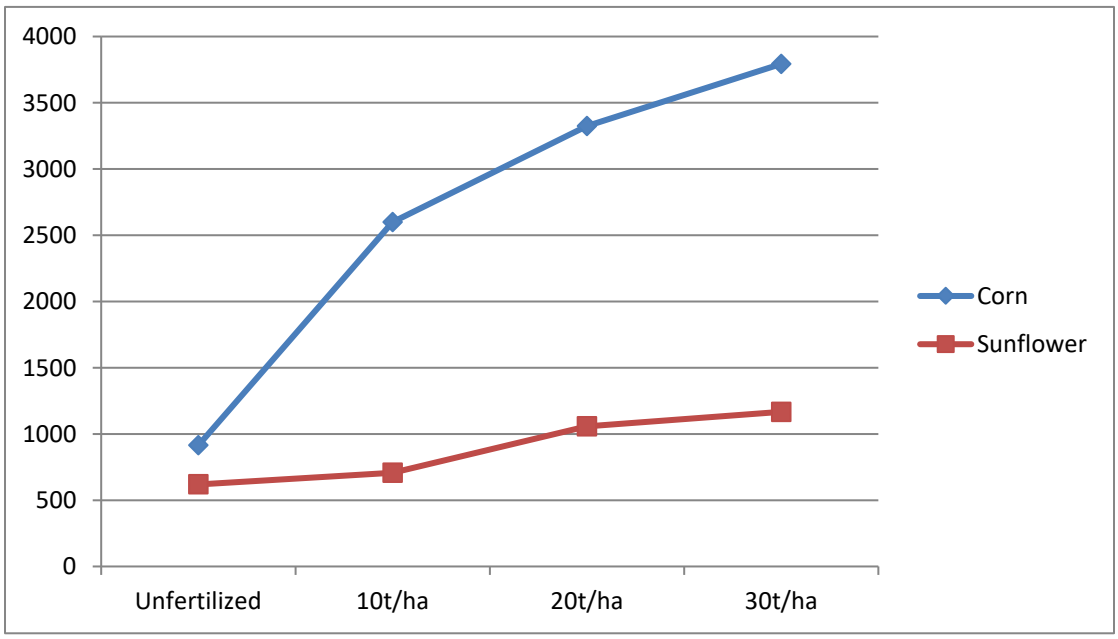

Figure 2. Corn and sunflower production depending on the amount of compost applied

The results of using different doses of chemical fertilizers on corn and sunflower crops, based on 25 t/ha of manure, are shown in Tables 3-4. It can be seen that, due to physical and chemical properties unfavorable to plant growth and development, especially the lack of nutrients, no yield is obtained from the corn crop. Even the application of low doses of nitrogen (N64) results in a yield of 1822 kg/ha.

Sunflower crops thrive on barren land without fertilizers (263 kg/ha). The use of nitrogen or nitrogen and potassium fertilizers results in an increase in yield to 650 kg/ha when N136P64 is used and to 853 kg/ha when N136P64K80 is applied.

Applying these fertilizers on top of 25 t/ha of manure doubled sunflower production.

b) Following the use of organic fertilizers such as compost

The compost used had the following chemical composition: 1.74% N; 0.73% P2O5; 0.16% K2O, 0.15% CaO, and 0.084% MgO. It was applied to corn and sunflower crops.

Corn and sunflower yields increase with the amount of compost used. Thus, for corn, at a quantity of 30 t/ha, the yield is three times higher than for unfertilized crops (3,793 kg/ha compared to 914 kg/ha), while for sunflowers, yields are double (1,167 kg/ha compared to 619 kg/ha).

Applying compost leads to the highest yields for both crops.

CONCLUSIONS

- The waste piles from the Husnicioara quarry have a very low fertility level, being classified in category V of suitability (10.5 rating);
- The use of chemical fertilizers is particularly important for growing various crops on waste rock piles; without chemical or organic fertilizers, wheat and corn crops cannot grow on waste rock piles;
- The use of N136P80K80 fertilizers results in yields of 4064 kg/ha for corn and 853 kg/ha for sunflowers, and when these fertilizers are used on top of 25 t/ha of manure, yields double;
- Using compost as organic fertilizer yields very good results when 30 t/ha is applied to all crops: corn and sunflowers;
- Compost has a positive effect on increasing the organic matter content, which is very necessary on waste rock piles, and therefore has a lasting effect in subsequent years;
- Taking into account the social and economic impact of mining operations and their harmful effect on soil and agricultural production, it is possible to assess the opportunity to continue and develop surface mining operations, while ensuring compliance with the legal framework that requires the recultivation of land free of technological burdens.

REFERENCES

Avarvarei I., Davidescu Velicica, Mocanu R., Goian M., Caramete C., Rusu M., 1997. Agrochimie. Editura Sitech, Craiova.

Becherescu C., 1998. Agrochimie. Reprografia Universitatii din Craiova.

Blaga Gh., Răuță C., Nastea Șt., Dumitru M., 1981. Studiul proprietăților fizice, chimie și biologice ale materialelor de haldă nivelate în scopul recultivării. Lucrările C.N.S.S. – Brașov, București.

Borlan Z., Hera Cr., 1984. Optimizarea agrochimică a sistemului sol – plantă. Editura Academiei RSR.

Mocanu R., 1994. Redarea în circuitul agricol a solurilor degradate de exploatările miniere la zi. Lucrările Simpozionului de Istorie și Retrologie Agrară Bacău.

Mocanu R., Marin N., Pană D., 1996. Însușirile agrochimice ale unor halde de steril din bazinul carbonifer Motru și Mehedinți. Analele Universității din Craiova, Vol. XXXII.

M. Susinski, R. Mocanu, C. Becherescu, Ana Maria Mocanu, I. Bala, 2003. Proprietăţile fizico-chimice ale unor

halde de steril din Oltenia, Chisinau, Simpozion Ştiinţific Internaţional “70 ani ai Universităţii Agrare de Stat din Moldova”.

Rusu M., 2008. Tratat de Agrochimie. Editura CERES, Cluj-Napoca.