# THE INFLUENCE OF FERTILIZATION ON WHEAT YIELD LOSSES ACHIEVED DURING THE AGROCHEMICAL MELIORATION OF A SOIL, UNDER CONTROL POLLUTED WITH CRUDE OIL, FROM ORADEA

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#### Abstract

The rehabilitation technologies of agricultural land polluted with organic substances, are based on biodegradation of pollutants "in situ" and the cultivating of tolerant plants, parallel to implementation of agro-technical measures, which aim: the soil aeration through loosening; the soil reaction correction and balancing of the ratio carbon / nitrogen C / N through the administration of organic and mineral fertilizers.

The objective of this paper is to analyze the yield losses of an under control polluted with crude oil of soil at a concentration of 3 %, compared to unpolluted soil, achieved in the last seven years of observations in the field for agrochemical melioration of a polluted soil, from Oradea, Bihor County.

The lowest average yield losses in spring wheat, during the research are obtained for the maximum amount of manure, of 150 t / ha and all doses of complex fertilizers, these being between 0.14 and 0.35 q / ha.

Key words: soil pollution, haplic luvisoil, fertilizing systems, rehabilitation, biodegradation;

## INTRODUCTION

In Romania the area polluted with petroleum products is estimated at about 50000 ha of which, in 2009, oil and salt water pollution from extraction occupies 2654 ha. After the 2009 data only Bacau, Covasna, Gorj, Prahova and Timis Counties, soil pollution with petroleum products spanning on 751 ha. (ANPM, 2009, http://www.anpm.ro/upload/16102\_5%20SOL%202009.pdf)

In Bihor county area affected by historical pollution with crude oil is about 250 ha and is located in the extraction fields from Suplacu de Barcău, Marghita and Oradea. (Sabău et Şandor, 2013)

Soil pollution by crude oil is very complex, toxic effects being felt by the crop plants at concentrations of only 1%, these registering yield losses due to of unbalancing the carbon / nitrogen C / N report.

In the case of agricultural land, polluted with organic substances, remediation technologies widely applied, appeal to rehabilitation "in situ"

trough biodegradation (Glick, 2010) and cultivation of tolerant plants to the given conditions of pollutant toxicity. (Gerhardt et al, 2009)

The process of biodegradation of organic pollutants is enhanced by culture technologies applied, which aim: soil aeration by loosening, correcting soil reaction and the equilibration of the report carbon / nitrogen C / N through administration of organic and mineral fertilizers. (Marques Alvarez et al, 2011)

The first researches regarding the effect of soil pollution with crude oil in our country were conducted at Research and Development Station Oradea, between 1993 and 2002 being evaluated the effects of pollution on agricultural production and the effect of applying a system of organic and mineral fertilization in the ecological restoration of soil under control polluted. (Colibaş et al, 1995; Sabău et al, 2009; Şandor, 2011)

Researches regarding the remediation of soils polluted with oil and salt water, in specific conditions from south of the country, were aimed at biodegradation of organic pollutants using microorganisms selected from the indigenous flora. (Voiculescu et al, 2006)

The objective of this paper is to analyze the yield losses of the controlled polluted soil with crude oil at a concentration of 3 %, compared to unpolluted soil, achieved in the last seven years of observations made in the field for agrochemical improving of an under control polluted soil from Oradea, Bihor County.

## MATERIAL AND METHOD

The field for agrochemical melioration of the soil, under control polluted with crude oil was placed in 1993, at Research and Development Station Oradea, on a haplic luvisol. (Colibaș et al, 1995)

The polyfactorial experience was of type 2 x 4 x 4, with three factors, located in plots with micro parcels of 1  $m^2$ , arranged randomized in three replications.

The studied factors were:

Factor A, pollution:  $A_0$  - witness unpolluted;  $A_1$  – polluted on plowed horizon, 3 % crude oil;

Factor B, Organic fertilizer:  $B_0 - 0$  t/ha manure,  $B_1 - 50$  t/ha manure,  $B_2 - 100$  t/ha manure,  $B_3 - 150$  t/ha manure;

Factor C, Mineral fertilizer:  $C_0 - N_0P_0K_0$  kg/ha,  $C_1 - N_{100}P_{80}K_{70}$  kg/ha,  $C_2 - N_{200}P_{160}K_{140}$  kg/ha,  $C_3 - N_{300}P_{240}K_{210}$  kg/ha;

The crude oil used for under control pollution of the parcels in the plot A1 was brought from Suplacu de Barcău, Bihor County.

The experimental field was cultivated with millet, in the first three years (1993 - 1995) a plant that has an increased tolerance to soil pollution

and then, in the last seven years (1996 - 2002) with spring wheat, Speranța bread.

The program "Research for the rehabilitation of degraded land with petroleum residue" from Agricultural Research and Development Station Oradea, Laboratory of Soil Science and Land Reclamation was part of the national program "Monitoring of soil quality" financed by the Research Institute for Soil Science and Agrochemistry Bucharest.

### **RESULTS AND DISSCUSIONS**

The yield differences between witness variants, unpolluted and controlled polluted by 3 % oil variants (A0-A1) are considered yield losses of polluted variants in comparison with the unpolluted, when they are positive and yield increases when these differences are negative. (Table 1.)

Table 1.

The yield losses in spring wheat (q/ha) between not polluted variants and under control polluted with 3 % crude oil variants (a1-a2) in the last seven years of melioration, Oradea (1996-2002)

<i>Gruueu</i> (1770-2002)										
Fertilizing system		Years							Average	
		4	5	6	7	8	9	10	mineral	
Organic	Mineral	1996	1997	1998	1999	2000	2001	2002	fertilizer	
bo	со	3.90	6.40	-0.68	6.31	0.61	-0.73	-0.53	2.18	
	c1	3.00	3.50	3.09	-1.40	0.64	-0.40	-1.12	1.04	
	c2	3.20	2.60	0.13	-1.50	0.76	-0.01	-2.10	0.44	
	c3	5.40	2.80	1.53	5.50	1.06	0.15	-0.63	2.26	
Ave	Average		3.83	1,02	2.23	0.77	-0.25	-1.10	1.48	
b1	со	5.60	5.40	-0.88	0.65	-0.19	-0.20	-2.42	1.14	
	c1	5.80	3.80	0.89	1.95	0.59	0.88	-1.96	1.71	
	c2	2.20	2.10	-2.46	-0.35	1.91	-0.44	0.49	0.49	
	c3	-1.00	-0.50	-1.18	3.77	0.48	-0.25	-1.73	-0.06	
Ave	Average		2.70	-0.91	1.50	0.70	-0.01	-1.41	0.82	
b2	со	4.20	4.80	-0.61	-2.50	0.08	-0.15	-2.23	0.51	
	c1	1.50	2.00	-1.35	2.93	1.63	-0.27	-2.80	0.52	
	c2	0.20	1.50	-2.00	3.48	1.22	-0.34	-2.39	0.24	
	c3	1.60	1.00	-0.31	3.06	0.78	-1.88	-1.52	0.39	
Ave	Average		2.33	-1.07	1.74	0.93	-0.66	-2.24	0.42	
b3	со	2.20	1.50	-0.18	3.12	1.23	-4.37	-0.65	0.41	
	c1	-0.30	1.30	-1.03	4.41	1.81	-2.07	-0.71	0.49	
	c2	-2.20	-1.30	2.00	-1.07	1.91	-1.45	-4.22	-0.90	
	c3	-5.40	-3.50	-2.36	-2.82	1.64	-1.73	-3.64	-2.54	
Average		-1.43	-0.50	-0.39	0.91	1.65	-2.41	-2.31	-0.64	
Average organic fertilizer		1.87	2.09	-0.35	1.60	1.01	-0.83	-1.77	0.52	

The average realized by organic fertilization with manure recorded the highest yield losses in 1997, of 2.09 q / ha, while in the last years,

polluted variants to register yield increases compared with witness variants, which are in 2002 of - 1.77 q / ha.

It may also be noted that in the last year of the experiment, in 2002 most of the differences in production are negative, indicating that the polluted variants is achieved yield increases towards unpolluted variants, the largest being of - 4.22 q / ha, for variant with maximum amount of manure (150 t / ha) and the mineral fertilizer dose N<sub>200</sub>P<sub>160</sub>K<sub>140</sub>.

The evolution of yield losses is closely linked to the quantities of manure, mineral fertilizer doses and their cumulative effect, the bifactorial, polynomial second degree correlations, without interaction between factors are very significant statistically. (Table 2.)

Table 2.

Bifactorial, polynomial correlations of yield losses in spring wheat LY (q / ha) and tim	e T
(years), and respectively the quantities of manure O (t / ha: 100) and doses of miner	al
fertilizers M (NPK x 100) in the last vers of soil polluted melioration (1996-2002)	

No. crt.	Type of equation	The equations	The correlation	Statistical significance
	1.37		report R	ste ste ste
1.	LY=	YL = 1,0/0381 + 0.7602281 -	0.77086	* * *
	f(T,O)	$0.099352T^2 - 0.76412 \text{ O} - 0.39214 \text{ O}^2$		
2.	LY=	YL = 0.773036 + 0.760228  T - 0.09352	0.73209	***
	f(T,M)	$T^2$ - 0.45036 M + 0,01619 M <sup>2</sup>		
3.	LY = f(T,	LY = -2,0635 + 1,756538 T - 0,16519	0,71377	***
	OxM)	$T^2 - 0,9078 \text{ OxM} - 0,0314 \text{ O}^2 \text{xM}^2$		

After the size of the correlation coefficients of the relationships thus established the closest connection is determined by the amount of manure applied. If we consider the  $a_{21}$  coefficient for the second factor of the equation (A, M, A x M), is underlined the importance of the cumulative effect of organic and mineral fertilization (-0.9078), followed by quantities of manure (-0.76412) and the mineral fertilizers doses (-0.455036) their sign suggesting the determination of the yield increases.

For the average yield losses in wheat, in the period under review was established a bifactorial correlation, of type polynomial second degree, with the interaction between the two factors in function of the quantities of manure (A) and doses of mineral fertilizers (M) applied, the ratio of correlation R = 0.78524 indicating that it is very significant statistically. (Figure 1.)

The form of spatial graphic representation of the average yield losses evolution show a nearly linear decreasing trend with the increasing of quantities of manure applied, while this trend it reduce with the increasing of mineral fertilizers doses. The lowest average yield losses in wheat, during the research period are obtained for the maximum amount of manure of 150 t / ha and for all doses of complex fertilizers, these being between 0.14 and 0.35 q / ha.



 $YL = 2.101677 - 0.73072 O - 0.07411 O^{2} - 0.60949 M + 0.134821 M^{2} + 0.007657 OM ; R = 0.78524 ***$ 



Figure 1. The correlative link between average yield losses in spring wheat YL (q/ha) and respectively amount of manure O (t/ha/100) and doses of mineral fertilizers (NPK x 100) administered

Analyzing the influence of fertilizer systems applied in the improvement of polluted soil by means of yield losses, it is noted that organic fertilization have more effect in enhancing of crude oil biodegradation than mineral fertilization.

## CONCLUSIONS

The average realized by organic fertilization with manure recorded the highest loss of production in 1997 of 2.09 q / ha, while in the last years, polluted variants to register production increases compared with witness variants, which are in 2002 of - 1.77 q / ha. The bifactorial correlations of second-degree polynomial type, without factors interaction, between the yield losses and respectively the time and doses of organic and mineral fertilizers, very significant statistically, demonstrates the cumulative effect of organic and mineral fertilization on reducing the yield losses.

The lowest average yield losses during the research period are obtained for the maximum amount of manure of 150 t / ha and for all doses of complex fertilizers, which are between 0.14 and 0.35 q / ha.

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