THE LINK BETWEEN AGRICULTURAL CROP AND FERTILIZER SYSTEM ON A HAPLIC LUVOSOIL UNDER CONTROL POLLUTED WITH CRUDE OIL, FROM ORADEA, BIHOR COUNTY

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Abstract: *The paper presents the partial results of researches regarding the agrochemical melioration of soils under control polluted by crude oil brought from the exploitation site at Suplacu de Barcău that took place at the Agricultural Research and Development Station in Oradea, Bihor County. The experimental device was made out of 1 m^2 micro parcels, spread out in subdivided parcels, in four repetitions, having three factors: A - the pollution by crude oil from Suplacu de Barcău,in two graduations a1-nonpolluted and a2-under control polluted with 3 % crude oil concentration; B – the organic fertilization with manure (0, 50, 100 and 150 to/ha) and C – the mineral fertilization with complex fertilizer in doses: $N_0P_0K_0$, $N_{100}P_{80}K_{70}$, $N_{200}P_{160}K_{140}$ and $N_{300}P_{240}K_{210}$. The experience was set out on a haplic luvosoil în the year 1993 and the soil was cultivated with millet in the first three years and with spring wheat in the last seven years of research. The millet hay average yield of studied variants is bigger in not polluted variant (44,91 q/ha) than in polluted by 3 % concentration of crude oil variant (40,16 q/ha) with 4,75 q/ha. Between annual and average yields of millet hay (q/ha) and the manure quantity and respectively mineral fertilizer doses was established linear and spatial linear correlations. The reply's crop at the rate of complex fertilizer administrated is in proximity but the slope of the line for polluted variant show an increase of yield at one rate's mineral fertilizer about 3,5 kg/ha while for the not polluted soil the increase is about 3,36 kg/ha. The shapes of the lines established for the first three researches years sows that the level of annual yields under the organic fertilizer system have a decrease tendency from the first year to the last year, on the not polluted variant while on the polluted variant the level of yield is smaller in the first year and afterward it stabilize to approximately 5 kg/ha for one unit of manure administrated. Analyzing the shapes of correlation lines established between the rates of mineral fertilizer and millet-hay annual yields we can see that this is approximately parallel and the differences between the yields on not polluted and polluted soil it reduced in the time of the first tree years of the observations. In the process of chemical melioration of soils polluted with crude oil the mineral fertilizer system is more important than the organic fertilizer system because of the nitrogen added in soil determine the equilibrium between organic carbon and nitrogen and these stimulate the activity of soil microorganisms, implicated in crude oil biodegradation.*

Key words: *oil pollution, crude oil, haplic luvosoil, agrochemical melioration;*

INTRODUCTION

Soil pollution with oil residue is a very complex phenomenon, which involves knowing the chemical nature and concentration of the pollutive agent and the soil conditions. Pollution with oil residue is manifested especially in the upper layer of the soil, but in more serious cases of pollution, effects were encountered at 80 cm depth on the soil profile, the depth at which the pollutive agent got into the soil was influenced by quantity, time of action on the soil, local microenvironment, physical and chemical soil properties.

In Romania a surface over 50 thousands ha are affected by the oveflowings of crude oil and salty water from oil extraction fields (COLIBAŞ I. and al., 1995).

Oil extraction, processing and transport in Bihor took place at the sites in Suplacu de Barcău, Marghita and Oradea, which have become nowadays stations for OMV and Petrolsub

SA Suplacu de Barcău Refinery, today in conservation. Following these activities, the soil is affected by historical pollution on a surface of about 250 ha, and is need of measurements of ecological rehabilitation (SABĂU N.C. and al., 2002).

The researches carried out in Romania by TOTI MH., and al., 2003 concerning the pollution effects on agricultural land from the Southern part of Romania, have proved that the plant`s average life expectation diminished after a pollution of 1kg oil residue / m² (0,3 %) in the ploughed layer. The authors consider that a pollution of 1,5 – 3,0 kg oil residue / m² is a moderate one, between 3 kg – 15 kg oil residue / m² the pollution becomes strong, and between 15 – 30 kg oil residue / m² it is extremely strong, and thus the plants seeds no longer germinate, and over 30 kg oil residue / m² it is excessive.

For the conditions in from Western Romania, COLIBAŞ I., and al., publishes in 1995 the first partial results of researches regarding yield losses in millet, in the first year of controlled pollution with different doses of crude oil.

Later, ŞANDOR et al., 2007 ŞANDOR and SABĂU 2007 and SABĂU et al. 2009, publish the results of yields, of some parcels polluted under control, at the experimental field from the Agricultural Research and Development Station Oradea and some correlations between yields and crude oil concentrations.

MATERIAL AND METHODS

Taking in consideration that on Romanian territory, from the surface which are affected by pollution with oil residue and salty water, near a half (49,4 %) is occupied by luvisoils and the type soil preponderantly polluted with crude oil at Suplacu de Barcău is also luvosoil, the experience carried out at Agricultural Research and Development Station Oradea, was placed on a stagnic haplic luvosoil.

The mains physical and chemical properties of the stagnic haplic luvosoil are presented in table 1. (COLIBAŞ I. and al., 2000)

Table 1.

Some physical and chemical properties of the stagnic haplic luvosoil from Oradea

Horizon	Depth (cm)	Textural class	DA (g/cm^3)	pH (H_2O)	V (%)	Humus (%)	N (%)	C/N
Ap	0-25	LP	1,35	5,51	64,3	2,40	0,116	13,0
El	25-44	LP	1,48	5,78	67,3	2,23	0,111	13,5
Bt_1w	44-60	TT	1,56	6,24	77,9	1,91	0,096	13,5
Bt_2	60-93	TT	1,58	6,46	83,4	1,73	0,087	13,4
BC	93-110	TT	1,62	6,51	86,6	0,70	0,036	13,3
C	110-152	TT	1,61	6,60	92,4	0,50	0,026	13,2

The soil reaction is acid in the ploughed A horizon, then slightly acid. The soil content in humus medium and it is well provided with mobile potassium and phosphorus.

The experiment looking "The agrochemical melioration of polluted by crude oil of soils" is an experiment having three factors, the type 2 x 4 x 4, with microparcels of 1 m^2, set out randomized, in four repetitions after the system of subdivided parcels.

The studied factors are:

The factor A: Pollution by crude oil: a_1 – control unpolluted and a_2 – polluted by crude oil, in concentration of 3 % (9 l/m^2) on ploughed layer;

The factor B: Organic fertilizer: b_0 – 0 t/ha manure, b_1 – 50 t/ha manure, b_2 – 100 t/ha manure and b_3 – 150 t/ha manure;

The 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 and c_3 – $N_{300}P_{240}K_{210}$ kg/ha;

The experimental device was carried out in 1993, at the same time with the

experiment looking the study of different doses of crude oil effect on yields, being cultivated in the first three years with millet and than in the next seven years with spring wheat, Speranța breed.

The researches carried out in Oradea have like objective the study of organic and mineral fertilizers effect on millet-hay yields, in the time of melioration process of a soil under control polluted with crude oil, from Suplacu de Barcău, Bihor County.

RESULTS AND DISCUSSIONS

The average yields of the first three research years in which the experiment was cultivated with millet, was included between 34,7 q/ha and 54,0 q/ha millet-hay on control not polluted variants (a1) while on the variants polluted by crude oil in 3 % concentration (a2) between 30,3 q/ha and 48,0 q/ha millet-hay (Table 2.)

Table 2.

The average millet-hay yields (q/ha) in the first three years of the experiment for agrochemical melioration of soil polluted with crude oil

Nr. crt. X_i	Variant	Factor B: Manure (to/ha)	Factor C: Complex fertilizer (kg s.a.)	Average millet (hay) yields (q/ha)	
				Not polluted (a1)	Polluted with 3 % crude oil (a2)
1.	b_0c_0	0	$N_0P_0K_0$ (0)	34,7	30,3
2.	b_0c_1	0	$N_{100}P_{80}K_{70}$ (1)	39,4	34,3
3.	b_0c_2	0	$N_{200}P_{160}K_{140}$ (2)	43,1	39,3
4.	b_0c_3	0	$N_{300}P_{240}K_{210}$ (3)	45,8	42,5
5.	b_1c_0	50	$N_0P_0K_0$ (0)	37,8	34,4
6.	b_1c_1	50	$N_{100}P_{80}K_{70}$ (1)	40,2	37,6
7.	b_1c_2	50	$N_{200}P_{160}K_{140}$ (2)	45,6	41,6
8.	b_1c_3	50	$N_{300}P_{240}K_{210}$ (3)	47,2	44,6
9.	b_2c_0	100	$N_0P_0K_0$ (0)	40,6	36,5
10.	b_2c_1	100	$N_{100}P_{80}K_{70}$ (1)	45,5	39,7
11.	b_2c_2	100	$N_{200}P_{160}K_{140}$ (2)	48,6	43,2
12.	b_2c_3	100	$N_{300}P_{240}K_{210}$ (3)	49,5	45,7
13.	b_3c_0	150	$N_0P_0K_0$ (0)	43,8	37,7
14.	b_3c_1	150	$N_{100}P_{80}K_{70}$ (1)	49,6	42,7
15.	b_3c_2	150	$N_{200}P_{160}K_{140}$ (2)	53,1	44,4
16.	b_3c_3	150	$N_{300}P_{240}K_{210}$ (3)	54,0	48,0
X_{max}		150	$N_{300}P_{240}K_{210}$ (3)	54,0	48,0
X_{min}		0	$N_0P_0K_0$ (0)	34,7	30,3
Suma		1200	$N_{2400}P_{1920}K_{680}$	718,5	642,5
X_{med}		75	$N_{150}P_{120}K_{105}$ (1,5)	44,91	40,16
s	Standard deviation			5,44	4,79

In both cases, the minimum average yields are resulted for the minimum quantity of manure (0 to/ha) and the minimum doses of complex fertilizers ($N_0P_0K_0$) and respectively the maximum average yields are obtained for the maximum doses of manure (150 to/ha) and complex fertilizers ($N_{300}P_{240}K_{210}$) administrated.

The average yield of studied variants is bigger in not polluted variant (44,91 q/ha) than in polluted by 3 % concentration of crude oil variant (40,16 q/ha) with 4,75 q/ha. The standard deviations are 5,44 q/ha, în the first case and 4,79 q/ha în the second case.

In order to point out the possible influence of the fertilizer systems, organic fertilizer (X_1) and mineral fertilizer (X_2), on the millet-hay average yields (Y), in conditions of soils not polluted and polluted with 3 % crude oil, spatial linear links, with two independent variables was established. (Table 3.)

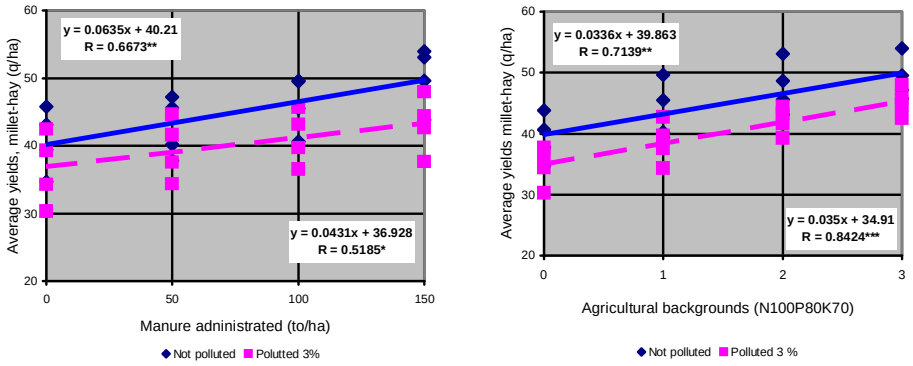
Table 3.

Spatial Linear correlations between average yields (Y) of millet-hay (q/ha) and quantity of manure X_1 (to/ha) x mineral fertilizers doses X_2 (NPK)

Variants	Values' number	Equations	Correlation ratio R	Correlation coefficient C	Signification
Not polluted	16	$Y = 4,28373 + 0,06295\ X_1 - 0,06295\ X_2$	0,653019	0,977885	***
Polluted 3 %	16	$Y = 37,04309 + 0,04305\ X_1 - 0,07706\ X_2$	0,486985	0,989116	***

These linear correlations are very significant statistically. The correlation ratio and the correlation coefficient are 0,653019 and 0.977885 in the case of the not polluted soil and respectively 0,486985 and 0,989116 in the case of the polluted soil.

If we analyze the influence of manure quantity administrated on not polluted and polluted with 3 % crude oil soil, on the average millet-hay yields at the al four ratio of mineral fertilizer, linear correlations ca be established. (Figure 1.a.)



a. b.

Figure 1. The influence of manure quantity administrated (a) and agricultural backgrounds (b) on not polluted and polluted soil in average millet yields (q/ha)

The correlation ratio is distinct significant statistically (R = 0,6673) for the not polluted variant and only significant statistically (R=0,5185) for the polluted with 3 % crude oil variant.

The slopes of the two lines shows that if on the not polluted variant the yield grows with 6,35 kg/ha for one to/ha manure administrated, on the polluted variant the yield grow only by 4,31 kg/ha for the same manure quantity.

It can concluded that the influence of organic fertilizer system is more important on the situation of not polluted soil than in the soil polluted with 3 % crude oil.

The correlative link between the crops and the quantity's manure, more weak on the polluted soil than on the not polluted soil can be explained by the fact that the crude oil is very rich in organic carbon and through the great quantities of manure administered is intensified crude oil's toxicity.

In the case of mineral fertilizer system, the links between average yields of millet-hay and the rates of complex fertilizer (NPK) when it is takes in consideration all crops induced by manure quantity applied are similarly linear equations, but the correlation rates are bigger. (Figure 1.b.)

The linear links are distinct significant statistically for not polluted variant (R=0,7139) and very significant statistically on the soil polluted in ploughed layer with 3 % crude oil (R=0,8424)

The reply's crop at the rate of complex fertilizer administrated is in proximity but the slope of the line for polluted variant show an increase of yield at one rate's mineral fertilizer about 3,5 kg/ha while for the not polluted soil the increase is about 3,36 kg/ha.

It can appreciate that in the case of mineral fertilizer system the better reply of crops is obtained for the polluted with crude oil variant, while in the case of organic fertilizer the maximum effect is obtained on not polluted variant.

Through the administration of complex mineral fertilizers, within the nitrogen is predominant, the carbon/nitrogen ratio on polluted with crude oil soil is equilibrated and trough these is stimulated the responsible in biodegradation of organic matter microorganisms activity from soil.

In order to show the links between annual yields of millet hay on not polluted and polluted with 3 % concentration of crude oil soils and the quantities of manure and respectively complex mineral fertilizers rates ($N_{100}P_{80}K_{70}$) administrated in the first three years are presented in figure 3.

The influence of the quantities' manure administrated on the millet-hay yields

In the first year of the research the linear correlations between annual millet-hay yields and manure quantity administrated are distinct significant statistically (R=0,7882) on not polluted variant and only significant statistically (R = 0,5128) on polluted soil.

The slopes of the lines, which indicate the response of the crop to the quantity of manure administrated show that the yield increase, for one unit of manure (to/ha) with 8,99 kg/ha on the not polluted variant and only with 3,03 kg/ha on the variant polluted under control by 3 % crude oil on ploughed layer.

For the second year of the experiment, the linear correlation link established on the polluted soil don't have statistic signification, while on the not polluted soil, the correlation ratio show that it remains distinct significant statistically (R = 0,6299)

The level of yields corresponding to one unit of manure administrated in this year, decrease on the not polluted variant to 7,94 kg/ha and on the polluted variant increase to 5,04 kg/ha.

In the last year of the researches the correlation rates of linear links established indicate that in the not polluted variant do not have statistic significant but in the case of polluted soil the link is significant statistically (R = 0,5332)

For the third year of researches the lines have approximately the same slopes, indicating that at one tone of manure administrated, the yields increase with 4,91 kg/ha on the polluted with 3 % crude oil concentration variant and only 3,54 kg/ha on the variant not polluted.

The shapes of the lines established for the first three researches years sows that the level of annual yields under the organic fertilizer system have a decrease tendency from the first year to the last year, on the not polluted variant while on the polluted variant the level of yield is smaller in the first year and afterward it stabilize to approximately 5 kg/ha for one unit of manure administrated.

The influence of rates' mineral fertilizer ($N_{100}P_{80}K_{70}$) administered on agricultural backgrounds of manure on millet-hay yields.

The rates of complex fertilizer administrated determine in the first year of the researches linear correlations that on the not polluted soil do not present statistic signification but on the polluted with 3 % crude oil concentration variant it is distinct significant statistically (R = 0,7599).

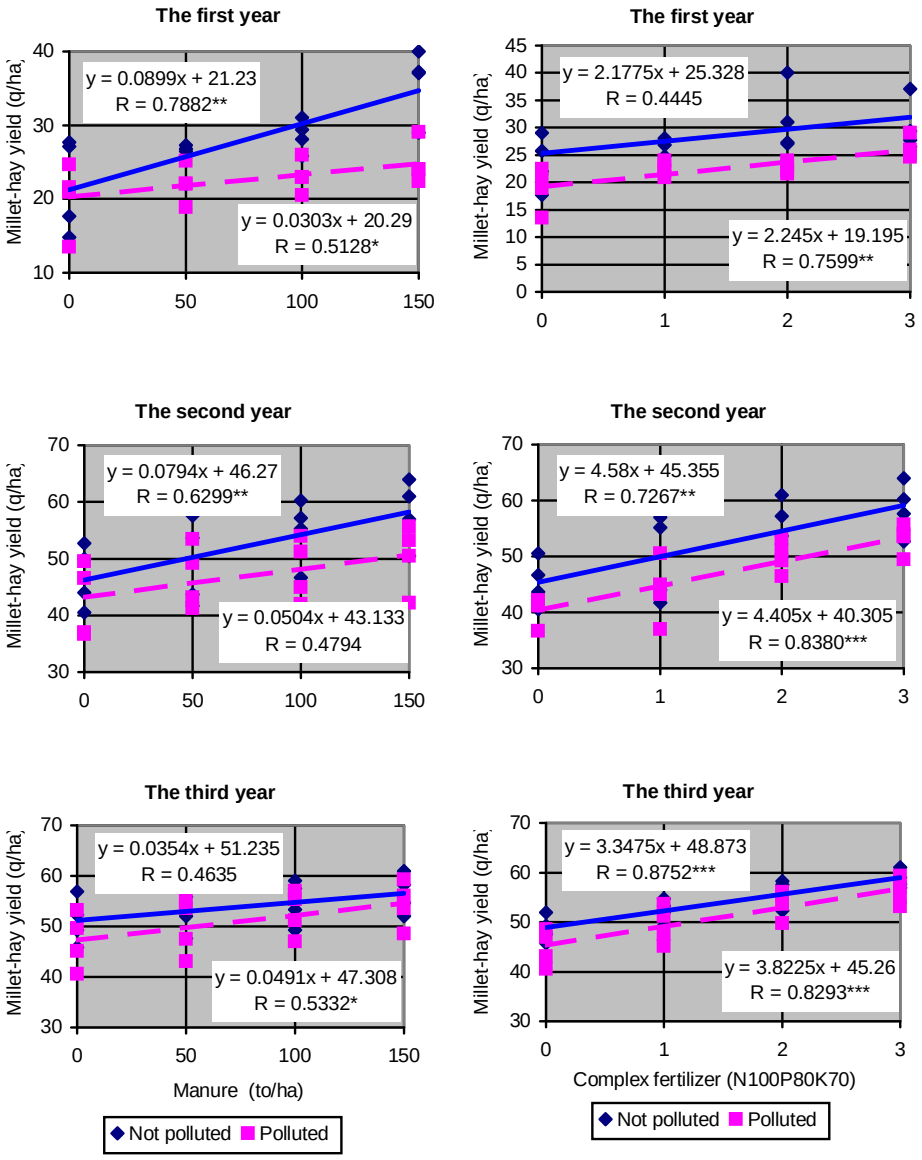


Figure 3. The influences of organic and mineral fertilizing systems on annual yields of millet/hay (q/ha) in the first three years of the researches

The slopes of lines correlation are very appropriate, that indicated the appropriate responses of crops to the rates of complex fertilizer administrated. These are 2,2778 q/ha for

one ratio of fertilizer on the not polluted soil and respectively 2,245 q/ha for one ratio of mineral fertilizer on the polluted soil.

In the second year of experiment the correlation rates increasing for the both variants studied, being about 0,7267 on the not polluted variant and 0,8380 on the polluted with crude oil variant. The links are distinct significant statistically in the first case and very significant statistically in the second case.

The responses of yields to the complex fertilizer rates applied increase near to 4,5 q/ha for one ratio of mineral fertilizer, being more big on not polluted soil, of 4,58 q/ha and more small, of 4,405 q/ha, on polluted soil.

The correlation rates of linear links established for the last year sows in both variants that it is very significant statistically. They are 0,8752 on the not polluted variant and respectively 0,8293 for polluted variant.

The responses of yields to the one ratio of complex fertilizer applied became in the last year of researches more small on the not polluted variant (3.3475 q/ha) and more big on the polluted variant (3,8225 q/ha)

Analyzing the shapes of correlation lines established between the rates of mineral fertilizer and millet-hay annual yields we can see that this is approximately parallel and the differences between the yields on not polluted and polluted soil it reduced in the time of the first tree years of the observations.

If the stronger linear links of organic fertilizer system are realized on the not polluted variant, the stronger influence of mineral fertilizer system is obtained on the variant polluted with 3 % crude oil concentration.

Thus we can assert that in the case of chemical melioration of soils polluted with crude oil the mineral fertilizer system is more important than the organic fertilizer system because of the nitrogen added in soil determine the equilibrium between organic carbon and nitrogen and these stimulate the activity of soil microorganism, implicated in crude oil biodegradation.

CONCLUSIONS

The researches carried out in Oradea have like objective the study of organic and mineral fertilizers effect on millet-hay yields, in the time of melioration process of a soil under control polluted with crude oil, from Suplacu de Barcău, Bihor County.

The average yield of studied variants is bigger in not polluted variant (44,91 q/ha) than in polluted under control by 3 % concentration of crude oil variant (40,16 q/ha) with 4,75 q/ha.

Between the millet-hay average yields (q/ha) and quantities of manure and respectively the rates of mineral fertilizer administrated, in conditions of soils not polluted and polluted with 3 % crude oil, spatial linear links, with two independent variables, very significant statistically was established.

The correlative link between the crops and the quantity's manure, more weak on the polluted soil than on the not polluted soil can be explained by the fact that the crude oil is very rich in organic carbon and through the great quantities of manure administered is intensified crude oil's toxicity.

In the case of mineral fertilizer system, the links between average yields of millet-hay and the rates of complex fertilizer (NPK) when it is takes in consideration all crops induced by manure quantity applied are similarly linear equations, but the correlation rates indicates distinct and very significant statistically correlations.

The shapes of the lines established for the first three researches years sows that the level of annual yields under the organic fertilizer system have a decrease tendency from the

first year to the last year, on the not polluted variant while on the polluted variant the level of yield is smaller in the first year and afterward it stabilize to approximately 5 kg/ha for one unit of manure administrated.

The shapes of correlation lines established between the rates of mineral fertilizer and millet-hay annual yields sows that this is approximately parallel and the differences between the yields on not polluted and polluted soil it reduced in the time of the first tree years of the observations.

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