

## THE LINK YIELD LOSSES, CLIMATE CONDITIONS ON A PRELUVOSOIL, POLLUTED UNDER CONTROL WITH OIL

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**Abstract:** The paper presents the results of the researches carried out at the Agricultural Research and Development Station Oradea, Bihor county, between 1993 and 2002, regarding agricultural yield from a preluvosoil polluted under control with oil brought from the exploitation site at Suplacu de Barcău, Bihor county. The experimental device was made out of micro parcels of 1 m<sup>2</sup>, set up in a randomized manner, in a Latin square, polluted with concentrations of: 0, 1, 3, 5 and 10 % (0, 3, 9, 15, and 30 l/m<sup>2</sup>), oil in the ploughed layer, in 4 repetitions. The experience was cultivated in the first three years with millet, a plant which is considered to be resistant to pollution, and then until 2002 with spring wheat. The analysis of the yield losses from the parcels polluted with oil in various concentrations, have shown that these decreases in time, without any sort of agropedameliorative measures. Starting from this observation this paper is committed to evaluating the influence of the climate factors, rainfall and temperatures, on the biodegradation process, through the accomplished yield losses of millet and wheat, in the research period. The climate conditions characterized by annual rainfall (661,2

mm) and temperature (11,0 °C) show that the 10 year period studied had with 26,2 mm more rainfall than the annual average and was warmer with 0,5 °C. The yield losses (%) of the variants polluted under control with oil residue have, in time, a decreasing tendency, demonstrating a biodegradation of pollutant and a decrease of the effect pollution has on yield. By analyzing the correlations between the millet yield losses in the first 3 years of research and the spring wheat yield losses registered in the last 7 years and respectively the climate factors (rainfall and air temperature) registered in the vegetation period, very significant square, polynomial correlations were established for each oil concentration. The 3D representation of this presents for each concentration a maximum value of yield losses at different values of rainfall and air temperature. For the variants with high pollutant concentration (3, 5 and 10 %) maximum positive differences of yields are obtained for maximum rainfall sum (600 mm) and maximum air temperature (17,5 °C), the moderate humidity and high temperatures stimulate the activity of the microorganisms responsible for soil oil degradation.

**Key words:** oil pollution, preluvosoil, biodegradation;

### INTRODUCTION

The extraction, processing and transportation of the oil products in the conditions of Bihor county took place at the oil plants in Suplacu de Barcau, Marghita and Oradea, today OMV centers and in the SC Petrolsub SA Refinery, in Suplacu de Barcau, today in preservation. Because of these activities the soil is affected by historical pollution, proxy. 200 ha are affected and are in need of measurements for ecological reconstruction.[3]

For the conditions in from Western Romania, Colibaș I. 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 petroleum. [1.]

The researches carried out in Romania by TOTI M.H. (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 1 kg waste / m<sup>2</sup> (0,3 %) in the ploughed layer. [9.] The authors consider that a pollution of 1,5 – 3,0 kg waste/m<sup>2</sup> is a moderate one, between 3 kg – 15 kg waste/m<sup>2</sup> the pollution becomes strong, and between 15 – 30 kg waste/m<sup>2</sup> it is extremely strong, and thus the plants seeds no longer germinate, and over 30 kg waste/m<sup>2</sup> it is excessive.

SABĂU N.C. and ŞANDOR MARIA – 2006, SABĂU N.C. – 2007, ŞANDOR MARIA, SABĂU N.C. and all. – 2007, 2009 publish the results of researches regarding yield of oil polluted plots that took place at the Agricultural Research and Development Station in Oradea, and correlations between yield and the concentration of oil residue in the soil and respectively the influence of climate conditions on yields [4,5,6,7,8]

### MATERIAL AND METHODS

The experimental field set out in 1993 is made out of parcels of 1m<sup>2</sup> set out in a Latin square, randomized, in four repetitions, which were willingly polluted with petroleum from Suplacu de Barcău with 0, 3, 9, 15, and 30 l/m<sup>2</sup>, thus resulting concentrations of 0 in the ploughed layer (unpolluted witness) and 1, 3, 5, 10 %.

The field was cultivated with millet in the first three years (1993 –1995), a plant that has an increased tolerance to pollution and that for the next seven years (1996-2002) with spring wheat, Speranta breed.

After analyzing the agricultural yields obtained in millet (hay) and spring wheat have shown that the yield differences decrease in time without applying any corrective measures.

Starting from this observation this paper is committed to evaluating the influence of the climate factors, rainfall and temperature, on the biodegradation process, through the accomplished yield losses of millet and wheat, in the research period.

### RESULTS AND DISCUSSIONS

Almost half of the soil polluted in Romania (49,397 %) are luvosoils and that the soil polluted at Suplacu de Barcău is a luvosoil, the experience was set up at on the preluvosoil at the Agricultural Research and Development Station in Oradea. The mains physical and chemical properties of stagic preluvosoil are presented [2.] in table 1.

*The climate conditions* characterized by annual rainfall (661,2 mm) and temperature (11,0 °C) show that the 10 year period studied had with 26,2 mm more rainfall than the annual average and was warmer with 0,5 °C.

The annual rainfall was between 367 mm in 2000 and 886 mm in 1996, having diverted from the annual average with values between – 294,2 mm and + 224,8 mm.

The variation interval of the average annual temperatures was between 9,6 – 12,0 °C, values that were registered in 1996 and 2000, with variations when compared to the multiannual average of –1,4 - + 1,0 °C.

Table 1.

Some physical and chemical properties of stagic preluvosoil from Oradea

Horizon	Depth (cm)	Textural class	DA (g/cm <sup>3</sup> )	pH (H <sub>2</sub> O)	V (%)	Humus (%)	N (%)	C/N
Ap	0-25	LP	1,35	5,51	64,3	2,40	0,116	13,0
E1	25-44	LP	1,48	5,78	67,3	2,23	0,111	13,5
Bt <sub>1w</sub>	44-60	TT	1,56	6,24	77,9	1,91	0,096	13,5
Bt <sub>2</sub>	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 values of differences Rainfall – Evapotranspiration (mm) in the vegetation was negative, that shows a drought period in the mean ten research years. (Figure 1.)

The annual average yield losses of the polluted plots vary due to the climate conditions in research period and due to oil concentrations; they are smaller in variants with small concentration of oil (1, 3 %) and bigger in variant with big concentration of oil (5, 10 %) on ploughed layer. (Table 2.)

Table 2.

Mean yield losses (%) on the preluvsol from Oradea (1993 – 2002)

Oil concentration (%)	Millet			Spring wheat						
	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	-19,3	-23,1	-9,8	-24,3	-13,9	-11,8	-23,9	8,2	-10,6	-13,1
3	-31,3	-42,3	-24,6	-50,9	-19,6	-33,8	-27,3	-23,9	-5,5	-12,1
5	-42,2	-61,5	-35,1	-60,1	-48,3	-40,1	-42,5	-22,6	-12,7	25,7
10	-63,6	-65,6	-45,9	-74,8	-59,3	-52,7	-54,6	-31,5	-18,2	-36,9

They are on plot cultivated with millet, between –9,8 % and – 65.6 % and respectively on plot cultivated with spring wheat between + 8,2 % and - 74,8 %.

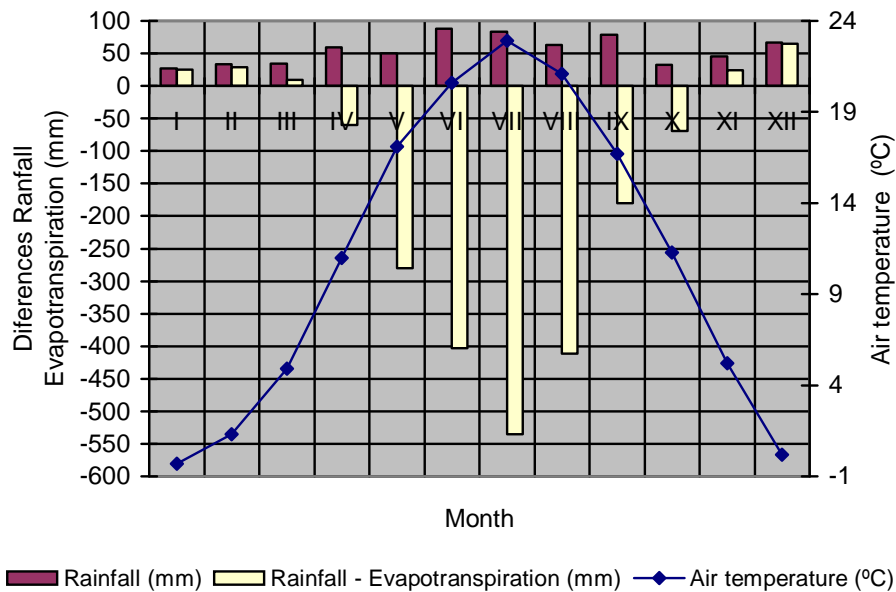


Figure1. Climatically characterization of research period (1993-2002)

The yield losses of the variants polluted under control with oil residue have, in time, a decreasing tendency, demonstrating a biodegradation of pollutant and a decrease of the effect pollution has on yield.

The yield losses (%) – rainfall sum (mm) correlations from the vegetation period (March – August) are second degree polynomial, and look like  $Y = aX^2 + bX + c$ . (Figure 2.) The correlative links thus established are significant for 1 % and 3 % oil concentration and very significant for the variant 5 % and 10 % oil concentration in ploughed layer.

By analyzing the regression curve we notice that they have a convex shape for the all variants studied and the minimum yield losses are registered for the rainfall sum in vegetation period of 300 – 400 mm.

The yield losses (%) – average air temperature (°C) correlations of the months in the vegetation period (March – August) are of the same type, polynomial of the second degree. (Table 3.)

Table 3.

Polynomial second degree correlations between Yield losses (%) and Air temperature (°C) in vegetation period, months March-August 1993 – 2002

Nr. crt.	Oil concentration (%)	Number of values	Regression equation	Correlation coefficient	Meaning
1.	1	40	$Y = 1,1259 T^2 - 3225 T + 211,94$	0,18628	-
2.	3	40	$Y = - 5,3621 T^2 + 182,42 T - 1572,5$	0,34828	*
3.	5	40	$Y = - 1,4158 T^2 + 55,322 T - 563,5$	0,38562	*
4.	10	40	$Y = - 2,5915 T^2 + 94,848 T - 905,92$	0,44113	**

In this case, the significant of correlations are very different: for 1 % oil concentration is not signification; for the variants with 3 and 5 % oil concentration, the correlations are significant and for the variant with 10 % oil concentration, they are distinct significant.

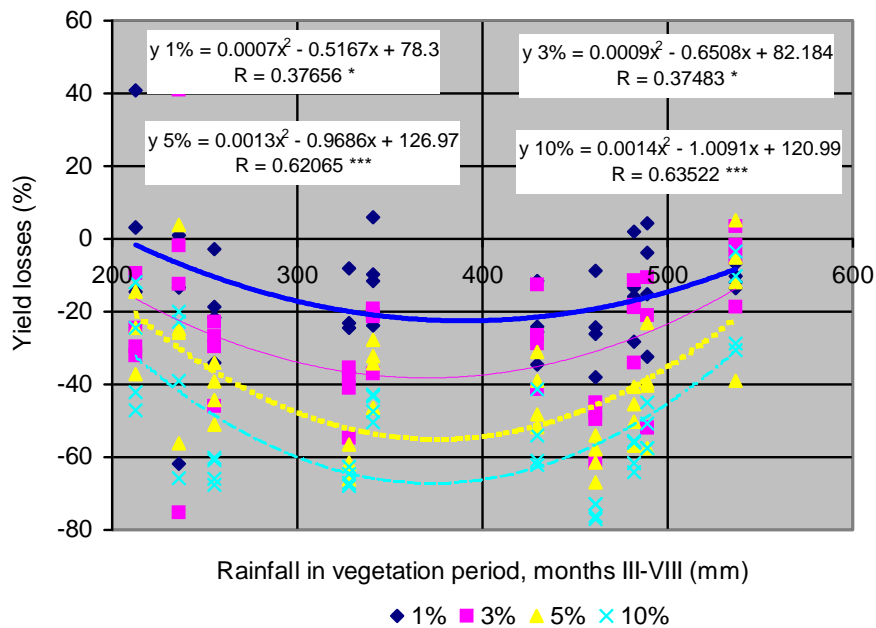


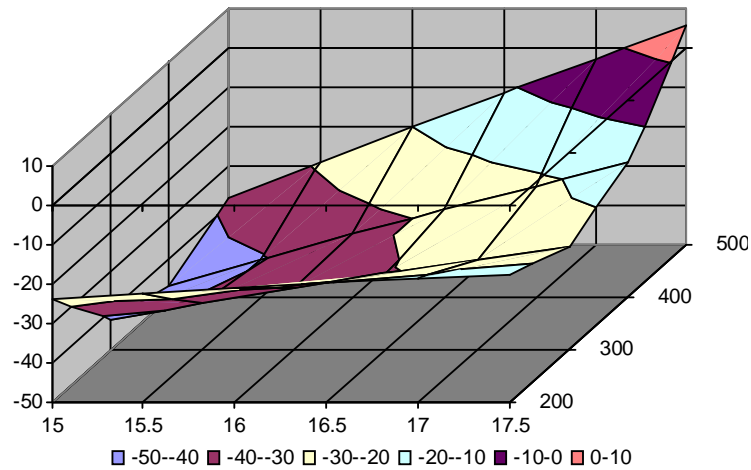
Figure 2. Correlations between yield losses (%) – Rainfall sum in months III-VIII (mm)

The second term of polynomial equation is positive, this suggests that the yield losses are reduced with the increase of main air temperature from vegetation period.

The significant second degree correlations established from the yield losses (%), for ten years and the rainfall sum and the average temperature in the vegetation period show that

they are dependant on the climate conditions of the period studied and the yields are dependant on quantity of oil residue biodegraded.

Seeing that the yields of variants polluted under control are in direct correlation with the sum of rainfall and the average temperature in the vegetation period, we tried to emphasize their influence on yield losses.



$$Y = 68,89374 - 1,28215R + 0,00069R^2 + 4,66021T - 0,37604T^2 + 0,05027RT$$

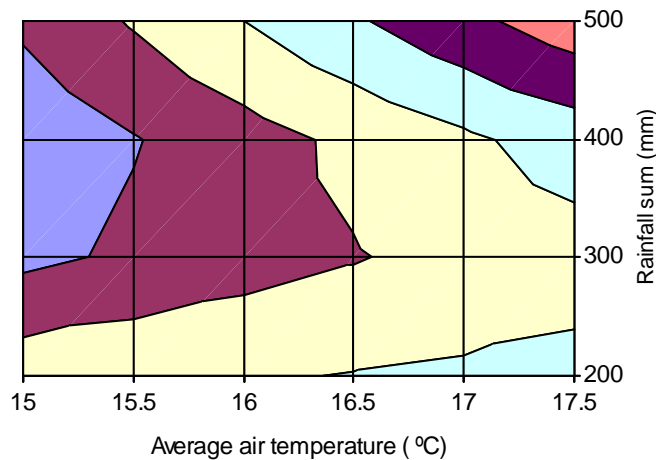


Figure 3. Correlation 3D, Yield losses (Y) – Rainfall sum (R) and Average air temperature (T) from vegetation period of the research

For the variants polluted in a controlled manner with oil residue, an interaction between the two factors, average yield losses (Y) on one side and the rainfall average sum (R) and average air temperatures (T) from the vegetation period on the other side are establish. These are second degree polynomial correlations, with two factors, and dependence between the two factors studied (Figure 3.).

In variant of 3 % oil residue concentration, the interaction between rainfall sum (R) and average air temperature (T) from vegetation period (March-August month) is positive, the yield losses are reduced and the yields increase.

For all variants studied, except the variant with 1 % concentration of pollutant, the space surface described by yield losses have a minimum at values of rainfall about 300-400 mm and increase with the increasing of average air temperature from vegetation period.

The links between the yield losses and the two factors taken into consideration is distinctly significant for the first variants studied, the correlation coefficients are 0,4143318 and 0,4969576, for 1 % and 3 % oil concentration and respectively very significant for the last two variant studied, with 0,6849449 (5 % oil concentration) and 0,7407745 for the 10 % oil concentration (Table 4.).

We can see the tendency for growth of correlation coefficient with the oil concentration increase, probably in link with the contribution in organic mater of the pollutant.

For all the variants, except 1 % variant, the polynomial second degree equation has the rainfall coefficient of the I order,  $a_{11}$  negative and the temperature coefficient I positive, the yield losses achieved grow in direct proportional with the average air temperature and inverse proportional with the rainfall sum in the vegetation period.

Table 4.

Second degree regression equations, with two factors and factor interaction  
Yield losses (Y) – Rainfall (R) and Average air temperature (T)

Oil concentration (%)	Number of values	Regression equation	Correlation coefficient	Meaning
1	40	$Y = -2407,033 + 0,1528413 R + 0,0008177 R^2 + 297,86219 T - 8,796545 T^2 - 0,050048 RT;$	0,4143318	**
3	40	$Y = 68,894 - 1,28215 R + 0,00069 R^2 + 4,66021 T - 0,37604 T^2 + 0,05027 RT;$	0,4969576	**
5	40	$Y = 2922,32324 - 3,58057 R + 0,00152 R^2 - 286,30578 T + 7,18305 T^2 + 0,14924 RT;$	0,6849449	***
10	40	$Y = 3593,259 - 3,77607 R + 0,00142 R^2 - 372,69177 T + 9,81866 T^2 + 0,16780 RT;$	0,7407745	***

The influence of the interaction between the sum of rainfall and the average air temperature on yield losses, described by the  $a_{1121}$  is very little and has a negative value negative (- 0,050048) for the 1 % variant, only to see it become positive in the 3, 5 and 10 % variants (0,05027, 0,14924 and 0,16780) and increase with the oil concentration.

The 1 % oil concentration variant shows a minimum yield loss over – 45 % for the rainfall sum close to 500 mm and an average air temperature close to 17,5 °C. The maximum positive difference of yield (+ 17,3 %) was registered for the maximum of rainfall sum (600 mm) and minimum of average air temperature (15 °C) from vegetation period.

The shape of response surfaces of the yield losses to the factors studied, from 1 % variant is very different that the last tree variants, because in period of research of ten years the pollutant was biodegraded.

The minimum yield losses for the last tree variants (3, 5 and 10 % oil concentration) of – 47,2; - 53,6 and – 66,7 % are obtained for similar conditions of rainfall sum, about 400 mm and small values of average air temperature to 15-16 °C. In all cases we can observe that the maximum positive differences of yields (+ 41- 87 %) are registered for the maximum of rainfall sum (600 mm) and maximum of average air temperature (17,5 °C) from vegetation period.

We can say that the level of the yield losses are bigger because a large quantity of oil residue is in course of being decomposed and the environment toxicity is very high.

In drought period of research, achieving maximum positive differences yields for high values of the average air temperature and maximum rainfall sum can be explained that high temperatures and moderate humidity ensures a good soil aeration and stimulate the activity of the microorganism in the soil that are responsible for the biodegradation of the oil residue. That determines the increase of the organic matter found in various stages of humification and the increase of the soil humus content.

### CONCLUSIONS

The second degree correlations significant and distinct significant established from the yield losses (%), for millet and spring whet cultivated in the ten years and the rainfall sum and the average air temperature in the vegetation period show that they are dependant on the climate conditions of the period studied.

The second-degree polynomial correlations with the interaction of two climate factors distinct and very significant show that the product between rainfall x temperature has a positive influence on the yield losses, except 1 % oil concentration variant, by determining the yield losses increase proportional with the increase of concentration's pollutant.

For the variants with high pollutant concentration (3, 5 and 10 %) maximum positive differences of yields are obtained for maximum rainfall sum (600 mm) and maximum air temperature (17,5 °C), moderate humidity and high temperature stimulate the activity of the microorganisms responsible for soil oil degradation.

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