THE IMPACT OF SULFONYL-UREA AND NON-SELECTIVE HERBICIDES ON BIOLOGICAL ACTIVITY OF SANDY SOILS

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ABSTRACT

The evaluation of soil biological activity under herbicide application is compulsory requested for all herbicides proposed for registration. Special attention is needed concerning sulfonyl-urea, α-hydroxy pyridine and several non-selective herbicides used due to the shortage in information and their extention of use. A number of 11 herbicides were tested for their effect on soil respiration, nitrogen mineralization and nitrification and soil microflora dynamics using a psamosoil with very low content of organic matter (0.4%) and clay (7%). The results emphasized the reversible inhibitory effect of the tested compounds on soil respiration but a long lasting negative action on nitrogen mineralization. Among soil microorganisms, most sensitive were bacteria (including cellulolitic bacteria) but in a less extend the soil fungi, especially to fluazifop-butyl, nicosulfuron and glyfosate. The present study pointed out that also in case of the new classes of herbicides much concern should be paid especially when applied to a soil with both low biological activity and poor native restoration capacity.

Key words: psamosoil, herbicides, sulfonyl-urea, α-hydroxy pyridine, non-selective herbicides, soil biological activity

INTRODUCTION

The Romanian legislation imposes, beside other ecotoxicologic indices, the evaluation of soil biological activity of the herbicides proposed for registration. In this respect the study of sulfonyl-urea herbicides is very useful considering the high dynamics of this class of substances.

The α-hydroxy pyridine derivatives is another class of herbicides, frequently used in Romania, because of the relatively high infestation with monocotyledonous perennial weeds (mostly *Sorghum halepense, Elymus repens*).

The extended use of the non-selective herbicides as glyfosate and ammonium glufosinate demands a careful study of their ecotoxicologic impact onto the environment.

MATERIALS AND METHODS

The experiment was carried out during 1993-1995 under laboratory conditions on physical models and field. For controlled conditions, psamosoil (collected from Dăbuleni field) treated with herbicides was incubated at 27°C and 18% soil moisture. The soil type used had the following characteristics: $pH_{(H_2O)}$=6.3-7; humus=0.4% and clay=7%.

The studied herbicides and doses were (in active ingredient):

-sulfonyl-urea: nicosulfuron-Mistral (0.1 and 0.5 mg/kg soil), rimsulfuron-Titus (0.1 and 0.5 mg/kg soil), amidosulfuron-Grodil (0.05 and 0.25 mg/kg soil);

- α-hydroxy pyridine derivatives: fluazifop p-butyl-Fusilade (0.3 and 1.7 mg/kg soil), haloxyfop-ethyl-Gallant (0.3 and 1.5 mg/kg soil), quizalofop-ethyl-Targa (0.3 and 1.5 mg/kg soil);

-phosphoric derivatives - non selective herbicides: glyfosate-Roundup (0.5 and 2.5 mg/hg soil), ammonium glufosinate-Basta (0.5-2.5 mg/kg soil)

-fluorochloridone-Racer (5.0 and 25.0 mg/kg soil)

-acetochlor-Guardian (4.0 and 20.0 mg/kg soil)

The considered herbicide concentrations, for the soil incubation, correspond to the recommended dose for field application and a five fold higher amount, respectively.

The following measurements were performed for both field and laboratory samples:

-soil respiration by measuring CO_2 emission on long standing using the method elaborated by Ştefanic, 1991;

-nitrogen mineralization and nitrification in soil (after Waksman, 1923);

-counting of total soil microorganisms (using agar soil extract medium), actinomycetes (on Berezova medium), fungi (on Martin medium with Bengal-rose and streptomycin) and cellulolitic bacteria (on Hutchinson medium). The method of soil decimal dilutions and inoculation by incorporation in culture media were applied according to the method established by Eliade et al. (1966).

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Statistical calculation by analysis of variance were considered for data exploiting (Snedecor 1957; Ceapoiu, 1968).

RESULTS AND DISCUSSIONS

Determination of the soil respiration capacity exhibited a strong inhibition of the process in the first days after treatment but a tendency of attenuation at the end of the considered interval (Figure 1).

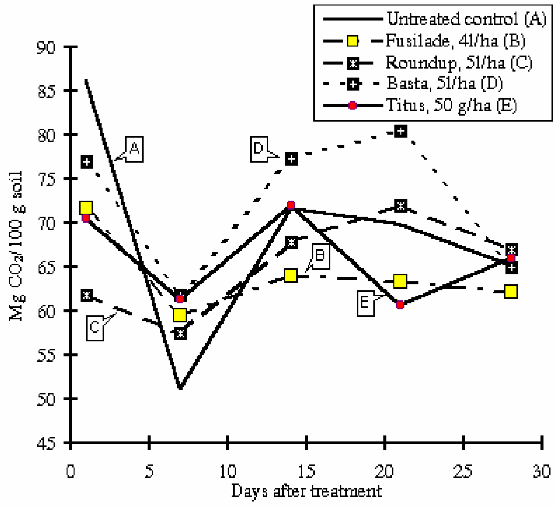

Figure 1. Effect of herbicide treatment on psamosoil respiration (CO_2 emission)

Previous studies using chlorsulfuron and thifensulfonmethyl emphasized a slight effect on soil respiration and dehydrogenase activity (Chiriță et al., 1982; Malkomes, 1992). We assume that the differences recorded in the present study are caused by the very low ad-

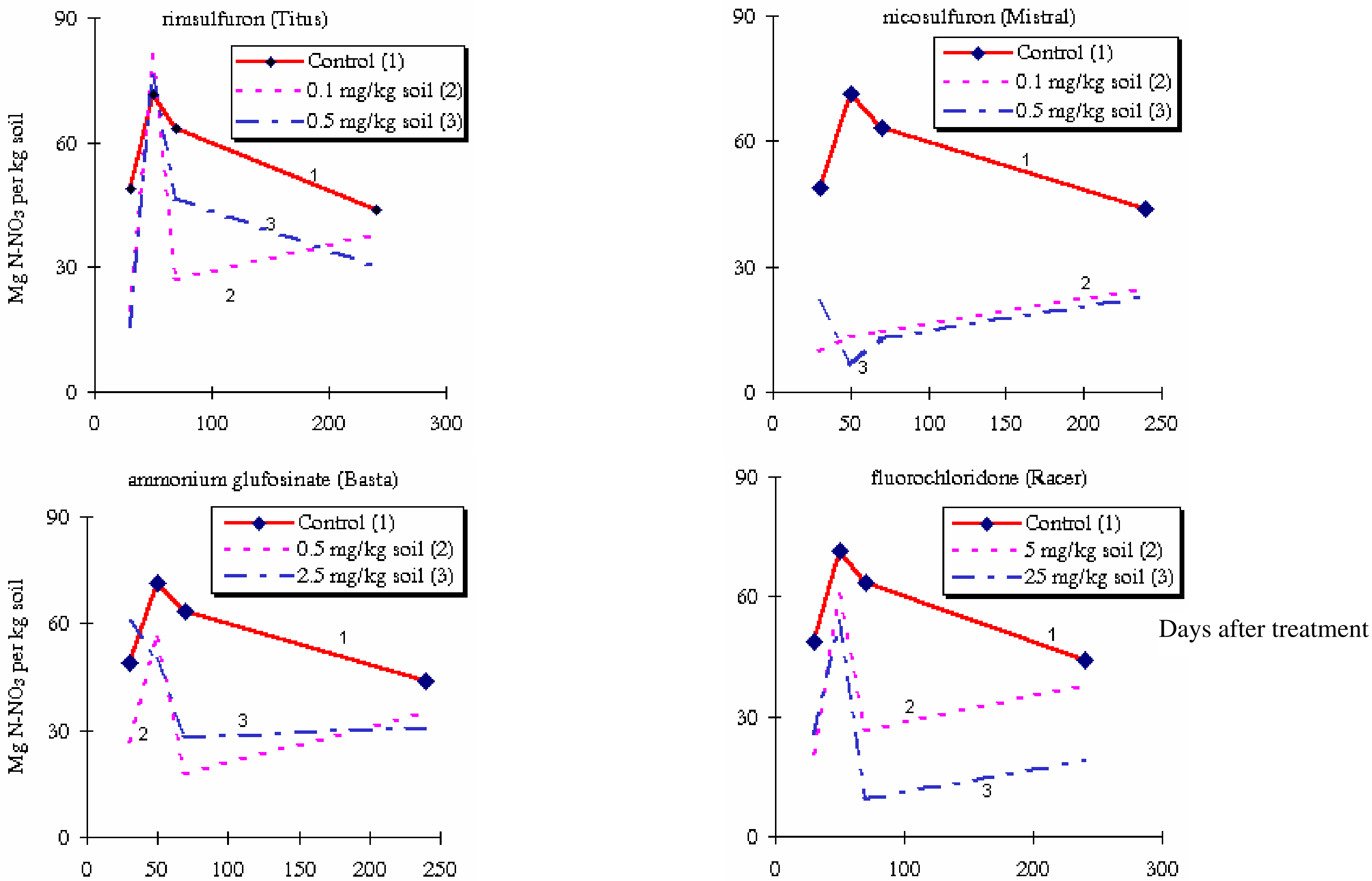

Figure 2. The effect of herbicide treatment on nitrogen mineralization process in psamosoil

Table 1. The influence of herbicide treatment on the main taxonomic groups of microorganisms in psamosoil

Herbicide applied (mg/kg soil)	Bacteria (total microorganisms)x10^6/g soil						Actinomycetes, x 10^6/g soil					
	30 days		100 days		120 days		30 days		100 days		120 days	
	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993
Control	33.4	56.8	24.5	44.1	3.3	42.9	4.1	6.56	6.2	8.7	5	9.36
Titus (0.1)	35.10	59.5	16.0	28.8	1.3	16.7	4.8	7.65	3.6	6.4	4	7.20
Fusilade (0.3)	11.6	23	14.6	25.6	2.1	27.5	2.5	7.32	4.0	6.9	4.8	9.06
Roundup (0.5)	20.3	33.4	15	27.0	2.1	26.9	11.4	12	6.3	6.6	4.1	7.25
Racer(5.0)	26.3	44.7	21.3	38.3	4.0	51.8	8.3	11.37	4.8	6.3	5.5	10.25
Mistral (0.1)	21.10	35.2	20.0	36.3	6.0	62.0	9.1	12.41	5.8	6.2	7.0	12.01
LSD for $P< 0.05$	9.17	15.6	4.58	8.24	1.36	17.7	2.98	4.0	3.04	3.61	3.16	
$P< 0.01$	13.04	22.2	6.51	11.72	1.93	25.1	4.23	6.70	3.27	3.72	4.49	
$P< 0.001$	18.82	32.1	9.12	16.40	2.78	36.1	6.16	9.83	4.74	5.06	6.50	

Herbicide applied (mg/kg soil)	Fungi, x 10^3/g soil						Cellulolitic bacteria, x 10^3/g soil					
	30 days		100 days		120 days		30 days		100 days		120 days	
	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993
Control	81.0	15.40	12.2	73.2	52	62.4	7.2	12.2	5.3	9.0	19.8	15.8
Titus (0.1)	68.0	12.95	17.1	102.5	41	49.3	14.3	24.3	10.0	16.8	14.0	15.7
Fusilade (0.3)	48.0	9.14	19.3	115.8	36	43.2	5.8	9.9	8.0	13.5	17.9	14.4
Roundup (0.5)	41.0	7.85	14.5	87.3	43	48.5	3.5	6.0	4.2	72	21.1	16.9
Racer (5.0)	55.0	10.50	34.5	121.1	69	69.2	3.1	4.9	3.0	5.0	1.8	7.7
Mistral(0.1)	70.0	13.70	23.5	119.0	26	30.9	4.1	5.5	3.9	7.1	8.4	9.4
LSD for $P< 0.05$	29.5	5.61	3.57	2.15	16.8	20.1	2.98	5.11	2.50	4.25	4.23	7.61
$P< 0.01$	42.3	8.04	5.08	3.05	23.9	28.7	3.10	5.22	4.24	7.21	5.10	9.18
$P< 0.001$	61.2	11.60	7.36	4.42	34.6	41.5	3.40	5.78	6.14	10.4	6.20	11.16

sorption capacity of the psamosoil.

The nitrogen mineralization process was highly affected by the presence of the investigated herbicides (Figure 2). Fluorochloridone and ammonium glufosinate exerted a stronger inhibition in comparison with rimsulfuron, fluazifop-butyl and glyfosate. Nicosulfuron showed a long and strong lasting inhibition (2-15 times from the control value). For the highest tested dose the inhibition was 48%, 240 days after treatment.

As concerns the evolution of soil microflora (bacteria) the values recorded in two experimental years are presented in Table 1. Thus, fluazifop-butyl and glyfosate herbicides exerted a more toxic effect as compared with rimsulfuron or nicosulfuron.

On the contrary, the actinomycetes were not negatively affected by the xenobiotics but exhibited a slight stimulation in the first days after treatment.

Some of the compounds as fluazifop-butyl, glyfosate and nicosulfuron inhibited the soil fungi in the first 30 days. At the end of the experiment, the number of the latest increased, most likely due to organic material provided by the bacteria biomass present in the system. A similar phenomenon was reported previously also for different toxic products (Grossbard, 1984; Ghinea et al., 1986).

Cellulolitic bacteria were inhibited by fluorocloridone and nicosulfuron but, surprisingly, stimulated by the presence of rimsulfuron.

CONCLUSIONS

The new range of herbicides are not absolute safety concerning the microbial activity of the soil, despite of the low applied quantities (the case of sulfonyl-ureas) or of the application during the vegetation period (when the active ingredient reaches the soil in minimum amount). It is therefore recommended to avoid two or many years of subsequent application on the same plot in order to prevent the complete shut off of the nitrogen mineralization and nitrification processes.

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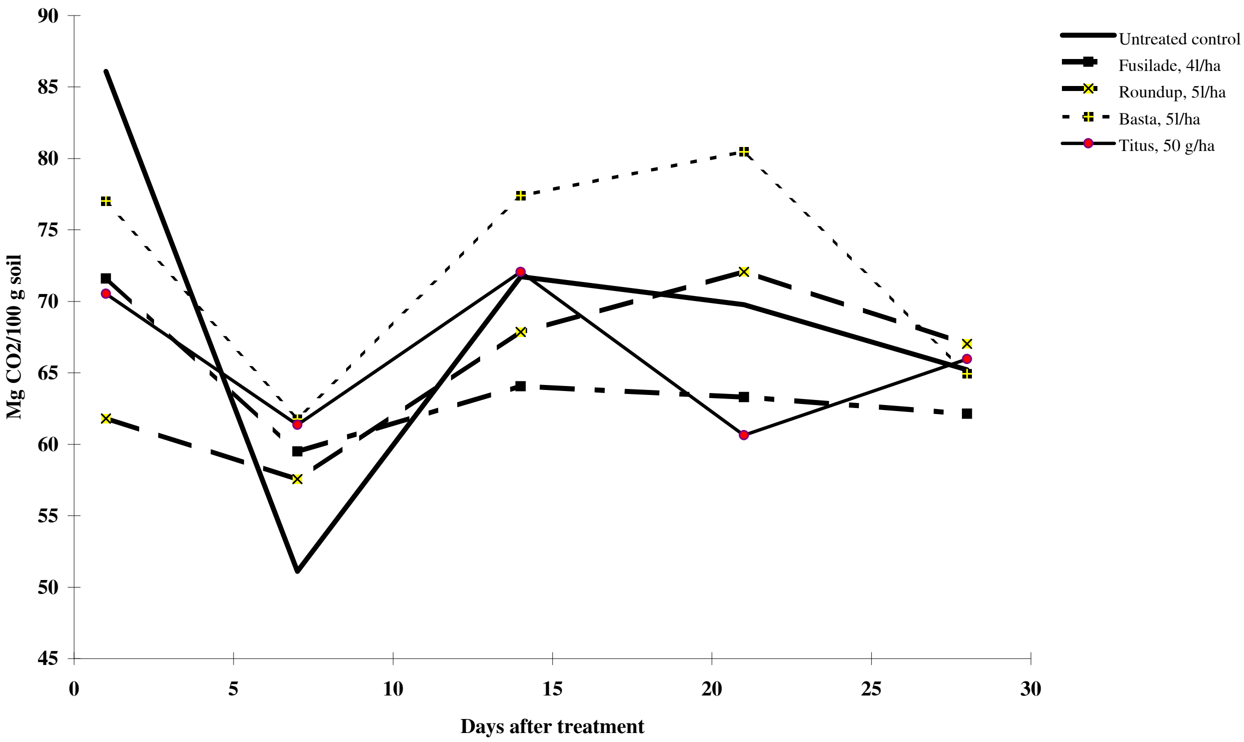

Figure 1. Effect of herbicide treatment on psamosoil respiration (CO_2 emission)

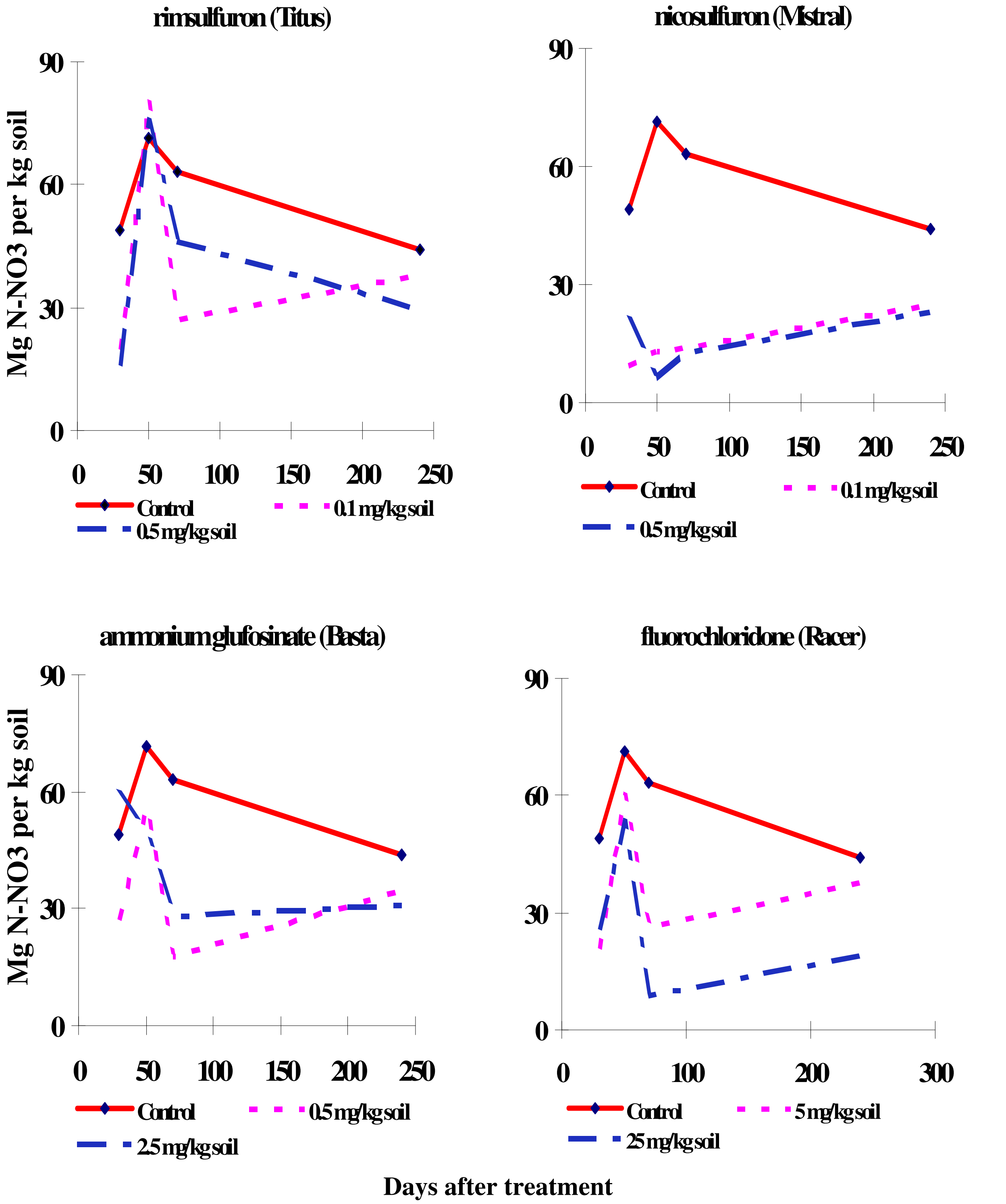

Figure 2. The effect of herbicide treatment on nitrogen mineralization process in psamosoil