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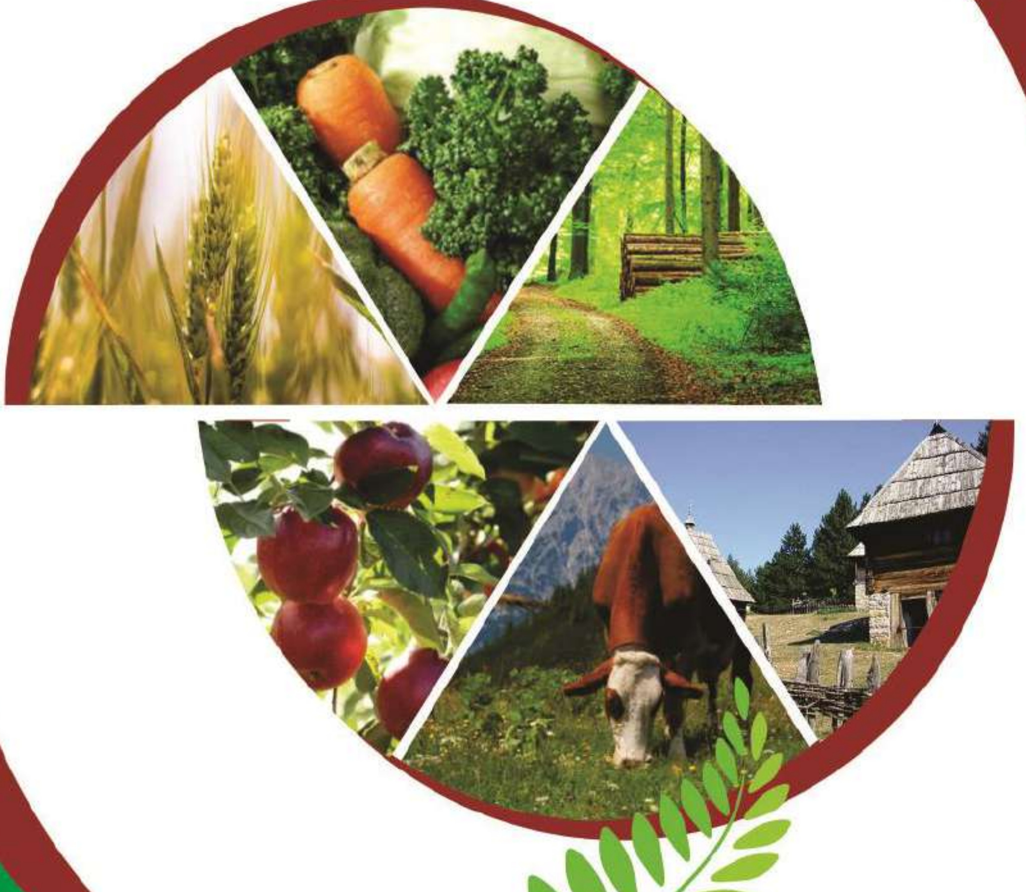

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EFFECT OF SOME HERBICIDES ON CELLULOSE DECOMPOSITION IN THE SOIL

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Abstract

The effect of simazine (62, 125, 250 and 500 μg/g soil), paraquat (37, 75, 150 and 300 μg/g soil) and 2,4 D (87, 175, 350 and 700 μg/g soil) on cellulose decomposition in two soils (sandy soil and chernozem) was studied. Simazine and 2,4 D were mixed with soil and cellulose (2% powdered cellulose) before humidification, whereas paraquat was introduced into the soil along with water during humidification. The soil receiving no pesticide treatment was the control. The modelled soil samples were incubated in a thermostat at 28 ˚C for 12 weeks. The amount of water that vaporized was added to the soil on a weekly basis.
Results showed that simazine rates had a slight inhibitory effect on cellulolytic activity in the tested soils. Only the highest rate of 2,4 D caused a considerable degree of inhibition of cellulose decomposition. Paraquat exhibited a higher level of toxicity compared to simazine and 2,4 D. As even the lowest application rates were several times greater than the rates commonly used in agricultural practice, the herbicides tested, when applied at recommended rates, cannot be inhibitory factors in cellulose transformation in these soils.

Key words: *herbicides, cellulolysis, soil, microorganisms*.

Introduction

Research on the effect of different chemical crop protection agents on microbial communities in the soil is of high theoretical and practical importance. Effects of pesticides under soil conditions are quite different from those under laboratory conditions.
On the one hand, some microbial populations have the ability to degrade pesticides and use them as sources of biogenic elements and energy required for physiological processes (Janjić et al., 1996; Regno et al., 1998; Singh, 2008). On the other hand, pesticides can change the biodiversity, activity and rhythm of reproduction of microorganisms (Johensen *et al*., 2001).
In agricultural ecosystems, herbicides are subjected to transformation and degradation processes, and constantly interact with soil microorganisms. Increasing consideration has been given to the quantitative and qualitative composition of microorganisms and their enzymatic activity as soil quality indicators which are, in agricultural soils, correlated with the herbicide application rate (Zain *et al*., 2013).
Many authors have studied the effect of pesticides on cellulose decomposition (Szegi, 1972; Malkomes, 1977; Mandić and Đukić, 2007; Baldrian *et al*., 2011). The application of Paraquat above its recommended label rate reduced cellulose degradation and soil respiration by 39-58%. The degree of inhibition decreases with increasing content of organic matter in the soil i.e. its increasing sorption (Bromilow, 2003). In study on the effect of herbicides (butachlor, pyrozosulphuran, paraquat and glyphosate) on the organic carbon content of the

soil, microbial biomass and activities of the enzymes (amilase, invertase, protease, urease and dehydrogenase), Baboo *et al*. (2013) found a decrease in organic carbon content and microbial biomass in the soil. Many studies have proven that paraquat is active only when it comes in direct contact with the plant, while in the soil it occurs in a strongly bound form (Bromilow, 2003). In field trials, normal rates of paraquat increase the numbers of bacteria, fungi and actinomycetes, whereas high rates are toxic to fungi (Camper *et al.*, 1973). Simazine can lead to changes in the bacterial community structure; however, some bacteria can become involved in simazine biodegradation, and autochthonous microbial communities can metabolize high rates of simazine in agricultural soils (Wan *et al*., 2014).

The transformation of the cellulose incorporated in the soil in the presence of crop protection agents is dependent on soil texture, humus content, soil pH, the amount of uptakeable nutrients and other factors (Schröder, 1979; Malkomes, 1993). This finding has been confirmed by Ayansina and Oso (2006) through their analysis of the effect of atrazine on organic matter content, soil pH and microbial numbers in the soil.

Manure stimulates cellulose decomposition and detoxification of the abovementioned pesticides as it provides sufficient amounts of nutrients for the massive reproduction of soil microorganisms. Compost and biohumus are additional sources of simazine-degrading microorganisms (Błaszak *et al*, 2011).

Therefore, non-judicious use of pesticides can affect transformation processes in the soil, primarily the degradation of crop residues. Fresh organic residues originating from plants, animals and microorganisms (biomass) undergo transformation, leading either to their complete mineralization or partially degraded substances which directly or indirectly make up humus. The degree of transformation is dependent on the type of plant material, temperature, water content and the activity of the microbial populations present in the soil. Cellulose, lignin and chitin are the three most common soil biopolymers. Micromycetes exhibit pronounced cellulolytic and chitinolytic activities which make them actively involved in the transformation of cellulose and dead biomass of different soil organisms, which are important sources of soil carbon (Baldrian *et al*., 2011).

The aim of this study was to examine the effect of herbicides (simazine, paraquat and 2,4 D) on cellulose decomposition in sandy and chernozem soils.

Material and methods

A model trial was established to determine the effect of pesticides on cellulose transformation in the soil. In the experiment, 2% powdered cellulose was homogenously mixed into 200 g sandy soil (pH_{KCl}- 6.4; humus-1.7%; N-0.1%; P_2O_5-0.068 mg g^{-1}; K_2O- 0.1 mg g^{-1}) and chernozem (pH_{KCl}- 7.2; humus-3.07%; N-0.2%; P_2O_5-0.37 mg g^{-1}; K_2O- 0.22 mg g^{-1}), and then the treated soil sample was humidified to a moisture content of 60% of maximum water holding capacity. The effect of the herbicides simazine (2-chloro-4,6-bis(ethylamino)-s-triazine), paraquat (dichloro-1,1-dimethyl-4,4-bipyridine) and 2,4 D (2,4-dichlorophenoxyacetic acid) was evaluated. Simazine was applied at 62, 125, 250 and 500 μg/g soil, paraquat at 37, 75, 150 and 300 μg/g soil, and 2,4 D at 87, 175, 350 and 700 μg/g soil in three replicates. Simazine and 2,4 D were mixed with the soil and cellulose before humidification, whereas paraquat was introduced into the soil along with water during wetting. The soil without pesticide treatment was the control. The modelled soil samples were incubated in a thermostat at 28 ˚C for 12 weeks. The amount of water that vaporized was added to the soil on a weekly basis. The amount of transformed cellulose was determined by the method described by Petkov and Markova (1969). The results obtained were subjected to an analysis of variance. The importance of differences in the level of cellulose degradation (%)

for each individual soils, as dependent on the herbicide application rate, was assessed by LSD test (Statistica SPSS 5).

Results and Discussion

As shown in Table 1, the three herbicides affected the percent decomposition of powdered cellulose mixed with soil samples, and different results were obtained. No simazine application rate had a significant inhibitory effect on cellulase activity. Similar findings were recorded for 2,4 D, although its highest rates (700 μg/g) inhibited cellulose decomposition by about 17% compared to the control. Paraquat was much more toxic than the other herbicides. The two highest rates (150 and 300 μg/g soil) had a significantly depressive effect on cellulose decomposition. The rate of 300 μg/g soil caused a reduction in cellulose decomposition by about 20% compared to the same process in the control soil. The two lowest rates (37 and 75 μg/g soil) did not prevent cellulose decomposition. Although even the lowest application rates were several times greater than the rates commonly used in agricultural practice, the recommended rate of paraquat in the soil is not an inhibitory factor in cellulose transformation processes. In this regard, as reported by Bromilow (2003), paraquat applied at high rates (1300 mg kg^{-1}) had no detrimental effect on cellulose decomposition in the soil; when used at recommended rates, it had no effect on bacterial and fungal activities in the soil. The adverse impact of paraquat on soil organisms is minimized through its high sorption by soil particles. Whitelaw-Weckert *et al*. (2004) observed that it is impossible to determine whether changes in soil microbial population are directly associated with pesticide use or with the indirect effect of pesticides manifested through reduced amounts of organic matter and rhizosphere exudates.

In contrast, Adomako and Akyeampong (2016) found significant changes in the growth and development of soil microorganisms as induced by atrazine, 2,4 D, glyphosate and paraquat applications. The toxic effect of some herbicides was observed immediately after their use, and paraquat treatment had a long-lasting effect on most microorganisms. Microorganisms respond to herbicides in a variety of ways, depending on herbicides themselves, their concentrations, exposure time, chemical and physical soil characteristics, and properties of the microbial populations present in the soil.

Tab.1. Effect of some herbicides on cellulose decomposition in the soil

Herbicides	**μg active ingredient per 1g soil**	**Cellulose decomposition, % relative to the control**	
		Sandy soil	**Chernozem**
Control	-	100 ab	100 ab
Simazine	62	105 a	97 c-f
	125	94 b	92 ef
	250	98 ab	96 def
	500	97 ab	94 def
Paraquat	37	97 ab	105 abc
	75	98 ab	108 a
	150	84 c	90 f
	300	79 c	71 g
2,4 D	87	100 ab	101 a-d
	175	99 ab	107 ab
	350	94 b	99 b-f
	700	83 c	91 f

Means followed by the same lowercase letters in rows are not significantly different ($p > 0.01$) according to LSD test

As the herbicide rate increased, the percentage of cellulose decomposition slightly decreased relative to the control in both soils (sandy soil and chernozem), which was consistent with the reports of many authors on the inhibitory effects of triazine, dinitroaniline and phenoxycarboxylic acid derivatives on total microbial count, bacterial biodiversity, microbial biomass and enzyme activity (Ayansina and Oso, 2006; Šantrić *et al*., 2015).

The percentage of cellulose decomposition slightly decreased with increasing simazine rate in both sandy soil and chernozem, most likely due to the effect of simazine on soil microorganisms *(*Harden *et al*., 1993; Kodoma *et al*., 2001).

Conclusion

The results of this research suggest the following:

- simazine application rates had a slightly inhibitory effect on cellulolytic activity in the soils tested;
- only the highest rate of 2,4 D was significantly inhibitory to cellulose decomposition in both soils;
- paraquat showed a much higher level of toxicity compared to simazine and 2,4 D;
- as even the lowest application rates were several times greater than the rates commonly used in agricultural practice, the herbicides tested, when applied at recommended rates, cannot be inhibitory factors in cellulose transformation processes in these soils.

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References

Adomako M.O., Akyeampong S. (2016). Effect of Some Commonly Used Herbicides on Soil Microbial Population Journal of Environment and Earth Science, 6(1): 30-38.

Ayansina A.D.V., Oso B.A. (2006). Effect of two commonly used herbicides on soil microflora at two different concentrations. African Journal of Biotechnology, 5(2): 129-132.

Baboo M., Pasayat M., Samal A., Kujur M., Maharana K.J, Patel A.K. (2013). Effect of four herbicides on soil organic carbon, microbial biomass-C, enzyme activity and microbial populations in agricultural, International Journal of Research in Environmental Science and Technology, 3(4): 100-112.

Baldrian P., Voříšková J., Dobiášová P., Merhautová V., Lisá L., Valášková V.. (2011). Production of extracellular enzymes and degradation of biopolymers by saprotrophic microfungi from the upper layers of forest. Plant Soil, 338: 111–125.

Błaszak M., Pełech R., Graczyk P. (2011). Screening of Microorganisms for Biodegradation of Simazine Pollution (Obsolete Pesticide Azotop 50 WP), Water Air Soil Pollut, 220: 373–385.

Bromilow R.H. (2003). Paraquat and sustainable agriculture, Biological Chemistry Division, Rothamsted Research, Harpenden, Herts, AL5 2JQ, UK, Pest Management Science Pest Manag Sci, 60: 340–349.

Camper N.D., Moherek E.A., Huffman J. (1973). Changes in microbial populations in paraquat-treated soils, Weed Research, 13: 231-233.

Harden T., Joergenses R.G., Mayer B. and Wolters, V. (1993). Soil microbial biomass estimated by fumigation-extraction and substrate-induced respiration in two pesticide-treated soils. Soil Biol. Biochem., 25: 679-683.
Janjić V., Radivojević Lj., Stanković-Kalezić R. (1996). The effect of herbicides on the microbiological activity of the soil. Acta herbol., 5: 5-17.
Johensen K., Jacobsen C.S. and Torsvik V. (2001). Pesticide effects on bacterial diversity in agricultural soils – a review. Biol. Fertil. Soils, 33: 443-453.
Kodoma T., Ding L., Yoshida M., Yajima M. (2001). Biodegradation of s-triazine herbicide, simazine. J. Molecular Catalysis, 11: 1073-1078.
Malkomes H.P. (1977). Decomposition of cellulose and straw in different soils after herbicide applications, In: The Interaction of Soil Microflora and Environmental Pollutions. Intern. Symposium. Pulawy, 211.
Malkomes H.P. (1993). Effect of pesticides used for seed treatment of potatoes on microbial activities in soil. Zentralblatt Fur Mikrobiologie, 148(7): 497-504.
Mandić L., Đukić D. (2007). Microbiological Purification of Soils Contaminated with Pesticides. Bulletin of the Republic Institution for the Protection of Nature in Podgorica, No. 29-30: 175-182.
Petkov P.D., Marcova T.Ch. (1969). A method of studying cellulose decomposition in soils. Biologii du Sol. Int. News Bull., Paris/N10, pp. 17-20.
Regno V., Arulgnanendran J., Nirmalakhandan N. (1998). Microbial toxicity in soil medium. Ecotox. Environ. Saf., 39: 48-56.
Šantrić Lj., Radivojević Lj., Gajić-Umiljendić J., Sarić-Krsmanović M., Đurović R. (2015). Influence of Glyphosate on microbiological activity of different types of soil. XIII Symposium with Plant Protection, Zlatibor, 23-26. November, Proceedings, 93-94.
Schröder D. (1979). The influence of agrochemical compounds on the decomposition of straw and cellulose in soil. Journal of Plant Nutrition and Soil Science, 141(4): 616-625.
Singh D.K. (2008). Biodegradation and bioremediation of pesticides in soil concept method and recent developments. Ind. J. Microbiol., 48: 35-40.
StatSoft.Inc. (1995). STATISTICA for Windows (computer program manual). Tulsa. OK: StatSoft.Inc.
Szegi J. (1972). Effect of few herbicides on the decomposition of cellulose. In: Proc. Symposium Soil. Microbiol. J. Szegi, (ed.), Akademiai Kiado, Budapest, Vol. 11, p. 349-354.
Wan R., Wang Z., Xie S. (2014). Dynamics of communities of bacteria and ammonia-oxidizing microorganisms in response to simazine attenuation in agricultural soil. Science of the Total Environment 472: 502-508.
Whitelaw-Weckert M., Hutton R., Rouse E., Lamont R. (2004). The effect of herbicides and permanent swards on soil microbial populations in the vineyard, SuperSoil 2004: 3rd Australian New Zealand Soils Conference, 5 – 9 December 2004, University of Sydney, Australia.
Zain N.M.M., Mohamad R.B, Sijam K., Morshed M.M., Awang Y. (2013). Effect of selected herbicides in vitro and in soil on growth and development of soil fungi from oil palm plantation. Int. J. Agric. Biol., 15: 820-826.