Зборник Матице српске за природне науке / Proc. Nat. Sci, Matica Srpska Novi Sad, № 109, 97—102, 2005

UDC 635.82:632.95

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SOIL FUNGI AS INDICATORS OF PESTICIDE SOIL POLLUTION*

ABSTRACT: Soil fungi, with their pronounced enzymic activity and high osmotic potential, represent a significant indicator of negative effects of different pesticides on the agroecosystem as a whole. In that respect, a trial was set up on the alluvium soil type with the aim to investigate the effect of different herbicides (Simazine, Napropamid, Paraquat), fungicides (Captan and Mancozeb) and insecticides (Fenitrothion and Dimethoate) on a number of soil fungi under apple trees.

The number of soil fungi was determined during four growing seasons by an indirect method of dilution addition on the Czapek agar.

The study results indicate that the fungi belong to the group of microorganisms that, after an initial sensible response to the presence of pesticides in the soil, very rapidly establish normal metabolism enabling them even to increase their number. The fungicides and insecticides applied were found to be particularly effective in that respect.

KEY WORDS: fungi, soil, pesticides, apple

INTRODUCTION

With the aim of obtaining high yields of agricultural crops, modern agricultural production demands use of different chemical compounds. According to the data obtained by Hajnis et al. (1979), 20% of crop farming production and almost 60% of fruit production are based on the use of chemical crop protection. Discontinuation of pesticide application, according to the FAO data, would decrease agricultural crops yield by 30—50% with the damage of about 75 billion dollars (Ejhler, 1986).

Besides an immediate desired effect, pesticides also have side-effects on biosphere, the extent of which is comparable to that of global ecological factors (Huston and Wagant, 1989). Soil microorganisms, particularly soil

* The paper was presented at the first scientific meeting MYCOLOGY, MYCOTOXICOLOGY AND MYCOSES held from 20—22 April 2005 in Novi Sad.

fungi, represent a biogeosphere component determining the level of their real toxic effect, since they take part in their detoxication and mineralization, using them as carbon and energy sources (Đukić and Mandić, 1998; Nunez et al., 2001). According to the data obtained by Bumpus and Tatarko (1994), the level of these processes depends on the soil-climatic conditions, oxidoreduction potential or, more precisely, on the secretion of enzymes of the lignin degradation system (of lignin peroxidase, manganese peroxidase, quinol oxidase etc.) — Stahl and Aust (1995).

On the other hand, high pesticide concentrations, decreased organic matter amount and soil moisture contribute to a decline in the number and activity of soil fungi (Kjoller and Rosendahl, 2000), impacting also the plant nutrition itself and change in soil structure and fertility (Bethlenfalvay and Shuepp, 1994).

The aim of the paper was to determine the effect of different herbicides (Simazine, Napropamid, Paraquat), fungicides (Captan and Mancozeb) and insecticides (Fenitrothion and Dimethoate) on the number of soil fungi in the soil under apple trees.

MATERIAL AND METHOD

The trial was set up on the alluvium soil type (pH_{nKCl} — 5.8, humus — 0.98%, N-0.04%, P_2O_5 — 14.80 mg 100 g^{-1} soil, K_2O — 16.80 100 g^{-1} soil) of the Experimental Farm of the Fruit and Grape Research Centre in Čačak, in a randomized block design with three replications. The experimental plot size was 20 m^2. Seedlings of the Idared apple variety were used as test plants and treated in early spring with the following pesticides:

Herbicides: Simazine — 4 dm^3 ha^{-1}, Napropamid — 9 dm^3 ha^{-1}, Paraquat — 4 dm^3 ha^{-1}

Fungicides: Captan — 0.2%, Mancozeb — 0.2%;

Insecticides: Fenitrothion — 0.2%, Dimethoate — 0.15%.

Once a month, four times during the growing season, soil sampling was performed for determining the soil fungi number.

The soil fungi number was determined by an indirect method of addition of 0.5 cm^3 10^{-5} dilution on the Czapek agar.

The data obtained were processed by the variance analysis method and the Lsd test was used to perform testing of the significance of differences.

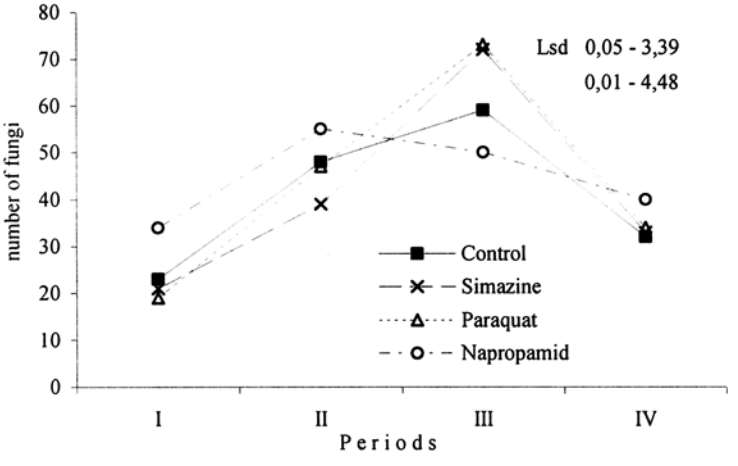
INVESTIGATION RESULTS AND DISCUSSION

Based upon the analysis of variance of the experimental data obtained, we conclude that the effect of the herbicides, fungicides and insecticides used on the number of soil fungi depended not only on their type, but also on the period of sampling for the analysis.

Besides Napropamid, in initial stages of the growing season, the rest of the herbicides used considerably decreased the number of soil fungi, Paraquat

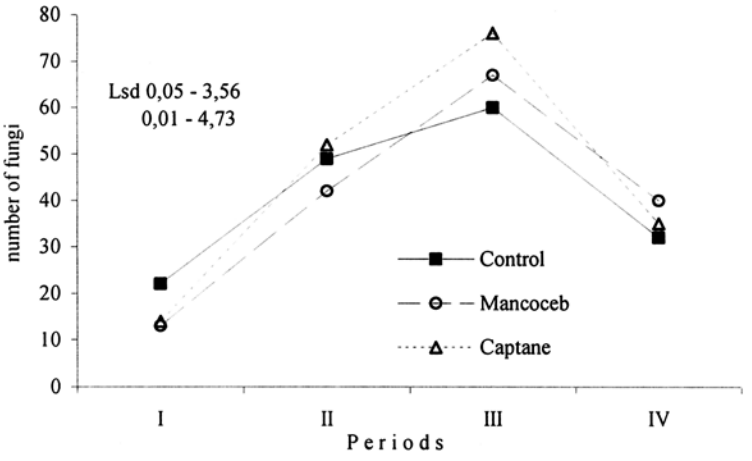
being the leading one in that respect (Graph. 1). After Čulakov et al. (1975), the use of this preparation affects the cell membrane permeability, indirectly impacting a decline in the number of this group of microorganisms. A decline in soil moisture during the second investigation period resulted from a pronounced depressive effect of Simazine as opposed to Napropamid and Paraquat the use of which resulted in increased numbers of this group of microorganisms. The increase in the number of soil fungi in the presence of optimal rates of the preparations was recorded by Chopa and Magu (1985), who associated it with the cometabolic effect in the soil, indirectly affecting the vitality and tolerance of soil fungi to herbicides. At the end of the growing season, excepting Napropamid, a moderate loss of the effects expressed was registered.

In terms of the growing season, the number of soil fungi increased till the third investigation period, whereas the lowest number was recorded at the end of the growing season being in correlation with the plant activity, that is with the amount and value of root exudations as potential food sources for this group of microorganisms (Yemtsev and Đukić, 2000).



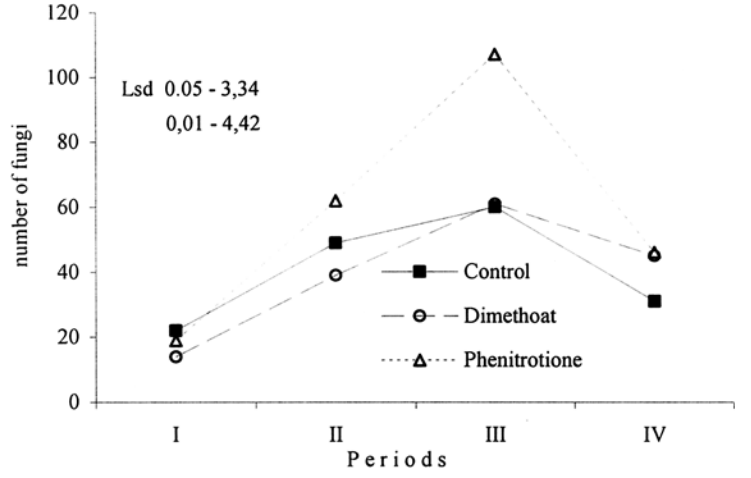
Graph. 1. Effect of herbicides on the number of soil fungi (10^5 g^{-1} soil)

The fungicides used, particularly Mancozeb, in the initial vegetation stages, significantly affected a decline in the number of soil fungi being in accordance with the results obtained by Kling and Jacobsen (1997), who underlined a significant effect of the fungicides on the growth reduction of hyphae and their division, as well as on the decrease in the activity of enzymes responsible for decomposition of these pesticides. During their further determination over the sampling periods, there was a rise in the number of fungi in all variants and a loss of the fungicide effect of the preparations being expressed till the end of the growing season (Graph. 2). Similar impacts of aftereffects of fungicides on the increase in the number of fungi were highlighted by Wainwright and Pugh (1975).



Graph. 2. Effect of fungicides on the number of soil fungi (10^5 g^{-1} soil)

In the first investigation period the Dimethoate insecticide highly significantly decreased the number of fungi, whereas the effect of Fenitrothion was statistically insignificant (Graph. 3). In the second and especially in the third period, a gradual loss of a depressive effect of dimethoate and a pronounced stimulative effect of Fenitrothion were recorded. At the end of the growing season, in spite of the decline in the fungi number, the stimulative effect of the insecticides used was still present. To that end are also the results of other authors who point out that with the extension of the incubation period, the number of soil fungi in the conditions of organophosphorous insecticide application increase, resulting as explained from stimulation of mineralization processes, respiration and oxidoreduction processes in the soil (T u, 1970, J e n k i n s o n, 1976).



Graph. 3. Effect of insecticides on the number of soil fungi (10^5 g^{-1} soil)

CONCLUSION

— The number of soil fungi depends not only on the type of pesticides used, but also on the growing season of the plants cultivated and the time of their determination;

— Of all the herbicides used, the highest and longest depressive effects on the development of soil fungi was registered with Simazine, the effect of Napropamid being the smallest;

— Both fungicides applied perform inhibition of soil fungi development during the first two months following their application;

— The smallest and shortest inhibitory effect on soil fungi was expressed by the insecticides used, Fenitrothion in particular.

A general conclusion could be made, being that the fungi belong to the group of microorganisms that after an initial sensible response to the presence of pesticides in the soil very rapidly establish normal metabolism, indicating that this parameter of soil biologic activity must be taken into account during monitoring of pesticide pollution of soil.

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ЗЕМЉИШНЕ ГЉИВЕ КАО ПОКАЗАТЕЉИ ЗАГАЂЕНОСТИ ЗЕМЉИШТА ПЕСТИЦИДИМА

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Резиме

Земљишне гљиве, са израженом ензимском активношћу и високим осмотским потенцијалом, представљају значајан показатељ негативних утицаја различитих пестицида на агро-екосистем као целину. У том погледу, извршен је оглед на алувијалном типу земљишта са циљем да се испита утицај различитих хербицида (Simazine, Napropamid, Paraquat), фунгицида (Captan и Mancozeb) и инсектицида (Fenitrothion и Dimethoate) на једном броју земљишних гљива под стаблима јабука.

Број земљишних гљива одређиван је током четири сезоне гајења индиректном методом додавања разблаживача на Чапек агар.

Резултати проучавања показују да гљиве које припадају групи микроорганизама који, после једног почетног осетљивог одговора на присуство пестицида у земљишту, врло брзо успостављају нормалан метаболизам који им омогућује да чак постају многобројнији. У том погледу, фунгициди и пестициди показали су се прилично успешнима.