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MINERAL FERTILIZERS AS A GOVERNING FACTOR OF THE REGULATION OF THE NUMBER OF FUNGI IN SOIL

ABSTRACT: Over 2003—2005 period, a study was performed on the effect of different rates of NPK fertilizer of formulation 8:16:24 + 3% MgO (N_1 — 400 kg ha^{-1}; N_2 — 600 kg ha^{-1}; N_3 — 800 kg ha^{-1}; N_4 — 1000 kg ha^{-1}) on development of the soil fungi. The trial was set up in the experimental plum orchard established by Fruit Research Institute Čačak, and the laboratory of Department of Microbiology, Faculty of Agronomy Čačak. Unfertilized soil was used as the control soil. Each of the stated variants was carried out in three replications. The size of the basic plot was 68 m^2. The effect of the studied mineral fertilizer rates was determined three times over the growing season, the number of fungi being checked by the indirect rarefaction method on Chapek nutritive medium. The results of the study inferred that the application of mineral fertilizers brought about the decrease in the number of fungi. Of all studied variants, the one with the highest nitrogen rate (variant N_4) exhibited the strongest effect. The influence of the fertilizer was highest at the third sampling. Furthermore, the effect was highest in season 2003.

KEY WORDS: fungi, mineral fertilizers, soil

INTRODUCTION

Intensive development of modern technologies has resulted in the progress of society in general, but it brought about damaging consequences as well. In addition, the problem of protection of soil from the pollution and other antropogenic factors appears to be one of the major problem of our time. The importance of the productive capacity of soil is reflected in the fact that by 2020 meeting world food requirements will presuppose 50% increase in food production. For that purpose, by 2010, about 90 million hectares of the global acreage will have to be turned into arable land, which presupposes maintainance of the current soil fertility (www.ekoforum.org.yu, 2000; Pešaković, 2007).

The spread of human-produced harmflul substances is a major cause of soil pollution. On the one hand, human loss of control over these substances leads to soil degradation, whereas on the other hand, these substances return to humans through the food chain. Aimed at lowering the level of both air- and soil-pollution, the control over the emission of harmful substances has been greatly intensified over the recent period. This issue has not been duly addressed so far in the field of technology of agricultural production. Such shortages may result in serious economic and ecological consequences reflected in lowering of soil productivity, the loss of agro-biodiversity, the incidence of methemoglobinemia, cyanosis as well as mutagenic and teratogenic effects. Therefore, one of the goals of science is ensuring intensive environmental and human-friendly agricultural production, whereby the attention should be focused on proper application of different fertilizing modes. Rational and efficacious application of fertilizers (mineral ones in particular) in modern agriculture need to be based on a more complex approach to the issue, which presupposes prominent positioning of macrobiological investigations (M a n d i ć et al., 2004). The objective of this work, i.e. the investigation of the effects of different fertilizer rates on the development of fungi in soil has been determined in accordance with the fact that the change in population pressure of some systematic and physiological microrganism groups may serve as a parameter for establishing the most optimal criteria for agricultural nutrition.

MATERIAL AND METHODS

The investigations in question were performed over 2003—2005 period in the experimental plum orchard established by Fruit Research Institute Čačak and the laboratory of Department of Microbiology, Faculty of Agronomy. The soil type is alluvium, and trial system included random-block design in three replications. The size of the basic trial plot was 68 m^2.

The soil was acid in type, pH = 1nKCl = 5.9. It was poor in organic matter (2.65% humus) and rich in available phosphorous (AL-method: mg 100 g^{-1} of soil = 15.0 P_2O_5), whereas potassium content was moderate (AL--method: mg 100 g^{-1} of soil = 20.4 K_2O).

A plum fruit of cv Stanley was used as a test fruit.

All cultural practices, i.e fertilization, green and winter pruning, inter-raw soil cultivation, protection from diseases and pests were applied at establishing a training system.

The temperature and water data of the studied region are presented in Table 1.

Tab. 1 — Weather characteristics (Čačak Weather Bureau) and long-term means (LTM)

Period		Precipitation rates and mean air-temperatures in Čačak*							Total	Mean
		May	June	July	Aug.	Sept.	Oct.	Nov.		
2003	mm	62	51	69	6	34	77	27	326	
	°C	19.8	25.1	24.2	26.4	17.3	10.2	8.9		18.8
2004	mm	66	121	82	58	35	27	98	487	
	°C	16	21.7	23.5	22.8	18.1	14.3	6.2		17.5
2005	mm	72	84	100	66	91	23	83	519	
	°C	17.2	21	23.7	20.3	18.2	11.8	5.2		16.8
LTM	mm	89	98	76	60	56	48	59	486	
(1965—1994)	°C	16.2	19.5	20.9	20.5	16.9	11.8	5.8		15.9

* 5 km eastwards from the trial field, as the crow flies.

Over 2000—2002 period, the soil was treated with different rates of mineral fertilizer of type 8:16:24 + 3% MgO, i.e. variant N_1 — 400 kg/ha; variant N_2 — 600 kg/ha; variant N_3 — 800 kg/ha; N_4 — 1000 kg/ha; variant Ø — the control (untreated soil).

The samples subjected to microbiological analyses were collected three times over the growing period, i.e. May 12, Sept. 17 and Nov. 11 in seasons 2000—2002.

The number of fungi was determined by indirect dilution method on Chapek nutritive medium. The duration of incubation was 5 days (28°C).

The analyses were performed in three replications, whereby the number of fungi was calcultated on 1.0 of absolutely dry soil.

The data provided by this research were subjected to variance analysis method of threefactorial trial of 5 x 3 x 5 form (chemical x period x year). The testing of significant differences among individual and interaction environments was carried out by the LSD test.

RESEARCH RESULTS AND DISCUSSION

The experimental results of the average number of fungi in soil in the studied variants by years inferred that all studied factors exerted statistically high significance regarding the presence of this microorganism group in soil (Tab. 2). In addition, it is obvious that the interaction among the studied factors (A x B, A x C, and B x C) had marked influence on the development of this microorganism group.

Generally speaking, all fertilizer rates had a stimulating effect on the development of soil fungi, which was particularly evidenced in high-rate variants over all phases of the growing season in this fruit species. This trend was notably observed in the N_4 variant applied in mid- and final phases of the growing season, the growing of which was favoured by higher temperatures and moisture rates alike (Tab. 1), which is also inferred by other authors' results (J e m c e v and Đ u k i ć, 2000).

The incorporation of higher rates of mineral fertilizers into soil, acid ones in particular, and their long-term usage is depressing for the majority of microorganisms (Jemcev and Đukić, 2000; Pešaković, 2007). The occurrence of this may be due to the transformation of alluminium compounds into the soil solution which becomes toxic not only for microorganisms but also for cultivated fruit species. However, soil fungi which exhibit a steady enzyme system that enables them to inactivate even heavily degradable chemical compounds (Mandić, 2002) fare well even under such conditions, and this stimulating effect of higher mineral fertilizer rates is therefore anticipated. With regard to the predominance of fungi in acid soils, it is also suggested that their population number rises with more intensive application of the stated fertilizers. A large number of authors addressing this issue (Acosta-Martinez & Tabatabai, 2000; Solovova et al., 2001; Zhang, Wang, 2006; Pešaković et al., 2008) account for this rise in population density and activity of the majority of microorganisms in soil by limiting of the C:N relation and the intensification of the mineralizing processes therein, as well as by the re-distribution within the complex of microbial cenoses in favour of soil fungi.

Tab. 2 — The average number of fungi in soil (10^5/1,0 g of absolutely dry soil) as affected by the applied fertilizers (A), period of sampling (B) and the year of study (C) in a trial field planted with plum cv Stanley

Fertilizer (A)				N_1	N_2	N_3	N_4	Ø	$\overline{X}$
Year (C)	2003	Period (B)	I	4,500	5,335	8,165	9,670	3,835	6,301
			II	13,500	15,835	22,335	23,330	8,831	16,766
			III	6,170	7,835	11,170	23,555	3,500	10,446
		$\overline{X}$		8.057	9.668	13,890	18,852	5,389	11,171
	2004	Period (B)	I	2,830	3,670	5,335	6,165	2,335	4,067
			II	8,500	11,665	13,000	14,500	7,000	10,933
			III	5,333	7,665	9,330	12,830	3,665	7,765
		$\overline{X}$		5,554	7,667	9,222	11,165	4,333	7.588
	2005	Period (B)	I	2,670	4,335	4,665	5.000	2.330	3.800
			II	9,330	12,500	14,335	16.330	6.835	11.866
			III	4,000	4,165	5,000	6.335	3.335	4.567
		$\overline{X}$		5,333	7,000	8,000	9,222	4,167	6.744
	$\overline{X}$		I	3,333	4,447	6,055	6,945	2,833	4.723
			II	10,443	13,333	16,557	18,053	7,555	13.188
			III	5,168	6,555	8,500	14,240	3,500	7.593
$\overline{X}$				6.315	8,112	10,371	13,079	4,630	8,501
lsd									
lsd	**A**	**B**	**C**	**AxB**	**AxC**	**BxC**	**AxBxC**		
0.05	1,831	1,418	1,418	3,171	3,171	2,456	5,492		
0.01	2,425	1,878	1,878	4,200	4,200	3,254	7,275		

The analysis of the interaction effect of the applied fertilizers and years of study suggests similar effects. Over the entire three-year period of study, N_4

variant (1000 kg/ha) exerted high effects, which could also be applied to N_3 variant (800 kg/ha), particularly in season 2003. Similarly, the most pronounced variation, in respect to the number of fungi was also evidenced in season 2003. The contrastive analysis of the obtained values with those of the control soil over the stated year inferred that all variants, except N_1, had quite an impact on the rise in the number of fungi.

The stated effects of the studied fertilizer were the most obvious in season 2003 when number of fungi was highest, whereupon the effect was observed to be gradually decreasing, which was particularly to evident at the end of the season 2005.

Generally speaking, the rise in fertilizer rate was accompanied by the rise in the number of soil fungi, which, by certain degree, may be considered positive. However, over-activation of fungi may be damaging, as the processes directed towards establishing of the disturbed balance lead to the weakening of physical, chemical and biological properties of soil (Mandić et al., 2004) and the incidence of toxic fungi (Milošević et al., 1993), whereby Penicillium species assume predominance (Mandić, 2002; Pešaković, 2007).

Besides causing undesirable effects on biosphere in general, and its constituent elements, inappropriate application of mineral fertilizers can influence agricultural production from the aspect of economy. In other words, the production of cultivated species can be markedly affected (Đukić et al., 2007a). Therefore, fertilizer rates exceeding 600 kg/ha may not only be unprofitable but may turn depressing on productivity of plum trees grown under the stated environmental conditions (Rakićević et al., 2004; Pešaković, 2007).

CONCLUSION

The results of the study of the effects of different mineral fertilizer rates on the number of fungi in soil planted with plum trees (cv Stanley) infer the following:

— the number of the studied group of microorganisms was dependent on fertilizer rates, period of sampling and year of study;

— the applied fertilizers brought about an increase in the number of fungi, particularly in the variants that included highest nitrogen content;

— the effect of the applied fertilizers on the number of fungi in soil was most evident at the end of the growing season 2003.

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МИНЕРАЛНА ЂУБРИВА КАО ФАКТОР РЕГУЛАЦИЈЕ БРОЈНОСТИ ГЉИВА У ЗЕМЉИШТУ

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Резиме

У периоду 2003—2005. године у експерименталном засаду шљива Института за воћарство Чачак и у Одељењу за Микробиологију Агрономског факултета у Чачку, праћен је утицај различитих доза минералног ђубрива формулације 8:16:24 + 3% MgO (N_1 — 400 kg ha^{-1}; N_2 — 600 kg ha^{-1}; N_3 — 800 kg ha^{-1} и N_4 — 1000 kg ha^{-1}) на развој земљишних гљива. Као контрола коришћено је земљиште које није ђубрено. Свака од наведених варијаната ђубрења била је заступљена у три понављања. Величина основне огледне парцеле износила је 68 m^2.

Ефекат примењених ђубрива одређиван је три пута током вегетације, а праћен је путем утврђивања бројности гљива индиректном методом разређења на Чапековој хранљивој подлози. Резултати истраживања су показали да је примена минералних ђубрива изазвала повећање бројности гљива. Од свих испитиваних варијаната ђубрива најизраженији утицај показала је N_4 варијанта (варијанта са највишом дозом азота). Утицај примењених ђубрива је био најизраженији на крају вегетације и током 2003. године.