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PRODUCERS EDUCATION ABOUT MICROBIOLOGICAL INOCULATES APPLICATION IN FUNCTION OF SOIL FERTILITY

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Abstract

Soil protection against degradation in agricultural production is one of the measurements in the frame of aims and guidelines of integral and organic production. Because of that, there are more and more researches which are directed toward finding the alternative - organic ways in soil fertilization, in the aim of undesirable effects avoiding. Application of microbiological inoculates with nitrogen fixing bacteria with the purpose of soil fertilization, replaces or refill nitrogen mineral fertilizers. Decrement of mineral fertilizers quantities complies with integral agricultural production concept, what represent important step to organic agriculture. Appliance of these new methods requests constant use of available knowledge through education of direct producers. Awareness and habits of producers have to be changed in the direction of multifunctional agriculture and rural development, with spreading of knowledge of soil fertility maintaining by the appliance of all bio-agro-technical measurements.

By inoculates appliance in maize, wheat and soy bean production with certain groups of nitrogen fixing bacteria, soil biogenity is being preserved and maintained, plants needs for necessary assimilation's nutrients are being satisfied, phytoparasites control is secured, healthy food is produced, what satisfied all ecological and economic criterions of viable system.

Key words: soil, nitrogen fixing bacteria, soy bean, wheat, maize, biogenity parameters

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Introduction

Soil represents significant natural resource, whit slow process of self creation. For 10 mm of soil surface fatness is needed more than 100 years. In compare with total Earth's crust it is really small mass, but its importance is great for nature and all living world. Ground is completely independent naturally-historic body "sui generius", and represents ecologic sphere which affects on other life spheres: hydrosphere, atmosphere and biosphere, and because of that, with them has to be managed properly.

Degradation and disappearance of soil are among the most important ecological threats to mankind. In world is cultivated only 10% of total surface, where just 3% of this amount is highly productive. Exponential growth of population and technical-technological progress are came to that many surfaces on which was produced food, now are cut off from further agricultural production (building of settlements and infrastructure, as of industrial and miners facilities, etc.). Arable land constantly decreased per inhabitant, and in world it counts about 0,88 ha, in Asia and Europe, which are most jeopardized, it is 0,60 ha. In Central Serbia in 2006, comparing to 1960, decrement is for 180.000 ha, or 10,5% of total agricultural land, in other words for 0,24 ha per inhabitant (Milanović et al. 2008). Having in sight statement that soil is basement of living world survival, as those arable surfaces are limited, it is not strange that soil quality is in focus of all worlds, because food quality strongly depends from it (Čuvardić et al. 2006). Different ways of soil management brings to different level of its degradation, so securing and protecting of chemical, physical and biological parameters have great ecological and economical character (Milošević et al. 2008).

Soil as natural habitat for microbes

Particularly, it is clearer that natural resources are not limitless so it exist need for coordination of food production relations, with rational usage of basic agricultural resources, so in that case environmental and agro ecosystems pollution would be reduced to minimum (Ladd et al, 1994). For changes identification, which is effect of man dealing, it is necessary to follow and control a bigger number of various parameters which define soil condition, in other words its fertility which is key factor of soil production characteristics (Vasin, 2008). One of the basic parameters of soil fertility is its biogenity, or number of microbes and their enzymatic activity.

Microbiological activity represent link of key processes connection which control intensity of organic matter decomposition, directions of mineralization and liberation of accessible plant nutrients. Besides that, microbes make 0,1 to 5% of total organic matter in soil. In soil with formed profile, microbes keep its structure,

level of organic matter and stability of all others characteristics. They take part in amount of total transformations in soil with 60 to 80% and they are main parts in the processes of energy flow and matter cycling. With their metabolic activities each year is mineralized up to 4% of organic matter in soil, what enable plant nutrition and viability of systems in biosphere. Development of agricultural production in the direction of viable agriculture, which considered elimination of mineral fertilizers and other chemical inputs, enabled usage of knowledge from the fields of biological nitrogen fixation, which significantly affect on balance of nitrogen in soil.

In conventional agricultural production for achieving of higher yields are used large amounts of mineral fertilizers, especially nitrogen one. Usage of high dosages of nitrogen fertilizers in longer time period can cause negative effects from ecological aspect, as from aspect of soil fertility violation. By this, numbers of microorganisms which are taking part in cycle of nitrogen circulation are decreasing. Such like this soil microbes changes affect on changes of organic matter and humus, which determine soil fertility. Because of that in world, as in Serbia too, exists more and more interesting for ascertainment of alternative ways of fertilization, with main clue of undesirable after effects avoiding. With knowing of role and flow of microbiological processes in soil, man can greatly direct appliance of certain groups of microbes in agricultural production. Usage of microbiological inoculates as fertilizers are multiply useful.

For appliance of new methods which are directed to creation of optimal conditions in quality food production, it is needed constant usage of available knowledge through producers' education. In distinction to conventional way of agricultural production, producers' awareness and customs it would be changed in direction of multifunctional agriculture and rural development with spreading of knowledge of soil fertility maintaining by usage of all bio-agro technical measurements.

Because of that as aim is set estimation of micro biotic inoculates appliance influence through various systems of fertilizing on certain parameters which define soil fertility and biogenity during maize, wheat and soy bean growing.

Importance, possibilities and perspective of nitrogen fixating bacteria usage in the function of bio-fertilizers in crop production

By appliance of nitrogen fixing bacteria, symbiotic or associative one, as fertilizer in crop and vegetable production, basic principles of organic agriculture system are satisfied: health principle, ecological and economic principles. This group of microbes which is living on root of leguminous (symbiotic) or on root and in rhizosphere of non leguminous plants (associative and free) simulative affects on

plant growth by production of biological matters (vitamins, hormones, gibberellins and auxins). Also, they affect on useful microbes population number and directions of microbiological processes in ground, and with that on its fertility. By their appliance is decreasing usage of expensive nitrogen fertilizers, and in some way protect and increase organic matter in soil, or quality of soil health (Milošević and Jarak, 2005, Cvijanović, et al. 2007). At beginning of 1990 is recommended biofertilization as addition or exchange to mineral nitrogen fertilizers, and only at leguminous it could be used as only one applied fertilizers. Usage of symbiotic bacteria today is obligated measure, especially for soils on which soy bean was not produced earlier. By usage of selection active types of symbiotic nitrogen fixing bacteria is achieved bigger yields (3.662 kg*ha^{-1}, JUS – macro experiment Agro institute, Sombor, 2005), higher content of protein (34,55% – macro experiment Agro institute, Sombor, 2005), decreasing of mineral nitrogen fertilizers appliance (60 kgN*ha^{-1}, change for around 130 kg of UREA – macro experiment Agro institute, Sombor, 2005), (Cvijanović D. et al. 2008). By usage of such this fertilizer, soy bean is needed to be fertilized only with 30 kgN*ha^{-1}, because low level of nitrogen allowed root recognizing and infecting.

By usage of associative nitrogen fixing bacteria (*Azotobacter, Azospirillum, Derxia, etc.*) in wheat, maize, sugar beet, sunflower and some vegetables production, shows that depending from type, exists possibilities of exchange in range up to 60 kgN*ha^{-1}, and even that quantities could be up to 150 kgN*ha^{-1}. Especially good results of associative fertilizers appliance are gotten in production of seedlings of vegetable plants, which grow up faster and more equal after replanting (tomato leaf surface – around three times bigger; paprika leaf surface – around two times bigger; tomato stem length – around 14 cm longer; paprika root length – around 40% longer. Testing is done by Jugoinspekt Belgrade, 2006.) (Cvijanović D., et al. 2008).

Nitrogen fixing bacteria in bio fertilization could be applied as single type of certain species, or as mixture of types of one or more species in various forms (liquid, wet, dry). Mostly is applied by infliction on seed (seed inoculation) just before sowing, through irrigation system drop by drop, or by direct application into ground. Nitrogen fixing bacteria which are used must have good ability of survival into new ambient, then good competitive relations with host plant and soil autochthonous microbes' population. Because of that in laboratories, nitrogen fixing bacteria selection is done based on long standing researching in indoor and outdoor spaces.

In maize institute Zemun Polje is done researching of influence of selected associative nitrogen fixing bacteria types and species in maize and wheat production, as influence of mixture of symbiotic and associative nitrogen fixing

bacteria in soy bean production, on soil biogenity basic elements towards various dosages of mineral nitrogen. Wheat seed is inoculated with mixture of same quantities of various highly effective types of associative species *Azotobacter chroococcum, Azospirillum lipoferum, Brijerinckia Derx, Klebsiella planticola*. In the case of soy bean inoculation is done with mixture of above underlined associative bacteria with symbiotic bacteria *Bradyrhizobium japonicum.* Maize seed is inoculated with mixture of following associative species: *Azotobacter chroococcum Azotobacter vinelandi, Azospirillum lipoferum, Pseudomona, Bacillus subtillis.* Before sowing is done fertilization with nitrogen mineral fertilizer: for wheat 80, 120 and 160 kg $N*ha^{-1}$, for soy bean 40, 60 and 80 kg $N*ha^{-1}$, and for maize 60, 90, 120 and 150 kg $N*ha^{-1}$. All agro technical measures are being done properly, in optimal time intervals.

Table 1 Effects of associative Azotobacter and mineral nitrogen usage on soil biogenity elements at maize

Fertilizer $kgN*ha^{-1}$	Total number of microorganisms		Number of *Azotobacter*		Dehydrogenase activity	
	10^7*g^{-1}soil	Index level	10^1*g^{-1}soil	Index level	$\mu gTPF*g^{-1}$ soil	Index level
0	245	100	47	100	407	100
60	355	144	174	369	526	129
90	412	167	180	383	438	107
120	302	123	98	208	440	108
150	158	64	57	123	113	27
Average	307	125	139	294	379	93

In researching was with standard microbiological methods followed dynamic of changes of basic biogenic parameters in rhizosphere soil: total number of microorganisms, number of *Azotobacter* and total soil breathing through its enzymatic activity. In frame of integral and organic production, entering of organic fertilizers affects increment of number of specific physiologic groups of microbes' (Strak et al., 2007). By their total activity are increasing quantum of available nutrients for plant, then microbes biomass, processes of humus creation are going up, soil structure is advanced what contribute to increment of its fertility and more qualitative production. All changes in soil, as biological processes mostly are with enzymatic characteristics. Biggest part of enzymes in ground is from microbes, and they have their dynamic which depends from applied measures in plant production. Breathing enzymes (dehydrogenase) are good parameter of soil biogenity, how they catalyzed all oxidation-reduction processes in soil. Microbes' number, their

mutual relation and enzyme dynamic is reflection of soil biological activity (biogenity). Analyzing gotten results it could be noticed that exists certain regularity of tested parameters increasing under low dosages of mineral nitrogen.

At maize the biggest number and percent of increment of tested parameters is estimated during the fertilization with dosage of 90 kgN*ha^{-1}, while the highest intensity of soil breathing is estimated at the dosage of 60 kgN*ha^{-1} (table 1). At wheat by the fertilizing dosage of 80 kgN*ha^{-1} is estimated the highest concentration of *Azotobactera* and intensity of total enzymatic activity, in other words soil breathing (table 2). If soil breathing intensity is higher, oxidation-reduction processes in soil are more intensive, in other words intensity of organic process disintegration is faster, as process of humus creation.

Table 2 Effects of associative Azotobacter and mineral nitrogen usage on soil biogenity elements at wheat

Fertilizer kgN*ha^{-1}	Total number of microorganisms		Number of *Azotobacter*		Dehydrogenase activity	
	10^7*g^{-1}soil	Index level	10^1*g^{-1}soil	Index level	µgTPF*g^{-1} soil	Index level
0	239	100	265	100	553	100
80	254	106	352	132	589	106
120	350	146	272	103	471	85
160	273	114	237	89	553	100
Average	279	117	281	106	541	98

Results in table 3 shows that the highest value of parameters was by usage of 40 kgN*ha^{-1}, what proved that in soy bean production is necessary fertilization with mineral nitrogen in amount up to 40 kg*ha^{-1}, as starting fertilizer while root nodules of young plants are still not developed.

With increment of mineral nitrogen quantum, it came to decreasing of number of researched parameters, except enzymatic reaction which was on same level as estimated in variety without fertilizing, which was at all three cultures referent value (table 3). From result it can be noticed that number of *Azotobacter* with increment of mineral nitrogen had decreasing tendency. This importance species of nitrogen fixing bacteria, because of its sensibility react very stormily, by decreasing of its number, at habitat conditions change, so they are good indicator of all changes, or degradations in soil. High dosages of mineral nitrogen in every soil affects disturbance of microbiological processes balance, and activity of many useful microorganisms are decreased.

Table 3 Effects of mixture of associative and symbiotic Azotobacter and mineral nitrogen usage on soil biogenity elements at soy bean

Fertilizer kgN*ha^{-1}	Total number of microorganisms		Number of *Azotobacter*		Dehydrogenase activity	
	10^7*g^{-1}soil	Index level	10^1*g^{-1}soil	Index level	µgTPF*g^{-1} soil	Index level
0	218	100	378	100	505	100
40	251	115	346	93	549	109
60	180	82	331	87	608	120
80	179	82	266	70	589	117
Average	207	95	330	87	562	111

Decrement of microorganisms' enzymatic activity is appeared because of that level of mineral nitrogen determine induction of gene expression which are responsible for nutrient acceptation. Also, big quantities of mineral nitrogen inhibited process of free nitro fixation, because it negative affects on enzyme nitrogenase, what is influenced by number decrement of this group of nitrogen fixing bacteria. This results are overlapping the fact that soy bean has significant place in organic agriculture from the aspect of soil fertility securing, maintaining of nitrogen balance, increment of biodiversity in agro-bio-ecosystem, by unitizing with other cultures or in crop rotation (Lampkin, 2001).

Conclusion

Based on research results it can be concluded that successfully could be used free living and associative microorganisms as bio-fertilizers in the form of microbiological fertilizers. Also, it can be concluded that their application has many benefits. They decrease the possibility of soil and underground water pollution with nitrates, they increase the amount of soil organic matter and they raise economic effect by saving of pure nitrogen in amount of 30 to 60 kg* ha^{-1}.

Also, its usage is in function of soil fertility maintaining, what is in balance with principles of organic agriculture, which are based on careful resources economy and which promotes: improvement of biological cycles, soil biological activity, increment of biodiversity and appliance of bio-agro technical measures which maintain, recover and improve ecological harmony. On that way it would be promoted rural development, production of health food with geographical origin, as total social inhabitants' status in these areas with infallible education of producers.

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