www.nsseme.com/journal.html

original scientific paper / originalni naučni članak

Ratar. Povrt. 49:2 (2012) 183-188

Effect of Co-Inoculation with Different Groups of Beneficial Microorganisms on the Microbiological Properties of Soil and Yield of Maize (*Zea mays* L.)

Timea Hajnal-Jafari • Mirjana Jarak • Simonida Đurić • Dragana Stamenov

received: 2 February 2012, accepted: 2 July 2012

doi:10.5937/ratpov49-1462

Summary: The effect of co-inoculation on the microbiological properties of rhizospheric soil and yield of maize was investigated in field conditions. The total number of microorganisms (TNM) was largest in variant where Plant Growth Promoting Bacteria (PGPB), Phosphorus Solubilizing Bacteria (PSB) and Arbuscular Mycorrhiza (AM) were applied. TNM was 418.10x10^7 /g soil. The largest number of fungi was achieved in the variant with PGPM (29.65 x10^4 /g soil). The joint use of PGPB, PSB and AM resulted in the largest number of phosphomineralizers (PM) (31.67x10^4 /g soil). Dehydrogenase activity (DHA) increased only in the variant where all the microorganisms were introduced (924μg TPF/10 g soil). The co-inoculation led on average to the increased activity of acid phosphatase (ACP) and alkaline phosphatase (ALP). The highest yield of maize was achieved in the variant with PGPB (15.33 t/ha). Correlation analysis proved a high degree of interdependence between microbiological activity and maize yield.
Key words: arbuscular mycorrhizae, enzymatic activity, inoculation, microorganisms, maize, PGPB, PSB, soils, yield

Introduction

It is necessary to provide maize with adequate amounts of macroelements for optimum growth and development, as well as achievement of high yield. A part of nutrients is provided by application of microbial inoculants (Dobbelaere et al. 2003). Inoculants are produced from different kinds of microorganisms, PGPB among others. PGPB, directly or indirectly, affect the growth and development of plants and the amount of yield through various mechanisms: associative nitogen fixation, production of phytohormones, ACC (l-aminocyclopropane-l-carboxylate) deaminase activity, production of phenazine and exopolysaccharides (Alami et al. 2000, Idriss et al. 2002, Ryu et al. 2003, Hernandez et al. 2004, Egamberdiyeva, 2007). Phosphomineralizers increase the supply of phosphorus by means of mineralization of organic phosphorus compounds. The important phosphomineralizing bacteria is *Bacillus*. Arbuscular mycorrhiza (AM) improve the physical properties of soil, soil aeration and water dynamics (Rillig et al. 2002). AM also enable release of phosphorus from inaccessible compounds (Whitelaw 1999, Harrier et al. 2003, Vessey et al. 2004). By means of inoculation, a large amount of exogenic microorganisms is introduced into the soil and they affect the indigenous microbial population. At the same time, the inoculants are exposed to the influence of resident microorganisms (Bolton et al. 1991, De Leij et al. 1995, Natsch et al. 1997). As microorganisms have an important role in agricultural production, it is necessary to observe changes in the microbiological activity in soil which are the result of different agrotechnical measures and inoculation itself.

The aim of this investigation was to determine the effect of co-inoculation with PGPM (*Azotobacter chroococcum, Azospirillum lipoferum*), PSB (*Bacillus megaterium*) and AM (*Glomus intraradices*) on the microbiological properties of soil as well as on the yield of maize (*Zea mays* L.)

Materials and Methods

The cultures of bacteria *A. chroococcum*, *A. lipoferum*, *B. megaterium* and fungus *G. intraradices* were taken from the collection of the Department of Microbiology, Faculty of Agriculture, University of Novi Sad.

T. Hajnal-Jafari* • M. Jarak • S. Đurić • D. Stamenov
University of Novi Sad, Faculty of Agriculture, Trg Dositeja Obradovića 8, 21000 Novi Sad, Serbia
e-mail: timeajafari@yahoo.com

A. chroococcum and *A. lipoferum* were grown in a liquid medium by Fjodorov (Anderson 1965). *B. megaterium* was grown in a liquid mesopeptonic medium. Inoculum of AM fungi was multiplied and sustained by the open-pot culture method (Gilmore 1968).

The field experiment was carried out in chernozem soil having the following characteristics: pH in H_2O 7.67, pH in KCL 6.90, %N 0.17, % humus 2.66, % $CaCO_3$ 0.98, P_2O_5 16.28 mg/100g of soil, K_2O 33.52 mg/100g of soil. The experiment was conducted in three repetitions. The size of the experimental plot was $5m^2$. The seeding was done in the optimum period (April). Before seeding, the maize (*Z. mays*) seed (hybrid NSSC 640, Institute of Field and Vegetable Crops, Novi Sad, Serbia) was inoculated with 150 ml of the liquid inoculum (10^8 CFU/ml and 100 g of AM inoculum containing mycelia and spores). The scheme of inoculation was the following: 1) control, 2) *A.chroococcum+A. lipoferum*, 3) *A.chroococcum+A.lipoferum+B. megaterium,* 4) *A.chroococcum + A.lipoferum + B.megaterium + G.intraradices*.

Irrigation was carried out in April in the period of 14 days. Digging was carried out in the phase of 6-8 leaves. Soil samples for microbiological analyses were taken from the rhizosphere at the end of the vegetation period. The yield of maize with 14% grain moisture was determined after harvesting.

The number of microorganisms was determined by the method of agar plates (Trolldenier 1996). The TNM was determined in an agarized soil extract :10^{-7} dilution (Wollum 1982). The number of fungi was determined in Czapek`s agar:10^{-4} dilution (Parkinson 1982) whereas the number of PM was determined in the Menkina medium:10^{-4} dilution (Niewolak 1980). All groups of microorganisms were incubated at the constant temperature of 28°C. The period of incubation for the TNM lasted seven days, five days in fungi and PM.

DHA was determined by the spectrophotometric method (Lenhard 1956) modified by Thalmann (1968). The activity of ACP and ALP was determined spectrophotometrically by Flint (1974).

The statistical data analysis included analysis of variance for determining LSD on the significance level of 0.05 and correlation analysis. The analyses were performed using software STATISTICS 10.0.

Results and Discussion

Inoculation affected the number of individual groups of microorganisms and enzymatic activity in different ways (Tables 1 and 2). The TNM increased in all inoculated variants. Fisher`s LSD test showed significant differences between the control and variant 4 (PGPB+PSB+AM). A statistically significant difference in the number of fungi was observed between the control and variant 2 (PGPB), and between variant 2 (PGPB) and variant 3 (PGPB+PSB). In the variants with inoculation the number of PM increased, but there were no significant differences between the control and the examined variants.

On average, DHA decreased in variants with inoculation. DHA increased only in variant 4 (PGPB+PSB+AM), although the increase was not statistically significant in comparison with the control. The activity of this enzyme significantly decreased in variant 2 (PGPB).

The co-inoculation on average led to an increase in ACP. However, there was no statistically significant difference between the control and the variants of the experiment nor between individual variants. Likewise, there was no statistically significant difference in the ALP between the control and the inoculated variants.

Table 1. The number of microorganisms in rhizospheric soil
Tabela 1. Brojnost mikroorganizama u rizosfernom zemljištu

Variants	*TNM (10^7/g soil)*	*Fungi (10^4/g soil)*	*PM (10^4/g soil)*
1	221.61^{b}	11.96^{b}	11.16^{a}
2	326.15^{ab}	29.65^{a}	22.63^{a}
3	244.67^{ab}	11.16^{b}	11.95^{a}
4	418.10^{a}	23.76^{ab}	31.67^{a}
Average 2-4	329.64	21.45	22.08

The table shows mean values (arithmetic mean of three repetitions). There is no statistically significant difference between mean values in each column with the same letter in superscript on the basis of LSD test ($p< 0.05$)

Key: (1) *control*, (2) *A.chroococcum+A.lipoferum*, (3) *A.chroococcum+A.lipoferum+B.megaterium*, (4) *A.chroococcum+A.lipoferum+B. megaterium+G.intraradices*.

Inoculation had a statistically significant effect on the grain yield of maize (Table 3). The highest yield was achieved in variant 2 (PGPB) and variant 4 (PGPB+PSB+AM). A statistically significant difference was observed between variant 2 (PGPB) and variant 3 (PGPB+AM).

Correlation analysis proved the existence of a high degree of interdependence between the investigated parameters of microbiological activity and grain yield of maize (Table 4). A strong correlational interdependence was observed between the TNM and fungi (r=0.752), PM

Table 2. Enzymatic activity in rhizospheric soil
Tabela 2. Enzimatska aktivnost u rizosfernom zemljištu

Variants	*DHA (µg TPF/10 g soil)*	*ACP (µmol pPN/s/ dm³)*	*ALP (µmol pPN/s/ dm³)*
1	832[b]	2.93[a]	3.00[a]
2	685[a]	3.33[a]	4.07[a]
3	831[b]	2.39[a]	3.87[a]
4	924[b]	3.9[a]	4.24[a]
Average 2-4	813.33	3.21	4.06

The table shows mean values (arithmetic mean of three repetitions). There is no statistically significant difference between mean values in each column with the same letter in superscript on the basis of LSD test (p< 0.05)
Key: (1) *control*, (2) *A.chroococcum+A.lipoferum*, (3) *A.chroococcum+A.lipoferum+B.megaterium*, (4) *A.chroococcum+A.lipoferum+B. megaterium+G.intraradices*.

Table 3. Grain yield of maize (t/ha)
Tabela 3. Prinos zrna kukuruza (t/ha)

Variants	Grain yield (t/ha)
1	13.64[ab]
2	15.33[a]
3	12.62[b]
4	14.13[ab]
Average 2-4	14.03

The table shows mean values (arithmetic mean of three repetitions). There is no statistically significant difference between mean values in each column with the same letter in superscript on the basis of LSD test (p< 0.05)
Key: (1) *control*, (2) *A.chroococcum+A.lipoferum*, (3) *A.chroococcum+A.lipoferum+B.megaterium*, (4) *A.chroococcum+A.lipoferum+B. megaterium+G.intraradices*.

Table 4. Correlation coefficients between the investigated parameters
Tabela 4. Koeficijenti korelacije između ispitivanih parametara

	TNM	*fungi*	*PM*	*DHA*	*ACP*	*ALP*	*Yield*
TNM	-						
Fungi	0.752*						
PM	0.996*	0.789*					
DHA	0.274	-0.413	0.229				
ACP	0.896*	0.749*	0.926*	0.226			
ALP	0.801*	0.670*	0.767*	0.003	0.475		
yield	0.517*	0.920*	0.582*	-0.557	0.679*	0.326	-

Correlation coefficients are the result of the average values for every examined parameter on the level of significance 0.05

(r=0.996), ACP (r=0.896) and ALP (r=0.801). There was a positive correlational interdependence between the number of fungi and ACP (r=0.749), and between the number of fungi and ALP (r=0.670). The number of PM is in positive correlational interdependence with the activity of ACP (r=0.926) and ALP (r=0.767). The correlation analysis showed a positive effect of the TNM, number of fungi and PM, and ACP on the grain yield of maize.

The introduced microorganisms can affect the structure of the indigenous microbial population in different ways (Nacamulli et al. 1997). Some microorganisms are stimulated, some are inhibited and in some microorganisms there is no change (Schwieger & Tebbe 2000, Bacilio-Jimenez et al. 2001).

In this research three different inocula containing two or more microorganisms were used. In the inoculated variants, there was an increase in the total number of microorganisms, the number of fungi and phosphomineralizers. It is assumed that the total microbial biomass in rhizospheric soil increased as the result of inoculation. However, the inoculation did not lead to an increase of dehidrogenase activity in rhizospheric soil. This points to the fact that the indigenous microbial population had a greater metabolic activity, i.e. that the introduction of microorganisms caused a change in oxidoreduction reactions. It is consistent with the results of Requena et al. (1997, 2001) and recent works of Andronov et al. (2009) and Gamalero et al. (2009). Averagely higher phosphatase activity in the inoculated variants points to intensification of the process of mineralization of phosphorus compounds and better provision of the plant with inorganic phosphorus. The results of this research showed that the co-inoculation of the maize seed had a positive or stimulating effect on the yield of the plant. The grain yield increased in the variant with the applied PGPR and in the variant with PGPR, PSB and mycorrhiza. Such positive effect may be the result of stimulation of seed germination, the resistance of seedlings to stress, production of active substances-growth promotors, associative nitrogen fixation (Egamberdiyeva, 2007). There are many different bacteria which promote plant growth. They include *Azotobacter sp*., *Azospirillum sp*., *Pseudomonas*, *Bacillus sp*. and many others (Turan et al. 2006). When PGPB and mycorrhiza are applied together, a mutualistic relationship forms in which PGPB induces the formation of mycorrhizal association with the plant by means of stimulating the growth of hyphae (Dunstan et al. 1998, Tiwari et al. 2004). Mycorrhizae enable better water provision and availability of plant nutrients and induce the protection mechanism of the plant against pathogens (Smith et al. 2001, Marulanda et. al 2003). Vivas et al. (2003, 2006) and Artursson et al. (2006) explain that the positive effect of co-inoculation with PGPR and AM on the plant yield could be the result of the fact that the bacteria help the release of nutrients after decomposing the mycelium of a mycorrhiza. Yazdani et al.(2009), Gholami et al. (2009), and Zaidi et al. (2006) reached similar conclusions.

The correlation analysis showed that fungi and phosphomineralizers are important producers of acid and alkaline phosphatase. Tabatabai (1994) also mentioned microorganisms as important producers of phosphatase. The results of the research conducted by Dick (1996), Hojati and Nourbakhsh (2006) were similar to the results in this research. They investigated enzymatic activity and microbial biomass in soil and confirmed a positive correlation between the microbial biomass of carbon and L-glutaminase activity, alkaline phosphatase, arylsulphatase and β-glucosidase.

Conclusions

The results of the present research point to the existence of a developed and active microbial population in the rhizospheric soil which formed and survived after the introduction of the inoculants. The success of inoculation is influenced by the environmental conditions especially when the experiments are carried out in the field. However, what is of greatest importance is the right choice of microorganisms. In our opinion, the choice should lean towards local isolates of microorganisms.

References

Alami Y, Achouak W, Marol C, Heulin T (2000): Rhizosphere soil aggregation and plant growth promotion of sunflowers by an exopolysaccharide-producing *Rhizobium* sp. strain isolated from sunflower roots. Appl. Environ. Microbiol. 66: 3393-3398

Anderson GR (1965): Ecology of *Azotobacter* in soil of the palouse region I: Occurance. Soil Sci. 86: 57-65

Andronov EE, Petrova SN, Chizhevskaya EP, Korostik EV, Akhtemova GA, Pinaev AG (2009). Influence of introducing the genetically modified strain *Sinorhizobium meliloti* ACH-5 on the structure of the soil microbial community. Microbiology 78: 474-482

Artursson V, Finlay RD, Jansson JK (2006): Interactions between arbuscular mycorrizal fungi and bacteria and their potential for stimulating plant growth. Environ. Microbiol.8: 1-10.

Bacilio-Jimenez M, Agilar-Flores S, del Valle MV, Perez A, Zepeda A (2001): Endophytic bacteria in rice seeds inhabit early colonization of roots by *Azosirillum brasilense*. Soil Biol. Biochem. 33: 167-172

Bolton H J, Frederickson J K, Thomas J M, Li S W, Workmann D J, Bentjen S A, Smith J L (1991). Field calibration of soil-core microcosms: ecosystem structural and functional comparisons. Microb. Ecol. 21:175-189

De Leij F A A M, Sutton E J, Whipps J M, Fenlon J S, Lynch J M (1995). Impact of field release of genetically modified *Pseudomonas fluorescens* on indigenous microbial populations of wheat. Appl. Environ. Microbiol. 61: 3443-3453

Dick RP (1996): Soil enzyme activity as integrative indicators of soil health. In: Biological indicators of soil health. Eds. Pankhurst, P.E. B. M. Doube and V.V.S.R. Gupta. CAB International, Wallingford: 121-156

Dobbelaere S, Vanderleyden J, Okon Y (2003): Plant-growth promoting effects of diazotrophs in the rhizosphere. Cr. Rev. Plant Sci. 22: 107-149

Dunstan WA, Malajczuk N, Dell B (1998): Effects of bacteria on mycorrhizal development and growth of container grown *Eucalyptus diversicolor* F. Muell. Seedlings. Plant Soil 201: 241-249

Egamberdiyeva D (2007): The effect of plant growth promoting bacteria on growth and nutrient uptake of maize in two different soils. Appl. Soil Ecol. 36: 184-189

Flint KP (1974): The occurance and properties of phosphatases in the bacterial flora of aquatic environments. Doctoral thesis. Faculty of Science and Engineering. University of Birmingham

Gamalero E, Lingua G, Berta G, Bernard R (2009). Beneficial role of plant growth promoting bacteria and arbuscular mycorrhizal fungi on plant responses to heavy metal stress. Can. J. Microbiol. 55: 501-514

Gholami A, Shahsavani S, Nezarat S (2009): The effect of plant growth promoting rhizobacteria (PGPR) on germination, seedlings growth and yield of maize. Proc. World Acad. Sci. Engin.Technol. 37: 19-24

Gilmore AE (1968): Phycomycetous mycorrhizal endogone collected by open pot culture. Hilgardia 39: 87-105

Harrier LA, Watson CA (2003). The role of arbuscular mycorrhizal fungi in sustanable cropping systems. Adv. Agron. 79: 185-225

Hernandez ME, Kappler A, Newman DK (2004): Phenazines and other redoxe-active antibiotics promote microbial mineral reduction. Appl. Environ. Microbiol. 70: 921-928

Hojati S, Nourbakhsh F (2006): Enzyme activities and microbial biomass carbon in a soil ammended with organic and inorganic fertilizers. J. Agron. 5: 563-579

Idriss EE, Makarewicz O, Farouk A, Rosner K, Greiner R, Bochow H, Richter T, Borris R (2002): Extracellular phytase activity of *Bacillus amyloliquefaciens* FZB45 contributes to its plant-growth-promoting effect. Microbiol. 148: 2097-2109

Lenhard G (1956): Die dehydrogenase aktivitat das Bodeusald Mass fur die Mikroorganizmentatigk eit im Boden. Z. Pflansenern. Dung Bodenkude. 73: 1-11

Marulanda A, Azco R, Ruiz-Lozano JM (2003): Contribution of six arbuscular mycorrhizal isolates to water uptake by *Lactuca sativa* plants under drougth stress. Physiol. Plant 119: 523-533

Nacamulli C, Bevivino A, Dalmastri C, Tabacchioni S, Chiarini L (1997): Perturbation of maize rhizosphere following seed bacterization with *Burkholderia cepacia* MCI 7. FEMS Microbial Ecol. 23: 183-193

Natsch A, Keel C, Hebecker N, Laasik E, Défago G (1997). Influence of biocontrol strain *Pseudomonas fluorescens* CHA0 and its antibiotic overproducing derivative on the diversity of resident root colonizing pseudomonads. FEMS Microbiol. Ecol. 23: 341-352

Niewolak S (1980): Occurance of microorganisms in fertilized lakes. II Lecithin/mineralizing microorganisms. Pol. Arch. Hydrobiol. 27: 57-71

Parkinson D (1982): Filamentous fungi. In: Methods of Soil Analysis, Part 2, Chemical and Microbiological Properties, Page, A.E. (ed) Madison, Wisconsin USA: 949-966

Requena N, Jimenez J, Toro M, Barea JM (1997). Interactions between plant-growth-promoting rhizobacteria (PGPR), arbuscular mycorrhizal fungi and *Rhizobium* spp. in the rhizosphere of *Anthyllis cytisoides*, a model legume for re-vegetation in Mediterranean semi-arid ecosystems. New Phytol. 136: 667-677

Requena N, Perez-Solis E, Azcon-Aguilar C (2001). Management of indigenous plant-microbe symbioses aids restoration of desertified ecosystems. Appl. Environ. Microbiol. 67: 495-498

Rillig MC, Wright SF, Elviner VT (2002): The role of arbuscular mycorrhizal fungi and glomalin in soil aggregation: Comparing effects of five plant species. Plant Soil 238: 325-333

Ryu CM, Farag MA, Hu SH, Reddy MS, Wei HX, Pare PW, Kloepper JW (2003): Bacterial volatiles promote growth in *Arabidopsis*. Proc. Natl. Acad. Sci. 100: 4927-4932

Schwieger F, Tebbe CC (2000): Effect of field inoculation with *Sinorhizobium meliloti* L33 on the composition of bacterial communities in rhizosphere of a target plant (*Medicago sativa*) and a non-target plant (*Chenopodium album*)-Linking of 16 rRNA gene-besed single-strand conformation polymorphism community profiles to the diversity of cultivated bacteria. Appl. Environ. Microbiol. 66: 3556-3565

Smith SE, Dickson S, Smith FA (2001): Nutrient transfer in arbuscular mycorrhizas: how are fungal and plant processes integrated? Aust. J. Plant Physiol. 28: 683-694

Tabatabai MA (1994): Soil enzymes. In: RW Weaver, JS Angle, PS Bottomly (Eds.), Methods of soil analysis, Part 2: Microbi-

ological and Biochemical properties. SSSA Book Series No. 5. Soil. Sci. Soc. Am. J. Madison, WI. 775-833
Thalmann A (1968): Zur Methodik des Bestmmung des Dehydrogenase aktivitat im Bodenmittels TTC. Landiw. Forch. 21: 249-258
Tiwari P, Roesti D, Adholeya A, Aragno M (2004): Interaction of plant growth promoting rhizobacteria with *Glomus intraradices* grown on Ri T-DNA transformed roots *in vitro.* X International Symposium on Microbial Ecology, Cancun, Mexico, 82
Trolldenier G (1996): Plate Count Technique. In: Methods in Soil Biology. Ed. Franz Schinner, Ellen Kandeler, Richard Ohlinger, Rosa Margesin. Springer-Verlag Berlin Heideberg, 20-26
Turan M, Ataoglu N, Sahin F (2006): Evaluation of the capacity of phosphate solubilizing bacteria and fungi on different forms of phosphorus in liquid culture. Sustainable Agric. 28: 99-108
Vessey JK, Pawlowski K, Bergman B (2004). Root-based N2-fixing symbioses: Legumes, actinorhizal plants, *Parasponia* sp. and cycads. Plant Soil 266: 205-230
Vivas A, Barea JM, Biro B, Azcon R (2006): Effectiveness of autochtonous bacterium and mycorrhizal fungus on *Trifolium* growth, symbiotic development and soil enzymatic activities in Zn contaminated soil. Appl. Microb. 100: 587-598
Vivas A, Voros I, Biro B, Campos E, Barea JM, Azcon R (2003): Symbiotic efficiency of autochtonous arbuscular mycorrhizal fungus (*G. mosseae*) and *Brevibacillus sp.* isolated from cadmium polluted soil under increasing cadmium levels. Environ. Pollut. 126: 179-189
Whitelaw MA (1999). Growth promotion of plants inoculated with phosphate-solubilizing fungi. Adv. Agron. 69: 99-151
Wollum II AG (1982): Cultural Methods for Soil Microorganisms. In: AE Page (ed.), Methods of Soil Analysis, Part 2, Chemical and Microbiological Properties, Madison, Wisconsin USA, 792
Yazdani M, Bahmanyar MA, Pirdashti H, Esmaili MA (2009): Effect of phosphate solubilizing microorganisms (PSM) and plant growth promoting rhizobacteria (PGPR) on yield and yield components of corn (*Zea mays* L.). Proc. World Acad. Sci. Engin. Technol. 37: 90-92
Zaidi A, Mohammad S (2006): Co-inoculation effects of phosphate solubilizing microorganisms and *Glomus fasciculatum* on green gram-bradyrhizobium symbiosis. Agric. Sci. 30: 223-230

Uticaj združene inokulacije sa različitim grupama korisnih mikroorganizama na mikrobiološka svojstva zemljišta i prinos zrna kukuruza (*Zea mays* L.)

Timea Hajnal-Jafari • Mirjana Jarak • Simonida Đurić • Dragana Stamenov

Izvod: Uticaj združene inokulacije na mikrobiološka svojstva rizosfernog zemljišta i na prinos zrna kukuruza je ispitivan u poljskim uslovima. Najveći ukupan broj mikroorganizama je bio u varijanti gde su primenjeni mikroorganizmi-stimulatori biljnog rasta (PGPB), fosfomobilizatori i mikorizna gljiva i iznosio je $418{,}10x10^7$ /g zemljišta. Najveći broj gljiva je dobijen u varijanti sa PGP bakterijama ($29{,}65x10^4$/g zemljišta). Zajedničkom primenom PGPB, fosfomobilizatora i mikorize povećan je broj fosfomineralizatora ($31{,}67x10^4$/g zemljišta). Dehidrogenazna aktivnost je povećana samo u varijanti gde su primenjeni svi ispitivani mikroorganizmi (924μg TPF/10 g zemljišta). U proseku je povećana aktivnost kisele i alkalne fosfataze, ali ono nije statistički značajno. Najveći prinos zrna kukuruza je dobijen u tretmanu sa mikroorganizmima-stimulatorima rasta (15,33 t/ha). Korelacionom analizom je utvrđen visok stepen međuzavisnosti između ispitivanih parametara mikrobiološke aktivnosti i prinosa zrna kukuruza.
Ključne reči: arbuskularna mikoriza, enzimatska aktivnost, fosfomobilizatori, inokulacija, kukuruz, mikroorganizmi, PGPB, prinos, zemljišta