# EFFECT OF SOYBEAN INOCULATION ON SOIL MICROBIAL ACTIVITY

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Soil fertility is associated with the activity of soil microflora, which in its turn depends on the content of organic matter in soil, soil moisture, temperature and pH, mineral nutrition, effectiveness of nodular bacteria and the crop grown. An experiment was established in 2002 at Rimski Šančevi experiment field of Institute of Field and Vegetable Crops in which the soybean variety Afrodita was treated with microbial fertilizers NS-Nitragin and BactoFil B. The soybean variety and NS-Nitragin have been developed at the Institute, while BactoFil B comes from Hungary. The experimental design was random blocks with four replications. Each replication consisted of six 5-m rows spaced 0.5 m apart. Seed inoculation variants were: noninoculated control (Ø); inoculation with NS-Nitragin for soybean (N) immediately before planting; inoculation with NS-Nitragin and BaktoFil B incorporation in soil (N+Bac.B). We monitored the effect of inoculation on soil biological activity and effectiveness of the symbiotic association. The microbial fertilizers NS-Nitragin and BactoFil B positively affected the presence of the analyzed microbial groups in the soil. The microbial fertilizers improved the agrochemical and biological properties of the soil. The incorporation of the microorganisms also affected the effectiveness of the symbiotic association. Soybean yield was highest in the variant of inoculation with NS-Nitragin and BactoFil B incorporation in the soil.

*Key words:* soil, microorganisms, soybean, symbiotic association, yield

## INTRODUCTION

Soil fertility is associated with the activity of soil microflora, the intensity of which depends primarily on the content of organic matter in soil. Population dynamics of soil microorganisms depends on agroecological conditions, soil tillage method, soil type, inoculation, etc. (Milić *et al*., 2003; 2004). It is known that root exudates affect the abundance of microorganisms. In their turn, microorganisms affect soil biological activity by their enzymatic activity, and plants by growth hormones. Pedogenetic and microbial properties of soil are linked and their joint action determined the effective and potential fertility of soil. Each soil type has a specific microflora, which changes in dependence of ecological conditions, soil tillage and crop grown. By determining the composition of microorganisms in a microbial fertilizer, it is possible to activate desirable microbial processes in the treated soil. Other factors that affect population dynamics of soil microorganisms and symbiotic N fixation are temperature, pH value, mineral nutrition, effectiveness of nodular bacteria, etc. (Milić and Mrkovački, 1994; Mrkovački *et al*., 1996; Mrkovački *et al*., 1997; Bounious *et al.*, 1997, Milić, 1999; Milić *et al.*, 2000).

Legumes are capable of providing their N requirement through the assimilation of mineral N and fixation of atmospheric N. Symbiotic N fixation can start only after root nodules are formed, naturally or following inoculation. However, the soil contains also free N-fixing bacteria capable of binding atmospheric N into a form available to plants. Soybean seed is regularly treated with a microbial fertilizer which contains nodular bacteria whose role is to improve the utilization of atmospheric N and reduce crop need for mineral N.

The objective of this study was to assess the effect of microbial fertilizers NS-Nitragin and BaktoFil B on the number of soil microorganisms, agrochemical soil properties and the effectiveness of symbiotic association between bacteria and legume plants.

## MATERIAL AND METHOD

A field trial was established in 2002 at Rimski Šančevi experiment field of Institute of Field and Vegetable Crops in Novi Sad. It involved soybean seed treatment (the cultivar Afrodita) with a microbial fertilizer NS-Nitragin (N) and the treatment with NS-Nitragin in combination with BactoFil B incorporation into the soil (N+Bac.B). NS-Nitragin contains a mixture of highly effective strains of a nodular bacterium for soybean (*Bradyrhizobium japonicum*). BacoFil B contains free N-fixing bacteria and microorganisms that facilitate the release of phosphorus and potassium (*Azotobacter sp., Bacillus sp., Pseudomonas sp., Azospirillum sp.).* BactoFil B was incorporated into the soil immediately before planting.

The experimental design was random blocks with four replications. Each replication consisted of six 5-m rows spaced 0.5 m apart. Seed inoculation variants were: noninoculated control (Ø); inoculation with NS-Nitragin for soybean (N)

immediately before planting; inoculation with NS-Nitragin and BaktoFil B incorporation in soil (N+Bac.B).

The soybean cultivar Afrodita and NS-Nitragin had been developed at the Institute, while BactoFil B was obtained from Hungary.

We studied the effect of inoculation on soil biological activity and symbiotic effectiveness of the strains. Microbiological analyses were conducted by the plating dilution method of Pochon and Tardieux (1962): the number of total microorganisms on soil agar (Z), ammonifiers on meat peptone agar (MPA), azotobacters and free N-fixing bacteria on Feodorov medium (F), fungi on Chapek agar (Č), and actinomycetes on synthetic agar of Krasilnikov.

## RESULTS AND DISCUSSION

The obtained results of microbiological analyses indicated that the applied inoculants and soybean plants changed the microbiological status of the soil and its total biological value. Depending on inoculation type and stage of plant development at the moment of sampling, differences existed in the abundance of specific microbial groups.

The microorganisms that comprise NS-Nitragin and BactoFila B tended to increase the average alkalinity of soil and they facilitated the release of soil phosphorus and potassium at the stage of flowering, making them available to soybean plants. Compared with the control and the variant with NS-Nitragin alone, the variant N+Bac.B increased the average pH value of the soil while decreasing the carbonate content. It also increased the contents of potassium and phosphorus in the soil, two elements as important in plant nutrition as nitrogen. At the stage of flowering, the number of microorganisms that affect the release of inorganic phosphorus was increased as well as the number of actinomycetes that take part in soil humification, as indicated by the increased humus percentage in the analyzed soil (Table 1).

Under the incluence of the microbiological fertilizer, the soil under soybeans increased the total number of microorganisms, free N-fixing bacteria, azotobacters, actinomycetes and the microorganisms that facilitate the release of organic phosphates from the soil. The number of fungi was simultaneously decreased. The numbers of azotobacters and free N-fixing bacteria were highest at the end of the growing season, which indicates that these microorganisms remain available to the subsequent crop (Table 2). Soybean inoculation with the microbial fertilizer increased the symbiotic effectiveness of the strains (dry weight of plant, length of above-ground plant part, number of nodules per plant, number of pods per plant, number of grains per plant and grain weight). Grain yield was highest in the variant with NS-Nitragin and BactoFil B (N+B) (Table 3).

The year 2002 was unfavorable for soybean growing because of a low rainfall (Graph 1). Dry conditions affected also the abundance of soil microorganisms and grain yield of soybean. Still, the rainfall in July and August

contributed in a large measure to soybean yield forming (Vidić *et al*. 2003), so that the 2002 average yield of soybean was satisfactory (2943 kg/ha).

The application of microbial fertilizers NS-Nitragin and BakoFil B and the rainfall in the period July-August stimulated plant growth at certain development stages and activated microbial processes in the soil, thus ensuring satisfactory yields of soybean in th eunfavorable year.

## CONCLUSIONS

It was concluded that the microbial fertilizers NS-Nitragin and BactoFil B affect positively the soil fertility, abundance of the analyzed microbial groups and the symbiotic effectiveness of the strains.

The microbial fertilizers NS-Nitragin and BactoFila B increased the numbers of azotobacters and phosphate bacteria while decreasing the number of ammonifiers in all variants.

The number of azotobacters was largest at the end of the growing season in the variant with the microbial fertilizers.

The number of actinomycetes was increased in relation to the control. The maximum number of actinomycetes was registered at the stage of soybean flowering.

The numbers of total microbes, free N-fixing bacteria, fungi, actinomycetes and microbes that release inorganic phosphates were largest in the variants with NS-Nitragin (N) and NS-Nitragin and incorporated BactoFila B (N+Bac.)

The applied microbial fertilizers influenced the symbiotic effectiveness of the studied strains - dry weight of plant, number of nodules per plant, number of pods per plant, number of grains per plant, grain weight and grain yield at maturity.

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# UTICAJ INOKULACIJE SOJE NA MIKROBIOLOŠKU AKTIVNOST ZEMLJIŠTA

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## S u m ma r y

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Plodnost zemljišta vezana je sa aktivnošću njene mikroflore, koja zavisi od sadržaja organske materije u zemljištu, vlažnosti zemljišta, temperature, pH sredine, mineralne ishrane, efektivnosti kvržičnih bakterija kao i od biljke domaćina. Na Oglednim poljima Naučnog instituta za ratarstvo i povrtarstvo na Rimskim Šančevima u toku 2002 godine je postavljen ogled sa sojom (Afrodita) uz primenu mikrobiološkog đubriva NS-Nitragina i BactoFila B. Genotip soje poreklom je iz Instituta kao i mikrobiološki preparat NS-Nitragin za soju, a BactoFil B poreklom je iz Mađarske Ogled je postavljen po slučajnom blok sistemu u 4 ponavljanja, svako ponavljanje sadržalo je šest redova, dužine 5m, razmak između redova bio je 0,5m. Varijante inokulacije semena su bile: kontrolna (Ø) (neinokulisana); varijanta inokulisano seme neposredno pred setvu NS-Nitraginom za soju (N); inokulisano seme sa NS-Nitraginom i inkorporirani BaktoFil B u zemljište (N+Bac.B) Praćen je efekat inokulacije na biološku aktivnost zemljišta i efektivnost simbiotske zajednice. Mikrobiološka đubriva NS-Nitragin i BactoFil B utiču pozitivno na zastupljenost ispitivanih grupa mikroorganizama u zemljištu. Primenom mikrobioloških đubriva poboljšavaju se agrohemijske i biološke osobine zemljišta, unošenjem mikroorganizama koji obavljaju određene procese u zemljištu utiče se i na efektivnost simbiotske zajednice. Prinos zrna soje najveći je kod inokulacije semena sa NS-Nitraginom i inkorporiranim BactoFilom B u zemljište.

*Ključne reči:* zemljište, mikroorganizmi, soja, simbiotska zajednica, prinos