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EFFECT OF ORGANIC GROWING SYSTEM ON MICROBIAL POPULATION IN RHIZOSPHERE OF MEDICINAL AND AROMATIC PLANT SPECIES

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Abstract

The aim of this study was to compare abundance of microorganisms in the rhizosphere of four different medicinal and aromatic plant species (basil, mint, dill and marigold) grown under both conventional and organic management. The trials were set up on chernozem soil at experimental field of Bački Petrovac, Institute of Field and Vegetable Crops, Novi Sad (northern Serbia). Rhizosphere soil samples were collected in two sampling terms during 2015 (June 2 and July 28, 2015) and analysed by the indirect dilution method followed by plating of soil suspension on selective nutritive media. The obtained results showed significant differences in microbial abundance between plant species, growing systems and sampling terms. The highest number of azotobacters and cellulolytic microorganisms were obtained in rhizosphere of marigold, while total microbial number and fungi were the most abundant in rhizosphere of basil. The most common population of ammonifiers, free N-fixing microorganisms and actinomycetes were recorded in rhizosphere of dill. Significantly higher number of microorganisms was found in organic growing system compared to conventional, while the number of most tested microbial groups was higher at the first sampling period.

Keywords: *basil, dill, marigold, mint, organic production*

Introduction

Microorganisms are one of the indicators of the overall soil biogeny since they are actively involved in the processes of mineralization of organic compounds to inorganic and mobilization of difficult soluble inorganic compounds in the soil. In addition to nutrient cycling, soil microorganisms are involved in other important ecosystem functions, such as the formation and preservation of soil structure (Bastida et al., 2008). Number and composition of microorganisms in the rhizosphere can be affected by several factors including soil management practices, which strongly influence the quality and fertility of agricultural soils and consequently, the size, composition and function of the soil microbial community (Wu et al., 2011). Conventional growing systems lead to the disturbance of these relationships, which is manifested by reduced number and enzymatic activity of microorganisms, especially because modern agricultural production involves the use of large amounts of pesticides and fertilizers (Zhang et al., 2012). Low-input systems such as organic farming, substantially reduce the use of synthetic fertilizers, pesticides, energy and mechanic stress, and mitigate these negative impacts in order to improve sustainable production (Gomiero et al., 2011).
Beside management practices and soil type, the diversity and composition of microbial community in the rhizophere also depend on plant species. A wide range of organic compounds secreted by plant roots increase microbial density and activity in the rhizosphere compared to bulk soil. Medicinal plants harbour a distinctive microbiome due to their unique and structurally divergent bioactive secondary metabolites that are most likely responsible for

the high specificity of the associated microorganisms (Ramesh et al. 2012). With the increased population pressure, costs and side effects and the development of resistance to allopathic drugs for infectious diseases, the uses of medicinal plants for a wide variety of human ailments are increasing. Using modern cultivation technologies to meet the demand for medicinal plants may degrade the quality of medicinal plant products, lead to resource degradation and negatively affect several soil ecological functions (Solaiman and Anawar, 2015). Development of innovative technologies and better understanding of short- and long-term responses of microbiological soil properties to different management practice in the cultivation of medicinal plants is required.
Therefore, the objective of this study was to compare the effects of conventional and organic system production on microbial number in the rhizosphere of different medicinal and aromatic plant species.

Material and Methods

The trial was set up on chernozem soil at experimental field of Bački Petrovac, Institute of Field and Vegetable Crops, Novi Sad (northern Serbia). Rhizosphere soil samples were collected from both conventional and organic grown four medicinal and aromatic plant species: mint (*Mentha x piperita* L.), marigold (*Calendula officinalis* L.), basil (*Ocimum basilicum* L.), and dill (*Anethum graveolens* L.). Samples for microbiological analyses were collected in two sampling terms (June 2 and July 28, 2015). Samples were analysed by the serial–dilution method followed by plating on different selective media (Bloem et al., 2006). Total number of microorganisms was determined on an agarized soil extract (dilution 10^7). Nitrogen–free medium was used for the determination of free N-fixing bacteria (dilution 10^6) and *Azotobacter* sp. (dilution 10^2). Ammonifiers (AMN) were determined on a mesopeptone agar (dilution 10^6). Cellulolytic microorganisms was determined on Waksman-Carey medium (dilution 10^5). The number of fungi was determined on Czapek–Dox medium, and actinomycetes on a synthetic medium (dilution 10^4). The microbiological analyses were done in three replications and the average number of microorganisms was calculated at 1.0 g absolutely dry soil (Jarak and Đurić, 2006). The variables were analysed in accordance with three–way model of analysis of variance (ANOVA) using Statistica software (StatSoft Inc. 2012), followed by mean separation according to Fisher's LSD test.

Results and Discussion

Determining the presence of certain systematic and physiological groups of microorganisms, provides insigh into general microbiological activity, potential soil fertility and general causes of the certain condition of soil (Marinković et al., 2007). In this study, the number of microorganisms depended on the plant species, growing system, and sampling term. Number of tested microbial groups significantly differed between four plant species, with exception in number of actinomycetes and cellulolytic microorganisms. Significant differences in microbial abundance were also obtained between growing systems and sampling terms, except in number of fungi for both factors, and total microbial number for sampling terms (Tables 1-7).

Table 1. Number of *Azotobacter* sp. in rhizosphere of medicinal and aromatic plant species in conventional and organic growing systems (CFU/ml g^{-1} absolutely dry soil)

Plant/Growing System	I sampling period		II sampling period		Plant Average
	Organic	Conventional	Organic	Conventional	
Mint	59 cdef	48 defg	82 bcd	24 gh	53 c
Marigold	53 defg	40 efgh	138 a	73 bcde	76 a
Basil	77 bcd	12 h	104 b	33 fgh	56 bc
Dill	54 defg	30 fgh	102 b	91 bc	69 ab

The different letter above the number indicates a significant difference at P < 0.05

Observed by plant species, the highest number of *Azotobacter* sp. was recorded in rhizosphere of marigold, significantly higher than number of this microbial group in the rhizosphere of mint and basil. Also, a higher number of azotobacters was obtained in an organic growing system compared to conventional at both sampling periods, while significant differences were recorded in rhizosphere of basil at first sampling period, as well as in mint, marigold and basil rhizosphere at second sampling (Table 1).

Table 2. Total number of microorganisms in rhizosphere of medicinal and aromatic plant species in conventional and organic growing systems (CFU/ml g^{-1} absolutely dry soil)

Plant/Growing System	I sampling period		II sampling period		Plant Average
	Organic	Conventional	Organic	Conventional	
Mint	80 bcde	31 e	110 abc	51 de	68 b
Marigold	66 cde	64 cde	91 abcd	42 de	66 b
Basil	138 a	127 ab	55 cde	65 cde	96 a
Dill	50 de	49 de	54 cde	73 bcde	57 b

The different letter above the number indicates a significant difference at P < 0.05

On average, significantly higher total number of microorganisms was recorded in the rhizosphere of basil compared to other plant species. Total microbial number was higher in organic growing system, except in rhizosphere of basil and dill at second sampling period. Significant differences between growing systems were established only in mint rhizosphere at second sampling (Table 2).

Table 3. Number of ammonifiers in rhizosphere of medicinal and aromatic plant species in conventional and organic growing systems (CFU/ml g^{-1} absolutely dry soil)

Plant/Growing System	I sampling period		II sampling period		Plant Average
	Organic	Conventional	Organic	Conventional	
Mint	77 def	73 def	97 bcde	60 def	76 b
Marigold	99 bcd	45 f	96 bcde	128 ab	92 ab
Basil	134 ab	84 cdef	69 def	81 cdef	92 ab
Dill	95 bcde	53 ef	152 a	124 abc	106 a

The different letter above the number indicates a significant difference at P < 0.05

The highest number of ammonifiers was recorded in rhizosphere of dill, while the smallest number was obtained in the rhizosphere of mint. Significant differences in the number of this group of microorganisms were obtained only between these two plant species. Organic growing system had a positive effect on the number of ammonifiers, while a higher number in conventional growing system was recorded only in the rhizosphere of marigold and basil at the second sampling period (Table 3).

Table 4. Number of N-fixing microorganisms in rhizosphere of medicinal and aromatic plant species in conventional and organic growing systems (CFU/ml g^{-1} absolutely dry soil)

Plant/Growing System	I sampling period		II sampling period		Plant Average
	Organic	Conventional	Organic	Conventional	
Mint	224 a	108 bc	96 c	63 c	123 a
Marigold	161 ab	166 ab	90 c	76 c	123 a
Basil	98 c	62 c	71 c	65 c	74 b
Dill	177 a	203 a	88 c	86 c	138 a

The different letter above the number indicates a significant difference at P < 0.05

On average, the highest number of N-fixing microorganisms was recorded in rhizosphere of dill, while significantly smaller number compared to other plant species was obtained in the rhizosphere of basil. A larger number of nitrogen-fixing microorganisms was recorded in an organic growing system, except in the rhizosphere of marigold and dill at the first period of sampling (Table 4).

Table 5. Number of fungi in rhizosphere of medicinal and aromatic plant species in conventional and organic growing systems (CFU/ml g^{-1} absolutely dry soil)

Plant/Growing System	I sampling period		II sampling period		Plant Average
	Organic	Conventional	Organic	Conventional	
Mint	9.6 abcd	8 abcd	8 abcd	3 d	7 b
Marigold	7 abcd	5 bcd	6 abcd	4 cd	6 b
Basil	11 ab	9 abcd	10 abc	12 a	11 a
Dill	7 abcd	4 cd	6 abcd	6 abcd	6 b

The different letter above the number indicates a significant difference at P < 0.05

The number of fungi was significantly higher in the rhizosphere of basil in comparison to other plant species. Larger number of fungi was observed in the organic growing system, except in the rhizosphere of basil at the second sampling period (Table 5).

Table 6. Number of *Actinomycetes* in rhizosphere of medicinal and aromatic plant species in conventional and organic growing systems (CFU/ml g^{-1} absolutely dry soil)

Plant/Growing System	I sampling period		II sampling period		Plant average
	Organic	Conventional	Organic	Conventional	
Mint	28 a	6 bcd	0 d	6 bcd	10 a
Marigold	20 ab	6 bcd	0 d	2 cd	7 a
Basil	16 abc	3 cd	3 cd	11 bcd	8 a
Dill	30 a	7 bcd	0 d	12 bcd	12 a

The different letter above the number indicates a significant difference at P < 0.05

The highest number of actinomycetes was recorded in the rhizosphere of dill, but significant differences between plant species were not established. At the first sampling period, a higher number of actinomycetes was recorded in organic growing system. On contrary, at the second sampling period, a larger number of actinomycetes was recorded in conventional system (Table 6).

Table 7. Number of cellulolytic microorganisms in rhizosphere of medicinal and aromatic plant species in conventional and organic growing systems (CFU/ml g^{-1} absolutely dry soil)

Plant/Growing System	I sampling period		II sampling period		Plant Average
	Organic	Conventional	Organic	Conventional	
Mint	24 bc	10 cd	14 cd	5 d	14 a
Marigold	42 a	13 cd	14 cd	10 cd	20 a
Basil	30 ab	9 cd	12 cd	12 cd	16 a
Dill	19 bcd	17 bcd	10 cd	10 cd	14 a

The different letter above the number indicates a significant difference at $P < 0.05$

On average, the most common number of cellulolytic microorganisms was recorded in the rhizosphere of marigold, but significant differences in relation to other plant species were not observed. A larger number of cellulolytic microorganisms was obtained in an organic system in both sampling periods, except in the rhizosphere of basil and dill at second period of sampling (Table 7).

These results are in agreement with those of Bjelić et al. (2015) who revealed significant differences in microbial abundance between plant species, growing systems and sampling periods. Similar results were obtained by Ahmed et al. (2014) who determined that microbial community composition differed between eleven medicinal plant species. Research conducted by Mrkovački et al. (2012) also indicated a significantly higher number of microorganisms under organic production system compared to conventional. Research of Adamović et al. (2015) showed that organic growing system affected the abundance of microorganisms in rhizosphere of species investigated, especially in the second term of sampling. According to Hartmann et al. (2015), fertilization scheme, the application and quality of organic fertilizers in particular, is the major determinant of microbial diversity. However, the presence of organic and inorganic materials in soil is connected to the increase in nutrient content and further impact on soil properties, including the soil microbiological activity, as Zhong et al. (2010) concluded.

Conclusion

Microbial abundance significantly differed between four plant species. On average, the highest number of azotobacters and cellulolytic microorganisms were obtained in rhizosphere of marigold. Total microbial number and fungi were the most abundant in rhizosphere of basil. The most common population of ammonifiers, free N-fixing microorganisms and actinomycetes were recorded in rhizosphere of dill. Significantly higher number of microorganisms was found in organic growing system compared to conventional, which confirm the positive effect of this agricultural practice on microbial activity in soil compared to conventional management. The number of most tested microbial groups was higher at the first sampling period.

References

Adamović D., Đalović I., Mrkovački N. (2015): Microbial abundance in rhizosphere of medicinal and aromatic plant species in conventional and organic growing systems. Field and Vegetable Crops Research 52: 1–6.

Ahmed EA., Hassan EA., El Tobgy KMK., Ramadan EM. (2014): Evaluation of rhizobacteria of some medicinal plants for plant growth promotion and biological control. Annals of Agricultural Sciences 59: 273–280.

Bastida F., Zsolnay A., Hernandez T., Garcia C. (2008): Past, present and future of soil quality indices: a biological perspective. Geoderma 147: 159–171.

Bjelić D., Mrkovački N., Marinković J., Tintor B., Đalović I. (2015): Seasonal changes of microbial population in maize and soybean rhizosphere under conventional and organic growing systems. Proceedings of VI International Agricultural Symposium „Agrosym 2015”, 15-18 October, Jahorina, Bosnia and Herzegovina, p. 1156–1161.

Bloem J., Hopkins WD., Benedetti A. (2006): Microbiological methods for assessing soil quality. CABI Publishing, Wallingford.

Gomiero T., Pimentel D., Paoletti MG. (2011): Environmental impact of different agricultural management practices: conventional vs. organic agriculture. Critical Reviews in Plant Sciences 30: 95–124.

Hartmann M., Frey B., Mayer J. Mäder P., Widmer F. (2015): Distinct soil microbial diversity under long-term organic and conventional farming. The ISME Journal 9**:** 1177–1194.

Jarak M., Đurić S. (2006): Laboratory Manual of Microbiology. Faculty of Agriculture, University of Novi Sad.

Marinković J., Milošević N., Tintor B., Vasin J. (2007): The occurrence of several microbial groups in different soil types. Field and Vegetable Crops Research 43: 319–327.

Mrkovački N., Đalović I., Marinković J., Červenski J., Najvirt B. (2012): Microbial abundance in the rhizosphere of maize and soybean: conventional and organic system production. Proceedings of III International Scientific Symposium „Agrosym 2012“, Jahorina, Bosnia and Herzegovina, p. 241–244.

Ramesh G., Hari B.N.V., Dhevendaran K. (2012). Microbial association with selected medicinal plants in rhizosphere and their biodiversity. Advances in Natural and Applied Sciences 6: 947–958.

Solaiman ZM., Anawar HMd. (2015): Rhizosphere microbes interactions in medicinal plants. In: Plant growth promoting rhizobacteria (PGPR) and medicinal plants, Egamberdieva D., Shrivastava S., Varma S. (Eds.), Springer International Publishing, pp. 19–41.

Wu M., Qin H., Chen Z., Wu J., Wei W. 2011. Effect of long-term fertilization on bacterial composition in rice paddy soil. Biology and Fertility of Soils 47: 397–405.

Zhang QC., Shamsi IH., Xu DT, Wang GH, Lin XY, Jilani G., Hussain N., Chaudhry AN. 2012. Chemical fertilizer and organic manure inputs in soil exhibit a vice versa pattern of microbial community structure. Applied Soil Ecology 57: 1–8.

Zhong W., Gu T., Wang W., Zhang B., Lin X., Huang Q., Shen W. 2010. The effects of mineral fertilizer and organic manure on soil microbial community and diversity. Plant and Soil 326: 511–522.