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The benefits of organic production of medicinal and aromatic plants in intercropping system

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Abstract: Organic production of medicinal and aromatic plants is consistent with numerous regulations; hence it is under strict legal control. It implies a production system that does not disturb the naturally consistent balance of ecosystems in which plants are grown, taking into account the preservation of healing properties of derivatives obtained by further processing thereof. This production can be established on virgin lands, or those used for agricultural production but without the application of synthetic chemicals, for a period of at least two years. The main cultivated medicinal and aromatic plants in Serbia are: rosemary, coriander, chamomile, peppermint, lemon balm, valerian, thyme, etc. Weeds are the most serious problem in the organic production system of these plants, while damages caused by diseases are not economically significant. Intercropping in the organic cultivation of medicinal and aromatic plants is the simplest and, at the same time, a very efficient method to reduce the occurrence of pests and diseases, since the use of pesticides is not allowed in the organic production system. Plant cultivation in this system, in relation to continuous cropping, contributes to increased biodiversity, better utilisation of natural resources, higher yields of many plants and reduced abundance of weeds and pests. Moreover, it is very important to emphasise that the effects of intercropping on the quality of an agro-ecosystem and plants themselves are great, which further leads to a more efficient ability of plants to develop resistance to insects and numerous pathogens.

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Introduction

Methods of conventional agriculture, applied for decades, have resulted in soil and water being polluted with pesticides and various synthetic chemicals that lead to damages not only to the environment and biodiversity, but also to human health (Popović *et al*., 2016; Golijan and Živanović, 2017). This fact indicates the necessity to alter the production methods used so far in order to achieve the sustainability of agricultural systems and provide the production of sufficient amounts of food in the future (Subić *et al*., 2010; Golijan and Veličković, 2015). Due to information on risks to human health and the need to conserve the environment (Veličković *et al*., 2016), organic production, as well as the market and demand for organic products have been permanently increasing, and therefore areas under this production are enlarging on a daily basis (Golijan and Popović, 2016; Golijan, 2016a). Considering the consequences of poorly managed agrarian policy during the transition period, Serbia, despite environmental degradation, still has a very significant potential for healthy food production and the entire sector of organic production in all agricultural macro-regions (Cvetković *et al*., 2000), which is contributed by the fact that over 80% of the soil remains unpolluted (Popović *et al*., 2017). The fundamental aims of organic production are as follows: 1) the increase of soil fertility, 2) minimising energy inputs, 3) the reduction of environmental risks and 4) maintenance of achieved production levels (Subić *et al*., 2010; Golijan *et al*., 2017). The organic production of medicinal plants may be initiated at once on a plot that has not been used (or has been used but without the application of synthetic chemicals) for a two-year period, while in case of medicinal plants planted for several years this period spans three years. In both cases, during the conversion period, the use of any chemicals is forbidden. Furthermore, during this period, the producer (applicant) has to keep adequate records, prescribed by the competent authority, on the method of utilisation of the plot intended for the organic production of medicinal plants. In developed countries all over the world, demands for medicinal raw materials originating from organically produced plants have been increasing, with the maximum harmonisation with the laws of nature (Golijan, 2016b). This implies such a type of production that will not disturb the environmental equilibrium, and that will, at the same time, preserve healing properties of obtained derivates, which will not be contaminated with harmful substances. In our country, the initial stages of cultivation of medicinal and aromatic plants date back to the beginning of the 20th century, while plantation production was established in the 1950s. Moreover, species such as *Valeriana officinalis* L., *Helichrysum arenarium* (L.) Moench, *Borago officinalis* L., *Satureja montana* L., etc. were cultivated during the 1970s (Radanović and Nastovski, 2002).

The objective of this study was to point out to the basic properties of the production of medicinal and aromatic plants according to the organic principles, as well as, the importance of intercropping within this system of production.

Basic characteristics of organic production of medicinal and aromatic herbs

Based on the reports of the most recent study on medicinal and aromatic plants in the flora of the Republic of Serbia, a total of 420 plants are officially registered, while 280 plant species are moving in the trade (total of approximately 700 species) (Filipović and Ugrenović, 2013). This type of plant production is fully legally regulated, and thus by ratifying international conventions, the resources of medicinal and aromatic plants in Serbia are under strict legal control (Agenda 21 - Rio Declaration, United Nations 1992, Bern Conventions, 1982, Council Regulation No 338/97, 1996) (Turdija-Živanović, 2015). Since this type of plant production is fully legally regulated, the concept of medicinal plants, based on legal principles, includes the following: 1) medicinal plants properly collected according to organic production methods, 2) dried or unprocessed medicinal plant species obtained from the production carried out on agricultural production areas according to basic principles of organic agriculture and 3) the product of medicinal plants obtained by processing of raw materials according to organic production methods.

Aromatic plants are plant species widely spread in nature. The number of these plant species grown in plantations with the aim to produce essential oils is particularly great. Species belonging to the genera *Lamiaceae, Apiaceae, Asteraceae, Rutaceae, Lauraceae, Myrtaceae,* etc. are the most commonly grown. Essential oils are easily volatile products of aromatic plants they are derived from, and they are obtained from various plant parts depending on where they are deposited by plants (above ground parts or even all plant parts) (Kostić *et al*., 2012). These oils are applicable in pharmaceutics, medicine, cosmetics, food industry, paint and varnish industry, soft and alcoholic beverages (Bošković *et al*., 2013). Microbiological safety, improved organoleptic and physical and chemical properties of essential oil-based products make them acceptable. At the same time, they are absorbed by the organism without side effects (Sovilj and Spasojević, 2001). All these high-quality properties provide use of aromatic plants and essential oils derived from them in the production of biologically valuable and healthy products.

The following medicinal and aromatic plants are grown in plantations in our country: rosemary, coriander, chamomile, peppermint, valerian, lemon balm, thyme, lovage, etc., while the most commonly used wild grown volunteer plants are: perforated Saint John's worth, yarrow, sage, thyme, juniper, laurel, everlasting, fir, pine and other species (Golijan, 2016b).

The organic production of medicinal and aromatic plants is exceptionally complex due to different biologies of species (there are annual, biennial and perennial species), methods of plantation establishment (vegetatively, by seedlings or by seed) and various cropping practices. Based on the propagation of species, there are the following seven types: 1) direct sowing (direct sowing of seeds in the field), 2) seedlings/plantlets (establishment of production by seedling production such as production in hot beds - HB), 3) direct planting of seedlings (direct sowing or seedling planting), 4) root cuttings (establishment by root vein cutting), 5) cuttings/tiller (establishment by rooting of cuttings or division of tillers), 6) rhizomes (establishment by planting of small rhizomes) and 7) establishment by planting of stolons (Radanović and Nastovski, 2002).

The establishment of spatial delineation may improve biodiversity within ecosystems by living walls of plants in organic plant production. Based on the results obtained by Ugrenović *et al*. (2010), the establishment of spatial delineation in organic production with perennial fennel pointed out to multiple benefits –production costs were not increased, fennel production had a higher gross financial result than the production of maize and sunflower that are most commonly used for the formation of such a living wall. Article 7 of the Regulations on Methods of Organic Plant Production and the Collection of Forest Fruits and Medicinal Plants as Products of Organic Agriculture (Official Gazette FRY, issue 51/2002) requires, in the transition period, the determination of the following on the basis of a field plot register: possible pollution of the plot with heavy metals, polycyclic aromatic carbohydrates, triazine herbicides, organic insecticides and other pesticides from previous production.

Furthermore, the Regulations also present the maximum tolerable amounts (MTA) of harmful substances in plots and fertilisers of organic origin that are used in organic production of medicinal plants (extracted in aqua regia - volumetric ratio of HNO_3 to HCl is 1:3): Cd < 0.8 ppm, Hg < 0.8 ppm, Pb < 50 ppm, Zn < 150 ppm, Cr < 50 ppm, Ni < 30 ppm, Cu < 50 ppm, PAH < 1.0 ppm, Mo < 10 ppm, As < 10 ppm, Co < 30 ppm. With regard to irrigation water, it is necessary that water belongs to the first and the second category (according to the provisions of the Regulations on Water Categorisation), and that, in accordance with it, MTAs of heavy metals in water are: Cd < 0.01, Pb < 0.1, Hg < 0.001, As < 0.03, Cr < 0.5, Ni < 0.1, F < 1.5, Cu < 0.1, Zn < 1.0, B < 1.0 mg/lit (Regulations, Official Gazette RS, issue 23/94).

Seed and planting material used in organic production have to originate from certified organic production (Berenji, 2009). It should be emphasised that, if a producer is not able to afford organically produced seed and planting material, the law permits the use of conventionally produced seed and planting material if it is not chemically treated.

Medicinal plant species are very numerous and exceedingly different in terms of adaptability to diverse ecological conditions, which is an exceptional advantage or the possibility of their growth in different regions with various ecological properties (Radanović and Marković, 2008). Therefore, prior to starting the organic production of medicinal and aromatic plats it is very important to make a proper selection of plant species and varieties that will best thrive under given ecological conditions. Thus, for example, elecampane, chamomile, bachelor's button, lavender, lovage, common mallow, marigold, white mustard, black samson echinacea and small-flowered hairy willow-herb successfully grow under low temperature conditions, while basil, alpine savory, dill, marjoram and lemon balm do not. On the other hand, species such as chamomile, caraway, common mallow, poppy, flax and yarrow belong to species that grow in different ecological environments. Fennel, coriander, lavender, marjoram, marigold, sage, thyme and hyssop prefer soils rich in lime. Fenugreek, alpine savory, marshmallow, fennel, garlic, coriander, lavender, marjoram, milk thistle, flax, white mustard, thyme and absinthe thrive in dry habitats, while wet habitats favour the cultivation of valerian, lovage, narrow-leafed plantain and belladonna.

Stepanović *et al*. (2001) state that the majority of medicinal and aromatic plant species are developed by seedling planting; hence, depending on species, plantations are established either in autumn (perennial species, such as lemon balm, oregano, valerian…) or in spring (annual species such as marjoram). Therefore, there are two periods when plantations are established: 1) summer period, in so-called open seedling beds and 2) winter-spring period, in cold frames. Growers of medicinal and aromatic plants in Serbia mainly produce (perennial) species in "open seedling beds" during the summer period, which results in a low cost price comparing to indoor production during the winter period.

In order to preserve the biological activity of the soil within the organic farming system, reduced tillage and minimum soil tillage are performed. The objectives of organic production are maintenance and increase of soil fertility, preservation of natural resources from pollution, erosion prevention, and to a large extent, omissions of inputs that originate outside the farm (Filipović and Ugrenović, 2013). As far as soil fertilisation is concerned in organic production of medicinal and aromatic plants, organic fertilisers and natural mineral fertilisers are allowed (Aćimović, 2013) (all types of organic fertilisers have to be produced on the farm where these plants are cultivated).

Weeds are the greatest problem in the production and protection of medicinal and aromatic plants (Matković *et al*., 2014). As legal regulations do not allow the application of herbicides, weeds are suppressed either mechanically or thermally (by burning weeds in the inter-row space using a gas burner or infrared radiation). In our country, there are no records on disease types that cause major economic damages (Starović *et al*., 2015). Some more serious diseases, wilting (the causal agent *Verticilium* spp.) and rust (the causal agent *Puccinia menthae*) may be detected on peppermint plants. In Serbia, chemical preparations (D-STOP, Z-STOP) based on the bacterium *Bacillus thuringiensis* var. *tenebrionis* have been developed. They are used to suppress caterpillars and larvae of beetles (Prpa and Jovanović, 2016). Azadirachtin is an active ingredient of neem oil of the neem tree (*Azadirachta indica*). Chemical preparations based on this active substance have a good nematocidal effect (it is used as an insecticide/acaricide). They act as an antifeedant and a repellent and also have fungicidal and fungistatic activity on causal agents of fungal diseases of medicinal plants (*Sclerotinia sclerotiorum, Sclerotium rolfsii, Fusarium oxysporum, Rhizoctonia solani*). Essential oils obtained from aromatic plants by the distillation process exhibit repellent, antifeedant and toxic effects on certain species of insects. Pyrethrin extracted from pyrethrum (*Chrysanthemum cinerariaefolium*) is successfully used in warehouses. However, due to thermo- and photolability, it does not provide adequate plant protection in the field during the vegetation cycle. A plant extract (biopreparation) technologically derived from fennel biomass is used in preventive protection against powdery mildew (Biofa, 2010). This biopreparation, used in organic production, stimulates induced resistance of plants to pathogens. An extremely important feature and the advantage of this preparation are that there is no safety application interval and that it is not harmful to beneficial insects. With regard to organic production of medicinal and aromatic plants, it is important to emphasise that the protection program against harmful insects is not performed, because the occurrence of these insects on these plant species is very poor and for now there are no insects that cause significant economic damage.

Harvesting of organically produced medicinal and aromatic plants is performed in accordance with the purpose of their further use, during the time period when plants have the highest quality. In the further processing of medicinal and aromatic plants, in order to obtain raw materials of utmost optimal quality, it is necessary to proceed each segment of processing according to the principles of organic production. Then, in order to provide an adequate quality of medicinal and aromatic plants and their further raw materials, it is necessary that their collection and production in plantations are carried out in accordance with the Good Agricultural and Collection Practice (GACP) (Mihailović, 2011).

Significance of intercropping in organic production of medicinal and aromatic plants

The intensity of interactions among plants within the agroecosystem may be increased in the function of time and space in various modes that will lead to yield stability and reduction in the occurrence of diseases and pests (Malezieux at al., 2009). The term intercropping (growing one crop between the rows of another) is related to a multiple cropping practice involving growing two or more plant species in the same plot at the same time. The increase in plant diversity within the agro-ecosystem by intercropping is a simple and efficient method to reduce the incidence of diseases and pests. This practice has been used in many regions in the world (Ma *et al*., 2006).

An important aspect of growing a large number of plants within the agro-ecosystem is the increase in resistance to diseases and pests. However, this aspect is very complex and can be both positive and negative. In any case, plant resistance is considerably greater if plants are not grown in continuous cropping, but the effectiveness of resistance varies. The presence of many species within the agro-ecosystem stimulates the presence of pests and predators, which regulate the number of harmful insects and also delay the incidence of the disease by reducing the spread of spores and by modifying environmental conditions that are less favourable for the development of some pathogens. Volatile leaf emitting compounds have an important role in interfering with herbivores in finding a host plant. The intercropping system affects the increase in yields of one or more crops that are simultaneously grown, due to the ability of the system to reduce the abundance of weeds and pests (Poggio, 2005; Hatcher and Melander, 2003), as well as the ability to make better use of available resources in the environment (in comparison to continuous cropping) (Park *et al*., 2002).

Although the interest in the role of medicinal and aromatic plants in intercropping has arisen in the organic production system, there is still lack of research on this topic. Previously obtained scientific data indicate that this system is a useful way to increase biodiversity (Huang *et al*., 2002). Singh and Kothari (1997) have shown that intercropping of *Artemisia annua* L., *Coriandrum sativum* L., *Chamomilla recutita* Rausch., *Foeniculum vulgare* Mill. and *Anethum sowa* Kurtz. reduced infestation by brown mustard aphid (the lowest and highest numbers of plant aphids were recorded in intercropping of mustard with fennel and coriander, respectively). In addition, similar results were obtained in other studies involving intercropping of *Cymbopogon martinii* Stapf. and *Cajanus cajan* L., as well as *Pelargonium* spp. and *Mentha arvensis* L. (Rao, 2002). Intercropping of *Glycyrrhiza glabra* L. and cereals, such as *Triticum* spp. and *Hordeum vulgare* L. is unfavourable for *Glycyrrhiza glabra* L. root yields (yield obtained without intercropping was 22.8 t ha^{-1}, while the yield gained in intercropping was reduced to 14 t ha^{-1}) (Marzi, 1996). *Datura stramonium* L. alkaloids affect the yield of crops grown in its surrounding, in a way that the yield of *Lupinus albus* L. is increased, while the yield of *Mentha piperita* L. is decreased.

Some studies have already demonstrated positive effects of intercropping on the performance of radish (Reddy *et al*., 2001), coriander (Chellaiah *et al*., 2002), vegetables, fodder, pulses and cereals (Verma *et al*., 2009; Singh *et al*., 2004; Islam *et al*., 2015).

Rose-scented geranium (*Pelargonium* species, family Geraniaceae) is a high value aromatic crop. Cornmint (*Mentha arvensis* L. f. piperascens Malinvaud ex Holmes, family Lamiaceae) is also a high-demand aromatic–cum–medicinal crop. Essential oils isolated through steam distillation of shoot biomass from Rose-scented geranium and Cornmint are extensively used in fragrance, flavour, and pharmaceutical industries and in aromatherapy. Rao (2002) studied the influence of different row spacings (60×30, 75×30, 90×30 and 120×30 cm) and intercropping of cornmint cv. Shivalik on biomass yield, essential oil yield and composition of rose-scented geranium cv. Bourbon (Table 1 and 2). He found that the 60×30 cm row spacing was superior over the other spacings and produced 57.4 t/ha total biomass yield and 52.7 kg/ha total essential oil yield. Intercropping of cornmint did not affect biomass yield and essential oil yield of rose-scented geranium. Biomass yield and essential oil yield of intercropped cornmint suffered reductions of 53.4 and 59.1%, respectively, compared with cornmint in monoculture. Importantly, intercropping controlled weed growth and decreased total biomass yield of weeds by 40.0% in rose-scented geranium intercropped with cornmint.

Table 1. Effect of row spacings and cropping systems on plant height, biomass yield and essential oil yield of cornmint

Treatments	**Plant height (cm)**	**Biomass yield (t/ha)**	**Essential oil yield (kg/ha)**
Spacings (cm)			
60×30	46.8	5.6	21.3
75×30	47.7	3.7	14.1
90×30	44.9	3.7	15.0
120×30	42.9	3.0	12.1
LSD[a](P=0.05)[b]	1.7	1.1	1.7
Cropping systems			
Monoculture	51.3	8.8	38.1
Intercropping	45.6	4.1	15.6
LSD (P=0.05)	2.9	2.0	3.1

[a]LSD, least significant difference. [b]P=0.05, probability level at 5% Source: Rao (2002)

Sujatha *et al*. (2011) showed that medicinal and aromatic plants can be successfully grown as intercrops in arecanut plantation, with increased productivity and net income per unit area. Kernel equivalent yield of medicinal and aromatic plants varied between 272 kg ha^{-1} in *Piper longum* and 1218 kg ha^{-1} in *Cymbopogon flexuosus*. *Asparagus racemosus* produced fresh root yield of 10.666 kg ha^{-1} of arecanut plantation and contributed to maximum kernel equivalent yield of 1524 kg ha^{-1} among all medicinal and aromatic plants. Intercropping has also important economic value. According to Sujatha *et al.* (2010), the net return per rupee investment was highest in *Cymbopogon flexuous* (4.25) followed by *Bacopa monnieri* (3.64), *Ocimum basilicum* (3.46) and *Artemisia pallens* (3.12).

Table 2. Chemical composition (% of essential oil) of the essential oil of cornmint in sole and intercropping systems

Compound	**Retention index**	**Sole crop**	**Intercrop**	**Method of identification**[a]
α -*Pinene*	935	0.7	0.6	a, b, c, d
β-Pinene	976	0.6	0.3	a, b, c, d
Myrcene+3-octanol	985	1.6	1.4	a, b, c, d
Limonene+1,8-cineole	1024	1.5	1.2	a, b, d
(*Z*)-β-Ocimene	1028	0.1	0.1	a, b, c, d
(*E*)-β-Ocimene	1042	0.1	0.1	a, b, d
trans-Sabinene hydrate	1060	0.1	0.1	a, b, d
Linaloool	1088	0.2	0.3	a, b, c, d
Methone	1139	9.0	9.5	a, b, d
Isomenthone	1149	2.1	2.8	a, b, d
Neomenthol	1157	1.7	1.2	a, b, d
Menthol	1169	75.2	74.5	a, b, c, d
Isomenthol	1174	0.1	0.2	a, b, d
Pulegone	1219	1.3	1.9	a, b, c, d
Piperitone	1233	0.5	0.8	a, b, d
Methyl acetate	1280	3.8	3.0	a, b, c, d
β-*Caryophyllene*	1422	0.3	0.4	a, b, c, d
Germacrene D	1480	0.1	0.2	a, b, d
(*E*)-Nerolidol	1548	0.1	0.1	a, b, d

[a]a, Retention time; b, Kovat's retention index; c, peak enrichment; d, mass spectra
Source: Rao (2002)

The total system productivity of arecanut + medicinal and aromatic plants intercropping system varied from 2990 to 4144 kg ha^{-1} (Table 3). Intercropping increases the content of soil organic carbon (Kumar Verma *et al.* 2014), especially in *Aloe vera, Artemisia pallens, Piper longum* and *Bacopa monnieri.*

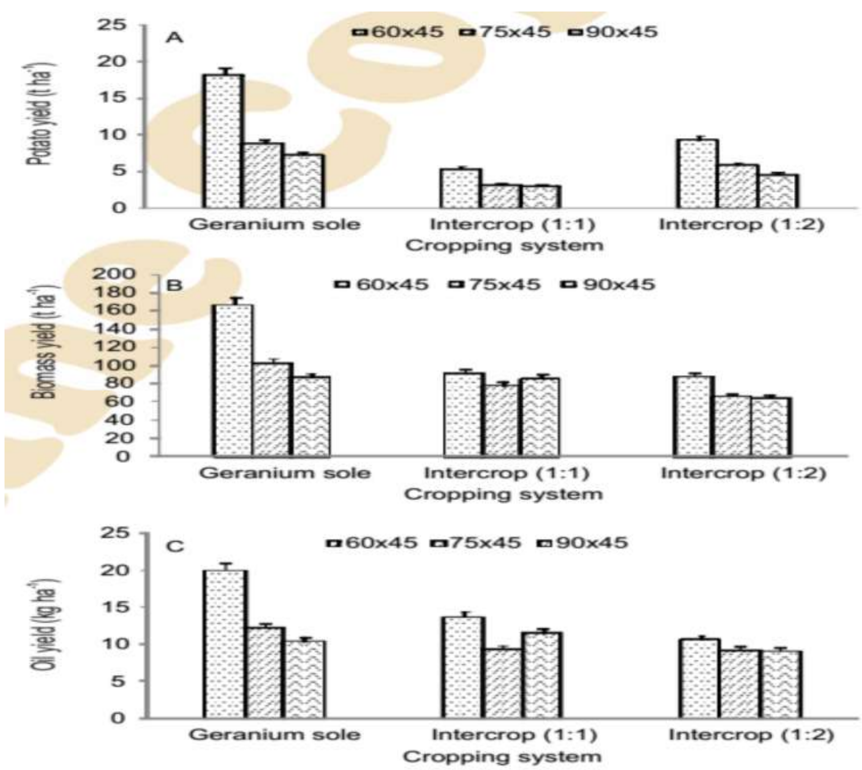
Table 3. Kernel yield of arecanut, system productivity and production efficiency of arecanut + medicinal and aromatic plants intercropping system (MAPs system) (data of 2004–2006)

Crop	**Pooled data of 3 years**		**Cumulative of 3 years for arecanut + MAPs system**		
	Kernel yield of arecanut (kg/ha^{-1})	System productivity (kg ha^{-1})	Total yield from system (kg ha^{-1})	Total duration of system (days)	Production efficiency of arecanut + MAPs system (kg ha^{-1} day^{-1})
Vetiveria zizanoides	2515^{ab}	3231^{abc}	9195^{ab}	2460	3.7^{a}
Asparagus racemosus	2835^{bcef}	4359^{e}	13.077^{e}	2190	6.0^{d}
Piper longum	2718^{bce}	2990^{a}	8971^{a}	2190	4.1^{b}
Bacopa monnieri	3586^{fg}	4325^{e}	12.975^{e}	2190	5.9^{d}
Nilgirianthus ciliatus	1884^{a}	3313^{abc}	9939^{abc}	2460	4.0^{b}
Catharanthus roseus	3440^{efg}	4144de	12.432^{de}	1635	7.6^{e}
Aloe vera	3081^{bcefg}	3552^{bc}	10.656^{bc}	2190	4.9^{c}
Cymbopogon flexuous	3121^{bcefg}	4338^{e}	13.015^{e}	2190	5.9^{d}
Cymbopogon martini	2678^{bc}	3164^{ab}	9491^{ab}	2190	4.3^{b}
Ocimum basilicum	3311^{cefg}	3708^{bcd}	11.125^{cd}	1365	8.2^{f}
Pogostemon cablin	3362^{cefg}	4225de	12.676^{e}	2190	5.8^{d}
Artemisia pallens	3595^{g}	4224de	12.673^{e}	1635	7.8^{e}
LSD (0.05)	756	553	1497	-	0.32

Means in the same column with different letters are significantly ($P < 0.05$) different. Source: Sujatha *et al*. (2011)

Kumar Verma *et al*. (2014) investigated the influence of geranium (*Pelagronium graveolens* L.) intercropping at different row strips (1:1 and 1:2) and plant density (60×45, 75×45 and 90×45 cm) with potato (*Solanum tuberosum* L.) on biomass, oil yield, monetary income and soil quality parameters. They showed that the between row distance 60×45 cm and row strip 1:1 was found to be superior and produced 92 t ha^{-1} biomass and 14 kg ha^{-1} oil yield. However, this production system had some variations in the content of available nutrients, soil microbial biomass, soil organic carbon, total organic N, and nitrogen (Fig. 1). The highest contents of soil organic carbon (41%) and total N (27.5%) were obtained with row strip 1:1 at 75×45 plant density. This study demonstrated that, apart from economic benefits (the row strip 1:2 intercrop earned a maximum 2107 dollars), intercropping provides better productivity and soil health, and also increases soil respiration rate, soil microbial biomass, nitrogen and microbial metabolic quotient (qCO_2-bioindicator of environmental stress on microbial communities).

Figure 1. Yield attributes of geranium and potato intercrop (A: Potato yield; B: Biomass yield of geranium; C: Oil yield of geranium). Bar denote mean ±SE



Maffei and Mucciarelli (2003) have shown that the content of peppermint essential oils was increased when peppermint was grown in the intercropping system with soya bean. Intercropping of geranium and potato increases production efficiency, improves soil quality in the geranium rhizosphere zone, increases yield and results in a greater accumulation of available nutrients, leading to better soil production capacity (Verma *et al*., 2014). Plants grown in the intercropping system absorb more efficiently various nutrients than plants grown in continuous cropping, thus inhibiting the growth of weeds. Compared to continuous cropping, growing a large number of plants within the agro-ecosystem more significantly affects the quality of both the system and plants themselves, which is important for developing resistance to insects (Marković, 2013).

Conclusion

Given that organic production is fully legally regulated, in order to obtain top quality raw materials of medicinal and aromatic plants, it is necessary to follow prescribed methods in each segment of their processing. At the same time, it is necessary to provide conditions for the collection and production of these plants to be performed in accordance with the Good Agricultural and Collection Practice of medicinal plant material. The intercropping system, as a specific type of interactions of plants within an agro-ecosystem, is a multiple cropping practice with the common goal to produce greater yields whileimproving soil quality and biodiversity, and most importantly, to reduce the abundance of weed species, pests and pathogens. Since there is a lack of scientific data related to the use of intercropping in the cultivation of medicinal and aromatic plants, especially in the organic system, further studies are necessary to provide better understanding and elucidation of interactions of plants in the intercropping system, because this production system does not pollute the environment, which is a crucial postulate in the organic production system.

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ZNAČAJ ZDRUŽENIH USEVA U ORGANSKOJ PROIZVODNJI LEKOVITOG I AROMATIČNOG BILJA

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Rezime

Organska proizvodnja lekovitog i aromatičnog bilja usklađena je sa brojnim regulativama, te se nalazi pod strogom zakonskom kontrolom. Podrazumeva takav sistem proizvodnje koji neće narušiti prirodno usklađenu ravnotežu ekosistema u kome se bilje gaji, vodeći pritom računa o očuvanju lekovitosti derivata koji se dobijaju daljom preradom istih. Organska proizvodnja lekovitog i aromatičnog bilja može se zasnivati na devičanskim zemljištima ili zemljištima iz poljoprivredne proizvodnje na kojima nije bilo upotrebe sintetičkih hemikalija u periodu od najmanje dve godine. Među gajenim vrstama lekovitog i aromatičnog bilja u Srbiji, najveću proizvodnju zauzimaju ruzmarin, korijander, kamilica, nana, matičnjak, valerijana, majčina dušica, a od samoniklih vrsta kantarion, hajdučka trava, žalfija, kleka, lovor, smilje, bor i druge vrste. Najveći problem u organskom sistemu proizvodnje ovog bilja predstavljaju korovi, dok bolesti ne čine ekonomski značajne štete. Primena združenih useva u organskom uzgoju lekovitog i aromatičnog bilja najjjednostavniji je, a pritom veoma efikasan način da se redukuje pojava štetočina i bolesti, s obzirom na to da u organskom sistemu proizvodnje nije dozvoljena upotreba pesticida. Uzgojem biljaka u ovom sistemu, u odnosu na monokulturu, povećava se biodiverzitet, bolje se iskorišćavaju resursi iz prirodnog okruženja, povećava se prinos mnogih biljaka, smanjuje brojnost korova i štetočina, a takođe, što je veoma bitno istaći, združeni usevi imaju veći uticaj na kvalitet agroekosistema i samih biljaka, što dalje utiče na efikasniju sposobnost biljaka u stvaranju otpornosti prema insektima i mnogim patogenima.

Ključne reči: organska proizvodnja, lekovito i aromatično bilje, združeni usevi.