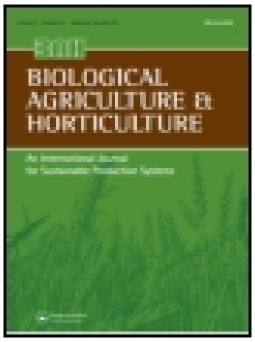


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# Challenges for commercial organic production of oil-bearing rose in Bulgaria

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**ABSTRACT**
Bulgarian rose oil is widely recognised for its high quality and versatile application. Increasing prices and market demand for organic rose flowers and oil are stimulating factors influencing organic cultivation of oil-bearing rose in Bulgaria. However, further improvement of the sector is still necessary. Commercial rose cultivation is mainly based on *Rosa damascena* Mill. f. *trigintipetala* Dieck. (Kazanlak rose), which is not resistant to the main diseases and pests causing economic losses. Therefore, implementation of effective pest and disease control strategies under organic management practices is necessary to achieve high flower yields and oil quality. Disease resistance combined with proper genotype preservation and plant propagation to maintain the demanded traditional aroma and chemical composition of rose oil are the main challenges faced by Bulgarian rose producers. Socio-economic factors influencing organic oil rose production in Bulgaria are also discussed.

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Organic roses; plant disease control; socio-economic challenges; *R. damascena*

## Introduction

The development of organic production in Bulgaria is advantaged by environmental and soil conditions. The country has a diverse climate and terrain which support high biodiversity and versatile biological control. In 2012, the total cultivated area under organic production reached 40,378 ha which was 50% more than in the previous year (Boshnakova 2014). The recent development of the organic sector followed the publication of the National Plan for Development of Organic Farming in Bulgaria, 2007–2013 (2006), which aimed to achieve 8% of agricultural land under organic management and 3% of the food sold on the market by 2013. However, by the end of this period, the estimates for both of these targets were below, or around, 1%, due to various challenges faced by organic producers, such as unpredictable prices for agricultural land, an under-developed irrigation infrastructure, complicated rules for access to subsidies, delay in payments and an under-developed local organic market (Boshnakova 2014). According to the same author, over 90% of the organic products were exported and local organic food sales did not exceed 1% due to low purchasing power of the consumers. To change this trend and to stimulate faster development of local organic sector, the National Strategy for Sustainable Development of Agriculture in Bulgaria for 2014–2020 (2015) prioritised organic farming as a major instrument for maintaining sustainability of agriculture especially in under-developed areas in the country.

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Most organic producers are concentrated in southern Bulgaria. Essential oil crops including roses are produced mainly in the Sub-Balkan Valley as well as in the Thracian Valley, which is considered the most appropriate for horticulture production. The total organic area cultivated with commercial crops, including oil-bearing rose, increased from 5845 ha in 2011 to 7909 ha in 2012, while the area planted with *Rosa damascena* alone increased from 845 to 1144 ha for the same years (Boshnakova 2014).

Bulgarian rose oil is widely recognised for its high quality and versatile application. Most of the production is directed to foreign markets with France, Germany, the USA and Japan being the main destinations for Bulgarian rose oil exportation (Kovacheva et al. 2010). Bulgarian rose oil is mostly used in cosmetics, perfumery and aromatherapy. However, recent studies have also demonstrated the pharmacological effects of rose oil and its constituents (Boskabady et al. 2011).

According to Gunes (2005), 100 kg fresh rose flowers are required to produce approximately 10 g essential oil. The genus *Rosa* consists of more than 200 species, but only a limited number of them have been commercially used as essential oil crops. Commercial cultivation of roses in Bulgaria predominantly includes *R. damascena* Mill. *f. trigintipetala* Dieck. (Kazanlak rose) due to its high rose oil content and chemical composition (Kovacheva et al. 2010). *Rosa alba* L. (white oil rose) is characterised with higher disease resistance but it is still less favoured for cultivation due to the lower oil content of the flower (Nedkov et al. 2009). The production of organic rose flowers and oil requires application of new agricultural practices, which require additional investment and technologies in order for the production to be certified as organic. This paper discusses some of the challenges faced by organic rose growers, which include genotype preservation, oil rose improvement and control of pests and diseases. Socio-economic issues are also discussed.

## Genotype preservation and oil rose improvement

Cultivation of *R. damascena* in Bulgaria has a long history dating back to the sixteenth century (Topalov 1978). However, commercial rose production is still based on a single genotype, the thirty-petal *R. damascena* Mill *f. trigintipetala* Dieck. (Rusanov et al. 2005). The same genotype has been used in Turkey and Iran for production of rose oil (Giray and Ormeci Kart (2012)). The conservative attitude of rose farmers to use this genotype is probably due to the tight prerequisites of the international oil market for maintaining the traditional aroma and chemical composition of rose products. To keep the authentic properties of *R. damascena* Mill *f. trigintipetala* Dieck., organic rose breeders propagate the plants vegetatively. For the same reason, the use of hybrids in oil rose production is not desired in Bulgaria (Kovatcheva 2011). Many new hybrid varieties with Kazanlak oil rose were developed, but despite the superior growth performance the quality of the oil was inferior compared to the Kazanlak rose oil (Nazarenko 1989). At present, most of the rose cultivation is based on the use of an improved population from selected oil rose clones. Kovacheva et al. (2010) implied that cultivation of mixed *R. damascena* clones rather than a single cultivar/clone may be more beneficial for achieving a unique essence from the rose flower processing.

Plant disease resistance is one of the most desired traits required in oil rose cultivation. However, *R. damascena* is not resistant to the major diseases and pests (Kovacheva et al. 2010). In conventional systems disease and pest control is achieved by chemical treatments, but in organic rose production other approaches are used. Plant modification through gene transfer technologies, which otherwise provides a unique opportunity for fast development of plants with improved characteristics, is not permitted in organic rose breeding. Plants with improved disease resistance may be developed through inter-specific hybridisation with closely related species. However, in the case of Bulgarian oil rose production, this is avoided due to concerns about changes in the rose oil composition and rose flower morphology. Still, although not readily accepted by Bulgarian rose growers, commercial use of *R. damascena* hybrids with enhanced disease resistance might be an opportunity for achieving higher financial profit and production of new and unique types of oils that are more attractive to the industry. Currently, no oil rose hybrids have been cultivated for commercial purposes in Bulgaria (Rusanov et al. 2009). According to the same authors, improvement of the oil rose can be facilitated by the application of DNA markers in marker assisted selection and breeding. Molecular markers have already been used in genetic diversity studies and identification of rose cultivars including *R. damascena* (Rusanov et al. 2005; Koopman et al. 2008). However, due to the complex genome structure of this species and because software for building genetic maps and allocation of quantitative trait loci of *R. damascena* is not yet widely available, the implementation of a marker-assisted breeding strategy for this plant has been impeded (Rusanov et al. 2009).

## Major rose diseases and pests

Rose plants are affected by various pathogenic fungi and bacteria, viruses, nematodes and pests (Horst & Cloyd 2007). Fungal diseases including black spot, powdery mildew and botrytis blight are considered the most economically important (Pal & Singh 2013; Yilmaz 2015). Rose pathogens impact negatively on overall plant performance, reduce flower yield and quality and thus lead to financial losses. As indicated in a survey of rose growers from China, South America, United States and Europe, the cost for disease and pest control may reach up to \$32,000 $ha^{-1}$ $year^{-1}$ (Debener & Byrne 2014). Average plant protection cost of *R. damascena* Mill., grown in Lakes region of Turkey, was estimated at € 593.31 $ha^{-1}$ $year^{-1}$, which accounted for 25% of total oil rose production costs (Yilmaz 2015).

Black spot is one of the most common and widely spread rose diseases and can reach epidemic levels during wet and warm spring season (Daughtrey & Benson 2005). The first and most obvious symptoms are the appearance of black spots rapidly followed by development of chlorotic areas. The disease is associated with premature leaf abscission and severally infected plants may lose their leaves by mid-summer. On the whole, black spot disease leads to development of immature and stunted rose plants with reduced flower production. *Diplocarpon rosae* is considered the major causative fungus of black spot disease (Smith et al. 1988). However, Ghosh and Shamsi (2014) identified five additional fungal species associated with black spot symptoms of *Rosa centifolia* L. They included *Cladosporium cladosporioides* (Fresen.) de Vries, *Cladosporium oxysporum* Berk. & Curt., *Marsonina rosea*, *Penicillium* sp. and *Pestalotiopsis guepinii*. The highest association frequency was established for *M. rosea* (30%) followed by *P. guepinii* (25%) and *C. cladosporioides* (22%).

Powdery mildew is caused mainly by *Sphaerotheca pannosa* var. *rosae* but other organisms such as *Tilletiopsis* sp. and *Verticillium lecanii* may also be involved in the symptomatic development of the disease (Horst & Cloyd 2007). *S. pannosa* var. *rosae* grows on the surface of rose leaves, penetrates tissues and forms haustoria. The growth of the fungus is favoured by mild temperatures and high humidity during nights (Xu 1999). Powdery mildew affects bud formation and leads to development of low quality of rose flowers. It is one of the most severe and damaging diseases affecting *R. damascena* in Iran (Kiani et al. 2010) and glasshouse grown roses in Italy (Gullino & Garibaldi 1996). According to Tjosvold and Koike (2001), up to 40% of pesticides applied on roses are used for the control of powdery mildew.

Botrytis blight is caused by *Botrytis cinerea* Pers. Ex Fr. and results in formation of small, light-colored spots surrounded by reddish holes on flower petals, which can quickly expand into large, irregular blotches (Volpin & Elad 1991). As a consequence, buds fail to open and often drop. Flower contamination may also occur during storage which leads to a significant reduction of the financial profit (Hammer & Mariois 1988).

Along with fungi, oil-bearing rose plants are attacked by various pests, with aphids, cane borer (*Agrilus cuprescens* Men.), rose curculio (*Homalorynchites hungaricus* Fussly.), rose scale insect (*Rodoccocus bulgariensis* Wunn.), rose chafer (*Epicometis hirta* Poda.) and red spider mite (*Tetranychus telarius*) being the most economically important (Yilmaz 2015). A survey of farmers growing *R. damascena* Mill.in Lakes Region of Turkey showed that aphids were the most encountered insect with frequencies reaching 77% (Yilmaz 2015). *Rhodococcus perrornatus* Cockerell & Parrott (Hemiptera: Coccidae) and *Macrosiphum rosae* (L.) (Hemiptera: Aphididae) were identified as the two most economically harmful pests in a study performed between 2006 and 2007 on five oil-bearing rose orchards in the Isparta area in Turkey where no chemical control was applied (Demirözer et al. 2011). In general, pest diversity and population density are highly variable and depend on the fluctuation of environmental conditions, soil micronutrients and water provision (Pal & Singh 2013).

## Management of major rose diseases and pests in organic system

Because of the lack of resistance of *R. damascena* to the main diseases and pests and the ban on using chemical treatments in organic farming, cultivation of healthy plants is a challenge. Biological approaches for plant protection need to be effective, environment friendly and compliant with the EU Regulation No 834/2007 on organic production (EC 2007). In Bulgaria, the use of commercial products for disease and pest control of organic oil-bearing rose is not scientifically based; instead it is determined by the availability of the products on the market, sale representative consultation practices and on the experiences of the rose growers. To our knowledge, research reports on the effectiveness and drawbacks of the commercial pest and disease control products on organically grown *R. damascena* are not available, though urgently needed. Some of the products that are commercially available and currently used by organic oil rose growers in Bulgaria, are discussed below.

### *Plant protection products for organic cultivation*

#### *Trifolio S-forte (Trifolio-M GmbH, Germany)*

Trifolio S-forte is a botanical surfactant and insecticide which is approved for use in organic production (Paaske 2013; FiBL 2016). Trifolio S-forte is environmentally friendly and is fully biodegradable. It contains 50% plant oils and 50% emulsifier based on renewable raw material (Walther & Detzel 2009; Paaske 2013; FiBL 2016). The plant oils have the capacity to hold active substances on the leaf surface providing effective penetration, while the emulsifier reduces the surface tension of the sprayed drops leading to the formation of a thin coating layer. Trifolio S-forte can be used for treatment on its own (Sallam et al. 2009; Atanasov et al. 2012) or in combination with quassia, azadiracthin or copper- and sulphur-based products (Walther & Detzel 2009). Quassia is an extract from the trees *Quassia amara* or *Picrasma exelsa* and azadiracthin (neem) is an extract from the tree *Azadirachta indica*. These products are allowed for use in organic production according to the EU Regulation 2092/91 (EC 1991; Paaske 2013). The effect of various concentrations of Trifolio S-forte against aphids was tested on wheat *T. aestivum* (Tommi cultivar), which was grown in controlled greenhouse conditions (Sallam et al. 2009). The mortality rate of *Rhopalosiphum padi* (L.) varied from 17 to 85% 72 h post treatment when applying 100 and 800 μL, respectively. The 800 μL application eradicated 96% of *Metopolophium dirhodum* (Wlk.) 72 h post treatment. Atanasov et al. (2012) reported that the combined treatment of Trifolio S-forte (3000 mL $ha^{-1}$) and NimAzal (3000 mL $ha^{-1}$), Madex (1013 granules $mL^{-1}$, 100 mL $ha^{-1}$) and Treisar (Spinozad 480 sp, 3000 mL $ha^{-1}$) of organically grown, late ripening prune variety Elena reduced worm damage (*Grapholita funebrana*) to 2%, red leaf spots (*Polystigma rubrum*) to 8%, and late brown rot (*Monilia fructigena* L.) to 2%, while the controls reached 9, 25 and 6%, respectively. Trifolio 0.25% in a combination with Milsana 0.40% (a plant extract of *Reynoutria sachalinensis*) treatment was included in the program for fungal disease prevention at Baden bei Wien rose-gardens where no synthetic pesticides, fungicides or herbicides were allowed to be used (Pleininger 2011). Milsana is a plant extract used to boost plants natural defense mechanisms and has been found to have good potential for the control of certain fungal diseases including powdery mildew (Leng et al. 2011). It is a natural botanical pesticide, considered as a potential alternative to copper for disease control in the Australian organic industry (van Zwieten et al. 2007). In Bulgaria, Trifolio-S-forte (3000 mL $ha^{-1}$) is recommended for winter treatment and before flowering in roses (organic rose grower personal communication). The same rate can be applied after flower gathering, if required.

#### *Botrysec*

Botrysec is a commercially available product with silicon dioxide as an active ingredient, which is allowed for use in organic agriculture (EC 1991; EGTOP 2014). Botrysec prevents development and progression of plant diseases such as botrytis, powdery mildew and downy mildew, which are favoured by high humidity. In addition, application of silicon dioxide may have an adverse effect on insect herbivores including folivores, borers, and phloem and xylem feeders (Reynolds et al. 2009). According to the same authors, the effect might partially be due to reduced digestibility and/or increased hardness and abrasiveness of plant tissues because of silica deposition. Diatomaceous earth, made from amorphous silicon dioxide, was found to be effective against the larvae of the Mediterranean flour moth (*Ephestia kuehniella* Zeller). When tested, the $LC_{50}$ of the formulation mixed with broken wheat kernels was estimated to be 2.4, 4.4 and 5.2 g $kg^{-1}$ at relative humidity of 58, 75 and 84%, respectively (Nielsen 1998). By studying biocontrol of blue mould of apple by *Candida membranifaciens* in combination with silicon, Farahani et al. (2012) found that combinations of different concentrations of this compound with *C. membranifaciens* improved the efficacy of the yeast in control of the disease compared with the use of silicon or yeast alone. Ebrahimi et al. (2012) demonstrated that silicon at 0.6% (wt/vol) concentrations, and above, completely inhibited the mycelial growth of *Penicillium expansum,* which causes blue mould disease on plants. In organic rose cultivation, Botrysec can be useful when applied before flowering and/or flower gathering (organic rose grower personal communication).

### Copper- and sulphur-based products

Copper and sulphur are elements permitted for use in organic agriculture according to EU Regulation No 2092/91(EC 1991). Compared to sulphur, copper is a relatively new fungicide introduced in agriculture at the end of eighteenth century in France to control downy mildew (*Plasmopara viticola*) on vineyards (Vitanovic 2012). La Torre et al. (2011) reported efficient utilisation of copper compounds against downy mildew (*Plasmopara viticola*) at levels sufficiently low not to cause significant increases in the levels of copper in the soil, compared to the control. The residual copper concentrations in grapes at harvest were much lower than 50 mg $kg^{-1}$. In a study of fungicide treatments and sanitation practices against *Monilinia laxa* (Aderhold&Ruhland) Honey on sour cherry (*Prunus vulgaris* Mill.), Holb and Schnabel (2005) found copper hydroxide not to be as effective as conventional fungicides. However, among fungicide treatments suitable for organic production, copper hydroxide and lime sulphur applied on their own or in combination with micronized wettable sulphur, were the most effective for blossom blight control when applied twice (at closed blossom and full bloom) or three times (at closed blossom, full bloom, and petal fall) during bloom. Copper was reported to be effective against the scab fungus *Venturia inacqualis,* as well. Under field conditions highly favourable for disease, copper (2.1 kg $ha^{-1}$ $year^{-1}$) combined with low rates of elemental sulphur (31.8 and 38.6 kg $ha^{-1}$) reduced scab severity on the fruits of apple cultivar 'Pinova' by 97% and 98% compared to water control in 2005 and 2006, respectively (Jamar et al. 2008). Due to its fungicidal properties, copper was suggested for use to control black spot on roses. It could also be applied on dormant bushes to prevent botrytis blight. In Bulgaria, a commercial product, based on copper as an active ingredient (АктивоCu – ActivoCu) is available for winter treatment of organic rose plantations at a dose of 1500–2000 mL $ha^{-1}$ (organic rose grower personal communication).

Copper has been extensively used in organic agriculture because of its effictiveness as a fungicide. However, long-term application of this compound may result in increased concentrations of copper in the top soil (Kovačič et al. 2013). For example, the annual application of 7.4 kg $ha^{-1}$ of pure Cu in organic vineyard resulted in 103 mg $kg^{-1}$ soil and 47 mg $kg^{-1}$ soil copper residues for soil depths of 0–20 cm and 20–40 cm, respectively (Pessanha et al. 2010). In comparison, concentrations in the range of 60–90 mg $kg^{-1}$ are considered the limit of ecotoxicity for copper (Official Gazette RS No. 84/05). The plant's requirements for copper for growth and reproduction cannot compensate against copper accumulation in soil. High copper levels in soil are considered harmful for agricultural flora and other organisms. In fact, higher copper concentrations are toxic to most plant species resulting in suppression of root development or chlorosis. By increasing copper concentration in soil, microbial biomass and enzyme activities were shown to decrease (Dewey et al. 2012). Maboeta et al. (2003) reported reduction in earthworm species population when copper oxychloride-containing fungicides were used in a field trial. According to Helling et al. (2000), copper concentrations as low as 9–16 mg $kg^{-1}$ were sub-lethal to earthworms. However, it should be taken into account that the negative effect of the element depends on its bioavailability. Copper tends to complex to organic matter of the soil, Fe and Mn oxides and silicate minerals, which makes it one of the least mobile metals in soil (Vitanovic 2012). Organically managed soils usually contain increased amounts of organic matter, which decrease copper mobility. Soil pH is another factor which should be considered when evaluating copper mobility. Still, to avoid any potential adverse effect of copper on surrounding environment, the use of this compound in organic agriculture is restricted to no more than 3–6 kg ha$^{-1}$ year$^{-1}$. Current re-evaluation of copper is likely to restrict its utilisation even further, directing the research community and organic practices to look for other alternatives efficient in plant disease control.

## *Farming measures for disease and pest prevention*

The management of pest and diseases in organic agriculture system is strongly connected to increased biodiversity in the production fields and the area around them (Baker et al. 2015). Production of oil-bearing rose in Bulgaria is concentrated in a valley region which is characterised with specific soil and climatic conditions and high natural biodiversity. Organic farmers maintain natural biodiversity around the plantations by leaving strips with natural vegetation. Regardless the abundance of data on biodiversity stimulated by organic agricultural practice in the published literature, there is not much consistency in the results from different studies. Through a meta-analysis of literature published before December 2002, Bengtsson et al. (2005) established that species diversity was 30% higher in organic than in conventional farming systems. Still, 16% of the published articles reported a negative effect of organic farming on species richness. Birds, insects and plants in organic farming systems were found to be 50% more abundant on organic fields compared to conventional ones. In most cases, organic farming was associated with higher biodiversity but differences between organism and landscapes should be expected. Pfiffner (2016) was more convinced of a positive connection between organic farming and biodiversity. According to the study, the lower farming intensities and higher proportion of semi-natural areas stimulated development of site-typical plant and animal species in organic farms, which allowed for the existence of a sustainably functioning ecosystem. By maintaining biodiversity on organically managed farms, evenness among natural enemies is achieved which leads to better pest control and higher crop yields (Crowder et al. 2010).

Application of animal manure, compost and green manure is a common practice in organic farming and this not only increases soil fertility but is also an important part of an integrated strategy for a disease control (Ghorbani et al. 2008). Cereal/legume mixtures (pea/barley, vetch /rye/wheat, etc.), which were sown between rose rows in autumn and ploughed in spring, added nitrogen and other nutrients for the roses and promoted soil microbial activity and diversity (Grantina-Ievina et al. 2015). A study, performed by Klingen et al. (2002) demonstrated a significant prevalence of insect pathogenic fungi in soils from arable fields of organically managed farms compared to conventional farms. The fungal species identified included *Beauveria bassiana, Fusarium merismoides, Metarhizium anisopliae* and *Tolypocladium cylindrosporum*. In general, the use of organic fertilisers increased soil microbial activity which suppressed pathogen development through nutrient competition. According to Sullivan (2001), the increase of active biomass decreased the availability of nutrients and energy in soil for soil-borne pathogens. The degradation of organic matter results in release of carbon dioxide and allelochemicals which may also exert suppressive effects on plant pathogens (Lampkin1990). In addition, enrichment of soil with organic matter stimulates growth of microorganisms that are antagonistic to plant pathogens and beneficial microorganisms that produce antibiotics. For example, *Streptomycetes* are saprophytic microorganisms which are associated with plant roots and they are well known for their capacity to excrete a great versatility of compounds with anti-bacterial activities (Kinkel et al. 2012).

Intercropping is a successful approach in organic farming. This improves utilisation of natural resources, stimulates biodiversity and promotes agro-ecosystem health (Pal & Singh 2013). Damask rose-based intercropping systems that included fast growing species with short life cycles have been documented. Yaseen et al. (2001) reported that intercropping of *R. damascena* with potato-maize, geranium-maize, and cowpea-maize increased economic profit. By evaluating eleven rose (*R. damascena* Mill) intercrop systems against pure rose cultivation, Tajuddin et al. (1993) reported that the quality of rose oil was not affected by the intercrops used.

### *Further possibilities and perspectives for disease and pest management*

Organic agriculture is a unique production management system where on-farm agronomic, biological and mechanical approaches are used to maintain and enhance agro-ecological health. As organic farmers have to comply with specific standards and requirements, crop protection can be complicated (Litterick et al. 2002). Successful protection of organic crops requires development of strategies that should be built on profound knowledge of the crop of interest and its interaction with the most likely weeds, pests and pathogens. Understanding the influence of local climate, topography and soils characteristics is a major factor for the implementation of a successful strategy for a disease and pests control. It depends more on the optimisation of the cropping system as a whole, than on the improvement of each single element of the agro-ecological system. Lack of effective, economic crop protection strategies is one of the major factors preventing the expansion of the organic agriculture in some countries (Litterick et al. 2002).

Integrated Pest Management (IPM) encompasses various measures, some of which are compatible with organic agricultural systems (Baker et al. 2015). The most commonly applied approaches were described by Olkowski et al. (1991) and include designing or redesigning the landscape, modifying the habitat to reduce the pest's resources and increase the habitats for natural predators, changing cultural methods such as cultivation, weeding, mulching as well as increasing inspections and tight monitoring of pest invasion. Direct and only local suppression of pests through physical and mechanical controls (e.g. weed removal, netting) or biological control used only when necessary and by using the least toxic method are also important measures for the successful management of organic farms. According to Baker et al. (2015), establishment of a synergistic partnership between organic agriculture and IPM is necessary to improve environmental quality, farm economic viability, soil and human health.

Biopesticides are biologically active compounds, which are derived from natural materials such as bacteria, plants, animals, and certain minerals, and are considered potential alternatives to the chemicals that are currently allowed in the organic systems (van Zwieten et al. 2007; Gupta & Dikshit 2010). The perspective use of the biopesticides in the disease control in organic farming is based on their advantages as biological agents. Usually, they are effective in disease control when applied in small quantities without causing serious harm to the ecological chain. They affect only one, or a few, target organisms thus causing low negative effects on the environment. They have a preventive rather than eradicating function (Gupta & Dikshit 2010). However, it should be taken into account that some biopesticides may express certain levels of toxicity and therefore extensive research is needed prior to their practical application. In addition, registration is required for alternative products to be used for disease control in organic farming, which is a time consuming and costly process. Botanical pesticides such as azadirachtin (extract from *Azadirachta indica*), plant oils (e.g. mint oil, pine oil, caraway oil) or quassia (extract from *Quassia amara*) are currently on the list of substances allowed in organic production of agricultural products according to EU Regulation No 2092/91 (EC 1991). While others, such as Milsana (extract from knotweed *Reynoutria sachalinensis*), are used as alternatives to chemical agents and show promise for expanding the number and versatility of natural products allowed in organic production.

## Socio-economic challenges

### *Legislation framework and current status of organic rose production*

The legislation framework of organic farming in Bulgaria complies with the EU directives and regulations on organic production (EU Regulation No 834/2007) (EC 2007). After 2001, Bulgarian legislation was synchronised with European standards for organic production to provide optimal conditions for the progress of the sector and to prevent the penetration of uncertified products and unfair competition in the organic market. A complete list of normative documents prior and after the accession of Bulgaria to the EU related to organic sector in Bulgaria, as well as a detailed discussion of their application, was described by Nikolova (2011). Organic farming is considered an important priority sector for the development of Bulgarian agriculture and is one of the major points of the Common Agricultural Policy of the EU for the period 2014–2020.

The agro-ecological centre in Plovdiv (Bulgaria) was developed in 1989 as a part of the Agricultural University, Plovdiv, aiming to promote and facilitate research and education in the field of organic farming. A significant development of the organic agricultural sector in the country began after 1997 stimulated by foreign investments and pioneering efforts of the non-governmental organisation Bioselena. Later, the establishment of Bio Bulgaria Oil Co-operative in 2004 further catalysed the production of organic essential oils and derivatives by organising the processing of the raw materials, finding markets and sales for the products, helping with preparation of business plans and achieving bank loans.

In recent years, industrial production of organic oil-bearing roses has become one of the fastest developing sectors of organic agriculture in Bulgaria. According to data provided by Bulgarian Ministry of Food and Agriculture (2013), in 2013 the total area cultivated with oil-bearing rose equaled 3800 ha, of which 1588 ha (42%) complied with the regulations for organic production (Figure 1). This trend was stimulated by the higher price for organically produced rose oil, which exceeded that of conventional rose oil by 20% (Kovacheva et al. 2010). The steady increase in the price for organic rose oil on the international markets also contributed to the growth of organic rose production in Bulgaria. While 1 kg of organic rose oil was traded for € 3860 in 2001, the price increased to € 5520 in 2008 (Kovacheva et al. 2010).

However, regardless of the rapid growth of the organic agriculture sector in recent years, the achievements are still far below the goals aimed for in the National Plan for Development of Organic Farming in Bulgaria, 2007–2013 (Nikolova 2011). The unstable profitability of organic production is the major factor making farmers resistant to convert from conventional oil-bearing rose cultivation to organic production. In an economic analysis comparing organic and conventional oil-bearing rose cultivation in the Göller (Lakes) region of Turkey, Ikiz and Demircan (2013) established that the yield of rose flowers in organic production was less than half (1869 kg $ha^{-1}$) of that in conventional production (4166 kg $ha^{-1}$). In addition, the production costs for rose flowers in organic production (3.08 TL $kg^{-1}$) were found to be higher than the production costs for conventional rose flowers (1.89 TL $kg^{-1}$). An almost twofold difference in the price of organic rose flowers was not a sufficient and effective mechanism to result in higher net profits. Although highly necessary, a similar economic analysis has not been performed in Bulgaria. Comparative data on organic and conventional production of oil-bearing rose is still scarce and not systematically organised. According to Kovacheva et al. (2010), in Bulgaria average yields from well-maintained rose plantations may reach 4000–5000 kg rose flowers $ha^{-1}$ especially where drip irrigation systems are used appropriately and timely. However, during the conversion period plants may experience adaptive physiological changes and lower crop yields, and therefore lower net profits can be expected (Crespo-Herrera & Ortiz 2015).

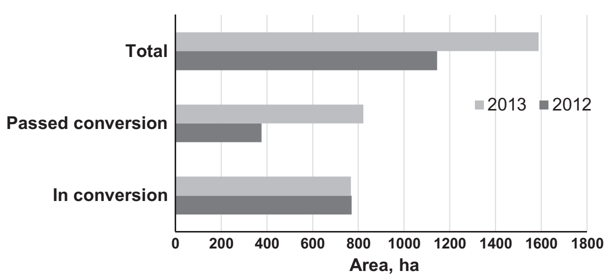


**Figure 1.** Area planted with organic oil-bearing rose *R. damascena* in Bulgaria.

### Funding for farmers

Most problems experienced by Bulgarian organic producers are of financial origin. According to the farmers, the rate of the subsidy per ha is low and insufficient, and therefore some of the producers are discouraged from changing to organic practices. According to Nikolova (2011), during the first year of Bulgarian membership to the EU, the direct payments per ha were 25% of the payments in the other EU member states, while in the following two years (2008 and 2009) the direct payments increased to 30 and 35%, respectively. At present (2017), the subsidy for permanent crops, including oil bearing rose, is € 505 $ha^{-1}$ $year^{-1}$ during the conversion period and € 418 $ha^{-1}$ $year^{-1}$ during the full-organic phase. However, as the financial support received by Bulgarian organic farmers is distributed in small amounts over a prolonged period, it is not considered to be very effective. In addition, the procedure for obtaining the payments is complicated and as it requires a minimum holding size many farmers in Bulgaria are precluded from receiving the financial support. According to Kayryakov (2010), approximately three quarters of the farms in Bulgaria have no access to direct payments from the EU. In addition, an application for financial support often requires development of a business plan, which farmers sometimes find difficult to do. Regardless of the existence of the organic co-operatives in Bulgaria and their efforts in assisting with the application process, farmers still remain reluctant to take advantage of the various financial measures that are available to support organic agriculture in the country. Complex and bureaucratic procedures, failure of meeting established deadlines for receiving the documentation and announcing results, delays in payments and unregulated practices discourage farmers from applying for financial support provided by local or European programmes (Penov & Manolova 2015).

### Employment and labour cost of organic rose production

The picking of the rose flowers is performed manually and is the most labour intensive aspect of rose oil production. In contrast to other crops where scientific and technical innovations can be applied to increase labour capacity and efficiency, rose gathering is difficult to automate and mechanise. Although some attempts for robotic harvesting of *R. damascena* have been made (Kohan et al. 2011), the methodology has not been implemented yet and the provision of manpower for the harvest season in organic rose production is a necessity at present. However, this is made more difficult by the depopulation of rural areas and by the ageing of the population observed in Bulgaria (Mladenov & Ilieva 2012). Both, the size of the rural population and the number of villages in the country have been decreasing and this tendency is even more pronounced in mountain- and semi-mountain regions of Bulgaria. The overall result is a decrease in the number of motivated people, capable of implementing new and innovative practices in agriculture (Ivanova & Sotirova 2014). To secure the required labour force, farmers may decide to pre-pay potential employees, but such investments can increase the labour cost and the price of the product.

Harvesting time and flowering stage are critical factors for obtaining high yields and quality of the oil (Pal & Singh 2013). Harvesting takes place early in the morning, from 06.00 to no later than 11.00, to avoid temperature increase during the day, which negatively affects the yield and the quality of the rose oil (Agaoglu 2000). The harvesting of the rose flowers takes place over a short period of time, which is weather dependent. Most often, it starts in the middle of May and continues for less than a month. Due to the short harvesting period, seasonality of the job as well as uncertainty of employment, less people are willing to get involved in rose flower gathering. The lack of seasonal workers in the regions near the rose plantations and the fluctuations in their availability increase the labour cost which contributes to the cost increase of organic rose oil production. Before 1989, the flower harvest was centrally organised, involving numerous students as a part of their overall education. Nowadays, the harvesting is organised by the farm owners themselves, which may also result in reduced yields. However, despite all this, increasing the volume of organic rose oil production is considered to be very important for increasing the total rose oil production in Bulgaria.

## Conclusions

The production of organic roses and rose oil is considered a vital and necessary part of the overall development of the rose oil industry in Bulgaria. Low resistance of *R. damascena* to major diseases and pests and conservative attitudes of farmers to the species genotype used for commercial production of oil-bearing rose are some of the major challenges for the sector. Proper application of the commercial products that are currently available as a part of an integrated strategy could lead to the successful control of most of the economically important pests and diseases. Further research and investigation of biopesticides and their potential registration as disease control agents in organic agriculture would increase farmers' choice and the possibility for treatment combinations to achieve healthier plants and higher yields. The provision of sufficient and timely financial support to organic producers would encourage the transition from conventional to organic cultivation of oil-bearing rose. Facilitating application procedures for subsidies and diminishing the bureaucracy in the sector are other important factors that would increase farmers' interest in organic production. However, regardless of the numerous challenges faced by organic rose growers, the increasing worldwide demand and price for organic rose oil provide a promising future for the organic rose sector in Bulgaria.

## Disclosure statement

No potential conflict of interest was reported by the authors.

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