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Challenges and Possibilities of Organic Seed Production with the Emphasis on Control of Pathogens

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Abstract

The aim of this paper is to show the state of production of seed intended for the establishment of organic crops in Serbia. Current regulations in many countries require that the seed and planting material used for organic farming must be produced according to the rules applicable to organic crops. Organic seed production, compared to conventional, carries a higher risk of weed seed contamination and of seed-borne diseases which make it more difficult to obtain high quality seeds. The early harvest is one of the possible measures to improve the seed health and there are various forms of seed treatments (natural plant extracts and substances of natural origin). Results within the field of seed production are closely related to conservation of plant landraces and exchange of their seeds that are necessary for organic food producers in Serbia.

*Key words***:** organic seed, certification, seed-borne diseases

Introduction

Agriculture, as a branch of the economy, reflects the state of the society and is proportionate to the degree of social development. A system of organic agricultural production has occurred as a response to increasing environmental pollution caused by the consequences of conventional agriculture, urbanisation and industrialisation (Popović et al., 2016).

In contrast to conventional agriculture, organic farming is based on the rules of imitation of nature and natural cycles and also on the principle of multi-functionality, animal welfare, biodiversity and autochthonism of species. The aim is to prevent rural decay caused by depopulation and to increase economic standard of human population (Šiljković, 2002). High-quality seed and particularly seed production according to organic principles, i.e. prescribed conditions, are additionally exceptionally important for organic agricultural production. Moreover, limitation of methods that could be applied in seed treatments to protect them against pathogen has been imposed (Howard, 2009). The International Federation of Organic Agriculture Movements - IFOAM and the European Union (Regulation 209/91) prescribed the basic principles for the development of organic agriculture. Moreover, EU Regulations, Codex Alimentarius and the Law on organic production and organic products of the Republic of Serbia are based on these standards. Production and treatments of seeds, bulbs and tubers according to principles of organic production represent an additional challenge for obtaining high-quality plant material for further propagation.

The aim of this study is to present the current status and difficulties which organic seed production in Serbia faces, with emphasis on control of pathogens.

The challenges and problems of seed production in Serbia

Due to the limited application of chemicals, the organic seed production suffers a higher risk of contamination with weed seeds and seed-borne pathogens (Roschewitz et al., 2005). In Serbia in 2008/2009, the organic seed production was initiated within the demonstration fields of the Institute "Tamiš" in Pančevo (Ugrenović et al., 2010a). Moreover, during the first year of conversion, conventional non-chemically treated seed of the following soya bean (*Glycine max* L.) cultivars was used: Domaća crna, Dukat and Galeb (breeder's seed category, „Selsem“ d.o.o., Beograd). In the second year, seeds of organically produced spelt wheat (*Triticum spelta* L.) was used (the status of the second year of conversion, variety Nirvana, breeder's seed category, Institute of Field and Vegetable Crops, Novi Sad). In the third year, organic seed of soya bean (*Glycine max* L.) was produced in a part of the plot (cultivar Laura, breeder's seed category, Maize Research Institute, Zemun Polje). Filipović and Ugrenović (2012) pointed out to the fact that seed of local varieties had been produced in the previous period, and due to it, existing autochthonous assortment and economic independence, to a certain extent, were preserved and protected.

Berenji (2009) indicated that the importance of the first count and germination was greater in organic than in conventional production. Due to this, studies are performed with the aim to increase both of these traits in organic seed. Producers in organic agriculture often use seed of landraces, autochthonous or introduced varieties. Local crops are particularly important in organic agriculture because their level of adaptability to existing ecological conditions (climate, soil), biotic factors (pests, pathogens) and growing systems of organic production is high (Prodanović and Šurlan-Momirović, 2006). However, the additional obstacle is the fact that local plant materials are often not available to producers of organic food (Ugrenović et al., 2010a). Milošević (2009) stated that conservation of genetic resources on farms was complex and risky, due to effects of environmental factors. Organic farms in our country could be associated in the group that would conserve and preserve plant landraces and that would exchange their seed. This type of conservation and preservation is called *in situ* or *on-farm* conservation and has been gaining importance all over the world (Ugrenović and Filipović, 2012). The development of such programmes could serve as a model for the production of seed material necessary for organic farms in Serbia (Ugrenović et al., 2010b).

There are significant technical challenges in producing healthy organic seed with high germination. Current regulations in many countries are aimed at the organic production of all seed and planting material. This production should be organised in accordance with prescribed organic methods. A similar consideration applies to the materials used in seed treatments, film coating and pelleting (Döring et al., 2012). The certification of the system of organic production is a key requirement. The organic seed production suffers a higher risk of contamination with weed seeds and seed-borne pathogens than conventional seed production. Seed-borne pathogens can be accumulated and, after a few cycles of seed propagation, they can become a serious problem.

For many crops, it is very difficult to achieve desirable seed quality standards. In some situations, early harvest is a possible measure to improve the health status of the seed. At present in the EU, due to the lack of sufficient amounts of organic material of required varieties, especially of vegetables, organic producers are permitted to use non-organically produced seed, i.e. seed of some plants produced using conventional chemicals provided that there are no chemical treatments after harvest. Patenting of breeding material from organic breeding or organic varieties is not allowed, because it is assumed that patenting would restrict free exchange of the material among farmers or breeders (Berenji, 2009). In Serbia, the lack of organically produced seed is the greatest in vegetable production. This type of production is particularly developed in the Centre for Organic Production in Selenča.

The company "Superior" from Velika Plana, had recognised the problems caused by the lack of certified seed in Serbia and by overseeing the requirements of the market, in 2016 this company, for the first time, produced certified organic seed of ox-heart tomato (that is the most famous type of tomato in the Balkans), elephant ear pepper, eggplant, zucchini and musky gourd (www.organiccentar.rs).

The issues of control of pathogens in organic seed production

Organic plant production encounters the most difficult problems in the sector of plant protection. Control of weeds, diseases and pests is a particularly sensitive segment, because many problems arise due to almost complete absence of chemical measures. Considering production of organic vegetable seeds, the main focus is aimed at finding ways of the easiest control of seed borne diseases. The importance of the largest number of seed borne diseases is equal, while effects of a certain number of these diseases are greater in organic than in conventional production (Table 1).

Only a few pathogens are less problematic in the organic system, such as *Fusarium* spp. in carrot. On the other hand, pathogens such as *Xanthomonas campestris* are more difficult to control in organic carrot production (due to the lack of adequate treatments). Exceptional attention in organic seed production should be paid to biennial species, such as *Brassica* spp., onion and carrot, because the development of diseases in the first year and a continued increase of the disease pressure in the second pose a special problem (Lammerts Van Bueren et al., 2003). Driessen et al. (2002) have studied *Alternaria* spp. in the production of organic carrot and have proven that alternative seed treatments with hot-water, natural plant extracts, priming and antagonists reduced seed infection.

In the USA in the production of organic soya bean seeds, Burgett (2015) has tested the ability of three organic oils (tea tree, coconut and lemon) to act as organic seed treatments to inhibit fungal growth on soya bean seeds that were badly infected with fungal disease. Each oil treatment was performed with the oil concentrations of 10%, 50% and 100%. Their results showed that lemon oil and coconut oil at all concentrations had failed to inhibit fungal growth. Tea tree oil at all three concentrations successfully prevented fungal infection on 100% of the seeds. Most experiences and information related to organic seed production originate from organic cereal production. Namely, gained experiences and performed studies point out that the highest number of seed lots was usually discarded due to common bunt of wheat (*Tilletia caries*), a significant seed borne plant disease in organic agriculture.

Tab. 1. Seed-borne diseases of several vegetable crops in conventional (Conv) and organic (Org) seed production systems: their economic importance and relevance of treatments in relation to the growth phase in which the disease occurs

Болести сјемена повртних врста у конвенционалној и органској производњи сјемена: економски значај и оправданост мјера сузбијања у контексту фазе раста у којој се болест појављује

Crop / *Усјев*	Pathogen / *Патоген*	Growth phase / *Фаза раста*					
		Germination - emergence / *Клијање - ницање*		Market crop production / *Производња за тржиште*		Seed production / *Производња сјемена*	
		Conv.	Org.	Conv.	Org.	Conv.	Org.
Brassica spp. / *купуси*	*Xanthomonas campestris* *Phoma lingam* *Alternaria brassicicola*	±[1], ph[2], ss[3] + ,ss ±,s	 ±,ph +,ph ±,ph	 ++ ++ +,s	 ++ +/++ ++	 ++ ±,s ++, s	 ++ ±/+ ++
Onions / *лукови*	*Botrytis adada* *Botrytis* spp. *Fusarium oxysporum* *Stemphylium* spp.	±,ss + ± +,ph	±,ph ±,ph - ±,ph	++ + + + ,s	+/++ ± - ±	++, ss ++, s ± ±	++ ++ ± ±
Carrots / *Шаргарепа*	*Alternaria radicina* *Alternaria dauci* *Fusarium* spp. *Xanthomonas campestris*	++, s,ph +,s, ph ±,s ±,ph	++,ph +,ph - ±,ph	++ ++ ± ++	++ ++ -/± +/++	++,s ++, ss + ±	++ ++ ± ++
Beans / *пасуљ*	*Ascochyta* spp. *Phoma* spp. *Pseudomonas syringae* *Fusarium solani*	+ ,ss + ++, s	±/+ - -	++ ++ ±	± - -	+ ++ ±	-/± - -/±
Lettuce / *Зелена салата*	Lettuce Mosaic Virus	-	-	+	+	+	+

[1] - not important; + important; ++ very important; ± importance not (yet) known or not clear
- *није значајно*; + *значајно*; ++ *високо значајно*; ± *значајност није утврђена или јасна*

[2]- ph- physical treatment important (incl. warm or hot water; steam);
- *ph- физичке мјере оправдане (укључујући топлу или врућу воду; прегријана пара)*

[3] - s - standard chemical treatment; ss - chemical treatment essential.
- *s – уобичајене хемијске мјере; ss – хемијске мјере основне.*

Source: Lammerts Van Bueren et al., 2003.

Other reasons, of the same importance, are ordinarily related to infected seed, reduced germination and seed borne diseases caused by *Fusarium* spp. and *Septoria nodorum*. Some alternative seed treatments (use of warm or hot water, seed coating with mustard flour, powder milk or treatments with acetic acid) have appeared to be very efficient - the degree of control was above 95%, while at the same time their effect on seed germination was limiting (Borgen and Davanlou, 2000). The lack of list of tolerance values specific for organic seed production represents an extremely important problem. Nielsen (2002) states that same threshold values recommended in conventional agriculture are used for organic seed treatments in Denmark. According to this author, the production of organic seed starts with certified seed (C_1) that comes from conventional agriculture but is untreated. This seed will be sown and the species will be cultivated organically, and then after harvest, seed will be declared as organic seed (C_2). Both types of seed - C_1 and C_2 are non-chemically treated, and there is a high risk of transmitting seed-borne diseases. For the "true" seed-borne diseases the tolerance is lower in C_1 than in C_2 to minimise the multiplication of these pathogens. The tolerances that the author uses in seed types C_1 and C_2 are as follows:

- *Tilletia tritici* i *Urocystis occulta*: C_1: 0 and C_2: 10 spores/g seeds,
- *Pyrenophora graminea*: C_1: 0 and C_2: 5% infected seeds,
- *Ustilago nuda*: C_1: 0 and C_2: 2% infected seeds

It means for example that in wheat no spores of *Tilletia tritici* will be accepted in certified seed C_1. On the other hand, in the big C_2 generation that has a certificate of organic seed, 10 spores per g seed will be accepted. The threshold in *Fusarium* spp. is 15% in wheat, rye, winter barely and triticale and 30% in spring barley. For species *Septoria nodorum* and *Pyrenophora graminea* the threshold is 15% infected seeds. During the last years a large number of organic seeds have been discarded due to seed infections above the tolerance level and in some cases, the quantities of organic seeds have been insufficient to supply the market. In these cases, until December 2003, the organic producers were allowed to use conventionally propagated seeds. However, after December 2003, this was no longer accepted in the EU countries, and further seed propagation based on organic principles has been possible only with organically produced seed.

Conclusion

Seeds obtained by organic production methods in order to be labelled "organic seed" in the certification process must previously meet all prescribed standards.

According to the Law on Plant Production, organic seed production is not only more complex but is also more expensive than conventional production of seed. There is no organic breeding in our country, and therefore not only organic seed production, but complete organic production are both slowed down. Agricultural producers mainly use seed of landraces and chemically untreated seed that is conventionally produced. Considering that the pesticide application is forbidden in organic agricultural production, seed production according to prescribed principles of this type of production mostly faces problems in the field of plant protection and therefore further studies are necessary in order to provide measures that can successfully control disease-producing agents, especially seed borne pathogens.

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Изазови и могућности производње органског семена са посебним освртом на контролу проузроковача болести

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Сажетак

Циљ овог рада је да укаже на стања производње сјемена намјењеног за заснивање органских усјева у Србији. Важећи прописи у многим земљама налажу да сјеменски и садни материјал коришћен за органску пољопривреду треба производити према прописима који важи за органске усјеве. Органска производња сјемена, у односу на конвенционалну, носи већи ризик од контаминације сјеменом корова и болести које се преносе сјеменом што отежава добијање партија сјемена високог квалитета. Рана жетва је једна од могућих мјера за побољшање здравственог стања сјемена а ту су и разни облици третирања сјемена (природним биљним екстрактима и супстанцама природног поријекла). Резултати у области производње сјемена у тјесној су вези с одржавањем локалних биљних популација и размјеном њиховог сјемена потребног произвођачима органске хране у Србији.

Кључне ријечи: органско сјеме, сертификација, болести које се преносе сјеменом

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