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INCREASING THE PEPPER SEED QUALITY USING MYCORRHIZAL FUNGI

POVEĆANJE KVALITETA SEMENA PAPRIKE PRIMENOM MIKORIZE

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ABSTRACT

The purpose of this paper is to evaluate the effect of the year of cultivation, seed population and mycorrhizal seed treatment on two most important indicators of the pepper seed quality, namely germination energy and total germination. The pepper seed quality parameters, i.e. the first count and the total germination rate, were examined in the period 2017-2018. The results obtained show significant differences ($p < 0.01$) between the parameter values under consideration relative to the year of cultivation (Factor A), seed population (Factor B) and mycorrhizal sees treatment (Factor C). In the first experimental year, there was an increase in the first count and total germination of 4 to 6 % compared to the control when pepper seeds were treated with the mycorrhizal formulation. In the second experimental year, an increase in the first count was in the range of 3 to 16 %, whereas an increase in the total germination was 3 to 4 %, compared to the control. The effect of mycorrhizal pepper seed treatment proved beneficial especially to aged seeds that were slow to germinate.

***Key words**: peppers, Glomus sp., Trichoderma sp., mycorrhiza, biostimulant*

REZIME

Cilj istraživanja je bio da se izvrši ocena uticaja godine, populacije semena i tretmana semana formulacijom mikorize na dva najznačajnija pokazatelja kvaliteta semena paprike. Kao materijal u istraživanjima korišćene su tri domaće populacije začinske paprike poreklom sa dva lokaliteta iz Srbije: istočna - Negotin (dve populacije slatka i ljuta) i zapadna - Badovinci (ljuta). Seme populacija paprika proizvedeno je u organskom sistemu gajenja 2017. godine. Utvrđivanje vrednosti pokazatelja kvaliteta (energije klijanja i ukupne klijavosti) semena paprika izvedeno je 2017. i 2018. godine u Laboratoriji za ispitivanje kvaliteta semena poljoprivrednog bilja Instituta za zaštitu bilja i životnu sredinu u Beogradu. Analiza energije klijanja i klijavosti semena paprika pokazala je visoko značajne razlike ($p<0,01$) pod uticajem svih pojedinačnih faktora godine (faktor A), populacije semena (faktor B) i tretmana (faktor C). Veoma značajne interakcije ispitivanih faktora u pogledu energije klijanja i ukupne klijavosti semena paprika dobijene su i kod inetrakcije faktora A × B.

Tretman semena populacija paprika izveden je komercijalnom formulacijom biostimulatora (Coveron) koji u sastavu sadrži Glomus mosseae, Glomus intraradices i Trihoderma atroviride. Tretmanom semena biostimulatorom u *prvoj godini zabeleženo je povećanje energije klijanja i ukupne klijavosti od 4 do 6%, u odnosu na kontrolu. U drugoj godini povećanje energije klijanja kretalo se u interval od 3 do 16%, dok je efekat povećanja ukupne klijavosti bio od 3 do 4%, u odnosu na kontrolu. Porastom starosti semena opada energija klijanja i ukupna klijavost. U tim slučajevima efekat tretmana semena paprika biostimulatorima posebno dobija na značaju, jer utičena poboljšanje parametara kvalieteta semena.*

***Ključne reči**: Paprika, Glomus sp., Trichoderma sp., mikoriza, biostimulator.*

INTRODUCTION

Quality seeds are one of the essential prerequisites for successful agricultural production, i.e. stable and high yields of high quality. Therefore, the identification and testing of seed quality (vigor) is of great importance. Seed vigor is used to describe the physiological properties of seeds responsible for their ability to germinate rapidly in the soil (*Tabaković et al., 2013*). In both Serbia and the world, there is a deficit of organic seeds, which are being substituted with conventional non-treated seeds. However, the EU experts announce that organic production will not be able to use untreated seeds from conventional production from 2021 and thereafter. Due to growing concerns about human health over the last 20 years, organic production has rapidly expanded (*Postic et al., 2018*). Consequently, recent comparative studies of various cultivation systems report lower levels of pesticide residues and nitrates in crops, mycotoxins in cereals, and increased concentrations of certain useful secondary metabolites in organically produced fruits and vegetables (*Lairon, 2009; Brandt et al., 2011*). Therefore, this strategy reduces the use of chemical fertilizers and pesticides resulting in higher crop sustainability (*Candidoet al., 2013*). Arbuscular mycorrhiza (AM) used as a biopesticide has shown beneficial effects on plant growth. Plants produce proteins in response to abiotic and biotic stress, and many of these proteins are induced by phytohormones such as ABA (*Jin et al., 2000*) and salicylic acid (*Hoyos and Zhang, 2000*). AM is associated with a vast majority of higher plants. It is the most common endomycorrhiza (*Brundrettet al., 1996*) which stimulates hormones for plant growth regulation and accelerates the rate of photosynthesis (*Al-Karaki, 2006*). AM provides a stable environment for plants to survive by colonizing the root system (*Al- Ghamdiet al., 2012*). AM is a biological strategy (*Cekicet al., 2012*) that could be suitable for Mediterranean regions, including semiarid conditions where soil is poor in organic matter and soil particles inhibit root development (*Coons et al., 1990*). *Glomus* spp. is a very common genus of AM (*Torrey, 1992*). Cytokinin-like substances are produced by the axenically grown mycelium of *Glomus mosseae* (*Barea and Azcon-Aguilar, 1982*). Cytokinins play a critical role in regulating the proliferation and differentiation of plant cells. They are known as essential regulators of the plant root system growth, as they are involved, antagonistically to auxin, in the control of lateral root organogenesis (*Sakakibara, 2006; Marhavý et al., 2011*). *Trichoderma* spp. is widely involved in plant production, both for disease control and yield increase (*Harman, 2006*). It has developed multiple mechanisms enhancing the resistance of plants to diseases, as well as plant growth and productivity (*Vinaleet al., 2008*). Trichoderma can produce metabolites with activities analogous to plant hormones (*Cutler et al., 1991*).

Indole-3-acetic acid (IAA) and its analogues positively affect the root growth and morphology. Trichoderma induces the plant's IAA production and so facilitates the root and seedling growth in different plants (*Morales et.al, 2004; Gravel et al., 2006*). Trichoderma, as reported by a number of authors (*Hanson, 2000; Howell, 2003*), can reduce seed infection and so prevent the seed borne disease occurrence in the field.

The purpose of this paper is to evaluate the effect of the year of cultivation, seed population and mycorrhizal seed treatment on two most important seed quality indicators (namely germination energy and total germination) of three pepper populations, with an emphasis on the importance of preserving genetic resources for organic production.

MATERIAL AND METHOD

A total of three domestic spice pepper populations were enrolled in the study, originating from two locations in Serbia: Eastern Serbia - Negotin (two populations of sweet and hot peppers) and Western Serbia - Badovinci (hot peppers). Seeds were produced in the organic production system in 2017. The pepper seed quality parameters, i.e. the first count and the total germination rate, were examined in the period 2017-2018 in the Laboratory for Seed Testing and Planting Material of the Institute for Plant Protection and Environment in Belgrade. The seed germination was carried out using the standard laboratory method, i.e. the filter paper moistened with 0.2 % water solution KNO_3 (control). The seed samples were treated with the commercial biostimulant (Coveron) mycorrhizal formulation for vegetable seeds, which contained Glomus mosseae, Glomus intraradices and Trihoderma atroviride at a dose of 30 g / 0.5 l H_20 per 1kg of seed. The seed germinated 14 days at a temperature of 20-30 ºC and a relative humidity of 95 %. On the seventh day of germination, the first count was evaluated, whereas the total germination was evaluated on the 14th day of germination (ISTA Rules, 2009).

The results obtained were analyzed using the analysis of variance (ANOVA, F-test; $P \leq 0.05$ and $P \leq 0.01$) and the effect of factors (year of cultivation, seed population, mycorrhizal seed treatment and their interaction). The data obtained were processed using the STATISTICA 8 program (StatSoft Inc, Tulsa, OK, USA).

RESULTS AND DISCUSSION

An analysis of the germination parameter values (namely the first count and total germination) of the spice peppers under consideration (Table 1) showed significant ($p < 0.01$) differences relative to the year of cultivation (Factor A), seed population (Factor B) and mycorrhizal sees treatment (Factor C). The significant A × B interaction was obtained with regard to the first count and total germination values of the pepper seed examined.

Table1. Effect of the factors under consideration on the parameters examined

Factors	First count	Total germination
Year (A)	**	**
Population (B)	**	**
Treatment (C)	**	**
A × B	**	**
A × C	*	ns
B × C	**	ns
A × B × C	*	ns

*** - significant at 0.01; * - significant at 0.05; ns - not significant*

The treatment of spice pepper seeds with the biostimulant Coveron increased the percentage of normal seedlings at the first (Table 2) and final counts (Table 3) compared to the control. In this study, two Glomus strains and one Trichoderma strain enhanced early germination and the total germination percentage, which is consistent with the results of a number of researchers obtained for different plants (*Hanson 2000; Mishra and Sinha, 2000; Oyarbide et al. 2001; Islam et al., 2011; Konings-Dudin et al., 2014*). In the first experimental year, the

Table2. Percentage of normal seedlings at the first count (%) in the two-year study on three spice pepper populations treated with the biostimulant Coveron

Population (B)	Treatment (C)	Year (A) 2017	Year (A) 2018	Average	Average (B)
Negotin (sweet pepper)	Coveron	85aA	56cB	70,5	67,0
	Control	79bA	48dB	63,5	
Negotin (hot pepper)	Coveron	86aA	71aB	78,5	73,5
	Control	82abA	55cB	68,5	
Badovinci (hot pepper)	Coveron	72cA	68bAB	70,0	68,3
	Control	68dA	65bAB	66,5	
Average	Coveron	81,0	65,0	73,0	69,6
	Control	76,3	56,0	63,15	
Average (A)		78,7	60,5	69,6	

** Means in the columns followed by the same letter are not significantly different according to the Fisher's protected LSD values (P = 0.05); Grouping information using the Tukey's method and 95 % confidence*

Table 3. Total germination (%) of three spice pepper populations treated with the biostimulant Coveron in the two-year study

Population (B)	Treatment (C)	Year (A) 2017	Year (A) 2018	Average	Average (B)
Negotin (sweet pepper)	Coveron	93a	80b	86,5	84,5
	Control	88b	77bc	82,5	
Negotin (hot pepper)	Coveron	94a	82b	88,0	86,3
	Control	90ab	79bc	84,5	
Badovinci (hot pepper)	Coveron	91a	87a	89,0	86,5
	Control	85bc	83b	84,0	
Average	Coveron	92,7	83,0	87,9	85,5
	Control	87,7	79,7	83,7	
Average (A)		90,2	81,3	85,8	

** Means in the columns followed by the same letter are not significantly different according to the Fisher's protected LSD values (P = 0.05); Grouping information using the Tukey's method and 95 % confidence* first count and total germination of the pepper seeds examined increased by 4 – 6 % in the seeds treatment with the biostimulant Coveron, compared to the control. In the second experimental year, the first count of the pepper seeds examined increased by 3 to 16 % (Table 2), whereas the total germination of the pepper seeds examined increased 3 to 4 % (Table 3), compared to the control. The increase in the first count in the second year, depending on the pepper population, ranged from 3 to 16% (Table 2), while the increase in total germination was from 3 to 4% (Table 3), compared to the control. Biostimulants proved beneficial especially to aged seeds that were slow to germinate.

CONCLUSION

The treatment of spice pepper seeds with the biostimulant Coveron led to an increase in the first count and the total germination values by 3.0-16.0 % and 3.0-6.0%, respectively. The present study confirms that the biostimulant Coveron has the potential to enhance the germination of spice peppers seeds.

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