

The logo for AgroSym 2022 is an oval with a dark red background and a gold border. The text "AgroSym" is written in a gold, serif font, with a small golden stalk of wheat positioned behind the letter 'y'. Below "AgroSym", the year "2022" is written in a smaller, gold, sans-serif font.

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The background of the cover is a large, oval-shaped photograph of a sunflower field. The sunflowers are in full bloom, with bright yellow petals and dark brown centers. The leaves are green and large. The sky is a pale blue with some light clouds. The entire image is framed by a dark red border with a gold inner line.

BOOK OF PROCEEDINGS

*XIII International Scientific Agriculture Symposium
"AGROSYM 2022"
October 6-9, 2022*

The logo for AgroSym 2022 features a green leaf icon above the text "AGRO 2022" in a bold, sans-serif font. Below "AGRO 2022", the word "sym" is written in a smaller, blue, sans-serif font.

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Jahorina, October 06 - 09, 2022

EXAMINATION OF SEED QUALITY PARAMETERS OF THREE PEPPER VARIETIES IN A FIVE-YEAR PERIOD (*CAPSICUM ANNUUM* L.)

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Abstract

Sweet pepper (*Capsicum annum* L.) is considered one of the most popular vegetables in the world. During five consecutive years (2017-2021) the most important indicators of seed quality (seed germination, energy, seed purity and moisture) and health safety were analyzed in three varieties of peppers (*Capsicum annum* L.): Palanačko čudo, Župska rana and Duga bela. During the research, very high values of all important parameters of seed quality were determined. The average determined seed purity was 98.6 % with a variation over the years of examination from 99.10% to 99.9%. Seed germination varied in the range of 73% to 94%, while the average germination was 86%. Germination energy was in the range of 61% to 88%. Seed moisture data showed that it was in the tolerance range of 6.3% to 7.4% per test year, with an average value of 6.9%. *Alternaria* spp and *Fusarium* spp were detected in minimal percent or no detection on variety of Palanačko čudo. Duga bela had the highest percentage of *Alternaria* spp. in 2020 and 2021, which were 2% and 3%, respectively. *Fusarium* spp. was presented in percentage more than in Župska rana and Palanačko čudo. The total germination of the Palanačko čudo, Župska rana and Duga bela during the observed five-year period was above the legal level of minimum and can be classified as quality seed.

Key words: *seed, energy, germination, moisture, purity.*

Introduction

Sweet pepper (*Capsicum annum* L.) belongs to the *Solanaceae* family and is considered one of the most popular vegetables in the world. Sweet peppers can be consumed as fresh, processed and dehydrated spice. Sweet pepper is considered as a commercial vegetable crop, grown mainly in greenhouses or in fields (Cvetković et al., 2022). Also, in Serbia pepper is one of the leading commercial vegetables, which covers an area of 2 million hectares (FAOSTAT, 2018). Good quality pepper seed is one of the factors which can enhance the final yield and reduce unnecessary losses caused by defective or infected pepper seeds (Wang et al., 2018). Methods for selecting high-quality seeds are based on physical methods such as germination, energy, weight, purity, moisture and biochemistry (Yildirim & Demir, 2020). Infected seeds are an important route of introduction and spread of several plant pathogenic fungi that can affect the quality and sustainability of plants, thus causing economic losses in the field or greenhouse (da Silva Pereira et al., 2018, Gebeyehu, 2020). There are common types of fungi in the literature that are associated with a disease or defective pepper seeds *Alternaria* spp. and *Aspergillus* spp., while *Fusarium* spp. acts as a member of the damping off complex in *Capsicum* spp. Moreover, these pathogens can produce toxins that render agricultural produce unsuitable for consumption (Samarah et al., 2016; Fajardo-Rebollar et al., 2021; Ahmad et al., 2022). Various factors such as taking seeds from healthy plants, adequate storage, and different preparations can significantly improve the quality of seeds.

The lower moisture and temperature can extend the germination of the seed (Wang et al., 2018).

Material and Method

Seed samples of three varieties of sweet pepper (Palanačko čudo, Župska rana and Duga bela) were used as research material. Parameters of quality seeds were examined during 2017-2021 on experimental fields on the locality of Smederevska Palanka at the Institute for Vegetables Crops. During the five-year period, the following seed quality indicators were monitored: total germination, energy, purity, moisture content and seed health. The parameters of seed quality were tested following the Standard of seed quality of agricultural plants (47/87), which is harmonized with the ISTA rules (2020). For testing energy and germination, 4 x 100 seeds were placed in a petri dish on filter paper previously moistened with 0.2% KNO₃ solution were used. The analysis was performed after 7-14 days in a thermostat at 20-30 °C and relative humidity of 95%. The estimated energy and total germination after 14 days were recorded for all three varieties of pepper. Seed purity is the ratio of the amount of pure seed of the tested species and the amount of seed from other agricultural plants, weeds and inert materials. The seed health of Duga bela, Palanačko čudo and Župska rana was tested on *Alternaria* spp. and *Fusarium* spp. Health testing of three varieties of peppers was performed with the standard method on filter paper. The allowed percentage of infected seeds is 5%. The procedure of moisture testing was performed with 5 g of a sample of three pepper varieties on an analytical balance. Moisture determination was performed at a temperature of 105 °C ± 2 °C for 17 h ± 1 h. Samples were statistically processed with SPSS software (version 23, IBM, USA) and compared with ANOVA and Tukey test. Statistical significance cut-off was p < 0.05.

Results and Discussion

The analyses of seed quality parameters (total germination, energy, purity, moisture and health) of Župska rana, Duga bela and Palanačko čudo were monitored from 2017 to 2021. The pepper varieties were compared with each other with a statistically significant difference between varieties and within one group. According to the Standard of seed quality of agricultural plants (47/87) for pepper (*Capsicum annuum* L.), the minimum purity is 97%, germination 65% and maximum moisture 12%. Results of quality parameters of three varieties pepper in five periods are shown in Table 1. The purity of all tested peppers was significantly above the defined limit (Table 1).

Table 1. Seed quality parameters of three varieties of pepper in a five-year period

Varity	Characteristics ^a	Years				
		2017	2018	2019	2020	2021
Palanačko čudo	Percent (%)					
	Energy	79*	76	81	73	78
	Total germination	86	91 ^{*b}	94 ^{*b}	75*	87 ^{*b}
	Moisture	6.8	7.1	6.9	6.9	6.5 ^{*b}
	Purity	99.3	99.5	99.4	99.8	99.9
Duga bela	Energy	70	80	80	61	68
	Total germination	86	87	85*	73	77*
	Moisture ^c	6.8	7.2	7.3	6.9	6.3
	Purity	99.5	99.6	99.2	99.9	99.9

	Energy	81	73	86 [*]	72	72
Župska rana	Total germination	86	87	89 ^{*b}	74	77 [*]
	Moisture	7.1 ^{*b}	7.3	6.6	6.6	7.4
	Purity	99.1	99.4	99.9	99.6	99.9

^a Characteristics were compared on statistical significance ($p < 0.05$) with years and between varieties of peppers but not with other characteristics.

^{*} Statistical significance between years ($p < 0.05$)

^b Statistical significance between varieties

The moisture of Župska rana, Palanačko čudo and Duga bela was below the defined limit ($< 12\%$). Statistical significance for moisture was obtained only for the last year between Palanačko čudo, Duga bela and Župska rana ($p < 0.05$). There is no statistical significance between the Župska rana and Duga bela for moisture ($p > 0.05$) (Table 1). Energy of Župska rana, Duga bela and Palanačko čudo was lowest in 2021 compared with other examined years. The highest percentage of energy was obtained in 2019 and amounted $> 80\%$ (Table 1).

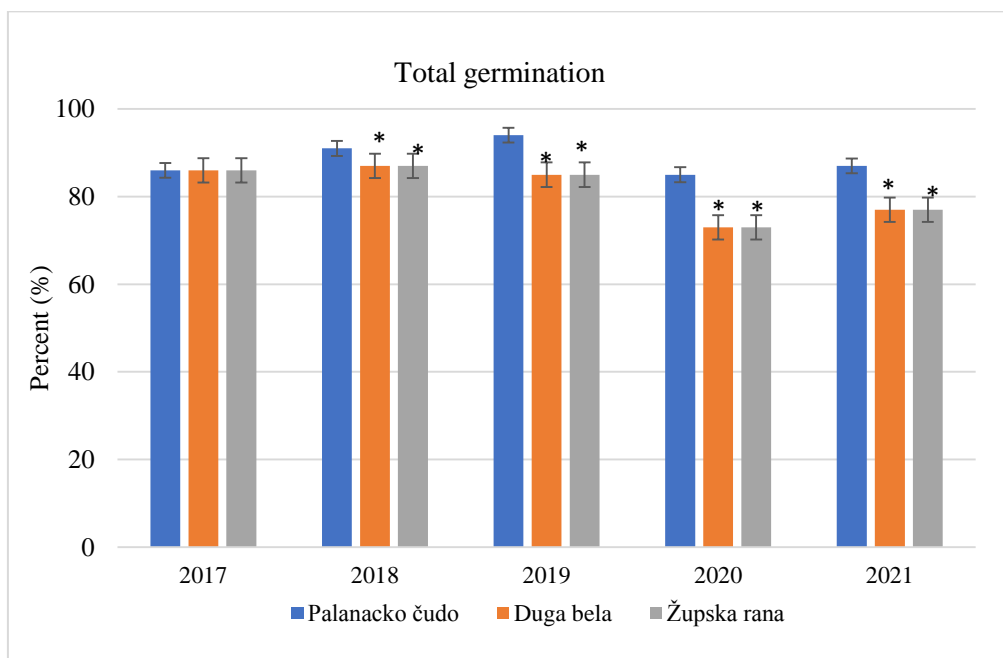


Figure 1. Total germination of Palanačko čudo, Duga bela and Župska rana in five years period with statistical significance ($p < 0.05$)

The total germination in the first observed year (2017) in all examined varieties of pepper was not statistically significant ($p > 0.05$) and amounted to 86% (Figure 1, Table 1). The highest total germination was obtained for Palanačko čudo (2018-2021) compared to Duga bela and Župska rana ($p < 0.05$). There was no statistically significant difference between Duga bela and Župska rana in the observed five-year period for total germination ($p > 0.05$). Total germination was the lowest in 2020 for all tested peppers compared to other observed years ($p < 0.05$) (Figure 1). *Alternaria* spp and *Fusarium* spp were detected in minimal percent or no detection on variety of Palanačko čudo (Table 1). Duga bela had the highest percentage of *Alternaria* spp. in 2020 and 2021, which were 2% and 3%, respectively. *Fusarium* spp. it was detected in percentages more than in Župska rana and Palanačko čudo (Table 1).

Tabela 2. Detected phytopathogens on the seeds of three varieties of pepper over a period of five years.

	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021
	<i>Alternaria</i> spp.					<i>Fusarium</i> spp.				
Palanačko čudo	1	0 ^{b*}	1	0 ^{b*}	1	0 ^{b*}	1	0	2	1
Duga bela	2 ^{*b}	1	1	2	3 ^{*b}	2	1	3 ^{b*}	2	1
Župska rana	0	2	1	3	1	2	2 ^{*b}	1	1	0 ^{b*}

* Statistical significance between years ($p < 0.05$)

^b Statistical significance between varieties.

Palanačko čudo had the lowest infection with *Alternaria* spp. and *Fusarium* spp. compared with Župska rana and Duga bela ($p < 0.05$). In the observing period (2017–2021) Palanačko čudo had total germination $> 85\%$ which can be related to low infection phytopathogens. *Alternaria* spp. and *Fusarium* spp. were detected in the highest percent compared to Župska rana and Palanačko čudo ($p < 0.05$). Tufail et al., 2020 detected *Alternaria* spp. in all tested samples and an average infection by 16% that caused reduced seed germination. However, there are no varieties of *C. annuum* L. with total resistance for *Fusarium* spp. or *Alternaria* spp. Important fungi are *Fusarium oxysporum* which can infect roots, stems, and leaves, could persistence in seeds, and can cause yield losses of up to 100% (García-Rodríguez et al., 2010; Li et al., 2017). The lowest percentage of phytopathogenic fungi in the three years was detected in Palanačko čudo. Recent studies indicate that applying different treatments can significantly improve total germination or prolong seed life (White et. 2019; Castillo et al., 2009). Some studies were performed using a treatment with a mycorrhizal formulation that increased the total germination of pepper seeds by 3–4% (White et. 2019; Poštić, 2019). Likewise, these treatments have an antifungal effect and improve seed quality. The lowest germination was achieved in samples of seed varieties Duga bela with the highest percent isolation of pathogenic fungi. Recent studies used treatments with *Trichoderma* which has antifungal effects on phytopathogens and increased total germination (Konings-Dudin et al., 2014; Murphy., 2017). According to Debnath et al., 2012 the maximum germination was obtained in samples where the prevalence of pathogenic fungi was lowest. In our samples of seed, we obtained that the Palanačko čudo has the lowest prevalence of *Alternaria* spp. and *Fusarium* spp. The total germination of Župska rana, Palanačko čudo and Duga bela was obtained from natural seeds, which indicates the possibility of increasing germination by applying some organic treatments.

Conclusion

The parameters of pepper seed quality depend on the sum of various factors such as storage temperature and humidity, the quality of the pepper and percent infection of seeds or the plant, the varieties, and the interaction of these factors. This analysis of the population structure of the pathogen of three varieties of pepper seeds over five year period helps to define preventive measures for the control of phytopathogenic species as well as the possibility of increasing total germination for all tested sample seeds. The total germination of the Palanačko čudo, Župska rana and Duga bela during the observed five-year period was above the legal level of minimum and can be classified as quality seed.

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