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# THE IMPACT OF CLIMATE CHANGE ON PEPPER SEED QUALITY PARAMETERS DURING TWO YEARS

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**Abstract:** Pepper (*Capsicum annuum* L.) is a commercial crop grown worldwide. Seed quality, including seed health, is an important prerequisite for obtaining a healthy and high-quality crop and ensuring high fruit yields. Changes in the quality of the seeds of autochthonous varieties of pepper seeds: Palanačko Čudo, Somborka, and Dora were monitored from 2023 to 2024. Total germination was highest in the first observed year (2023). The Palanačko Čudo genotype had a total germination of 91%, which was statistically significantly different from Somborka (75%) and Dora (73%), respectively, between which there was no difference. The highest percentage of phytopathogenic fungus presence was detected in Palačanko čudo. While *Fusarium* spp. was not detected in the last observed year. A significant difference was observed in the overall germination rate in 2024, which was extreme in terms of temperatures, especially in the summer months.

**Keywords**: pepper, seeds, quality, temperature

## Introduction

Climate change is an urgent global concern, profoundly affecting crop productivity worldwide. Climate change is having detrimental effects, especially on sensitive crops such as sweet peppers and various types of chili peppers, leading to alarming consequences for the sustainability of agriculture (Zakir et al., 2024). These stresses have a negative effect on vegetable growth, fruit quality, and fruit yield (Khalid et al., 2022). Sweet pepper (*Capsicum annuum* L.) ssp. is the third largest crop producing over 26 million tons of fruit after tomato and potato and is a bell-shaped perennial vegetable with four or three leaves and colors including red-orange, green, yellow and purple-black (Li et al., 2018). The area under pepper in Serbia was estimated at 10.278 ha in 2021, and the total production at 147.663 tons (Statistical Office of the Republic of Serbia, 2022).

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Qualty seeds (high vigor) play a decisive role in the production of every plant species (Poštić et al., 2012). Seed viability is determined by the nature of the plant species itself, the conditions of production, and the conditions of seed storage. Different genotypes within a variety can vary significantly in the length of the seed viability period. Pepper production in Serbian growing conditions is frequently exposed to X. euvesicatoria infections (Živković et al., 2023). The International Seed Testing Organization (ISTA, 2020) has defined seed quality parameters that are mandatory for seed to be available on the market. This research included testing the seed quality parameters of two pepper genotypes obtained in the 2024 season, when a year with exceptionally high temperature values, especially in summer, was recorded.

## Materials and methods

Seed testing of three pepper varieties (*Capsicum annuum* L.): Palanačko Čudo, Somborka and Dora was carried out using standard methods for assessing quality and health in the seed quality testing laboratory of the Institute of Vegetable Growing in Smederevska Palanka. The quality of the three seed varieties was assessed through germination parameters (energy and total germination), moisture and seed health. The seed quality of the selected pepper varieties was tested according to the standard for the quality of seeds of agricultural plants (47/87), which is in line with the ISTA rules (2020). Total seed germination (TSG) and germination energy (GE) were performed using the standard filter paper method. Samples of 100 seeds of the selected pepper varieties in four replicates were placed in Petri dishes with filter paper moistened with 0.2% KNO3. Germination analysis indicates abnormal germs (damaged, defined, rotten) that cannot develop into a normal plant. The placed samples were incubated for 7 and 14 days at 23 C. The health of the seeds of Palanačko Čudo, Somborka and Dora was tested for *Alternaria* spp. and *Fusarium* spp. The health testing of the three pepper varieties is carried out using the standard method on filter paper. The allowed percentage of infected seeds is 5%. Moisture content is defined as the water in the seed and is expressed as a percent. The moisture testing procedure is performed with 5 g of a sample of three pepper varieties on an analytical balance. Moisture determination is performed at a temperature of 105 °C ± 2 °C for 17 h ± 1 h.

## Results and discussion

The pepper Palanačko Čudo genotype had statistically significantly better quality parameters in 2023 compared to the other genotype, while there was a decline in vigor and overall germination in 2024 (Table 1). There was no statistical difference between Somborka and Dora in energy germination and total germination. A significant decrease in total germination was observed in all three genotypes during 2024 ($p<0.05$).

According to the Republic Hydrometeorological Institute of Serbia, intense heat waves in July and August brought long periods of dry and sunny weather, which had numerous consequences: problems with severe drought, low water levels, and water supply (РХМЗ - Републички Хидрометеоролошки Завод Србије 2024). Absence of precipitation accompanied by high temperatures leads to a significant decrease in germination compared to seeds produced under conditions of sufficient humidity and average daily temperatures below 22 ºC (Đukić et al., 2011). Numerous studies have shown that absence of water is the primary limitation affecting seed quality (Ramirez-Tobias, et al., 2014; Luna B., 2016).

**Table 1.** Parameters of quality (energy, total germination and moisture) of three pepper seed samples (2023 –2024)

| Samples | Energy Germination (%) | Total Germination (%) | Moisture content (%) | Energy Germination | Total Germination | Moisture content |
|---|---|---|---|---|---|---|
| | 2023 | 2024 | | | | |
| Palanačko Čudo | 65.2±0.3$^{a}$ | 91.1±0.4$^{a}$ | 10.1±0.1$^{a}$ | 52.2±0.2$^{a}$ | 80.3±0.1$^{a}$ | 9±0.2$^{a}$ |
| Somborka | 56.3±0.2$^{b}$ | 75.2±0.2$^{b}$ | 8.5±0.2$^{b}$ | 50.5±0.5$^{a}$ | 70.2±0.2$^{b}$ | 8.4±0.1$^{b}$ |
| Dora | 55.2±0.1$^{b}$ | 73.2±0.2$^{b}$ | 8.3±0.1$^{b}$ | 45.7±0.2$^{b}$ | 65.2±0.3$^{c}$ | 8.2±0.02$^{b}$ |

Values are presented as means ± standard error ($p \leq 0.05$) , Tukey's Multiple Range test for the column; different lowercase letters indicate a statistically significant difference within the rows.

The highest percentage of Alternaria spp. infection was detected in Palanačko Čudo with 4.23%, while Somborka had 2.21%, and Dora was not

present (Table 2). Seed moisture affects the emergence of pathogens by providing an optimal environment for their development. *Alternaria* spp. was the most prevalent, while *Fusarium* spp. was not detected in all tested pepper seeds of the genotype during 2024. Similar research was conducted by Guš et al. (2011) and Loha et al. (2006) who indicated that differences in seed quality parameters were positively correlated with differences in climatic conditions of the geographical areas from which the samples were obtained.

**Table 2. Presence of phytopathogenic fungi in the seeds of selected pepper varieties**

| Samples | *Alternaria* spp. (%) | *Fusarium* spp. (%) | *Alternaria* spp. (%) | *Fusarium* spp. (%) |
|---|---|---|---|---|
| | 2023 | | 2024 | |
| Palanačko Čudo | 4.23±0.3$^{a}$ | 1.0±0.1$^{a}$ | 3.75±0.2$^{a}$ | 0±0$^{a}$ |
| Somborka | 2.21±0.1$^{b}$ | 0±0$^{b}$ | 1±0.1$^{b}$ | 0±0$^{a}$ |
| Dora | 0±$^{c}$ | 0±$^{b}$ | 1±$^{b}$ | 0±$^{a}$ |

Values are presented as means ± standard error ($p \leq 0.05$); different lowercase letters indicate a statistically significant difference within the rows.

## Conclusion

Seed quality and health depend on agronomic measures such as fertilizer, irrigation, crop rotation, handling, and proper seed storage. These techniques contribute to improving yields. Certain seed quality parameters (vigor, total germination and presence of phytopathogenic fungi) differed at a statistically significant level between the two years, indicating the importance of the impact of elevated temperatures in the period from 2023 and 2024.

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