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# RESPONSE OF OILSEED RAPE SEED QUALITY PARAMETERS TO CHEMICAL TREATMENT
# REAKCIJA PARAMETARA KVALITETA SEMENA ULJANE REPICE NA HEMIJSKI TRETMAN

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## *ABSTRACT*

*Rapeseed is a major oilseed crop that has various uses in the food, feed, and industrial sectors. The first condition for successful production and achieving high yields is to provide high-quality seeds, which, in addition to high seed vitality, also implies good seedling protection. The goal is to ensure an optimal number of plants per hectare, which is also a basic prerequisite for achieving high yields. Quality seed treatment has proven to be the best solution for plant protection in the initial stages of development. The seeds were treated with fungicides with the a.i. carboxin + thiram and fluopicolide + fluoxastrobin, as well as an insecticide with a.i. flupyradifuron, and the control was untreated seed. Treatments had a great influence on germination energy, seed germination, number of abnormal seedlings, length and weight of seedlings. The fungicidal fluopicolide + fluoxastrobin treatment had the greatest positive effect on most of the tested parameters, while the carboxin + thiram + flupyradifuron treatment had the greatest negative effect on the seed germination parameter.*

***Keywords:*** *oilrape, chemical treatment, germination, root length, shoot length, seedling weight.*

## *REZIME*

*Uljana repice spade u vodeće uljane biljne vrste u svetu koja se koristi za različite namene u prehrambenom, stočnom i industrijskom sektoru. Prvi uslov za uspješnu proizvodnju i postizanje visokih prinosa je osiguranje kvalitetnog semena, što osim visoke vitalnosti semena podrazumeva i dobru zaštitu klijanaca. Cilj je osigurati optimalan broj biljaka po hektaru, što je ujedno i osnovni preduslov za postizanje visokih prinosa. Kvalitetno tretiranje semena pokazalo se kao najbolje rešenje za zaštitu biljaka u početnim fazama razvoja. U ovom istraživanju seme je tretirano fungicidima sa a.m. karboksin + tiram i fluopikolid + fluoksastrobin, kao i insekticidom sa a.m. flupiradifuron, a kontrola je bilo netretirano sjeme. Tretmani su imali značajan uticaj na energiju klijanja, klijavost semena, broj abnormalnih klijanaca, dužinu i masu klijanaca. Tretman fungicidom fluopikolid + fluoksastrobin imao je najveći pozitivan uticaj na većinu ispitivanih parametara, dok je tretman karboksin + tiram + flupiradifuron imao najveći negativan uticaj na parametar klijavosti semena.*

***Ključne reči:*** *uljana repica, hemijski tretman, klijavost, dužina korena, dužina nadzemnog dela, masa klijanaca.*

## INTRODUCTION

Oilseed rape is one of the most important oilseed crops. It is primarily cultivated for its edible oil, which is rich in oleic and linoleic acid. Due to its high protein content, it is an excellent animal feed and ranked as second in global production after soybean meal (*Wittkop et al., 2009; Elferjani and Soolanayakanahally, 2018*). It is also used in the production of lubricants, the paint industry, but it is also a raw material for the production of biodiesel (*Haj Sghaier et al., 2022*). Observing the last decade, the areas sown with oilseed rape are continuously increasing and today exceed 35 million hectares in the world (*FAO, 2023*). Production in Serbia follows this trend. However, that not everything is always ideal and that it is not always easy to provide the necessary amount of seeds is indicated by the fact that in the last decade there has been a certain reduction in the area under rapeseed in the territory of Europe. Namely, in 2013, the European Union introduced a ban on the use of insecticides from the group of neonicotinoids, which until then had been the dominant and efficient way of protecting seeds from insects. The same situation also befell producers in Serbia, although the pressure of pests is lower compared to the main production regions of Europe. However, in the following years, new bans on the use of pesticides by the European Union followed, which led to the fact that most fungicides had to be phased out. With that, a new challenge was put before the seed companies, but also the producers of seed protective products.

The first condition for successful production and achieving high yields is to provide high-quality seeds, which, in addition to high seed vitality, also implies good seedling protection. The goal is to ensure an optimal number of plants per hectare, which is also a basic prerequisite for achieving high yields. Quality seed treatment has proven to be the best solution for plant protection in the initial stages of development.

In order to solve this problem, new pesticides containing new active substances were registered on the market, the effectiveness of which had to be determined. Every serious seed company tests new pesticides for seed treatment before putting them into use because it has been shown that all pesticides do not have the same effect on the germination and viability of seeds, especially if they are seeds of higher categories (*Mrđa et al., 2011a; Tamindžić et al., 2016; Vujošević et al., 2017*). The additional burden when choosing the appropriate seed protection and the effectiveness of its action is also the problem of climate change, which we have witnessed in recent years. Namely, agriculture itself is going through a phase of agroecological transition caused by climate change, endangering food security due to warming, changes in precipitation distributions, and increased frequency of extreme temperatures (*Krstić et al., 2022; Krstić et al.; 2023*). In addition to the inevitable impact on the plants themselves, climate change also affects pests, changing their diversity, abundance and area of distribution.

## MATERIAL AND METHOD

The trial was carried out during 2019 in the internal laboratory for seed quality testing at Sunflower Department of Institute of Field and Vegetable Crops in Novi Sad. The research included three oilseed rape varieties (Anna, Zorica and Jasna) grown during the 2018 growing season. Anna is a winter variety, "00" type, with a high genetic potential for yield. The oil content of the seed is 45%, and the protein content is 22%. The oil is suitable for human consumption, processing and production of biodiesel. Residues after pressing can be used for feeding domestic animals. Zorica is a "00" type winter variety with a low content of erucic acid and glucosinolates. It has a high genetic potential for yield, and the oil content in the seed is about 46%. The oil is suitable for human consumption, processing and production of biodiesel. Jasna is a winter variety with a low content of erucic acid and glucosinolates, "00" type. It has a high genetic potential, and the oil content in the seeds is about 44%. The oil is suitable for human consumption, processing and production of biodiesel. Residues after pressing can be used for feeding domestic animals.The seeds were treated with fungicides with the a.i. carboxin + thiram and fluopicolide + fluoxastrobin, as well as an insecticide with a.i. flupyradifuron, and the control was untreated seed. The seeds were treated with a wet method, and on that occasion, a polymer was also applied, which enables better adhesion of the pesticide to the seeds. The following combinations were selected for the research: control (C), only polymer (T0), polymer + carboxin + thiram (T1), polymer + fluopicolide + fluoxastrobin (T2), polymer + fluopicolide + fluoxastrobin + flupyradifuron (T3) and polymer + carboxin + thiram + flupyradifuron (T4). The standard dose of the preparation recommended by the chemicals companies was used.

Germination energy, seed germination and abnormal seedlings were determined using the standard laboratory test according to *ISTA Rules (2018)*. Germination test was performed in four replicates per hundred seeds on filter paper in Petri dishes. The incubation period has lasted for seven days at 20°C - 30°C. After 5 days, seedlings were transferred from Petri dishes to filter paper, which was wrapped in order to ensure the free shoots and roots growth. Germination energy was determined after five days, and seed germination and abnormal seedlings after seven days. To calculate the length and weight of fresh seedlings, four replicates per ten seedlings were used, immediately after germination testing. Using millimeter paper, the whole seedling was first measured, then the shoot and the root individually, while the dry weight of whole seedlings was determined after drying in an oven for 17 hours at 80°C until constant weight.

The data were statistically processed used SPSS 21 statistical program (trial version). The methods of basic statistics, two-way analysis of variance (ANOVA) and Pearson's correlation were used.

## RESULTS AND DISCUSSION

The *Table 1* shows the probabilities of the F-test of ANOVA for the investigated parameters.

*Table 1. F-values from ANOVA for influence of variety (V), treatment (T) and interaction variety x treatment (V x T) on observed parameters of oilseed rape seed.*

| Factor | Seed quality parameter | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | GE | G | AS | SRL | SSL | SL | SFW | SDW |
| Variety (V) | 1.854$^{ns}$ | 1.973$^{ns}$ | 7.852$^{**}$ | 27.852$^{**}$ | 133.495$^{**}$ | 76.319$^{**}$ | 5.504$^{ns}$ | 8.690$^{**}$ |
| Treatment (T) | 19.268$^{**}$ | 11.041$^{**}$ | 2.270$^{ns}$ | 4.577$^{**}$ | 5.771$^{**}$ | 5.407$^{**}$ | 6.649$^{**}$ | 2.110$^{ns}$ |
| Variety x Treatment (V x T) | 3.649$^{**}$ | 3.568$^{**}$ | 0.715$^{ns}$ | 1.252$^{ns}$ | 0.928$^{ns}$ | 1.336$^{ns}$ | 5.391$^{**}$ | 1.117$^{ns}$ |

*$^{**}$ Significant at level 0.01; $^{ns}$ no significant.*
*GE-Germination energy; G-Seed germination; AS-Abnormal seedling; SRL- Seedling root length; SSL- Seedling shoot length; SL- Seedling length; SFW- Seedling fresh weight; SDW- Seedling dry weight.*

Based on the obtained results, it can be concluded that there was a statistically highly significant influence of variety and treatment on all tested parameters (Fpr=<.001) except for the variety on germination energy, seed germination and seedling fresh weight and the treatment on abnormal seedling and seedling dry weight, where there was no statistically significant influence. Unlike the individual factors, interaction had a highly significant effect only on germination energy, seed germination and seedling fresh weight.

According to the research results shown in *Fig. 1*, it is indicated that the highest values of germination energy (94 %) and seed germination (95 %), on average for all varieties, were found in the T2 treatment.

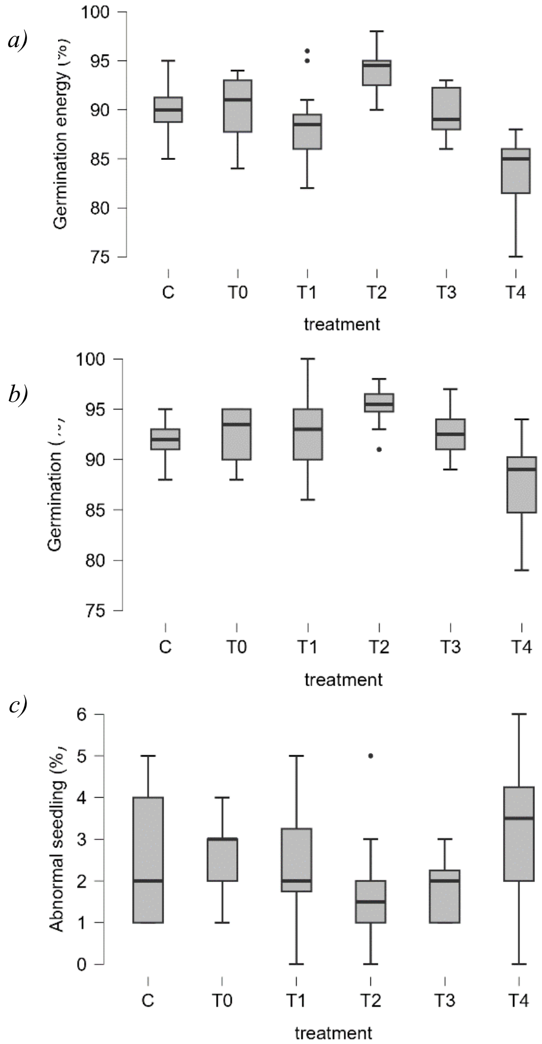


*Fig. 1. Germination energy, germination and abnormal seedlings of oilseed rape seed under different chemical treatments. (a) Germination energy; (b) Seed germination; (c) Abnormal seedlings.*

The seeds were treated only with fungicides, pesticides in the process of registration, as a potential replacement for the previously used preparations that were on the prohibited list. If we compare the results obtained when determining the number of abnormal seedlings, it can also be seen that with this treatment their number was the lowest. Therefore, it can be concluded that this preparation had a positive effect on the seeds of the tested rapeseed varieties and that it was precisely the smaller number of abnormal seedlings that made the difference compared to the treatment with only polymer and the control. Results of *Ergin et al. (2021)* showed that the fungicides did not adversely affect germination and a higher germination was obtained from the safflower seeds treated with fungicides. Namely, the effectiveness of fungicide reduced the development of seed-borne pathogens and thus enabled the seedlings to develop normally. On the other hand, in the treatment T4, in which the combination of insecticide and fungicide was also included, the values of germination energy (84 %) and seed germination (88 %) were the lowest, while the number of abnormal seedlings was the highest. A large number of researchers in various plant species has dealt with the problem of seed treatment. What can be concluded is that insecticide treatments in almost all studies led to a decrease in seed germination, especially if the seeds were left standing for a longer period of time (*Kuhar et al., 2002; Mrđa et al., 2011a; Tamindžić et al., 2013. Vujošević et al., 2017*). However, in certain situations, treatments with insecticides can lead to an increase in the examined parameters or to their being at the control level (*Bača et al., 2002; Tamindžić et al., 2016*). Despite the differences that appeared, the values of seed germination in all tested treatments were, according to the national rulebook, above the minimum values required for marketing.

The influence of chemical treatment on the length of seedlings is shown in the *Fig. 2*. Similar to seed germination, treatment T2 had the greatest positive effect on the length of the entire seedling and the length of the root. With these parameters, the largest average lengths were 16.42 cm for whole seedlings and 10.51 cm for roots. The largest length of the shoot was 6.25 cm in the T3 treatment. From the presented results, it can be seen that all seed treatments had a positive effect on seedling growth, because in all three traits, the smallest length was achieved in untreated seeds. In agreement with the results of this research, *Ergin et al. (2021)* concluded that fungicides increased root and shoot growth. However, *Panozzo et al. (2023)* stated that after treating the seeds, the growth of shoots and roots was reduced, which indicates that the fungicides became phytotoxic. In inbred lines of mayze, insecticides had different effects that depended on the genotype itself. Weak positive and statistically negatively significant effects on the growth of roots and shoot were recorded (*Tamindžić et al., 2013*).

The results of testing the effect of chemical treatment on the weight of seedlings of three rapeseed varieties are shown in the *Fig. 3*. On average, the seeds treated with the T3 treatment (0.48 g) had the highest fresh weight of seedlings, while the smallest in the control was only 0.40 g. On the other hand, there were no differences in the dry weight of seedlings between the treatments. Contrary to the results of this research, *Mrđa et al. (2009)* in examining the sensitivity of sunflower inbred lines concluded that the seeds treated with insecticide had the highest value of dry root weight, while *Inđić et al. (2008)* found that insecticides reduced root dry weight of oil gourd genotypes. Also, *Mrđa et al. (2011b)* concluded that treatment with fungicides had a positive effect on the seedlings dry weight of the tested sunflower hybrids. *Tamindžić et al. (2016)* state in their research that chemical treatments had both a positive and a negative effect on the dry weight of seedlings, and that this primarily depended on the genotype itself. They came to the same conclusion when examining the fresh weight of seedlings. *Ergin et al. (2021)* concluded that the seedling weight of safflower cultivars was not changed by the application of fungicides.

*a)*

*b)*

*c)*

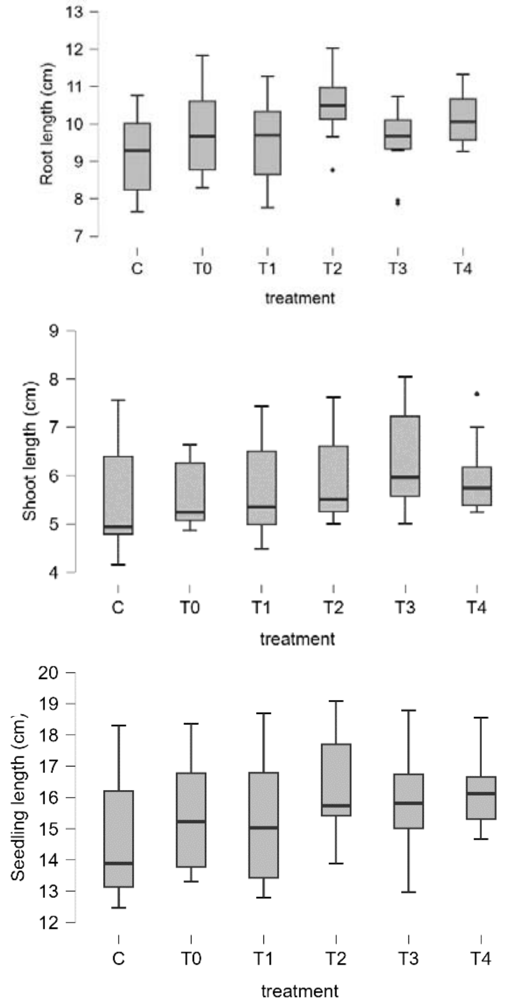


*Fig. 2. Parameters of growth of oilseed rape seedlings under different chemical treatments. (a) Seedling root length; (b) Seedling shoot length; (c) Seedling length.*

*a)*

*b)*

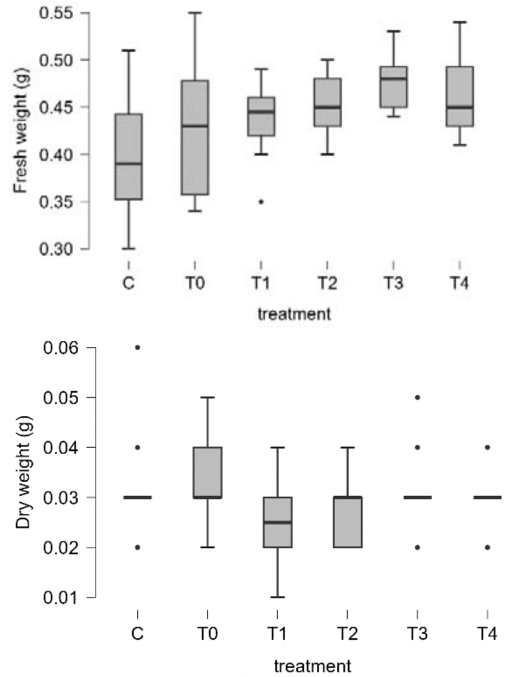


*Fig. 3. The weight of oilseed rape seedlings under different chemical treatments. (a) Seedling fresh weight; (b) Seedling dry weight.*

According to the Pearson coefficient (*Table 2*), the strongest positive correlation ($p<0.001$) was established between germination energy and seed germination ($r = 0.911$), seedling length and seedling root length ($r = 0.891$), and seedling length and seedling shoot length ($r = 0.849$), as expected. A negative and highly significant ($p \leq 0.001$) correlation was established between seed germination and abnormal seedlings ($r = -0.483$) and germination energy and abnormal seedlings ($r = -0.411$). These results agreement with the results (*Poštić et al., 2022; Poštić et al., 2023*).

*Table 2. Person correlation coefficient between the observed parameters of oilrape varieties.*

| No | Parameter | GE | G | AS | SRL | SSL | SL | SFW | SDW |
|---|---|---|---|---|---|---|---|---|---|
| 1 | GE | - | | | | | | | |
| 2 | G | $0.911^{**}$ | - | | | | | | |
| 3 | AS | $-0.411^{**}$ | $-0.483^{**}$ | - | | | | | |
| 4 | SRL | $0.223^{ns}$ | $0.180^{ns}$ | $-0.171^{ns}$ | - | | | | |
| 5 | SSL | $0.116^{ns}$ | $0.060^{ns}$ | $-0.346^{*}$ | $0.517^{**}$ | - | | | |
| 6 | SL | $0.199^{ns}$ | $0.143^{ns}$ | $-0.288^{ns}$ | $0.891^{**}$ | $0.849^{**}$ | - | | |
| 7 | SFW | $0.046^{ns}$ | $0.087^{ns}$ | $-0.085^{ns}$ | $0.337^{*}$ | $0.372^{**}$ | $0.405^{**}$ | - | |
| 8 | SDW | $-0.035^{ns}$ | $-0.116^{ns}$ | $0.107^{ns}$ | $0.109^{ns}$ | $-0.064^{ns}$ | $0.033^{ns}$ | $0.104^{ns}$ | - |

*** Significance of correlation at level 0.01; * significance of correlation at level 0.05; ns - no significance*
*GE-Germination energy; G-Seed germination; AS-Abnormal seedling; SRL-Seedling root length; SSL- Seedling shoot length; SL- Seedling length; SFW-Seedling fresh weight; SDW- Seedling dry weight.*

## CONCLUSION

Seed treatment is the best solution for plants protecting in the initial stages of development. Choosing the best combination of pesticides, especially if you take into account the dynamics of the availability of individual active substances, poses a great challenge to seed companies. In order to find the best possible solution for the most effective and safest combination, it is necessary to test all pesticides whose use is allowed for a given market, but also those whose registration is still planned. Through numerous studies, it has been proven that the genotype itself plays a significant role in the reaction to tested pesticides, so you should not accept the offered solutions without first testing your own material. The results of this work show that the applied pesticides do not have the same effect on the tested parameters, as well as that the new generation has the potential to adequately replace those that are prohibited.

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