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SEED GERMINATION AND SEEDLING GROWTH OF OILRAPE UNDER SALINE STRESS CONDITIONS

KLIJAVOST SEMENA I PORAST PONIKA ULJANE REPICE U USLOVIMA SONOG STRESA

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ABSTRACT

Oilrape is used for human consumption, domestic animal consumption, for biodiesel production, as bee pasture and as an important green manure. This crop is tolerant to many soil types (including saline soils) in the growing regions across the globe.

Testing was done on three oilrape winter varieties: Ana, Slavica and Ilija. The influence of salinity on seed quality was determined after the harvest using standard laboratory methods under laboratory conditions. Seed germination in the control ranged from 92.75 % do 96 %. As NaCl concentration increased from 150 mmol/l to 250 mmol/l, germination decreased, and statistically the lowest values were obtained at the concentration of 300 mmol/l in Slavica and Ilija varieties (57-84 %). In all studied genotypes, the first seedlings emerged after three days of testing in the control and at NaCl concentrations of 75 mmol/l, 100 mmol/l, 150 mmol/l and 200 mmol/l. The seed germinated on the medium moisturized with 250 mmol/l NaCl started to germinate after four days of testing, while the seed germinated on the medium moisturized with 300 mmol/l NaCl started germination after five days. The length of seedlings was statistically the most significant in the control in all three varieties. Statistically the lowest values were obtained in the seedlings at NaCl concentration of 300 mmol/l. For successful production under stress conditions, adaptable genotypes which have pronounced positive interaction with environmental conditions should be chosen.

Key words: oilrape, seed germination, salinity stress.

REZIME

Uljana repica je biljna vrsta koja je tolerantna na mnoge tipove zemljišta u regionima gajenja širom sveta, koja dobro podnosi zaslanjena zemljišta. Ispitivanja su izvedena na tri sorte ozime uljane repice: Ana, Slavica i Ilija. Nakon žetve, utvrđen je uticaj zaslanjenosti na kvalitet semena primenom standardnog laboratorijskog metoda. Filter papir je kvašen destilovanom vodom (kontrola) i različitim koncentracijama NaCl (75 mmol/l, 100 mmol/l, 150 mmol/l, 200 mmol/l, 250 mmol/l i 300 mmol/l). Nakon 7 dana utvrđeni su klijavost semena, brzina klijanja semena i dužina ponika.

Klijavost semena u kontroli se kretala od 92.75% do 96%. Sa povećanjem koncentracije NaCl od 150 mmol/l do 250 mmol/l klijavost se smanjivala i statistički najniže vrednosti dobijene su na koncentraciji od 300 mmol/l kod sorti Slavica i Ilija (57%-84%). Kod svih ispitivanih genotipova prvi klijanci su se pojavili nakon tri dana ispitivanja i to u kontroli i na koncentracijama NaCl od 75 mmol/l, 100 mmol/l, 150 mmol/l i 200 mmol/l. Seme naklijavano na podlozi kvašenoj sa 250 mmol/l NaCl počelo je da klija nakon 4 dana ispitivanja, a nakon 5 dana na podlozi kvašenoj sa 300 mmol/l NaCl. Dužina ponika je bila statistički značajno najveća u kontroli, kod sve tri sorte. Statistički značajno najniže vrednosti su dobijene kod ponika na koncentraciji 300 mmol/l NaCl.

Za uspešnu proizvodnju u stresnim uslovima treba odabirati genotipove koji su adaptabilni i imaju izraženu pozitivnu interakciju sa uslovima spoljne sredine.

Ključne reči: uljana repica, klijavost semena, soni stres.

INTRODUCTION

Oilrape is used for human consumption, domestic animal consumption, for biodiesel production, as bee pasture and as an important green manure. This crop is tolerant to many soil types in the growing regions across the globe. Oilrape is successfully grown on various types and subtypes of soil on the territory of the Republic of Serbia (Marinković *et al.*, 2011). For successful production of both the seed and vegetative mass, climatic conditions are as important as the soil. Climatic changes have great impact on agricultural production, especially on the crop and the yield growth (Marjanović-Jeromela *et al.*, 2011). It is estimated that drought decreases the yield by 17 %, salinity by 20 %, high temperatures by 40 %, low temperatures by 15 %, and the remaining factors by 8 % (Ashraf *et al.*, 2008). In order

to prevent the negative impact of drought and high temperatures, irrigated areas in the world and in our country are increased. During the process of irrigation the physical structure of the soil is disrupted due to the increase of Na⁺ and Cl⁻ ions and occurrence of salinity soils.

Soil and climatic conditions in Vojvodina can cause salinization of the soil by usage of inadequate irrigation water (Nešić *et al.*, 2003). Oilrape is a plant which has high tolerance towards salinity. Sensitivity of the plant towards the quantity of the salt in soil is not the same in all its growth stages. The most sensitive are the plants in the initial stages – germination and emergence. Presence of salt in the soil diminishes the plant capacity to absorb water from the medium (Munns, 2002), which has a direct influence on the germination process and seedling growth. In addition, the increased presence of Na⁺ and Cl⁻ ions affects the metabolism of protein and nucleic acids (Dantas *et*

al., 2007, Gomes-Filho et al., 2008). The mentioned negative effects of the salt present in the medium, as well as the quality of the seed itself will first affect the germination of the seed, then the plant stand, which will further influence the yield. Introducing modern agricultural production made the producers aware of the significance of high quality seeds, which are capable of germinating quickly and uniformly under diverse environmental conditions. Determination of the seed quality and its vigor reveals which seed lots can be found on the market. Therefore, it is important to make good estimation of the methods and tests used for testing seeds i.e. their vigor (Milošević et al., 2010). Advances in modern production allows for creation of new genotypes with better adaptability to various agroecological conditions (Mladenov et al., 2016).

The aim of this study was to determine the influence of various salt concentrations of the medium on seed germination, speed of germination and seedling length in the seed of various oilrape genotypes.

MATERIAL AND METHOD

Testing was done using three winter oilrape varieties: oilrape Ana (variety approved in Ukraine), Slavica (Standard in the Varietal commission of Republic of Serbia), and Ilija (variety approved in the European Union), all three developed at the Institute of Field and Vegetable Crops in Novi Sad. The impact of salinity on seed germination was studied after the harvest using standard laboratory methods, under laboratory conditions in the Laboratory for Seed Quality and Seed Health Testing, "Agricultural Station" Novi Sad.

Four replicates x 100 seeds were tested using a standard germination test. Filter paper was used as the medium. Filter paper was moisturized using distilled water (control) and various concentrations of NaCl (75 mmol/l, 100 mmol/l, 150 mmol/l, 200 mmol/l, 250 mmol/l and 300 mmol/l). Germination was tested in a germination chamber at alternating temperature of 20-30 °C, lower temperature and light regime for 16 h a day, and higher temperature and at night for 8 h, and relative air humidity of 95 % (ISTA, 2016). Determination of germinated seeds was done every day. Total test time was 7 days. Upon this period of seed germination, the speed of seed germination and seedling length were determined.

The obtained results were statistically analyzed using analysis of variance. The significance of difference between means was determined using Duncan's test ($p < 0.05$).

RESULTS AND DISCUSSION

Germination ranged from 92.75 % (Ana) to 96.00 % (Ilija) (Fig. 1). Seed germination in Ana variety was on the control level at all applied concentrations, ranging from 88.25 % (200 mmol/l NaCl) to 94.50 % (100 mmol/l NaCl). Seed germination in Slavica variety was 93.50 % (control), while statistically significantly lower value was obtained in seed germinated at the concentration of 300 mmol/l NaCl (84.00%). In Ilija variety seed germination at the concentrations of 75 mmol/l NaCl (95.50 %) and 100 mmol/l NaCl (96.00 %) was on the control level (96.00 %), while statistically significantly lower values of the tested parameter were obtained in seed germinated at the concentrations of NaCl 250 mmol/l (81.25 %) and 300 mmol/l (56.75 %). Seed germination at the concentration of 300 mmol/l NaCl was statistically significantly higher in Ana variety (92.75 %) compared to Slavica (84.00 %) and Ilija (56.75 %) varieties. From the obtained results, it can be seen that plants can tolerate lower NaCl concentrations, which have no negative effects on

the germination process, while high NaCl concentrations exert negative effects on the tested parameter. According to Mohammadi (2009), high NaCl concentrations have negative effects on the process of water absorption from the medium, as a result of changes in osmotic regulation in the plant, and the increased concentrations of Na^+ and Cl^- ions are toxic. Different varietal sensitivity to increased salt concentration in the medium was determined by Jovičić et al. (2014) in his studies. Seed germination depends on the production year (Vujaković et al., 2014). Water stress, insufficient nutrients and extreme temperatures negatively affect seed germination (Castillo et al., 1994).

The first seedlings emerged in the control and at NaCl concentrations of 75 mmol/l, 100 mmol/l, 150 mmol/l and 200 mmol/l after three days of testing in all tested genotypes (Tab. 1.). Those ungerminated seeds germinated after four days of testing on the medium moistened with NaCl concentrations of 250 mmol/l. Seeds of Ana variety placed on the medium moistened with 300 mmol/l NaCl started to germinate after four days, and seeds of Slavica and Ilija varieties after five days of testing. Germination speed depended both on the concentration of NaCl in the medium, and on the variety. Negative effect of NaCl on the germination speed was determined by Faravani et al. (2013) in his studies. Draught (Shahverdikadi et al., 2011) and temperature (Gairola et al., 2011) also exert great influence on the speed of germination.

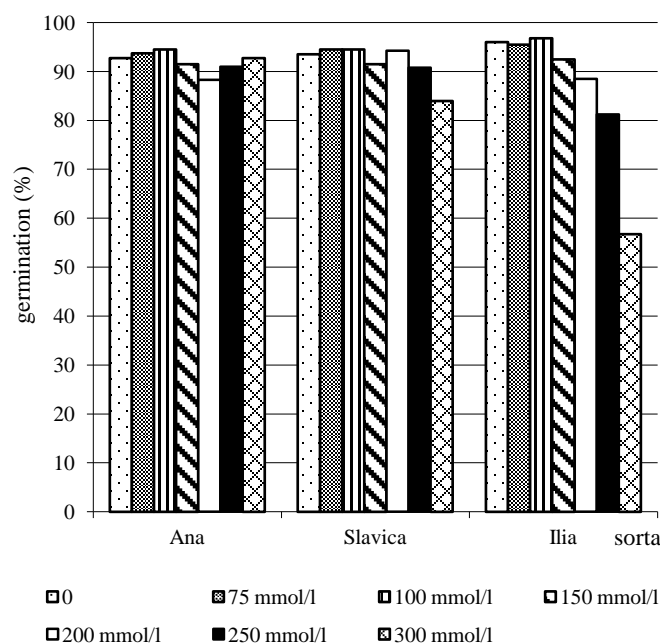


Fig. 1. Germination of oilrape seed at various concentrations of NaCl

Seedlings length was statistically significantly highest in the control (114.50-122.13 mm) in all three varieties (Fig. 2). As NaCl concentration increased, the length of seedlings decreased. Statistically significantly lowest values were obtained for the seedlings at the concentrations of 300 mmol/l NaCl. (20.63-44.88 mm). The same as in seed germination, the increased concentration of Na^+ ions has negative effect on seedling growth due to changes in osmotic potential in young plants (Munns and Tester, 2008). According to Othman et al. (2006), increased salt concentration reduces the use of spare nutritious substances in seed, which is reflected on the seedling length.

Table 1 – Speed of oilrape seed germination at various NaCl concentrations

Variety	Concentration (mmol/l NaCl)	Germination per days (%)						
		1	2	3	4	5	6	7
Ana	0	0	0	88.50	90.25	91.75	92.75	92.75
	75	0	0	90.50	93.00	93.75	93.75	93.75
	100	0	0	92.25	93.00	93.75	94.50	94.50
	150	0	0	81.50	90.00	91.25	91.50	91.50
	200	0	0	21.00	86.00	87.30	88.30	88.30
	250	0	0	0	79.75	88.50	91.00	91.00
	300	0	0	0	10.50	89.00	92.75	92.75
Slavica	0	0	0	91.00	91.50	92.75	93.50	93.50
	75	0	0	92.25	93.75	94.50	94.50	94.50
	100	0	0	91.25	92.75	94.50	94.50	94.50
	150	0	0	86.25	90.50	90.75	91.50	91.50
	200	0	0	20.00	90.75	93.00	94.25	94.25
	250	0	0	0	54.75	88.50	90.75	90.75
	300	0	0	0	0	68.50	83.25	84.00
Ilija	0	0	0	92.50	94.75	95.25	96.00	96.00
	75	0	0	93.50	94.75	95.00	95.50	95.50
	100	0	0	93.80	95.30	96.30	96.80	96.80
	150	0	0	40.75	90.25	92.00	92.50	92.50
	200	0	0	6.25	85.00	88.50	88.50	88.50
	250	0	0	0	23.25	76.75	81.25	81.25
	300	0	0	0	0	31.50	52.75	56.75

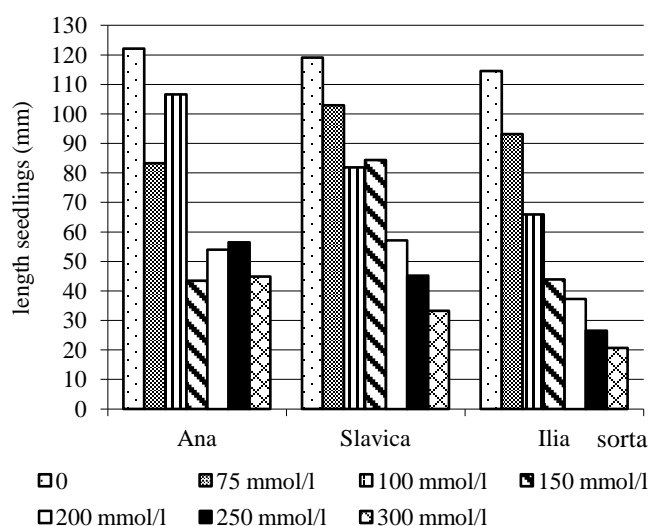


Fig. 2 - The length of oilrape seedlings at various NaCl concentrations

CONCLUSION

Based on the obtained results the following can be concluded:

- NaCl concentration of 300 nmol/l had negative effect on oilrape seed germination in Slavica and Ilija varieties. Ana variety proved to be the most tolerant to increased NaCl concentrations.

- Speed of germination depended on NaCl concentration in the medium.

- The length of seedling was the highest in the control, and statistically significantly lowest in the seedlings obtained at NaCl concentration of 300 nmol/l. - For successful production under stress conditions, the adaptable genotypes which have pronounced positive interaction with environmental conditions should be chosen. The study has been granted by the Ministry of Education, Science and Technological Development, Republic of Serbia, project: Development of new varieties and improvement of new production technologies of oil crops for different purposes, No TR 31025, duration: 2011-2016.

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