Biblid: 1821-4487 (2015) 19; 4; p 171-174
UDK: 62-634.5

Original Scientific Paper
Originalni naučni rad

VIABILITY OF OIL RAPE SEED (*Brassica napus* L.)

ŽIVOTNA SPOSOBNOST SEMENA ULJANE REPICE (*Brassica napus* L.)

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ABSTRACT

According to the surfaces on which the oil rape is grown, it is considered the third most important oil crop of moderate climate zone in the world today. The aim of this paper was to determine the seed viability by application of both the standard laboratory test and the vigor tests.

Testing was done using 9 oil rape genotypes (three winter varieties: Slavica, Zlatna and Ilija; three spring varieties: Mira, Jovana and JR-NS-7; three hybrids NS-UR 4, NS-UR 6 and NS-UR 13). Seed germination, seedling growth parameters, fresh seedling mass, and vigor index were determined using standard laboratory (SL) test, accelerated aging (AA) test, and controlled deterioration (SD) test.

With applied SL test, on average, statistically significantly higher values for all tested parameters were obtained in comparison to AA and CD tests. By calculating the vigor index genotypes Zlatna, JR-NS 7, NS-UR 4, NS-UR 6 and NS-UR 13 were singled out, in which statistically significantly higher values were obtained with SL in relation to AA and CD tests.

***Key words**: oil rape, seed germination, seed viability.*

REZIME

Danas je uljana repica najvažnija uljana biljka umerenog klimata i po površinama na kojima se gaji zauzima treće mesto među uljaricama u svetu. Zbog svoje raznovrsne primene, površine pod ovom kulturom se povećavaju iz godine u godinu, pa je potrebno obezbediti dovoljne količine kvalitetnog semena. U laboratorijskim uslovima se životna sposobnost semena ispituje različitim metodama. Cilj rada je bio da se utvrdi životna sposobnost semena primenom standardnog laboratorijskog testa i vigor testova.

Ispitivanja su izvedena na 9 genotipova uljane repice (tri ozime sorte: Slavica, Zlatna i Ilia; tri jare sorte: Mira, Jovana i JR-NS-7; tri hibrida NS-UR 4, NS-UR 6 i NS-UR 13). Utvrđena je klijavost semena, dužina ponika, sveža masa ponika i vigor indeks primenom standardnog laboratorijskog (SL) testa, testa ubrzanog starenja (AA) i testa kontrolisanog propadanja (CD).

Primenom SL testa u proseku dobijene su statistički značajno više vrednosti za sve ispitivane parametre u odnosu na primenu AA i CD testa. Izračunavanjem vigor indeksa izdvojili su se genotipovi Zlatna, JR-NS 7, NS-UR 4, NS-UR 6 i NS-UR 13 kod kojih su se javile statistički značajno više vrednosti primenom SL testa u odnosu na primenu AA i CD testa. Uzorci navedenih genotipova su pokazali manju tolerantnost na nepovoljne uslove visoke temperature i visoke vlažnosti vazduha. Vigor testovi su korisni jer nam daju pouzdaniju informaciju o kvalitetu semena, a naročito ih treba koristiti ako se setva vrši u vreme pojave nepovoljnih uslova u vreme nicanja i ako je potrebno vršiti skladištenje i čuvanje semena za narednu vegetacionu sezonu.

***Ključne reči**: uljana repica, klijavost, životna sposobnost semena.*

INTRODUCTION

The oil rape seed is considered today the third most significant oily plant of the moderate climate in the world. It is primarily grown for its seed containing high quantity of oil (40-80 %) (*Marinkovic et al., 2009*). Upon oil extraction remains a by-product meal containing 25-40% of protein (*Enami, 2011*) and 8 % of oil, which is used as a quality component for domestic animal feed. Besides, the oil rape plays a significant role in biodiesel production and the significant source of renewable energy, used both as green manure and as honey plant (*Mustapic, 2008*).

Due to its diverse application the oil rape is an interesting plant species and it is necessary to provide the quality seed ie. high vigor seed for its production. Seed viability or vigor is a set of properties that determines the activity and behavior of a seed lot of commercially acceptable germination under various environmental conditions. This is not the trait that can be measured separately as it is possible with seed germination, but rather a term encompassing several traits regarding the following aspects of the condition of a seed lot such as: speed and uniformity of germination and seedling growth, ability of seed to emerge under unfavorable environmental conditions, and state of seed upon storage, and first of all retention of germination capacity (*ISTA, 2014*). Determination of seed viability is very significant for seed stored under unknown or unfavorable conditions, for this trait is used as an indicator of seed lot storage potential (*AOSA, 2002*).

Since the testing of seed quality and viability indicate the seed lots that can be placed on the market, it is necessary to consider methods and tests used for these testing in detail (*Milošević et al., 2010*). Vigor tests proved to be the better indicators of seed behavior under field conditions (*Kolasinska et al., 2000*). These tests provide additional information on speed and uniformity of germination and emergence in field under various unfavorable environmental conditions (*Powell and Matthews, 2005*). Test of controlled deterioration (CD) and accelerating aging test (AA) are both successfully used for ranking and prediction of emergence under unfavorable conditions for *Brassica* species and vegetables (*Powell and Matthews, 1981; Bennett et al., 2004; Mavi and Demir, 2007*). When CD test is applied the wet seed is exposed to high temperature, and with AA test it is exposed to both the high temperature and high moisture, which all together contribute to rapid deterioration of the seed quality. The aim of this paper was to determine germination and viability of oil rape seed by application of standard laboratory and vigor tests (test of controlled seedling deterioration, and accelerated aging test).

MATERIAL AND METHOD

Testing was done on nine oil rape genotypes (three winter varieties: Slavica, Zlatna and Ilija; three spring varieties: Mira, Jovana and JR-NS-7; three winter hybrids NS-UR 4, NS-UR 6 and NS-UR 13). Tested genotypes were selected at the Institute of field and vegetable crops in Novi Sad, and were chosen according to their significance within the breeding program. Seed germination, seedling length, fresh seedling mass and vigor index were determined for oil rape genotypes using standard laboratory test, test of controlled deterioration and accelerated aging test.

Standard laboratory test (SL test) was performed in four replications/100 seeds each on filter paper and temperature of 20-30 ^{o}C (*ISTA, 2014*). Mentioned parameters were determined after seven days of testing. The tests were done at the ”Agricultural station“ in Novi Sad.

Accelerated aging test was also done in four replications/100 seeds each. Seed was placed in dishes and in water bath at temperature of 39 ^{o}C and relative air humidity of 100 % for 72 hours (*Hampton and TeKronyn, 1995*). Following this treatment the seed was subjected to vigor testing as with standard laboratory testing, and determination of the mentioned parameters took place after seven days.

Test of controlled deterioration (CD test) starts by elevating the seed moisture content to 20 %. Wet seed is placed in nylon bags, tightly closed, wrapped with Al-folia and placed into a refrigerator at 7 ^{o}C for 24 hours. Upon that period the seed is transferred to water bath at 45 ^{o}C for 24 hours (*ISTA, 2014*). After all treatments, 4 x 100 seeds are subjected to germination under optimal laboratory conditions. After seven days the mentioned parameters are determined.

Vigor index is the product of seedling length and seed germination.

Obtained results were statistically processed using variance analysis. Significance of differences among means was determined using Duncan test ($p<0.05$).

RESULTS AND DISCUSSION

On average, statistically significantly lower values for seed germination were obtained by applying AA test (88.64 %) and CD test (88.06 %) in relation to SL test (93.08) (Tab. 1). Germination of seed in all tested genotypes ranged from 88,75 to 96.00 % when SL test was applied, from 81.25 to 92.00 % (AA test), and from 82.50 to 94.00 % (CD test). Values of the tested parameter in all tested genotypes and all applied tests were above 75 %, which is a legal minimum prescribed by the Rule on quality of seed of agricultural plants (Official gazette 47-87). Statistically significantly the lowest value was obtained for genotypes NS-UR 13 (SL and AA tests), while among other genotypes no significant differences were found. CD test gave the highest values of the tested parameters in genotypes Ilia and Zlatna, and in relation to them statistically significantly lower values were obtained for genotypes Jovana, JR-NS 7 and NS-UR 13. Compared to the values obtained by the applied SL test, the CD test gave statistically significantly lower values for genotypes Mira, Jovana and JR-NS 7.

Seedling length depended on the applied test. Statistically significantly the highest values were obtained with the applied SL test (118.7 mm) (Tab.1). When SL test was applied the seedling length in all tested genotypes ranged from 100.5 mm (Slavica) to 136.3 mm (NS-UR 4), with AA test from 91.5 mm (Ilia) to 115.1 mm (NS-UR 6), and with CD test the values ranged from 91.0 mm (Jovana) to 115,1 mm (NS-UR 4). Genotypes Zlatna, JR-NS 7, NS-UR 4, NS-UR 6 and NS-UR 13 had statistically significantly lower values of the tested parameter with applied SL test in comparison to the values obtained when AA and CD tests were applied.

Table 1 – Germination of seed, seedling length, fresh seedling mass and vigor index in various oil rape genotypes obtained by application of the standard laboratory test, accelerated aging test and test of contolled deterioration

Test	Genotype	Seed germination (%)	Seedling length (mm)	Fresh seedling mass (g)	Vigor index
Standard laboratory test (SL test)	Slavica	96.00 ^{a}	100.5 $^{e-j}$	0.46 $^{a-f}$	9642.00 $^{e-i}$
	Zlatna	94.25 $^{a-c}$	130.0 ^{ab}	0.48 $^{a-e}$	12257.62 ^{ab}
	Ilia	95.75 ^{ab}	109.4 $^{d-i}$	0.48 $^{a-f}$	1047.12 $^{c-e}$
	Mira	92.50 $^{a-d}$	100.5 $^{e-j}$	0.42 $^{d-h}$	9304.37 $^{e-i}$
	Jovana	92.00 $^{a-d}$	108.4 $^{d-i}$	0.47 $^{a-f}$	9978.37 $^{c-h}$
	JR-NS 7	92.00 $^{a-d}$	121.0 $^{b-d}$	0.41 $^{e-h}$	11145.62 $^{b-d}$
	NS-UR 4	92.25 $^{a-d}$	136.3 ^{a}	0.53 ^{a}	12565.12 ^{a}
	NS-UR 6	94.25 $^{a-c}$	133.9 ^{ab}	0.48 $^{a-f}$	12618.25 ^{a}
	NS-UR 13	88.75 $^{d-g}$	128.1 $^{a-c}$	0.48 $^{a-e}$	11370.00 $^{a-c}$
	Average	**93.08 ^{a}**	**118.7 ^{a}**	**0.47 ^{a}**	**11040 ^{a}**
Accelerated aging test (AA test)	Slavica	92.00 ^{a}	105.8 $^{d-j}$	0.46 $^{a-f}$	9724.50 $^{d-i}$
	Zlatna	92.00 $^{a-d}$	112.3 $^{d-g}$	0.45 $^{a-f}$	10325.50 $^{c-f}$
	Ilia	90.00 $^{a-d}$	91.5 ^{j}	0.35 ^{h}	8255.75 ^{ij}
	Mira	87.75 $^{c-g}$	109.9 $^{d-h}$	0.41 $^{f-h}$	9660.75 $^{e-i}$
	Jovana	88.25 $^{d-g}$	109.1 $^{d-i}$	0.41 $^{e-h}$	9647.87 $^{e-i}$
	JR-NS 7	90.50 $^{c-f}$	94.9 $^{h-j}$	0.37 $^{g-h}$	8582.37 $^{h-j}$
	NS-UR 4	87.75 $^{d-g}$	113.5 $^{d-f}$	0.50 $^{a-d}$	9957.50 $^{c-h}$
	NS-UR 6	88.25 $^{d-g}$	115.1 $^{c-e}$	0.51 $^{a-c}$	10152.37 $^{c-g}$
	NS-UR 13	81.25 ^{i}	93.8 ^{ij}	0.45 $^{b-f}$	7616.00 ^{j}
	Average	**88.64 ^{b}**	**105.1 ^{b}**	**0.44 ^{b}**	**9325 ^{b}**
Test of contolled deterioration (CD test)	Slavica	90.00 $^{c-g}$	97.9 $^{f-j}$	0.47 $^{a-f}$	8809.75 $^{g-j}$
	Zlatna	91.00 $^{b-e}$	104.5 $^{e-j}$	0.44 $^{c-g}$	9489.50 $^{e-i}$
	Ilia	94.00 $^{a-c}$	99.3 $^{f-j}$	0.42 $^{e-h}$	9329.12 $^{e-i}$
	Mira	86.75 $^{e-h}$	95.8 $^{h-j}$	0.37 $^{g-h}$	8291.75 $^{i-j}$
	Jovana	82.50 $^{h-i}$	91.0 ^{j}	0.37 $^{g-h}$	7492.00 ^{j}
	JR-NS 7	85.50 $^{g-h}$	97.0 $^{g-j}$	0.44 $^{c-g}$	8071.25 $^{i-j}$
	NS-UR 4	86.75 $^{e-h}$	115.1 $^{c-e}$	0.52 ^{ab}	9977.87 $^{c-h}$
	NS-UR 6	90.00 $^{c-g}$	112.4 $^{d-g}$	0.46 $^{a-f}$	10120.75 $^{c-g}$
	NS-UR 13	86.00 $^{f-h}$	103.3 $^{e-j}$	0.50 $^{a-d}$	8858.50 $^{f-j}$
	Average	**88.06 ^{b}**	**101.8 ^{b}**	**0.44 ^{b}**	**8960 ^{b}**

The fresh seedling mass in all tested oil rape genotypes ranged from 0.41 g (JR-NS 7) to 0.53 g (NS-UR 4) (Tab. 1) with the applied SL test. Application of SL test gave statistically significantly higher value in genotype NS-UR 4 in comparison to genotypes Mira and JR-NS 7. With applied AA test statistically significantly higher values were obtained in genotypes NS-UR 4 (0.50 g) and NS-UR 6 (0.51 g) in comparison to genotypes Ilia (0.35 g), Mira (0.41 g), Jovana (0.41 g) and JR-NS 7 (0.37 g). Genotype NS-UR 4 (0.52 g) had statistically significantly higher value of the tested parameter with applied CD test in comparison to genotypes Zlatna (0.44 g), Ilia (0.42 g), Mira (0.37 g), Jovana (0.37 g) and JR-NS 7 (0.44 g). Statistically significant differences of the seedling mass were observed in genotype Ilia between values obtained with applied SL test (0.48 g) and AA test (0.35 g), as well as in genotype Jovana with applied SL test (0.47 g) and CD (0.37 g).

Vigor index had, on average, statistically significantly higher value when SL test was applied (11040) in comparison to AA test (9325) and CD test (8960) (Table 1). Statistically significantly higher values of the tested parameters were obtained in genotypes Zlatna, JR-NS 7, NS-UR 4, NS-UR 6 and NS-UR 13 with applied AA and CD tests. Samples of the above mentioned genotypes proved to be less tolerant to high temperature and high air humidity, ie. they were less vigorous. Vigour index is the product of the seedling length and seed germination, so the differences that occurred between tests and genotypes gave more reliable picture of the quality of seed in comparison to other parameters.

The seed quality and primarily its germination and viability depend on production and storage conditions. Seed produced under unfavorable conditions at the time of formation and maturation of seed has decreased viability, and is not recommended for early sowing, when conditions for emergence are unfavorable because it would lead to unsatisfactory stand density influencing the yield (*Vujaković et al., 2011*). Seed germination depended on production year (*Vujaković et al., 2014*). Production of seed in the condition of water stress, insufficient nutrients, temperature extremes lead to diminished seed quality (*Castillo et al., 1994*). On the other hand, mechanical damages occurred during harvesting and processing, as well as the improper storage may negatively affect the seed vigour (*Peksen et al., 2004*). Beside the effect that seed size has on 1000-grain weight, it can also affect other seed quality parameters. Seedswith higher content of reserve nutrients provide better developed plants, so it is possible to expect higher yields (*Kostić et al., 2013*). Standard laboratory test is a good indicator of seed viability, which can be used to predict field emergence only if the soil conditions are almost ideal (*Durrant and Gummerson, 1990*). However, oil rape sowing under our production conditions is performed at the end of August and the beginning of September, when unfavorable conditions such as high temperatures, draught or excess moisture may occur, and values obtained with standard laboratory test may fail to be confirmed under field conditions. Accelerated aging test is one of the most commonly used tests today for vigor testing, primarily because it showed a good correlation with field emergence (*Lovato et al., 2005*).

With accelerated aging test seed is subjected, for a short period of time, to double stress conditions, high temperature and high relative humidity, which cause accelerated aging of seed (*Hampton and TeKrony, 1995*). During controlled deterioration the seed is subjected to high temperature while steadily and precisely elevating the seed moisture content. These conditions cause accelerated deterioration and aging of seed. Moisture content in seed is elevated before subjecting the seed to higher temperature, and in that way insuring that all samples that are being tested are subjected to previously determined degree of damage during testing (*ISTA, 2014*).

Highly vigorous seeds retain high germination even after application of these tests, while the seed with poor vigour has low germination. In our studies genotypes Mira, Jovana and JR-NS 7, had statistically significantly lower values of seed germination with applied CD test in comparison with the values obtained with SL test, which proved that seed of these genotypes was less vigorous compared to others. In our studies, somewhat lower values of our parameters, but not statistically significant were obtained with CD test in comparison to AA test. *Mavi and Demir (2007*) are of the opinion that CD test gives more accurate results of seed vigour in comparison to AA test. Some genotypes were singled out for their high or low values, but in most genotypes no statistically significant differences were found. *Mavi and Demir (2007)* find that an increase in temperature and duration of exposure of seed to unfavorable conditions in AA and CD tests contribute to a better separation, ie. obtaining differences among studied genotypes or seed lots. All these facts should be taken into account, because optimal plant density is achieved by sowing high quality seed, which also affects the yield alone. On the other hand, seed of genotypes and lots having high vigour can be successfully stored and kept for the following season.

CONCLUSION

Based on the obtained results the following conclusion can be drawn:

With applied SL test, on average, statistically significantly higher values for all tested parameters were obtained in comparison to AA and CD tests.

By calculating the vigor index genotypes Zlatna, JR-NS 7, NS-UR 4, NS-UR 6 and NS-UR 13 were singled out, in which statistically significantly higher values were obtained with SL in relation to AA and CD tests. Samples of the above mentioned genotypes were less tolerant to high temperature and high air humidity.

Vigor tests are useful for they provide reliable information on seed quality, and they should be used in particular if sowing is performed during adverse wheater conditions, and during field emergence, and in case the should be stored and kept for the following season.

ACKNOWLEDGEMENT: The study has been granted by 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: 2011-2014

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Received: 23. 02. 2015. Accepted: 02. 07. 2015.