Biblid: 1821-4487 (2019) 23; 2; p 55-57
UDK: 581.48

Original Scientific Paper
Originalni naučni rad

OILSEED RAPE SEED AGING

STARENJE SEMENA ULJANE REPICE

Milka VUJAKOVIĆ, Ana MARJANOVIĆ-JEROMELA**, Jelena OVUKA**, Dušica JOVIČIĆ**, Jasna SAVIĆ****
*Agricultural Extension Service *„Agricultural station", 21000 Novi Sad, Temerinska 131, Serbia*
*** Institute of field and vegetable crops, 21000 Novi Sad, Maksima Gorkog 30, Serbia*
**** Faculty of Agriculture, University of Belgrade, 11080 Beograd, Nemanjina 6, Serbia*
e-mail: milka.vujakovic@gmail.com

ABSTRACT

The purpose of this study is to determine the quality of oilseed rape seeds, produced at various locations, immediately after harvest and after a one-year storage period under controlled and uncontrolled conditions. The experimental testing was performed on seeds of five winter oilseed rape varieties produced at two localities (Rimski Šančevi and Pančevo). Following harvest and a one-year storage period, the seed quality was determined under laboratory conditions using standard germination tests. Seed germination, seedling length and vigour index were determined after seven days. The seed germination, length of seedling and vigour index values of the seeds produced at both localities were lower after one year of storage. Differences obtained between the seeds stored under controlled and uncontrolled conditions were not statistically significant. The seeds with higher initial values of all the tested parameters proved better under storage conditions.

***Key words:** oilseed rape, seed germination, seed aging*

REZIME

Cilj istraživanja je bio da se utvrdi kvalitet semena neposredno posle žetve i nakon godinu dana skladištenja, u kontrolisanim i nekontrolisanim uslovima, kod semena proizvedenog na različitim lokalitetima.

Ispitivanja su izvedena na semenu, pet sorti ozime uljane repice, proizvedenog na dva lokaliteta (Rimski Šančevi i Pančevo). Nakon žetve i godinu dana skladištenja, u laboratorijskim uslovima, utvrđen je kvalitet semena primenom standardnog laboratorijskog metoda. Nakon 7 dana utvrđeni su klijavost semena, dužina ponika i vigor indeks.

Klijavost semena kod sorata proizvedenih na lokalitetu Rimski Šančevi kretala se 91,00 – 95,50%. Nakon godinu dana starenja kod semena čuvanog u kontrolisanim uslovima klijavost je bila niža i iznosila je 85,00 – 91,75%, dok je kod semena čuvanog u nekontrolisanim uslovima klijavost iznosila 84,50 – 90,75%. Klijavost semena kod sorata proizvedenih na lokalitetu Pančevo je bila značajno manja i neposreno posle žetve je iznosila 73,75 – 82,50%. Nakon godinu dana starenja klijavost je statistički značajno opala i kod semena čuvanog u kontrolisanim (51,25 – 71,0%) i nekontrolisanim uslovima (53,50 – 71,25%). Dužina ponika i vigor indeks su bili niži nakon godinu dana sklaištenja kod semena proizveenog na oba lokaliteta. Razlike dobijene između semena čuvanog u kontrolisanim i nekontrolisanim uslovima nisu bile statistički značajne. Seme koje je imalo više početne vrednosti ispitivanih parametara bolje je podnelo uslove sklaištenja.

***Ključne reči:** uljana repica, klijavost semena, starenje semena*

INTRODUCTION

Oilseed rape is grown as an oil plant in moderate climate regions. According to the area devoted to oilseed rape, it is considered the third most important oil crop in the world. Areas devoted to this species are constantly growing. It is grown mainly for its seeds containing a high quantity of oil (40-80%) (Marinković et al., 2009). Upon oil extraction, the meal containing 25-40 % of protein and 8 % of oil remains as a by-product, which is used as a quality component for domestic animal feed (Enami, 2011). Furthermore, oilseed rape plays a significant role in the biodiesel production as a source of renewable energy, thus offering the possibility of using bio-ethanol instead of fossil methanol (Kiss and Bošković, 2012).

In addition to different biotic and abiotic factors, the successful production and achievement of high yields also depend on the quality of seeds. The most important seed quality parameter is seed germination, which influenced by a great many factors. Seed germination depends on weather conditions, especially temperature, as well as the quantity and distribution of rainfalls during the period between blooming and seed maturation. Timely harvest, storage conditions after harvest and seed processing exert a significant effect on the quality and longevity of seeds. Aging presents a serious problem in developing countries where seeds are stored in places without proper humidity and temperature control (Mohammadi et al., 2011). Various biochemical and physiological changes take place in seeds and the rates of these changes depend on the storage temperature and relative air humidity (Ratajczak et al., 2015). Reductions in vigour (Gupta and Aneja, 2004) and seed germination (Arefi and Abdi, 2003) are the consequence of seed aging. During seed storage under unfavourable conditions, the quantity of free radicals increases affecting the enzyme inactivation, protein degradation, and disruption of cellular membranes and DNA (McDonald, 1999). Protein damage caused by oxidative stress may lead to reductions in seed vigour and seed viability (Barreto and Garcia, 2017).

The purpose of this study is to determine the quality of oilseed rape seeds, produced at various locations, immediately after harvest and after a one-year storage period under controlled and uncontrolled conditions.

MATERIAL AND METHOD

The oilseed rape seeds used in this study were produced at Rimski Šančevi and Pančevo in 2016/2017. A total of five oilseed rape genotypes were enrolled in the study (NS Vid, Triangle, AMJ-2, AMJ-3, NS Ras). In the genotypes tested, the genetic potential for the oil content is 45 % and the protein content is 20 %. The genotypes tested were selected at the Institute of Field and Vegetable Crops in Novi Sad.

The seed moisture (ISTA, 2016), seed germination, seedling length and vigour index of the seed samples examined were determined under laboratory conditions after harvest using the standard laboratory method in the Laboratory for Seed Testing in Novi Sad. The standard laboratory test was performed in quadruplicate on 100 seeds of each genotype tested at temperature of 20-30 ^{o}C using filter paper (ISTA, 2016). The parameters stated above were determined after seven days of testing. The vigour index is the product of seedling length and seed germination. The testing was repeated after a one-year storage period under controlled conditions (moisture 55-60 % and temperature 4 ^{o}C) and in the warehouse. The results obtained were statistically processed using the analysis of variance. The significance of differences between the means obtained was determined using the LSD test ($p < 0.05$).

RESULTS AND DISCUSSION

The moisture content of the oilseed rape genotypes harvested at the Rimski Šančevi locality ranged from 5.1 – 5.2 % (NS Vid 5.1 %, Triangle 5.2 %, AMJ-2 5.2 %, AMJ-3 5.1 %, NS Ras 5.1 %), whereas the moisture content of the oilseed rape genotypes harvested at the Pančevo locality was significantly higher ranging from 11.4 – 15.1 % (NS Vid 12.8 %, Triangle 11.4 %, AMJ-2 13.7 %, AMJ-3 12.9 %, NS Ras 15.1 %).

The early germination of seeds produced at the Rimski Šančevi locality was very high (91.00 – 95.50 %) (Table 1). After 12 months of storage, the germination declined, but it was not statistically significant. Some non-significant differences were also found between the values obtained for the seed stored under controlled conditions (85.00-91.75 %) and the seed stored in the warehouse (84.50-90.75 %). The germination of seeds produced at the Pančevo locality was significantly lower (73.75 – 82.50 %) in all the tested genotypes. The seed germination of the genotypes NS Vid and AMJ-3 was below the legal minimum, which is 75 % (The Rule on the Seed Quality of the Agricultural Plants, Official Gazette SFRJ 47/87). After 12 months of storage, significantly lower values of the tested parameters were obtained in all the studied genotypes (51.25 – 71.25 %). The values obtained did not meet the minimum values prescribed by the Rules. Significantly higher values were obtained in the NS Ras genotype for the seeds stored under controlled conditions (67.00 %), whereas significantly higher values were obtained for the Triangle genotype seeds kept in the warehouse (57.00 %). In all other genotypes, somewhat higher values were obtained for the seeds stored under controlled conditions, but the differences recorded were statistically non-significant. Weather conditions during the vegetation period of 2016/2017 were favourable for oilseed rape production at both localities under consideration (Table 2). Temperature and distribution of rainfalls were similar at both studied localities, thus the differences obtained did not result from the weather condition impact. The moisture content of the seed produced at the Pančevo locality was significantly higher, which had a negative effect on the seed germination. Walters et al. (2010) reported that increased moisture content, storage temperature, genotype characteristics and their interactions had an adverse effect on the seed quality. The dependence of seed germination on the production year was determined by Elis and Copelan (2001). The highest seedling length value of the seeds tested immediately after harvest was found in the genotype AMJ-2 produced at the locality of Rimski Šančevi (125.38 mm), whereas the lowest value was obtained in the genotype AMJ-3 at the Pančevo locality (107.50 mm) (Table 3). In contrast to the genotypes Triangle and NS Ras, all the other tested oilseed rape genotypes exhibited a statistically significant decline in the parameter values examined after 12 months of storage under controlled conditions and in the warehouse at the Rimski Šančevi locality. A statistically significant decline in the seedling length was not observed only in the genotype AMJ-3 stored in a warehouse at the Pančevo locality. An adverse aging effect on the carrot seedling growth was determined by Al-Maskri et al. (2003).

Table 1. Seed germination of various oilseed rape genotypes produced at the Rimski Šančevi and Pančevo localities

Locality	Genotype	Seed germination (%)		
		0 month	12 months under controlled conditions	12 months in warehouse
Rimski Šančevi	NS Vid	93.75^{ab}	90.75^{abcd}	87.50^{bcdef}
	Triangle	91.00^{abcd}	85.00^{cdef}	84.50^{def}
	AMJ-2	94.75^{a}	90.50^{abcd}	90.75^{abcd}
	AMJ-3	95.50^{a}	91.50^{abc}	88.75^{abcde}
	NS Ras	94.25^{ab}	91.75^{abc}	90.00^{abcd}
Pančevo	NS Vid	73.75^{hi}	62.50^{jk}	58.00^{kl}
	Triangle	80.75^{fg}	51.25^{l}	57.00^{kl}
	AMJ-2	81.75^{f}	55.50^{l}	53.50^{l}
	AMJ-3	74.00^{gh}	71.00^{hi}	71.25^{hi}
	NS Ras	82.50^{e}	67.00^{ij}	58.75^{kl}
LSD 0.05 locality x genotype x storage duration				6.884

Table 2. Precipitation and mean monthly air temperatures during the 20016/2017 growing season (Rimski Šančevi and Pančevo)

Month	Precipitation (mm)		Air temperature (^{o}C)	
	Rimski Šančevi	Pančevo	Rimski Šančevi	Pančevo
August	45.8	60.8	21.1	22.3
September	33.7	47.8	18.5	19.7
October	84.8	76.8	10.2	11.1
November	67.1	71.8	6.3	7.7
December	2.2	2.6	-0.3	0.9
January	18.5	23.4	-4.9	-3.3
February	20.1	23.5	4.2	5.4
March	30.5	27	9.9	11.5
April	57	51.8	11.4	12.7
May	82.9	86.1	17.6	18.7
June	65.7	53	23.2	24.3

Table 3. Seedling length of various oilseed rape genotypes produced at the Rimski Šančevi and Pančevo localities

Locality	Genotype	Seedling length (mm)		
		0 month	12 month under controlled conditions	12 month in a warehouse
Rimski Šančevi	NS Vid	111.62^{bcde}	94.50^{klm}	100.37^{ghik}
	Triangle	110.60^{bcdef}	107.88^{bcdefg}	102.12^{fghijk}
	AMJ-2	125.38^{a}	83.50^{n}	97.25^{ijklm}
	AMJ-3	113.25^{bcd}	96.50^{ijklm}	98.37^{hijklm}
	NS Ras	110.63^{bcdef}	103.25^{efgijk}	112.12^{bcdef}
Pančevo	NS Vid	111.12^{bcdef}	96.75^{ijklm}	99.62^{ghijkl}
	Triangle	116.00^{abc}	94.62^{jklm}	90.25^{lmn}
	AMJ-2	114.25^{bc}	89.75^{mn}	97.75^{ijklm}
	AMJ-3	107.50^{cdefgh}	89.38^{mn}	104.50^{dfghi}
	NS Ras	117.13^{ab}	89.25^{mn}	104.00^{dfghij}
LSD 0.05 locality x genotype x storage duration				9.387

Table 4. – Correlation coefficient (r) for the seed germination and seedling length of the oilseed rape genotypes examined

Genotype	NS Vid	Triangle	AMJ-2	AMJ-3	NS Ras
r	0.659 *	0.662 *	0.361 ns	0.301 ns	0.538 *
Statistical significance level: ns not significant $p \geq 0.05$, * significant $p \leq 0.05$					

On the basis of the correlation coefficient obtained for the seed germination and seedling length of the oilseed rape genotypes examined, a significant correlation was found in the genotypes NS Vid, Triangle and NS Ras (Table 4).

The vigour index value of the seeds tested immediately after harvest was the highest in the genotype AMJ-2 produced at Rimski Šančevi (11882), whereas the lowest vigour index value was recorded in the genotype AMJ-3 produced at the Pančevo locality (7971) (Table 5). All the tested genotypes produced at Rimski Šančevi exhibited significantly higher parameter values than those recorded in the genotypes produced at the Pančevo locality. After 12 months of storage, a statistically significant decline of the parameter values obtained was observed in both types of storage. The AMJ-2 and NSRas seeds were found to exhibit the highest parameter values of all the oilseed rape genotypes produced at Rimski Šančevi, whereas the Triangle and AMJ-3 seeds were found to exhibit the highest parameter values of all the oilseed rape genotypes produced at the Pančevo locality. The Triangle seeds produced at Rimski Šančevi were found to exhibit the highest parameter values of the seeds stored under controlled conditions. The tested parameter was negatively affected by seed aging. The vigor index is the product of seedling length and seed germination, and differences found between the genotypes under consideration reflect in the seed quality (Vujaković et al., 2015).

Table 5. Vigor index values of various oilseed rape genotypes produced at the Rimski Šančevi and Pančevo localities

Locality	Genotype	Vigor index		
		0 month	12 months in controlled conditions	12 months in warehouse
Rimski Šančevi	NS Vid	10457^{bc}	8573^{hi}	8787^{gh}
	Triangle	10068^{cd}	9171^{efg}	8616^{hi}
	AMJ-2	11882^{a}	7553^{kl}	8822^{fgh}
	AMJ-3	10820^{b}	8822^{fgh}	8725^{ghi}
	NS Ras	10425^{bc}	9474^{e}	10092^{cd}
Pančevo	NS Vid	8204^{ij}	6034^{mn}	5763^{n}
	Triangle	9372^{e}	4229^{p}	5162^{o}
	AMJ-2	9343^{ef}	4982^{o}	5207^{o}
	AMJ-3	7971^{jk}	6348^{m}	7447^{l}
	NS Ras	9674^{de}	5972^{mn}	6120^{mn}
LSD 0.05 locality x genotype x duration of storage				522.6

Table 6. Correlation coefficient (r) for the seed germination and vigor index of the oilseed rape genotypes examined

Genotype	NS Vid	Triangle	AMJ-2	AMJ-3	NS Ras
r	0.942 *	0.985 *	0.865 *	0.893 *	0.950 *
Statistical significance level: ns not significant $p \geq 0.05$, * significant $p \leq 0.05$					

On the basis of the correlation coefficient obtained for the seed germination and vigor index of the oilseed rape genotypes examined, a significant correlation was found in all the genotypes under consideration (Table 6).

CONCLUSION

On the basis of the results obtained, the following conclusions can be drawn: Storage conditions exerted no significant impact on seed germination. A decline in seed quality was slower in seeds with higher initial germination values. A negative effect of high moisture content on the germination and longevity of seeds was observed. Seedling length decreased with a prolonged storage period. Seed aging had an adverse effect on the vigour index.

ACKNOWLEDGMENT: The study was funded by the Ministry of Education, Science and Technological Development of the Republic of Serbia, within the ***project*** *Development of New Varieties and Improvement of New Production Technologies of Oil Crops for Different Purposes, No TR 31025.*

REFERENCES

Al-Maskri A. Y., Khan M. M., Khan I. A., Al-Habsi K. (2003). Effect of accelerated ageing on viability, vigor (RGR), lipid peroxidation and leakage in carrot (*Daucus carota* L.) seeds. Internacional Journal of Agriculture and Biology, 5 (4), 580-584.

Arefi, H. M., Abdi, N. (2003). Study of variation and seed deterioration of *Festuca ovina* germplasm in natural resources genebank. Iranian Journal of Rangelands and Forests Plant Breeding and Genetic Research, 11, 105-125.

Barreto L. C., Garcia Q. S. (2017). Accelerated ageing and subsequent imbibition affect seed viability and the efficiency of antioxidant system in macaw palm seeds. Acta Physiologiae Plantarum, 39, 72, 10.1007/s11738-017-2367-z.

Elias, S. G., Copeland, L., O. (2001). Physiological and harvest maturity of canola in relation to seed quality. Agronomy Journal, 93, 1054-1058.

Enami, H. R. (2011). A review of using canola/rapeseed meal in aquaculture feeding. Journal of Fisheries and Aquatic Sciences, 6, 22-36.

Gupta, A., Aneja, K.R. (2004). Seed deterioration in soybean varieties during storage - physiological attributes. Seed Research, 32, 26-32.

ISTA (2016). International Rules for Seed Testing, Internacional Seed Testing Association, Switzerland.

Kiss, F., Bišković, G. (2012). Life cycle energyts of biodiesel produced from rapeseed oil in Serbia. Jurnal on Processing and Energy in Agriculture, 16 (1), 28-32.

Marinković, R., Marjanović-Jeromela, A., Mitrović, P. (2009). Osobenosti proizvodnje ozime uljane repice (*Brassica napus* L.). Zbornik radova Instituta za ratarstvo i povrtarstvo, 46, 33-43.

McDonald, M. B. (1999). Seed deterioration physiology repair and assessment. Seed Science and Technology, 27 (1), 177-237.

Mohammadi, H., Soltani, A., Sadeghipour, H. R., Zeinali E. (2011). Effect of seed aging on subsequent seed reserve utilization and seedling growth in soybean. International Journal of Plant Production, 5 (1), 65-70.

Ratajczak E., Małecka A., Bagniewska-Zadworna A., Kalemba E. M. (2015). The production, localization and spreading of reactive oxygen species contributes to the low vitality of long-term stored common beech (*Fagus sylvatica* L.) seeds. Journal of Plant Physiology, 174, 147–156.

Rule on quality of seed of agricultural plants – Official gazette SFRJ, No. 47/87.

Walters C., Ballesteros D., Vertucci V. A. (2010). Structural mechanics of seed deterioration. Standing the test of time. Plant Scienca, 179 (6), 565-573.

Vujaković M., Marjanović-Jeromela A., Jovičić D. (2015). Viability of oilrape seed (*Brassica napus* L.). Jurnal on Processing and Energy in Agriculture, 19 (4), 171-174.

Received: 20. 02. 2019. Accepted: 30. 03. 2019.