UDC (UDK) 631.53.027:678.049.4

Svetlana BALEŠEVIĆ-TUBIĆ,
***Mladen TATIĆ, Vuk ĐORĐEVIĆ, Vojin ĐUKIĆ*[1]**

SEED AGING OF OIL CROPS

ABSTRACT

Changes occurring in seed during storage are very significant in terms of the quality and longevity of seed. The characteristics of seed composition of oil crops are also influenced by the specificity of the processes occurring in seed during storage. The seed of sunflower and soybean genotypes were subjected to accelerated aging test, as well as to the natural aging in controlled and conventional (uncontrolled) conditions for the period of six and 12 months. Seed aging, artificial as well as the natural one has caused its damage, which negatively affected quality and seed germination of the examined soybean and sunflower genotypes. The degree of damage and the ability of seed to resist the negative aging effects have influenced, beside the time of aging, also the type of storage and plant species. The best way of seed storage is the one that had smallest influence on changes of seed biological nature, which can be acomplished by efficient regulation of relative humidy and temperature.

Keywords: seed, soybean, sunflower, storage, vigor

INTRODUCTION

Seed storage has marked effects on seed viability. Resolution of this problem must begin in the field during seed production, and it should be continued after the harvest. Viable seed is capable of producing new plant under both favorable and unfavorable climatic conditions.

Storage is done to maintain harvesting quality of product. The main external factors causing seed damage during storage are the temperature, relative air humidity and oxigen. Possibility to regulate these factors makes the basis for longer seed storage. Seed with low viability dies first. The speed at which the seed aging process takes place depends on the ability of seed to resist degradative changes as well as on its protection mechanisms which are species specific (Gupta and Aneja 2004, Sismal and Delibas 2004, Balešević-Tubić et al. 2005, Mohammadi et al. 2011).

Seed rich in lipids has limited longevity due to its specific chemical composition. During storage of oily species declining trend of total oil content and seed germination can be observed. A fatty acid composition is the most

[1] Svetlana BALEŠEVIĆ-TUBIĆ, (corresponding author: svetlana.tubic@ifvcns.ns.ac.rs), Mladen TATIĆ, Vuk ĐORĐEVIĆ, Vojin ĐUKIĆ, Institute of field and vegetable crops, Maksima Gorkog 30, 21000 Novi Sad, Serbia

important factor which determines oils susceptibility to oxidation (Morello et al. 2004). Quality parameters of seed such as oil content, fatty acid composition and protein content are significantly influenced by storage conditions and time (Ghasemnezhad and Honermeier 2007).

Seed vigor can be viewed as a measure of accumulated damage in seed as viability declines. Testing for vigor becomes more important if seed were stored under unknown conditions or under unfavorable storage conditions (Mendes and Moraes 2009). Unfavourable storage condition could cause great variations in seed vigour. Moisture content in seed and storage temperature are major factors determining seed viability and storage potential (Balešević-Tubić et al. 2000). For seed viability testing numerous tests such as cold, accelerated aging and Hiltner can be applied (Milošević and Malešević 2004).

One of the major issues when it comes to seed storage is to predict the optimum conditions for preserving seed quality during storage. Model for estimation of seed germination during storage can be based on accelerated aging test, and can be helpful in making a decision on duration of soybean seed storage. If observation included more parameters of oxidative stress and seed viability, the model of prediction of seed deterioration would be more precise (Balešević-Tubić et al. 2011).

The aim of this investigation was to determine the degree of seed deterioration of diferent oil crops during natural storage and to examine the possibilty to predict the speed of seed deterioration using accelerated aging test, which is very important from the aspect of seed quality preservation.

MATERIALS AND METHODS

Six soybean and five sunflower genotypes developed at Institute of Field and Vegetable Crops, Novi Sad, were used in this investigation. The seed was submitted to accelerated and natural aging.

Accelerated aging: The seed was placed in metal dishes, on metal sieve and submerged into water bath at 42 °C, and relative humidity of 100%. The exposure lasted three and five days and then seed was tested using standard laboratory germination test (Hampton and TeKrony 1995)

Natural aging: Seed was stored in two ways: in cool chamber (controlled conditions) at 4 °C and relative humidity of 80 to 85%, and under conventional storage conditions (uncontrolled conditions). Testing was done upon six and 12 months of storage.

Germination of fresh seed (harvested seed), and that of artificially and naturally aged seed were estimated by standard laboratory germination test, using four replications (ISTA, 2004).

The results of the above treatments were compared with the germination of fresh seed (measured at the start of the experiment and used as the control treatment) and statistically processed by twofaktorial analysis of variance using the MSTAT program. The significance of differences was determined by the LSD test at the 0.05 and 0.01 significance levels. Simple linear regression was

done using statistical software Statisica8. All values represented in this paper are average over four replications.

RESULTS AND DISCUSSION

Germination of tested sunflower seed lines declined with prolonged seed storage duration (Table 1). This decline was significant at 12 months of natural aging, except in seed of L4 in which there were no significant differences in germination of stored and fresh seed. Sunflower seed storage demands special attention due to high oil content, otherwise processes leading to loss of germination ability and seed viability may occur (Balešević-Tubić et al. 2007).

It is important to mention that seed germination of tested sunflower lines declined more in seed stored under conventional storage conditions in relation to seed stored under controlled conditions. These differences were more pronounced at 12, than at six months of seed storage. It seems that temperature, moisture and storage duration are the most important factors which influence stored product quality and quantity (Sisman, 2005). According conclusion of Ghasemnezhad and Honermeir (2007), the storage life of sunflower seed can be decreased by longer storage time and higher storage temperature.

Table 1: Germination of sunflower seed under natural aging (%)

Lines	Oil content (%)	Fresh seed	Uncontrolled storage conditions		Controlled storage conditions	
			6 months	12 months	6 months	12 months
L1	37	97	94	91	94	91
L2	53	85	80	72	83	75
L3	48	87	85	79	86	83
L4	43	92	90	89	91	90
L5	49	89	80	60	81	69
Average		**90.0**	**85.8**	**87.0**	**78.2**	**81.6**

LSD (variety*treatment) $_{0.05}$ = 4.4

LSD (variety*treatment) $_{0.01}$ = 6.2

The seed germination of tested soybean varieties decreased more under conventional storage conditions than that under controlled conditions at 4 °C and 85% relative humidity (Table 2). Obtained results provided confirmation that beside storage conditions, the storage duration and variety were significant factors affecting soybean seed germination.

Different storage conditions, first of all temperature and relative air humidity had significant influence on soybean seed germinability (Nkang and Umoh 1997). The same authors concluded that optimal conditions for soybean seed storage are the temperature not higher than 25 °C, and relative air humidity ranging from 55% to 65%.

Tested sunflower and soybean genotypes had similar initial seed germination, 90 and 89.7%, respectively. However, decline in seed germination after six and twelve months of storage was more pronounced in soybean genotypes, especially under conventional conditions compare with sunflower genotypes. The obtained results showed that soybean was significantly more sensitive to the duration of storage, as well as to storage conditions. Sunflower was more stable in terms of storage duration, and decrease of germination after 12 months of storage was approximately equal to the decline in germination of soybean genotypes after six months of storage, both under controlled (sunflower 81,6%, soybean 81,0%), and under conventional conditions (sunflower 78,2%, soybean 76,8%).

Table 2: Germination of soybean seed under natural aging (%)

Variety	Fresh seed	Uncontrolled storage conditions		Controlled storage conditions	
		6 months	12 months	6 months	12 months
Afrodita	95	78	49	88	76
Lasta	89	80	60	80	67
Balkan	92	67	50	76	67
Novosadjanka	88	70	47	72	68
Vojvodjanka	85	83	65	84	79
Morava	89	83	70	86	77
Average	**89.7**	**76.8**	**81.0**	**56.8**	**72.3**

LSD (variety*treatment) $_{0.05}$ = 4.4

LSD (variety*treatment) $_{0.01}$ = 6.2

Extreme conditions of artificial seed aging caused significant decline in germination. Comparison of decline in germination after artificial aging and storage in the conventional conditions (Figure 1) revealed that the sunflower seed was more resistant to stress conditions in comparison to soybean seed for the same period of aging. It can be said that for the 12 months of natural aging the seed of soybean genotypes suffered stress that occurred in seed subjected to extreme conditions of accelerated aging for five days. These results indicate that more intensive processes occurring in the soybean seed causing greater seed damage and more difficult storage of soybean seed in relation to sunflower seed. Seed germination of sunflower lines submitted to accelerated aging for three days was approximately equal to seed germination after 12 months of natural aging (R^2 = 0,93). The high dependence of soybean seed germination after five days of artificial aging and the seed stored for 12 months under conventional conditions was recorded (R^2 = 0,92). Many authors have observed changes in seed germination of oil crops, as well as changes in biochemical parameters of artificially aged seed (Bailly et al. 2002, Tatić, 2007). Accelerated ageing of seed i.e. seed lot exposure to high temperature and high relative humidity leads the

loss of seed viability, and that is an excellent method to determine the vigor changes during seed storage (Balešević-Tubić, 2001, Tian et al. 2008). Accelerated aging test revealed that the aging seed is characterized by the loss of germination, reduced speed of germination, and poor seedling development (Lekić, 2003, Tatić et al. 2008).

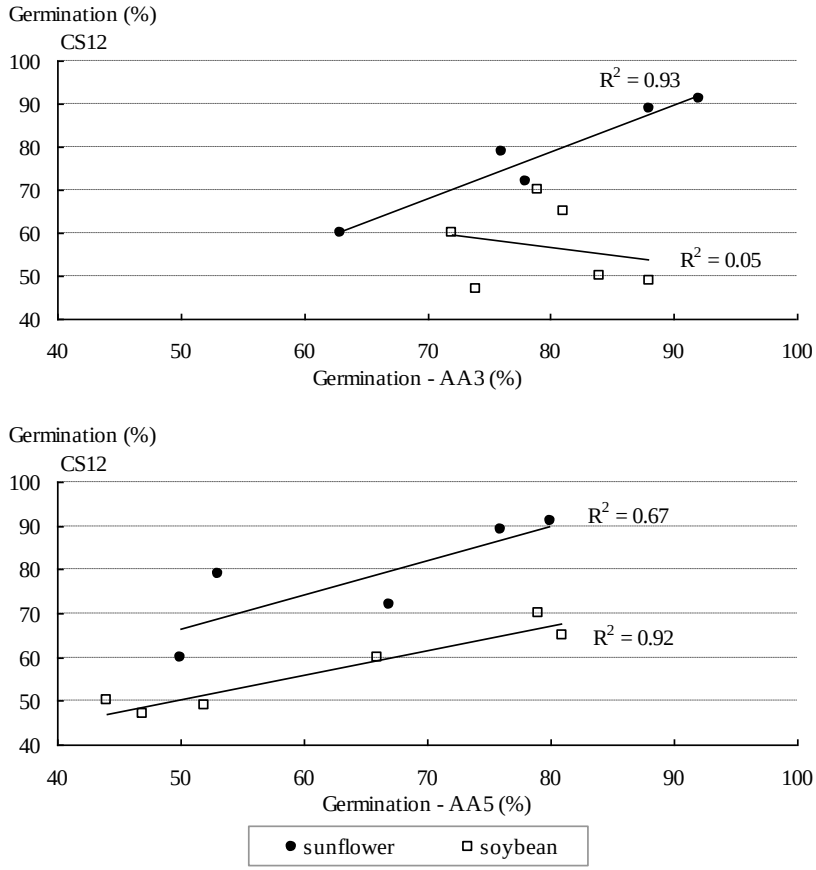

Figure 1: Prediction of sunflower and soybean seed germination under natural aging based on accelerated aging test (CS12-conventional storage after 12 months; AA3 and AA5-accelerated aging test at 3 and 5 days)

Obtained results confirmed the view that application of accelerated aging test can predict the response of seed to a certain period of natural aging. Fabrizius et al. (1999) confirmed the possibility of predicting the actual soybean seed germination during natural aging by applying accelerated aging test, and pointed out the main factors: duration of natural aging and degree of seed deterioration.

CONCLUSION

Natural aging causing decrease of seed germination in relation to germination of fresh seed, and the most intensive decrease was notice under conventional storage conditions with their variable temperature and relative humidity, compared with storage under controlled conditions. Soybean seed was more susceptible to damage and reduced germination during storage than sunflower seed. Effectes of accelerated aging test on changes in sunflower and soybean seed confirmed that degree of seed damage during natural aging and ability of seed for storage can be predicted in laboratory.

REFERENCES

Balešević-Tubić, S., Milošević, M., Vujaković, M., Zlokolica, M., Nikolić, Z. (2000): Seed aging. Field Veg. Crop Res., 33: 207-212.

Balešević-Tubić, S. (2001): The influence of aging process on seed viability and biochemical changes in sunflower seed. PhD Thesis – University of Novi Sad, Novi Sad.

Balešević-Tubić, S., Malenčić, Đ., Tatić, M., Miladinović, J. (2005): Influence of aging process on biochemical changes in sunflower seed. Helia, 28 (42): 107-114.

Balešević-Tubić, S., Tatić, M., Miladinović, J., Pucarević, M. (2007): Changes of fatty acids content and vigour of sunflower seed during natural aging. Helia 30: 61-67.

Balešević-Tubić, S., Tatić, M., Đorđević, V., Nikolić, Z., Subić, J., Đukić, V. (2011), Changes in soybean seeds as affected by accelerated and natural aging. Romanian Biotechnological Letters, 16(6): 6740-6747.

Fabrizius, E., TeKrony, D., Egli, D.B., Rucker, M. (1999): Evaluation of a viability model for predicting soybean seed germination during warehouse storage. Crop Sci., 39: 194-201.

Ghasemnezhad, A. & Honermeier, B. (2007): Influence of storage conditions on quality and viability of high and low oleic sunflower seeds. Intern. J. Plant Prod., 3(4): 41-50.

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

Hampton, J.G. & TeKrony, D.M. (1995): Handbook of Vigour Test Methods. 3rd Edition, International Seed Testing Association, Zurich, Switzerland.

ISTA, (2004): International Rules for Seed Testing. International Seed Testing Association, Switzerland.

Lekić, S. (2003): Vigour of seed. Association of breeders and seed researchers of Serbia, Belgrade.

Mendes, C.R., De Moraes, D.M. (2009): Respiratory activity for the differentiation of vigor on soybean seed lots. Revista Brasileira de Sementes, 31(2): 171-176.

Milošević, M. & Malešević, M. (2004): Seed production. Institute of Field and Vegetable Crops, Novi Sad: 110-114.

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

Morello, J.R., Motilva, M.J., Tovar, M.J., Romero, M.P. (2004): Changes in commercial virgin olive oil (CV Arbequina) during storage with special emphasis on the phenolic fraction. J. Food Chem., 85: 357-364.

Nkang, A., Umoh, E.O. (1997): Six month storability of five soybean cultivars as influenced by stage of harvest, storage temperature and relative humidity. Seed Sci. and Technol., 25: 93-99.

Sisman, C. & Delibas, L. (2004): Storing sunflower seed and quality losses during storage. Journal of Central European Agriculture, 4: 239-250.

Sisman, C., (2005): Quality losses in temporary sunflower stores and influences of storage conditions on quality losses during storage. Journal of Central European Agriculture. 6: 143-150.

Tatić, M. (2007): Effect of endogenous and exogenous factors on aging process and soybean seed viability. PhD Thesis – University of Novi Sad, Novi Sad.

Tatić, M., Balešević-Tubić, S., Vujaković, M., Nikolić, Z., (2008): Changes of germination during natural and ascelerated aging of soybean seed. Proceedings The Second PSU-UNS International Conference on BioScience: Food, Agriculture and Environment, Serbia: 256-259.

Tian, X., Song, S., Lei, Y. (2008): Cell death and reactive oxigen species metabolism during accelerated ageing of soybean axes. Russ. J. Plant Physiol., 55(1): 33-40.

Svetlana BALEŠEVIĆ-TUBIĆ,
Mladen TATIĆ, Vuk ĐORĐEVIĆ, Vojin ĐUKIĆ

STARENJE SJEMENA ULJANIH BILJNIH VRSTA

SAŽETAK

Promjene koje se dešavaju u sjemenu tokom čuvanja, veoma su značajne u pogledu kvaliteta i dugovječnosti sjemena. Karakteristike sastava sjemena uljanih biljnih vrsta povlače i specifičnost procesa koji se u njemu događaju prilikom skladištenja. Sjeme genotipova soje i suncokreta podvrgnuto je testu ubrzanog starenja, kao i prirodnom starenju u kontrolisanim i redovnim skladišnim uslovima, u trajanju od šest i dvanaest mjeseci.

Starenje sjemena, kako vještačko tako i prirodno, prouzrokovalo je oštećenje sjemena, što se negativno odrazilo na kvalitet, odnosno klijavost sjemena ispitivanih genotipova suncokreta i soje. Na stepen oštećenja i sposobnost sjemena da se odupre negativnim posledicama starenja imali su uticaja, pored dužine perioda starenja, način čuvanja, kao i biljna vrsta. Najbolji način skladištenja sjemena je onaj koji u najmanjoj mjeri utiče na promjene bioloških osobina sjemena što se postiže efikasnom regulacijom vlage i temperature.

Ključne riječi: sjeme, soja, suncokret, skladištenje, vigor