

VIGOR OF SUNFLOWER AND SOYBEAN AGING SEED

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SUMMARY

Seed aging and deterioration affect seed vigor and viability. The characteristics of the chemical composition of oil crops seed are related to specific processes occurring in the seed during storage. This study was performed to examine the changes in seed vigor of different sunflower and soybean genotypes under controlled and conventional (uncontrolled) conditions of natural aging for six and twelve months. Obtained results show that the degree of seed damage and the ability of seed to resist the negative effects of aging were influenced by duration and type of storage, as well as seed characteristics of the tested genotypes. The most valuable vigor test for both sunflower and soybean was cold test.

Key words: vigor tests, seed, storage, germination, sunflower, soybean

INTRODUCTION

Seed aging and viability are affected by a number of factors during storage, with air temperature and humidity being indisputably the most important ones of the external factors. The speed of seed aging process depends on the ability of seed to resist degrading 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). Due to its specific chemical composition, seed rich in lipids has limited viability. For example, sunflower seed storage demands special care due to high oil content which can easily provoke processes that can lead to loss of germination and viability. Fatty acid composition is the most important factor which determines oils susceptibility to oxidation (Morello *et al.*, 2004). Seed quality parameters such as oil content, fatty acid composition and protein content are significantly influenced by storage conditions and duration (Ghasemzhad and Honermeier, 2007).

Seed vigor can be viewed as a measure of accumulated damage in seed as viability declines. Vigor testing becomes more important in seeds stored under

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unknown or adverse storage conditions (Andrić *et al.*, 2007; Mendes *et al.*, 2009). Seed vigor testing is also used as an indicator of the storage potential of seed and proves to be a more reliable indicator than germination test (Balešević-Tubić *et al.*, 2000; Tatić, 2007). There are many viability tests such as cold test, accelerated aging test, Hiltner test, *etc.* Since single tests fail to satisfy all demands, a few vigor tests should be used to assess seed viability. Cold test (Milošević and Malešević, 2004) provides data on seed viability even in very adverse germination conditions, which gives better insight into seed behavior during field emergence. Hiltner test imposes a physical stress on the seed, predicting seed emergence capacity under conditions of soil crust formation.

This research was conducted aiming at assessment of seed viability of plant species with high oil content (such as sunflower and soybean) after seed had been stored and aged for a certain period. Based on aged seed vigor assessment, we can establish its field emergence capacity and possibility of forming vigorous and healthy plants which will be high-yielding.

MATERIALS AND METHODS

Sunflower and soybean genotypes used in this research were developed at Institute of Field and Vegetable Crops, Novi Sad, Serbia. The seed was kept in two ways: 1) in a cool chamber (controlled conditions) at 4°C and relative humidity 80-85% and 2) under conventional storage conditions (uncontrolled conditions). Testing was performed after storage for 6 and 12 months.

Standard laboratory test

Four replicates \times 100 seed of each line were tested. Wet blotter paper (roll type) was used as germination medium for sunflower. Number of normal seedlings was estimated after a 10-day incubation period at 25°C and relative humidity of 95%. Moistened sterilized sand was used as germination medium for soybean. Number of normal seedlings was estimated after 9 days under the same condition as for sunflower.

Hiltner test

4 \times 50 seeds were placed onto moistened sand, and a 3 cm layer of cracked brick (previously sterilized and moistened) was placed upon them. Incubation period under optimal condition lasted for 10 days.

Cold test

4 \times 50 seeds were placed onto moistened soil (up to 40% of field capacity) at 5-8°C for seven days, and afterwards placed in a germination chamber at 25°C for four days.

Germination (number of normal seedlings) was evaluated for both cold and Hiltner tests (ISTA, 2004). The results of the mentioned treatments were compared with fresh seeds germination (measured at the start of the experiment and used as the control treatment).

Statistical analysis

Mean comparison (t-test) was performed using statistical software Statistica 8 and relative values of differences between control and germination of stored seed were calculated for all vigor tests. Linear regressions between initial seed germination (control) and aged seed germination estimated by vigor tests were tested for slope significances, also using software Statistica 8.0. All values represented in this paper are average over four replications.

RESULTS AND DISCUSSION

Under the same storage conditions, seeds of various plant species lose viability to different extents. Negative effects of this process include decreased seedling emergence and decreased resistance to adverse germination conditions, ultimately resulting in yield loss. Storage mode and duration affects seed vigor, which can best be viewed from the relative values, *i.e.*, difference between vigor of aged seed and control (Figure 1).

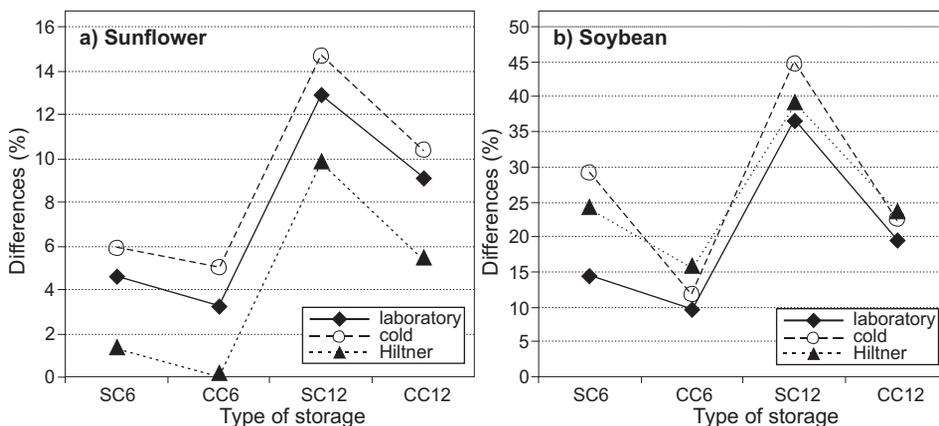


Figure 1: The difference between initial seed germination and seed germination under different storage types (SC-conventional conditions, CC-controlled conditions, after 6 and 12 months)

Both tested plant species are known to express differences in seed vigor during storing as compared to the control, especially after 12 months under conventional storage conditions. The lowest difference was found in seed stored under controlled conditions for 6 months. Adverse storage conditions can provoke significant variations in seed viability (Tatić *et al.*, 2008), and storage duration is negatively corre-

lated with seed vigor (Šimić *et al.*, 2007). Seed vigor declines first as seed deteriorates, followed by loss of germination and viability. The highest difference in vigor of aged seed and control in both plant species was found when cold test was applied. Due to stress caused by cold test low temperatures, the seed damaged during aging showed lowest vigor as compared to the control. Obtained results only confirm that a cold test is the most reliable test for assessing aged seed viability and seed reaction under field emergence conditions, as previously reported by Trawatha *et al.* (1995) and Balešević-Tubić *et al.* (2007a).

Regarding seed reactions to decreased vigor during storage, differences were found among certain genotypes (Table 1).

Table 1: Seed vigor of sunflower and soybean genotypes depending on duration and type of storage (SC-conventional conditions, CC-controlled conditions, after 6 and 12 months)

Duration and type of storage	Germination (%)										
	Sunflower genotypes					Soybean genotypes					
	Sf1	Sf2	Sf3	Sf4	Sf5	Sb1	Sb2	Sb3	Sb4	Sb5	Sb6
a) Standard laboratory test											
Control	97	85	87	92	89	95	89	92	88	85	89
SC6	94	80	85	90	80	78	80	67	70	83	83
CC6	94	83	86	91	81	88	80	76	72	84	86
SC12	91	72	79	89	60	49	50	50	47	65	70
CC12	91	75	83	90	69	76	67	67	68	79	77
LSD_{0.05} sunflower 4; soybean 7											
b) Cold test											
Control	94	82	85	90	79	86	74	80	74	78	84
SC6	90	77	80	86	71	59	60	49	43	61	66
CC6	91	79	82	86	70	80	71	63	62	70	75
SC12	86	68	72	83	58	38	45	42	38	43	57
CC12	89	70	78	85	63	70	57	55	55	63	69
LSD_{0.05} sunflower 4; soybean 8											
c) Hiltner test											
Control	95	79	78	91	79	90	86	88	86	84	88
SC6	94	78	76	90	77	65	69	53	60	73	75
CC6	94	79	79	91	76	78	74	65	68	77	77
SC12	90	73	74	85	57	44	57	43	48	56	70
CC12	90	76	76	87	69	76	62	57	63	69	72
LSD_{0.05} sunflower 3; soybean 7											
	Sunflower genotypes:					Soybean genotypes:					
	Sf1-ocms-74					Sb1-Afrodita					
	Sf2-cms-v-8931-3-4					Sb2-Lasta					
	Sf3-ocms-22					Sb3-Balkan					
	Sf4-ocms-98					Sb4-Novosadjanka					
	Sf5-cms-ol-3					Sb5-Vojvodjanka					
						Sb6-Morava					

The largest variation in sunflower was found in genotype 5, and differences among genotypes were especially profound when cold test was applied to seed stored under conventional storage conditions. Soybean genotypes that stood out most were genotypes 1 and 3, but the differences in genotypes' reactions were significantly more profound as compared to the tested sunflower genotypes. Genetic factors and seed chemical composition influence the expression of seed deterioration and vigor decline (Balešević-Tubić, 2001; Malenčić *et al.*, 2003). One must be always keep in mind that seed is a living organism in which many biological processes take place that can damage the seed and reduce its quality, especially in case of oily seeds, where the genotypes specificity is important (Balešević-Tubić *et al.*, 2010).

Considering initial seed germination of sunflower genotypes (control) and seed germination after a certain storage period, a high correlation was found both in standard laboratory germination and in cold test. Obtained high correlation, especially when cold test was applied (from $R^2=0,92$ to $R^2=0,98$), shows that the initial sunflower seed germination can be taken as one of the most important factors of storage duration and seed damage degree (Figure 2).

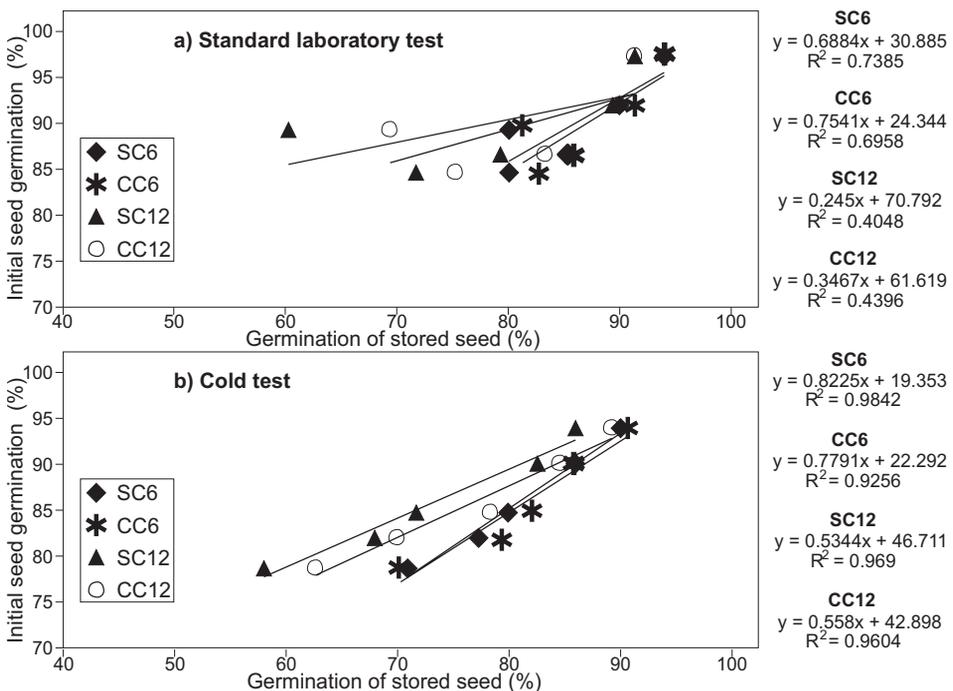


Figure 2: Correlation between stored seed germination and initial seed germination of sunflower genotypes estimated by vigor tests (SC-conventional conditions, CC-controlled conditions, after 6 and 12 months)

High vigor seeds are expected to tolerate high temperature and humidity and retain their capability to produce normal seedlings (Balešević-Tubić, 2001). Soybean genotypes (Figure 3) showed correlation between initial germination and germination after storage only when cold test was applied, and this correlation was much lower than in sunflower genotypes. The highest correlation was in seed stored under controlled conditions ($R^2 = 0.50$; $R^2 = 0.68$), indicating that soybean genotypes can utilize initial germination as a factor of seed storage duration only under mild stress conditions. Under high stress of conventional storage conditions, initial seed germination of soybean genotypes is not as important for its viability, presuming that other factors also strongly affect processes within stored seed. Seed vigor is clearly related to many other components of physiological seed quality, as well as production and storage conditions (Walters, 1998; Bailly *et al.*, 2002; Nasreen and Khan, 2002; Sisman, 2005).

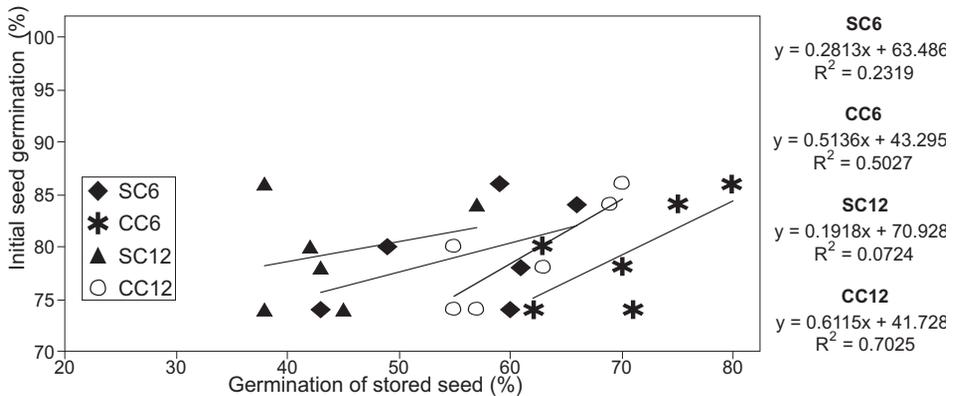


Figure 3: Correlation between stored seed germination and initial seed germination of soybean genotypes estimated by cold test (SC-conventional conditions, CC-controlled conditions, after 6 and 12 months)

CONCLUSIONS

Seed storage includes seed protection and preservation. Stored seed damage is not often manifested as significant germination loss, but as seed viability and vigor loss.

Vigor testing is more important for stored seed, especially under conventional (uncontrolled) storage conditions. Cold test was the best indicator of aged seed damage, which was most profound after 12 months under conventional storage conditions both in sunflower and soybean genotypes. Differences in genotypes' sensitivity to storage conditions and duration were evident, especially in soybean which was more sensitive than sunflower. According to very significant dependence of initial sunflower seed germination and seed germination after a certain storage period,

it can be said that initial sunflower seed germination can be used as a reliable factor when deciding on storage duration. However, soybean genotypes showed substantial effects of other factors, thus the initial seed germination must be considered with care, especially under uncontrolled storage conditions.

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