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Influence of storage condition on seed quality of maize, soybean and sunflower

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Abstract

The study was aimed to examine the changes in seed vigor and oil content in different genotypes of maize, soybean and sunflower over four years (2002-2006) in two type storage conditions differed in terms of air temperature and humidity: 25 °C/75 % and 12 °C/60 %, respectively. Affected by storage longevity, on an average, seed vigor decreased for 18,7% in maize and for 57,1 % in both soybean and sunflower, respectively. Seed oil content decreased for 1,12 % in maize, 2,27 % in soybean and 12,05 % in sunflower. Differences in seed vigor and oil content affected by storage longevity were significant among tested crops and genotypes into crop. Storage longevity was negatively associated with seed vigor and oil content. At storage conditions by 12 °C/ 60 %, decline of seed vigor was less for 17 % (maize), for 24 % (sunflower, soybean) and decreasing of seed oil content was less for 0.87 % (maize), 0.91 % (soybean) and 2,27 % (sunflower) than in storage conditions by 25 °C/75 %. In summary, the lowest seed quality losses were in maize, then in soybean and the highest losses were in sunflower. Decreasing seed quality losses is possible with providing suitable storage conditions, particularly for soybean and sunflower.

Key words: maize, soybean, sunflower, seed vigor, seed oil content, storage longevity, storage conditions.

Introduction

Seed quality is a multiple criterion that encompasses several important seed attributes: genetic and chemical composition, physical condition, physiological germination and vigor, size, appearance and presence of seed borne pathogens, crop and varietals purity, weed and crop contaminants and moisture content. During storage, seed quality can remain at the initial level or decline to a level that may make the seed unacceptable for planting purpose what is related to many determinants: enivronments conditions during seed production, pests, diseases, seed oil content, seed moisture content, mechanical damages of seed in proccessing, storage longevity, package, pesticides, air temperature and relative air humidity in storage, biochemical injury of seed tissue and similary (TeKrony et al., 1987; Reuzeau and Cavalie, 1995; Anfinrud, 1997; Al-Yahya, 2001; Šimic et al., 2004; Guberac et al., 2003; Heatherly and Elmore, 2004). Storage longevity may varies from six months (usually for maize, soybean and sunflower), up to 20 months or longer if the seeds are to be carried over. Longevity of seed in storage is influenced by the stored seed quality as well as stored conditions. Irrespective of initial seed quality, unfavourable storage conditions, particularly air temperautre and air relative humidity, contribute to accelerating seed deterioration in storage. Hence, it's difficult to assess

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the effective storage period because the storability of the seed is a function of initial seed quality and the storage conditions (Anfinrud, 1997; Fabrizius et al., 1999; Heatherly and Elmore, 2004). Intensity of quality decreasing of stored seed is different among plant specieses and within plant species (genotypic variability), implying considerable influence of genetic (heritable) component on phenothypic expression of traits which determine seed quality (Morenomartinez et al., 1994; Al-Yahya, 1995, 2001; Guberac et al., 2003; Vieira et al., 2001). The objective of this study was to examine the changes in two seed quality attributes: seed vigor and oil content in maize, soybean, and sunflower affected by storage longevity under two levels of storage conditions differed in terms of air temperature and relative humidity.

Material and methods

This study was carried out during four years (2002-2006) at the Agricultural Institute Osijek (Croatia) using basic seed of three agronomic crops: maize, soybean and sunflower. Selected maize hybrids (‘OSSK 596’, ‘OSSK 602’-FAO group 600), sunflower hybrids (‘Fakir’, ‘Apolon’-middle-early) and soybean cultivars (’Tisa’-maturity group (MG) I; ‘Kaja’-MG 0) are creations of the Institute. The testing began after harvest of sunflower, maize and soybean in 2002 year. Samples of dried, cleaned and processed seeds for each of tested crops were taken as follows: 2 x 500 kg for maize and soybean, and 2 x 200 kg for sunflower. Before storage, the seed moisture content, seed vigor and seed oil content of all tested genotypes were determined. Seed samples was packed in bags and stored separately in two small storages with controlled conditions: Storage 1 - 75 % air relative humidity; 25 ^{o}C air temperature and Storage 2 - 60 % air relative humidity 60 %; 12 ^{o}C air temperature. After four years of storage, from both storages were taken average seed samples of each genotype for laboratory analysis. Seed vigor (%) were determined by the cold test (AOSA, 1983) and seed oil content (% in absolutely dry matter-ADM) were determined by Nuclear Magnetic Resonance (NMR) analyzator. The obtained experimental data were statistical processed (ANOVA, LSD test, coefficient of variation, particular correlation coefficient, t-test) using computer program Statistical Analysis System Version 8.2 (SAS Institute, 1989).

Results and discussion

The means of seed vigor and oil content for tested genotypes of maize, soybean and sunflower before and after storage in both type of storages with results of statistical analysis are presented in Table 1. From the analysis of presented data it is obvious that analyzed seed quality traits varied amongst tested agronomic crops as well as within crops (genotypic variation), with statistically highly significant differences ($P \leq 0.01$). Prior to storage, the seed vigor means were 91% in maize, 88.5 % in soybean and 89 % in sunflower. After four years of storage, on an average for both type of storage, seed vigor values were in maize 72 %, in soybean 50 % and in sunflower 35 %.

These observation suggested that greater decline of seed vigor was in soybean and sunflower (decreasing 57 %) than in maize (decreasing 18 %) in response to effect of storage longevity. Differences in level of seed vigor between years of storage (storage longevity) were statistically justifiable on level $P \leq 0.01$. As regards seed oil content, before storage, mean values of this trait were 4.4 % in maize. After four years, on an average for both storages, seed oil content was 4,07 % in maize, 21.61 % in soybean and 42.51 % in sunflower. By comparison the means of this trait before and after storage, greater decline of oil content was in sunflower (decreasing for 12.05 %), than in soybean (for 2.27 %) and maize (for 2.27 %). Differences in seed oil content affected by storage longevity (between storage years) were statistically highly significant ($P \leq 0.01$) consistent across tested crops. The effect of storage longevity on level of seed vigor and oil content varied between storages.

After four years of storage, in the Storage 1 (25 °C/75 %), the average decline of seed vigor was 20 % in maize, 43 % in soybean and 45 % in sunflower. Over the same stored period, in the Storage 2 (12 °C/60 %), the average decreasing of seed vigor was for 16 % in maize, for 35 % in soybean and 50 % sunflower. Comparing the changes in level of seed vigor between two examined storages affected by storage longevity, the changes were less in the Storage 2 by 12 °C/60 % for 4 % in maize and for 10 % in soybean and sunflower in relation on the Storage 1 by 25 °C/75 %. As regards seed oil content, in the Storage 1, the average decreasing of oil was for 0.8 % in maize, for 2.1 % in soybean and for 9.2 % in sunflower. In the Storage 2, the average decreasing of oil was for 0.45 % in maize, for 1.41 % in soybean and for 7.16 % in sunflower. There is obviously that changes in oil content were less in the Storage 2 for 0.5 % in maize, for 0.6 % in soybean and for 2.9 in sunflower than in the Storage 1. Differences in intensity of decreasing seed vigor as well as oil content affected by different storage conditions were highly significant at level of $P \leq 0.01$ during the same period of storage consistent across tested crops. Analysis of variance showed that interaction between tested crops and examined storage longevity, then between storage longevity and storage type were highly significant ($P \leq 0.01$) for both traits, while interaction between crops and storage type was significant on level of $P \leq 0.01$ for seed vigor and on level of $P \leq 0.05$ for seed oil content, respectively.

Summarizing the obtained results of this study,

Table 1. Means of seed vigor (%) and oil content (% in ADM) of tested genotypes of maize, soybean and sunflower as regards storage longevity (2002-2005) and storage conditions: S1 (25 °C/75 %); S2 (12 °C/ 60 %).

Crops	Genotype	Seed Vigor (%)		Oil content in seed (% in ADM)	
		Storage 1	Storage 2	Storage 1	Storage 2
Before storage (2002)					
Maize	OSSK 596	91	91	4.70	4.70
	OSSK 602	91	91	4.20	4.20
Soybean	Tisa	89	89	23.18	23.18
	Kaja	88	88	23.40	23.40
Sunflower	Fakir	90	90	47.76	47.76
	Apolon	88	88	53.35	53.35
After storage (2006)					
Maize	OSSK 596	71	78	3.76	4.07
	OSSK602	70	75	3.69	3.82
Soybean	Tisa	48	56	20.05	20.32
	Kaja	42	54	20.02	20.05
Sunflower	Fakir	41	52	41.97	42.47
	Apolon	26	31	39.32	42.21

Sources of variation	*F* test	LSD test 0.05	LSD test 0.01	*F* test	LSD test 0.05	LSD test 0.01
Crops(A)	5675.333**	1.001	1.387	59537.441**	0.238	0.328
Storage longevity (B)	4422.239**	0.699	0.920	7128.33**	0.071	0.093
Storage type (C)	22.358**	0.786	1.034	35.020**	0.058	0.077
Interaction AxB	364.333**	2.012	2.930	1601.833**	0.204	0.297
Interaction AxC	1.533**	2.265	3.300	3.355*	0.168	0.244
Interaction BxC	12.739**	1.040	1.410	14.667**	0.105	0.147
Interaction AxBxC	1.479	3.43	5.681	2.467	n.s.	n.s.

*, **, n.s. - significant at level $P \leq 0.05$, $P \leq 0.01$, not significant, respectively.

obviously that the effect of storage longevity is negative on level of seed vigor and oil content in maize, soybean and sunflower, with significant differences amongst these crops in intensity of decreasing quality stored seed. Thus, on an average for both storages, decreasing of seed vigor and oil content was less in maize in relation on soybean and sunflower, suggesting on higher stability of analyzed quality seed attributes during storage in maize than in both soybean and sunflower, respectively. In the same time, differences in seed deterioration between soybean and sunflower were also existed, particularly in oil content. It could be connected with differences amongst crops in expression of protective system of enzymatic and non-enzymatic processes which influence on intensity of seed deterioration. Thus, in oil crops, such as soybean and sunflower, autooxidation of lipids and increasing the content of free fatty acids during storage period are the main reasons for rapid deterioration of seed of oil plants as announced by Reuzeau and Cavalie, 1995; Trawatha et al., 1995; Balaševic-Tubic et al., 2005). Longevity of stored seed of any crops considerably depends of the stored conditions, primarily in terms of air temperature and relative air humidity in storage. Results of our study showed that in the worst storage conditions (25 °C/75 %) were higher seed quality losses than in the storage with lower temperature and lower relative humidity (12 °C/60 %). These findings corresponded well to those reported elsewhere that unfavorable storage conditions (high air temperature and high humidity of air) accelerate seed deterioration, causing seed quality losses and therein lower germinability percentage of stored seed (Burris, 1980; Tewari and Gupta, 1981; Al-Yahya, 1995; Depaula et al., 1996; Beratlief and Iliescu, 1997).

Conclusion

In summary, data obtained in this study indicate that effect of storage longevity on seed vigor and oil content is more or less negative and considerably affected by storage conditions. If suitable storage conditions aren't supplied, quality and quantity losses increase. Decreasing these losses is possible providing suitable storage conditions and storage management, what enables the preserving seed quality attributes, such as seed vigor and oil content, on the satisfactory level acceptable for production purposes. Furthermore, over the same storage period and under same storage conditions, the intensity of seed quality decline is different among plant species due to genetic diversity, what implies on importance of creating suitable storage conditions according to crop that will be stored.

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