Lazzari, S. M. N., Karkle, A. F., & Lazzari, F. A. (2006). Resfriamento artificial para o controle de Coleoptera em arroz armazenado em silo metálico. Revista Brasileira de Entomologia, 50(2), 293-296. Retrieved from www.scielo.br/scielo.php

Monroy, J. F., & Valencia, A. (1978). Efecto de la aireación nocturna en el almacenamiento del maíz. Revista Del Instituto Colombiano Agropecuario, 13, 603-616.

Morales-Quiros. A. (2017). Evaluation of ambient and chilled aeration strategies to maintain the quality of stored grain in tropical climates and during summer in temperate climates. MS Thesis. Manhattan, KS: Kansas State University, Dep. of Grain Science & Industry.

Noyes, R. T., & Maier, D. E. (2002). Aeration and grain quality management systems engineering. Facility Design Conference of the GEAPS, 1-57.

Noyes, R., & Navarro, S. (2002). Operating aeration systems. In R. Noyes, & S. Navarro (Eds.), The mechanics and physics of modern grain aeration management (pp. 315-397). Boca Raton, FL: CRC Press LLC.

Recio, M. (1999). Aireación bajo condiciones ambientales de alta humedad relativa y baja temperatura para la conservación de maíz amarillo almacenado. Licentiate thesis. University of Costa Rica. San José, Costa Rica.

Roskopf, R., & Bartosik, R. (2009). Refrigeración artificial en silos. Retrieved from www.engormix.com/MA-agricultura/maiz/articulos/temperatura-en-silost2672/417p0.htm

Rulon, R. A., Maier, D. E., & Boehlje, M. D. (1999). A post-harvest economic model to evaluate grain chilling as an IPM technology. J. Stored Prod. Res., 35(4), 369-383.

Sinicio, R., & Muir, W. E. (1998). Aeration strategies for preventing spoilage of wheat stored in tropical and subtropical climates. Appl. Eng. in Agric., 14(5), 517-527.

Zeledón, M., & Barboza, R. (2000). Temperature and RH inside the plenum of a commercial silo when empty, full and during early morning aeration periods. Unpublished manuscript.

CHILLING TEMPERATURE AND LOW MOISTURE CONTENT TO KEEP SOYBEAN GRAIN QUALITY DURING STORAGE

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Abstract

Soybeans are used as food, feed, oil and fuel. Losses may happen at harvesting, transportation, and mainly during storage. Moisture content (MC %) and temperature (T °C) of the soybean grain mass during storage are the main factors affecting quality, quantity and value of the product by favoring the development of microorganisms and insects. Large grain chillers have been used to maintain soybean quality and reduce insect infestation during storage. To evaluate the effect of MC and temperature on the quality parameters of soybean seeds, samples were stored at 58±2% RH, with five different MCs, at 15 °C (chilling temperature) and 30 °C (average temperature inside silos in Brazil) for 180 days. The following was observed: reduction in the MC at higher temperature; the weight of soybeans was maintained at either temperature when the MC was at about 12%; MC above 14% reduced the weight value independent of storage temperature; at 15°C the weight of 1,000 seeds was maintained during storage; low MC and temperature kept germination and vigor of the seeds at high rates; low MC and temperature reduced electrical conductivity; there was no noticeable influence of the storage temperature, regardless of the MC of the beans, on the free fatty acid content. In general, quality attributes tend to be reduced during storage, being more remarkable at higher temperature and MC of the seeds. In conclusion, the temperature of 15ºC, which simulates grain cooling conditions, favors the maintenance of quality, quantity and value of soybean for long-term storage.

1. Introduction

Soybean is one of the most important crops in Brazil and worldwide. It is used as food, feed, oil and fuel. Quality and quantitative losses in soybeans may happen during harvesting, transportation, and mainly in storage. Moisture content and temperature of the soybean mass during storage are the main factors that affect quality, quantity and value of the product.

The main cause of weight loss in stored soybeans is consumption of the dry matter (starch, proteins and fats) by storage fungi (Christensen and Meronuck, 1986). Lazzari (1997) stored soybeans for six months at 15 and 25 °C and water content varying from 13.9 to 22.1% wet basis (% w.b.). He concluded that the higher the temperature and the water content, the greater the fungi infection and consequently the dry matter loss which could range from 0.24 to 1.25% at 15 °C and from 0.39 to 36.6% at 25°C.

Teixeira (2001) mentions low temperature associated with drying of soybeans, allows a longer storage time without compromising quality during this critical period. Teixeira (2001) also mentions that grain with moisture content between 16 and 18.5% (% w.b.) can be stored safely for 3 to 18 months at cooling temperatures of 3 to 10°C, inhibiting the development of fungi, insects and the germination loss of seeds. It is important to consider that artificial cooling can be a cost effective alternative to aeration with ambient air. Considering the benefits, cooling soybean kernels during storage might be a valuable technology to reduce postharvest losses, although the effects of low temperatures and different water contents of soybean seeds need more complete evaluation.

In order to determine the benefit of cooling technology on the quality of soybean seeds, samples were stored at 58+2% RH, with five different water contents, at two temperature levels. The following parameters were evaluated: 1. variation in water content, 2. seed weight, 3. apparent specific mass, 4. weight of 1,000 kernels, 5. electric conductivity, 6. germination, 7. accelerated aging and 8. fat acidity.

2. Materials and Methods

The experiment was carried out in the Preprocessing and Storage of Vegetable Products laboratory, Department of Agricultural Engineering, University of Viçosa (UFV), Minas Gerais, Brazil. A 2 x 5 factorial experimental design was implementd in two climate-controlled chambers: one at 15°C simulating the cooling condition, and the other at 30± 2°C simulating storage temperature conditions prevalent in most areas of Brazil. The relative humidity was of 58+2% in both chambers. The subplots were five water content levels: 12, 14, 16, 18 and 20%, and five storage intervals (0, 45, 90, 135, and 180 days), for seven parameters evaluated, with three replicates.

Soybean seeds from the BIOAGRO/UFV experimental units were used, with initial water content of 22% (% w.b.). The seeds were dried in a fixed bed dryer, with air heated to 40°C using a LPG burner. The gravimetric process was used to obtain the water content of soybeans at 20, 18, 16, 14 and 12%. The variation of the mass of the evaporated water during drying from the initial water content was estimated by separating the fractions to obtain each of the desired levels. The final water content was measured after the seeds were in equilibrium at room temperature expressed as percentage wet basis (% w.b.). The soybean samples were packed in plastic bags measuring 0.40 x 0.45 m, with a capacity of 5 kg, and stored under the defined conditions, from April to October 2011.

Water content, weight of one thousand seeds, germination and accelerated aging were measured according to the methodology described in Brazil (2009). The electrical conductivity in the solution containing the soybean seeds was made using the "Glass System" (Vieira & Carvalho, 1994). The specific mass was determined using a weight scale with a capacity of 1 liter. The ethereal extract and total titratable acidity were performed according to the methodology described by Silva (2002).

3. Results

The temperature of the seeds remained practically uniform in most samples, with variations below 4°C at different points. The data indicate that the natural convection of the intergranular air was minimal, reducing the mass transfer (water vapor) between the grains and the intergranular air and promoting stability in the water content of the grain (Fig. 1).

Water Content

At 15°C and 58+2 % RH, the values of the initial water contents were 12.6, 12.4, 15.9, 17.2 and 19.7% (Fig. 1A). After 180 days of storage, the water contents were 12.9, 12.8, 15.8, 17.0 and 19.7%, showing that seeds with water content lower than 13% suffered small increments in their humidity values, while those containing initial water contents of 15.9 and 19.7% did not present moisture content alteration (Table 1).

At 30°C, the initial water contents were 11.5, 13.6, 15.9, 17.8 and 20.0%. After 180 days of storage, the respective water contents were 11.2, 13.3 and 15.0%, without noticeable variation between the initial and final moisture contents. As expected, seed samples with the initial water contents of 17.8 and 20.0% were totally deteriorated by fungal activity at 90 days of storage (Fig. 1B and Table 1).

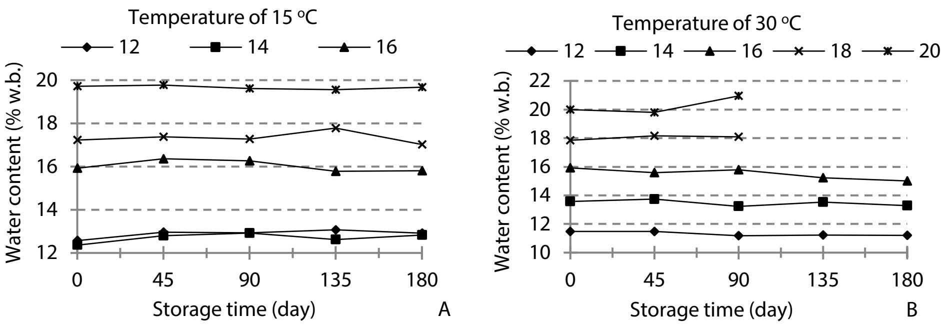

Fig. 1 Water content of soybean seeds stored at 15ºC (A) and 30°C (B) for 180 days at 58+2% RH.

Seed Weight

For the seed weight variation (Table 1), it was found that at 15°C moisture gain was obtained for the drier seeds (12.6 and 12.4% initial water contents). Seeds with water contents equal to or greater than 15.9% lost water during the storage period.

Total soybean loss was found in the product stored at 30°C when its initial water contents were 17.8 and 20.0%. There was a slight gain in moisture when the product was stored with initial water contents of 12.6 and 12.4% at 15°C. Moisture losses of 24.4 kg t^{-1} and 21.4 kg t^{-1} occurred at 30°C with the initial water contents of 11.5 and 13.6%, respectively.

Apparent Specific Mass

When storing at 15°C, the highest value of apparent specific mass was 690.2 kg m^{-3} and the lowest was 636.6 kg m^{-3} for the seeds with initial water content of 12.9 and 19.7%, respectively. It was observed that soybeans with a lower water content had the specific mass unchanged after 90 days of storage (Fig. 2A). For soybeans with the other water contents, variation of the specific mass values was observed, which could be attributed to the tendency of adjustments related to hygroscopic equilibrium. However, soybeans with the initial water content of 19.7% had the specific mass reduced from 650.6 to 636.1 kg m^{-3}, indicating a mass loss for this qualitative attribute and that, even at the temperature of 15°C, this water content was too high for storing soybeans for 180 days. Storage fungi could grow in soybeans with moisture content above 16% and temperature of 15°C after 90 days in storage.

The results of the apparent specific mass reduction of the soybean seeds at 30°C with water contents ranging from 11.5 to 20.0% are shown in Fig. 2B. The seeds with water contents of 17.8 and 20.0% were badly degraded after 90 days in storage. The lowest observed value of the specific mass was 637.6 kg m^{-3} at 90 days of storage, when soybean seeds were infected by fungi of different species. The highest value was 691.7 kg m^{-3}, when soybeans had a water content of 11.2% at 135 days of storage.

Tab. 1 Initial and final water content, mass alteration and weight variation of soybean samples at 15ºC and 30ºC, at five levels of moisture content for each temperature, stored at 58+2% RH for 180 days.

Temperature (°C)	Water content (%w.b.)		Mass change (weight%)	Weight variation (kg t^{-1})
	Initial	Final		
15	12.6	12.9	(+) 2.70	(+) 27.0
	12.4	12.8	(+) 3.72	(+) 37.2
	15.9	15.8	(-) 0.81	81.6
	17.2	17.0	(-) 1.16	11.6
	19.7	19.7	(-) 0.25	2.5
30	11.5	11.2	(-) 2.43	24.4
	13.6	13.3	(-) 2.13	21.4
	15.9	15.0	(-) 5.71	57.2
	17.8	-	(-) 100.0	Total
	20.0	-	(-) 100.0	Total

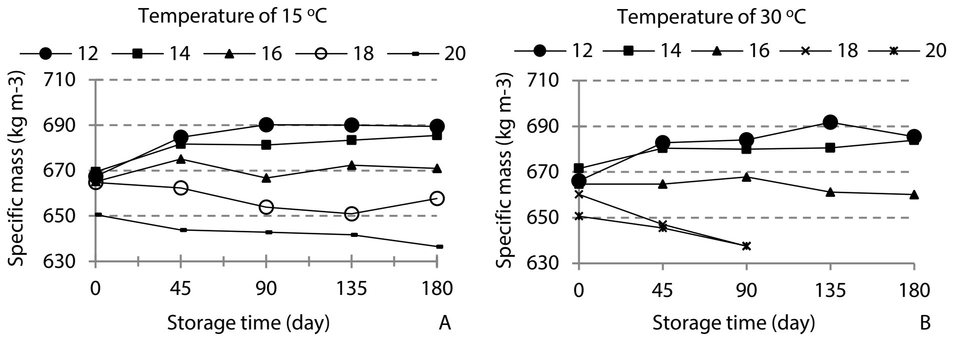

Fig. 2 Apparent specific mass (kg m^{-3}) of soybean with different water content stored at 15ºC (A) and 30°C (B) for 180 days at 58+2% RH.

Weight of 1,000 Soybean Seeds

At 15°C, after 180 days the weight of 1,000 soybean seeds was between 188 and 181.8 g for the seeds with water contents between 16 and 20% (Fig. 3A). At 30°C, the weight was between 200 and 180 g for the samples between 16 and 20%, by the 90th day (Fig. 3B). In the beginning of storage, the weight of 1,000 seeds with water contents of 16 and 20% were of the order of 195 g and those with moisture of 12, 14 and 18% had a similar weight of 175 g. After 180 days of storage, only the seeds with a water content of 18% experienced weight reduction, resulting in a range of 180 to 185 g.

For the soybean samples stored at 30 °C, smaller dispersions were observed in the values of the weight of 1,000 seeds with the different water contents. However, these values were lower, ranging from 170.0 to 193 g, as compared to the samples stored at 15°C, after 180 days.

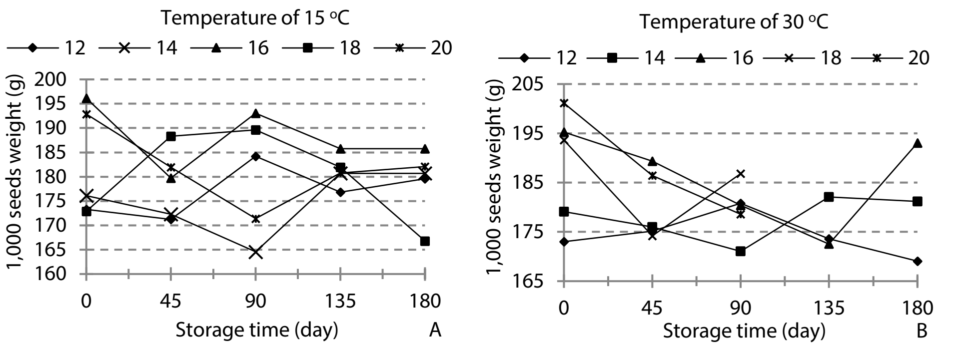

Fig. 3 Weight of 1,000 soybean seeds with five different water contents (% w.b.) stored at 15°C (A) and 30°C (B) for 180 days at 58+2% RH.

Electrical Conductivity

The average values of the electrical conductivity of soybeans stored at 58+2% RH, 15°C for 180 days, with water contents between 12 and 20%, ranged from 72.6 and 80.0 µS cm^{-1} g^{-1}, respectively (Fig. 4A). At 30°C, the average values ranged from 96.5 to 95.1 µS cm^{-1} g^{-1} (Fig. 4B).

It was observed during the storage period at 15°C that there was an increase in the electrical conductivity values of the order of 60 to 100 µS cm^{-1} g^{-1} (Figure 4A). For a water content of 20%, this value reached close to 140 µS cm^{-1} g^{-1}, indicating greater degradation of the product with higher water content after 180 days of storage. In soybean stored at 30°C, the damage was more intense at higher water contents. At a water content of 16%, the electrical conductivity ranged from 56.1 to 322 µS µS cm^{-1} g^{-1}. For a water content of 12%, the variation was from 68.8 to 141 µS cm^{-1} g^{-1}, and for a water content of 14%, it ranged from 62.0 to 191. µS cm^{-1} g^{-1}.

Germination

The average value of the germination index for soybean seeds stored at 15°C with a water content of 12% was above 98.7% from zero to 180 days of storage (Fig. 5A). With 14% water content, the variation was from 100 to 97.3%; at 16% it was from 99.3 to 91.3%; at 18% it varied between 99.3 and 88.7%, and at 20% between 100 and 55.3%. After 90 days of storage, there was a reduction in the germination index of the seeds with water content of 20%, from 100 to 86.7%.

In soybean seeds from the same samples stored at 30°C with the same water contents, higher deterioration rates were observed as compared to storage at 15°C. It was observed that after 45 days of storage the germination index of soybean seeds with water content of 18 and 20% reduced from 98.7 to 74% and from 100 to 24.7%, respectively (Fig. 5B). After this period, seeds with these water contents were totally degraded. The samples with 16% water content had the germination index reduced from 100 to 25.3% by the 90^{th} day and to 0% by the 135^{th} day. At 14%, the reduction in the germination index was from 99.3 to 10.7%, and at 12% from 100 to 92.7%,by the 180^{th} day.

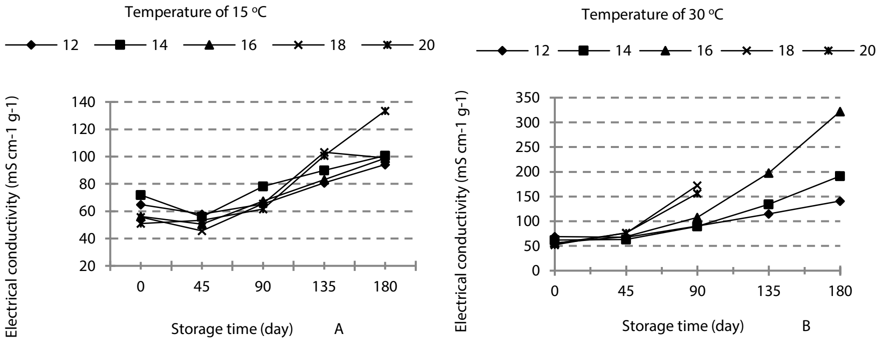

Fig. 4 Electrical conductivity of soybean seeds with different water contents (% w.b.) stored at 15°C (A) and 30°C (B) for 180 days at 58+2% RH.

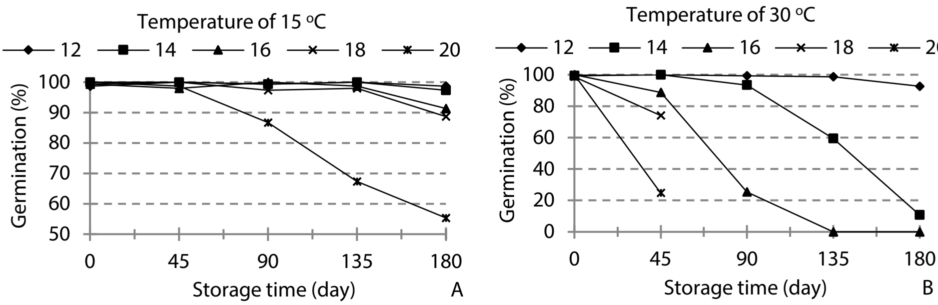

Fig. 5 Germination of soybean seeds with different water contents (% w.b.), stored at 15°C (A) and 30°C (B) for 180 days at 58+2% RH.

Accelerated aging

Figures 6A and 6B show the deterioration of soybean seeds with different water contents measured by the vigor index (accelerated aging) when stored at 15 and 30°C.

For storage at 15°C (Fig. 6A) the higher the water content, the higher the seed degradation index. At 12%, the accelerated aging index varied between 100 and 99.3%; at 14% it stabilized at 100%; at 16% it was reduced from 97.3 to 77.3%; at 18% it was reduced from 99.3 to 72.7%, and at 20% it was reduced from 99.3 to 44.7%.

At 30°C for the same variety and water content, the seed degradation rate increased as compared to storage at 15°C. Reduction in the vigor index from 99.3 to 39.3% and from 98.7 to 9.3% was observed for the 18 and 20% water contents, respectively. At 45 and 90 days of storage the vigor index decreased further to 0%. For water content of 16%, the reduction was from 100 to 5.3% at 90 days, and to 0% at 135 days of storage. At 14%, the vigor reduction was from 99.3 to 68.7% at 90 days of storage, and to 0% at 135 days. At 12%, the reduction was from 100 to 63.8% after 180 days of storage.

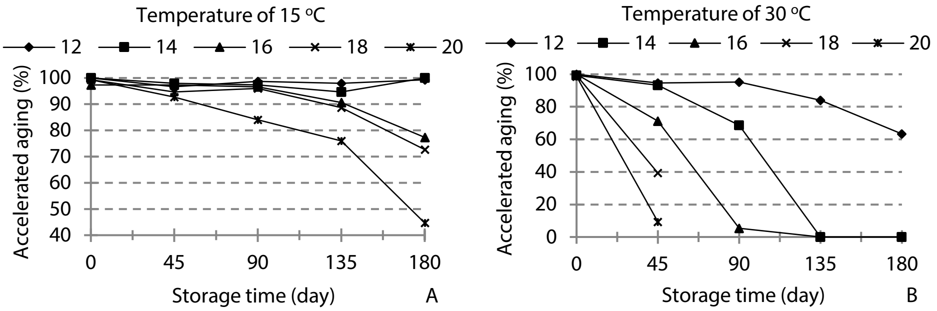

Fig. 6 Accelerated aging of soybean seeds with different water content (% w.b.) stored at 15°C (A) and 30°C (B) for 180 days at 58+2% RH.

Fat acidity

There was little variation in the fatty acid content during the entire storage period at 15°C, ranging from 0.94 to 2.32% at the beginning of the storage period. These acid contents had a noticeable increase for both temperatures after 135 days of storage. There was an accentuated decrease from about 4.0 at 135 days to about 1% at 180 days. At 30°C, variation between 0.48 and 1.2% was observed for soybeans stored at water contents between 12 and 16%. The seeds stored at 18 and 20% water contents were spoiled after 90 days of storage. Influences of temperature and water content on the fatty acid content were not observed.

Figures 7A and 7B show the variations in the fatty acid index of soybeans stored at different water contents and temperatures.

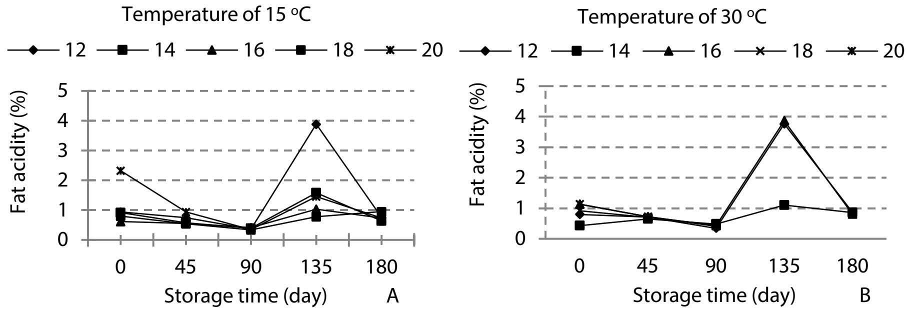

Fig. 7 Fat acidity of soybean seeds with different water content (% w.b.) stored at 15°C (A) and 30°C (B) for 180 days at 58+2% RH.

4. Discussion

The results showed that 15°C for each water content was a more adequate storage condition than 30°C for maintaining the initial seed characteristics including the sample with the highest water content. The higher temperature resulted in a greater reduction in water content of soybeans during storage. According to Christensen and Meronuck (1986) and Lazzari (1997), the higher the temperature and the water content, the greater the fungi infection and the resulting increase of dry matter loss and grain deterioration, as observed here in our experiment.

Our results demonstrated that for the same equilibrium relative humidity conditions at 15°C, the mass losses due to drying were lower than those at 30 °C. The specific mass values of soybeans stored at 15 and 30°C can be maintained when their water content was low (12 to 14%). For water content above 14%, there was a reduction in the specific mass values, independent of the storage temperature. The main cause of the weight loss in stored soybeans was consumption of dry matter (starch, proteins and fats) by storage fungi (Christensen and Meronuck, 1986; Lazzari, 1997).

The higher the apparent specific mass value of soybeans, the lower its water content. The apparent specific mass of 12% soybeans is considered to be on the order of 750 kg m^{-3}. In our tests, after 90 days in storage soybeans with water content of 17% and above were so badly degraded due to infection by microorganisms that it was impossible to carry out the laboratory tests. On the other hand, the samples with lower water contents and lower temperature had the expected variation in the values of the specific mass indicated in the literature. Our results show stability of this quality attribute during 90 days at 15°C. However, a longer storage time of about 135 days resulted in lower apparent specific mass caused by fungi growth, despite the lower temperature.

According to Brazil (2009), the weight of 1000 soybean seeds varies according to their water content. Storage temperature of 15°C maintained the mass of 1000 seeds with a weight value higher than at 30°C. The variations observed in our tests, considering the studied range, may indicate the influence of possible dispersion of the values of water contents of individual soybean seeds in relation to the average value observed, and even a certain independence of the weight of 1000 kernels in relation to the water content. Petter et al. (2014) found mean values of 146 ± 14.2 g while in the study of Morais et al. (2014) they were in the range of 159.8 to 178.1 g, which are lower than those observed in the present study. These differences can be attributed to the agronomic characteristics of the varieties studied and the moisture content variation of individual soybean seeds (Lazzari, 1997).

The electrical conductivity test can be considered an auxiliary resource to assess early aging and possible damage to cell walls, allowing ionic solutions to be formed as a function of cell leakage. At both temperatures, the electrical conductivity increased with increasing storage days, indicating loss of soybean quality. For healthy soybeans, the values may vary depending on the variety studied; however, in the same variety, an increase in temperature and water content of soybeans results in greater damage to the cell walls of the seed. Researchers observed values of 56 µS cm^{-1} g^{-1} for the "Embrapa 48" soybean and 46 µS cm^{-1} g^{-1} for the "Paradise" variety. Low values of electrical conductivity indicate low leakage and consequently high physiological quality. The higher the temperature and water content of soybeans, the greater the increase in electrical conductivity and the resulting physiological damage, as observed in our tests, agreeing with Woodstock, cited by Simoni (2007), who mentions that seeds stored at low temperatures have less tissue deterioration.

Due to their sensitivity, the results of the germination test showed the importance of reducing the temperature and water content of the seeds in order to carry out storage safely, aiming at the physical, biochemical, nutritional and sanitary aspects of these seeds. Germination can be influenced by temperature, water content and length of storage. Under the same storage condition and for the same variety, the increase in water content resulted in a reduction in germination index at the end of the storage period for both temperatures, but it was considerably more accentuated at 30°C. Thus the lower the storage temperature, the higher the rate of germination and vigor during storage of soybean seeds. However, according to Lazzari (1997), even cool soybean seeds can be spoiled if stored with high water content.

The vigor index (accelerated aging) is another quality attribute that can be used to verify the physiological degradation of seeds. It was observed, at both storage temperatures, that there was a qualitative loss during storage as a function of the higher water content of the product. The higher the water content, the higher the seed degradation index. Our results indicate that soybeans with 14% is a moist product for storage in the natural environment. It was observed that for the same variety, even with low storage temperature, physiological degradation of the seeds may occur due to the higher storage water content. Thus, at a given temperature, high water content tends to reduce germination and vigor of the seeds. Also, time of storage reduces those two important parameters for stored seeds.

Another attribute of great importance for evaluating the quality of soybeans during storage is the acidity index. Soybeans are the main oil source for human consumption in Brazil and there is a maximum acidity limit for the commercialization of the product. In our tests, regardless of the water content of the seeds there is no noticeable influence of the storage temperature on the acidity of the soybean fat. The behavior of this parameter did not follow an expected pattern. According to Christensen and Kaufmann (1969), the vigorous development of fungi and their lipases at a specific moment of the deterioration of the seed increases the free fatty acids value. This explains the drop observed in our graphs, which could be the result of the consumption of portions of the fatty acids by fungi.

Overall, quality, quantity and value attributes of stored soybeans tend to reduce with storage time, being more remarkable at higher temperature and higher moisture content. One can conclude that the temperature of 15ºC, which simulates grain cooling conditions, favors quality maintenance of soybean seeds within a range of water content considered safe for storage. This range should be below 14%, because at or above this level of water content the soybean seeds are considered a moist product and may deteriorate during the storage period, unless the seed mass is stored under cooled conditions.

References

Brasil 2009. Ministério da Agricultura, Pecuária e Abastecimento. Regras para análise de sementes/Ministério da Agricultura, Pecuária e Abastecimento. Secretaria de Defesa Agropecuária. – Brasília: Mapa/ACS, 399 p.

Christensen, C.M. and Kaufmann, H.H. 1969. Grain storage – The role of fungi in quality loss. University of Minnesota Press, Minneapolis. 158p.

Christensen, C. M. and Meronuck, R. A. 1986. Quality maintenance in stored grains and seeds. University of Minnesota Press, Minneapolis. 138p.

Lazzari, F. A., 1997. Umidade, fungos e micotoxinas na qualidade de sementes, grãos e rações. Curitiba: UFPR. 134 p.

Morais, L. B. D., R. Colussi and, L.C. Gutikoski, 2014. Emprego do resfriamento artificial no armazenamento de grãos de soja. Passo Fundo: Centro de pesquisa em Alimentação – CEPA/UPF. 17 p. 2014. (Relatório técnico).

Petter, F. A., A.U. Alves, J.A. Silva, E.A. Cardoso, T.F. Alexandre, F.A. Almeida and L.P. Pacheco 2014. Produtividade e qualidade de sementes de soja em função de doses e épocas de aplicação de potássio. Londrina: Semina: Ciências Agrárias. **35**(1), 89-100. (DOI: 10.5433/1679-0359).

Silva, D.J., 2002. Análise de alimentos: métodos químicos e biológicos. Viçosa, MG: UFV, 235 p.

Silva, J. S., P.A. Berbert, A.D.L. Afonso and S. Rufato, 2000. Qualidade de grãos. In: Silva, J. S.(Ed). Secagem e Armazenagem de Produtos Agrícolas. Viçosa, MG: Aprenda Fácil. p 63-105. 2000.

Simoni, F., 2007. Germinação e vigor de sementes de soja em função da disponibilidade hídrica do solo e presença de *Phomopsissojae*. Tese. (Faculdade de Ciências Agrária e Veterinária – UNESP) Jaboticabal: UNESP. 44p. 2007.

Teixeira, G. V., 2001. Avaliação das perdas qualitativas no armazenamento de soja. Dissertação. Faculdade de Engenharia Agrícola. UNICAMP. Campinas: UNICAMP. 50 p. 2001.

Vieira, R.D. and N.M. Carvalho, 1994. Testes de vigor em sementes. Jaboticabal-SP: FUNEP/ UNESP, 1994, 164p.

Assessment of a mobile solar biomass hybrid dryer for insect disinfestation in dried maize grains

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Abstract

Considerable losses of stored food grains occur through insect infestation in tropical countries because climatic conditions are conducive for insect activity throughout the year. Studies have shown that in order to kill stored grain insects of all life stages temperatures above 50°C are required. However, grain simply laid in the sun or placed in a solar dryer does not reach such high temperatures. This study describes the use of a 1 tonne batch capacity mobile solar biomass hybrid dryer for disinfestation of infested maize and prevention of F1 progeny emergence in stored maize grains. To assess the effect of temperature and exposure period on mortality of maize weevils, infested maize in experimental cages were exposed for 3 and 6 hours of thermal disinfestation