Scientific Electronic Archives
Issue ID: Sci. Elec. Arch. Vol. 12 (3)
June 2019
Article link
http://www.seasinop.com.br/revista/index.php?journal=SEA&page=article&op=view&path%5B%5D=805&path%5B%5D=pdf
Included in DOAJ, AGRIS, Latindex, Journal TOCs, CORE, Discoursio Open Science, Science Gate, GFAR, CIARDRING, Academic Journals Database and NTHRYS Technologies, Portal de Periódicos CAPES.
ISSN 2316-9281

Sanitary quality of corn seeds submitted to different drying temperatures

E. Neves, B.S. Oliveira, G.L. Correia

Universidade do Estado de Mato Grosso – Câmpus Universitário de Nova Mutum

Author for correspondence:eletisanda@unemat.br

Abstract. The fungi that appear during storage demand less water for their development, therefore they proliferate with greater intensity in the grain mass in the post-harvest period. However, field fungi contaminate the grains during the cultivation and development of the plants in the field because they require environments with relative humidity higher than 80%. Storage fungi are found in large numbers in warehouses, mills, garners, hoppers, elevators, equipment and places where agricultural products are stored, handled and processed. In this context, the objective of the research was to evaluate the effect of drying temperatures on the sanitary quality of the corn seed in storage in two types of packages under uncontrolled environmental conditions. It was used the Dow Agrosciences variety with initial moisture of 26%. Three temperature combinations of drying air were used: 40-45°C; 50-55°C and 70-75°C and the control temperature was sun drying. The experiment was conducted in randomized complete design, and for the two types of packaging there were four treatments, consisting of a storage environment and three sampling times for evaluations, in factorial arrangement, with three replications per treatment of temperatures. The drying temperature combination of 70-75°C was the one that most influenced the reduction of the main storage fungi in the paper packaging grains during the four and six-month periods of storage.
Keywords: Storage, Pathogens, Temperatures

Introduction

The corn culture is very vulnerable to pests and diseases, which cause damage to the plantation, newly harvested seeds and stored seeds. Generally, the fungus infection process in seeds and grains already begins in the field during the maturation phase of the seeds and/or grains, and proceeds in the following stages when harvesting, drying, storage, transport and processing.

In many tropical and subtropical regions, the climate conditions allow year-round agricultural production; however, these same conditions, high humidity and temperature, are also conducive to the development of fungi.

The sanitary factors are characterized by the deleterious effect caused by the occurrence of microorganisms and insects associated with the seeds, from the field of production to storage. Insects can cause widespread damage, such as damage to the embryo and the reserve tissue required for its growth, damage by egg laying, increase in temperature, humidity, and carbon dioxide production. Microorganisms, on its turn, are another limiting factor to production, as is the case of bacteriosis, viruses and fungal diseases existing in various agricultural regions.

The sanitary and physiological quality of corn seeds (*Zea mays L*.) influence the productivity of this crop, due to the role they play in establishing the crop as well as in the spread of diseases, thus interfering with productivity rates. Amidst the fungi transmitted by this route, are highlighted *Stenocarpella maydis* and *Diplodia maydis*, for their potential to cause direct damages to the seeds (CASA et al., 1998).

Corn seeds can be infected by various fungi, from their formation, during their development and also after harvest, in storage. In this way, the seeds can allow the survival and propagation of pathogens, as well as the proliferation of storage fungi, responsible for its deterioration. According to the results reached by Reges et al., (2016) evaluating the occurrence of fungi on corn grains, verified that the fungal development of *Penicillium sp*. had a percentage variation from 10.42% to 37.94% of the corn samples collected in the field and *Aspergillus flavus* presented a variation of 12.98% to 66.38% growth in corn samples after harvest. Among the

field fungi propagated by corn seeds in Brazil, *Fusarium moniliforme* is the most frequent. As for storage fungi, the most frequent ones are *Aspergillus spp.* and *Penicillium spp*., which may appear in derived products, such as rations. According to Cardoso Filho, et al. (2013) studies that determine fungal microbiota and its mycotoxins in foods are important because they allow information collection inherent to the product quality.

Material and Methods

A batch of corn cob (*Zea mays L*.) seed was used, triple hybrid, DowAgrosciences variety with initial moisture of 26%.

After the harvest, the cobs were transported to a place where manual destrawing was carried out, removal of infected cobs and before drying was determined an initial moisture and sampling of the seed lot to determine the seed quality. After drying, it was done manual threshing of the cobs, to obtain the seed samples and evaluated the quality.

In relation to the drying air temperature, the conditions of industrial drying of corn seed were simulated, where lower temperatures, generally 5°C below the maximum drying temperature, were employed at the beginning of the process. Thus, in each of the different combinations studied, the lowest temperature was used for 24 hours followed by high temperature for the time required for the seeds to reach 13% moisture. Three temperature combinations of the drying air were used: 40-45°C; 50-55°C and 70-75°C and the sun drying control sample.

The cob layer was about 0,80m, and the cobs were randomly distributed. After reaching 13% moisture, the seeds were manually threshed, the final humidity and the physiological and sanitary quality of the samples of each treatment will be determined.

The seeds were packed in bags of multifolium Kraft paper and plastic bags consisting of four replicates for each type. After that, they were stored in a non-controlled environment where the temperature varied between 18 and 32°C and the relative air humidity between 65 and 95%.

At intervals of two months, a sample of 400 seeds was taken, to evaluate the sanitary quality. The method used was that of filter paper with freezing, the objective of this procedure to prevent the germination and to facilitate the examination of the seeds (Tempe, 1970; Machado, 1988). The seeds were placed equidistant from each other in 9 cm diameter Petri plates (10 seeds / plate) containing two sheets of filter paper moistened with distilled water.

They were then maintained for 24 hours at a temperature of 20-22°C and 12/12h dark photoperiod and 40W white fluorescent light, positioned 40cm above the plates and 20cm apart. Afterwards, the seeds were submitted to freezing for 24 hours, returning to the incubation room previously described, where they remained for another five days. The detection of the fungi associated to the seeds was carried out in a stereomicroscope and, when necessary, slides were examined in the composite microscope, thus identifying the pathogens.

Pathogen Incidence Count

The pathogen incidence was verified by the fungal count in the samples in the different combinations of drying temperatures in the two types of storage containers and in each evaluation period (E1 = 2 months, E2 = 4 months and E3 = 6 months).

The experiment was set up in a randomized complete design, with four treatments, consisting of one storage environment and three sampling periods for evaluations, in a factorial arrangement, with three replications per temperature treatment.

Results and Discussion

Samples of freshly harvested corn seeds showed the fungi of the genus *Fusarium verticillioides* (99%); *Aspergillus spp*. (65%); *Penicillium spp* (55%) and *Cladosporium spp* (57%).

After the drying treatment in the different temperature combinations and before storage. The incidence result at room temperature (sun drying) was 82% (*Fusarium verticillioides*); 74.5% (*Aspergillus spp*); 81% (*Penicillium spp*); 22.5% (*Cladosporium spp*); 23.5% (*Rhizoctonia spp*); 0.5% (*Nigrospora spp*) and 1% (*Rhizopus spp, Mucor spp* and *Gonatobotrys spp*). At temperatures of 40-45^{o}C, 50-55^{o}C and 70-75^{o}C was observed an incidence of the genus *Fusarium verticillioides* (98,100 and 100%); *Aspergillus spp* (23, 81 and 68%); *Penicillium spp* (97.5, 80 and 7%) and *Cladosporium spp* (19.5, 17 and 9%), respectively, for the temperature combinations. Results that consider the assertion of Bento et al., (2012) that determined the presence of *Fusarium spp*., *Aspergillus sp*. and *Penicilium spp*. in the corn grains stored after drying the grains, with a safe humidity of 13%, suggesting that the contamination occurred during field cultivation. The percentages found were high when in comparison to the Embrapa (2015) statement that the fungi contaminated grains are depreciated because they undergo color alteration, chemical composition degradation and their maximum tolerance of burned grains in commercial lots of corn is 3%.

It can be observed that the treatments of drying with high temperatures controlled the presence of *Cladosporium spp*, but for the genus *Fusarium verticillioides* the temperatures were not efficient in its control. The *Fusarium* species cause a number of diseases in crops throughout the world generating significant economic losses according to Villa-Martínez et al. (2015). It is also observed that the drying treatment in the sun favored the appearance of other species before storage. Possibly, this happened because the seeds had been exposed to climatic conditions for a longer

period until reaching the final moisture for storage. Due to this, the sanitary quality of the samples was affected by species of low economic importance for corn seeds. However, these were eradicated with the use of high drying temperatures. It was also verified that with the increase of the temperature there was a decrease of the pathogen *Penicillium spp.*, agreeing with Villela and Silva (1991) that using the intermittent drying in corn seeds verified that there was a decrease in the incidence of this pathogen according to the increase in drying temperature.

According to Figure 1, it can be seen that there was a decay in the incidence of major pathogens after four and six months of storage in the drying treatment of 70-75°C in the paper packaging in relation to the two-month period. The 40-45°C treatment appeared to be the most favorable one to control the fungus of genus *Penicillium spp*, which had lower incidences in all periods of evaluation. It is believed that in this treatment the period that the seeds remain in the dryer is higher in relation to the other temperatures until reaching a humidity of 12%. This heat exposure period to the seeds and the used model of the stationary dryer demonstrates to be efficient to control *Penicillium spp*

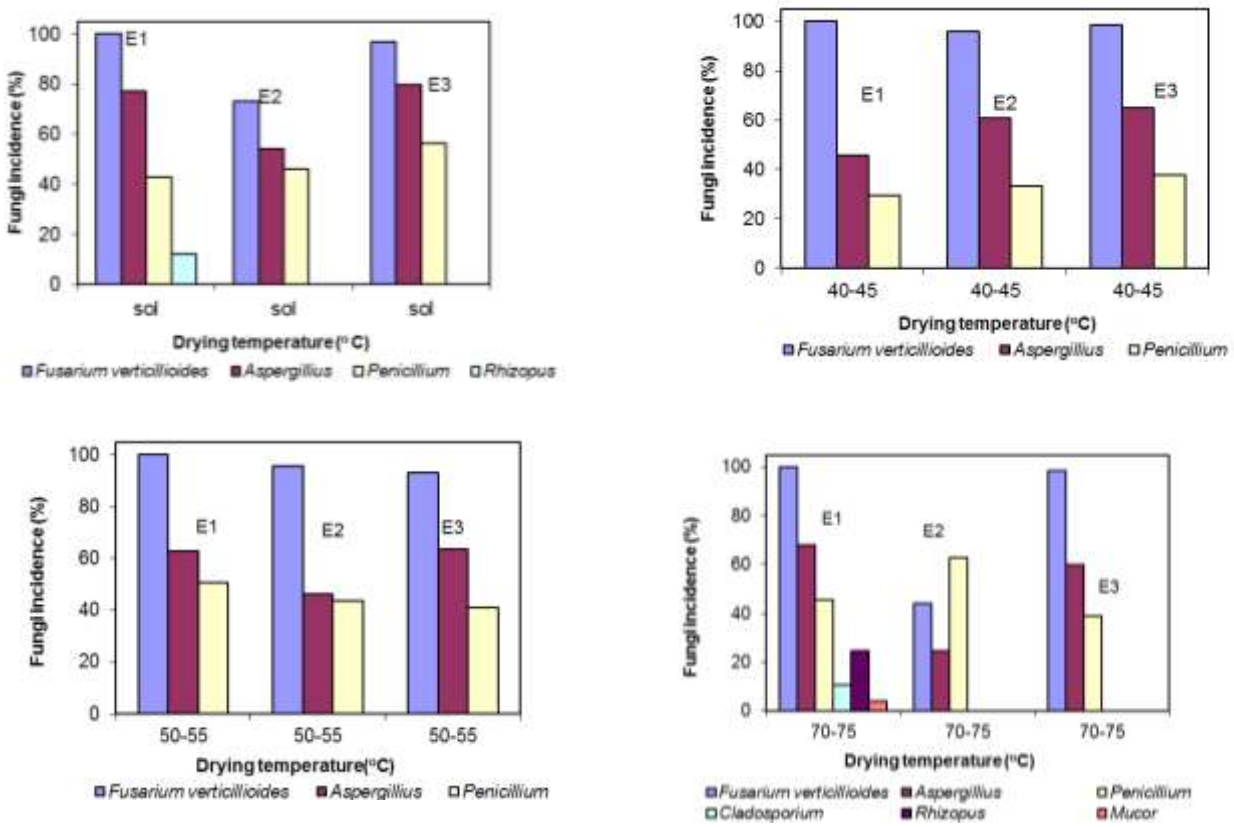

Figure 1. Medium incidence values of fungi present in stored corn seeds in paper bags at different drying temperatures during a six-month storage period.

The genus *Fusarium verticillioides*, which is classified as a field fungus, remained with an incidence percentage of practically 100% in all treatments, throughout the storage period, with an incidence drop only four months in the treatment of 70-75°C. This result is in agreement with Wetzel (1987) who verified in stored germplasm that the field fungi survive for years in the seeds and maintain its pathogenicity, amongst them, he quotes the *Fusarium spp* in corn seeds.

In general, the storage period of four months was the one that most controlled the incidence of pathogens in the samples of seeds stored in paper bags, in relation to six months in which there was an increase in the incidence of fungi. This control was possibly due to the environmental conditions and humidity of the samples, which were low in relation to the period of two and six months of storage. Although in those periods the seed moisture was below 12%, a value that controls the appearance of pathogens in seeds.

Figure 1 also shows that *Rhizopus spp* and *Cladosporium spp* pathogens, which produce seed coating discoloration in many seed species; *Mucor spp* and *Fusarium semitectum*, which are found in soybean seeds, causing seedling abnormalities and cotyledon deterioration. These pathogens, which had a low incidence on the seeds, did not survive or decrease drastically over the storage period.

According to Figure 2, it can be seen that there was a decrease in the incidence of major pathogens after four and six months of storage in

the drying treatment of 50-55°C in the plastic bag packaging over the two-month period. In the two-month storage period, there was a drastic control of the incidence rate of the fungus *Penicillium spp* in the 40-45°C drying treatment in relation to the initial incidence in this treatment, which was 97.5%. However, the percentage of incidence increased in four and six months of storage. Bento et al. (2012) remarks that the different factors that may influence the growth of these fungi are climatic conditions, pre-harvest, genetic differences, broken grain index, insects presence and others.

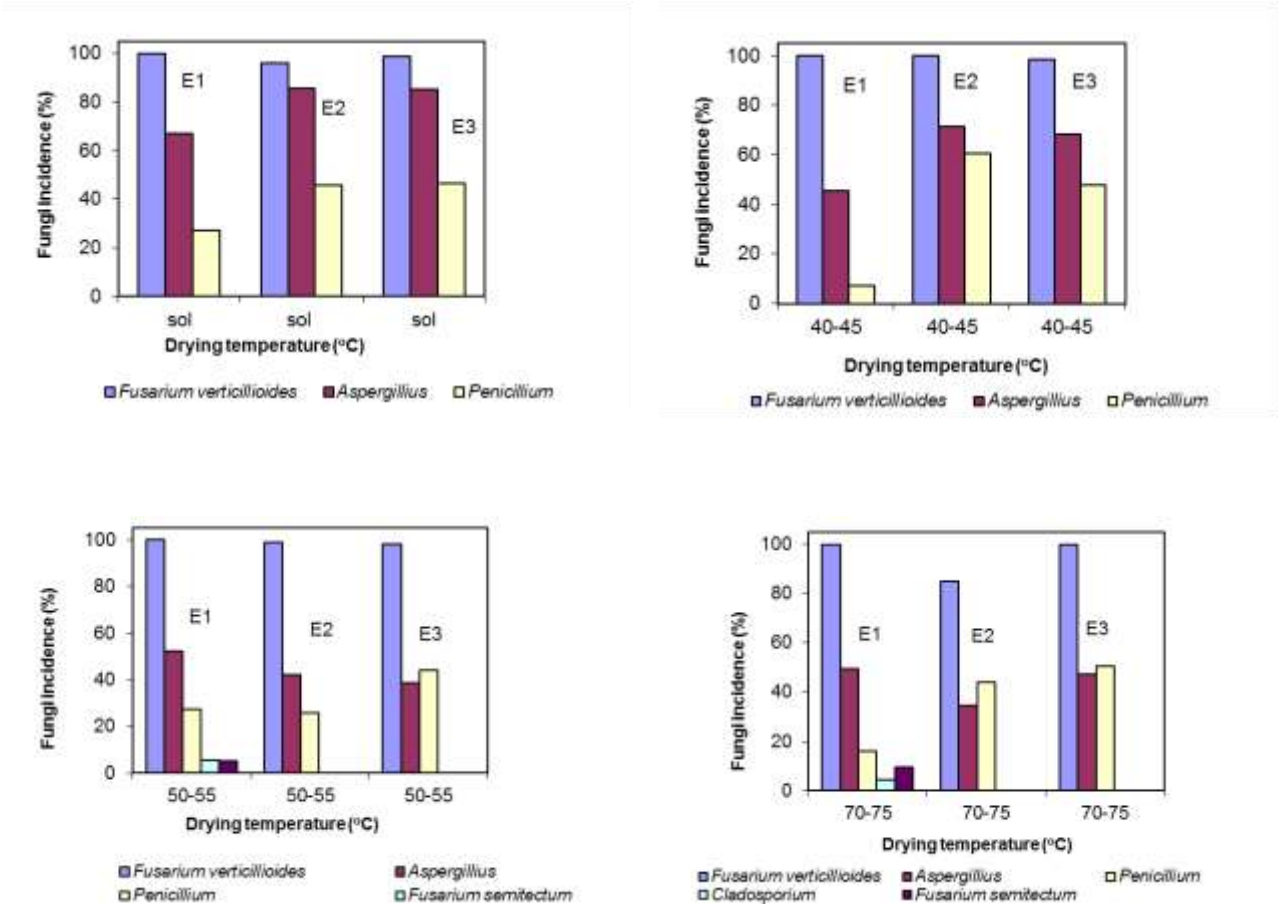

Figure 2. Medium incidence values of fungi present in stored corn seeds in plastic bags at different drying temperatures during a six-month storage period.

The plastic bag packaging generally presented results of lower incidences of the major storage fungi *Aspergillus spp* and *Penicillium spp* for the 50-55°C drying treatment, but in the sun drying treatment the incidence levels of the fungus *Aspergillus spp* were higher in the periods of four and six months than in the other treatments on the same period. Corn *Aspergillus* species produce aflatoxins that are extremely toxic to humans because they have a carcinogenic, mutagenic, immunosuppressive and teratogenic potential. According to Mulunda et al., (2013) it can interfere or even stop grain exportation and reduce productivity in livestock due to poisoning and in severe cases, animal's death.

In both Figure 1 and Figure 2, the predominance of *Fusarium verticillioides* was verified, which occurrence may have been favored by the drier seed conditions and storage environment.

Conclusions

The 70-75°C drying treatment was the only one that had influence in the reduction of the major storage fungi in the paper packaging during the periods of four and six months.

The presence of *Penicillium spp* can be reduced with the use of plastic bag packaging (semipermeable) up to two months of storage, regardless of the drying temperature.

The pathogens *Rhizopus spp, Cladosporium spp* and *Fusarium semitectum* did not survive after two months of storage.

References

BENTO, L. F., CANEPPELE, M. A. B., ALBUQUERQUE, M. C. F., KOBAYASTI, L., CANEPPELE, C., ANDRADE, P. J. Ocorrência de fungos e aflatoxinas em grãos de milho. **Revista Instituto Adolfo Lutz.** São Paulo, 71(1) p.44-9, 2012.

CARDOSO FILHO, F.C; CALVET, R.M;ROSA, C.A.R;PEREIRA, M.M.G;COSTA, A.P.R; MURATORI, M.C.S. Monitoramento de fungos toxigênicos e aflatoxinas em rações utilizadas em piscicultura. **Revista Ciência. Animal. Brasileira**, Goiânia, v.14, n.3, p. 305-311, jul./set. 2013, DOI: 10.5216/cab.v14i3.15414.

CASA, R.T., REIS, E.M. & ZAMBOLIM, L. Fungos associados a semente de milho produzida nas Regiões Sul e sudeste do Brasil. Fitopatologia Brasileira 23:370-373. 1998.

EMBRAPA MILHO E SORGO. Armazenamento inadequado de grãos, 2015. Disponível em: <https://www.embrapa.br/busca-de-noticias/noticia/3860638/armazenamento-inadequado-de-graos-resulta-em-cerca-de-15-de-perdas grãos resulta em cerca de 15% de perdas> Acesso em: 29 abr. 2018.

MACHADO, J.C. **Patologia de sementes**: **fundamentos e aplicações**. MEC/ESAL/FAEPE. Lavras, Minas Gerais, 1988, 106p.

MULUNDA, M.; DZOMA, B.; NYIRENDA, M.; BAKUNZI, F. Mycotoxins occurrence in selected staple food in main markets from Lubumbashi, Democratic Republic of Congo. **Journal of Food, Agriculture and Environment**, v.11, p.51-54, 2013.

REGES, J.T.A.; JESUS, M.N.; SILVA,S.D.R.;SOUZA,M.H.;SANTOS,I.J.; SANTOS,S.M.;RODRIGUES, J.W. Ocorrência de fungos e micotoxinas em grãos de milho em Jataí-GO, Brasil. **Revista Colombiana Investigación Agroindustriales**. 2016 p- 34-39. ISSN 2422-0582 e- ISSN 2422-4456 DOI: http://dx.doi.org/10.23850/24220582.342.

TEMPE, J. de. Handbook on seed health testing:routine methods for determining the health condition of seed in the seed testing station. Proceeding of the International Seed Testing Association. v.35. n°1. 1970.

VILLA-MARTÍNEZ, A., PÉREZ-LEAL, R., MORALES-MORALES,H.A., BASURTO-SOTELO, M., SOTO-PARRA, J.M;MARTÍNEZ-ESCUDERO, E. Situación actual en el control de Fusarium spp. y evaluación de la actividad antifúngica de extractos vegetales. **Revista Acta Agronómica**, 2015, 64 (2), 194-205. ISSN 0120-2812 e-2323-0118. **DOI:** 10.15446/acag

VILLELA, F.A.;SILVA, W.R. **Efeitos da secagem intermitente sobre a qualidade de sementes de milho**. 1991. ESALQ/USP,48:185-209, Piracicaba, São Paulo, 1991

WETZEL, M.M.V.S. Fungos de armazenamento. In: SOAVE, J. & WETZEL, M.M.V.S. (Ed.) Patologia de sementes. Campinas. Fundação Cargill. 1987. pp. 260-275.