RUFORUM Working Document Series (ISSN 1607-9345) No. 14 (3): 167-172.
Available from http://repository.ruforum.org

Research Application Summary

Effects of harvesting date on aflatoxin contamination in groundnuts in northern Mozambique

Zuza, E.J.[1], Mondjana, A.M.[1], Muitia, A.[2] & Amane, M.[2]
[1]Eduado Mondlane University, Department of Crop Protection, P. O. Box 257, Maputo, Mozambique
[2]Mozambique Institute of Agriculture Research, Department of Legume Crops, P. O. Box 3658, Maputo, Mozambique
Corresponding author: manzyzuzajnr@gmail.com

Abstract

Groundnut (*Arachis hypogaea* L.) is the third most important crop in Mozambique. Despite its importance as food, the presence of mycotoxins, especially aflatoxins has the potential to limit its use in both the human and livestock diet. In this study, the effect of time of harvesting on aflatoxin (AF) contamination were examined at two locations in Nampula and Mapupulo. A split-plot design with four replications was used with three groundnut varieties (ICGV-SM 99568, JL-24 and ICGV-SM 01514) as main plots and three harvesting dates (10 days before physiological maturity, at physiological maturity and 10 days after physiological maturity) as the sub-plots. In both locations field observations indicated that on average AF contamination levels were lower at physiological maturity (H2) compared to harvesting too early (H1) (> 15 ppb) and harvesting too late (H3) (> 20 ppb). The higher AF contamination levels at H1 were because of higher pod and kernel moisture content and adverse conditions of wet and humid weather which provided a conducive environment for fungal growth and subsequently AF contamination. Delayed harvesting resulted into highest levels of AF contamination compared to H1 and H2. This could be attributed to heavy damage of pods by insects especially termites which provided ready entry of the fungus and consequently AF contamination. Physical damage of pods as a result of dry weather during H3 may also have resulted into the higher AF contamination levels at this harvest time. It is therefore advisable that farmers' harvest at physiological maturity in order to reduce AF contamination of groundnuts.

Key words: Aflatoxin contamination levels, groundnuts, harvesting dates, Mozambique

Résumé

L'arachide (*Arachis hypogaea* L.) est la troisième culture la plus importante au Mozambique. Malgré son importance dans l'alimentation, la présence de mycotoxines, en particulier d'aflatoxines, a le potentiel de limiter son utilisation. La présente étude a examiné l'effet de la période de récolte sur la contamination par l'aflatoxine à Nampula et à Mapupulo. Un dispositif de split plot avec quatre répétitions a été utilisé, avec trois variétés d'arachide

(ICGV-SM 99568, JL-24 et ICGV-SM 01514) comme parcelles principales et trois dates de récolte (10 jours avant maturité physiologique, à maturité physiologique et 10 jours après maturité physiologique) comme sous-parcelles. Sur les deux sites, les observations sur le terrain indiquaient que les niveaux moyens de contamination étaient inférieurs à la maturité physiologique (H2) comparativement à une récolte trop precoce (H1) (> 15 ppb) et trop tardive (H3) (> 20 ppb). Les niveaux de contamination les plus élevés à H1 étaient dus à une teneur en humidité plus élevée des gousses et grains et à des conditions météorologiques humides qui ont favorisé la croissance fongique et, par la suite, la contamination par l'aflatoxine. La récolte tardive a entraîné les niveaux de contamination les plus élevés par rapport à H1 et H2. Ceci pourrait être dû aux dégâts importants causés aux cosses par les insectes, en particulier les termites, qui permettent une entrée facile des champignons et, par conséquent la contamination par l'aflatoxine. Les dommages physiques subis par les cosses à cause de la saison sèche pendant H3 peuvent également avoir entraîné des niveaux de contamination par l'aflatoxine plus élevés. Il est donc suggéré que les agriculteurs fassent la récolte de l'arachide à maturité physiologique afin de réduire leur contamination par l'aflatoxine.

Mots clés: niveaux de contamination par l'aflatoxine, arachide, dates de récolte, Mozambique

Introduction

Groundnut (*Arachis hypogaea* L.) is the third most important crop in Mozambique after maize and cassava (Muitia, 2013). It is a major cash crop and the main source of cooking oil for many Mozambican families (Muitia, 2005). In terms of production, groundnut occupies the largest area among the grain legumes in the country (Arias and Libombo, 1994) with the largest concentration in Nampula and Cabo Delgado provinces. Despite its importance as food, the presence of mycotoxins, especially aflatoxins has the potential to limit its use in both human and livestock diets (Rahmianna *et al*., 2007). Poor management practices by farmers and adverse climatic conditions at harvest and post-harvest are some of the factors that encourage post-harvest AF contamination. The timing of harvesting greatly influences mould production (Guo *et al*., 2003). Wright *et al.* (2005) highlighted that farmers who delay harvesting their crop expose it to mould infections and subsequent aflatoxin contamination. Therefore, this study aimed at assessing the effect of harvest date on aflatoxin contamination of groundnuts in Northern Mozambique.

Materials and methods

The field experiments were conducted in two sites at Nampula Research Station (PAN) and Mapupulo Research Station (CIAM). The study was carried out during the 2015/2016 growing season. The test materials were evaluated using a randomized complete block design in a split-split plot arrangement with four replications. Spanish groundnut varieties were used for the study namely: ICGV-SM 99568, JL-24 and ICGV-SM 01514. The experiments were established on 23rd December and 24th December in Mapupulo and Nampula, respectively, at the onset of the rains. Experimental plots were divided into three harvesting time treatments: (i) 10 days before physiological maturity indicated as H1; (ii) at

physiological maturity indicated as H2 and (iii) 10 days after physiological maturity indicated as H3.

Results

A summary of mean air temperatures, relative humidities (RH) and rainfall during the 2015-2016 season at CIAM is presented in Table 1. The mean daily air temperature during the pod-filling period was about 26.3°C. The site received on average total rainfall amounting to 900 mm. The average RH were between 80 to 85 % during the groundnut harvesting and drying periods. PAN received lower rainfall during the 2015-16 growing season compared to CIAM (Table 2). The mean daily air temperatures at PAN were higher than normal ranging from 30-35 °C along with very high RH ranging from 75-85 %.

Aflatoxin contamination levels in groundnuts at different harvest timing are presented in Figure 1. Significant differences ($P < 0.01$) were observed in the mean AF levels with H2 having the lowest AF levels. The highest AF contamination was observed at delayed harvest (H3) compared to early harvesting (H1) which had slightly lower AF levels. Additionally significant differences in AF contamination was observed among the varieties. The variety JL-24 had the lowest mean AF levels. The mean AF levels of ICGV-SM 99568 (14.5 ppb) was significantly lower compared to that of ICGV-SM 01514 (17.9 ppb).

Table 1. Mean air temperatures, total rainfall and relative humidities during the 2015-16 at Mapupulo Research Station

Month	December	January	February	March	April
Average max temperature (°C)	34.1	30.5	31.4	31.9	30.8
Average min temperature (°C)	21.8	21.6	21.3	22.0	20.3
Average rainfall (mm)	516.6	1300.6	568.7	800.4	859.7
Total number of rainy days	10	20	18	16	22
Relative humidity (%)	68	83	80	81	79

Table 2. Mean air temperatures, total rainfall and relative humidities during the 2015-16 at Nampula Research Station

Month	December	January	February	March	April
Average max temperature (°C)	35.3	34.8	36.3	35.2	32
Average min temperature (°C)	33.2	29.6	32.1	32.3	29.7
Average rainfall (mm)	232.9	469.6	299.8	799.1	43.9
Total number of rainy days	6	12	11	18	4
Relative humidity (%)	83	87.7	76.3	83	85

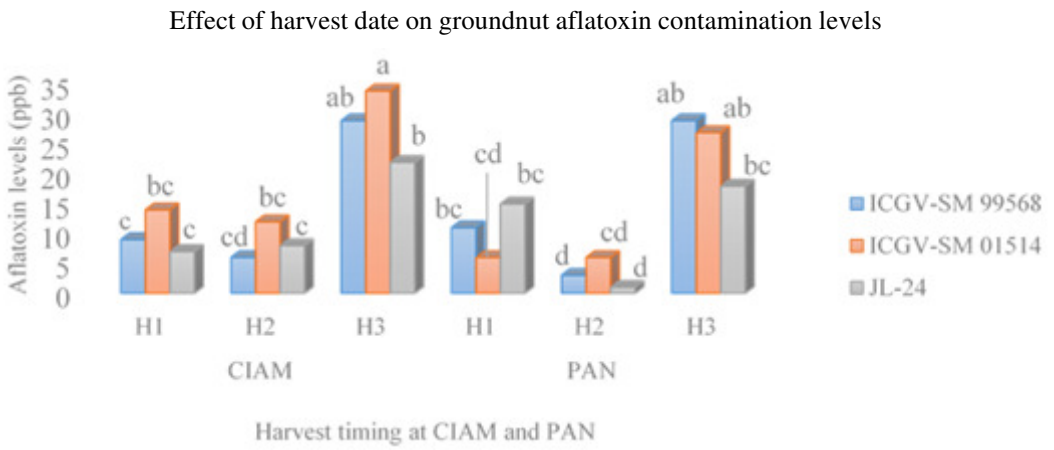

Figure 1. Aflatoxin contamination levels in groundnuts at different harvest timing

Discussion

A number of studies have shown that weather directly influences host susceptibility to aflatoxin contamination (Cotty, 2007). The differences in the intensity of AF contamination between CIAM and PAN could be attributed to the variability in soil moisture, temperatures and relative humidity. Generally, AF contamination was severe both at CIAM and PAN and this could have been due to higher than normal temperatures (> 30 °C), high RH (> 70 %) and late season rainfall providing suitable conditions for fungal growth and subsequent AF contamination (Payne *et al*., 1992).

Field observations from this study have shown that on average AF contamination levels were lower at physiological maturity (H2) compared to harvesting too early (H1) and harvesting too late (H3). The higher AF contamination levels at H1 could be attributed to immature pods, higher pod and kernel MC and adverse conditions of wet and humid weather which provided a conducive environment for fungal growth and development. Additionally most of the pods were small and shriveled which provided access to entry of the fungi into the pods and consequently attacking the kernels and subsequently aflatoxin contamination. Similar results were also reported by Okello *et al*. (2010). Turner *et al*. (2005) stated that major portion (80%) of aflatoxin contamination is often associated with small, shriveled, mouldy and stained groundnuts.

Delayed harvesting resulted into highest levels of AF contamination compared to H1 and H2 among the groundnut varieties in both study locations. Moreover this study has shown that delayed harvesting resulted into higher AF contamination levels greater than the FDA/ WHO regulatory levels of 20 ppb (Mphande *et al*., 2004). High AF contamination levels at H3 could be attributed to heavy damage of pods by insects especially termites which provided ready entry of the fungus and consequently AF contamination. Furthermore Kombiok *et al*. (2012) indicated that insects such as termites cause scarification of pods, which weakens the shells and makes them liable to crack during harvesting leading to further insect, microbial

and disease infestations. Moreover delayed harvesting coincided with some post-harvest rainfall, along with high RH (> 75 %) and high air/soil temperatures (30-35 °C) that provided optimum conditions for fungal growth and subsequent AF contamination. This phenomenal confirms the findings of Cotty and Jaime-Garcia (2007) who stated that influences of delayed harvest on AF contamination are most severe when crops receive rain just prior to or during harvest.

Conclusion

The results of this study have indicated that proper post-harvest management of groundnuts such as harvesting at physiological maturity gave lower aflatoxin contamination levels lower than the FDA/WHO regulatory levels of 20 ppb in comparison to harvesting either too early or too late. It is therefore recommended that farmers harvest their crop at physiological maturity in order to prevent AF contamination of their crop.

Acknowledgement

This project was funded by the Peanut and Mycotoxin Innovative Lab (PMIL) and the Mozambique institute of Agriculture Research (IIAM). This paper is a contribution to the 2016 Fifth African Higher Education Week and RUFORUM Biennial Conference.

References

Arias, F.J. and Libombo, M.L. 1994. Groundnut evaluation in Mozambique: Preliminary results from the 1993/94 season in Maputo Province. In: Ndunguru, B.J. *et al.* (Eds.). Sustainable Groundnut Production in South and Eastern Africa. Swaziland, Mbabane: International Crops Research Institute for the Semi-Arid Tropics.

Cotty, P.J. and Jaime-Garcia, R. 2007. Influences of climate on aflatoxin producing fungi and aflatoxin contamination. *International Journal of Food Microbiology* 119: 109-115.

Guo, B.Z., Sobolev, V., Holbrook, C.C. and Lynch, R.E. 2003. Impact of phytoalexins and lesser cornstalk borer damage on resistance to aflatoxin contamination. *Phytopathology* 93.

Mphande, F.A., Siame, B.A. and Taylor, J.E. 2004. Fungi, aflatoxins and cyclopiazonic acid associated with peanut retailing in Botswana. *J Food Prot* 67: 96–102 .

Muitia, A. 2005. Combination of root-knot nematodes (*Meloidogyne* spp.) resistance and edible seed quality for peanut (*Arachis hypogaea* L.) production in Mozambique and in the U.S. Lubbock, Texas: Plant and Soil Science, Texas Tech University.

Muitia, A. 2013 Farmer perceptions and genetic studies of rosette disease in groundnut (*Arachis hypogaea* L.) in northern Mozambique. PhD Thesis, University of KwaZulu-Natal: African Centre for Crop Improvement.

Okello, D.K., Kaaya, A.N., Bisikwa, J., Were, M. and Oloka, H.K. 2010. Management of aflatoxins in groundnuts: A manual for farmers, processors, traders and consumers in Uganda. Entebbe: National Agricultural Research Organisation.

Payne, G.A. 1992. Aflatoxin in maize. *Crit Rev Plant Sci.* 10 (5): 423-440.

Rahmianna, A.A., Taufiq, A. and Yusnawan, E. 2007. Effect of harvest timing and postharvest storage conditions on aflatoxin contamination in groundnuts harvested from the Wonogiri regency in Indonesia. *SAT eJournal* 5: 1-3.