An Overview of Research on the Management of Aflatoxin Contamination of Groundnut

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Aflatoxin contamination of groundnut is one of the most important constraints to groundnut production in many countries. It is also of significance in relation to public health and exports (Pettit et al. 1989, Waliyar 1978 and 1990, Wynne et al. 1991).

Most countries/institutions give high priority to research on the groundnut aflatoxin problem. Many national agricultural research systems (NARS) in Asia and Africa are faced with this problem because of the difficulty in reducing aflatoxin contamination in groundnuts and groundnut products to an acceptable level for export.

The concept of Aflatoxin Working Groups for Asia and Africa will help us to arrive at a better understanding of the actual research orientation of the activities of ICRISAT/NARS in Asia and Africa.

This paper gives an overview of aflatoxin research worldwide to allow for better planning of ICRISAT's future activities with NARS partners. A complete review and literature database on the groundnut aflatoxin problem is available at ICRISAT (Mehan et al. 1991).

Overview of Research on Aflatoxin Contamination

Aspergillus flavus infection of groundnuts occurs under both preharvest and postharvest conditions (Cole et al. 1989, Diener et al. 1987, Manzo and Misari 1989). Preharvest infection by *A. flavus* and consequent aflatoxin contamination are important in the semi-arid tropics (SAT), especially when end-of-season drought occurs (Azaizeh et al. 1989, Kisyombe et al. 1985). Drought stress may increase susceptibility to fungal invasion by decreasing the moisture content of the pod and seed, or by greatly lowering the physiological activity of the groundnut plant (Azaizeh et al. 1989, Kisyombe et al. 1985, Mehan et al 1988).

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Worldwide Progress in Aflatoxin Research

Research on the aflatoxin problem is not regularly carried out by all groundnut-producing countries. This is because of the lack of qualified personnel. Nevertheless some countries have been regularly monitoring groundnuts and groundnut products for aflatoxin at different stages (farm, storage etc.).

Before the 1980s, the aflatoxin problem was considered a postharvest problem. Therefore, research was focussed only on postharvest problems. However, severe preharvest aflatoxin contamination was reported in Australia, and in several countries in Asia and Africa.

Since the early 1980s, several national and international institutes, including ICRISAT, have carried out research on preharvest aflatoxin contamination. It is now well-established that aflatoxin contamination is also a preharvest problem in the SAT, particularly in areas where late-season drought is common. In the more humid tropics, it-is largely a postharvest problem. Investigations on the effects of climate, edaphic factors, and their interactions in the field and under controlled conditions have provided considerable information on pre- and postharvest infection by *A. flavus* and consequent aflatoxin production. Accordingly, a number of important recommendations were formulated for use by farmers and those concerned with purchase, storage, and processing of groundnuts and groundnut products (Dickens 1977, Mehan et al. 1991, Mehan 1992). These practices include:

- Avoiding damage to plants and pods from soilborne diseases and during cultivation,
- Avoiding late-season drought stress by manipulation of crop duration and supplementary irrigation,
- Lifting the crop at optimum maturity,
- Discarding damaged pods,
- Drying pods to below 8% moisture content,
- Storage under clean, dry, and insect-free conditions, and
- Avoiding re-wetting of pods/seed during storage.

Genetic Resistance

One of the possible means of reducing aflatoxin contamination of groundnut is the use of resistant cultivars. Several studies have established the presence of field resistance to seed infection by *A. flavus* in some cultivars. Resistance to preharvest field infection is particularly important in areas where late-season drought stress is a common occurrence (Mehan et al. 1987, Mehan et al. 1991, Mixon 1983, Waliyar et al. 1994, Zambettakis et al. 1981). Some cultivars such as J 11, 55-437, and PI 337394F have shown stable resistance to A *flavus* across locations. These sources among others have been used in breeding programs, and several lines have been reported to possess resistance and produce high yield. Several breeding lines from ICRISAT have been reported to be resistant to seed infection and colonization; these are ICGVs 87084, 87094, 87110, 91278, and 91284.

More resistant cultivars adapted to different production systems need to be developed to meet the requirements of producers and users.

The relationship between different resistance mechanisms, and their interactions have not been clearly established. Therefore, there is a need to carry out research to elucidate the mechanisms of resistance to pod/seed infection by A *flavus* and aflatoxin production.

Biotechnological Research

Efforts have been made to develop aflatoxin-resistant transgenic groundnut plants. This can be an effective long-term genetic approach to the problem.

Biological Control

Several biocontrol agents have been reported to control aflatoxin in groundnut. Cotty (1990) has done considerable research on the use of nontoxigenic strains of *A. flavus* to control aflatoxin contamination. This approach is based on the substitution of aflatoxin-producing strains of *A. flavus* with nontoxigenic strains. As high levels of the inoculum of nontoxigenic strains are required, this may result in the increased incidence of aflaroot in the field, and increased seed infection can lead to the production of free fatty acids and the loss of seed quality for commercial processing.

Detoxification and Decontamination

Large-scale detoxification procedures, using ammonia under high pressure, have been developed; these are now operational in Senegal and in the Sudan. Detoxification techniques suitable for small groundnut processors are needed. In India, some simple approaches for the detoxification of groundnut oil have been developed. Detoxification of crude oil in binding aflatoxin in groundnut oil and cake was studied. Some of these procedures can be used at the small-scale industry or the household level (Mehan 1995). The use of red clays in West African countries has been found to be very effective in binding aflatoxin in contaminated groundnut cake.

In Senegal, it was found that exposure to sunlight for 18 to 24 h destroyed 100% of the toxin in contaminated oil (Kane 1996). The contaminated oil is kept in sunlight in transparent and translucent containers. This simple method is a very useful way of reducing aflatoxin levels, and can be used by oil processors at the village level.

Other methods such as use of electronic devices to remove infected seed from groundnut lots have been used. These methods are expensive and not suitable for farmers in the SAT.

Cultural Control

Several recommendations have been made for the control of aflatoxin by adopting certain cultural practices. Some cultural practices, such as adjustments of sowing and harvesting dates, and application of gypsum, are effective in preventing aflatoxin contamination. The relationship between drought stress, termite population and seed contamination has been established. A period of drought at the end of the rainy season also favors aflatoxin contamination and increases the termite population.

There is a need for on-farm research to demonstrate the effectiveness of these cultural practices.

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