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# EFFECT OF PRE-HARVEST RAINFALL ON INFESTATION OF TOXIGENIC MOULDS AND RISK OF MYCOTOXIN CONTAMINATION IN GRAINS OF PEARL MILLET (*Pennisetum typhoides* (BURN. F.) STAPF AND HUBBARD) IN AGRA U. P., INDIA

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**ABSTRACT**

Millets are small seeded grains comprising major millets like pearl millet and sorghum; minor millets such as foxtail, finger millet, kodo millet, barnyard millet and proso millet, which are a potential source of good feed and fodder in different countries. Out of these, pearl millet (Bajra) is quite important and India now contributes nearly 50% of world production. In U.P. and other states, pre-harvest rainfall during the retreating monsoon in northern India. This rainfall increases grain moisture and humidity of atmosphere. As a result, the grain are liable to be infested with moulds and consequently the risk of mycotoxin contamination increases. In view of this fact, 40 samples of grains were collected from standing crop of 4 district viz; Agra, Firozabad, Mathura and Mainpuri of Agra Commissionary and analyzed for association of moulds by standard techniques. In all 36 fungi species were recognized which include a dozen species of *Asspergill*us, 5 species of *Fusarium*, 3 species of *Penicillium*, 2 species each of *Acremonium, Alternaria, Cladosporium, Curvularia* and *Chaetomium* and one species each of *Bipolaris, Cobaltosphorium, Rhizopus, Drechslera, Helminthosporium, Mucor, Paecilomyces,* and *Trichothecium.*

It is interesting to note that *Asspergillus flavus* and *Fusarium graminearum* were found to be dominant moulds in all the samples. Further, *Aspergillus ochraceus, Alternaria alternata,* and *Penicillium chrysogenum* were as co-dominant moulds showing 70- 80% incidence. Analysis of 26 grain samples by TLC method showed that Aflatoxin $B_1$ in the range of 250-800 ppb and Aflatoxin $G_1$ in the range of 100- 250 ppb. Futher analyses is under progress. These finding clearly indicate that toxigenic moulds i.e. *Aspergillus flavus, Aspergillus ochraceus, Fusarium* species, *Alternaria alternata* and *Penicillium* species are quite harmful to consumers as they can produce highly toxic mycotoxins such aflatoxin $B_1$, ochratoxin, zearalenone, fumonisin, patulin and alternariols.

***Key words*:** Pear millet, mycotoxins, mycotoxigenic moulds

## Introduction

Millets are an important staple crop with the capacity to withstand the harsh conditions of semiarid tropical regions of Asia and Africa. India is the major millet growing hub because of its diverse agricultural practices and rich cultural activities it contributes considerably to the food security and nutritional well being of its population. India is the world largest producer of millets. In the year 2021-22, pearl millet generated 58% of the total millet production followed by sorghum 29%, and finger millet 10% (Sharma *et al*., 2021). The principal millet producing states in India include Rajasthan, Karnataka, Maharashtra, Uttar Pradesh, Haryana, Gujrat, Madhya Pradesh, Tamil Nadu, Andhra Pradesh and Uttarakhand.

Food safety and security are among the major problems in the current scenario of increasing population. These are mainly determined by their key aspects viz; (1) enough food availability (2) access to safe food and (3) utilization of food in terms of quality for a healthy life. The failure of any these aspects leads to food insecurity

and malnutrition that further influences health of human and domestic animals. In addition, food and feed contamination by mycotoxins are one of the key factors responsible for creating food in security (Udomkun *et al*., 2017). As per Food and Agriculture Organization (FAO) one fourth of the world crops is affected by mycotoxins (Pankaj *et al*., 2018). Among various types of mycotoxins aflatoxins (Afs) are highly toxic and are known to contaminate a wide variety of food and feed. Food processing techniques are not sufficient to eliminate Afs from contaminated food and feed due to their heat resistant nature (Medina *et al*., 2017). The ingestion of Afs from contaminated food and feed has led to serious health complications in humans and animals because they (Afs) are carcinogenic, mutagenic, teratogenic, cytotoxic and immunosuppressive. Further the aflatoxins and other mycotoxins are produced both In pre and post-harvest conditions (Hesseltine 1974).

In view of the above facts, the present investigation has been taken to study the effect of pre-harvest rain fall (Retreating rain) on the infestation of moulds and mycotoxins particularly aflatoxins in matured grains of pearl millet. The pearl millet crop is mainly grown in kharif season in Agra region which includes 4 districts viz., Agra, Firozabad, Mathura and Mainpuri and the results so obtained are presented in this paper.

## Materials and Methods

In the present study, survey of pearl millet fields was undertaken and 40 samples of each (10 each from 4 district of Agra commissonary) were collected during pre-harvest period (September and October 2025). The grains were separated by traditional village method and collected in sterilized polythene bags. The bags were kept in refrigerator till analyzed. The mycoflora associated with pearl millet grains was isolated following seed plating method and dilution plate method (Graves and Hesseltine 1966) using PDA medium. After incubation at 28±1°c for 7 days, the plates were examined for moulds with the help of stereobinocular microscope. The fungi were separated purified and identified with the help of illustration and description given by Bennet (1960) and Subrahmanian (1971). Simultaneously, moisture content of pearl millet grains was determined by "Hot air oven drying method "as outlined by Lawerence (1964).

The qualitative and quantitative estimation of aflatoxins was made by thin layer chromatographic method following Scott *et al*., (1970).

## Results and Discussion

The perusal of Table 2 clearly indicates that a total of 36 fungal species were found associated with pearl millet grains during pre-harvest stage. These fungi include a dozen species of *Aspergillus*, 5 species of Fusarium, 3 species of *Penicillium*, 2 species each of

*Acremonium, Alternaria, Cladosporium,* Curvularea and *Chaetomum,* and one species each of *Bipolaris, Cephalosporium, Drechslera, Helminthosporium, Mucor, Rhizopus, Piecilomyces and Trichothecium.*

**Table 1:** Collection of pearl millet grain samples during pre-harvest stage and their moisture content.

| S. No. | Sampling Place | No. of grain samples collected | Mean moisture content of grainsamples (%) |
|---|---|---|---|
| 1 | Agra Rural | 10 | 12.8 |
| 2 | Firozabad | 10 | 13.0 |
| 3 | Mathura | 10 | 12.8 |
| 4 | Mainpuri | 10 | 13.0 |
| **Total No. of grain samples** | | **40** | |

It is interesting to note that *Aspergillus ûavus* and *Fusarium graminearum* were recorded from all the samples showing 100% frequency. Further, these were graded as most dominant moulds in pearl millet grains. *Aspergillus ochraceus, Alternaria alternata* and *Penicillium chrysogenum* were adjudged as co-dominant moulds showing 70-80% incidence. Other fungi showed less than 50% incidence. It is not worthy to mention here is that *Aspergillus ûavus,*

*Aspergillus ochraceus, Fusarium species, Alternaria alternata* and *Penicillium species* are well known for their toxigenic nature and they produce highly toxic metabolites (Mycotoxins). The main mycotoxins produced by them include aflatoxins ($B_1$, $B_2$ $G_1$ and $G_2$), Ochratoxins (A, B, C), Zearalenone, gumonosin, patulin and alternariols.

Further, qualitative and quantitative analysis of aflatoxins in grain samples by TLC indicated that Aflatoxin $B_1$ was found in the range of 250-800 ppb in 20 grain samples and aflatoxin $G_1$ was recorded in the range of 100-250 ppb in these samples. However, Aflatoxin $B_2$ and $G_2$ were not detected. Further work on this is under progress.

Cereals and cereal based products are the major foods for human consumption worldwide. Among cereals, rice, corn and wheat are mostly contaminated by aflatoxins. However, millets are less studied in relation to mycotoxin contamination. There is meagre information about sorghum and pearl millet contamination by aflatoxins. Tripathi (1975) reported aflatoxin in sorghum grains infected with heal moulds. Reddy and Nusrath (1986) recorded mycotoxin formation in sorghum in field conditions. Further, Gupta (1998) reported incidence of

**Table 2:** Mycoflora associated with pearl millet grains at pre-harvest stage.

| S. No. | Name of Fungi | Place of samples | | | |
|---|---|---|---|---|---|
| | | AG | FB | MT | MP |
| 1 | *Acremonium vitis* | +(3) | +(4) | +(2) | +(3) |
| 2 | *Acremonium glaucum* | – | +(3) | – | +(2) |
| 3 | *Alternaria alternata* | +(8) | +(9) | +(8) | +(10) |
| 4 | *A. tenuissima* | – | +(2) | +(4) | +(3) |
| 5 | *Aspergillus aculeatus* | +(3) | +(4) | +(2) | +(5) |
| 6 | *A. ûavus* | +(10) | +(10) | +(10) | +(10) |
| 7 | *A. fumigatus* | +(5) | +(6) | +(4) | +(7) |
| 8 | *A. japonicus* | +(6) | +(5) | +(4) | +(5) |
| 9 | *Aspergillus niger* | +(3) | +(4) | +(6) | +(7) |
| 10 | *A. nidulans* | +(2) | +(4) | +(2) | +(3) |
| 11 | *A. ochraceus* | +(7) | +(8) | +(8) | +(9) |
| 12 | *A. sydowii* | +(3) | +(2) | +(4) | +(5) |
| 13 | *A. tamari* | +(4) | +(3) | +(4) | +(6) |
| 14 | *A. terreus* | +(5) | +(4) | +(3) | +(5) |
| 15 | *A. ustus* | – | – | – | +(2) |
| 16 | *A. versicolor* | +(2) | +(3) | +(3) | +(4) |
| 17 | *Biplolaris spicifera* | +(4) | +(5) | +(3) | +(6) |
| 18 | *Cephaloshorium sp.* | +(2) | +(2) | – | +(3) |
| 19 | *Chaetomium globosum* | +(7) | +(6) | +(4) | +(4) |
| 20 | *C. spirale* | – | – | +(2) | +(3) |
| 21 | *Cladosporium herbarum* | +(8) | +(8) | +(6) | +(7) |
| 22 | *C. cladosporoides* | +(3) | +(4) | – | – |
| 23 | *Curvularia lunata* | +(8) | +(7) | +(9) | – |
| 24 | *C. hawienses* | +(7) | +(5) | +(4) | +(5) |
| 25 | *Drechslera specifera* | +(3) | +(4) | +(5) | +(3) |
| 26 | *Fusarium roseum* | +(4) | +(3) | – | +(5) |
| 27 | *F. moniliforme* | +(6) | +(6) | +(5) | +(7) |
| 28 | *F. graminearum* | +(7) | +(7) | +(3) | +(5) |
| 29 | *F. oxysporum* | – | – | +(4) | +(3) |
| 30 | *F. sporotrichoides* | +(7) | +(6) | +(8) | +(6) |
| 31 | *Helminthosporium sp.* | +(4) | +(4) | +(3) | +(5) |
| 32 | *Mucor hiemalis* | +(5) | +(5) | +(6) | +(4) |
| 33 | *Paecilomyces sp.* | – | +(3) | – | +(3) |
| 34 | *Penicillium patulum* | +(5) | +(5) | +(6) | +(6) |
| 35 | *P. chrysogenum* | +(6) | +(7) | +(5) | +(6) |
| 36 | *P. citrinum* | +(5) | +(5) | +(3) | +(5) |
| 37 | *Rhizopus stolonifera* | +(4) | +(4) | – | +(4) |
| **Total No. of Fungi** | | **31** | **34** | **30** | **36** |

AG: Agra; FB: Firozabad; MT: Mathura; MP: Mainpuri
+denotes presence of fungi; –Denotes absence of fungi;
Figures in parenthesis indicate the Number of samples in which fungus was present.

zearalenone producing *Fusarium* species on sorghum grains. Kumar and Singh (1990) studied mycoflora in pearl millet grains during field and storage and noted 20 and 30 fungal species respectively. Later Mishra and Daradhiyar (1991) recorded mould flora and aflatoxin contamination of stored and cooked samples of pearl millet in Paharia tribal belt of Santhal pargana, Bihar, India and also noted disorders due to consumption of aflatoxin contaminated pearl millet food. Thus, proper survey and detection methods and proper control strategies are crucial to combat the burning issue of mycotoxin contamination in food and feed.

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