

Prevalence and Transmission of Seed-Borne Fungi of Maize Grown in a Farm of Korea

A. B. Basak^{1*} and Min Woong Lee

Department of Applied Biology, Dongguk University, Seoul 100-715, Korea

¹Department of Botany, University of Chittagong, Chittagong 4331, Bangladesh

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Seed-borne fungi of some maize cultivars/lines grown during the months from May to September of 2001, collected from Dongguk University farm, Go Young City, IL Sang Gu, Korea were detected by blotter method. In all six fungi namely *Alternaria alternata* (Fr.) Keissler, *Aspergillus niger* Van Tiegh, *Fusarium moniliforme* Sheldon, *Fusarium* sp., *Penicillium* sp. and *Ustilago zaeae* Unger. were found to associated with maize seeds. Prevalence of seed-borne fungi also varied. The highest percentages of seed-borne fungi were recorded with *Fusarium moniliforme* and the lowest in *Penicillium* sp. Transmission of all seed-borne pathogens from seeds to seedlings were also detected by test tube seedling symptom test. Among the seed-borne fungi, *Alternaria alternata*, *Fusarium moniliforme* and *Fusarium* sp. produced distinct seed rot and seedling infection symptoms. All the transmitted seed-borne fungi might be caused primary source of infection to the maize crop.

KEYWORDS: Maize, Seed-borne fungi, Transmission

Maize, the important cereal crop of Korea is grown extensively in different glass houses and in field conditions. The crop is affected with as many as 85 diseases (KSPP, 1998; Nyvall, 1989; Rangaswamy, 1979) of which 31 diseases were caused by fungi. Some of the fungal diseases are known to seed-borne and transmitted through seeds (Anderegg and Guthrie 1981; Chang and Kommedahl, 1972; Foley 1962; Futrell and Kilgore, 1969; King 1981; Nyvall 1989; Richardson 1979; Korean Society of Plant Pathology, 1998). From Korea, Kim *et al.* (1984) tested seven seed samples of corn obtained from Kangweon Provincial Office of Rural Development and found that all the samples were infected with *Fusarium moniliforme* to an extent of 6.0–79.5%. Nyvall (1989) recorded eight diseases namely-anthracnose leaf blight, black bundle diseases, black kernel rot, ergot, eye spot or brown spot, *Fusarium* stalk rot, *Pythium* seed and seedling blight and seed and seedling blight caused by *Colletotrichum graminicola* (Ces.) G. W. Wilson; *Cephalosporium acremonium* Cda.; *Botryodiplodia theobromae* Pat.; *Claviceps gigantea* Fruentes, de la Isle Ullstrup & Rodriguez; *Kabatiella zaeae* Narita & Hiratsuka; *Fusarium moniliforme* Sheldon and *F. subglutinans* (Wollenw & Reink) Nelson, Toussoun & Marasas Comb nov.; *Pythium* spp.; *Diplodia maydis* (Earle) Sutton, *Gibberella zaeae* (Schw.) Petch, *F. moniliforme* Sheldon, *Rhizoctonia solani* Kühn respectively and found all these fungal pathogens were transmitted by seeds. During the present study, a severe infection on maize kernel was observed at Dongguk University Farm, Go Young City, IL San Gu, during March-

October 2001. Literature review shows that no extensive work on the prevalence of seed-borne fungi and their transmission from seed to seedling of maize seeds has done in Korea. Moreover, every year seed-borne fungi cause heavy yield loss of the crop and some fungi act as a primary source of infection.

Considering the seriousness and common occurrence of kernel rot of maize in a farm of Korea and inadequate information regarding the seed-borne fungi and their transmission from seeds to seedlings this study was undertaken.

Materials and Methods

Isolation of seed-borne fungi. Ten samples of maize seeds of different cultivars/lines grown during June–October, 2001 were collected directly from the experimental field of Dongguk University farm, Go Young City, IL San Gu in the months of November. During collection, seeds from infected maize kernels (Fig. 1A) were isolated separately and preserved in paper bags. Before detection of seed borne fungi from the seeds all the samples were preserved in refrigerator. The mycoflora of the collected seeds samples were detected by blotter method as recommended by International Seed Testing Association (ISTA 1976). The fungi from the seeds were identified by observing their growth characteristics on the incubated seeds in the blotter following the keys offered by different authors (Booth, 1971; Ellis, 1971; Ramnath *et al.*, 1970) and by examining under stereo-binocular microscope whenever necessary.

Test tube-seedling symptom test. The test tube seedling symptom test developed by Khare *et al.* (1977) was

*Corresponding author <E-mail: mwlee@dgu.ac.kr>

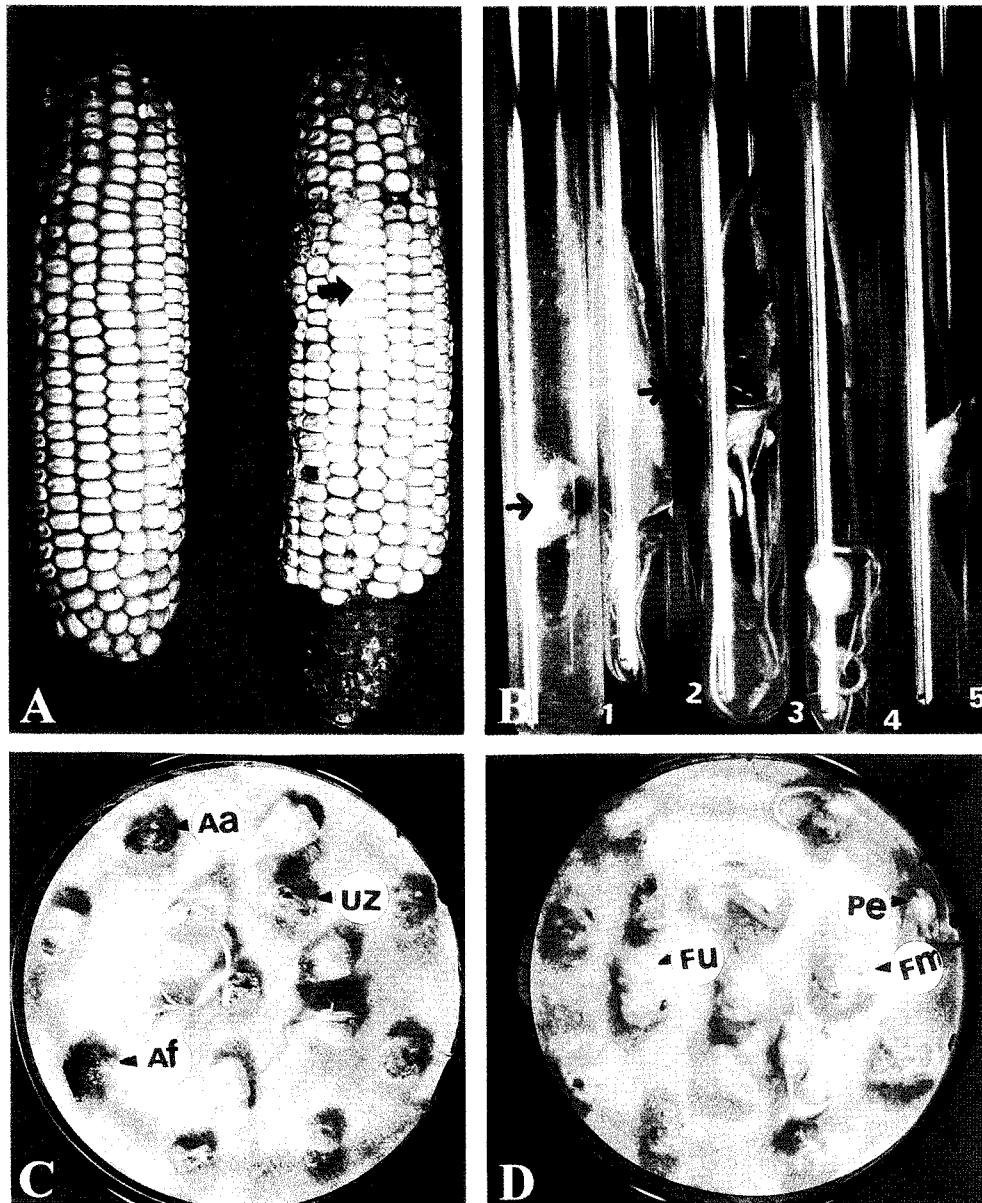


Fig. 1. A. Maize kernel showing infection of seed-borne fungi. B. Transmission of seed borne fungi from seeds to seedlings as determined by the test tube seedling symptom test: (B1) Non germination of seeds or seed rot caused by *Fusarium moniliforme*; (B2) Seedling infection caused by *Alternaria alternata*, (B3), *Fusarium* sp. (B4) and *F. moniliforme* and (B5) A Healthy seedling without fungal infection. C & D. Different seed borne fungi as detected by blotter method: *A. alternata* (Aa), *A. flavus* (Af), *F. moniliforme* (Fm), *Fusarium* sp. (Fu), *Penicillium* sp. (Pe) and *Ustilago zaeae* (Uz).

used for this study. Test tube slants were prepared by pouring 6 ml of 2.0% water agar and sterilized in autoclaved for 10 minutes and 15 lb pressure at 121°C. In all two samples having highest percentage of seed infection were employed in this experiment. Two hundred seeds for each sample were used at the rate of one seed per test tube. The test tubes with the seeds were then incubated in the laboratory desk at room temperature ($20 \pm 2^\circ\text{C}$). The mouths of the test tubes were properly plugged with cotton and the test tubes were placed on the wooden test incubation. The germination seeds and seedlings in the

test tube examined for the presence of visible symptoms (seed rot, germination failure and infection or death of emerged seedlings) caused by the pathogens present in the seed. The symptoms produced on the germinating seeds and seedlings by the associated pathogen were confirmed by examining the seeds under stereo- binocular microscope.

Results and Discussion

Prevalence of seed-borne fungi. The occurrence of

Table 1. Percentage occurrence of seed borne fungi of selected seed samples of maize grown in a farm of Korea during May-September, 2001

Isolated fungi	Number of seeds with fungi out of 200 seeds	Percentage of	
		Occurrence of fungi ^a	Fungi associated with seeds ^b
<i>Alternaria alternata</i>	125	8.5	6.3
<i>Aspergillus flavus</i>	57	3.9	2.9
<i>Fusarium moniliforme</i>	693	47.0	34.7
<i>Fusarium</i> sp.	551	37.4	27.6
<i>Penicillium</i> sp.	26	1.8	1.3
<i>Ustilago zeae</i>	23	1.6	1.1

^aOut of total number of fungal infection of 1475.

^bPercent of seed-borne infection of different fungal species was calculated on the basis of 2000 seeds.

individual fungi varied widely. From the total population of fungi encountered in this study, only 5 genera were identified. These were *Alternaria alternata* (Fr.) Keissler, *Aspergillus flavus* Lk. Ex Fr., *Fusarium moniliforme* Sheldon, *Fusarium* sp., *Penicillium* sp., and *Ustilago zeae* Unger. The most predominant fungi detected, in order of prevalence were *Fusarium moniliforme*, *Fusarium* sp., *Alternaria alternata* and *Aspergillus flavus* Table 1 (Fig 1C and 1D). The highest severity of infection of individual fungus differed greatly. Maximum fungal association was recorded with *Fusarium moniliforme* and the minimum with *Ustilago zeae*.

Transmission of seed-borne fungi. Results of transmission of three seed-borne fungi of maize from seed to germinating seeds and seedlings as determined by test tube seedling test are presented in Table 2 (Fig. 1B). In all three kernel rot pathogens namely *A. alternata*, *F. moniliforme* and *Fusarium* sp. were found to transmit to the germinating seeds causing pre-emergence and post emergence death. The rate of transmission of the test kernel rot pathogens from seed to germinating seeds causing pre emergence death or seed rot were always higher than that of transmission to seedling infection or seedling mortality. The highest percentage of seed borne infection 49%, pre emergence death or seed rot (15.5%), seedling infection (11.2%), post emergence death (8.32%) and total disease development (35%) were recorded from the seedlings transmitted from *Fusarium moniliforme* infected seeds and the lowest from *Alternaria alternata*.

A. alternata first produced brownish black fluffy col-

ony on the seeds and around the base of seedlings. The fungus infected the cotyledons; as a result the cotyledonary leaves could not open. Sometimes infected seedlings collapsed and finally died (Fig. 1B2). On the total seed-borne infection (9%) of *A. alternata*, 3.0% could cause seedling infection or death of seedlings. On the other hand 4.0% seeds could not germinate at all. In field, this pathogen produces Alternaria leaf blight disease. The disease appears as chlorotic streaks that later become necrotic forms on leaves of all ages. Leaves may be killed in one week if heavy and prolonged dews occur.

Fusarium moniliforme produced orange to dark violet fluffy colony on the seeds and around the base of seedlings (Fig. 1B1). From the colony the mycelia of the fungus were found to infect emerge out seedling. The cotyledonary leaves could not open. Such infected seedlings collapsed and finally died. In an average 11.2% of the seed borne infection of *F. moniliforme* were capable of causing seedling infection (Fig 1B4) and 8.3% of post emergence death. Moreover 15.5% seeds failed to germinate.

In case of *Fusarium* sp., it produced whitish fluffy colony on the seeds and around the base of seedlings. In the total seed borne infection (26.0%), on an average could not rise to 8.5% seedling infection (Fig. 1B3) and 7.5% post emergence death. In this case 41.0% could not germinate.

The fungi, which have been detected during the study are known to be transmitted with maize seeds (Richardson, 1979). Most of the fungi encountered in the seeds of maize grown during months from May to September of

Table 2. Transmission of seed borne fungi of maize from seeds to germinating seeds and seedlings as determined by test tube seedling test

Seed-borne fungi	% of seed-borne infection	% of seed-borne fungi carried			
		Pre-emergence death (%)		Post-emergence death	Total disease development
		seed rot	seedling		
<i>Alternaria alternata</i>	12.0	4.0	3.0	2.0	9.0
<i>Fusarium moniliforme</i>	49.0	15.5	11.2	8.3	35.0
<i>Fusarium</i> sp.	35.0	10.0	8.5	7.5	26.0

2001 in the present investigation are recorded by different research workers (Chang and Kommedahl 1972; Kim *et al.*, 1984; King and Scott 1981; Windels *et al.*, 1976), but occurrence of *Alternaria alternata*, *Fusarium* sp. and *Ustilago zaeae* seems to be new record for Korea. In 1984, Kim *et al.* detected *Fusarium moniliforme* as a seed-borne fungus of maize grown in Korea.

The fungal pathogens namely *A. alternata*, *A. flavus*, *F. moniliforme* and *U. zaeae* causing Alternaria leaf blight, Aspergillus ear rot, Fusarium kernel rot and Common smut respectively with maize seeds may provide initial inoculum in the field through root soils of the seedlings. In test tube seedling symptom test, three pathogens namely *A. alternata*, *F. moniliforme* and *Fusarium* sp. were found responsible for transmission from seed to germinating seeds and seedlings. All these fungi under favourable environmental conditions can infect the growing plants and can also serve as source of inoculum for field crop. So, the seed-borne fungi namely- *Alternaria*, *Fusarium* should be eliminated to explore the possibility of seed transmission of these fungi under Korean field conditions. Moreover, no infected kernel or seeds from infected kernel should be preserved for raising seedling for the next year. Healthy kernel with seeds should always be preferred for seed preservation purposes.

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