SEED-BORNE MYCOFLORA OF MAJOR FOOD CROPS IN GHANA

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ABSTRACT
Seed-borne fungi of 152 seed samples of sorghum, pearl millet, rice, maize, groundnut, cowpea, okra, pepper, watermelon, tomato and garden eggs were assessed for fungal infection using the blotter method. Twenty genera and 32 species of fungi were recorded from the seed samples. One hundred and three sorghum samples examined were infected by 24 fungi of which Phoma sorghina (43.3%) and Fusarium moniliforme (40.3%) were the largest groups of fungi recorded. Twenty pearl millet samples tested were infected by 14 fungi with P. sorghina (30.9%) and F. moniliforme (12.2%) as the most frequently recorded fungi. Seven rice samples examined had eight fungi recorded with low percentage infections of important seed-borne pathogens namely Bipolaris oryzae (0.9%), Microdochium oryzae (0.7%) and Sarocladium oryzae (0.5%). Eight fungal organisms were recorded on three samples of maize with F. moniliforme (32.3%) occurring most frequently. Two samples of groundnut tested were found to be heavily attacked by Aspergillus flavus (50.3%) and A. niger (21.8%). Seven fungi were recorded on two samples of cowpea with F. pallidoroseum recording the highest infection of 30.1%. The fungal load of vegetable seed samples was comparatively low with the exception of Phoma sp. and F. moniliforme that occurred in higher numbers on both tomato and pepper while F. pallidoroseum and F. moniliforme occurred in appreciable levels on okra. The least occurring fungi were recorded in the text.

Keywords: Seed-borne fungi, seed samples, genera, species

INTRODUCTION
Agriculture is the mainstay of the economy of Ghana. About 67% of the population derives their livelihood from agriculture, which constitutes 64% of the Gross National Product. Farm sizes in Ghana are generally small with 85% of farmers cultivating less than 2 ha of land; 60% of farms are less than 1.2 ha (MOFA, 2001). About 2 million of these small farm holdings directly support 10.1 million people and provide 80% of the domestic food supply. In spite of this contribution, small-scale farmers do not receive adequate technical support on seed-saving and seed management practices to enhance their capacity to produce and maintain seed security stocks. Most of the seeds planted by farmers have been saved on the farm and they are generally in very bad condition with low germination rates. Where seed samples were of poor or low quality, the causes of the problem were usually due to grain mould complexes.

Very few crops, such as maize, rice, cowpea and soybean, have standards for certification. It is

expected that standards would soon be developed for cassava, groundnut and cotton in view of their increasing importance in the country's agriculture. The need has been felt very strongly for establishing minimum standards for certification of local varieties of vegetable crops since exotic ones such as cabbage and carrot do not commonly flower under Ghanaian conditions and seed has to be imported.

Presently, the informal seed sector has been playing a dominant role in seed supply and needs to be improved and strengthened for its effective role in agriculture to ensure effective seed delivery at the district and village levels.

The scarcity of information available about seed-borne diseases has been an important constraint to the development of quality seed production. The aim of the present investigation was to determine the seed-borne organisms associated with one hundred and fifty-two seed samples of eleven major food crops of Ghana.

Materials and Methods

One hundred and fifty-two seed samples of eleven crops comprising cereals, grain legumes and vegetables, harvested in 1997 from different parts of the country, were saved in plastic bags and stored in the cold room at 5°C for study in 1998. Sorghum and pearl millet seed samples were collected from the research experimental plots of the Savannah Agricultural Research Institute, Nyankpala, and the outstations at Damongo and Manga in Northern and Upper East Regions, respectively. The Plant Genetic Resources Centre, Bunso, obtained seeds of other crops from farmers at Bawjiase, Bekwai, Bunso, Donfete, Donkorkrom, Lawra, Nandom, Nsawam, Swedru and other smaller villages and grain markets at Kasoa and Techiman. The samples were taken to the Danish Institute of Seed Pathology, Copenhagen, Denmark, and examined for the presence of fungi by the blotter method (ISTA, 1966).

Two hundred seeds of each sample were placed on three layers of moistened blotters in sterile plastic petri dishes (9 cm diameter). The number of seeds incubated per plate depended on the size of the seed tested; 50 in the case of small seed (pepper, tomato and garden eggs), 25 for medium size seed (sorghum, millet, rice, okra and watermelon) and ten for large size seed (maize, peanut and cowpea). The petri dishes were incubated at 21°C under alternating cycles of 12 hours near ultraviolet (NUV) and 12 hours darkness for seven days. Fungi developing from seeds were identified under stereomicroscope based on their growth characters. Occasionally, identifications were confirmed by examining slide preparations of the fungi under the compound microscope. Infection levels were recorded as the percentage infected seeds in a sample.

RESULTS

Sorghum

One hundred and three seed samples were tested and a total of 24 species of fungi recorded (Table 1). The most important pathogens recorded were *Phoma sorghina* (mean infection 43.3%) and *Fusarium moniliforme* (mean infection 40.3%). Besides, *F. pallidoroseum* (syn. *F. semitectum*), *F. equiseti*, *Bipolaris maydis*, *Colletotrichum sublineolum*, *Gloeocercospora sorghi*, *B. bicolor* and *Exserohilum rostratum* occurred on considerable number of seed samples with mean infection ranging between 0.8-12.7%. The following fungi were found in one or more seed samples but in moderate amounts (mean infections ranged between 0.5 to 4.3%): *Acremonium strictum*, *Botryodiplodia theobromae*, *Cercospora sorghi*, *Colletotrichum gloeosporioides*, *C. truncatum*, *Curvularia lunata*, *E. monoceras*, *F. solani*, *F. subglutinans*, *Macrophomina phaseolina*, *Myrothecium verrucaria*, *Nigrospora* sp., *Pestalotia* sp., *Phomopsis* sp. and *Verticillium* sp.

Pearl millet

Twenty seed samples were tested and a total of

Table 1: Fungi recorded in sorghum seed samples harvested in 1997 in Ghana and tested by the blotter method

Fungi	No. of infected seed samples	Infection (%) Mean	Range
Acremonium strictum	9	0.6	0.5-1.0
Bipolaris bicolor	25	1.4	0.3-3.1
Bipolaris maydis	39	1.1	0.1-6.0
Botryodiplodia theobromae	2	4.3	0.5-8.0
Cercospora sorghi	2	0.5	0.5
Colletotrichum gloeosporioides	12	1.3	0.1-4.5
Colletotrichum sublineolum	35	12.7	0.5-90.5
Colletotrichum truncatum	1	0.5	0.5
Curvularia lunata	16	2.0	0.3-5.1
Exserohilum rostratum	25	0.8	0.3-2.5
Exserohilum monoceras	1	0.5	0.5
Fusarium equiseti	55	1.5	0.1-8.0
Fusarium moniliforme	103	40.3	3.0-88.5
Fusarium pallidoroseum	89	3.8	0.3-18.5
Fusarium solani	1	0.5	0.5
Fusarium subglutinans	3	3.9	0.7-5.5
Gloeocercospora sorghi	34	1.1	0.3-3.5
Macrophomina phaseolina	5	3.3	0.2-6.5
Myrothecium verrucaria	2	0.5	0.5
Nigrospora sp.	1	0.5	0.5
Pestalotia sp.	1	0.5	0.5
Phoma sorghina	102	43.3	3.1-96.0
Phomopsis sp.	11	0.7	0.5-7.5

Table 2: Fungi recorded in pearl millet seed samples harvested in 1997 in Ghana and tested by the blotter method

Fungi	No. of infected seed samples	Infection (%) Mean	Range
Acremonium strictum	1	0.5	0.5
Bipolaris bicolor	1	3.0	3.0
Bipolaris maydis	1	0.5	0.5
Bipolaris setariae	8	1.6	0.9-3.5
Colletotrichum gloeosporioides	2	0.5	0.5
Colletotrichum sublineolum	1	0.2	0.2
Curvularia lunata	9	8.7	0.5-33.5
Fusarium equiseti	7	2.6	0.5-6.0
Fusarium moniliforme	12	12.2	0.2-27.0
Fusarium pallidoroseum	11	4.0	0.5-9.0
Fusarium subglutinans	7	0.7	0.5-1.5
Nigrospora sp.	1	0.5	0.5
Phoma sorghina	19	30.9	0.2-79.5
Phomopsis sp.	2	0.4	0.2-0.5

Table 3. Fungi recorded in rice seed samples harvestedin 1997 in Ghana and tested by the blotter method

Fungi	No. of infected seed samples	Infection (%) Mean	Range
Bipolaris oryzae	4	0.9	0.5-2.0
Fusarium equiseti	4	5.3	2.0-7.5
Fusarium moniliforme	7	5.6	0.5-17.0
Fusarium pallidoroseum	3	1.7	0.5-3.0
Microdochium oryzae	3	0.7	0.5-1.0
Myrothecium verrucaria	1	1.0	1.0
Phoma sp.	5	2.5	0.2-3.5
Sarocladium oryzae	1	0.5	0.5

Table 4: Fungi recorded in maize seed samples harvested in 1997 in Ghana and tested by the blotter method

Fungi	No. of infected seed samples	Infection (%)	
		Mean	Range
Acremonium strictum	2	8.0	6.5-9.5
Bipolaris maydis	1	0.5	0.5
Botryodiplodia theobromae	2	11.3	1.5-21.1
Diplodia maydis	1	21.5	21.5
Fusarium moniliforme	3	32.3	3.3-55.0
Fusarium pallidoroseum	2	7.0	0.5-13.5
Fusarium subglutinans	1	1.0	1.0
Nigrospora sp.	1	0.5	0.5

Table 5: Fungi recorded in groundnut seed samples harvested in 1997 in Ghana and tested by the blotter method

Fungi	No. of infected seed samples	Infection (%)	
		Mean	Range
Aspergillus flavus	2	50.3	42.7-58.0
Aspergillus niger	2	21.8	19.0-24.7
Botryodiplodia theobromae	1	19.8	19.8
Macrophomina phaseolina	2	8.7	0.4-17.0

Table 6. Fungi recorded in cowpea seed samples harvested in 1997 in Ghana and tested by the blotter method

Fungi	No. of infected seed samples	Infection (%)	
		Mean	Range
Botryodiplodia theobromae	2	4.0	1.6-6.5
Fusarium equiseti	1	0.5	0.5
Fusarium moniliforme	2	0.7	0.5-0.9
Fusarium pallidoroseum	2	30.1	15.8-44.5
Fusarium subglutinans	1	2.0	2.0
Macrophomina phaseolina	2	10.6	4.2-17.0
Phoma sorghina	2	1.1	0.7-1.5

Table 7: Percent mean infection of fungi recorded in seed samples of some vegetable crops harvested in 1997 in Ghana and tested by the blotter method

No. of seed samples	2	6	3	2	2
Crops / **Fungus**	*Abelmonschus esculentus (okra)*	*Capsicum annuum (pepper)*	*Citrullus lanatus (watermelon)*	*Lycopersicon lycopersicum (tomato)*	*Solanum aethiopicum (garden eggs)*
Acremonium sp.	4.0	3.0		0.5	
Bipolaris maydis				0.5	
Botryodiplodia theobromae	1.5				
Colletorichum gloeosporioides		0.7		0.2	
Colletotrichum sublineolum				0.9	
Colletotrichum truncatum	0.5	1.0			
Fusarium equiseti		0.2		0.2	
Fusarium moniliforme	8.5	17.0		17.6	
Fusarium pallidoroseum	13.5	3.5	0.6	0.9	
Fusarium solani		0.5	3.0		
Fusarium subglutinans		0.9		1.3	0.2
Gloeocercospora sorghi				0.5	
Myrothecium roridum		0.5	0.2		
Pestalotia sp.				0.5	
Phoma sp.		15.3	7.3	38.5	
Phomopsis sp.	5.0	0.4			
Verticillium sp.	0.5				

ashy stem blight/charcoal rot (Nakawuku *et al.*, 1997). The disease caused by *F. pallidoroseum* and two other infrequently isolated fungi, *F. moniliforme* and *Botryodiplodia theobromae* was unknown. However, the presence of high levels of *F. pallidoroseum* is alarming since *Fusarium* spp. are known to produce mycotoxins (Agrios, 1988). *Phoma sorghina* is also reported to cause seed rot (Nakawuku *et al.*, 1997).

The fungi recorded in seeds of vegetable crops are common seed-borne organisms. They were mostly recorded in trace to moderate amounts except for three fungi, notably *Phoma* sp. and *Fusarium moniliforme* in both tomato and pepper and *F. pallidoroseum* in okra.

CONCLUSIONS

Organisms recorded in one hundred and fifty-two seed samples of 11 major food crops constitute a comprehensive list of seed-borne fungi for Ghana. Sorghum and pearl millet constituted the main bulk of samples tested. There were marked differences in the level of infections of the various organisms isolated. *Phoma sorghina*, *Fusarium moniliforme* and *Colletotrichum sublineolum* were among the most frequently isolated fungi. Other fungi, including *Fusarium pallidoroseum*, *Aspergillus flavus*, *A. niger* and *Macrophomina phaseolina* were also present in significant numbers. The infrequently isolated fungi mentioned in the text were found in one or up to four seed samples but in trace amounts. The widespread occurrence of *Acremonium*, *Botryodiplodia*, *Colletotrichum*, *Fusarium* and *Phoma* infecting a considerable host range is of particular interest for further surveillance. Seed testing of food crops in the seed quality control system is highly recommended. This is because the basis for increase in plant production is adoption of better varieties of crop plants and establishment of better production to secure seed lots of the best possible quality in terms of germination, purity and health.

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