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Fungi associated with maize and bean grown as a mixture by small scale farmers in Kenya, and their control.

Resumen. Con el fin de observar los hongos portados en ellas, se analizaron semillas de dos cultivares de maíz y dos de frijol utilizados en mezcla por agricultores de pequeña escala en Kenia. Los principales hongos recuperados fueron *Fusarium moniliforme*, *Aspergillus niger* y *Penicillium* sp para maíz, y *Fusarium solani* f. sp *phaseoli* y *Penicillium* sp. para las semillas de frijol. El hongo *Penicillium* sp mostró una amplia distribución en los cultivares de maíz y frijol analizados

De tres fungicidas probados, el benomil fue el más efectivo en la reducción del porcentaje de recuperación total de hongos y en el aumento del porcentaje de germinación de las semillas *in vitro*, seguido por el captan y el oxicloruro de cobre.

The majority of small scale farmers in Kenya who constitute about 90% of the community, grow maize (*Zea mays* L.) and bean (*Phaseolus vulgaris* L.) as a mixture. These two are important food crops, and one of the main factors which can limit its cultivation is the incidence of seed-borne fungi which are often associated with reduced emergence, yield and seed quality (6, 9). The present study was, therefore, undertaken to identify and to determine the percentage incidence of fungi associated with seeds of maize and bean varieties which are grown repeatedly by small scale farmers, and also to study the efficacy of three fungicides for the control of seed-borne fungi detected and percentage germination of seeds *in vitro*.

Materials and methods

Seed samples of hybrid maize and local var 'Gikuku' and local bean varieties 'Gituru' and 'Wairumu' commonly grown in Kiambu District were collected from different small scale farmers. 400 seeds randomly taken from each cultivar were tested by the standard blotter method (7). Seeds were surface disinfected in a solution of 2% sodium hypochlorite for about 5 minutes and spaced (six maize seeds/plate; eight bean seeds/plate) on two moist blotters in Petri-plates. Plates were incubated at 24 ± 2°C continuously under artificial light. Seeds were observed after eight days of incubation as recommended for routine seed health testing (7).

The effect of fungicidal seed treatment on the percentage of occurrence of seed-borne fungi and percentage of seed germination was determined by using 200 seeds of each cultivar, surface sterilized as above, in the suspension of a systemic fungicide benomyl (Benlate 45.49% a.i.) and two other non-systemic fungicides, captan (Orthocide 76.2% a.i.) and copper oxychlorite (50.1% a.i.) at the rate of 30, 20, and 30 μg active ingredientes per 20 g of seeds respectively. Seeds were treated in each fungicide for about four hours. Non-treated seeds served as control, and seeds were spaced and incubated in similar conditions as described before. Results are summarized in Table 2.

Results and discussion

Noble and Richardson (10) and Neergaard (9) have listed more than sixty fungi associated with maize and about twenty or so on bean seeds from data collected from different countries. In the present investigation, however, only eight fungi on maize and six on bean seeds could be detected using blotter method and incubating seeds at 24 ± 2°C under continuous artificial light. The genera of fungi detected from the seed lots of two cultivars of maize and bean, and percentage germination of seeds *in vitro* are presented in Table 1. The majority of seeds tested were found to be invaded with seedborne fungi, and the percentage germination of seeds of all cultivars was poor, around 30 percent. The donimant fungi recovered were *Fusarium moniliforme*, *Aspergillus niger* and *Penicillium* sp. from maize, and *Fusarium solani* f. sp. *phaseoli* and *Penicillium* sp. from bean seeds. *Penicillium* sp proved to be a wide spread fungus on the seed lots of both maize and bean cultivars.

Aspergillus and *Penicillium* spp. are known to affect stored grain and invade seeds after harvesting.

Table 1. Percentage distribution of seed-borne fungi and their effect on germination of two cultivars each of maize and bean. (Observation based on 400 seeds of each cultivar, using standard blotter method, incubation at 24 ± 2°C under continuous artificial light).

Fungi	Percentage of infection			
	Maize cultivars		Bean cultivars	
	Hybrid	Gikuku	Gituru	Wairumu
Fusarium moniliforme	18	26	2	–
F. solani f. sp. *phaseoli*	–	–	14	3
Aspergillus niger	8	18	–	–
Aspergillus flavus	3	2	–	–
Penicillium sp.	45	39	58	62
Epicoccum sp.	–	1	–	–
Stemphyllium sp.	–	–	1	–
Chaetomium sp	4	1	–	–
Alternaria sp	–	–	1	1
Rhizopus sp.	4	–	5	8
Germination %	30	26	13	30

Table 2. Percentage germination *in vitro* and total fungal recovery (TFR) of treated and non-treated seeds of two cultivars each of maize and bean grown as a mixture (Observations based on 200 seeds, using standard blotter method and incubation at 24 ± 2°C under continuous artificial light).

Treatments	Maize cultivars				Bean cultivars			
	Hydrid		Gikuku		Gituru		Wairumu	
	Germ	TFR	Germ	TFR	Germ	TFR	Germ	TFR
	%							
Benlate	92	3	96	0	95	0	90	1
Captan	82	25	85	21	90	17	87	15
Copper oxychloride	70	36	65	28	68	22	66	33
Non-treated	32	80	27	85	15	82	31	75

They may be present on the seed or may be as dormant mycelium within the tissue of pericarp or seed coat. Most of the maize and bean seeds were found to be invaded with the species of *Aspergillus*, *Penicillium* and *Fusarium* spp. causing seed and seedling rots, and the seedling blight in some of the cases. Some of the seeds did not even germinate due to colonization of the fungus, particularly the *Fusarium* and *Penicillium* spp., and the seeds become rotted. *Fusarium* spp. have been reported to cause seed decay (2, 4), and *Aspergillus* and *Penicillium* spp. reported to be prominent fungi associated with bean seeds from Central Brazil (1). *Fusarium moniliforme* has been recovered fairly well in both of the maize cultivars and the fungus completely colonized the germinated seeds. This species is pathogenic and causes ear and kernel rot, stalk rot and the seedling blight of maize (10). In bean cultivars the percentage recovery of this fungus was found to be 2% and thus has no considerable harmful effect on seeds. *Fusarium solani* f. sp. *phaseoli* was recovered from both cultivars of bean, much more in 'Gituru' than 'Wairumu' cultivar. This pathogen has been reported to be seed-borne, causing severe post-emergence blight (5).

Data presented in Table 2 shows the percentage germination *in vitro* and the total fungal recovery

of treated and non-treated seeds of two cultivars each of maize and bean. It is evident that all fungicidal seed treatment increased the percentage of germination with the reduction of the total fungal recovery as compared to the control, of maize and bean cultivars. Of the three fungicides tested Benlate was the most effective seed treatment followed by captan and copper oxychloride in reducing percentage of total fungal recovery and increasing percentage germination *in vitro*. Benlate completely checked the fungal incidence in 'Gikuku' cultivar of maize and 'Gituru' bean cultivar while in other two cultivars the total fungal recovery was very low. Benlate is effective as seed treatment for other seed-borne pathogens because of being a systemic fungicide which becomes systemic in seeds and seedlings (3, 8, 11). Captan was equally effective increasing considerably the percentage germination of both seeds above 70%. Copper oxychloride was less effective as compared to Benlate and captan.

Summary

Seeds from two local cultivars each of maize and bean grown as a mixture by small scale farmers in Kenya were tested for seed-borne fungi. The dominant fungi recovered were *Fusarium moniliforme, Aspergillus niger* and *Penicillium* sp. from maize, and *Fusarium solani* f. sp. *phaseoli* and *Penicillium* sp. from bean seeds. *Penicillium* sp. proved to be a wide spread fungus on the seed lots of both maize and bean cultivars tested. Of the three fungicides tested Benlate was the most effective seed treatment followed by captan and copper oxycloride in reducing the percentage of total fungal recovery and increasing the percentage germination *in vitro*

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