Identification of seed borne fungi on farmer saved sorghum (*Sorghum bicolor* L.), pearl millet (*Pennisetum glaucum* L.) and groundnut (*Arachis hypogaea* L.) seeds

*Syed Danish Yaseen Naqvi, Shiden T, Merhawi W and Mehret S*

Department of Plant Protection, Hamelmalo Agricultural College, Hamelmalo, Eritrea, North East Africa

*Corresponding Author's Email: syeddanishnaqvi84@gmail.com*

**Abstract**

Seed-borne fungi of sorghum, pearl millet and groundnut in 14 villages of different zones (Anseba, Debub and Gshahbarka) of Eritrea were surveyed. A total of 30 seed samples, 10 of each species, were collected during August-September 2011. Data were recorded for seed germination percentage, percent pathogen frequency and major seed borne fungi, which were identified and quantified using the blotter method as recommended by ISTA (International Seed Testing Association). Seed germination percentage were high in pearl millet 97.3% (Mhretab-Adinamm) followed by sorghum 93.3% (Araya-Hastina) and groundnut 91.2% (Siele-Hastina); seven, six and five fungal genera were found in seed samples of sorghum, pearl millet and groundnut, respectively. Fungi most frequently isolated and identified were *Alternaria*, *Aspergillus*, *Fusarium*, *Helminthosporium*, *Mucor*, *Penicillium* and *Rhizopus* from sorghum, whereas in pearl millet above fungal pathogens were identified except *Mucor* while in groundnut seed samples *Alternaria*, *Aspergillus*, *Fusarium*, *Helminthosporium* and *Rhizopus* were detected. Percent pathogen frequency of seed borne fungi was higher in groundnut 73.0% in Fshaye - Areza and minimum in sorghum 15.3% in Abdu-Hamelmalo.

**Key words:** Sorghum, pearl millet, Groundnut, Farmer saved seeds, Seed-borne fungi, Eritrea.

**INTRODUCTION**

Seed-borne diseases have been found to affect the growth and productivity of crop plants. A seed-borne pathogen present externally or internally or associated with the seed as contaminant may cause seed abortion, seed rot, seed necrosis, reduction or elimination of germination capacity as well as seedling damage resulting in development of disease at later stages of plant growth by systemic or local infection. Seeds are regarded as highly effective means for transporting plant pathogens over long distances. Besides, the mold fungi which grow on the seed substratum produce mycotoxins which are hazardous to humans and animals (Halt, 1994). Studies were carried out to study the composition of seed-borne mycoflora occurring in sorghum, pearl millet and groundnut grains which are the main crops grown in Eritrea.

Commercially, discoloured sorghum seeds caused by fungi are of poor quality reducing their acceptability and thus, low market value of the produce. Grain mold causes crop loss by reducing seed size and weight, the food value and keeping quality of grains (Bandyopadhyay, 1986). Seed-borne mycoflora of sorghum reported from different parts of the world include *Alternaria alternata*, *Aspergillus flavus*, *A. fumigatus*, *A. niger*, *Cladosporium* spp., *Fusarium moniliforme*, *F. oxysporum*, *F. pallidoroseum*, *Drechslera tetramera*, *Nigrospora* spp., *Phoma* spp., and *Rhizopus* spp.

Fungi are one of the factors in storage seeds which reduce seed viability. Seed-borne fungal diseases are the most limiting factor. Fungi form a major group of pathogens that can be seed-borne or transmitted through seeds.
The significance of sustainable agricultural production is hidden in the use of quality seed. It is the most crucial and vital input for enhancing productivity. Since seed is the custodian of the genetic potential of the cultivars, the quality of the seed determines the limits of productivity to be realized in a given cropping system. Though seeds are of great economic interest and also contribute a major part of diet, they play a vital role in associating microorganism, which prove hazardous for the seed or the new plant created from it, so, any infections agent (bacteria, fungi, nematode, etc.) which is associated with seeds having potential of causing a disease in a seedling or plant, is termed as seed-borne pathogen (Agarwal, 1996).

Hence, the storage fungi are especially insidious because they invade seeds stored at moisture contents that practical grain men consider safe and often cause serious damage before their presence even suspected. Therefore, with few exceptions spoilage of stored fungi, this may be introduced during the post harvest handling process. It is well known fact that several fungi are known to cause considerable damage to seeds in storage and produce various activities.

It is in view of this that the current study aimed at detecting seed-borne fungal pathogen on farmer saved sorghum, pearl millet and groundnut seeds at different zoba (state) of Eritrea, North East Africa.

MATERIALS AND METHODS

Experimental location

The experiment was conducted in the Department of Plant Protection, Hamelmalo Agricultural College, subzone of Hamelmalo, Eritrea. Hamelalo has an average temperature of 36°C and annual rainfall of 400mm, its altitude is 1328 meter above sea level.

Sources of experimental materials

Thirty seed samples of sorghum (Var. Bushuka, shambuko), pearl millet (Var. Hagaz, Kona) and groundnut (Var. Spanish valentia) were collected for the isolation and identification of seed-borne fungi from three zones of Eritrea (Anseba, Debub and Gashbarka) covering 14 villages, viz., Adinamn, Areza, Bashery, Begu Dbarwa, Elabered, Endagergish, Golug, Hagaz, Hamelmalo, Hastina, Ksadeka, Oana, and Sabnait during August to November 2011. Farmers were selected randomly for sampling. From each seed sample, an amount of 250g seeds were taken and checked in the laboratory for seed germination, identification of seed-borne fungal and percent fungal frequency.

All materials except seeds, which used in this experiment, were sterilized using 70% ethyl alcohol. Formalin (10%) was used for Petri plate sterilization. Cotton blue and lacto phenol were used for staining of the fungal cytoplasm and for providing a light blue background, against which the walls of hyphae can readily be seen (Aneja, 2004).

Plating of the seed component: Standard blotter method as described by the International Seed Testing Association (ISTA 1976), was used for the isolation of the seed-borne fungi associated with the groundnut seed samples. The seed samples in their various forms according to their crops were then inoculated on three moistened filter papers (dia. 9.0 cm) in 9.0 cm Oswald Petri-dishes. Twelve seeds were arranged at the periphery of the plate, nine at the centre, and four at the centre in case of sorghum and pearl millet while in case of groundnut, five seeds were arranged at the periphery of the plate, four at the middle, and two at the centre. A total of ten seed samples per crop, with three replications, were used, and then kept in dark place for seed germination.

Examination of incubated seeds

Sampling for germination was done at 3 days after incubation, while identification of fungi was done at 7 days. The Petri dishes were brought to the examination area in the laboratory, where each seed was examined under a microscope for growth habits of the various fungi growing in the Petri plates. Slide preparations of the various fruiting structures of the fungi were made and identified under the stereozoom compound microscope.

Slide preparation and identification

The samples of fungus were taken randomly from each crop. These samples were identified on the basis of colony characteristics and microscopic examinations. Standard books and research papers were consulted during the examination of these fungi (Aneja, 2004; Rifai, 1969; Barnet and Hunter, 1999). The binocular compound microscope was used to determine the type of fungus in each plate. The seed-borne fungi were identified using identification keys and cross-checked for each seed plates to identify the type of fungus growing on each seed. After seven days of incubation, fungal species found growing on the surface of seeds, were identified and their percentage frequency (PF) of occurrence of fungal was calculated by applying the following formula:

$$PF = \frac{\text{No. of seeds on which fungus appear}}{\text{Total number of seeds}} \times 100$$

Results and Discussion

Seed germination: The results obtained (Table 1 and figure 1) showed that 30 samples, 10 each, of sorghum,
Table 1. Seed germination percentage of sorghum, pearl millet and groundnut seeds collected from different zoba of Eritrea. (Mention location names with samples)

<table>
<thead>
<tr>
<th>Sample, Farmer’ name and location</th>
<th>Sorghum %</th>
<th>Sample, Farmer’ name and location</th>
<th>Pearl millet %</th>
<th>Sample, Farmer’ name and location</th>
<th>Groundnut %</th>
</tr>
</thead>
<tbody>
<tr>
<td>S₁ Araya, Hatsina</td>
<td>93.33</td>
<td>S₁, Abdelkerim, Bashery</td>
<td>77.30</td>
<td>S₁, Ibrahim, Hamelmalo</td>
<td>49.32</td>
</tr>
<tr>
<td>S₂ Belay, Areza</td>
<td>90.66</td>
<td>S₂, Amir, Elabered</td>
<td>86.66</td>
<td>S₂, Humed, Hagaz</td>
<td>66.60</td>
</tr>
<tr>
<td>S₃ Brhane, Dbarwa</td>
<td>92.00</td>
<td>S₃, Salih, Basheri</td>
<td>80.00</td>
<td>S₃, Mahamed, Basheri</td>
<td>81.60</td>
</tr>
<tr>
<td>S₄ Mensur, Hamelmalo</td>
<td>95.30</td>
<td>S₄, Abdherihim, Begu</td>
<td>89.30</td>
<td>S₄, Ali, Hamelmalo</td>
<td>18.10</td>
</tr>
<tr>
<td>S₅ Abdu, Hamelmalo</td>
<td>46.60</td>
<td>S₅, Mohamed, Hamelmalo</td>
<td>28.00</td>
<td>S₅, Mahamedali, Oana</td>
<td>57.50</td>
</tr>
<tr>
<td>S₆ Zeineb, Hamelmalo</td>
<td>45.30</td>
<td>S₆, Said, Sabnait</td>
<td>77.30</td>
<td>S₆, Osman, Basheri</td>
<td>48.58</td>
</tr>
<tr>
<td>S₇ Ahmedin, Sabnait</td>
<td>89.30</td>
<td>S₇, Tesfay, Sabnait</td>
<td>93.30</td>
<td>S₇, Fatuma, Oana</td>
<td>65.53</td>
</tr>
<tr>
<td>S₈ Mhretab, Adinamnn</td>
<td>82.00</td>
<td>S₈, Ismail, Hamelmalo</td>
<td>97.30</td>
<td>S₈, Ahmed, Hagaz</td>
<td>89.33</td>
</tr>
<tr>
<td>S₉ Sile, Hatsina</td>
<td>84.00</td>
<td>S₉, Zeineb, Golug</td>
<td>86.66</td>
<td>S₉, Haile, Ksadeka</td>
<td>91.22</td>
</tr>
<tr>
<td>S₁₀ Fshaye, Areza</td>
<td>76.00</td>
<td>S₁₀, Tahir, Hamelmalo</td>
<td>93.00</td>
<td>S₁₀, Habtu, Endagerghsh</td>
<td>77.03</td>
</tr>
<tr>
<td>Average</td>
<td>76.65</td>
<td></td>
<td>80.88</td>
<td></td>
<td>64.48</td>
</tr>
<tr>
<td>CD (p=0.05)</td>
<td>1.237</td>
<td></td>
<td>0.796</td>
<td></td>
<td>0.272</td>
</tr>
</tbody>
</table>

Figure 1. Seed germination Percentage of sorghum, pearl millet and groundnut.

The results showed that for all the samples germination of pearl millet was higher in Ismail-Hamelmo (S₈) 97.3% followed by Tesfay-Sabanait (S₇) 93.3%, Tahir-Hamelmo (S₁₀) 93.0%, Abdherihim-Begu (S₄) 89.3%, Amir -Elabred (S₂) and Zeineb-Golug (S₉) 86.7%, Salih-Basheri (S₃) 80.0%, Said-Sabanait(S₆) 77.3% and Mohammed-Hamelmo (S₅) 78.0%. In case of groundnut seed germination percentage was higher in Haile-Ksadeka (S₉) 91.2% and minimum in Ali-Hamelmo (S₄) 18.1%. These results are in agreement with those of Abdussalam and...
### Table 2. Percentage frequency of seed-borne fungi in various seed samples collected from Anseba, Debub and Ghashbarka regions.

<table>
<thead>
<tr>
<th>Sample, Farmer’ name and location</th>
<th>Sorghum %</th>
<th>Sample, Farmer’ name and location</th>
<th>Pearl millet %</th>
<th>Sample, Farmer’ name and location</th>
<th>Groundnut %</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1 Araya, Hatsina</td>
<td>45.33</td>
<td>S1, Abdelkerim, Bashery</td>
<td>26.66</td>
<td>S1, Ibrahim, Hamelmalo</td>
<td>48.50</td>
</tr>
<tr>
<td>S2, Belay, Areza</td>
<td>22.66</td>
<td>S2, Amir, Elabered</td>
<td>26.70</td>
<td>S2, Humed, Hagaz</td>
<td>24.00</td>
</tr>
<tr>
<td>S3, Brhane, Dbarwa</td>
<td>34.66</td>
<td>S3, Salih, Basher</td>
<td>18.70</td>
<td>S3, Mahamed, Basher</td>
<td>58.00</td>
</tr>
<tr>
<td>S4, Mensur, Hamelmalo</td>
<td>33.33</td>
<td>S4, Abderhim, Begu</td>
<td>37.30</td>
<td>S4, Ali, Hamelmalo</td>
<td>24.20</td>
</tr>
<tr>
<td>S5, Abd, Hamelmalo</td>
<td>15.32</td>
<td>S5, Mohamed, Hamelmalo</td>
<td>19.30</td>
<td>S5, Mahamedali, Qana</td>
<td>24.00</td>
</tr>
<tr>
<td>S6, Zeineb, Hamelmalo</td>
<td>21.30</td>
<td>S6, Said, Sabnait</td>
<td>29.00</td>
<td>S6, Osman, Basher</td>
<td>57.00</td>
</tr>
<tr>
<td>S7, Ahmed, Sabnait</td>
<td>33.33</td>
<td>S7, Tesfay, Sabnait</td>
<td>27.00</td>
<td>S7, Fatuma, Qana</td>
<td>52.00</td>
</tr>
<tr>
<td>S8, Mhretab, Adinamn</td>
<td>26.66</td>
<td>S8, Ismail, Hamelmalo</td>
<td>23.00</td>
<td>S8, Ahmed, Hagaz</td>
<td>12.10</td>
</tr>
<tr>
<td>S9, Siele, Hatsina</td>
<td>45.33</td>
<td>S9, Zeineb, Golug</td>
<td>40.00</td>
<td>S9, Haile, Ksadeka</td>
<td>48.50</td>
</tr>
<tr>
<td>S10, Fshaye, Areza</td>
<td>24.00</td>
<td>S10, Tahir, Hamelmalo</td>
<td>28.00</td>
<td>S10, Habtu, Endagnergsh</td>
<td>73.00</td>
</tr>
<tr>
<td>Average</td>
<td>30.19</td>
<td></td>
<td>27.57</td>
<td></td>
<td>42.13</td>
</tr>
<tr>
<td>CD (p=0.05)</td>
<td>0.321</td>
<td></td>
<td>0.135</td>
<td></td>
<td>1.578</td>
</tr>
</tbody>
</table>

**Figure 2.** Isolation of seed borne fungi in sorghum in humid chamber


Several reports about seed-borne mycoflora on sorghum, pearl millet and groundnut [Soetan et al. (2006), Grish et al. (2004)] have been published. Post-harvest fungal infection, according to farmers, has been one of the constraints for mass production of these grains and less seed germination and viability. Mathur et al. (1975) observed reduction in germination rate of sorghum and pearl millet due to *Alternaria alternata*, *Aspergillus* spp., *Rhizopus* spp., *Curvularia lunata* and *Fusarium equiseti* present in or on seed surface. Our results indicated that these seed borne fungi could be the main seed borne pathogen affect the seed viability. The high frequency of occurrence of mycoflora which affect the seed viability and germination of the above organisms was also observed by Tarp et al. (1987).

Percent frequency of seed borne fungal pathogen: The results obtained (Table 2 and figure 2) showed that percent frequency of occurrence of the pathogen in sorghum seeds higher in Araya-Hastina (S1) and Siele-Hastina (S9) 45.3% followed by Brhane-Dbarba (S3)
Table 3. Identification of seed-borne fungal pathogens detected in various seed samples of groundnut which collected from three Zoba (Anseba, Debub and Ghashbarka).

<table>
<thead>
<tr>
<th>Sample</th>
<th>Alternaria</th>
<th>Helminthosporium</th>
<th>Fusarium</th>
<th>Aspergillus</th>
<th>Rhizopus</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1. Ibrahim, Hamelmalo</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>S2. Humed, Hagaz</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>S3. Mahamed, Basheri</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>S4. Ali, Hamelmalo</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>S5. Mahamedali, Oana</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>S6. Osman, Basheri</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>S7. Fatuma, Oana</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>S8. Ahmed, Hagaz</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>S9. Haile, Ksadeka</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>S10. Habtu, Endagerghsh</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
</tbody>
</table>

34.7%, Ahmedin-Sabnait (S7) 33.3%, Mensur-Hamelmalo (S4) 33.3%, Fshaye -Areza (S10) 24.0%, Mhretab-Adinamm (S6) 26.7%, Belay-Areza (S2) 22.7% and Zeineb-Hamelmalo (S6) 21.3% and minimum in Abdu-Hamelmalo (S8) 15.3%.

Frequency of occurrence of the pathogen in pearl millet (Table 4 and figure 3) was higher in Zeineb-Golug (S9) 40.0% followed by Abderhim-Begu (S4) 37.3%, Said-Sabnait (S6) 29.0%, Tahir-Hamelmalo (S10) 28.0%, Tesfay-Sabnait (S7) 27.0%, Amir-Elabred (S2) 26.7%, AbdElkarim-Bashery (S1) 26.7%, Ismail-Hamelmalo (S8) 23.0%, and Mohamed-Hamelmalo (S8) 19.3% and minimum in Salih-Bashri (S3) 18.7%. In case of groundnut, higher frequency of occurrence of the pathogen was recorded in Habtu -Endagerghsh (S10) 73.0% whereas minimum in Ahmed-Hagaz (S8) 12.1%. In overall among all three crops average percent frequency of pathogen in groundnut was 42.1% followed by sorghum 30.2% and groundnut 27.6%. Our results corroborate the finding of Fakhrunnisa and Hashmi (1992), Singh (1983) and ICRISAT (1980). Mathur and Kongsdal (2003) also reported that percent frequency of seed-borne fungal pathogens were more in pearl millet as compared to sorghum.

Groundnut seed mycoflora: Results of fungal identification in Table 3 showed that all the seed samples were contaminated with various fungal pathogens. Fungal pathogens identified included Alternaria, Aspergillus, Fusarium, Helminthosporium and Rhizopus. All the seed samples were found to be infected by Aspergillus whereas five samples with Fusarium S2 (Humed, Hagaz), S4 (Ali, Hamelmalo), S5 (Mahamedali,
Sample | Alternaria | Helminthosporium | Fusarium | Mucor | Aspergillus | Rhizopus | Penicillium
--- | --- | --- | --- | --- | --- | --- | ---
S₁, Araya, Hatsina | + | - | + | - | + | - | +
S₂, Belay, Areza | + | + | - | - | + | + | +
S₃, Brhane, Dbarwa | + | - | + | + | + | - | -
S₄, Mensur, Hamelmalo | + | + | - | - | + | - | +
S₅, Abdu, Hamelmalo | + | - | + | - | + | + | -
S₆, Zeineb, Hamelmalo | + | - | + | + | + | + | +
S₇, Ahmedin, Sabnait | + | + | - | - | + | + | -
S₈, Mhretab, Adinann | + | - | + | + | + | + | +
S₉, Siele, Hatsina | + | - | - | + | + | + | +
S₁₀, Fshaye, Areza | + | + | - | - | + | - | -

Oana), S₈ (Ahmed, Hagaz) and S₉ (Haile, Ksadeka); three samples each with Helminthosporium S₂ (Ali, Hamelmalo), S₇ (Fatuma, Oana) and S₁₀ (Habtu, Endagergsh) and Rhizopus in S₂ (Humed, Hagaz), S₅ (Mahamedali, Oana) and S₉ (Haile, Ksadeka) and two samples with Alternaria sp. S₁ (Ibrahim, Hamelmalo) and S₈ (Osman, Basheiri) were detected by blotter method. Jovicvic (1980) also reported that the filter paper method was most practical method for routine analysis of seed health. Such similar results were observed by Khan et al. (1988) on rice seeds and by Dawar and Ghaffar (1991) on sunflower seed. The sample collected from Hamelmalo showed the highest incidence of fungi (Aspergillus and Fusarium). Present result showed that Aspergillus were the predominant fungi of groundnut. Mukherjee et al. (1992) also found that Aspergillus were the predominant storage fungi of groundnut seed. Species of Aspergillus, Fusarium and Rhizopus have also been reported on groundnut seed (Lumpungu et al. 1989).

Sorghum seed mycoflora: A total of seven fungal genera Alternaria, Aspergillus, Fusarium, Helminthosporium, Mucor, Penicillium and Rhizopus sp. were detected in sorghum seed samples (Table 4). All the seed samples tested in September to November 2011 were infected by Aspergillus and Alternaria sp., whereas Rhizopus sp. was found in seven samples S₂, S₃, S₅, S₆, S₇ and S₉; Penicillium found in seven samples S₁, S₂, S₃, S₆, S₇, S₈ and S₁₀ while Fusarium sp. in four samples S₁, S₂, S₅ and S₆ and Alternaria sp. also detected from four samples. Mucor sp. was encountered in two samples S₃ and S₆. The results of this study show that the association of sorghum seeds with plant pathogens in different villages of Zoba- Anseba, Debub and Ghashbarka appears to be a prevalent situation. All the samples tested were associated with at least one known pathogen (Alternaria ). These results are in agreement with those of Kamal and Mughal (1968) and Khan et al. (1974), who reported the presence of Alternaria, Helminthosporium, Fusarium, Rhizopus, Aspergillus, and Penicillium species in sorghum seeds. The results also corroborate those of Khan and Bhutta (1994) and Bhutta and Hussain (1999), who reported the occurrence of Helminthosporium and Fusarium moniliforme as major pathogens of sorghum seed. Other reports by Singh (1983) also showed that Aspergillus, Helminthosporium, Penicillium and Fusarium spp. were common associates of stored sorghum seeds. The common occurrence of other pathogens like Alternaria, Fusarium, Aspergillus, and Penicillium have been widely reported (Martin et al., 1984). The implications of this widespread seed infestation is highlighted in the report of Dharmvir et al. (1968), who determined that sorghum seeds colonized during storage were responsible for reducing plant population by 42% in the field. The consequence of such infestation is not only limited to yield losses, but also accounts for the build-up of mycotoxins in infected grains. The findings of this study are therefore, important as they highlight the need for effective measures aimed at reducing seed-borne infection of sorghum seeds in Eritrea.

Pearl millet seed mycoflora: The standard blotter method was used to detect a wide range of fungi which are able to arise easily from seed in presence of humidity. Twenty five seeds from each samples were plates on moisten blotter in petri dishes and incubate for seven days at room temperature found six fungal genera Aspergillus, Alternaria, and Fusarium (Table 5). Examination of incubated seeds revealed that Alternaria and Aspergillus were found in all samples. Rhizopus and Penicillium were found in three samples S₁ (Abdelkerim, Bashery), S₄ (Abderhim, Begu), and S₇ (Testay, Sabnait). Fusarium in two samples S₅ (Mohamed, Hamelmalo) and S₉ (Zeineb, Golug), while Helminthosporium in one samples (S₇ - Testay, Sabnait).

This result corroborates the report of Zida et al. (2008) that pearl millet seeds are highly susceptible to diseases as they act as a source of stored nutrients for fungi such
as Aspergillus, Penicillium and Rhizopus sp. All the samples tested were associated with Aspergillus. These results are in agreement with those of Dawson Andoh et al. (2000), Mathur et al. (1975), Ahmed et al. (1992, 1997) and Fakhrunnisa and Hashmi (1992).

### CONCLUSION

Good seed is recognized as an important input in any agricultural production system. One of the important aspects of good seeds besides high germination and purity is the absence of seed-borne pathogen. At least 5 seven fungal genera were encountered in high percent frequencies of seed-borne fungal pathogen and infection percentage in 30 samples of sorghum, pearl millet and groundnut collected from farmers own saved seeds from 14 villages of three Zoba (Table 2, 3, 4 and 5). Alternaria, Aspergillus, Fusarium, Helminthosporium, Penicillium and Rhizopus sp. were the main fungi occurring frequently in sorghum, pearl millet and groundnut seeds. Out of the fungi Penicillium and Helminthosporium were important pathogens whose inoculums are present on the surface of seeds, were recorded for the first time in farmer saved seeds of sorghum and pearl millet from Hamelmalo.

Of the fungi isolated Aspergillus sp. is an important mycotoxin producer and produces four major metabolites of aflatoxin B1, B2, G1 and G2 which are heptacarcinogenic (Goldblatt, 1969). There is, therefore, need for reducing the mold growth and mycotoxin production in sorghum, pearl millet and groundnut seeds by improving the storage condition. The presence of so many pathogenic fungi at high level in farmer saved seed from various geographical area indicates a clear need for field surveys for these and other pathogens. There also a clean need to increase public awareness on aspects related to seed health and to develop suitable management practices for improving the quality of seeds.

### RECOMMENDATIONS

1. Testing seed health of major crops should be introduced in the national seed quality system.
2. Seeds for planting should be free from seed-borne pathogen to insure seed viability and germination.
3. But, it still needs more investigations to be concluded in this regard for proper recommendations.
4. Further seed health analysis needs to be done for sorghum, pearl millet and groundnut crops across Eritrea so that disease mapping is done and updated regularly for research to target potentially important pathogens. Further work needs to be done to determine consistency of the pathogens isolated across seasons to determine disease incidences and severity under favourable conditions.

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