were collected in sterilized minigrip bags. The sphacelia were scooped out and surface sterilized in 0.1 % sodium hypochlorite, followed by thorough washing in sterile distilled water. The sphacelia were cut into small bits and were plated on potato-dextrose agar (PDA) and incubated at 25°C for 30 days with 12 h light/dark cycle. Later the culture was characterized for radial growth, colony color, puckering nature, sporulation and sectoring. The sclerotial samples and culture were deposited at the Mycological Herbarium, Indian Agricultural Research Institute, New Delhi, India and the herbarium number was obtained.

Results and Discussion

The pathogenicity test carried with 10-year-old sclerotia (Herbarium number: 44440) recorded 65% infection indicating that sclerotia can remain viable for several years and can still cause infection. Sclerotial viability has been reported to be for 3 years based on its germinability in soil under greenhouse conditions (Sangitrao et al. 1997). However, we report here the viability of 10-year-old sclerotia based on pathogenicity test.

The sclerotial morphology indicated wide variation in their size (3-10 mm in length) and basal width (1.5-3 mm). The distal width varied from 1 to 2 mm. The sclerotial shape was both straight and curved (Fig. 1). The sclerotia were categorized into six groups: (1) short and straight with slight curvature; (2) long and curved; (3) long and curved with constricted distal end; (4) short and curved; (5) small and oval; and (6) branched.

The colonies were white, cottony, compact and granular. Radial growth of the colony varied from 27 to 30 mm with distinct sporulation towards the periphery and devoid of puckering and sectoring. Based on Munsell's scale, the colony pigmentation matched at 10YR/7/3 (Anonymous 1973).

Figure 1. Variability in morphology of ten-year-old sclerotia from Akola, Maharashtra, India (size: 0.3-1.0 cm in length, a = basal end, and b = distal end).

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Mechanical Harvesting Reduces Sphacelia/Sclerotia Levels of *Claviceps africana*

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Introduction

In Australia, ergot caused by *Claviceps africana* is endemic on *Sorghum* species used for grain and forage production, and on *Sorghum* weed species (Ryley et al. 2003). The disease has a significant impact on the Australian sorghum *(Sorghum bicolor)* industry by necessitating the use of triazole fungicides in breeder's nurseries and hybrid seed production, forcing the adoption of new management practices for sorghum grain growers, and creating uncertainty about the toxicity of sphacelia/sclerotia (Ryley et al. 2002). Australian research has demonstrated that high levels of dihydroergosine, the major alkaloid component of sphacelia/sclerotia, is detrimental to livestock by causing agalactica in cows and sows (Blaney et al. 2000b), and hyperthermia and reduced weight gain in beef cattle (Blaney et al. 2000a). In Australia, the maximum allowable limit for sphacelia/sclerotia in sorghum grain intended for stockfeed is 0.3% (w/w), although there is considerable variation in the alkaloid content between sphacelia/sclerotia of similar ages (Blaney et al. 2003).

Management options for sorghum grain growers include early planting to reduce the risk of flowering during cool weather in late March-April, sowing when soil moisture and nutrient levels are optimum to assist in even crop flowering, and adjusting row width to minimize tiller production (Ryley and Blaney 2002). Options at harvest include killing tillers and late flowering plants with herbicides to reduce honeydew contamination at harvest, segregating badly ergot-infected parts of the paddock, and increasing the fan speed in harvesters to maximize the number of sphacelia/sclerotia which are ejected from the harvester. This last process is effective because sphacelia/sclerotia weigh 0.007-0.015 g, which is in the order of 2-4 times lighter than a typical sorghum grain.

Three categories of sphacelia/sclerotia are often observed after mechanical harvesting of ergot-infected sorghum crops: (1) mature sclcrotes which are light tan to reddish brown, 2.5-5.0 mm long x 1.5-2.5 mm wide, with a rough surface and a mean mass of approximately 0.007 g; (2) sphacelia whose pointed tips protrude past the attached floral elements, and with a mean mass of approximately 0.015 g; and (3) sphacelia covered by the black, convoluted sporodochia of *Cerebella* spp, and with a mean mass similar to the last category. In addition, healthy grain and the three types of fungal bodies described above can be clumped together with honeydew. Only the three sphacelial/sclerotial bodies are considered for the purposes of the 0.3% w/w stockfeed limit.

A study was undertaken in southern Queensland (Qld) and northern New South Wales (NSW) between 1999 and 2001 to quantify the reduction in sphacelia/sclerotia during mechanical harvesting of eight commercial sorghum crops, with the aim of extending more accurate information for the management of sorghum ergot to Australian sorghum growers and harvesting contractors.

Materials and Methods

Sample collection. Eight crops from six properties were used in the study: Crop 1, grower A, at Warwick (Qld) in 1999; Crops 2 and 3, grower B, at Warwick in 2000 and 2001 respectively; Crops 4 and 5, grower C, at Nobby (Qld) in 2000; Crop 6, grower D, at Willowtree (NSW) in 2001; Crop 7, grower E, at Kingaroy (Qld) in 2001; and Crop 8, grower F, at Dalby (Qld) in 2001. The crops were several popular, commercial Australian hybrids. At physiological maturity 5-10 quadrats each approximately 20 m x 20 m were randomly selected within each crop, and from each area 50 sorghum panicles were collected and placed in numbered bags. The areas were marked, and as the harvester passed over them samples of sorghum grain were collected at the auger outlet above the seed collection bin. A total of 1-2 kg of sorghum grain was collected from each area. The harvesters covered the range of machines which are used by growers and contractors to harvest sorghum grain in Australia, and their settings were those used by the growers in their normal harvesting operations.

Preparation of samples and counting of sclerotes. The samples taken prior to harvesting were threshed using a stationary thresher, and the seed and sphacelia/sclerotia were collected. These samples, together with the seed samples taken from the headers at harvest, were dried to approximately 12% moisture in drying ovens at 45°C. Three sub-samples of approximately 200 g were taken from each sample, the seed and sphacelial/sclerotial bodies were separated with the aid of a microscope, and both weighed. The numbers of sclerotes were also counted.

Results and Discussion

The results of the trials are summarized in Table 1. There was considerable variation in the mean number (21-477) and mass *(%* w/w) of sphacelia/sclerotia between crops before harvest (0.12-3.00%), and in the range of values within crops (for example, in Crop 1, 206-1642 and 0.75-12.4% respectively). This variation was also reflected in the "after harvest" data, with mean numbers ranging from 10 to 127 and % w/w from 0.05% to 0.29% between crops, and 36-205 and 0.19-1.05% respectively in Crop 1. In six of the eight crops (Crops 1, 3, 4, 5, 7, 8) the mean numbers and % w/w of sphacelia/sclerotia after harvest were significantly less (P <0.05) than the corresponding values before harvest. The after-harvest % w/w mean values for seven of the eight crops (Crops 2-8) were less than the Australia stockfeed limit of <0.3%, but in three of these (Crops 3, 4 and 7) the upper value of the range was >0.3%. This finding suggests that at least portions of the harvested grain from these crops would have admixtures of sphacelia/sclerotia at high levels to have deleterious effects on livestock.

The reduction in mass (% w/w) of sphacelia/sclerotia as a result of the mechanical harvesting process ranged from 44% for Crop 4 to 76% for Crop 1, and the reduction in numbers ranged from 0% for Crop 2 to 80% for Crop 5. Ribas (1999) reported that the majority of sclerotia are discarded at the harvesting stage, and he provided some limited data to substantiate that claim. His data showed that the 'sclerotia' number was reduced from 0.24% to 0.10% in one sub-field and from 2.34% to 1.65% in another field during harvesting. These are in the order of magnitude of reductions found in the current study.

The differences in reduction (%) between crops may be due to a number of factors. Firstly, there would undoubtedly be differences in the relative number (and

Table 1. Number and mass of sphacelia/sclerotia of *Claviceps africana* before and after mechanical harvesting of 8 commercial sorghum crops.

Crop/Grower	Number per 200g sample		Mass (% w/w per 200g sample)	
	Before	After	Before	After
1/A	206-1642(477)[1]	36-205 (127*)[2]	0.75-12.4 (3.00)	0.19-1.05 (0.71*)[2]
2/B	8-44 (21)	13-33 (21)	0.04-0.24 (0.12)	0.05-0.12 (0.08)
3/B	72-114 (80)	4-57 (25*)	0.28-0.64 (0.43)	0.02-0.54 (0.22*)
4/C	98-225 (139)	13-71 (45*)	0.31-0.74 (0.45)	0.06-0.38 (0.25*)
5/C	42-136 (94)	14-26 (18*)	0.13-0.38 (0.28)	0.07-0.11 (0.08*)
6/D	12-41 (22)	6-36 (15)	0.05-0.20 (0.12)	0.02-0.15 (0.05)
7/E	29-179 (121)	14-54 (43*)	0.24-1.41 (1.02)	0.08-0.48 (0.29*)
8/F	10-33 (26)	5-14 (10*)	0.10-0.32 (0.22)	0.06-0.14 (0.09*)

1. Mean values are given in parentheses.
2. Mean after-harvest values followed by an asterisk are significantly lower ($P < 0.05$) than the corresponding mean before-harvest values using Student's t-test.

mass) of the three sphacelial/sclerotial categories between crops, particularly between sclerotia and the other two catagories. Individual sclerotia are lighter than the sphacelial bodies, so differences before harvest may be further exacerbated during harvesting. Secondly, the relative efficiency of harvesters in reducing sphacelia/ sclerotia may vary depending on the characteristics of the individual harvesters.

Our findings suggest that mechanical harvesting can significantly reduce the admixture levels of sphacelia/ sclerotia in sorghum grain. In all but one of the crops which we studied, the levels of these potentially toxic fungal bodies were reduced to a level less than the Australian sorghum stockfeed limit of 0.3% w/w. Adjustments in fan speed and other settings on individual harvesters to optimize the numbers of sphacelia/sclerotia which are ejected has the potential to further improve harvesting efficiency.

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Use of Polythene Bags to Reduce Grain Mold Infection in Rainy Season Sorghum

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Introduction

Grain mold is one of the serious problems of the rainy (*kharij*) season sorghum (*Sorghum bicolor*) in India.