Montes Belmont, Roberto; Flores Moctezuma, Hilda Elizabet; Nava Juárez, Raúl Arnulfo
Alternate hosts of claviceps africana frederickson, mantle and de millano, causal agent of sorghum ergot in the State of Morelos, Mexico
Revista Mexicana de Fitopatología, vol. 21, núm. 1, enero-julio, 2003, pp. 63-66
Sociedad Mexicana de Fitopatología, A.C.
Texcoco, México

Available in: http://www.redalyc.org/articulo.oa?id=61221109
Alternate Hosts of *Claviceps africana* Frederickson, Mantle and de Millano, Causal Agent of Sorghum “Ergot” in the State of Morelos, Mexico

Roberto Montes-Belmont, Hilda Elizabet Flores-Moctezuma, and Raúl Arnulfo Nava-Juárez, Instituto Politécnico Nacional, Centro de Desarrollo de Productos Bióticos, km 8.5 Carr. Yautepec-Jojutla, San Isidro, Yautepec, Morelos, México CP 62730. Correspondence to: rbelmont@ipn.mx

(Received: June 14, 2002 Accepted: September 3, 2002)


**Abstract.** In recent years, sorghum ergot (*Claviceps africana*) spread out to American and Australian continents, where it may have new potential hosts, an important component of the disease cycle. This is particular important in Mexico, where there is great variation in climate and vegetation. Weeds from sorghum plots and surrounding areas showing ergot symptoms, were collected and identified in Jonacatepec and Yautepec, Morelos between 1998 to 2000. Macroconidia morphology and dimensions, as well as the presence or absence of sclerotia were determined for each weed. Cross-inoculations were also carried out using conidia isolated from sorghum and weeds. *C. africana* macroconidia were found in *Digitaria horizontalis*, *Isophorus unisetus*, *Echinochloa crusgalli*, *Sorghum halepense*, *Cenchrus echinatus*, and *Panicum maximum*. No sclerotia were found in all the weed species. Cross-inoculations showed that the last three species mentioned, serve as alternate hosts for *C. africana*, but only *S. halepense* has features that could make it a source of primary inoculum.

Additional keywords: *Sorghum bicolor*, host range, collateral hosts, cross-inoculations.

**Resumen.** El ámbito de hospederos de *Claviceps africana*, agente causal del cornezuelo del sorgo, constituye un componente importante del ciclo de la enfermedad. En años recientes se ha diseminado a los continentes americano y australiano donde podría haber nuevos hospederos potenciales de este hongo; esto es particularmente importante en el caso de México por su diversidad climática y de vegetación. En el presente trabajo se colectaron e identificaron malezas con síntomas de cornezuelo dentro y en el área circundante de parcelas de sorgo en los municipios de Jonacatepec y Yautepec, Morelos, entre 1998 y 2000. En cada muestra se caracterizó la morfología y las dimensiones de los macroconidios, así como la presencia o ausencia de esclerocios; posteriormente se hicieron inoculaciones cruzadas utilizando conidios aislados de sorgo y las malezas. Se encontraron macroconidios de *C. africana* en *Digitaria horizontalis*, *Isophorus unisetus*, *Echinochloa crusgalli*, *Sorghum halepense*, *Cenchrus echinatus* y *Panicum maximum*. En ninguna de las malezas se encontraron esclerocios. Las inoculaciones cruzadas mostraron que las 3 últimas especies sirven como hospederos alternantes para *C. africana*, pero sólo *S. halepense* presenta características para actuar como fuente de inóculo primario.

Palabras clave adicionales: *Sorghum bicolor*, rango de hospederos, hospederos colaterales, inoculaciones cruzadas.

Worldwide, ergot is an important disease of sorghum during grain development. Several species of the genus *Claviceps* cause ergot, including *Claviceps africana* Frederickson, Mantle and de Millano, which is the most widely distributed; *C. sorgi* Kulkarni Seshadi and Hedge in India is important; and *C. sorghicola* Tsukiboshi, Shimanuki and Uematsu, in Japan (Pauzotová et al., 2000). Ergot is an important problem, especially for hybrid seed production, since inbreds are used and infection occurs in the ovary before pollination and fertilization. A fungal mass (sphacelia) follows infection. After ovary is fertilized ergot rarely occurs. Hybrid germplasm is seriously affected when flowering of the inbreds fails to nick. If climatic conditions are less than 13°C three weeks before anthesis, pollen production is incomplete (Bandyopadhyay et al., 1998). Losses caused by ergot in India are 10-80%, and 12-100% in Zimbabwe (Bandyopadhyay et al., 1996). Despite the significance of this disease, epidemiological parameters such as the case of alternate hosts (Futrell and Webster, 1966) are poorly researched. Numerous reports on alternate hosts have been reported (Chinmaduri and Govindaswamy, 1971; Bandyopadhyay et al., 1998), but most of them are rather questionable, since several species of *Claviceps* attack a wide range of hosts (especially graminoides) and similar symptoms may be observed. The only way to test the validity of these data, besides studying the fungus morphological
characteristics, and cross inoculations between sorghum and gramineous plants, are procedures commonly used. Frederickson and Mantle (1996) found that *C. africana* isolated from *Panicum maximum* Jacq., *Dicanthium annulatum* (Forsk.) Stapf., *Brachiaria mutica* (Forsk.) Stapf., *Sorghum drummondii* Millsp. and Chase, *S. altum* L., and *S. halepense* (L.) Pers. was able to infect sorghum. Recently, Claflin (1999) and Reed *et al.* (2002) concluded that only *Sorghum* species are alternate host of ergot disease. Limited research on alternate host deserves further study. Since the appearance of sorghum ergot in Mexico in 1997 (Aguirre *et al.*, 1997), several studies related to the host range of *Claviceps africana* and its epidemiological importance, have indicated that this pathogenic specie can be found in new habitats different from the original one. In the state of Tamaulipas, San Martín *et al.* (1997) found *Sorghum halepense* and Angleton grass *Dicanthium aristatum* (Poiret) C.E. Hubb infected with *C. africana*. Velázquez-Valle *et al.* (1998) have found in the states of Guanajuato, Michoacan, Jalisco, Tamaulipas, and Texas (USA) that *S. halepense* was the only weed infected with *C. africana*. Also, they found that inoculating *Cenchrus ciliaris* L. with sorghum honeydew did not reproduce the symptoms of the disease. In the state of Morelos, sorghum is grown under climatic conditions and vegetation different from other states studied in Mexico. This research was conducted to identify the alternate hosts of *C. africana* in Morelos.

**MATERIALS AND METHODS**

Weeds from sorghum plots and their surrounding areas showing ergot symptoms were collected and identified in the municipalities of Jonacatepec and Yautepex, during June to September 1998, 1999, and 2000. Later, weeds were processed for herborization following the methodology described by Hitchcock (1971), and identified at the National Center for Phytosanitary Weed Reference - SAGARPA. To determine macrocomidia shape and size, samples of honeydew produced on infected panicles were taken for observation under the compound microscope. Taxonomic keys for identification of *Claviceps* species according to Loveless (1964) were used. The presence or absence of sclerotia for each plant was also determined. In year 2000, in a sorghum free area in the municipality of Yautepex, inoculations were made on 12 plants per weed species, spraying a suspension of secondary conidia.

**Table 1. Susceptible weeds to *Claviceps africana* in the state of Morelos, Mexico.**

<table>
<thead>
<tr>
<th>Plant specie</th>
<th>Common name</th>
<th>Years of detection</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Sorghum halepense</em></td>
<td>Johnson grass</td>
<td>1998-2000</td>
</tr>
<tr>
<td><em>Cenchrus echinatus</em></td>
<td>Hedgehog grass</td>
<td>1998-2000</td>
</tr>
<tr>
<td><em>Digitaria horizontalis</em></td>
<td></td>
<td>1998</td>
</tr>
<tr>
<td><em>Erophorus unisetus</em></td>
<td>Honduras grass</td>
<td>1998</td>
</tr>
<tr>
<td><em>Echinochloa crusgalli</em></td>
<td>Barnyard grass</td>
<td>1998-2000</td>
</tr>
<tr>
<td><em>Panicum maximum</em></td>
<td>Guinea grass</td>
<td>1999-2000</td>
</tr>
</tbody>
</table>

Fig. 1. *Sorghum halepense* growing in a sorghum plot with severe damage of *Claviceps africana*
(2.2 and 4.7 x 10⁴ conidia/ml) of *C. africana* obtained from sorghum. These plants were in their natural habitat and after inoculation, they were covered with wet polyethylene bags for 15 h to enhance infection. Bags were removed and symptoms recorded starting 7 days after inoculation. Inoculum from infected weed plants was used to prepare secondary conidia suspensions (at concentrations between 2 and 7 x 10⁴ conidia/ml) to inoculate forage sorghum plants of the genotype SX-16 during anthesis (15 plants per weed species). The percentage of infected plants was recorded 7-10 days after inoculation.

**RESULTS AND DISCUSSION**

Susceptible weeds to *C. africana* are presented in Table 1. The weed species *Sorghum halepense* (Fig. 1), *Cenchrus echinatus* L. (Fig. 2A), *Echinochloa crusgalli* (L.) Beauv. (Fig. 2B), *Isophorus unisetus* Schulte. (Fig. 2D), and *Digitaria horizontalis* (L.) Scop., were identified with ergot in 1998. They showed hyaline macroconidia oblong to elliptical, with rounded ends, slightly constrained at the center, usually with two vacuoles comprising almost all their length, and their average size was within the admitted ranges for *C. africana* (10.5-13.7 x 4.1-6.8 µm). Besides *C. africana*, hyaline navicular macroconidia with dimensions that corresponded to *C. fusiformis* (11-15.8 x 3.1 x 5.0 µm) were observed in *C. echinatus*. In 1999, ergot was detected in *S. halepense* after the beginning of August, several weeks before sorghum flowering. By the end of September, a new host *Panicum maximum* Jacq. (Fig. 2C), besides *C. echinatus* and *E. crusgalli*, was also detected. No ergot symptoms were found in *D. horizontalis* or in *I. unisetus*. In year 2000, diseased plants were found again among the four species mentioned for 1999 (*S. halepense*, *C. echinatus*, *P. maximum*, and *E. crusgalli*). An abnormally reduced number of macroconidia and secondary conidia, mixed with polyhedral crystals derived from the honeydew produced by the fungus was found in *E.
crusgalli. This might represent an evidence of the plant response to the pathogen. Sclerotia were not found in any of the weed surveyed during the three years. Once the plants reached senescence, sphaecia dried and remained attached to the panicle glumes. These results agree with the report by Velásquez et al. (1998) who did not find sclerotia in S. halepense or any other weed infected with other species of Claviceps. S. halepense, C. echinatus, and P. maximum showed a 100% infection and reproduction of symptoms, after inoculation with C. africana obtained from sorghum. Only E. crusgalli remained free of the disease. A 100% infection was observed in forage sorghum plants after inoculated with ergot inoculum from P. maximum and S. halepense, while this rate was 60% when the inoculum originated from C. echinatus. It can be concluded that P. maximum, S. halepense, and C. echinatus are alternate hosts of C. africana; however, since only S. halepense grows side by side with sorghum all year round, it seems to be an important source of primary inoculum. It was also the only species infected with ergot, even before the disease was apparent in sorghum. Previous reports indicate that S. halepense, like sorghum, is infected during flowering when temperatures are below 13°C (Holm et al., 1991). It was observed that panicles of S. halepense did not produce seeds between March to May; probably, this had to do with the minimum temperatures (below 13°C) occurring from October 1999 to February 2000, which may be related to the phenological stage where differentiation of anther progenitor cells is particularly vulnerable to low temperatures (Brooking, 1976). The other host species only developed during the rainy season, and they were not infected before sorghum in any of the years when the study took place; therefore, it seems that they might be a secondary inoculum source. As for D. horizontalis and I. unisetus, although infected plants were observed in 1998, apparently their morphological and/or physiological characteristics do not allow the completion of C. africana biological cycle. In consequence, no more infected plants of these species were found in 1999 and 2000. As a control measure, destruction of Johnson grass just before sorghum is sown, could reduce ergot occurrence.

LITERATURE CITED


