prevalence of C. *sorghi* as a predominant species in this region. The type 4 sclerotia observed here suggest the coexistence of *C. sorghi* and *C. africana* in India.

Based on a comparative study of *C. sorghi* and C. *africana,* Frederickson et al. (1991) and Bandyopadhyay et al. (1998) indicated that the ability of *C. africana* in producing secondary conidia may be considered as a differentiating character of this species. Subsequently, occurrence of *C. africana* in India was reported by Bogo and Mantle (1999). Further, Pazoutova et al. (2000) reported that *C. africana* has a greater epidemiological advantage, ie, dispersal efficiency, than *C. sorghi* as it produces secondary conidia in vivo. However, in this study, profuse production of secondary conidia was also observed in *C. sorghi.* Therefore, the production of secondary conidia may not be considered as a differentiating character of the two species. Pazoutova and Bogo (2001) have concluded that *C. sorghi* is present in Central India as a minor pathogen. However, in this study, only one of the 74 isolates resembled *C. africana* and the remaining 73 were morphologically similar to *C. sorghi* indicating that it is a major pathogen in South India. Thus C. *sorghi* has retained its original niche without replacement by *C. africana* It is necessary to conduct further studies on *C. sorghi* and to better understand its diversity and distribution.

References

Bandyopadhyay R, Frederickson DE, McLaren NW, Odvody GN and Ryley MJ. 1998. Ergot: a new disease threat to sorghum in the Americas and Australia. Plant Disease 82(4):356-367.

Bogo A and Mantle PG. 1999. *Claviceps africana* discovered in India. Plant Disease 83:79.

Frederickson DE, Mantle PG and deMilliano WAJ. 1991. *Claviceps africana* sp. nov., the distinctive ergot pathogen of sorghum in Africa. Mycological Research 95(9): 1101-1107.

Frederickson DE, Odvody GN and Isakeit T. 1999. Sorghum ergot distinguishing sphacelia and sclerotia of *Claviceps africana* in seed. Texas, USA: Texas Agricultural Extension Service, Texas A&M University.

Pazoutova S, Bandyopadhyay R, Frederickson DE, Mantle PG and Frederiksen RA. 2000. Relation among sorghum ergot isolates from the Americas, Africa. India and Australia. Plant Disease 84:437-442.

Pazoutova S and Bogo A. 2001. Rediscovery of *Claviceps sorghi* (Ascomycotina: Clavicipitaceae) in India. Mycopathologia 153:99-101.

Rajasab AH. 1980. Aerobiological investigations on some diseases of sorghum. PhD thesis, Mysore University, Mysore, India. 228 pp.

Ramaswamy C. 1968. Meteorological factors associated with the ergot epidemic of *hajra* (*Pennisetum*) in India during the *kharif* season, 1967 - A preliminary study. Current Science 37:331-335.

Sangitrao CS. 1982. Studies on sorghum ergot in Vidarbha region. PhD thesis, Dr Panjabrao Deshmukh Krishi Vidyapeeth. Akola, Maharashtra, India. 208 pp.

Tsukiboshi T, Shimanuki T and Uematsu T. 1999. *Claviceps sorghicola* sp. nov., a destructive ergot pathogen of sorghum in Japan. Mycological Research 103(11)1403-1408.

Prevalence of Sorghum Ergot in Southeast Asia

VA Tonapi[1,2]*, Komin Wirojwattanakul[3], Dang Van Vinh[4], Moung Moung Thein[5], SS Navi[1,6] and PW Tooley[7] (1. ICRISAT, Patancheru, 502 324, Andhra Pradesh, India; 2. Present address: National Research Centre for Sorghum, Rajendranagar, Hyderabad 500 030, Andhra Pradesh, India; 3. Division of Plant Pathology and Microbiology, Department of Agriculture, Chatujak, Bangkhen, Bangkok 10900, Thailand; 4. Wheat Research Department, Vietnam Agricultural Science Institute (VASI), Thanh Tri, Hanoi, Vietnam; 5. Department of Plant Pathology, Central Agricultural Research Institute (CARD, Yezin-Pyinmana, Myanmar; 6. Present address: Department of Plant Pathology, College of Agriculture, Iowa State University, Ames, Iowa 50011-1020, USA; 7. USDA-ARS, 1301 Ditto Avenue, Fort Detrick, MD 21702, USA)

*Correspondig author: vilastonapi@hotmail.com

Introduction

Ergot is a serious endemic disease in most of the sorghum *(Sorghum bicolor)* producing countries of the world, with most recent outbreaks being in central and South America (Reis et al. 1996). It is caused by the fungus *Claviceps* spp. Three species are predominant: *C. africana* is prevalent in southern and eastern Africa, South America, Southeast Asia, Australia, and India; *C. sorghi* in India and Southeast Asia; and *C. sorghicola* in Japan.

Ergot can cause widespread damage of male-fertile cultivars in farmers' fields when environmental conditions favorable to the pathogen occur at flowering (Molefe 1975, Kukedia et al. 1982, Navi et al. 2002). In addition, ergot has great potential to damage sorghum nurseries and cause significant damage to hybrid seed production. Losses from ergot have been estimated at 10-80% in India and South Africa and 10-100% in Brazil (Bandyopadhyay et al. 1996). In this article, we report

prevalence and distribution of ergot pathogens in different geographic regions of Vietnam, Thailand and Myanmar.

Materials and Methods

Locations surveyed. The objective of the survey in Southeast Asia was to understand the diversity in sorghum ergot pathogen and prevalence of different species as was done in India by Bandyopadhyay et al. (2002). The disease was identified using the identification keys of Frederiksen and Odvody (2000). Incidence and severity from each sorghum field was recorded from an area of approximately 12 m^2 at three spots selected at random. Disease incidence (%) was recorded based on number of plants infected out of the total plants counted, and the severity was recorded on 0-100% based on floral infection (%) in individual panicles (0% = healthy and 100% = entire panicle infected).

Extensive on-farm disease surveys were conducted between August and November 2002 in Vietnam, Thailand and Myanmar. We surveyed 21 farms in two provinces (Sonla and Nghean) in Vietnam; 178 farms in 7 provinces (Nakhon sawan, Lopburi, Saraburi, Kanchanaburi, Nakhonratchasima, Sa Keo and Suphanburi) in Thailand; and 87 farms in 10 townships (Taktone, Nyaungoo, Onetwine, Nwahtogy, Nyangoo, Tuangtha, Monywa, Chuangoo, Yezagyo and Kyaukpadaung) in Myanmar.

Ergot prevalence and sampling. A total of 24 ergot samples were collected during the survey (Table 1); of these, two were from Vietnam, 18 from Thailand, and four from Myanmar. The samples were placed separately in brown paper bags, air-dried and stored at laboratory conditions (25±1°C) for further studies at the United States Department of Agriculture (USDA) laboratory of Dr Paul Tooley at Fort Detrick, Maryland, USA for their cultural characteristics and their genetic diversity.

Pathogenicity test of samples collected in Thailand. Conidial suspensions of the ergot samples collected in Thailand were spray-inoculated separately using conidial spore suspension at the concentration adjusted to 1 x 10^6 conidia ml^{-1} (Tonapi et al. 2002) on to sorghum cultivar 296A at stigma emergence stage. The study was conducted under controlled environment at the Division of Plant Pathology and Microbiology, Department of Agriculture, Bangkok, Thailand. The inoculated panicles were covered with brown paper bags and incubated for 3-5 days at 25±1°C. Further, the plants were incubated under greenhouse conditions (25±1°C) for disease development. From the infected panicles, 5-6 infected spikelets were collected in sterilized paper bags and dispatched to the Foreign Diseases and Weed Science Research Institute, USDA, Fort Detrick,

Cropping Pattern

Sorghum is a minor crop in Vietnam and is grown in very small areas in remote hilly regions mainly for fodder.

Table 1. Prevalence of sorghum ergot in Southeast Asia.

Province/District/ Division/Township	Village	No. of fields surveyed	No. of fields with ergot	Disease incidence (%)	Disease severity (%)	No. of samples collected
Vietnam		21	2			
Mochau	Hangchang			Traces	2-7	2
Thailand		178	18			
Lopburi, Moung	Nikhom			8-10	2-60	2
Lopburi, Moung	Khoktoom			Traces	2-10	3
Lopburi, Pathanikhom	Delang			2-5	5-15	1
Lopburi, Moung	Khoukeinlai			Traces	2-15	2
Nakhon sawan, Moung	Nongpring			Traces	10-40	
Saraburi, Wang moung	Manavan			10-30	50-90	
Saraburi, Wang moung	Namsuk			5-20	30-70	
Saraburi, Paphuthabat	Saraburi			2-15	20-100	
Kanchanaburi, Dhamakantiya	Dhamakantiya			Traces	10-100	
Sa Keo, Wangnamyen	Sa Keo			20-60	80-100	
Saraburi, Wang moung	Wang moung			5-20	60-100	
Suphanburi, Uthong	Suphanburi			15-80	45-100	
Myanmar		87	4			
Onetwine, Mandalay	Shawbin			2-40	10-80	2
Onetwine, Mandalay	Beckone			Traces	5-40	1
Onetwine, Mandalay	Oktwin			2-15	20-80	1

The sorghum genotypes were tall, with sweet stalk, red grains, and take >150 days to mature. In Thailand, hybrid sorghums are predominant over varieties and forage types. In Myanmar, sorghum is grown for food as well as for fodder. Sorghum varieties in Myanmar were similar to those of Thailand and Vietnam. During the survey the crop was in various growth stages from vegetative to physiological maturity or harvestable maturity stages.

Prevalence of Ergot in Farmers' Fields

The most obvious external symptom of ergot observed on panicles (on nodal tillers or on the main plant) was the honeydew exudation from the infected flowers. Honeydew was either uniformly yellow-brown to pink or superficially dull white. However, no sclerotial stage symptoms were observed.

In Vietnam, ergot incidence was in traces with a severity from 2 to 7%. In Thailand, disease incidence ranged from traces to 80% and severity from 2 to 100% while in Myanmar, disease incidence ranged from traces to 40% and severity from 5 to 80% (Table 1). The samples from Myanmar and Vietnam appear to be *C. sorghi.* Putative *C. africana* types were observed only in the Thailand samples collected from Saraburi, Manavan and Namsuk villages (Saraburi province) and Suphanburi (Suphanburi province). *Claviceps sorghi* was also observed in some samples from Thailand. Reproductive potential of ergot pathogen(s) is an important determining factor, which decides the relative predominance of one species, over the other. Results from molecular analysis are awaited to distinguish species or variability within the species.

Acknowledgment. This research project was funded by USDA, USA. The views expressed are not necessarily those of USDA. The cooperation of farmers, non-government organizations (NGOs), staff of agricultural universities, research stations, village councils and Department of Agriculture in Vietnam, Thailand and Myanmar is acknowledged. We thank Suresh Pande, ICRISAT, Patancheru, India and R Bandyopadhyay, IITA, Nigeria for their guidance and help during this survey.

References

Bandyopadhyay R, Frederickson DE, McLaren NW and Odvody GN. 1996. Ergot - a global threat to sorghum. International Sorghum and Millets Newsletter 37:1-32.

Bandyopadhyay R, Muthusubramanian V, Tooley PW, Chakraborty S, Pazoutova S and Navi SS. 2003. Distribution and diversity of the sorghum sugary disease pathogens in India. Pages 75-79 *in* Sorghum and millets diseases (Leslie JF, ed.). Ames, Iowa, USA: Iowa State University Press.

Frederiksen RA and Odvody GN. 2000. Compendium of sorghum diseases. Second edition. St. Paul, Minnesota, USA: American Phytopathological Society.

Kukedia MV, Desai KB, Desai MS, Patel RH and Raja KRV. 1982. Natural screening of advanced sorghum varieties to sugary disease. Sorghum Newsletter 25:117.

Molefe TL. 1975. Occurrence of ergot on sorghum in Botswana. Plant Disease Reporter 59:751-753

Navi SS, Bandyopadhyay R, Nageswara Rao TG and Tooley PW. 2002. An outbreak of sorghum ergot in parts of Andhra Pradesh, India. International Sorghum and Millets Newsletter 43:68-70.

Reis EM, Mantle PG and Hassan HAG. 1996. First report in the Americas of sorghum ergot disease caused by a pathogen diagnosed as *Claviceps africana.* Plant Disease 80:463.

Tonapi V, Ryley M, Vic Galea, Bhuiyan S and Wearing A. 2002. Influence of temperature and relative humidity on pollen traits and ergot severity in sorghum. International Sorghum and Millets Newsletter 43:74-76.

Simple Techniques for Production of Secondary Conidia and Ergot Inoculation in Sorghum

VA Tonapi[1,*], MJ Ryley[2], V Galea[3], S Bhuiyan[3] and A Wearing[3] (1. ICRISAT, Patancheru 502 324, Andhra Pradesh, India; Present address: National Research Centre for Sorghum, Rajendranagar. Hyderabad 500 030, Andhra Pradesh, India; 2. Agency for Food and Fibre Sciences, Department of Primary Industries, PO Box 102, Toowmba, Queensland 4350, Australia; 3. School of Agriculture and Horticulture, University of Queensland, Gatton, Queesnald 4343, Australia)

*Corresponding author: vilastonapi@hotmail.com

Introduction

Ergot (sugary disease), caused by several species of *Claviceps* including *C. africana,* is a serious panicle disease in most of the sorghum *(Sorghum hicolor)* producing countries of the world (Bandyopadhyay et al. 1998). Airborne secondary conidia are the primary source of inoculum of *C. africana* (Bandyopadhyay et al. 1998) and are responsible for the rapid spread of the pathogen (Frederickson et al. 1989,1991,1993). Secondary conidia are produced on sterigmata from germinated macroconidia from the honeydew. To date, all infection studies have been conducted with mixed suspensions of macroconidia and secondary conidia, sprayed onto stigmas. However, in nature this does not occur, as the