Vol. 2, No. 1 (Jul 2000)

Sorghum Variety Macia Released in Tanzania

The improved sorghum variety Macia (SDS 3220) was released on 14 Dec 1999 by the Tanzania National Variety Release Committee. Macia is a high-yielding, early-maturing, white-grained variety developed jointly by ICRISAT and national scientists in southern Africa. It has so far been released in five SADC countries—Mozambique, Botswana (under the name Phofu), Zimbabwe, Namibia, and now Tanzania. It is suitable for areas with a growing season of 3-4 months.

Macia was developed by mass selection in the F_4 generation from material originally developed at ICRISAT-Patancheru (India). The new line, indexed as SDS 3220, was selected by breeders at the SADC/ ICRISAT Sorghum and Millet Improvement Program (SMIP) in 1984/85. A series of preliminary and advanced trials at SMIP demonstrated its potential, after which SDS 3220 was evaluated in collaborative trials at multiple locations across the region between 1988/89 and 1990/91. It then underwent multilocational testing in Tanzania for three seasons—1991/92 (7 sites), 92/93 (5 sites), and 93/94 (2 sites). Grain yields of Macia in these trials were 15% higher than those of two released, improved varieties, Pato and Tegemeo. In on-farm trials conducted in northern Tanzania, Macia gave yields comparable to or better than Pato and Tegemeo.

The new variety has several other advantages. It has large heads and a high degree of uniformity. It matures earlier than other improved varieties, and is thus less susceptible to terminal drought. Plants are short, making bird scaring easier. It is also a multipurpose variety, suitable for food, fodder, and other uses.

A smallholder farmer in Tanzania, one of the early adopters of Macia

Macia has white, medium-sized grains, a thin pericarp, and a white pearly endosperm. It produces white flour, which is universally preferred throughout the region. Farmer-participatory assessments have confirmed the grain quality characteristics of the variety and its potential for widespread adoption. Macia also has the potential for improving fodder supplies—it has broad leaves that stay green even after maturity, a key advantage in mixed crop-livestock systems. Analytical laboratory tests by SMIP have shown that Macia has a high SDU value (Sorghum Diastatic Unit), indicating its suitability for malting. Current efforts in the five countries where it has been released are geared towards sustainable production and distribution of seed to farmers.

Sorghum Ergot—a Sticky Disease Problem in Southern Africa

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Ergot disease of sorghum is not new to Africa - the causal pathogen, *Claviceps africana* Frederickson, Mantle, and de Milliano was first recorded in Kenya as far back as 1923. However, ergot disease only began to gain recognition as a potential problem in sorghum production in the 1960s, when all the A-lines in Nigeria's national breeding program became infected, to the near complete exclusion of seed production (Futrell and Webster 1965).

The pathogen has now been recorded in every sorghum-growing country on the continent. By 1997, when it had reached the Americas, Australia, and the USA, ergot disease had gained notoriety as the major biotic constraint to sorghum production globally (Bandyopadhyay et al. 1998). Ergot causes annual losses of 12-25% and 60% in hybrid seed production in Zimbabwe and South Africa respectively.

The pathogen, *Claviceps africana,* is a fungus that specifically targets the sorghum ovary. The spores, or conidia, germinate on the stigma and the germ tubes track down the ovary wall to the distal nutrient supply. Once the fungus has access to this sugar-rich nutrient source there is enormous proliferation of hyphae and almost complete destruction of the ovary to form the soft, white, globose body or sphacelium. The sphacelium produces millions more conidia in a sticky exudate called honeydew. Conidia represent the asexual form of the fungus, enabling rapid clonal propagation during the sorghum growing season. Honeydew droplets may collect on the tips of infected florets or may drip to smear the whole panicle or drip onto the leaves or soil.

Under conditions of high relative humidity, the honeydew turns from clear or brown throughout to superficially white. Here the first-formed primary or macroconidia germinate to form secondary conidia which, unlike macroconidia, are windborne. Secondary conidia are crucial to the pathogen for rapid disease increase to epidemic proportions, and for spread over moderate distances of tens to hundreds of kilometers (Frederickson et al. 1989, 1993).

Towards the end of the sorghum growing season, the ergot pathogen ceases spore production and may form a more resilient type of tissue adjacent to the sphacelium. For *Claviceps* species in general, this sclerotial tissue enables pathogen survival and perennation from one season to the next.

In Africa, where an alternate host with a role in perennation has yet to be found, *C. africana* sclerotia may possibly assume this role by germination to produce the sexual stage. However, conidia in crop residues contaminated with sphacelia/sclerotia may also assume that function. Thus inoculum may possibly be seedborne by one or both routes.

There are no ergot-resistant sorghum genotypes anywhere in the world. Pollen and pathogen take the identical route into the ovary and any biochemical or mechanical stigmatic or gynoecial exclusion mechanism probably has mutual consequences: no ergot but no seed! Fertilization of the ovary precludes infection, so varieties with good fertility tend to "escape" ergot most of the time; and in evolutionary terms, no other "resistance" mechanism has probably ever been necessary.

It is obvious, therefore, that male-sterile A-lines in hybrid seed production are at greatest risk. All ovaries of all sorghums are potentially susceptible, however, depending upon environment. Cold nights (temperatures below 12^{o}C) at pollen microsporogenesis, inducing pollen sterility, lead ubiquitously to reduced fertility and increased ergot severity (McLaren and Wehner 1992). Selecting varieties, hybrids, and their parents with cold-tolerance has had some success in minimizing ergot severity. However, rainfall or high RH at anthesis will have an overriding influence, because these factors disrupt pollen-shed, deposition and germination, and simultaneously induce secondary conidiation, splash dispersal, and favor germination of pathogen spores.

Screening for cold-tolerance in sorghum is clearly one good strategy to reduce ergot. Few other methods are currently available. Early planting, which in Zimbabwe means before the end of December, reduces the risk of ergot, in part by avoiding flowering around the time of lowered night temperatures.

The protection of valuable germplasm by the application of triazole fungicides at heading may occasionally be warranted in seed production but severely reduces the already slim profit margins.

The reason for the lack of alternative control strategies is that there are wide gaps in our knowledge of the life-cycle and biology of the pathogen. The INTSORMIL (International Sorghum/Millet Collaborative Research Support Program) project, networking with other scientists in the region and globally, focuses primarily on the very important question of inoculum mentioned earlier. The key question is:

What is the source of initial inoculum each season (e.g. honeydew, conidia, sphacelia, sclerotia)? To answer this question requires research in the following areas:

- The effect of environment on the survival of macroconidia in honeydew, in sphacelia/sclerotia, and on the survival of secondary conidia
- Formation, survival, and germination of sclerotia to produce ascospores (sexual reproduction)
- How frequently does sexual reproduction occur in nature; how much variability does the pathogen exhibit in Zimbabwe and regionally[1] ?

Answers to these questions will help us target the critical stages of the life-cycle of C. *africana,* enabling us to formulate new strategies and integrate multiple strategies for better control of ergot on all sorghum genotypes.

References

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Dr Frederickson is very keen to network with anyone in the region with an interest in sorghum ergot, or who would be able to provide samples from their country.

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