Bioscience Research Communications
Vol. 14, No. 3, June 30, 2002
Printed in Nigeria

0795-8072/2002 $3.00 + 0.00


BRC 2001050/14301

# Evaluation of newly developed pearl millet varieties [*Pennisetum glaucum* (L).R. Br] for reactions to Downy Mildew, Stem Borer and *Striga hermonthica* under natural field conditions in Northern Nigeria

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(Received April 6, 2001)

ABSTRACT: Pearl millet [*Pennisetum glaucum* (L.) R. Br.] varieties – SOSAT-C88 (newly released in Nigeria) and LCIC 9702 (about to be released) were evaluated under natural infestation in 53 farmers' fields in five states of Northern Nigeria during 1999 for reactions to downy mildew [*Sclerospora graminicola* (Sacc.) J. Schrot.], parasitic weed *Striga hermonthica* and pearl millet stem borer [*Coniesta ignefusalis* Hampson]. The objectives of the survey were to assess the effects of these biotic constraints on the new varieties to prioritize areas for future improvement in order to enhance adoption process. Our study reveals that SOSAT-C88 appears to be resistant to downy mildew not only in on-station experiments but also in farmers' field conditions. This variety could serve as potential source parent for transfer of downy mildew resistance genes to elite materials or as a resistant check in downy mildew screening experiments. However, SOSAT-C88 seems to be susceptible to *S. hermonthica* in the two test environments. Babura, Ajiwa and Kamba were endemic to *S. hermonthica* on pearl millet. These locations could be useful as hot sports for screening pearl millet lines for resistance studies under natural infestations. LCIC 9702 appears to tolerate these diseases while local cultivars are highly susceptible to downy mildew but tolerant to Striga and stem borer. Incidence of pearl millet stem borer was lower than expected; this could probably be due to adoption by farmers of early sowing practices and burning of millet stem before the commencement of rains in most locations. More information is needed on the reactions of SOSAT-C88 to downy mildew in order to fully ascertain the stability of the resistance over time and space. Also the performance of SOSAT-C88 under artificial infestation of Striga should be further investigated. Intercropping systems was the dominant practices and two and three crop mixtures were prevalent in all the states surveyed.

Keywords: Pearl millet, *Pennisetum glaucum*, Downy mildew, *Scerospora graminicola, Striga hermonthica*, Millet stem borer, *Coniesta ignefusalis*, Cropping system.

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## Introduction

Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is an important food crop widely grown in sudanian and sahelian regions of Nigeria where it is second to sorghum in importance.

Nigeria is the largest producer of pearl millet in Africa with over 40 percent of the regional output (The world Sorghum and Millet economies, 1996). Downy mildew [*Sclerospora graminicola* (Sacc.) J. Schrot.], *S. hermonthica* and stem borer [Iconiesta ignefusalis *Hampson (Lepidoptera: Pyralidae)*] are widespread pests and diseases of pearl millet in Nigeria (Ajayi *et al*., 1997) Yield losses of up to 50 percent from downy mildew have been reported in Western Africa (Singh *et al*., 1993). Downy mildew occurs in all millet growing areas of Nigeria. The magnitude of loss depends on millet cultivar and management practices.

Many methods have been suggested for the control of downy mildew but no single method has provided effective control measure. However an integration of host plant resistance, seed treatment, crop rotation and crop management practices would be required for effective control of the disease. *S. hermonthica* [Del. Benth.] is a major constraint to millet production in the sahel where yield losses of up to 65 percent have been reported. (Werder and Manzo, 1992). Infection in farmers' fields is more severe in low fertility soils. King (1992) noted that less is known about Striga on millet than on maize and sorghum. Resistance to Striga has not been found in millet (Werder and manzo, 1992). Ajayi *et al* (1997) reported 100 percent yield losses from stem borer. The millet stem borer is the most widespread and most damaging insect pest in Nigeria. Total crop loss occurs under severe infestation especially near villages where millet stems have been used for fencing or building (Dike and Ajayi, 1997). Various millet types and varieties exhibit different levels of susceptibility to the stem borer but no resistant varieties are as yet available (Ajayi, 1995b). The destruction of infested millet stems before the beginning of the rainy season is a very important control measures (Harris, 1962).

There are three types of pearl millet grown in Nigeria. The early maturing type called 'gero' is the most widespread. Maiwa and dauro are late maturing and areas under cultivation are limited. Farmers in Nigeria grow different types and varieties of millet. These varieties react variously to biological stresses depending on ecology and pests and disease pressure (Ajayi *et al*., 1997). The national mean yield of millet under peasant farming conditions is below 1000 kg/ha$^{-1}$. (The World Sorghum and Millet Economies, 1996). Improved varieties yields above 2000 kg/ha$^{-1}$. Many factors are responsible for this low yield such as use of unimproved varieties, pests and diseases and abiotic factors. One major solution to the low yield is the use of improved varieties which combines high yield, adaptation to local environment and resistance to major pests and diseases. Some improved varieties may be high yielding but susceptible to diseases and may therefore reduce adoption rate. A survey was carried out to monitor the reaction of SOSAT-C88 ( a newly released millet variety in Nigeria) and LCIC 9702 (about to be released) to downy mildew, *S. hermonthica* and stem borer. The purpose of this survey was to assess the effects of these biotic constrains on the new varieties and prioritize areas for future improvement in order to facilitate adoption process.

## Materials and Methods

A survey of pests and diseases was conducted on farmers' fields between 30 August and 11 September 1999 in Jigawa, Katsina, Zamfara and Kebbi States while survey in Kano State was carried out between 15 -17 September, 1999. The gero millet was at the hard dough stage while maiwa was at the vegetative stage in all the states at the time of survey. Survey routes included Kano, Kazaure, Babura, Ajiwa, Sabolayi, Safana, Bela, Yandoton-Daji, Argungu, Bunza, Kamba, Sumaila, Shiddar and covered a distance of about 2000 km. These routes covered all the major millet-growing belts in Nigeria.

Fields were sampled from pearl millet based on-farm trial meant to identify the adaptation zones of these new varieties in five states. Sixteen farmers were selected per state. Each farmer grew three varieties consisting of two improved varieties (SOSAT-C88 and LCIC 9702) and a local variety (check). Plot size was made up of 400m$^2$ per treatment. The farmers were instructed

to follow their usual practice in planting. Experimental design was randomized block design with each farmer serving as a replicate. Rainfall was normal in Zamfara, southern part of Katsina and Kebbi states while rains came late and ceased early in Kano, Jigawa, Northern parts of Kebbi and katsina states. A total of 53 farmer's fields were surveyed.

Incidence of these pest and diseases were recorded following a 1-6 damage rating (DR) scale where 1 = no symptom; 2 = 1-5%; 3 = 6-10%; 4 = 11-20%; 5 = 21-40% and 6 = > 40% infected plants. Fifty randomly selected stands were examined per farm and the proportion of stands showing symptoms of infections for downy mildew and stem borer and proportion of stands showing symptoms of attack and Striga plants was expressed as a percentage. Additional information were obtained from the farmers on type and variety of millet grown in their farms, cropping systems practiced, date of sowing, expected date of harvest, use of seed dressing chemical before planting and the most destructive millet diseases and pests. Observation was also made from on-station trials involving SOSAT-C88, LCIC 9702 and local checks.

## Results and Discussion

Gero millet was sown sole and in various combinations with sorghum, groundnut , cowpea, cotton, soybean, seseme, bambara nut. Intercropping of millet with any of these crops in various row arrangements was generally practiced. One row of millet to one row of legume is very common in most parts of Kano, Jigawa and in drier part of Katsina states. Seseme is an important component of intercrop in drier part of Jigawa state. Two or more rows of millet to one or more rows of maiwa, sorghum and legumes were frequently observed in fields in Zamfara and Kebbi states. Planting millet sole or relay with early or late cowpea is commonly practiced in wetter part of Katsina state and in all parts of Zamfara state. Two crops mixture are most common in Kano, Katsina and Zamfara states while three crops mixtures are very common in Jigawa and Kebbi states.

This observation confirm the report by Andrews and Kassam (1976); Harwood and Price (1976); Okigbo and Greenland (1976), that intercropping is a predominant system and widely practiced among farmers in Asia and Africa, because of its higher total yield and greater returns than sole cropping. Norman (1974) also noted that in West Africa, insect-susceptible grain legumes such as cowpea, were generally intercropped with cereals. The growth period of millet, cowpea, sorgum, and groundnut are 90 – 130 days, 60 – 120 days, 100 – 160 days and 90 – 140 days respectively. Millet was sown between May and July depending on the type of millet and rainfall pattern. Gero was normally harvested between August and September while maiwa was harvested in November. The most dominant local millet is Zango and Weyin Bejimi. Weyin Bejimi is more preferred because it withstands wind-causing lodging. Zamfaruwa is predominant in Zamfara and parts of Kebbi state. Ex-Bornu is the only improved variety adopted by about 35 percent of the farmers. SE 2124 was introduced but not well accepted by farmers because of low yield and susceptibility to downy mildew.

Figure 1 shows that downy mildew incidence was prevalent in all the locations except in Babura where the incidence was low. Babura falls within Sahel zone with annual rainfall of 400-600 mm. Highest incidence was recorded in Bela, Yandoto-Daji and Kamba, these locations falls within sudan ecologies. Striga incidence was low in all the locations except babura, Ajiwa and kamba where the severity was more than 40%. These locations are endemic for *S. hermonthica* on pearl millet and could be used as hot sports to screen pearl millet lines for striga resistance under natural infestations. Apart from Sumaila, Shiddar, Babura and Kamba that recorded slightly higher incidence of stem borer, all other locations recorded very low damages. Pearl millet was sown late in Sumaila, Shiddar, Babura and kamba locations owing to late establishment of rains that resulted in high incidence of stem borer. Pande *et al*, (1997) and Ajayi *et al*, (1997) reported that early sowing ameliorates incidence of major pearl millet diseases while late sown millet are more vulnerable to attack irrespective of the millet variety.

Table 1 reveals that SOSAT-C88 was least infested with downy mildew with mean percentage damage of 2 while LCIC 9702 and local varieties exhibited 14 and 25 mean percent damage rating respectively, showing that LCIC 9702 could be regarded as tolerant while local cultivars was

Table 1: Incidence of Downy mildew, Striga and Stem borer on pearl millet.

| State | Location | Ecology | % Downy mildew | | | % Striga | | | % Stem borer | | | Number of fields surveyed |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | SOSAT-C88 | LCIC 9702 | Local variety | SOSAT-C88 | LCIC 9702 | Local variety | SOSAT-C88 | LCIC 9702 | Local variety | |
| Kano | Sumaila | Sahel-sudan | 0 | 12 | 25 | 0 | 0 | 0 | 0 | 15 | 22 | 6 |
| | Shiddar | Sahel | 0 | 3 | 23 | 0 | 0 | 0 | 0 | 20 | 12 | 6 |
| Katsina | Ajiwa | Sahel | 1 | 11 | 14 | 50 | 15 | 10 | 0 | 0 | 0 | 4 |
| | Sabolayi | Sahel-sudan | 3 | 14 | 19 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| | Safana | Sahel-sudan | 1 | 10 | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| Zamfara | Bela | Sudan | 3 | 11 | 28 | 0 | 0 | 0 | 0 | 0 | 0 | 8 |
| | Yandoton Daji | Sudan | 3 | 24 | 32 | 0 | 0 | 0 | 0 | 0 | 0 | 8 |
| Kebbi | Kamba | Sudan | 0 | 30 | 47 | 30 | 25 | 15 | 0 | 0 | 0 | 3 |
| | Bunza | Sahel-sudan | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 14 | 2 |
| Jigawa | Babura | Sahel | 0 | 0 | 0 | 45 | 5 | 10 | 2 | 10 | 15 | 7 |
| Total | farmers | Surveyed | - | - | - | - | - | - | - | - | - | 53 |
| Mean % | Damage | | 2 | 14 | 25 | 31 | 15 | 12 | 2 | 13 | 16 | - |

1 = no incidence, 2 = 1.5%, 3 = 6 – 10%, 4 = 11 – 20%, 5 = 21 – 40%, 6 = > 40% infested plants.

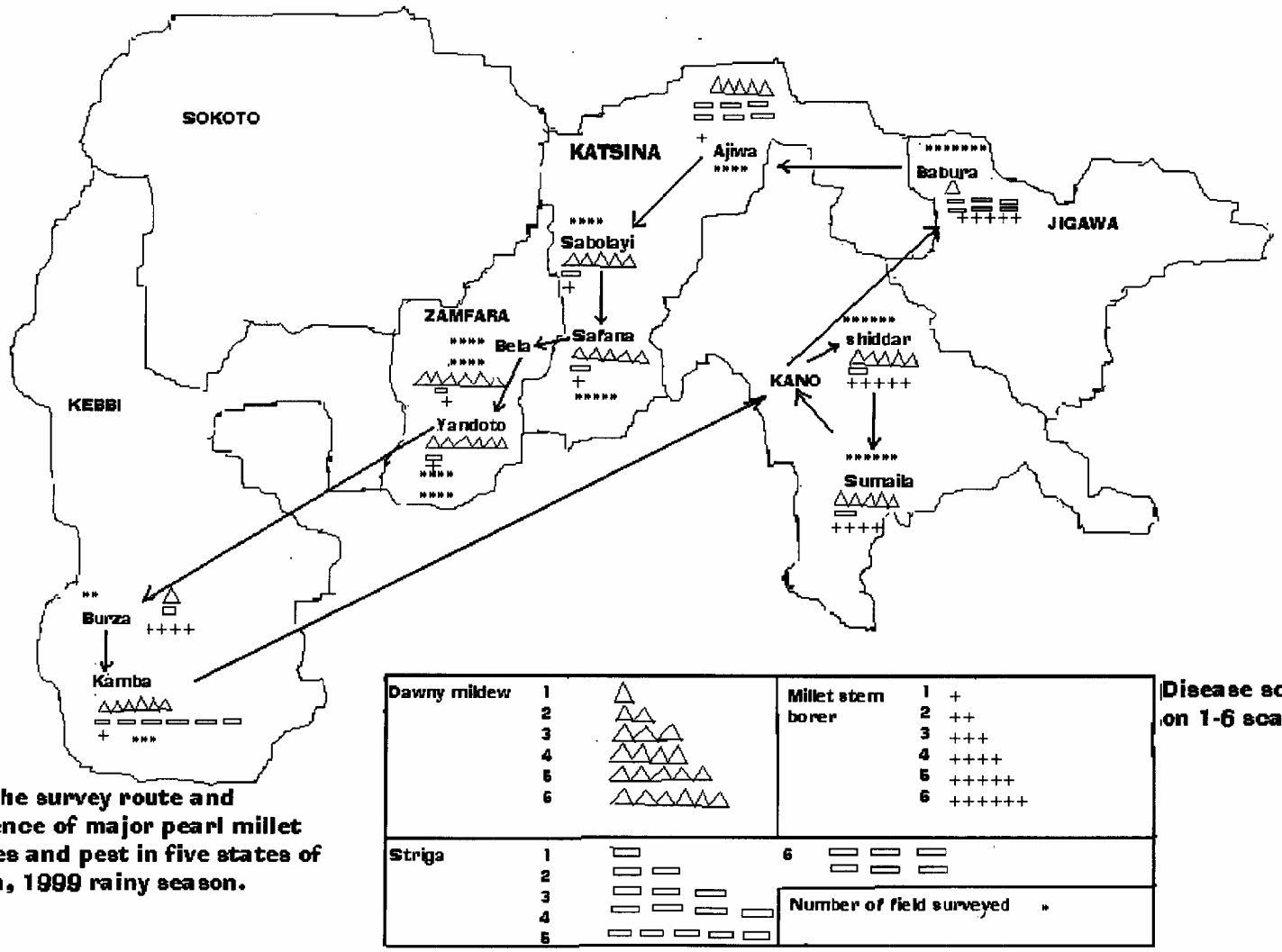


**Fig1: The survey route and occurence of major pearl millet diseases and pest in five states of Nigeria, 1999 rainy season.**

susceptible to downy mildew than improved varieties. On-station data also in Table 2 shows that SOSAT-C88 recorded lowest incidence of downy mildew in comparison with other varieties. SOSAT-C88 appears to be resistant to downy mildew. SOSAT-C88 recorded highest incidence of Striga with mean percentage damage of 31, LCIC 9702 and local varieties recorded 15 and 12 mean damages respectively. On-station data show that SOSAT-C88 possess highest mean Striga plants in comparison with other varieties. This investigation has shown that LCIC 9702 and local varieties seem tolerant to Striga while SOSAT-C88 is susceptible. This observation is in support of King (1992) who noted that local cultivars of pearl millet show some tolerance to Striga. Striga equally devastated SOSAT-C88 in agronomy trial plots in Maiduguri (Bibinu, Pers. Comm.., November, 2000). Stem borer damage was lowest in SOSAT-C88 but highest in local cultivars. However, incidence of stem borer was generally lower than expected, this could probably be due to adoption of early sowing practices and burning of millet stalk by all the farmers before the commencement of the cropping season.

LCIC 9702 appears to be tolerant to these diseases. This variety is high yielding and early maturing (70 days) and highly preferred by farmers in drier parts of the states where drought is always a common phenomenon. SOSAT-C88 is a medium maturing variety (85-90 days) with a superior yield advantage over Ex-Bornu a popular millet variety.

Most farmers interviewed indicated that downy mildew was one of the most important diseases militating against millet production. None of the farmers dress their seeds before planting because of high cost and scarcity of seed dressing chemicals.

This survey has provided evidence that SOSAT-C88 is resistant to downy mildew not only in on-station environment but also in farmer's field conditions. This variety could be a potential source parent for the transfer of downy mildew resistance genes to elite varieties. However, more information is needed on the reactions of SOSAT-C88 to downy mildew in order to ascertain the stability of the resistance over time and space. LCIC 9702 appears to tolerate these diseases while local cultivars were susceptible to downy mildew but tolerates Striga and stem borer.

Field monitoring of promising materials should be a routine exercise. Performance of SOSAT-C88 under artificial infestation of Striga should be further investigated.

Table 2: On-station data on downy mildew and *Striga hermonthica* incidence on pearl millet varieties and hybrids in Bagauda.

| Entry | Downy mildew (%) | Striga count/plot |
|---|---|---|
| SOSAT-C88 | 2 | 3.8 |
| ExBornu | 4 | 0.8 |
| LCIC 9702 | 4 | 0.8 |
| SE 2124 | 7 | 1.5 |
| Gwagwa | 10 | 1.5 |
| DMR 65 | 15 | 0.9 |
| 80A-5 x LCIC 9702 | 14 | 0.9 |
| 20A-2 x DMR 15 | 15 | 0 |
| 75A-6 x ZATIB | 18 | 0 |
| Farmers' Local | 24 | 2.3 |
| | | |
| Standard Error | 0.8 | 0.26 |
| Mean | 9 | 0.37 |
| CV (%) | 93 | 123 |

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