# Effect of Sowing Date on Anthracnose of Sorghum in the Nigerian Sudan Savanna

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Keywords: Foliar- Panicle anthracnose- Integration

## Summary

*The effect of different sowing dates on anthracnose using ICSV 247, a midge resistant cultivar was investigated under field conditions in 1995 and 1996 at Bagauda, Nigeria. Early planting in June and July had higher disease i.e. foliar and panicle anthracnose incidence than the late July and August sowings. Although there was a significant correlation between higher relative humidity for the early sowings and disease severity, the June and early July sowings gave higher yields (although with high mould severity) than later sowing dates. Results indicate that the use of sowing date as a measure for control of anthracnose on sorghum will only be meaningful when farmers integrate it with other control measures including the use of resistant varieties. Based on this data, the need for careful adoption of ICSV 247 in highly midge infested areas of the Sudan savanna is highlighted.*

## Résumé

**L'effet des dates de semis sur l'anthracnose du sorgho dans la zone soudanienne du Nigeria**

*L'effet de la date de semis sur l'anthracnose a été évalué au champ en utilisant la variété ICSV 247 en 1995 et 1996 à Bagauda, Nigeria. L'incidence de la maladie était plus importante pour les plantes semées précocement en juin et juillet que celles des plantes semées plus tard, c'est- à- dire fin juillet et en août. Bien qu'il y ait une corrélation entre l'humidité relative et l'incidence de la maladie, les plantes des semis précoces ont donné un meilleur rendement en graines par rapport aux plantes semées tardivement. Les résultats obtenus montrent que les dates de semis peuvent constituer un facteur de lutte contre l'anthracnose du sorgho. Elles ne peuvent toutefois être efficaces que lorsqu'elles sont intégrées aux autres moyens de lutte tel que l'utilisation des variétés résistantes dont la variété ICSV 247.*

## Introduction

Sorghum (*Sorghum bicolor* [L.] Moench) is one of the most important cereal crops in Nigeria, where it is cultivated during the wet season i.e. May to October with an estimated total production of 8.5 million tones (12). It is produced primarily for human consumption. However, over 600,000 tones is utilized in the industrial production of livestock feed, alcoholic and non-alcoholic beverages, and sweeteners (20).

Sorghum cultivation in this area suffers from various abiotic and biotic constraints (18, 21), however, anthracnose of sorghum caused by *Colletotrichum graminicola* (Ces.) Wilson (syn.= *C. sublineolum*) is the most important foliar disease (3). It is reported to be most predominant in the Sudan and northern Guinea savanna zones of Nigeria (23) where six physiological races have been identified (5, 15). Further, a report (9) indicates, that panicle anthracnose is now commonly observed on farmers' fields in Nigeria. This underscores the need for the determination of the role of sowing date on the disease as grain anthracnose is reported to be part of the complex of fungi causing grain mould of sorghum in Nigeria (10, 11). Disease management in the past has depended on planting of resistant varieties of which some have been identified, developed and released to farmers in Nigeria (16, 17) and the possible use of fungicides (2) especially where breeder seed materials are involved. Attempts at integrated management of sorghum foliar diseases using various agronomic practices have not been reported for Nigeria while for other important cereals e.g. maize, there have been attempts in this direction (22).

This paper reports results of experiments performed to determine the effect of sowing date on anthracnose, using a cultivar identified to be resistant to sorghum midge and targeted at farmers in the Sudan ecology that suffer up to 25 to 50% yield loss (13, 18) as a result of midge infestation.

## Material and methods

Trials were established at International Crops Research Institute for the Semi-Arid Tropics, Bagauda field station, Kano, Nigeria, ($11^0$ 39'N $08^0$ 27'E) in 1995 and 1996. Each site was harrowed twice and ridged 75 cm apart. Split application of fertilizer with 64 kg, 30 kg P and 30 kg K/ha of NPK (20:10:10) was applied. Half of N and all of P and K were applied at harrowing, while the second application of N occurred four weeks later.

Sorghum variety ICSV 247 (photo-insensitive, mature in 110-120 days resistant to sorghum midge, susceptible to anthracnose) was planted on six dates: 17, 24

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Received on 12.02.01. and accepted for publication on 10.03.03.

and 31 July; 7, 14 and 21 August in 1995 and on 25 June, 2, 9, 16, 23 and 30 July, in 1996. Seeds were sown in 5 m plots, 30 cm apart on 10 ridges and thinned to two plants per hill, four weeks after emergence. The experiment was designed as a randomised complete block design with two replications. At 14 days after sowing 10 plants/plot were each tagged for disease assessment. Appearance of the disease on leaves was noted. When plants were physiologically mature, peduncle, grain and total panicle anthracnose symptoms were recorded.
Foliar, peduncle and grain anthracnose were determined using a visual rating scale as described by Marley *et al.* (15, 26) and shown in table 1. At harvest, total grain yield, was recorded in 1995 and 1996.

Data obtained were subjected to analysis of variance using SAS General Linear Model procedures (25) and least significant differences were calculated between treatments. Correlation analysis of combined results during the two seasons was carried out to determine the degree of association between foliar, peduncle and grain anthracnose, rainfall, relative humidity and grain yield.

**Table 1**
**Visual rating scales used to assess foliar, peduncle and panicle anthracnose severity on sorghum, Bagauda, Nigeria in 1996 and 1997**

| Scale | Anthracnose severity | | |
|---|---|---|---|
| | Foliar | Peduncle | Grain |
| 1 | No disease | No infection | No infection |
| 2 | 1 - 5% of total leaf area diseased | 1 – 5% peduncle damaged | < 5% grain damaged |
| 3 | 6 – 10% of total leaf area diseased | 6 – 10% peduncle damaged | 6 – 10% grain damaged |
| 4 | 11 – 20% of total leaf area diseased | 11 – 20% peduncle damaged | 11 – 20% grain damaged |
| 5 | 21 – 30% of total leaf area diseased | 21 – 30% peduncle damaged | 21 – 30% grain damaged |
| 6 | 31 – 40% of total leaf area diseased | 31 – 40% peduncle damaged | 31 – 40% grain damaged |
| 7 | 41 – 50% of total leaf area diseased | 41 – 50% peduncle damaged | 41 – 50% grain damaged |
| 8 | 51 –75% of total leaf area diseased | 51 – 75% peduncle damaged | 51 – 75% grain damaged |
| 9 | > 75% of total leaf area diseased | > 75% peduncle damaged | > 75% grain damaged |

Source: Modified from Thomas *et al.* (26).

**Table 2**
**Effect of sowing date on severity* of anthracnose on sorghum variety ICSV 247 at Bagauda, 1995**

| Sowing date | Anthracnose severity | | | Yield t/ha |
|---|---|---|---|---|
| | Foliar | Peduncle | Grain | |
| July 17 | 6.5[a]** | 8.8[a] | 1.9[a] | 2.0[a] |
| July 24 | 5.7[ab] | 7.5[ab] | 1.4[ab] | 1.9[a] |
| July 31 | 5.3[bc] | 6.5[b] | 1.0[b] | 1.8[a] |
| August 7 | 4.6[c] | 5.6[b] | 1.0[b] | 1.8[a] |
| August 14 | 3.4[d] | 2.9[c] | 1.0[b] | 0.5[b] |
| August 21 | 2.9[d] | 1.9[c] | 1.0[b] | 0.2[b] |

* Based on visual rating scale of 1- 9 where 1= no disease and 9= >75% of area diseased.

**Figures not followed by same letters are significantly different (P= 0.05) according to Duncan's Multiple Range Test.

## Results

In 1995, foliar anthracnose was most severe for the July 17 sowing with a disease rating of 6.5. However, it was not significantly different (p= 0.05) from the July 24 sowing which had a rating of 5.7. August sowing had the least severity with 2.9. Peduncle and grain anthracnose were most severe in the July 17 sowing and least severe in the August 21 sowing (Table 2). Sowing between July 31 and August 21 gave no infection of grain anthracnose (severity ratings of 1.0).

Foliar anthracnose severity was significantly higher (p= 0.05) in sowings of June 25 and July 2 than the July 9 to July 30 sowings (Table 3).

The severity of peduncle anthracnose varied significantly (p= 0.05) from 8.7 for June 25 sowing to 3.2 for the July 30 sowing. Grain anthracnose severity was highest in the June 25 sowing with 7.5, but was significantly (p= 0.05) different from other sowing dates. Grain infection did not occur for the July 16 to July 30 sowing, while it was low in the July 2 and July 9 sowings with 2.4 and 1.2.

Results of correlation analysis show that foliar anthracnose was significantly (p< 0.01) correlated with peduncle anthracnose (r= 0.75), yield (r= 0.92), rainfall (r= 0.94) and relative humidity (r= 0.75). Peduncle anthracnose was significantly (p< 0.01) correlated with yield (r= 0.82), rainfall (r= 0.80) and relative humidity (r= 0.78). Grain anthracnose correlated significantly with yield (r= 0.62, p< 0.05) rainfall (r= 0.56, P< 0.05) and relative humidity (r= 0.83, p< 0.01). Yield was significantly correlated with rainfall (r= 0.96, p< 0.01) and relative humidity (r= 0.86, p< 0.01) (Table 4).

**Table 3**
**Effect of sowing date on anthracnose severity on sorghum variety ICSV 247 at Bagauda, 1996**

| Sowing date | Anthracnose severity | | | Yield t/ha |
|---|---|---|---|---|
| | Foliar | Peduncle | Grain | |
| June 25 | 8.6[a**] | 8.7[a] | 7.5[a] | 4.6[a] |
| July 2 | 8.5[a] | 8.5[a] | 2.4[b] | 4.1[a] |
| July 9 | 8.1[ab] | 7.5[ab] | 1.2[b] | 3.6[ab] |
| July 16 | 8.0[ab] | 7.0[b] | 1.0[b] | 3.4[ab] |
| July 23 | 6.9[ab] | 4.9[c] | 1.0[b] | 2.2[b] |
| July 30 | 6.1[b] | 3.2[a] | 1.0[b] | 1.3[b] |

*Based on visual rating scale of 1- where 1= no disease and 9=>75% of area diseased.

**Figures not followed by same letters are significantly different (P= 0.05) according to Duncan's Multiple Range Test

**Table 4**
**Correlation coefficients of foliar, peduncle, and grain anthracnose severities, and weather factors on grain yield of sorghum at Bagauda, Nigeria in 1995 and 1996**

| Correlations | Foliar | Peduncule | Grain | Yield | Rainfall |
|---|---|---|---|---|---|
| Peduncule | 0.7498** | | | | |
| Grain | 0.3813 | 0.4855 | | | |
| Yield | 0.9166** | 0.8154** | 0.6159* | | |
| Rainfall | 0.9438** | 0.7984** | 0.5616* | 0.9632** | |
| Humidity | 0.7476** | 0.7753** | 0.8304** | 0.8638** | 0.8493** |

[b] Symbols * and ** indicate departure from a zero relationship at P< 0.05 and P< 0.01 respectively.

## Discussion

In both years, data show that June and July sowings predispose a susceptible cultivar in the Sudan ecology to severe foliar anthracnose infestation while August sowing as observed in 1995 has lower levels of disease severity. This observation is similar to the reports of other authors (3, 4). However, in contrast, a recent report by Ngugi *et al*. (19) on trials conducted at Alupe, Kenya (humid equatorial climate) showed late or delayed planting reduced time to disease onset and increased absolute rate of disease progress, resulting in maximum severity at crop "milk stage" and maturity. The differences between the latter report and our results could be due to differences in environmental conditions at trial sites. Bagauda, Nigeria is located in the dry Sudan savanna while Alupe, Kenya has a humid equatorial climate.

Although the July sowings had higher foliar disease, yields were higher than for August sowings, and thus did not cause significant yield loss. This could be due to the fact that early sown crops have early access to soil nutrients such as nitrogen, are thus more vigorous and will thereby tolerate higher disease levels. Foliar disease development and its effect on yield and grain weight have been reported elsewhere (26). The latter authors reported that infection on a susceptible, medium-maturing cultivar IS 18696 increased gradually until anthesis, then increased rapidly so that most leaves were killed at physiological maturity. This would account for the high disease levels on June and July sowings in our own trials.

Panicle anthracnose was also high in June and July sowings, although peduncle anthracnose was aggravated by stem borer damage (data not shown). Grain anthracnose severity ratings were high for June and early July sowings and therefore mouldy. Positive correlation patterns observed between foliar, peduncle and grain anthracnose and relative humidity are expected as high relative humidity is reported to increase anthracnose severity (Marley, unpublished data; 16). Further, positive correlations between anthracnose and yield clearly indicate that anthracnose causes yield loss in susceptible sorghum varieties. Marley (8) and Marley *et al*. (14) reported anthracnose to cause up to 47% yield loss in Nigeria while Ali *et al.* (4) and Thomas *et al.* (26) reported yield losses of up to 67%.

Results indicate that higher yields were obtained in the June and July sowings, however, grain quality was low as grain had high infection of *C. graminicola*. Grain mould, caused by a complex of fungi to which *C. graminicola* belongs (3) is a serious disease problem limiting the production and utilization of sorghum in Nigeria (6, 7, 10) the latter meaning that mouldy grain from early sown sorghum cultivars is not suitable for use in beverage, brewing and livestock feed industries, while it is unacceptable for human consumption because they are reported to contain mycotoxins (24).

Cultivars ICSV 247 and ICSV 197 are midge resistant (1) and had been recommended for possible release to farmers in the southern Sudan savanna zone of Nigeria who suffer from high infestation of sorghum by midge. From our data, it is clear that cultivar ICSV 247 is highly susceptible to foliar and panicle anthracnose. Therefore, the use of ICSV 247 by farmers in midge infested areas has to be undertaken with care as results presented here show that early planting predisposes the cultivar to anthracnose while an earlier report (11) also shows that cultivar ICSV 247 can be predisposed to high levels of grain mould damage when sown early in the field.

Where this cultivar, ICSV 247 is used, it is important that farmers be advised to be mindful of their requirements i.e. whether they will prefer high yields with mouldy grains when planted early, or have acceptable yields with clean grains when planted from mid July. In the alternative, they could combine the use of the cultivar with other affordable, practical and appropriate practices within their areas.

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## AVIS

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Nous pensons ainsi, grâce à votre aide, pouvoir rendre un grand service à la communauté pour laquelle vous travaillez.

Merci.

## BERICHT

Wij herrineren al onze lezers eraan, vooral diegenen in de ontwikkelingslanden, dat TROPICULTURA bestemd is voor ieder die werk verricht op het gebied van het platteland en dit in de meest ruime zin van het woord.

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Met uw hulp denken we dus een grote dienst te kunnen bewijzen aan de gemeenschap waarvoor u werkt.

Dank U.