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INCIDENCE AND SEVERITY OF SORGHUM ANTHRACNOSE AS INFLUENCED BY SOWING DATE IN THE NORTHERN GUINEA SAVANNA OF NIGERIA

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ABSTRACT

The incidence and severity of anthracnose which is caused by *Colletotrichum graminicola* as influenced by sowing date was investigated in 2004 and 2005 cropping seasons using two *Sorghum* varieties SAMSORG 4, susceptible to anthracnose and SAMSORG 41 resistant to the anthracnose pathogen, *Colletotrichum graminicola.* Split plot design replicated four times with sowing date as the main plots and sorghum varieties as sub-plots was used in each year. The anthracnose infection each year was dependent on natural inoculum controlled by weather, especially rainfall pattern. The result showed that sowing in early July pre-disposes the sorghum plant to higher anthracnose infection than later dates. This is particularly manifested in the combined analysis. Anthracnos*e* incidence and severity was significantly ($P<0.05$) higher on SAMSORG 4 than SAMSORG 41 in both years. Accordingly, the grain yield per plot was significantly higher in SAMSORG 41 than SAMSORG 4. The interaction between sowing date and varieties was not significant in the individual years, but was found to be highly significant ($P<0.01$) in the combined years. Based on the results, planting dates as a measure of control to sorghum anthracnose is more meaningful when integrated with other control strategies especially the use of resistant varieties.

Keywords: Sorghum; Anthracnose; Disease incidence; Disease severity; Sowing date.

INTRODUCTION

Sorghum (*Sorghum bicolor* L. Moench), also known as guinea corn, is one of the most important cereal crops of the semi-arid tropics. It is a staple food to more than 500 million people in about 500 countries of the world including Nigeria, the whole of Africa, Asia and the World over. In Nigeria production of this crop is concentrated in three agro-ecological zones - Sahel savanna, Sudan savanna and Guinea savanna (400-600, 600-1000 1000-1300mm of annual rainfall, respectively). The total production of this crop in West and Central Africa is estimated to be 10.2million tones, of which Nigeria is the major producer with an estimated production of 8.5million tones per annum (ICRISAT/FAO, 1996; Marley and Ogungbile, 2002). Sorghum is primarily produced for human consumption. However in Nigeria and some West African countries over 600,000 tones of this crop is utilized industrially for production of beverages, as well as the manufacture of sweeteners (Marley and Ajayi, 2003; Marley and Ogungbile, 2002). Sorghum production in Nigeria and West Africa is limited by diverse constraints including biotic and abiotic factors. However, anthracnose of sorghum caused by *Colletotrichum graminicola* (Ces. Wilson) (syn. = *C. sublineolum*) is the most important foliar disease (Ali and Warren, 1992; Marley and Ajayi, 2001; Marley and Ajayi, 2003; Marley *et al.*, 2002). Sorghum anthracnose was first reported in 1902 from Togo, West Africa. It has since been observed to be widely prevalent under hot humid conditions in most tropical and sub-tropical regions of the world (Ali and Warren, 1992; ICRISAT and FAO, 1996; Marley *et al.*, 2002). This paper reports the results of a two-year trial conducted to determine the effect of sowing date on the incidence and severity of anthracnose as a strategy for managing the disease.

MATERIALS AND METHODS

Study Area and Treatments

Trials were carried out in 2004 and 2005 in the field of the Institute for Agricultural Research located at Samaru (11^0 11^1N, 07^0 38^1E; Altitude 686m above sea level) near Zaria. Two varieties namely, ICSV400 (SAMSORG 41) and BES (SAMSORG 4) were randomly assigned to the sub-plots measuring 18.7m^2 while the sowing date was assigned to the main plots in a split plot design. The two varieties are both early maturing with life cycle of 65-80 days. The field was harrowed twice and ridged each year. Each sub-plot consisted of four meter long ridges, 75cm apart. Within rows plants were thinned to a spacing of 20cm. sowing was done using three dates in each year namely, July 2, July 10 and July 18 in 2004 and 2005 respectively. Plants were thinned to two plants per stand at three weeks after sowing. Fertilizer was applied at the rate of 90kgN, 45kg P_2O_5 and 45kg K_2O/ha respectively. Half of the N and all the P and K were applied as compound fertilizers (15:15:15). The remaining N was applied as top dressed urea at seven weeks after sowing. This was immediately followed by moulding up. To minimize inter-plot interference the experimental plots were bordered by four rows of maize.

Source of Inoculum

The trial was established in "anthracnose sick plot". The natural inoculum had built up during several years of cultivation of susceptible *Sorghum* (BES/SAMSORG 4 and the like). Also infected *Sorghum* plant residues from previous year's cultivation were incorporated into the soil at land preparation.

Disease Rating

The disease was assessed by calculating the incidence and severity in each sub-plot. Disease incidence, that is frequency of occurrence was calculated using the formula of Ngungi *et al.(*,2002)

$$\text{Disease incidence} = \frac{\text{Number of infected plants per plot}}{\text{Total number of plants per plot}} \times 100$$

Thus disease incidence was estimated at dough stage using visual recording of the number of plants infected with anthracnose in each plot divided by the total number of plants per plot multiplied by 100.

On the other hand, disease severity was assessed through unrestrictive systematic sampling of 10 plants tagged earlier from the middle rows. When plants were physiologically mature, foliar anthracnose was determined at weekly intervals using the visual rating scale described by Thomas (1996) and Marley (2002) where: 1 = No symptoms or presence of chlorotic flecks; 2 = 1-5% leaf area covered with lesion; 3 = 6-10% leaf area covered with lesion; 4 = 11-20% leaf area covered with lesion; 5 = 21-30% leaf area covered with lesion; 6 = 31-40% leaf area covered with lesion; 7 = 41-50% leaf area covered with lesion; 8 = 51-75% leaf area covered with lesion; 9 = above 75% leaf area covered with lesion.

Disease severity indices were calculated using the formula of Mbaye (1994):

$$\text{Disease severity index} = \frac{n_1\,(1-1) + n_2\,(2-1) + n_3\,(3-1) + \ldots + n_{10}\,(10-1)}{N\,(10-1)} \times 100$$

Where $n_1 - n_{10}$ = number of plants with different disease grades, while N = number of plants assessed.

Grain yield was estimated with the following formula as reported by Ziraffi (2004):

$$\text{Yield} = \frac{Y_1 - Y_2}{Y_1} \times 100$$

Where Y_1 = yield from the least infected sowing date/main plot or near absence of anthracnose, while Y_2 represents sowing date with the highest anthracnose infection.

The grain yield of sorghum in kilogram per hectare (kg/ha) was computed from the yield of each sub plot using the method of Gwary and Asala (2006) as follows:

$$\text{Grain yield (kg/ha)} = \frac{\text{Grain yield/plot} \times 10{,}000\text{m}^2}{\text{Net plot size } (18.7\text{m}^2)}$$

Statistical Analysis

Data obtained was subjected to analysis of variance using SAS General Linear Model procedures (1989). Least Significant Differences (LSD) were calculated between treatment means.

RESULTS AND DISCUSSION

The results presented in Table 1 indicate that sowing on July 2 and July 10 significantly produced higher anthracnose incidence than July 18. Similarly, the anthracnose severity by sowing on July 2 was significantly ($P<0.05$) higher than those of July 18. On the other hand, sowing on July 2 (though not statistically significant) showed much higher anthracnose severity over the sowing of July 10. Similar results were obtained between July 10 and July 18. On the other hand, sowing on July 2 showed significantly (P<0.05) higher anthracnose severity than the July 18 sowing. In terms of grain yield both July 2 and July 18 sowing showed significantly higher yield (393.00kg/ha and 392.00kg/ha respectively) than the sowing of July 10 (153.00kg/ha). The above results are similar to those of earlier researchers (Ali *et al.*, 1987; Ali and Warren, 1992). With regard to anthracnose development in the two cultivars, the anthracnose incidence, though not statistically significant in SAMSORG 4, was higher than SAMSORG 41. On the other hand, anthracnose percentage severity (28.1%) in SAMSORG 4 was significantly (P< 0.05) higher than that of SAMSORG 41 (20.1%). Lastly, the grain yield of *Sorghum* plants from SAMSORG 41 was significantly higher than those of SAMSORG 4. Foliar disease development and its effect on yield and grain weight were earlier reported (Marley and Ajayi, 2001). Also in another study, Marley and Ajayi (2003) reported that infection of susceptible medium maturing cultivar ISI8696 increased gradually until anthesis, then increased rapidly so that most leaves were killed at physiological maturity. Their report is similar to the observation in the present study where BES/SAMSORG 4 consistently showed higher susceptibility to the anthracnose infection. The interaction between sowing date and variety was not significant even at 5% level.

Table 1. Incidence and severity of foliar anthracnose and grain yield of *Sorghum* as influenced by sowing date and varieties in 2004

Treatments	Anthracnose		
	Incidence (%)	Severity (%)	Grain Yield (kg/ha)
Sowing Date (SD)			
July 2	20.0	29.0	393.00
July 10	20.0	23.3	153.00
July 18	18.4	20.4	392.00
LSD (P = 0.05)	1.9	7.3	54.92
Variety (V)			
SAMSORG 41	16.9	20.1	336.00
SAMSORG 4	22.0	28.1	289.33
LSD (P = 0.05)	6.2	6.0	36.62
Interaction			
SD x V	NS	NS	NS

NS = Interaction of SD x V not significant at P < 0.05

From Table 2, year 2005 showed no significant difference in foliar anthracnose incidence and severity among the three sowing dates. In the case of grain yield, July 18 plants yield (908.67kg/ha) was significantly (P<0.05) higher than those of July 10 (729.33kg/ha), and also produced higher but not statistically significant yield than the sowing of July 2 (858.67kg/ha). This result is in agreement with the reports of Marley and Ajayi (2001) and Marley and Ajayi (2002) who stated that the use of sowing date as cultural control measure is hardly consistent. Thus early sowing does not necessarily produce higher infection or lower grain yield probably due to the condition of the particular environment. In terms of variety, SAMSORG 4 (26.8 and 31.6%) showed significantly higher anthracnose incidence and severity than SAMSORG 41 (18.0 and 24.8%). Accordingly, SAMSORG 41 produced significantly (P<0.05) higher grain yield (1005.33kg/ha) than SAMSORG 4 (658.67kg/ha).

The interaction between sowing date and cultivar was significant (P<0.05) only in anthracnose severity.

Table 2. Incidence and severity of foliar anthracnose and grain yield of *Sorghum* as influenced by sowing date and varieties in 2005

Treatments	Anthracnose		
	Incidence (%)	Severity (%)	Grain Yield (kg/ha)
Sowing Date (SD)			
July 2	22.3	28.2	858.67
July10	23.1	28.3	729.33
July 18	21.8	28.1	908.67
LSD (P = 0.05)	6.2	6.3	71.02
Variety (V)			
SAMSORG 41	18.0	24.8	1005.33
SAMSORG 4	26.8	31.6	658.67
LSD (P = 0.05)	5.1	5.1	47.34
Interaction			
SD x V	NS	NS	NS

NS = Not Significant

Table 3 shows the combined incidence and severity of foliar anthracnose and grain yield of the two *Sorghum* varieties as influenced by sowing date. The results indicate that the anthracnose incidence showed no significant difference between dates 1 and 2 (32.2% and 29.3%) respectively. However, plants from both sowing dates showed significantly (P<0.05) higher anthracnose incidence than those of sowing date 3 (26.0%). In terms of sorghum varieties, anthracnose incidence was significantly higher on SAMSORG 4 (33.5%) than SAMSORG 41 (25.2%).

With regard to anthracnose severity, there was significantly higher (P<0.05) anthracnose percentage severity in plants of sowing date 1 than those of date 2 both of which were in turn significantly higher than those of date 3. The foregoing observations are in agreement with those of Ngugi *et al.* (2002) in their experiment conducted at Alupe in Kenya (humid equatorial climate), where they found that late or delayed planting reduced time to disease progress resulting in higher severity at the crop “milk stage” and maturity. Their report particularly tallies with the results in Table 3 of the present study contrary to the observations in the individual years (Tables 1 and 2). Also Marley and Ajayi (2003) reported that sowing date is more effective when combined with other cultural practices in addition to the use of resistant sorghum varieties. The grain yield from dates 1 and 2 were significantly (P<0.05) higher than the yield of date 3, but not with each other. The grain yield from SAMSORG 41 was significantly higher than SAMSORG 4 .

In terms of interaction, apart from years, sowing date and varieties (YRS x SD x V) all other interacting parameters, sowing date/variety; years/variety and years/sowing date

(SD x V, YRS x V and YRS x SD) showed significant difference (P<0.05) in foliar anthracnose incidence. As regards anthracnose severity, all the interacting parameters (except years/variety, which was highly significant) were all not significant. On the other hand in grain yield, Sowing Date/Variety; Years/Variety and Years/Sowing Date /Variety (SD x V ; YRS x V and YRS x SD x V) were significant (P<0.05), while Years/Sowing Date (Yrs x SD) was highly significant (P < 0.01).

Another important observation during the trials was the fact that early sowing produced higher yield in some cases as shown in the combined analysis (Table 3). However at other times the grain quality of such yields were greatly reduced by mould, a complex of fungi among which is *C. graminicola.* Similar observations were earlier reported (Marley *et al.*, 2001; Marley and Ajayi , 2003; Kalu *et al*., 2006a). The reason for higher yield despite high cumulative severity of foliar anthracnose in the early sowing of July compared to later dates could be due to access to soil nutrients such as nitrogen and thus more vigorous plants and will thereby withstand higher disease levels.

Table 3. Combined anthracnose foliar incidence and severity and grain yield as influenced by sowing date and sorghum varieties

Treatments	Anthracnose		
	Incidence (%)	Severity (%)	Grain Yield (kg/ha)
Sowing Date (SD)			
July 2	32.2	29.3	602.67
July 10	29.3	25.4	577.33
July 18	26.0	22.4	499.33
LSD (P = 0.05)	3.2	2.5	28.69
Varieties (V)			
SAMSORG 41	25.2	21.8	650.67
SAMSORG 4	33.5	29.6	468.67
LSD (P = 0.05)	2.6	2.1	19.13
Interaction			
SD x V	*	NS	*
Yrs x V	*	**	*
Yrs X SD	*	NS	**
Yrs X SD X V	NS	NS	*

* Interaction of SD x V significant at P < 0.05; ** Interaction highly significant at (P < 0.01); NS = Not Significant

CONCLUSION

Based on the findings in this study, it is concluded that sowing date is more effective when integrated with other management strategies including the use of resistant varieties like SAMSORG 41/ICSV400 in controlling anthracnose. This will go a long way towards enhancing the farmer's objective of reaping a bumper harvest thereby actualizing the dream for food security which indeed is a panacea to poverty alleviation in Nigeria and the world over, where sorghum is not only part of the food crops, but also used as fodder for animals.

REFERENCES

Ali, M.E.K and H. L. Warren (1992). Anthracnose of Sorghum and Millet Disease: A Second World Review (de Milliano, WAJ; Federiksen, R.A. and Bengston, G.D.ed.). Patancheru, A.P. 502, 324, India International Crop Research for the Semi arid Tropics.

Ali, M.E.K., H.L. Warren and R.X. Latin (1987). Relationship between Anthracnose leaf blight and looses in grain yield of sorghum. *Plant Disease* 71: 803-806.

Gwari, D. M., T. D. Rabo and A. B. Anaso (2003). The development of anthracnose symptoms on sorghum gynotypes in Nigerian savanna. *Journal of Plant Disease and Protection.* 111 (1) :96 – 103.

Gwary, D. M. and S. W. Asala (2006). Progress of *Sorghum* leaf anthracnose symptom types under field fungicides treatments in the Nigerian savanna. International *Journal of Agriculture and Biology*, 8 (3) : 309 – 312.

Ikemefuna, N.I. (2006). Indigenous and Conventional Plant Protection Practices for Enhanced Crop Production in Nigeria. A Paper Presented at the 33rd Annual Conference of Nigerian Society for Plant Protection, ABU, Zaria. 8 -11 May, 2006.

International Crop Research Institute for Semi-arid Tropics/Food and Agricultural Organization of United Nations (1996). The World Sorghum and Millet Economics, Facts, Trends and Outlook.

Kalu, U.U., O. Alabi, M.D. Alegbejo and P.S. Marley (2006). Effect of Sowing Date On Incidence and Severity of Anthracnose of Sorghum. A Paper Presented at the 33rd Annual Conference of Nigerian Society for Plant Protection (NSPP), ABU, Zaria, 8 - 11 May, 2006.

Marley, P.S. and O. Ajayi (2002). Assessment of Anthracnose (*Colletotrichum graminicola*) in Sorghum (*Sorghum bicolor*) Germplasm under Field Conditions in Nigeria Journal of Agricultural Science Cambridge 138 (2): 2001-2008.

Marley, P.S. and O. Ajayi (2001). Effect of Sowing Date on Grain Mold Infection and heading damage of sorghum in Nigeria. *Trop. Science* 41:203-207.

Marley, P.S. and O. Ajayi (2003). Effects of sowing date on grain anthracnose in Nigeria Sudan Savanna. *TROPICULTURA*, 21 (3):107-112.

Marley, P.S. and A.O. Ogungbile (2002). Sorghum and Pearl Millet Production in the Sudano-Guinea zone, Case of Nigeria. A Paper Presented at CFC Sponsored Workshop on Sorghum and Pearl Millet Production and Utilization in West Africa held at Bamako, Mali April 23-26, 2006. 16Pp.

Marley, P.S., M. Dioute, A. Neya, P.S.K. Nutsugah, P. Sereme, S.O. Katile, D.E. Hess, D.F. Mbaye and Z. Ngoko (2002). Sorghum and Pearl Millet Diseases in West and Central Africa. In "Global 2000: *Sorghum and Pearl Millet Diseases* 111" (ed. J. J.Leslie). Proceedings of Global Conference held at Guajuanalo, Mexico 23 -30 September, 2000. Pp. 419-426.

Marley, P.S., K.A. Elemo, D.A. Abba, L. Onu, and I. Akintayo (2001). A Reaction of Sorghum Genotype to Anthracnose and Grey Leaf Spot Disease under Sudan and Sahel Savanna Field Conditions in Nigeria. *Journal of Sustainable Agriculture. USA* 18 (2/3):105-116.

Marley, P.S., J.A.Y. Shebayo, D.A. Abba, I. Onu and I. Akintayo (2000). Analysis of biotic Constraints in Sorghum Production in the Sudan - Sahelian ecology of Nigeria, *Samaru Journal of Agricultural Research* 18 (2):105-116.

Marley, P.S., R.P. Thakur and O. Ajayi (2001). Variation among Foliar Isolates of *Colletotrichum sublineolun* of Sorghum in Nigeria. *Field Crop Research* 69:133-142.

Mbaye, D.F. (1994). Une du Pathosysteme *Pennisetum glaucum Sclrospora graminicola*.Application ala Gesttio du mildiou du mil au Senegal Monipiellier.France Ecole Nationale Supreme Agronomique de Montellier, PhD. Thesis 152 P.

Ngugi, H.K., A.M. Julian, S.B. King and B.J. Peacoke (2000). Epidemiology of Sorghum Anthracnose (*Colletotrichum sublineolum*) and Leaf Blight (*Exerohilum turcicum*) in Kenya. *Plant Path.* 49:129-140.

Ngugi, H.K., S.B. King, G.O. Abayo and S. Reddy (2002). Prevalence, Incidence and Severity of Sorghum Diseases in Western Kenya. *Plant Disease* 86 (1):65-70.

SAS Institute (1989). SAS General Linear Model Procedures User's Guide StatisticsVersion 6.09. SAS Institute, Cary North Carolina, NC.

Thomas, M.D., I. Sissoko and M. Sacko (1996). Development of Leaf Anthracnose and its Effect on Yield and Grain Weight of Sorghum in West Africa. *Plant Disease* 80:151-153