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Kalu, U.[1], Alabi, O.[2], Alegbejo, M. D.[2] and Akpa, A. D.[2]

[1]Alvan Ikoku Federal College of Education, Owerri, Imo State
[2]Institute of Agricultural Research, Ahmadu Bello University, Zaria, Kaduna State

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Losses in Yield of Sorghum Varieties influenced by Sowing Date on Incidence of Anthracnose *(Colletotrichum graminicola* Cesati Wils)

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[1]Alvan Ikoku Federal College of Education, Owerri, Imo State
[2]Institute of Agricultural Research, Ahmadu Bello University, Zaria, Kaduna State

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Abstract

Yield loss assessment influenced by incidence of anthracnose indicate that crops sown on July 2 showed higher incidence (32.2%) than those of July 17 (29.3%) was in turn higher than those of august 2 (26.0%). There was significantly higher incidence of anthracnose on the variety BES/SAMSORG4 (35.5%) than ICSV400/SAMSORG 41 (25.2%). The first year trial produced significantly higher grain yield on July 17 (874.00kg) than both July 2 (339.20kg) and August 2 (243.33kg). Losses in yield on July 2 (61%) and August 2 (72%) in the first year was significantly (LSD=2.83) higher than those of plants of July 17 with zero percentage yield loss. However in the 2nd year July 17 plants showed yield loss of 61% compared to zero losses for both July 2 and August 2. The combined effect of anthracnose incidence on yield loss showed higher significant yield loss (LSD=0.9) on August 2 (17%) than July 17 (4%) as against zero loss for July 2. Based on the findings, it is noted that sowing date as a cultural control practice to anthracnose is not reliable, but its efficacy becomes pronounced when used in concomitant with other management strategies especially host plant resistance.

Keywords: Sowing Date, Anthracnose, Incidence and Yield Loss

For corresponding author:
E-mail: *info@esxpublishers.com*
Subject: *1013-0224*

Introduction

Sorghum production in Nigeria and West Africa as a whole is limited by diverse constraints both biotic and abiotic (Marley *et al.*, 2002). Also Marley (2004) reported the occurrence of 32 diseases of sorghum in Nigeria. Of these sorghum anthracnose is one of the most important sorghum diseases limiting grain production in most of the areas in which sorghum is grown, especially semi arid tropics. Sorghum anthracnose was first reported in 1902 from Togo, West Africa (Sutton, 1980) and has since been observed in most regions of the world where sorghum is grown. However, it is more prevalent in warm humid areas (Tarr, 1962; Pastor Corrales and Frederiksen,1980) where grain yields from susceptible cultivars may be reduced by to up to 50% during severe epidermic (Harris and Johnson, 1967; Ukpai Kalu,2009). Anthracnose occurs on aerial parts of the sorghum plant, leaves, leaf sheath, stalk, panicle and seed. The foliar phase is most common and debilitating characterized by circular to elliptical red spots up to 0.5-5.0 mm in diameter with few or numerous acervuli. The lesions may coalesce to occupy most or all of an infected leaf and may even kill the leaf (Mathur *et al.*, 2002;Marley *et al.*, 2002; UkpaiKalu, 2011).

This paper was aimed at assessing losses in yield of sorghum varieties influenced by sowing date on incidence of anthracnose (*Colletotrichum graminicola*).

Materials and Methods

Trials were conducted at the Institute of Agricultural Research (IAR) farms, Samaru (11^0 11^1N, 07^0 38^1 E, altitude 686 m above sea level) in two cropping seasons. Effect of sowing date on anthracnose incidence and resultant losses in yield of sorghum varieties – SAMSORG 41(ICSV400) and SAMSORG 4(BES) were investigated in both years. Split plot design replicated four times was used. Sowing date formed the sub plot ($18.7m^2$), while sorghum varieties constituted the main plot ($527m^2$). Each sub plot consisted of 5m ridges spaced 75cm apart. Sowing was done using three dates each season as follows: July 2, July17 and August 2 respectively. The dates were selected on the basis of the climatic condition of the area especially erratic rainfall. Seeds were sown at a spacing of 20 cm on ridges. The seedlings were thinned to two per stand after two weeks of sowing. Weeding was done 3-4 weeks after sowing depending on rainfall pattern each season. Split application of fertilizer was adopted each year with 15:15:15 NPK compound fertilizer and spot applied at rate of $60kgP_205$ and $30KgK_2O$/ha respectively. Half of the N and all the P and K were applied initially. The remaining N was applied to top dressed urea after moulding up at beginning of booting stage (6-9 weeks after sowing). To minimize inter-plot interference, the experimental plots were surrounded by four rows maize.

Disease Rating

The disease was assessed by calculating the incidence in each sub-plot. Disease incidence, that is, Frequency of occurrence was calculated using the formula:

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

In calculating the anthracnose incidence, an estimation of the relationship between sowing date, anthracnose incidence and yield of sorghum varieties was calculated by weighing 10 samples of sorghum heads (un-threshed and threshed), bulk/total yield (un-threshed and threshed) from each sub-plot using Gallen Kamp spring balance. The grain yield of sorghum in kilogram in kilo per hectare was computed from the yield of each sub plot using the method of Gwary and Asala (2006) as follows:

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

Analysis

After the determination of disease, the data were subjected to analysis of variance (ANOVA) using SAS General linear procedure (1989) and the means were separated using Least Significant Differences (LSD).

Finally, percentage yield loss was calculated using the formula of Gupta and Sigh (1996), Zirafi (2004) as follows:

$$\text{Percentage (\%) yield loss/plot} = \frac{Y_1 - Y_2}{Y_2} \times 100$$

Where:

Y_1 = yield from sowing date with least infection.

Y_2= yield from sowing date with highest infection.

Results and Discussion

The result in Table 1 shows that there was no significant difference between sowing date and foliar anthracnose incidence. However, there were higher mean percentage indices for sowing of July 2 and July 17 compared to the sowing of August 2 in the year 1 cropping season. Similarly the year 2 cropping season showed higher mean percentage foliar incidence among plants in the three sowing dates – July 2, July 17 and August 2 that is 50%, 42% and 40% respectively. For sorghum varieties, there was significantly ($P \leq 0.05$) higher foliar incidence in SAMSORG 4 than SAMSORG 41 in both cropping seasons. The combined analysis showed no significant difference between the first two dates (32.2 and 29.3%) respectively. Plants from these two dates showed significantly ($P \leq 0.05$) higher anthracnose foliar incidence than the third sowing date (26.0%). Also the combined analysis showed significantly higher foliar incidence on SAMSORG 4 (33.5%) than SAMSORG 41 (25.2%).

The yield for the year 1 cropping season (Table 2) shows that the last two dates (July 17 and August 2) produced plants with significantly higher yield in both un-threshed and threshed 10 heads than those of the first date (July 2). However, the bulk or total grain yield of plants sown in July 17 was significantly ($P \leq 0.05$) higher than those of July 2 and August 2 in both un-threshed and threshed grains. However, July 2 and August 2 showed no difference in grain yield.. In terms of yield loss July 2 sowing showed 61% yield depreciation whereas plants sown in August 2 recorded yield loss as high as 72%. Also SAMSORG 4 showed a yield loss of 44% over SAMSORG 41 which produced significantly plants with higher grain yield. Year 11 cropping season (Table 3) indicates that plants sown in August 2 produced significantly higher grain yield than those of July 2 and July 17 both in un-threshed and threshed 10 heads. In the bulk or total grain yield, July 2 showed yield than the sowing of July 2 and August 2. Also 61% yield loss was observed in the sowing July 17. Again SAMSORG 4 recorded 14% yield loss compared over the other variety. The combined yield analysis (Table 4) shows that July 2 sowing date produced plants with significantly ($P \leq 0.05$) higher yield than July 17 and August 2. Accordingly, July 17 and August 2 recorded 4% and 17% losses in yield respectively.

In both cropping seasons, early sowing was found to predispose susceptible variety, SAMSORG 4 (BES) to severe foliar anthracnose infection. While late sowing such as later in July or early August results in lower incidence of anthracnose. These results are similar to earlier reports (Ali and Warren, 1992; Marley and Ajayi, 2003). It was noted in another report by Ngugi *et al.* (2002) that late or delayed sowing reduced time to disease on set and increased absolute rate of disease progress resulting in higher occurrence of the disease at crop milk stage and maturity. This report corroborate the present study in which disease on set occurred two weeks after sowing in early planting date while the crops sown later in July and early August manifested the disease much later. This could be attributed to rain fall pattern during the two cropping seasons of the trial.

It is noted from the results that early sown plants gave higher yield in most cases, but grain quality of such was reduced by mould, a complex of fungi among which is *Colletotrichum graminicola* (Marley and Ajayi, 2003; Marley, *et al., 2001*). The high yielding associated with early July sowing despite high cumulative foliar anthracnose could be due to the fact that early sown have early access to soil nutrients such as nitrogen and thus are vigorous and thereby tolerate higher disease levels. Foliar disease development and its effect on yields and grain weight was earlier reported (Marley and Ajayi, 2003; Thomas, *et al., 1996*). The susceptibility of SAMSORG 4 (BES/KSV4) was shown by its high anthracnose foliar incidence, though the variety was high yielding and early maturing. This corroborates the reports early researchers that BES is highly susceptible to the anthracnose pathogen (Thomas *et al.,* 1995). Also Thomas, *et al.,* (1996) and Sannousi, *et al.,* (2002), reported yield losses of up to 47% in BES. However, Losses of 44% was recorded in the present study. The slight difference in yield loss could be attributed to differences in weather during two years of the trial. According to Ali and Warren, (1992), Mathur, *et al.,* (2001), the premature drying of leaves and defoliation due to foliar anthracnose can reduce the sorghum grain and fodder by 30-50% in susceptible cultivar during severe epidemics. Thus, observation from the present study indicate that SAMSORG 4 (BES) considerably showed high percentage losses (44,14 and 28%) in the Year 1, year 11 trials and the combined Tables 1, 2 and 3) respectively compared to SASORG 41 (ICSV 400) which did not record any during same period.

Conclusion and Recommendations

Based on the findings of this study, it was noted that sowing sorghum at different dates as a cultural control measure against anthracnose will be more rewarding if it is combined with appropriate integrated management strategies including the use of resistant varieties like SAMSORG41 (ICSV 400) among other approved methods such as crop rotation, intercropping sorghum with other crops such as cowpea. In addition to field sanitation, the benefits of early sowing could be reaped by the farmer whose primary goal is to achieve bumper harvest.

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Tables

Table 1: Percentage (%) Anthracnose Incidence as Influenced by Sowing Date on Sorghum Cultivars in Two Cropping Seasons and the Combined Disease incidence (%)

Treatments	**Yr 1**	**Yr 2**	**Combined**
2nd July	20.0	50.0	32.2
17 July	20.0	42.6	29.3
2nd August	18.4	40.0	26.0
LSD (P =0.05 Variety (V)	1.9	10.4	03.2
SAMSORG 41	16.9	37.3	25.2
SAMSORG 4	22.0	51.5	33.5
LSD (P =0.05)	2.6	6.2	8.5
Interaction			
SD X V	NS	NS	*
Yrs X V	*		
Yrs X SD	*		
Yrs X SD X V	*		

LSD = Least Significant Difference. V = Variety. SD = Sowing Date

Table 2: Effects of Sowing Date on Incidence of Anthracnose and Yield of SorghumVariety in Year 1 Cropping

Treatment	**Grain Yield (Kg) per hectare for:**				
	U.10h	**T.10h**	**U.BIK**	**T.BIK**	**Yield Loss (%)**
Sowing Date (SD)					
July, 02	202.58	134.17	533.33	339.20	61
July, 17	300.00	185.00	1039.20	874.00	-
August 2nd	303.75	210.42	522.50	243.33	72
LSD (P = 0.05)	16.49	9.19	142.09	119.00	3.27
Variety (V)					
SAMSORG 41	304.50	201.33	853.33	623.90	-
SAMSORG 4	233.06	152.00	543.33	347.80	44
LSD (P = 0.05)	10.99	6.12		94.73	79.33	2.83
Interaction					
SD X V	NS	NS	NS	NS	* *

LSD = Least Significant Difference
NS = Not Significant
U.10h = Un-threshed 10 Heads
T.10H = Threshed 10 Heads
U.BLK = Un-threshed Bulk
T.BLK = Threshed Bulk
** Significant at 1% level (Highly Significant)

Table 3: Effect of Sowing Date in Incidence of Anthracnose and Yield of SorghumVariety

Treatment	**Grain Yield (Kg) per Hectare of:**				
	U.10h	**T.10h**	**U.BIK**	**T.BIK**	**Yield Loss (%)**
Sowing Date (SD)					
July 2nd	152.50	85.83	656.70	393.00	-
July, 17	171.25	117.67	253.30	153.00	61
August 2	267.08	155.83	504.20	392.00	-
LSD (P = 0.05) Variety	17.23	9.45	77.70	54.92	0.9
SAMSORG 41	245.28	136.67	532.78	336.00	-
SAMSORG 4	148.61	102.89	410.00	289.33	14
LSD (P = 0.05) Interaction	11.52	6.34	51.80	36.62	1.08
SD X V	NS	NS	NS	NS	**

Table 4: Effects of Sowing ON Incidence Anthracnose and Yield of Sorghum Varieties in Year Cropping

Treatment	**Grain Yield (kg) per hectare of:**				
	U.10h	**T.10h**	**U.BIK**	**T.BIK**	**Yield Loss (%)**
Sowing Date (SD)					
2nd July	208.67	145.33	828.00	602.67	-
July, 17	261.33	172,00	755.33	577.33	4
August, 2		287.33	190.67	762.67	499.33 17
LSD (P = 0.05)					
Variety (V)	8.80		26.57	33,91	28.69 0.9
SAMSORG 41	283.33	188.00	928.00	650.67	-
SAMSORG 4	221.33	150.00	636.67	484.67	28
LSD (P =0.05)	5.87		117.71	22.61	19.13 28
Interaction					
SD X V	NS	NS	NS	NS	*
Yrs X V	NS	NS	*	NS	*
Yrs X SD	*	**	**	**	**
Yrs X SD X V	NS	NS	NS	NS	*

LSD = Least Significant Difference
NS = Not Significant
* = Statistically Significant at 0.05
* = Statistically Significant at 0.01 (Highly Significant
U.10h = Unthreshed 10 Heads
T. 10h = Threshed 10 Heads
U.BLK/T,BLK = Unthreshed Bulk/Threshed Bulk.