



## INCIDENCE AND DISTRIBUTION OF HEAD AND LOOSE SMUTS OF SORGHUM (*S. BICOLOR* L. MOENCH) IN THE NIGERIAN SUDAN SAVANNA

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### ABSTRACT

In this study, field surveys were conducted (between October to November) in the 2008 and the same period in the 2009 agricultural years to determine the incidence, prevalence and severity of head and loose smuts of sorghum in the Sudan savanna agro-ecological zone of Nigeria. The surveys were conducted in three states, namely; Kano, Katsina and Jigawa states representing the Sudan savanna region during which farmers' fields were surveyed every 15-20 km on a road network. Disease incidence was obtained from a random sample of 100 plants each from three fields in an "X" or "W" pattern across each farm. Results of the study revealed that both head and loose smuts occurred in both years and in more than 84% of the fields surveyed. Incidence of both loose and head smuts varied significantly ( $P=0.05$ ) between years and locations probably because of the variability of the pathogens and the little differences in climatic factors of the two years. The incidence of loose and head smuts in 2008 was 8.33% and 3.33%, respectively but both diseases were more prevalent and severe in Kano and Katsina states than Jigawa state. In 2009 on the other hand, head smut incidence was relatively higher averaging 5.00% compared to loose smut with mean incidence of 3.00%. However, prevalence and severity of the two diseases were still higher in Kano and Katsina states compared to jigawa state. It appeared that the incidence of the two smuts varied with the year, location and sorghum variety. The severity of the two smuts was generally low but taken together, could result into serious financial loss to farmers. So efforts should be made to find means of minimizing these losses.

**Key words;** survey, head and loose smuts, Sudan savanna, incidence

### INTRODUCTION

Sorghum [*Sorghum bicolor* (L.) Moench] has been the most important staple food crop in the semi-arid regions of Africa both in terms of production and total land area put to cultivation (Purseglove, 1972; FAO, 2005; Daniel and Maria, 2000; Ngugi *et al.*, 2002). In Nigeria, the crop ranks first among all other cereal crops cultivated in the savanna zone between latitude 8° and 14°N (Marley *et al.*, 2002). Also, in the Sudano-sahelian savanna zones, the cropping systems are mainly based on sorghum (Ogunbile *et al.*, 1998; Marley *et al.*, 2002). Nigeria is the largest producer of sorghum in Africa, producing about 8.0 million metric tones in 2004 (FAO, 2005). However, despite the importance of this crop, grain yields at farmers' levels are reported to be 1.3 t/ha due to limitations imposed by biotic and abiotic factors (Marley *et al.*, 2002). Earlier reports by other workers on the cereal crops revealed that the great variations in the yield of the crop from one agro-ecological zone to another were due to soil factors, rainfall pattern and the adverse effect of pests, parasites and diseases (Remison, 1980; Akpa and Tsammani, 1993; Marley *et al.*, 2002). For example, Akpa *et al.* (1996) reported 28 diseases affecting sorghum while Marley *et al.* (2002) reported 12 constraints of sorghum production in the Sudan savanna zones of Nigeria. Also, Ngugi *et al.* (2002) reported 15 diseases of sorghum in Kenya, and Ajayi (1989), Uvah and Alabi (1989) have reported several insect pests of sorghum while Emechebe *et al.* (1991) reported *Striga* as the main parasitic weed

of sorghum in West Africa. In general, sorghum suffers from more than 30 fungal diseases (USDA, 1960). Richardson (1990) listed 40 seed-borne fungal pathogens causing 32 different diseases in the crop such as downy mildew, moulds, and smuts, etc. The most common fungal disease of destructive nature which affects sorghum is smut. In Nigeria and the world over, four distinct smut diseases have been identified; they are covered kernel smut (*Sporisorium sorghi*, synonym: *Sphacelotheca sorghi*); loose kernel smut (*Sporisorium cruentum* synonym: *Sphacelotheca cruenta*); head smut (*Sporisorium reilianum* synonym: *Sphacelotheca reiliana*) and long smut (*Soroposporium ehrinbergii* synonym *Tolyposporium ehrenbergii*) (Frowd, 1980; Pande *et al.*, 1993; Marley *et al.*, 2002; Gwary *et al.*, 2007).

The objective of this paper is to study the incidence, and distribution of loose and head smuts in the Sudan savanna agro-ecological zone of Nigeria.

### MATERIALS AND METHOD

Survey of farmers' fields was conducted in three states, namely; Kano, Jigawa and Katsina states during the 2008 and 2009 rain-fed growing season at grain filling stage; when the diseased plants could easily be recognized. The three states are considered as representative of the Sudan savanna agro-ecological zone (AEZ) in terms of their biophysical characteristics as well as their potential for high productivity of sorghum crop (Shaib *et al.*, 1997).

During the two years, the incidence, severity and prevalence of the two smuts were studied. Farmers' fields were surveyed every 15-20 km along the road networks of Kano-Malumfashi road, Malumfashi-Katsina road, Kano-Katsina road, Kano-Hadejia road, Kano-Maiduguri road, Kano-Zaria road, and Kano-Kiru road (Bigirwa *et al.*, 1998; Olanya *et al.*, 1993; Kutama *et al.*, 2009). At every stop, three farmers fields of sole sorghum or sorghum as major crop in

a mixture were surveyed, each field serving as replicate (Zarafi and Emechebe, 2005; Kutama *et al.*, 2009). Disease incidence was obtained by carefully counting the number of infected heads out of a random sample of 100 plants obtained by walking in an "X" or "W" pattern across each of the farms surveyed. Incidence (%) was calculated for every location using the equation; as recommended by James (1974).

$$\text{Incidence (\%)} = \frac{\text{Number of diseased panicles/heads}}{\text{Number of plants examined}}$$

X100

The prevalence of the disease in the three states was obtained from the % incidence of the various locations in the states. Severity of the disease was based on the percentage of diseased panicles or heads for, the severity of smut is directly proportional to the number of panicles/heads infested (Sundaram,1980). During the second year survey, all efforts were made to revisit the farmers' fields surveyed during the preceding season, i.e. during the first year. Where it happened that the field was grown with another crop, not sorghum, then the next field close to it was surveyed. During the first year (2008) survey, a total of 99 farmers' fields in 33 locations were surveyed. In the second survey (2009) however, 108 farmers' fields in 36 locations were surveyed. Apart from disease incidence other parameter determined during the study was the geographical location of the field using GPS 315, MANGELLAN 2000 model.

#### **Statistical analysis**

Data obtained on the incidence of the diseases was statistically analyzed with the use of SAS 9.2, version 2002-2007 Cary Institute, using the command PROC MEANS OPTION LSD;

#### **RESULTS AND DISCUSSION**

In the 2008 survey, a total of 99 farmers' fields in 33 locations were surveyed while in the 2009 survey, 108 farmers' fields in 36 locations were surveyed for loose and head smuts symptoms. Head smut incidence was higher in 2009 than in 2008 (Table 1) particularly in Kano state (Table 2). However, the disease was observed in all the 33 locations (100%) in 2008 and in 34 out of the 36 (94.4%) locations surveyed in 2009 (Table 1). In this survey, the disease was especially severe on clay soils which were found in Kumbotso, Faskari, Makole and Wudil locations (Table 1). This agrees with the report by Sundaram (1980) that head smut was especially severe in the northern Sudan savanna region of Nigeria as was obtained in this study (Tables 2 and 3). However, Marley and Aba (1999) did not find head smut in the Sudan savanna of Nigeria up to a significant level relative to covered and loose smuts in the region. It appeared that the incidence of head smut is probably dependent on the season and the variety of sorghum cultivated. Selvaraj (1980) observed that although smuts are widespread diseases in all sorghum growing areas of Nigeria, they are more damaging on traditional cultivars than improved cultivars. Throughout this survey, it was noted that in virtually all the fields surveyed, local sorghum varieties were cultivated; these included

local red Kaura, local white, Farafara, and Yalai. An early study suggested 8-10% yield loss due to head smut (King, 1970). The high incidence of head smut in many locations in 2009 obtained in most of the states surveyed might be due to the short period of drought during the growing season as reported by Selvaraj (1980) that long and head smuts might be serious in northern Nigeria in drought years probably because head smut pathogen (*S. reilianum*) is more virulent in this part of the region as demonstrated by Kutama *et al.*, (2010). Reports of other workers suggest that these smuts might be more serious in late maturing than in early varieties of sorghum (Marley and Aba,1999; IPM, 2008; Gwary *et al.*, 2007) which were the major sorghum varieties cultivated in the region noted in this study or; when seed dressing is not practiced (Bdliya, 2005). The severity of the diseases was generally low but more severe in some fields in 2009 (Table 3).

Comparatively, loose smut was observed in 29 out of the 33 (87.9%) locations surveyed (Table 4) in 2008 while head smut was observed in 28 (84.8%) of the 33 locations surveyed (Table 1). The incidence of loose smut was generally high this year (2008) with places such as Bagwai having up to 17% incidence (Table 4) which could be considered as an hot spot. In other places however, the incidence was low. In all the states surveyed in 2008, the incidence of loose smut was relatively higher in locations in Kano state (Table 5). The disease seemed to be more prevalent in Kano and Katsina states than in Jigawa state which had significantly higher incidence ( $p \leq 0.05$ ). This could be attributed to the fact that Kano and Katsina states received more rainfall in 2008 than Jigawa state and that early maturing sorghum varieties were usually been cultivated in Jigawa state as demonstrated earlier by Severaj (1980).

On the other hand, in 2009, 108 farmers' fields in 36 locations were surveyed out of which loose smut was found in 34 locations (94.4%). However, similar to the preceding year, the incidence of loose smut in 2009 was generally high ranging from 1 to 10% (Table 4) but lower than in 2008 despite the fact that more fields were surveyed in 2009. The distribution of the loose smut disease in 2009 (shown in table 6) revealed that the disease was still more in Kano and Katsina states than in Jigawa state. Similar results were obtained by Zarafi and Emechebe (2005) on pearl millet downy mildew and Kutama *et al.* (2009) on sorghum downy mildew in the Sudan and Sahel savanna zones.

**Conclusion**

The present study has shown that loose and head smuts occur in more than 84% of the fields surveyed in 2008 and 2009. Although the overall incidence of the two smuts was generally low, it is essential to uncover the fact that this could result into a serious financial loss by the farmers and an unrewarded

cultivation of large amount of agricultural land example; a loss of 1 % typically causes yield reduction of 4.1 million kg in Rajasthan (India) and a financial loss of 2.1 million rupees (Sundaram,1980). In Nigeria, as far back as 1963, Haris (1963) estimated a 1.3 % loss due to covered smut at 500,000 or the unrewarded cultivation of 70,000 hectares of land.

**Table 1. Incidence of sorghum head smut in the Sudan savanna zone of Nigeria in 2008 and 2009 surveys.**

S/N.	Location	State	GPS Coordinate		Disease incidence (%)	
			Latitude	Longitude	2008	2009
1.	Babura	GJ	12°22.79N,	005°30.560E	4.67	7.33
2.	Bagwai	KN	12°22.768N	008°30.79E	2.00	1.00
3.	Bengel	KT	12°22.55N	008°30.534E	1.33	6.67
4.	B/kudu	JG	10°48.892N	009°48.56E	3.00	4.33
5.	Bunkure	KN	11°50.210N	008°30.668E	4.00	3.33
6.	Danbattat	KN	12°11.573N	008°24.368E	2.67	2.33
7.	Dangora	KN	11°37.508N	008°20.468E	NS	4.33
8.	Dazawa	KT	12°28.671N	007°27.930E	3.00	3.33
9.	Dungurawa	KN	12°06.298N	008°24.948E	4.00	3.66
10.	Faskari	KT	11°47.501N	007°03.712E	5.00	4.00
11.	G/Mallam	KN	11°37.508N	008°23.571E	4.00	4.67
12.	Gantsawa	KT	12°01.115N	008°38.092E	NS	7.76
13.	Getso	KN	11°57.032N	007°57.175E	3.00	5.33
14.	Gezawa	KN	12°07.158N	008°42.977E	1.33	3.33
15.	Gwaram	JG	12°11.238N	008°16.341E	3.0	1.00
16.	Janguza	KN	11°58.308N	008°22.888E	2.67	10.33
17.	K/huguma	KN	11°48.423N	008°0.033E	4.33	6.00
18.	K/soli	KT	12°30.405N	007°4.588E	4.67	0.00
19.	Kalfulde	KT	12°18.200N	007°27.324E	5.00	7.00
20.	Kankara	KT	11°56.75N	007°24.645E	3.00	2.33
21.	Kanye	KN	11°057.344N	008°04.583E	1.67	9.67
22.	Kazaure	JG	12°03.234N	007°52.234E	4.00	1.00
23.	Kiru	KN	11°28.247N	008°12.31E	0.33	8.33
24.	Kofa	KT	12°27.119N	11°28.830E	1.33	0.33
25.	Kumbotso	KN	11°56.178N	005°26.414E	4.00	10.67
26.	Kunya	KN	12°12.238N	008°34.866E	1.00	8.67
27.	M/kankara	KT	11°45.550N	007°32.975E	3.00	8.00
28.	Mainika	KN	11°52.227N	007°52.654E	NS	5.00
29.	Makole	KN	11°049.128N	008°42.318E	0.67	6.33
30.	Minjibir	KN	12°12.373N	008°34.292E	1.33	1.00
31.	R/Gado	KN	11°58.622N	008°15.658E	0.33	9.00
32.	Shanono	KN	12°04.914N	008°01.375E	1.33	4.67
33.	T/biri	KT	12°06.550N	007°28.830E	5.00	9.33
34.	Wudil	KN	11°51.843N	008°42.411E	3.00	8.67
35.	Yakasai	KT	12°12.824N	008°16.101E	5.00	0.00
36.	Yammama	KT	11°51.940N	007°38.949E	2.00	1.33
	Mean				2.98	3.100
	S.E.D. location				2.90	5.00
	S.E.D. incidence				1.43	1.036
	L.S.D. Location				6.54	6.180
	L.S.D. incidence				3.11	2.055

NS = Not Surveyed KN=Kano, KT= Katsina, JG=Jigawa.

**Table 2. Prevalence of Head smut in Kano, Katsina and Jigawa states in 2008 and 2009.**

State	Prevalence % in:	
	2008	2009
Kano	2.45	5.80
Katsina	3.67	4.55
Jigawa	3.77	4.23

**Table 3. Number of locations in Kano, Katsina and Jigawa States with head smut and % incidence in 2008 and 2009.**

State	% Disease Incidence and number of location								
	2008				2009				
	0-0.9	1-5	6-10	11-15	0-0.9	1-5	6-10	11-15	
Kano	3	15	0	0	1	10	9	2	
Katsina	0	11	0	0	2	4	4	0	
Jigawa	0	4	0	0	3	0	0	4	
Total	3	30	0	0	6	14	13	6	36

**Table 4. Incidence of sorghum loose smut observed in the Sudan savanna zone of Nigeria in 2008 and 2009.**

S/N.	Location	State	GPS Coordinates		Disease incidence (%)	
			Latitude	Longitude	2008	2009
1.	Babura	JG	12°22.79N,	005°30.560E	0.00	2.33
2.	Bagwai	KN	12°22.768N	008°30.79E	17.00	1.33
3.	Bengel	KT	12°22.55N	008°30.534E	4.67	0.33
4.	B/KUDU	JG	10°48.892N	009°48.56E	1.00	2.00
5.	Bunkure	KN	11°50.210N	008°30.668E	10.33	2.00
6.	Danbattat	KN	12°11.573N	008°24.368E	6.67	1.33
7.	Dangora	KN	11°37.508N	008°20.468E	NS	2.00
8.	Dazawa	KT	12°28.671N	007°27.930E	3.33	1.00
9.	Dungurawa	KN	12°06.298N	008°24.948E	6.33	3.00
10.	Faskari	KT	11°47.501N	007°03.712E	6.00	4.7
11.	G/Mallam	KN	11°37.508N	008°23.571E	5.67	3.33
12.	Gantsawa	KT	12°1.115N	008°38.092E	NS	1.67
13.	Getso	KN	11°57.032N	007°57.175E	4.33	3.67
14.	Gezawa	KN	12°07.158N	008°42.977E	0.00	10.00
15.	Gwaram	JG	12°11.238N	008°16.341E	NS	0.33
16.	Janguza	KN	11°58.308N	008°22.888E	13.33	3.33
17.	K/huguma	KN	11°48.423N	008°0.033E	4.67	0.00
18.	K/soli	KT	12°30.405N	007°4.588E	6.00	0.00
19.	Kalfulde	KT	12°18.200N	007°27.324E	4.00	4.33
20.	Kankara	KT	11°56.75N	007°24.645E	5.00	3.00
21.	Kanye	KN	11°057.344N	008°04.583E	5.33	4.00
22.	Kazaure	JG	12°03.234N	007°52.234E	7.00	1.67
23.	Kiru	KN	11°28.247N	008°12.31E	3.33	2.33
24.	Kofa	KT	12°27.119N	11°28.830E	3.00	4.33
25.	Kumbotso	KN	11°56.178N	005°26.414E	11.33	6.00
26.	Kunya	KN	12°12.238N	008°34.866E	0.00	6.00
27.	M/kankara	KT	11°45.550N	007°32.975E	1.67	6.00
28.	Mainika	KN	11°52.227N	007°52.654E	NS	1.33
29.	Makole	KN	11°049.128N	008°42.318E	11.00	4.00
30.	Minjibir	KN	12°12.373N	008°34.292E	3.00	3.67
31.	R/Gado	KN	11°58.622N	008°15.658E	9.33	3.67
32.	Shanono	KN	12°04.914N	008°01.375E	1.67	3.00
33.	T/biri	KT	12°06.550N	007°28.830E	7.00	1.67
34.	Wudil	KN	11°51.843N	008°42.411E	6.33	3.67
35.	Yakasai	KT	12°12.824N	008°16.101E	0.00	1.67
36.	Yammama	KT	11°51.940N	007°38.949E	2.00	3.33
	Mean				5.04	3.08
	S.E.D. location				3.01	2.98
	S.E.D. incidence				5.08	3.23
	L.S.D. Location				3.45	2.76
	L.S.D. incidence				3.12	2.87

NS = Not Surveyed, KN=Kano, KT= Katsina, JG=Jigawa.

**Table 5. Prevalence of loose smut in Kano, Katsina and Jigawa states in 2008 and 2009.**

State	% Prevalence in:	
	2008	2009
Kano	6.30	3.10
Katsina	4.27	3.18
Jigawa	4.21	2.66

Table 6. Number of locations in Kano, Katsina and Jigawa states with loose smut and % incidence in 2008 and 2009.

State	%incidence and number of location							
	2008				2009			
	0-0.9%	1-5%	6-10%	11-15%	0-0.9%	1-5%	6-10%	11-15%
Kano	2	6	5	5	1	17	3	0
Katsina	0	6	3	0	2	6	1	0
Jagawa	1	4	1	0	3	3	0	0
Total	3	16	9	5	6	26	4	6

Table 6. Number of locations in Kano, Katsina and Jigawa states with loose smut and % incidence in 2008 and 2009.

State	Incidence% and number of locations							
	2008				2009			
	0-0.9	1-5	6-10	11-15	0-0.9	1-5	6-10	11-15
Kano	2	6	5	5	1	17	3	0
Katsina	0	6	3	0	2	6	1	0
Jigawa	1	4	1	0	3	3	0	0
Total	3	16	9	5	6	26	4	0

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