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Full Length Research Paper

Determinants of the growth and yield parameters of sorghum genotypes screened for loose smut in the Sudan savanna region of Nigeria

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One hundred and four sorghum genotypes were screened under field conditions for loose smut using the hypodermic stem injection artificial inoculation method and laid on a randomized complete block design with two replications. Results showed that, of the 104 sorghum genotypes screened for loose smuts, there was marked reduction in growth parameters in 26 (diseased) plants compared to healthy or non- infected (78) plants. Similarly, number of day to 50% heading as well as grain yield/hectare were significantly (P<0.05) affected in loose smut infected plants than in healthy plants, with the former usually having less number of days to heading, as well as less yield than the latter. However, day to 50% flowering was not significantly (P>0.05) affected even among the diseased plants. The present study have confirmed the fact that in loose smut, plants showing symptoms usually matured earlier and produced less grain yield but did not confirm the hypothesis that the affected plant flowers earlier than the healthy ones.

Key words: Growth and yield parameters, loose smut, sorghum genotypes, Sudan Savanna.

INTRODUCTION

Sorghum loose smut is incited by *Sporisorium cruentum* (syn. *Spacelotheca cruentum*) (Kuhn). The disease is one of the most destructive of the smut diseases known to mankind (Kutama et al., 2011a). Plants affected by *S. cruentum* causing loose smut are usually stunted, have thin stalks and according to many workers, their heads emerge earlier than in healthy plants (Tarr, 1962; Singh, 1998; IPM, 2008; Mehrotra and Aggarwal, 2003). They may also produce abundant branches or tillers (ICRISAT, 1978; Singh, 1998). Ears are usually produced earlier than normal. Infected heads are characteristically looser, bushier and of a darker green color than normal ones due to the induction of hypertrophy of the glumes by the pathogen (IPM, 2008). Usually, all the spikelets of an infected head are smutted but some may escape or proliferate (Tarr, 1962; ICRISAT, 1978). The head is always bushy because the covering membrane of the sorus ruptures very early releasing the powder of dark coloured spores (Singh, 1998). For this reason, in loose

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smut, plants attacked by *S. cruentum* normally head prematurely often two weeks before normal, the fungus speeding up the growth cycle of the stem and depressing the infection (Tarr, 1962). The tillers are usually short, slender plant and abundant (Kutama et al., 2011a,b). The major difference between covered and loose smut is that the plants affected by loose smut are stunted, have thin stalks and heads emerge earlier than healthy plants. It has been hypothesized that in plants affected by loose smut, growth and yield parameters such as plant height, number of leaves, days to flowering and heading as well as the grain yield are usually affected. Therefore, the aim of this work was to determine the growth and yield parameters of sorghum genotypes screened for loose smut in the Sudan savanna region of Nigeria.

MATERIALS AND METHODS

Collection of sorghum germplasm

One hundred and four sorghum germplasm collections were obtained from the Institute of Agricultural Research, Samaru, Ahmadu Bello University, Zaria, Nigeria in 2009. The various sorghum genotypes obtained were kept in air tight polythene bag, in a dry place in the laboratory.

Field screening of sorghum genotypes for resistance to loose smut

Field screening was conducted at the Faculty of Agriculture, Bayero University, Kano research farm located on the coordinates 11°58.981N, 008°25.298E.The altitude of the research site is 454 m above sea level. The location received a total of 1214 and 979 mm rainfall during the trial period (2010 and 2011, respectively).

Randomized Complete Block Design (RCBD) with two replications was conducted. The plot size was 1.5 m by three ridge each measuring 0.75 m apart and one sorghum genotype was sown per plot at the rate of 3 kg/ha, 3 seeds per hole and 0.45 m plant spacing (Komolafe et al., 1985). Each replication comprised of 104 plots and therefore planted with 104 sorghum genotypes.

This was randomized in the second replication. Sowing was done immediately. One week after germination, seedlings were thinned to one plant per stand. First weeding was done manually at 14 days after germination while the second weeding was done four weeks after germination because there was rapid regeneration of weeds two weeks after the first weeding. Compound fertilizer (NPK, 20:10:10) at the rate of 50 kg/ha (Louis et al., 2007) was applied in two equal split doses, one after the first weeding and the next at booting stage (Kutamaet al., 2011b).

Artificial inoculation

Exactly 0.5 g of previously collected, dried and laboratory stored teliospores of loose smut (*S. cruentum*) were germinated separately in 1 L of distilled water each for 28 h and blended for 30 s using an electric blender. One milliliter of the suspension was introduced into the main stem of the plant three weeks after sowing (3WAS), with a pediatric syringe by inserting the needle gently into the stem or growing point. Care was taken to prevent damage by carefully holding and supporting the whole plant with a hand.

The same procedure was repeated 40 days after sowing (40DAS). The plants were allowed to grow normally up to physiological maturity (Sundaram, 1980; Kutama et al., 2011c).

Determination of growth and yield parameters

Plant height (cm) was measured at 14 day intervals after inoculation (WAI) up to 10 weeks after inoculation (WAI). The height was determined by measuring from the base/ground level to the apex or the growing point using a measuring tape. At least two plants were measured from the middle row and the average was taken per plot. Other parameters determined include; the number of leaves per plant which was determined from two weeks after inoculation up to 8 WAI at 2 week intervals.

Number of tillers per plant was determined two weeks after inoculation up to 8 WAI fortnightly. Number of days to 50% flowering in a plot was determined when 50% of the plants in each plot showed booting stage. This was calculated from the days after sowing.

Number of days to 50% heading was determined when 50% of the sorghum heads in each plot produced grains. This was calculated from the days after sowing. When the various genotypes have attained physiological maturity, the sorghum heads from the inner row in each plot were cut, sun dried, threshed and winnowed manually. The grains were weighed. The figures were later converted to kilograms per hectare (Kutama et al., 2011a).

RESULTS AND DISCUSSION

Results of the growth parameters (mean plant height, number of leaves and number of tillers) of sorghum genotypes screened for loose smut are shown in Table 1. There was significant difference ($P \leq 0.05$) among all the sorghum genotypes screened from 2WAI up to 8WAI when data collection terminated. However, significant reduction in plant height and increase in tiller number were observed in all the sorghum genotypes found to be smutted at the end of data collection period.

Day to 50% flowering (Table 2) did not significantly

Table 1. Mean plant height (cm), number of tillers and number of leaves/ plant of sorghum genotypes screened for resistance to loose smut.

No.	Sorghum genotypes	Growth parameters at											
		2WAI			4WAI			6WAI			8WAI		
		Plht	Tlno	Lfno.	Plht	Tlno	Lfno.	Plht	Tlno	Lfno.	Plht	Tlno	Lfno.
1	**SSV2006002#**	85.25	0	7.5	90.7	2.5	12	99.2	3.0	12	122.35	1.5	12
2	SSV2006006	63.75	2	8	71.6	3.5	11	82.9	3.0	12	125.2	2	12
3	SSV2006007	87.95	0.5	8	88.65	2.0	8	98.25	2.0	12	109. 2	1.5	12
4	SSV2006011	78.2	2.5	6.5	79.35	0.5	8	86.75	0.5	11	98.2	2	11
5	**SSV2006013#**	76.75	3	7	80.2	1.5	8	86.65	1.5	11.5	90.6	1	11.5
6	SSV2006014	63.25	0	6.5	70.3	2.5	10	82.2	2.5	12	97.25	1.5	12
7	SSV2006015	107.7	0	6.5	112.6	2.5	10	114.6	2.5	12	121.15	1	12
8	SSV2006016	76.6	0	6.5	79.35	2.0	12	87.65	2.5	12	99.15	2.5	12
9	SSV2006017	102.2	1.5	6.5	112.35	2.5	11	120.5	3.0	12	120.5	1	12
10	SSV2006018	86.75	0.5	8	88.65	2.5	12	97.1	2.5	11.5	98.15	1.5	11.5
11	SSV2006021	69.75	0.5	7	70.8	3.0	11	78.1	2.5	11	87.6	1	11
12	**SSV2006024#**	70.75	2	6.5	72.1	1.5	10	87.2	2.0	11.5	92.55	1.5	11.5
13	**SSV2006026#**	62.7	1	7	65.15	1.5	10	72.1	1.0	11.5	84.15	1.5	11.5
14	SSV2006027	61.75	0	7	63.2	1.5	10	75.55	1.5	11.5	93.5	1.5	11.5
15	SSV2006029	71.6	2.5	7	75.25	1.5	11	78.75	1.0	11.5	88.7	0.5	11.5
16	**SSV2006030#**	75.25	3	7	77.7	2.5	12	77.7	1.5	11.5	86.45.	0	11.5
17	**SSV2006031#**	75.35	0.5	6	80.65	1.5	12	82.1	1.5	11.5	90.15	0.5	11.5
18	**SSV2006033#**	50.95	3	6	56.25	2.0	7	86.75	1.5	11.5	94.2	0	11.5
19	SSV2006035	79.95	0	8	81.15	2.0	12	86.15	1.5	12	98.25	0	12
20	SSV2006036	64.00	0	8	65.65	2.5	11	86.75	2.0	12	92.75	1.5	12
21	SSV2006039	61.95	0	7.5	66.15	1.5	11.5	79.25	1.5	12	94.75	2	12
22	SSV2006041	62.2	0	5.5	62.5	2.0	12	71.2	1.5	12	91.15	1	12
23	SSV2006045	94.95	0	7	100.65	2.0	10.5	110.95	1.0	12	118.4	1.5	12
24	SSV2006047	70.35	4	6.5	72.1	2.5	11.5	74.7	2.0	12	88.65	0.5	12
25	SSV2008001	64.95	0.5	7	66.2	1.0	10	77.75	1.0	12	131.6	0.5	12
26	SSV2008002	71.6	0	7	72.6	2.0	8	80.65	1.0	12	80.65	0	12
27	SSV2008004	66.15	3	6.5	67.2	2.0	8	73.2	1.5	12	73.2	0.5	12
28	SSV2008005	65.5	3	7	67.7	1.0	7.5	77.2	2.0	11.5	77.2	1	11.5
29	**SSV2008006#**	62.2	2.5	7	66.65	1.5	8.5	75.75	1.0	11	75.75	0.5	11
30	SSV2008007	55.2	2.5	7	61.15	2.5	9.5	70.15	0.5	10.5	70.15	0	10.5
31	SSV2008008	67.75	2.5	7	71.15	1.5	10	77.75	2.0	11.5	77.75	2	11.5
32	SSV2008009	66.85	0.5	6	70.7	0.5	11	78.9	1.0	12	78.9	0	12
33	**SSV2008010#**	67.85	0	6.5	71.7	2.0	10	81.2	2.0	12	81.2	1.5	12
34	SSV2008012	55.1	0	6.5	63.75	1.0	8	83.7	1.0	11	83.7	0	11
35	SSV2008013	62.3	2.5	7	63.8	1.0	9	78.3	1.0	11	78.3	0	11
36	SSV2008017	66.3	2	6.5	67.15	2.0	8	81.8	2.0	11	81.8	0	11
37	SSV2008018	72.1	2	7	72.9	2.0	8	77.3	2.0	10.5	77.3	0.5	10.5
38	SSV2008019	66.35	0.5	7	67.25	1.5	9	77.85	1.5	11	77.85	0.5	11
39	SSV2008021	73.95	2	7	74.55	1.0	8	79.85	1.0	11	79.85	1	11
40	SSV2008022	62.35	1	7	62.75	1.5	9	67.75	1.5	11	67.75	1.5	11
41	SSV2008023	48.35	0	7	56.55	2.0	8	67.6	2.0	11.5	67.6	1	11.5
42	SSV2008025	65.65	0	7	66.85	2.0	11	68.8	2.0	12	68.1	1	12
43	SSV2008026	72.95	0	7	75.2	2.0	9	77.6	2.0	12	77.6	1	12
44	SSV2008028	63.5	1.5	6.5	66.6	2.5	10	80.0	2.5	12	80.0	2	12
45	SSV2008029	53.45	2.5	7	67.3	2.0	10	80.85	1.5	12	80.85	0.5	12
46	**SSV2008030#**	56.75	2.5	7	63.2	2.5	10	81.15	1.5	12	81.15	1.5	12
47	SSV2008031	67.8	1	7.5	69.85	2.5	10	78.85	2.5	12	78.85	2	12

Table 1 Contd.

48	SSV2008032	51.6	0.5	6	55.6	1.5	8	81.55	1.5	12	81.55	0.5	12
49	**SSV2008033#**	58.7	0	7	61.0	2.5	8	72.75	2.5	12	72.75	0.5	12
50	**SSV2008034#**	52.8	0	6	55.6	1.0	7.5	72.5	1.0	12	72.5	1	12
51	SSV2008035	53.9	1.5	7	77.25	0.5	12	88.3	1.0	12	88.3	0.5	12
52	SSV2008036	64.45	3.5	6.5	76.25	2.5	10	88.25	1.0	11	88.25	1.5	11
53	**SSV2008039#**	63.0	0	7	72.5	1.5	8	86.75	1.5	11	86.75	1	11
54	SSV2008040	82.2	0	7.5	92.05	1.0	7	103.7	1.0	11	103.7	1	11
55	SSV2008041	59.6	0	6	72.0	0.5	10	77.5	0.5	10	77.5	0.5	10
56	SSV2008042	49.95	0	7	86.7	1.0	7	99.8	1.0	10	99.8	0.5	10
57	**SSV2008044#**	65.5	0	7	78.55	0.0	9	90.25	0.5	11	90.25	0.5	11
58	SSV2008046	57.3	1.5	7	71.05	1.0	10	90.15	1.0	12	90.15	0.5	12
59	SSV2008047	58.95	1.5	7	75.6	2.0	9.5	82.55	1.0	11.5	82.55	1	11.5
60	**SSV2008048#**	51.00	1	6.5	76.00	1.0	7.5	91.1	0.5	11	91.1	0.5	11
61	SSV2008049	68.2	0	6.5	78.8	1.0	9.5	92.6	1.5	11.5	92.6	1	11.5
62	**SSV2008051#**	52.05	0	7	84.8	0.5	10	93.95	0.5	11.5	93.95	0.5	11.5
63	SSV2008052	52.8	0.5	7	85.6	2	9	94.15	2.0	11	94.15	1.5	11
64	SSV2008053	60.25	2	7	82.95	1	10	91.85	1.0	12	91.85	1	12
65	**SSV2008054#**	53.75	0.5	7	70.7	1	9	89.7	1.0	12	89.7	1	12
66	SSV2008055	83.85	2	7	103.5	0.5	9	108.6	0.0	12	108.6	1	12
67	SSV2008056	64.8	0.5	8	90.4	1	9	115.15	1.0	12	115.15	1.5	12
68	SSV2008057	94.25	0.5	8	93.35	1.5	9	122.6	2.0	12	122.6	1	12
69	SSV2008058	56.7	2	7	62.85	2	8	95.7	2.0	10	95.7	1	10
70	SSV2008059	64.15	0	7	84.55	2	10	93.5	2.0	12	93.5	1.5	12
71	SSV2008061	67.75	0	7	88.15	1	10	98.25	0.5	12	98.25	1	12
72	SSV2008063	65.3	0	7	88.15	1.5	7	93.75	1.5	10	93.75	1	10
73	SSV2008064	59.35	3	6.5	68.0	0.5	7	87.45	1.0	11	87.45	1	11
74	**SSV2008066#**	47.45	0	6.5	78.9	1	11	91.55	1.0	12	91.55	1	12
75	SSV2008067	49.4	2	7	72.55	0.5	9	90.25	0.5	12	90.25	0.5	12
76	**SSV2008070#**	61.75	1	6.5	76.55	1.5	9	98.5	1.0	11.5	98.5	0	11.5
77	SSV2008072	80.15	2	7.5	71.1	1	8	78.25	1.0	11	78.25	1	11
78	SSV2008074	76.75	1	8	83.55	1.5	8	98.9	1.5	11	98.9	0.5	11
79	**SSV2008075#**	75.8	1	7.5	65.4	1	9	90.65	0.5	11	90.65	0	11
80	SSV2008076	72.2	2.5	7	66.25	1.5	8	81.65	0.5	11	81.65	0	11
81	SSV2008078	66.2	0.5	7	63.0	1.5	9	82.65	0.5	11.5	82.65	0.5	11.5
82	SSV2008079	57.5	2	7	63.85	3.5	10	79.25	2.0	12	79.25	1	12
83	**SSV2008080#**	52.45	2.5	7	56.6	2	9	81.65	2.0	12	81.65	1	12
84	**SSV2008082#**	67.15	0	7	67.1	2	7	87.2	1.5	10	87.2	1.5	10
85	SSV2008084	62.1	2	7	73.05	1.5	8	87.65	1.5	11	87.65	1	11
86	SSV2008085	77.2	0	7	78.25	2	9	89.5	1.5	11	89.5	1.5	11
87	SSV2008086	70.6	1	7	53.9	1	9	81.7	1.0	11.5	81.7	1.5	11
88	SSV2008087	61.25	2.5	7	66.15	1.5	8	81.2	1.0	12	81.2	1	11
89	**SSV2008088#**	59.00	1.5	7	82.15	1.5	7	99.6	1.5	12	99.6	1.5	11
90	**SSV2008089#**	49.75	3.5	7	68.15	2	8	79.2	1.0	10	79.2	2	10.5
91	SSV2008090	55.05	3	6.5	73.9	1	9	89.6	1.0	11	89.65	1	12
92	SSV2008094	51.3	3.5	7	75.55	2.5	9	88.75	2.5	11	88.75	1.5	12
93	SSV2008096	49.1	3	6.5	75.55	1	8	88.55	1.5	11	88.55	1.5	12
94	SSV2008100	57.55	2.5	7	76.3	1.5	12	89.75	1.5	11	91.75	1	12
95	SSV2008101	52.6	0.5	6.5	71.2	1	10	91.05	1.5	11	91.05	1.5	12
96	SSV2008107	48.2	0	6.5	64.4	1.5	10	80.7	1.0	10.5	80.7	1	12
97	SSV2008110	57.7	1	6.5	88.25	1	7	95.15	0.0	12	95.15	0	11

Table 1 Contd.

98	SSV2008111	64.8	0	6	68.35	2	10	87.25	2.0	12	87.25	1.5	11.5
99	SSV2008112	65.2	0	6.5	84.25	1	11	97.7	0.0	12	97.7	0	11.5
100	**SSV2008113#**	55.2	0.5	6	85.65	2	8	101.15	2.0	12	101.15	1.5	11
101	SSV2008116	83.2	0.5	7.5	71.6	1	9	98.1	1.5	12	98.1	1.5	12
102	SSV2008117	62.65	1.5	6	76.65	0.5	8	86.7	1.0	12	86.7	1	11
103	SSV2008125	71.65	2	6.5	77.6	0	9	86.1	0.5	11	86.6	0.5	11
104	**SSV2008181#**	60.2	4	7	87.55	1	9	91.00	0.0	10	91	0	10
Mean		65.46	1.212	6.889	74.33	1.577	9.308	86.82	1.428	11.471	90.03	0.966	11.471
S.E.		0.696	0.0952	0.0068	0.1605	0.136	0.408	0.553	0.1156	0.0272	2.234	0.238	0.0272
CV(%)		1.1	7.9	0.1	0.2	8.6	0.4	0.6	8.1	0.2	2.5	24.6	0.2
Mean squares		1211.2*	3.23*	41.23*	5037.32*	2.91*	89.23*	7690.01*	3.12*	143.23*	7901.89*	0.987*	134.7*
LSD (0.05)		5.029	1.489	0.8847	2.7035	1.7596	0.9737	4.029	1.7922	0.8039	13.761	1.3052	0.8039

Plht=plant height; Tlno.=number of tillers; Lfno.- number of leaves; WAI= week after inoculation. *indicates significant different at 5% probability. # indicates infected genotype.

Table 2. Mean number of days to 50% flowering, number of days to 50% heading and grain yield of sorghum genotypes screened for loose smut.

No.	Genotype	Day to 50% flowering	Day to 50 % heading	Grain yield (kg/ha)
1	**SSV2006002#**	67.0	98	117.9
2	SSV2006006	70.0	98	395.5
3	SSV2006007	72.0	92	368.7
4	SSV2006011	75.5	102	291.4
5	**SSV2006013#**	78.0	100	182.1
6	SSV2006014	76.0	97	259.5
7	SSV2006015	79.0	104	401.0
8	SSV2006016	90.0	120	352.6
9	SSV2006017	87.5	112	339.0
10	SSV2006018	87.0	113	455.5
11	SSV2006021	100.0	140	265.6
12	**SSV2006024#**	89.0	111	476.0
13	**SSV2006026#**	71.5	100	236.6
14	SSV2006027	84.0	120	311.5
15	SSV2006029	77.0	110	467.4
16	**SSV2006030#**	80.0	109	280.6
17	**SSV2006031#**	79.0	98	227.1
18	**SSV2006033#**	81.0	95	397.0
19	SSV2006035	72.5	98	372.0
20	SSV2006036	90.0	102	278.9
21	SSV2006039	85.0	108	397.0
22	SSV2006041	78.0	105	421.5
23	SSV2006045	82.0	114	338.9
24	SSV2006047	81.0	108	386.9
25	SSV2008001	69.0	97	398.0
26	SSV2008002	68.0	99	172.5
27	SSV2008004	66.0	98	139.0
28	SSV2008005	64.0	97	408.9
29	**SSV2008006#**	78.5	95	112.7
30	SSV2008007	57.0	100	244.2

Table 2 Contd.

31	SSV2008008	72.5	104	451.9
32	SSV2008009	84.0	100	229.6
33	**SSV2008010#**	76.0	97	237.0
34	SSV2008012	83.0	104	400.4
35	SSV2008013	100.0	120	458.6
36	SSV2008017	91.0	112	420.5
37	SSV2008018	86.0	113	400.0
38	SSV2008019	99.5	140	424.1
39	SSV2008021	91.0	111	590.0
40	SSV2008022	67.0	100	509.1
41	SSV2008023	93.5	120	359.5
42	SSV2008025	87.0	110	139.8
43	SSV2008026	89.0	109	266.6
44	SSV2008028	67.0	98	332.5
45	SSV2008029	65.0	95	186.0
46	**SSV2008030#**	70.0	98	284.2
47	SSV2008031	80.0	102	401.6
48	SSV2008032	68.0	108	333.6
49	**SSV2008033#**	59.0	87	231.6
50	**SSV2008034#**	65.0	99	499.6
51	SSV2008035	65.0	98	183.5
52	SSV2008036	69.0	87.5	288.5
53	**SSV2008039#**	72.0	95	431.0
54	SSV2008040	74.0	98	348.6
55	SSV2008041	76.0	99	164.6
56	SSV2008042	78.0	108	399.5
57	**SSV2008044#**	73.0	100	582.0
58	SSV2008046	80.0	119	281.6
59	SSV2008047	80.0	108	300.6
60	**SSV2008048#**	80.0	113.5	225.5
61	SSV2008049	90.0	120	414.0
62	**SSV2008051#**	81.0	112	224.1
63	SSV2008052	83.5	113	271.5
64	SSV2008053	97.0	140	459.0
65	**SSV2008054#**	78.0	110	378.1
66	SSV2008055	69.0	100	434.9
67	SSV2008056	80.0	120	496.5
68	SSV2008057	89.0	110	487.0
69	SSV2008058	78.0	109	401.4
70	SSV2008059	69.0	98	526.5
71	SSV2008061	70.0	103.5	486.5
72	SSV2008063	78.0	98	388.0
73	SSV2008064	78.5	102	515.5
74	**SSV2008066#**	78.0	108	481.0
75	SSV2008067	69.0	87	442.0
76	**SSV2008070#**	78.0	99	430.5
77	SSV2008072	70.0	98	222.9
78	SSV2008074	78.0	97	397.0
79	**SSV2008075#**	69.0	95	485.6
80	SSV2008076	78.0	98	386.4

Table 2 Contd.

81	SSV2008078	70.0	99	330.5
82	SSV2008079	79.0	103	489.6
83	**SSV2008080#**	73.0	100	179.7
84	**SSV2008082#**	78.0	109	197.6
85	SSV2008084	84.0	110	479.0
86	SSV2008085	83.0	102	301.2
87	SSV2008086	78.0	109	301.1
88	SSV2008087	71.5	97	540.0
89	**SSV2008088#**	78.0	99	356.1
90	**SSV2008089#**	69.0	100	211.1
91	SSV2008090	90.0	120	505.5
92	SSV2008094	78.0	114	457.6
93	SSV2008096	80.0	112	277.1
94	SSV2008100	88.0	116.5	398.0
95	SSV2008101	89.0	114	393.0
96	SSV2008107	87.0	112	496.5
97	SSV2008110	79.0	111	343.5
89	SSV2008111	80.0	110	418.0
99	SSV2008112	80.0	102	121.5
100	**SSV2008113#**	82.5	107	310.0
101	SSV2008116	80.0	97	424.0
102	SSV2008117	68.0	99	339.5
103	SSV2008125	72.5	110	323.0
104	**SSV2008181#**	85.0	120	250.1
	Mean	78.25	105.61	352.7
	SE	0.347	0.408	34.34
	Mean squares	7234.12*	1823.02*	11262.9*
	LSD (0.05)	7.4	5.557	218.59
	CV(%)	0.4	0.4	9.7

*indicates significant different at 5% probability. # indicates infected genotype.

differ (P>0.05) among sorghum genotypes screened for loose smut with mean of 78 days indicating that most of the sorghum genotypes screened for loose smut flowered early without much differences among them and that infection due to loose smut had no significant effect on the days to flowering. However, day to 50% heading significantly varied among sorghum genotypes indicating that the varieties produced heads at significantly different periods with a mean of 105 days after sowing (Table 2).

Similarly, the grain yield (kg/ha) was generally low and varied but was significantly different among sorghum genotypes. Grain yield ranged from 102.1 kg/ha in some diseased sorghum genotypes such as SSVV2006002, SSV2006013, SSV2006024, SSV2006026, SSV2006030, SSV2006031, SSV2006033, SSV2008006, SSV2008010, SSV2008030, SSV2008033, SSV2008034, SSV2008039, SSV2008044, SSV2008048, SSV2008051, SSV2008054, SSV2008066, SSV2008070, SSV2008075, SSV2008080, SSV2008082, SSV2008088, SSV2008089, SSV2008113 and SSV2008181 to about 600 kg/ha in some uninfected genotype such as SSV2008087 (540.0 kg/ha), SSV2008044 (582.0 kg/ha), SSV2008021 (590.0 kg/ha) and many more (Table 2). In this trial, most of the susceptible genotypes matured earlier than the resistant or immune genotypes.

Sorghum genotypes screened for their reactions to loose smuts showed significant variations in plant height, number of leaves, number of tillers, days to 50% heading, as well as grain yield. Diseased plants consistently showed reduction in plant height, high number of tillers with differences between genotypes being significant. The variations in the growth and yield parameters of the diseased plants could be due to differences in the reactions of the different genotypes to smut pathogens (Kutama, 2012) and environmental factors such as soil/edaphic factors, rainfall etc (Kutama et al., 2011c). Tarr, (1962) had earlier demonstrated significant reduction in plant height and increased tillering in loose smutted plants with variations among cultivars. Similarly, Williams et al. (1978) showed that plants infected with

loose kernel smut invariably flower prematurely up to two weeks earlier than non-infected plants and often showed increased tillering as observed in the present study. Matheussen et al. (1991) noted that some aspects of head smut in sorghum suggest that plant hormones are involved in the disease. Frederiksen (1977) had noted that head smut causes a substantial reduction in plant height and this effect was documented by Naidoo et al. (1991). The reduction in height and other growth and yield parameters in most diseased sorghum genotypes in loose smut infected plants observed in present study shows that plant height and other parameters such as number of tillers, grain yield, days to flowering and heading as well as grain yield are important components of the smut diseases. Matheussenet al. (1991) attributed these reductions in growth and yield due to Gibbrelic acid ($GA_{3)}$ production in the diseased plant. Phinney and Spray (1982) reported both plant height and sexual development are altered in some head smut-infected maize mutants with blocks in their GA3 biosynthetic pathway. According to these authors, when symptoms are less severe (partial infection), the production of GAs by the panicle is less affected and dwarfing is not severe. This hypothesis does not exclude the possibility that GAs is also made in the nodes and internodes and thereby influence elongation. Similarly, the great variations in growth parameters of the different varieties might be due to their origin and adaptation. While most genotypes grown in the Sahel and Sudan savanna AEZs tend to mature within 3-5 months, cultivars grown in the Guinea savanna AEZs mature in 4 -7 months period. Another reason for the difference in growth and yield parameters was probably due to late sowing. Early planting has been shown to increase both growth and yield parameters in all crops (David and Adam, 1998) as such late planting may results into reduced growth and yield characters as found in the present study.

CONCLUSION

The results of the present study have shown that the growth and yield components of all the infected sorghum genotype screened for loose smut were significantly reduced compared to the un-infected or healthy ones. This connotes that plant screened for loose smut are usually stunted and produced low yield. However, there was no any significant effect of disease on the days to 50% flowering and 50% heading indicating that infection did not alter the time of flowering in sorghum.

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