Distribution, Incidence and Severity of Covered Kernel Smut and Reaction of Some Sorghum Genotypes to the Disease in Northwest Ethiopia

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Abstract

The study was made to survey the distribution, incidence and severity of covered kernel smut on sorghum fields in Gondar Zuria and Alefa Takussa districts of North Gondar Zone, Amhara Region in northwestern Ethiopia. In addition, the study aimed to assess the reaction of sorghum genotypes to the disease. Sampling for the field survey was made by randomly selecting 11 peasant associations (PAs) from each district and 10 farmers' fields from each PA. In Gondar Zuria district, the disease was highly distributed throughout the surveyed areas. The disease incidence among the PAs ranged from 10.5% at Tach Teda to 29.2% at Sarwuha. There was highest disease severity at Bahri Ginb (54.66%) and lowest at Sarwuha (26.57%). In Alefa Takussa district, the disease was distributed through out the area with mean incidence of 12.25%. The highest incidence was at Goy (17.43%) and the lowest at Chima Lembez (5.5%). The highest disease severity was encountered at Ayibiga (48.35%) and the lowest at Chima Lembez (31.05%). Nine local cultivars were encountered during the survey. Four of the cultivars — Aysham Demozie, Bulie, Kuche/Tabir, and Zengada/Dinkosh — were distributed in the surveyed districts. Cultivars Tetron and Zengada/Dinkosh scored lower mean incidence of 3 and 9% and severity of 23 and 31%, respectively. In addition, the reaction of 12 improved and local sorghum genotypes to the disease was studied under artificial inoculation at Babile Research Sub-center, eastern Ethiopia, in 2000/2001. The local cultivar Tetron was resistant and Zengada/Dinkosh moderately resistant. Whereas, the other genotypes were susceptible. Moreover, the cultivars differed in yield loss due to the disease. There was highest yield loss (40%) on 97 MW 6129(NVT-11 4), while there was no loss on Tetron.

Key words: diseases, covered kernel smut, sorghum, genotypes, Ethiopia

Introduction

Ethiopia is the second largest sorghum [*Sorghum bicolor* (L) Moench.] producing country in eastern and southern Africa next to Sudan. The crop is grown in the highlands and intermediate elevation areas, where rainfall is adequate and reliable, and in the dry, hot lowlands of the country (IAR 1986, Berhane 1979). Northwestern Ethiopia is one of the major sorghum producing areas in the country. The productivity of sorghum in the country is impeded by various production constraints, including diseases. Among diseases, covered kernel smut, which is caused by the fungus *Sporisorium sorghi* Link in Willd [syn. *Sphacelotheca sorghi* (Link) G.P. Clinton], is the most important one (HCOA 1971, Mengistu 1982, Temam 1990) and the extent of combined loss of grain sorghum due to smuts may reach up to 30% (HCOA 1971). Covered kernel smut has been endemic in many sorghum fields from year to year, and it is has widely distributed in all sorghum growing areas of the country (Mengistu 1982). In northwest Ethiopia, covered kernel smut has been reported to be a limiting factor in sorghum production, and its intensity is currently increasing (BPHC

Table 1 Incidence and severity of covered kernel smut in 11 peasant associations of Gondar Zuria Woreda, North Gondar Zone, 2000/2001

Location (peasant association)	Altitude range(m)	Variety	Incidence (%)	Mean incidence (%)	Severity (%)	Mean severity (%)
Bahri Ginib	1850-1950	Zengada	12.5	15.3	**63.7****	**54.7****
		Bulie	16.0		43.5	
		Amedo	17.3		56.8	
Chinchaye	1800-1900	Zengada	11.5	13.3	42.8	42.4
		Bulie	16.5		38.5	
		Amedo	7.0		30.3	
		Aysham-Demozie	18.0		58.0	
Lay teda	1890-1950	Zengada	9.0	19.2	31.0	51.7
		Bulie	28.0		60.0	
		Amedo	22.0		76.8	
		Aysham-Demozie	19.0		56.4	
		Kuche /Tabir	18.0		34.3	
Lemba	1800-1900	Zengada	29.0	23.4	52.8	49.0
		Bulie	18.5		60.8	
		Amedo	20.0		39.5	
		Aysham Demozie	26.0		42.8	
Manterino	1850-1950	Zengada	10.0	12.3	36.7	33.8
		Bulie	13.0		28.3	
		Amedo	14.0		36.3	
Miniziro Teklehaimanot	1850-1950	Zengada	15.0	15.5	52.0	43.1
		Bulie	19.7		50.5	
		Amedo	13.5		40.0	
		Kuche /Tabir	14.0		30.0	
Mitirha Abawarka	1750-1790	Zengada	10.0	16.6	45.2	53.0
		Bulie	24.0		48.5	
		Amedo	16.0		48.6	
		Aysham Demozie	16.0		64.8	
		Kuche /Tabir	27.0		58.0	
Sarwuha	1800-1900	Zengada	**6.5***	**10.5***	**24.1***	**26.6***
		Bulie	11.0		35.3	
		Kuche /Tabir	14.0		20.3	
Seguaj Tsion	1850-1950	Zengada	15.5	16.1	39.7	41.7
		Bulie	15.6		39.3	
		Amedo	17.3		46.2	
Tach Teda	1890-1950	Zengada	19.0	**29.2****	46.8	53.3
		Bulie	25.5		62.2	
		Amedo	**42.0****		46.7	
		Aysham Demozie	40.5		53.2	
		Kuche /Tabir	19.0		58.8	
Tikara	1790-1850	Zengada	11.0	17.0	39.2	40.3
		Kuche /Tabir	23.0		41.4	
Average			**17.13***		**44.5***	

* = Lowest disease incidence and/or severity
** = highest disease incidence and/or severity

Another local cultivar, Zengada showed moderate resistance and scored the second lowest disease incidence (6%) and severity (15%). All of the other genotypes were susceptible. The disease incidence on the cultivars ranged from 21 to 47% and disease severity from 40 to 50%. In general, only one cultivar was highly resistant, one resistant, and all others moderately resistant (Table 3).

Yield losses

Evaluation of 12 cultivars tested for yield losses due to covered kernel smut under artificial infection in the field showed variation. There were significant differences

for yield of healthy and diseased heads. The degree of yield loss variation depended on the resistance level of genotypes and disease severity. The highest yield loss (44%) was recorded on genotype 97 MW G129 (NVT.II-4), while there was no loss for the local genotype Tetron (Table 4).

Table 2. Incidence and severity of covered kernel smut in 11 peasant associations of Alefa Takussa Woreda, North Gondar Zone, 2000/2001

Location (peasant association)	Altitude range (m)	Variety	Incidence (%)	Mean Incience (%)	Severity (%)	Mean severity (%)
Amchahwa	1900-2050	Aysham-Demozie	21.5	16.2	40.0	36.4
		Bulie	10.0		38.0	
		Gumbrit	11.0		36.9	
		Kuche/Tabir	**27.5***		40.0	
		Zengada/saha	11.0		27.0	
Atsede-Mariam	2000-2200	Aysham-Demozie (Tembelta)	16.3	12.8	45.5	36.4
		Bulie	13.0		17.0	
		Gumbrit	16.5		**15.5***	
		Kuche	11.0		68.9	
		Zengada/saha	7.0		35.3	
Ayibiga	2000-2050	Bulie	20.0	11.5	56.5	**48.4****
		Gumbrit	12.0		58.9	
		Jihola	8.0		53.0	
		Zengada/Dinkosh	6.0		25.0	
Chemera-Bambarwuha	1800-1880	Bulie	12.0	11.0	42.99	35.6
		Gumbrit	15.0		40.00	
		Zengada/Saha	6.0		21.90	
Chima-Lembez	1750-1850	Jihola	11.0	**7.50***	37.8	**31.1***
		Tetron	4.0		24.3	
Delgi-Mekonita	1800-1880	Bulie	10.5	7.8	33.9	33.9
		Gumbrit	13.0		39.1	
		Zengada/Dinkosh	1.5		23.3	
		Zengada/Saha	6.0		39.1	
Dikularva-Kurabas	1900-2050	Bulie	14.5	11.8	38.4	
		Gumbrit	8.0		40.0	38.1
		Jihola	9.3		39.1	
		Kuche	18.3		46.1	
		Zengada/saha	9.0		26.9	
Endona-chiba	1900-2050	Bulie	15.0	16.00	32.7	38.3
		Gumbrit	15.0		25.00	
		Jihola	21.0		47.80	
		Zengada/saha	13.0		47.70	
Goy	1900-2050	Bulie	15.0	**17.4***	30.00	33.8
		Gumbrit	14.7		45.10	
		Kuche	27.0		40.0	
		Zengada/saha	13.0		20.00	
Kezen-Tara	2000-2200	Bulie	14.0	12.10	35.00	47.5
		Gumbrit	16.5		35.00	
		Kuche	14.0		49.00	
		Zengada/Dinkosh	7.0		45.90	
		Zengada/saha	9.0		**72.80***	
Sebi-Serako	1700-1900	Aysham-Demozie (Tembelta)	17.5	10.8	48.00	42.7
		Bulie	14.0		46.67	
		Gumbrit	10.0		48.00	
		Tetron	**2.0***		21.00	
		Zengada/saha	10.0		50.00	
Average			**12.25***		**38.38***	

* = lowest disease incidence and/or severity
** = highest disease incidence and/or severity

Table 3. Reactions of twelve sorghum genotypes to covered kernel smut under artificial inoculation condition in the field, 2001

Variety	Incidence (%)	Severity (%)	Reaction**
Baji	40.353	45.707	MS
Birmash	35.767	40.117	MS
Bulie	21.190	14.463	MR
Gambella 1107	43.210	40.570	MS
IS 9302	33.730	51.817	S
IS 9323	30.523	52.827	S
Kuche	20.953	45.193	MS
Tetron	**0.000**	**0.000**	HR
Zengada	5.657	15.457	MR
76T #123	37.057	40.263	MS
95 MW 6129 (NVT-I-5)	31.307	**53.270**	S
97 MW 6129 (NVT-11-4)	**46.730**	41.220	MS
Mean	28.873	39.075	
CV%	19.43%	17.06%	
LSD (5%)	9.50	11.29	

* *Severity on the 1-5 disease scoring scale, where 1 stands for no damage/highly resistant, 2 for 1-10% damage/resistant, 3 for 11-25% damage/moderately resistant, 4 for 26-50% damage/moderately susceptible, and 5 for more than 50% head damage/susceptible

** S, susceptible; MS, moderately susceptible; MR, moderately resistant

Table 4. Effect of covered kernel smut on yield of fifteen healthy and diseased heads of different sorghum genotypes, 2001

Variety	Yield (kg/ha)		Yield loss (%)
	Healthy heads	Diseased heads	
Baji	1618	985	39.00
Birmash	1884	1248	34.00
Bulie	1724	1379	20.00
Gambella 1107	1678	1006	40.00
Is 9302	1511	1027	32.00
Is9323	1582	1127	29.00
Kuche	1173	942	20.00
Tetron	1120	1120	0.00
Zengada	960	914	5.00
76T #123	978	647	34.00
95MW G129 (NVT-I-5)	2293	1603	30.00
97 MW G129 (NVT-11-4)	1902	1067	44.00
Mean	1535	1117	27.00
CV %	10.82	10.86 %	
LSD (5%)	158	113	

Table 5. Effect of covered kernel smut on seedling emergence and thousand seed weight

Variety	Seedling emergence* (%)	1000 seed weight** (g)
Baji	90.0	51.2
Birmash	84.0	52.2
Bulie	85.0	52.6
Gambella 1107	68.0	50.0
Is 9302	80.0	49.0
Is9323	74.0	52.5
Kuche	78.0	53.0
Tetron	72.0	54.0
Zengada	76.0	53.0
76T #123	87.0	51.0
95MW G129 (NVT-I-5)	86.0	52.2
97 MW G129 (NVT-11-4)	70.	50.0
Mean	79.17	51.70
CV%	5.4%	5.32
LSD (5%)	7.234%	NS

*Seedling emergence of artificially inoculated seeds
**1000 Seed weight of partially diseased heads

Table 6. Estimates of correlation coefficients

	Incidence (%)	Severity (%)
Yield loss (%)	0.99**	0.76**
Thousand seed weight	0.82**	-0.58*
Germination (%)	0.14	0.36

** = significant at p < 0.01%
* = significant at p < 0.05%

The study findings showed significant differences among the genotypes for percentage seed emergence. Out of the 12 sorghum genotypes tested, there was high emergence percentage on Baji (90%) and low on Gambella 1107 (68%). The effect of the disease on thousand seed weight was not significant (Table 5).

Correlations with disease intensity

Analysis of the study on estimates of correlation coefficients of percentage disease incidence and severity with percentage yield loss, thousand seed weight and germination showed different levels of correlation. The incidence and severity of the disease in the sorghum fields surveyed were significantly and positively correlated with yield loss (Table 6). Whereas, with thousand seed weight, the incidence of the disease was significantly and positively correlated, while the severity of the disease was significantly and negatively correlated (Table 6). In addition, plant emergence positively correlated with the incidence and severity of the disease; but it was not significant.

The results indicated that yield loss was mainly due to high incidence and severity of the disease. The results of coefficient of determination (r^2) also indicated that the incidence accounted for high yield loss of up to 99.8%. Whereas, disease severity accounted only for yield loss of 58.36%.

Discussion

The findings of the present study showed that covered kernel smut was widely distributed in almost all the surveyed areas, covering different altitudes that ranged from 1750 to 2200 m. Therefore, the results indicated that altitude and climate did not seem to be factors limiting the distribution of covered kernel smut in the surveyed areas. Similar results were reported by other studies (Mengistu 1982, Temam 1990).

In addition, the results of the present study were similar with findings reported from some other African countries on disease incidence in peasant farms. For instance, Marley and Aba (1999) reported that covered kernel smut was predominant in farmers fields of major sorghum growing areas of Sudanian Zone, the Nigerian Savannah regions and Northern Guinea Zone with incidence of 24.8 and 29.5%, respectively.

In all the surveyed peasant farms, only landraces of sorghum were encountered with low to high levels of covered kernel smut infection. The results indicated that farmers in the surveyed areas grew only local landraces of sorghum. The disease was found to be prevalent in all the cultivars grown except Tetron. In general, the survey findings showed that covered kernel smut caused by *Sporisorium sorghi* was an important disease of sorghum in the surveyed areas. Its wide distribution in the Amhara National Regional State, particularly northwestern part, calls for an urgent intervention to control the disease.

According to the results of the present study, two of the landraces growing in the area, Tetron and Zengada, performed better against covered kernel smut. The two landraces could therefore, be used in breeding programs for resistance to the disease. In addition, more field surveys on the status of covered kernel smut covering larger areas must be carried out. There should also be concerted effort in the collection and evaluation of more sorghum landraces for reaction to the disease. Moreover, further yield loss assessment studies on sorghum genotypes due to covered kernel smut infection need to be carried out both under natural and artificial conditions.

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