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Full Length Research Paper

Evaluation of three potential botanicals against sorghum covered smut (*Sphacelotheca sorghi*) at Bako, Western Oromia Ethiopia

Aschalew Sisay*, Fekede Abebe and Kedir Wako

Bako Agricultural Research Center, P.O. Box 03, Bako, Ethiopia.

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An experiment was conducted at Bako Agricultural Research Center for two cropping seasons (2007 and 2008) with the objective of determining the effectiveness of some locally available plant species (botanicals) in controlling covered smut (*Sphacelotheca sorghi*) of sorghum. The botanicals tested were *Calpurnia aurea*, *Maesa lanceolata* and *Vernonia amygdalina*. These botanicals were compared with thiram (fungicide) as standard check and untreated check. Smut inoculated sorghum seed of variety Birrmash was treated with the filtrate of the crude aqueous extracts of the botanicals at the rate of 20 ml extract diluted with the same amount of water; 200 g of the seeds were treated and then air dried before planting. The first year result showed that *M. lanceolata* significantly (P≤0.05) controlled the disease more than the untreated check. Infection percentage and number of plants infected by covered smut were significantly (P≤0.05) reduced by thiram and *M. lanceolata* treatments. Statistically significant (P≤0.05) difference in yield was observed among the treatments. The second year result showed that, thiram and *M. lanceolata* significantly (P≤0.05) controlled the disease although the botanical was a bite lower to the fungicide in controlling the disease. The over all result indicated that the use of *M. lanceolata* leaf extract, as a seed treatment against sorghum smut is potentially useful for resource poor farmers of Bako and similar agro-ecological areas of Sub Saharan Africa. The two botanicals *Vernonia amygdalina* and *Calpurnia aurea* did not control the disease effectively.

Key words: Covered smut, sorghum, botanicals, leaf extract, bio-fungicide.

INTRODUCTION

Sorghum (*Sorghum vulgare*) is one of the major food crops in Ethiopia. It is largely grown from the lowlands (<1600 m.a.s.l) to the intermediate (<1900 m.a.s.l) areas having annual rainfall of <600 and >1000 mm respectively. It also shows good potential in the highlands (>1900 m.a.s.l with 800 mm rain fall) of Eastern Ethiopia (Brehane, 1981). Most small-scale farmers traditionally grow sorghum. The cultivation of this crop is challenged by numerous production constraints such as diseases, insect pests and others. Among them, disease is one of the major problems that hinder its production.

Smut is a widespread panicle disease that causes serious yield reduction especially in small-scale sorghum producer. Annual yield losses due to smut in Africa reaches 10% with localized losses of 60% or more (Kranz et al., 1977). The incidence of covered kernel smut varies from place to place but in Ethiopia, it was estimated to be about 50% (Mengestu, 1982; Teclemariam, 1985). Covered smut caused by *Sphacelotheca sorghi* Clinton is more important than the other two smut types (loose and head). It occurs widely in sorghum growing different agro-ecological zones and causes sever yield losses when conditions are favorable for infection and proper control measure are not adopted (Yilma and Brhane, 1979; Doggett, 1988; Singh, 1998). Sphacelotheca over all, causes greater grain losses than other diseases (Tares, 1962). The first clear symptoms are smutted heads. In infected heads, the individual grains are replaced by sori, and sometimes nearly all the grains are affected but frequently may be partially smutted (Tarr, 1962). Sori are produced in the ovary between glumes. Spore germination varies morphologically under an optimum

*Corresponding author. E-mail: aschsisay638@yahoo.com.

Table 1. Name of botanicals used.

Number	Local name	Scientific name	Parts used
1	Cheeka (Orm)	*Calpurnia aurea*	Fresh leaf
2	Abbayyii (Orm); Kelewa (Amh)	*Maesa lanceolata*	Fresh leaf
3	Eebicha (Oro); Grawa	Vernonia amygdalina	Fresh leaf
4	Thiram (Chem)	-	-
5	Untreated check	-	-

Amh- Amharic; Orm- Afaan oromoo; Chem- chemical.

temperature from 20 to 23°C and spores retain viability for four years when kept in dry condition (Kranz et al., 1977; Paul, 1980). During threshing, spores get lodged on the surface of healthy sorghum seeds and are carried over to contaminate seeds. The disease is extremely seed borne and seedling infection occurs at the time of germination and emergence of seedlings (Agrios, 1997; Sharma, 1998; Singh, 1998). Survey report and various field observations carried around Bako, showed that smuts are important disease of sorghum and their incidence and severity are high in the western part of the country (Fekede and Kedir, 1998). Due to high cost and unavailability, usage of fungicides under small-scale farmers is very rare. Farmers over the years practiced the use of locally available botanical plants as bio-pesticide against different types of diseases on different crops (Gaby, 1982). Some farmers in pocket localities of western Ethiopia were reported to use some tree species to control sorghum smut (Personal communication). About 2000 species of plants are known to have pesticidal effects on crop pests (Gaby, 1982; Coen et al., 1992). Therefore, this work was done to evaluate the effectiveness of leaf extract of some indigenous plants/ trees such as *Calpurnia aurea*, *Vernonia amygdalina* and *Maesa lanceolata* in controlling smut in sorghum. These plant species grow 5 to 10 m tall and are found in intermediate to highlands of degraded bush land, wasteland and at the edges of a forest. Some of the species are used in local medicine (Reinhard and Admassu, 1994). This type of crop protection system avoids or reduces the use of synthetic chemicals, thereby making farmers less dependant on external inputs and create safe environment. The objective of this experiment was to determine the effectiveness of some locally available plant materials to control covered smut on sorghum with the ultimate goal of developing effective, environmentally safe, culturally accepted and sustainable disease management practice.

MATERIALS AND METHODS

Geographically, Bako Agricultural Research Center lies between 9° 6' N latitude and 37° 09' E longitude at an altitude of 1650 msl. The mean annual rainfall is 1217 mm and its pattern is uni-modal. The rainy period covers April to October. It has a warm humid climate with mean minimum, mean maximum and average temperatures of 14, 28 and 21°C respectively. 60% of the soil is reddish brown Nitosols with pH of 5 to 5.31, which is slightly acidic. The experiment was conducted at Bako Agricultural Research Center for two cropping seasons (2007 and 2008). Three different species of botanicals (Table 1) were evaluated together with thriam EC and untreated check to see the efficacy of the botanicals on covered smut (Sphacelotheca sorghi) and loose smut of sorghum.

Plant extraction

Fresh leaves of the above mentioned plants were collected and ground into pieces to form paste by adding little water. When the leaves were completely shredded into fibers, the paste was squeezed and filtered out through cheesecloth. The inoculated seeds were treated with the plant extract solution at the rate of 20 ml fresh leaf extract per 200 g of seed as suggested by different authors (Loving and Wildt-Persson, 1998; Karade and Rahuri, 1999). The seeds were then exposed to open air and dried under shade before planting. Germination test was carried out in the laboratory to test the effect of the treatment on germination of the seeds.

Experimental design

A randomized complete block design in three replications with a plot size of 5 m × 3.75 m (18.75 m^2) was used. The recommended nitrogen (73 kg/ha) and phosphorus (69 kg/ha) were used for the experiment. All cultural practices such as weeding, thinning, cultivation, harvesting and threshing were done manually. Plant population was taken both after thinning and before harvesting. Other disease incidence (percent) and severity (1 to 9 scoring scale) were taken at flowering and at the dough stage of the crop. Date of first smut appearance was recorded; smutted plants were counted and infection percentage calculated.

RESULTS

The germination test done in the laboratory indicated that, the treatment of seeds with botanicals had no effect on the germination of sorghum seeds (Table 2). Among the botanicals tested, *M. lanceolata* controlled the disease equally as thiram (Tables 2 and 3). The grain yield for sorghum treated with *M. lanceolata* was significantly ($P < 0.05$) higher compared to that of cheeka and the untreated check (Table 2). In 2007, the highest yield was recoded for thiram and *M. lanceolata* treated sorghum seed. The grain yield per hectare for *M. lanceolata* was significant at $P< 0.05$ for both years

Table 2. Mean percentage of smutted head, number of harvested heads and yield of sorghum 2007.

Number	Treatment	Mean covered smut		Harvested head number	Germination (%)	Yield (kg/ha)
		Count number	Infection (%)			
1	*Calpurnia aurea*	18.67[b]	3.81[b]	133.0	61.33[a]	2933.73[bc]
2	*Maesa lanceolata*	0.00[d]	0.71[d]	141.0	66.67[a]	3399.09[a]
3	*Vernonia amngadila*	11.00[c]	2.77[c]	140.0	69.33[a]	3194.87[abc]
4	Thiram	0.00[d]	0.85[d]	133.3	68.00[a]	3301.24[ab]
5	Untreated check	27.33[a]	4.37[a]	144.7	66.67[a]	2773.65[c]
	SE±	3.404	0.36	12.794	11.761	445.774
	CV (%)	36.36	17.61	11.32	15.34	17.50

Values in the same column with the same letter (s) are not significant (DMRT P<0.05).

Table 3. Mean percentage of smutted head, number of harvested heads and yield of sorghum2008.

Number	Treatment	Mean covered smut		Harvested head number	Yield (kg/ha)
		Count number	Infection (%)		
1	*Calpurnia aurea*	17.00[a]	3.30[a]	164.00	3354.59[c]
2	*Maesa lanceolata*	1.33[d]	1.08[c]	167.67	3957.62[ab]
3	*Vernonia amngadila*	11.00[c]	2.70[b]	160.33	3472.32[bc]
4	Thiram	0.33[d]	0.82[d]	163.67	4049.99[a]
5	Untreated check	15.67[b]	3.20[a]	160.33	3383.52[c]
	SE±	1.287	0.219	6.337	316.706
	CV (%)	17.38	11.70	4.76	7.52

Values in the same column with the same letter (s) are not significant (DMRT P<0.05).

(Tables 2 and 3). However, the yield of *M. lanceolata* was a bite lower than thiram in the second year (Table 3). The highest mean numbers of infection were observed in sorghum treated with *C. aurea* and the untreated check (Tables 2, 3 and Figures 1 and 2).

DISCUSSION

High smut infection is favored by relatively low soil temperature, high soil moisture, soil pH and planting depth, etc. In this experiment, the lower infection percentage observed was attributed to the weather conditions during the seasons (Figures 3 and 4). Tarr (1962) reported that high percentage of covered smut infection at field level was difficult due to the environmental condition such as soil temperature, moisture, soil pH, planting depth, fertilizer and emergency rate of host. For higher covered smut infection, optimum temperature of 25°C and half moistened soil during planting are more important than other factors. The crop was more susceptible to the disease for about a week after planting. High temperature and low soil moisture encourage seed germination and discourage smut mycelium invasion of the germinated coleoptiles of the host plant. Meanwhile low temperature, moisture content of the soil and deeper planting of sorghum initiate high infection level (Tarr, 1962). *M. lanceolata* (Abbayyi) effectively controlled the disease though the mechanisms are yet to be studied. Higher plants are known to have anti fungal property due to their ability to produce some compounds such as alkaloids, phenolic compounds, terpenoids and others. These alkaloids or phenolic compounds may protect the germinated coleoptiles from being infected by smut mycelium. The role of the plant in controlling the plant can be fungicidal, where the fungus will be killed or fungistasis where growth will be checked. In this study, fresh leaf extract of *M. lanceolata* (Abbayyi) was identified as an effective botanical plant for the control of covered smut of sorghum. Its performance was similar to the standard fungicide thiram. In conclusion, *M. lanceolata* and thiram significantly reduced the infection percentage and increased the yield significantly compared to the other treatments. Therefore, in areas where covered smut infection is high, *M. lanceolata* can be used to reduce or avoid the loss due to this disease.

The use of *M. lanceolata* as seed treatment against sorghum smut is less costly and non-polluting and is potentially useful for resource poor small-scale farmers. It is locally available and environmentally safe. However, further study is required to determine the rate of application, the mechanism of control, the chemical

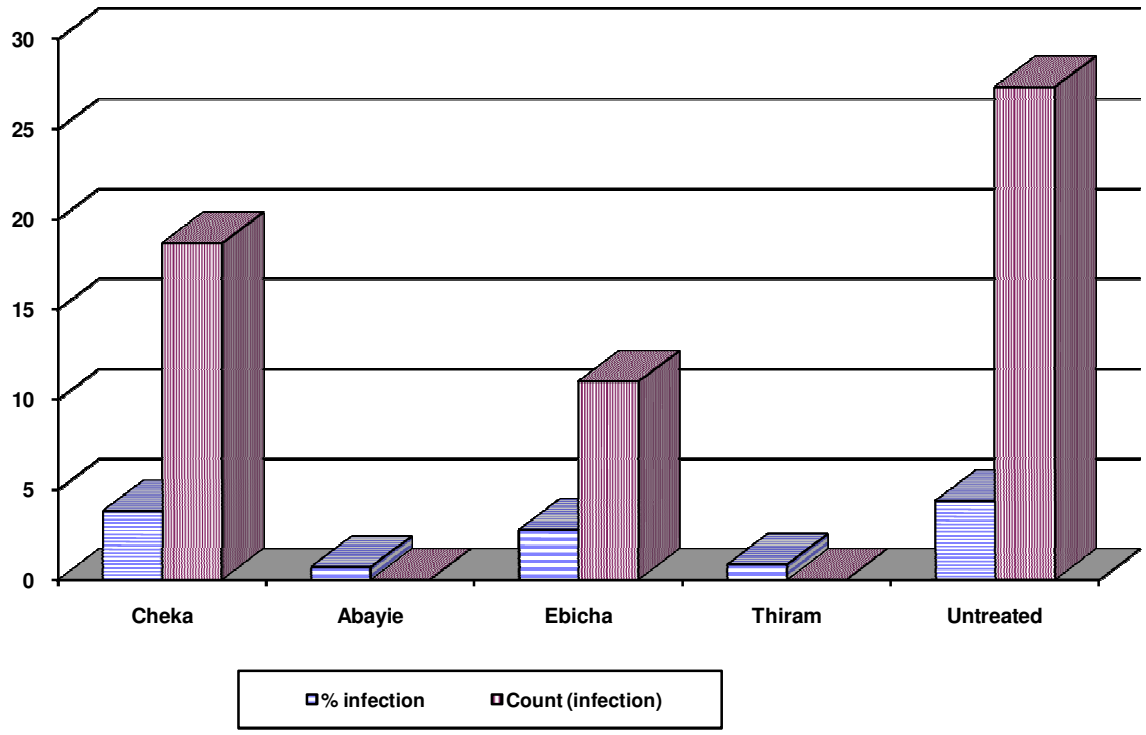

Figure 1. Mean percentage and number of infected covered smut of sorghum (1998).

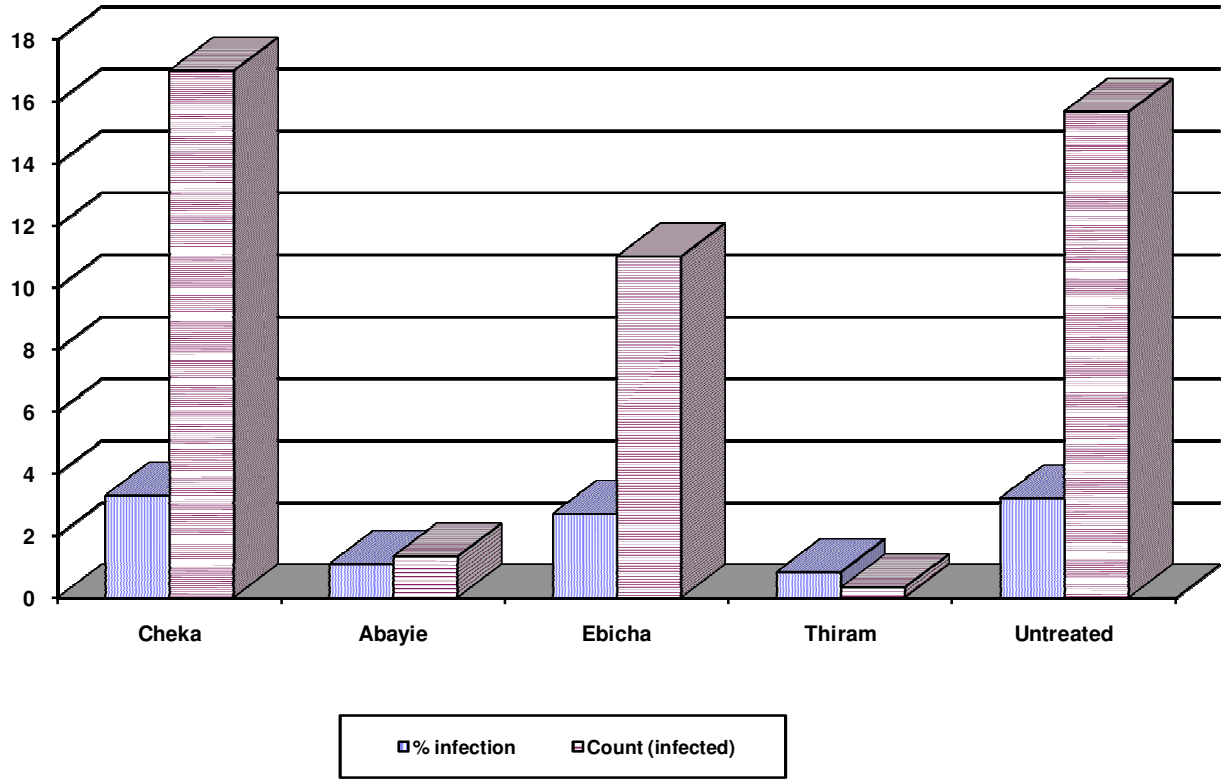

Figure 2. Mean percentage and number of infected covered smut of sorghum (1999).

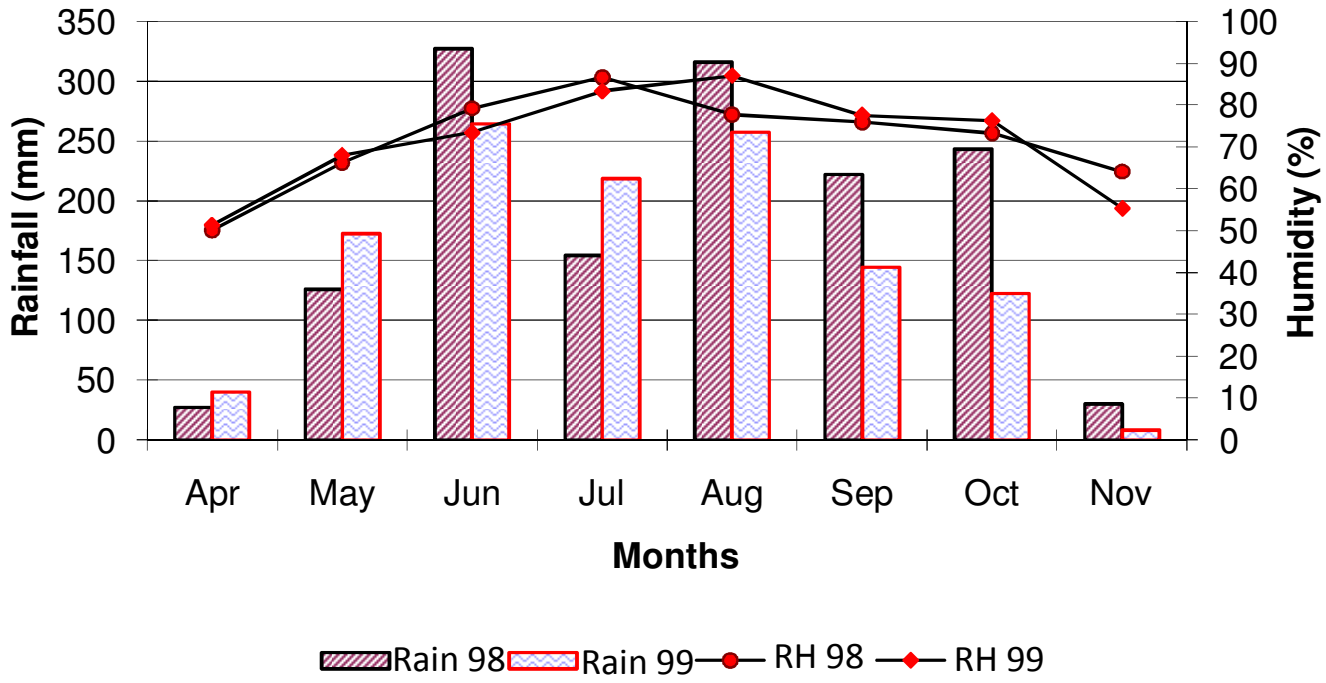

Figure 3. Rainfall and humidity data of Bako for 1998 and 1999.

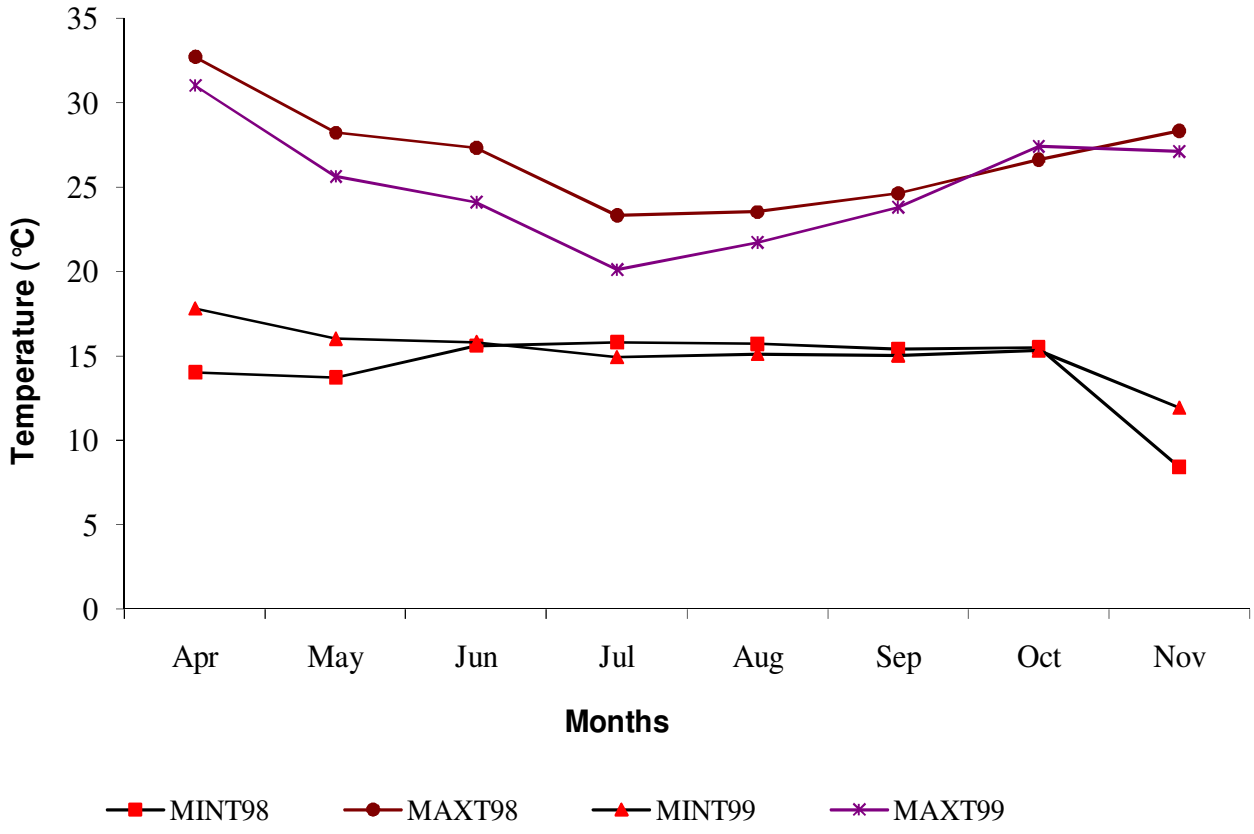

Figure 4. Maximum and minimum temperatures data of Bako for 1998 and 1999.

responsible for such activity and its chemical and physical properties.

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