On Farm Training and Demonstration of Covered Smut (*Sphacelotheca Sorghi* Clint) Management Technologies on Sorghum

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ABSTRACT

Sorghum suffers from a lot of pests among which covered smut is the most important. Covered smut induced by the fungus *Sporisorium sorghi* and it is extremely seed borne and seedling infection occurs at the time of germination and emergence of seedlings. The incidence of covered kernel smut varies from place to place, but in Ethiopia it was estimated to be about 50%. This activity initiated to provide practical training on sorghum covered identification, monitoring and technical skills to experts and farmers and to demonstrate effect of seed dressing fungicides and traditional packages against sorghum covered smut. The field demonstration was laid out on single plot with 4 treatments; Cow urine 1:1 (v/v) mixture, Thiram, Apron plus with 3g/kg and Control untreated as check. The plot size of the experiment was 10m x 10m with plant spacing of 15cm and 75cm row spacing. Data on covered smut incidence and grain yield were recorded yield loss and partial budget analysis was made. Training of trainers on sorghum agronomic practices and diseases was given to 79 male and 37 female development agents for four woreda in central Gondar and development agents also gave training for 7925 male and 502 female farmers. There was no infestation of covered smut on fungicide dressed and cultural cow urine soaked plots on both locations while an incidence of 2.8% at Gondar Zuria and 22.7% at Mirab Belesa. A relative yield advantage of the fungicides and cow urine is calculated over the control untreated check. A yield advantage of 20-26% on apron plus, 13-30% on Thiram and 16-35% on cow urine were obtained over the untreated control check. Farmers have to be use the nearby available cultural (cow urine) practice method and if not one of the available fungicides for control of covered kernel smut on sorghum production and should also be scale out.

Key words: sorghum, covered smut, incidence, On Farm Training

INTRODUCTION

Sorghum suffers from a lot of pests sorghum leaf anthracnose (*Colletotrichum graminicola*), oval leaf spot (*Ramulispora sorghicola*), rust (*Puccinia purpurea*), smut (*Sphacelotheca spp.*) were predominantly prevalent in the northern Ethiopia (Girma *et. al.*, 2008). Among which smut is the most important. Four distinct smut diseases of sorghum are recognized, they are Covered head smut induced by the fungus Sporisorium sorghi (Synonym Sphacelotheca sorghi), loose head smut induced by the fungus Sporisorium cruentum (Synonym Sphacelotheca cruenta), head smut induced by Sporisorium holci-sorghi (Synonym Sphacelotheca reiliana) and long smut attributed to the fungus described as Sorosporium ehrenbergii Kuhn though its generally accepted name since 1903 has been Tolyposporium ehrenbergii (Marley PS, 2004; Pande *et al.*, 1993). The most important sources of inoculum for sorghum smut are seed. 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 (Sharma, 1998; Singh, 1998).

Yield losses up to 80.4% have been reported in Romania (Tusa *et al.*, 1981). In China, smut incidence on sorghum has been recorded up to 70% in continuous cropping plots

(Yao and Wang, 1984). 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% (Mengistu, 1982; Teklemariam, 1985).

Several control measures have been recommended, all aimed at reducing disease damage to the crop. Seed dressing with fungicide is one of the most effective means of controlling seed and soil borne sorghum disease like smut. It is convenient for farmer's use, improve stands and seedlings raised from treated seeds are healthier than those from un-treated seeds (ICRISAT, 1992). As S. sorghi is seed-borne, comparatively more research efforts have been mainly focused on evaluating chemical seed treatments (Mtisi, 1996) worldwide. Results indicated that thiram/lindane (Fernasa-D) and Apron plus (Thiamethoxan+Mefenoxam+Difenocunazole) reduced both covered and loose smuts incidence in early-planted sorghum, but trace incidence was observed in late-planted sorghum, particularly in covered smut (Girma *et al.*, 2008). The disease can be effectively controlled by thiram (Wall and Meckenstock, 1992). According to Akpa and Manzo (Akpa and Manzo, 1991) systemic fungicide, Apron plus 50% dust can reduce the risk of smut diseases. Similarly, Marley (Marley, 1997) also reported that metalaxyl and thiram based formulations gave better control of covered smut. However, this approach is often not easily adapted by the majority of subsistence farmers in Ethiopia and is not sustainable for a variety of reasons, including inaccessibility of the chemicals and lack of safe application methods.

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 and other materials like cattle urine against different types of diseases on different crops (Gaby, 1982). Resource-poor farmers traditionally practice various methods to control sorghum smuts. Recently, effects` of cow and goat urine stored at different days and diluted with water have been evaluated on both covered and loose smuts (EARO, 1998). Study revealed that cow urine stored for seven days significantly reduced covered kernel smut incidence by up to 81% in 1999 and 26 to 70% in 2000 and increased grain yield, respectively, by up to 95% in 1999 and up to 38% in 2000. Irrespective of storage durations, goat urine treatments significantly reduced smut incidence by 50 to 85% in 1999 and 55 to 82% in 2000, respectively. Sorghum grain yield increased, respectively, to 20 and 140% in 1999 and 28 and 67% in 2000 compared to the control (Girma *et al.*, 2008).

Additionally, it was also concluded that soaking one kilograms of sorghum seed for 20 minutes in either cow or goat urine diluted with water in a 1:1 (v/v) mixture appeared most effective than 1:2 and 1:3 (v/v) in reducing covered smut. Subsequent tests after soaking sorghum seeds with cow and goat urine and stored for 2–3 weeks also revealed increased seedling height, percent germination and seedling emergence compared to the control treatment (EARO, 1998). Thus, it was concluded that farmer's practical knowledge has significant role in sorghum smut management. However, this simple practice is not widely adopted (Girma *et al.*, 2008).

Therefore the objective of this training and demonstration is to provide practical training on sorghum disease identification, monitoring and technical skills to experts and farmers and to demonstrate effect of fungicides and traditional packages against sorghum covered smut.

MATERIALS AND METHODS

The demonstration was done at farmers' field on 2017 cropping season at Mirab Belesa and Gondar Zuria. The field demonstration was laid out on single plot with 4 treatments; Cow urine 1:1 (v/v) mixture, Thiram/lindane (Fernasa-D) with 3g/ka, Apron plus (Thiamethoxan+Mefenoxam+Difenocunazole) with 3g/ka and Control untreated as check. Seeds of sorghum was inoculated with spore of the fungi (*Sphacelotheca sorghi* Clint) to be infected with 3gram per kilo gram of seed. The plot size of the experiment was 10m x 10m with plant spacing of 15cm and 75cm row spacing. There was 1m spacing between plots. A seed rate of 15kgha^{-1}, three weed frequency, Fertilizer was applied at the rate of 100kg/ ha NPS (all at planting) and urea 100kg/ha (half at planting and half after thinning) were applied. All agronomic practices applied as recommended to sorghum in the area.

Yield and disease assessment

Data on covered smut incidence and grain yield were recorded. In addition a yield loss: Yield advantage due to covered smut was measured as percentage yield reduction of undressed plots compared with the most integrated plot using the following formula:

$$RL\ (\%) = \frac{(Y_1 - Y_2)X\ 100}{Y_1}$$

Where, RL = relative loss (reduction of the parameters yield and yield components)

Y_1 = mean of the respective parameter on maximum protected plot

Y_2 = mean of the respective parameter in other treatments and unprotected plot

Cost Benefit Assessment

Partial budget analysis was done by considering the variable cost available in the respective treatment. Net benefit and marginal rate of return was computed. To measure the increase in net return associated with each additional unit of cost (marginal cost), the marginal rate of return (MRR) was calculated as:

$MRR = \Delta NI/\Delta IC$

Where, MRR is marginal rate of returns, ΔNI – change in net income compared with control, ΔIC – change in input cost compared with control.

Training was given to development agents, experts and farmers on sorghum diseases identification, monitoring, management spray equipment manipulation, calibration and amount of active ingredient to be sprayed and fungicide management.

RESULT AND DISCUSSION

Training

Table 1: Number of trained development agent and farmers per Woreda in 2017

Woreda	Development Agent		Farmers	
	Male	Female	Male	Female
Mirab Belesa	14	10	19525192	7788
Misrak Belesa	13	10	1431	64
Gondar Zuria	25	2	2202	200
Dembia	27	15	2340	160
Total	79	37	7925	502

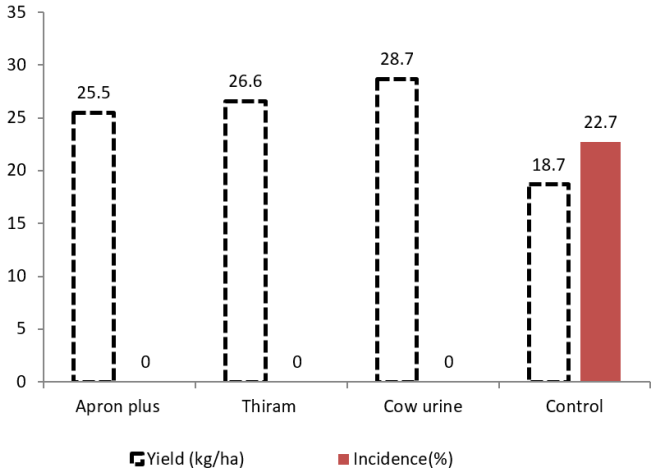
Training of trainers on sorghum agronomic practices and diseases was given to 79 male and 37 female development agents for four woreda in central Gondar and development agents also gave training for 7925 male and 502 female farmers (Table 1). The training was conducted on sorghum diseases identification based on the symptoms, monitoring on assessment, ways of scoring (incidence, severity and prevalence) and reporting, and management of diseases especially on covered smut resistance, cultural and chemical methods. In addition, training also given on fungicide management in relation to rate, frequency, action, disposal and calibration of water and also on spray equipment manipulation and maintenance.

Farmers and experts were given the following feed backs:

- The crop is best performed and expected good yield
- Farmers and experts perceive that the fungicides and cow urine can manage the diseases
- Farmers and experts perceive a yield difference between untreated and treated plots
- Can identify the diseases from other diseases
- plan to use especially cow urine for future in their sorghum production
- Farmers were eager to adopt the technology

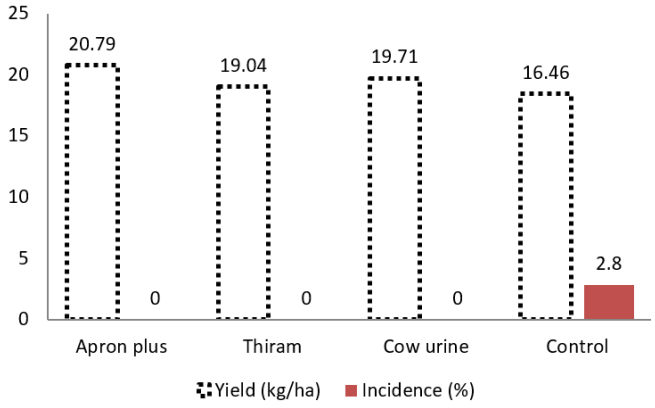
Yield and covered smut intensity

A demonstration plots was sown at Mirab Belesa and Gondar Zuria. Seed dressed plots (treatments) gave higher yield than undressed control plot. A higher yield was obtained from cow urine soaked plot (2870kg/ha) followed by Thiram treated (2660kg/ha), and apron plus treated plot (2550kg/ha) while the lowest was obtained on undressed control plot (1870kg/ha) at Mirab Belesa.



Graph 1: Yield and covered smut incidence at Mirab Belesa

Similarly at Gondar zuria a higher yield was obtained from treated plots, apron plus treated plot (2079kg/ha) gave the higher and followed by cow urine (1971kg/ha) and Thirm treated plot (1904kg/ha) while the lowest was obtained on undressed control plot (1646kg/ha) at Gondar zuria. Similar study by Samuel et al. (2013) indicate that The ANOVA for the average combined yield for two years for two locations revealed that the highest yield of 33.7 and 35.11 quintal per hectare were recorded by Apron star treated sorghum seed of Abshir at Fedis and Babile respectively. The lowest yield of Abshir 16.85 quintal/hectare at Fedis and 20.7 quintal per hectare at Babile were observed on untreated seeds of the variety respectively. The lowest yield of Gubiye 15.85 quintal/hectare at Fedis and 18.37 quintal per hectare at Babile were observed on untreated seeds of the variety respectively.



Graph 2: Yield and covered smut incidence at Gondar Zuria

Disease incidence data were taken on the demonstration plots there was no infestation of covered smut on fungicide dressed and cultural cow urine soaked plots on both locations while an incidence of 2.8% at Gondar Zuria and 22.7% at Mirab Belessa (Graph 1 and 2). This result agree with Girma et al. (2008) Cow urine stored for seven

days significantly reduced covered kernel smut incidence by 26 to 70% and thiram and Apron (Thiamethoxan+Mefenoxam+Difenocunazole) reduced both covered and loose smuts incidence in early planted sorghum at Sirinka. Similarly a study by Adane and Gautam (2000), clearly revealed that seed treatment with cow and goat urine, hot and cold water treatments besides Thiram and Apron plus except cold water were equally effective in reducing the incidence of both covered and loose smut on sorghum as compared to control. In addition similar study at cow urine fermented was compared with apron star and untreated seeds as control as a result like apron star fermented cattle urine seed treatments significantly ($P \leq 0.05$) reduced the prevalence of disease more than the untreated checks and the highest disease incidence of 30.1% was recorded at Babile in 2011 on untreated Abshir variety. While the lowest incidence of 0% was observed on Abeyi, cattle urine and Apron treated seeds in 2011 cropping season (Samuel et al., 2013).

Table 3: Relative yield advantage of treated compare to untreated treatment for sorghum covered smut at Mirab belesa and Gondar Zuria

Treatments	Mirab Belesa		Gondar Zuria	
	Yield (kg/ha)	RYA (%)	Yield (kg/ha)	RYA (%)
Apron plus	2550	+26.6	2079	+20.8
Thiram	2660	+29.7	1904	+13.6
Cow urine	2872	+34.9	1971	+16.5
Control	1871	-	1646	-

A relative yield advantage of the fungicides and cow urine is calculated over the control untreated check. A yield advantage of 20-26% on apron plus, 13-30% on Thiram and 16-35% on cow urine were obtained over the untreated control check (Table 3).

Table 3. Partial Budget analysis of fungicides

No.	Cost benefit data	Treatment			
		Con.	Cow urine	Thiram	Apron
1	Adj. yield (kg/ha) (yield x0.90)	1582.2	2178.5	2052	2080
2	Price (Birr kg-1)	10	10	10	10
3	Sale revenue (1x2)	15822	21785	20520	20800
4	Total input cost (Birr ha-1)	0	20	57.5	177.5
5	Benefit	15822	21765	20462.5	20622.5
6	Dominance analysis			D	D
7	Marginal cost (Birr ha-1)	0	20		
8	Marginal benefit		5943		
9	MRR (%)		29715		

A partial budget analysis was done for both location yields for the treatments a higher benefit was obtained from cow urine (21765 Birr) and followed by apron plus (20622.5) and Thiram (20462.5birr) and the lowest was from control (15822 birr) untreated plot. Even though Thiram and apron plus are beneficial they are dominated by cow urine treated plots. Marginal rate of return was gained on cow urine soaked (29715) so for additional 1 birr cost on cow urine it hosts 297.15 birr. These indicate that use of the fungicides and cultural practice cow urine are cost effective or are profitable on sorghum production for covered smut control (Table 3).

Conclusion and Recommendation

Low yield and high incidence of covered smut found on untreated control sorghum plots on both locations. Treating smutted seeds of sorghum with Cow urine 1:1 (v/v) mixture, Thiram and Apron plus effectively control covered smut of sorghum. Treating smutted seeds of sorghum with Cow urine 1:1 (v/v) mixture, Thiram and Apron plus cost effective. So farmers have to be use the nearby available cultural (cow urine) practice method and if not one of the available fungicides for control of covered kernel smut on sorghum production and should also be scale out.

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