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Evaluating the efficacy of pre-plant seed disinfection practices against seed bourn sorghum covered smut in Eastern Ethiopia

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Grain sorghum is major a staple food for millions of farmers and pastoralist in Ethiopia particularly in the eastern provinces. Due to the absence of clean seed supply system farmers use contaminated seed without disinfecting them. This has resulted in the buildup of disease like covered smut of sorghum caused by *Sphacelotheca sorghi*. Six pre-plant seed disinfection treatments were evaluated to determine their efficacy against the sorghum covered smut and to find out best, easily available and simple seed disinfection options for the farming community of eastern Ethiopia. Treatments were T1 (hot water at 55°C for 5 minute), T2 (hot water at 55°C for15 minute), T3 (neem leaf extracts for 30 minute, T4 (NaOCl 5.25% for 2 minute), T5 (NaOCl5.25% for 5 minute), T6 Datane-M45® (mancozeb 80% WP at 20g/kg as check) and T7 (untreated control). Treatments were evaluated in RCBD and one way ANOVA was performed and treatment effect was assessed using LSD test at P<0.05 level. According to the result except T1 and T7 other treatments resulted in significant reduction on incidence and severity of covered smut. Lowest incidence 18.33 and 29.67% and severity of 3.31 and 4.49 were recorded from T5 and T6 respectively. At harvest highest severity was recorded on T7 followed by T1 and T2 similarly, reduction in seed and panicle weight was also observed on T7, T1 and T2. Therefore it could be concluded that Sodium hypochlorite (NaOCl 5.25%) pre-plant seed socking for 5 minute (T5) can be best alternative for sorghum seed disinfection and the result was also comparable with Datane-M45®(mancozeb 80% WP at 20g/kg).

Key words: seed disinfection, covered smut, incidence, severity, sorghum

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INTRODUCTION

In Ethiopia sorghum is largely grown from the lowlands to the intermediate areas having annual rainfall of 600-1000 mm respectively (Sisay et al., 2012). It is drought tolerant, widely produced and popular cereal crop in pastoralist and agro-pastoralist communities in eastern Ethiopia (Shiferaw et al., 2015). The cultivation of this crop is challenged by numerous production constraints such as diseases, insect pests and others limited the productivity (Abebe and Wubshet, 2015). In Eastern Ethiopian lowland sorghum has been the principal component of the farming system and staple food for millions of farmers and pastoralist. Therefore, due to continuous mono cropping for long period of time almost all fields in the study area are exhibited with significant level of crop specific pest buildup (Shiferaw et al., 2015).

Among reported problem covered smut disease caused by *Sphacelotheca sorghi*is the major bottleneck for sorghum growing localities of Ethiopia requiring close attention (Abebe and Wubshet, 2015). The incidence of cover smut varies from place to place it was estimated to be about 50-100% (Sisay et al., 2012).The disease is mostly seed borne the smut sori break during threshing releasing the spores; that adhere to the surface of healthy seeds and remain dormant till next season (Ashok et al., 2011).When the farmer uses farm saved seed without treating it encourages the accumulation of seed borne pathogens which lead to outbreak and spread of diseases (Natecho et al., 2018). In Ethiopia most farmers don't have access for clean seed therefore they use seed from other farmer or their own saving from previous cropping season (Tekeste and Abebe, 2018).This has resulted in the spread and buildup of seed borne diseases like covered smut and others (Abebe and Wubshet, 2015).

Several study report indicated that seed treatment and seed dressing of sorghum seed with different types of fungicide is an effective method to control the seed borne disease (Sisay et al., 2012; Natecho et al., 2018). They are convenient for farmers use and improve crop stand. Seedlings raised from treated seeds are healthier than those from un-treated seeds. Widely synthetic fungicides are recommended for seed treatment against seed borne diseases. Though fungicides are effective and widely recommended to control covered smut in sorghum several factors may determine the applicability to resource poor farmers. Among the limitation of fungicide including unavailability in remote areas, potential health hazard, environment pollution and economic factors discourages the users (Shiferaw et al., 2014). Therefore there has to be simple and safe method of seed disinfection before planting to farmers of Eastern Ethiopia. Therefore current study was intended to determine the efficacy of different seed disinfection alternatives against seed borne sorghum covered smut and to find out best, easily available and simple seed disinfection options for the farming community of eastern Ethiopia

MATERIAL AND METHODS

Description of Study Area

Field experiment was conducted during 2018 main cropping season in Fafen administrative zone of Eastern Ethiopia. The area is located between the geographical coordinates of 912, 270 –1,058,809.8 UTM north and 877,449.1- 975,927.2 UTM East. It belongs to the warm semi-arid to cool and humid agro-climatic zone. The altitude is between 1400 m.a.s.l. The average annual temperature ranges from 18-27.5^0 C. In this area sorghum is regarded as major staple food (Shiferaw et al., 2015).

Treatment and experimental design

Sorghum seed was obtained from farmer's seed store nearby the experiment site and where covered smut disease is prevalent. The seed was carefully selected from those panicles with covered smut infection. The heads then manually trashed and thoroughly mixed with covered smut spore released during manual threshing. Seed disinfection treatment was carried out at the dry land crop sciences laboratory of Jigjiga University as specified in (Table 1). The experiment had six different seed disinfection options, control and Datane-M45® (mancozeb 80% WP 2g/kg) seed treatment was used as check. Treated and untreated seeds were planted in 30 x 75 cm spacing manner on experimental plots. Treatments were arranged in RCBD and replicated in three.

Table -1 Treatment

Code	Treatments
T1	Hot water at 55^{o}C for 5 minute
T2	Hot water at 55^{o}C for 15minute
T3	Neem leaf aqueous extract for 30 minute
T4	Seed deep in Sodium hypochlorite (NaOCl 5.25%)for 2 minute
T5	Seed deep in Sodium hypochlorite (NaOCl 5.25%) for 5 minute
T6	Datane-M45®(mancozeb80% WP 20g/kg)
T7	Untreated control

Preparation of neem leaf extract

For preparation of the neem leaf extracts, 250g of the neem leaf was taken in a clean mortar and pestle and grounded without water. The pulverized plant tissues were squeezed through three folds of fine cloths and then the filtrate was used as an extract. Then the seeds were drenched in the solution for about 30 minute.

Hot water seed treatment

In hot water method a method described by (Bennett and Colyer,2010) was utilized. The infected seeds were presoaked in tap water before the treatment. The soaked seeds then placed in distilled hot water which was heated to 55°C by keeping (±1.5°C) in a 6 liter water bath. Temperature in water bath was monitored with an alcohol thermometer. After treatment, seed were allowed to dry on clean plastic plate lined with paper towels inside a laminar flow hood.

Method of data collection and analysis

Yield Data: data on 1000 seed weight was collected after harvesting, threshing and separating 1000 seeds harvested from the experimental plots of each treatment. Average panicle weight data were collected from randomly selected ten plants/plot. Grain yield data was collected after panicles were harvested from experimental plots then the panicles were threshed and cleaned the grain was weighed and converted to ton/ha.
Incidence of sorghum covered smut: incidence of sorghum covered smut was recorded by manual counting the plants showing the symptom of covered smut from each plot and converting into percentage. It was recorded every ten days interval for four rounds from 72 DAE (days after emergence) to 102 DAE.
Covered smut severity: Starting from the heading to physiologic maturity, the severity was scored from the pre tagged 10 plants using the severity rating scale suggested by (Gwary et al., 2007) as follows: 1 = No infected florets, 2 = < 10 infected florets, 3 = 11 - 20% infected florets, 4 = 21 - 29% infected florets, 5 = 30-41% infected florets, 6 = 42-52%infected florets, 7 = 53-63%infected florets, 8 = 64-74% infected florets and 9=> 75% infected florets.

The data on yield and disease infection was analyzed using one way Analysis of Variance (ANOVA) using SAS 9.1.3 edition computer packages statistical software. Treatment effects were assessed using Least Significant Difference (LSD) at P<0.05 level.

RESULTS AND DISCUSSION

Effect of treatment against covered smut incidence and severity

The present study was performed to evaluate the efficacy of different seed treatment options against covered smut of sorghum. According the result of the study there were significance difference among treatment at P<0.05 on incidence and severity of sorghum covered smut. All six pre-plant seed treatment practices used *viz*. hot water treatment, neem leaf extract, NaOCl 5.25% and Datane-M45®(mancozeb 80% WP at 2g/kg) reduced significantly the covered smut severity compared to the control. According to result presented in (Figure 1 A-D) each treatment responded differently for incidence taken every10 days interval. Relatively slow increment in incidence was observed on T3, T4, T5 and T6 compared to the T7, T2 and T1. During harvest incidence was higher in T7 and T1 followed by T2.

Figure 1A Incidence of sorghum covered smut at 72 DAE

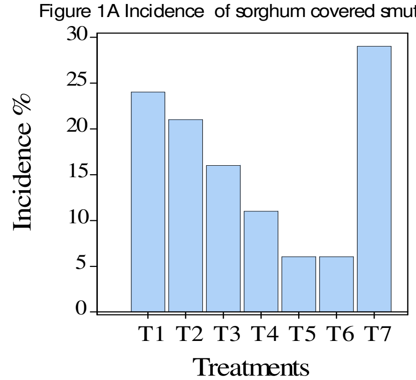


Figure 1B Incidence of sorghum covered smut at 82 DAE

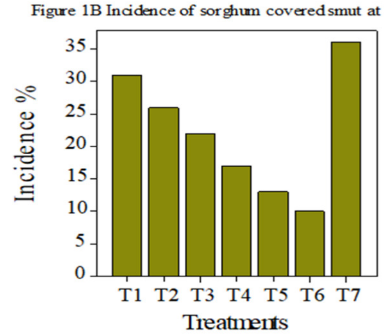


Figure 1C Incidence of sorghum covered smut at 92 DAE

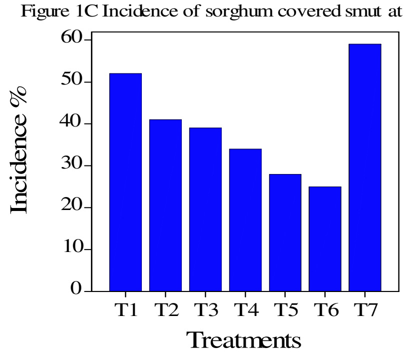
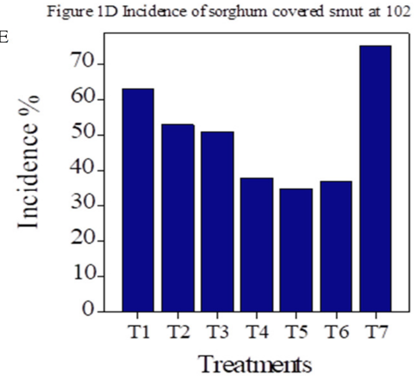


Figure 1D Incidence of sorghum covered smut at 102 DAE



According to the result in the (Table-2) compared to control (T7), all seed treatment options reduced severity of covered smut which was taken at first week of grain filling(SFWGF). There were also statistically significant variability observed among treatments at ($P<0.05$) on severity records taken on weekly interval. The result in the (Table-2) minimum SFWGF was recorded from T5 (seed socking NaOCl 5.25% for 5 minutes) and T6 (mancozeb WP (80% at 2g/kg). Severity record taken during third week of grain filling and at harvest indicted that all treatments except T1 and T2 had reduced severity significantly compared to control (T7).

The results of hot water treatment, neem leaf extracts and NaOCl 5.25% in reducing seed-borne pathogenic fungi of sorghum obtained in the present study are consistent with the findings reported in wheat and rice by (Ashok et al., 2011; Masum, et al., 2009). Miche´ and Balandreau, (2001) reported that using hypochlorite for rice seed disinfection strongly stresses the bacterial inoculums on the seed surfaces. Similarly Mtui et al., (2010) indicted that chlorine and hot water seed treatment significantly reduced bacterial populations.

According to (Perelló, 2013) highest reduction of the total seed infections of the seed borne fungal pathogens was obtained with Vitavax-200 (97.7%), followed by hot water treatment (92.2%), garlic tablet (91.3%) and neem leaf extract (86.7%). Household bleach, as seed disinfectant is safe and less costly compared to the fungicides (Mtui et al., 2010). Since common house hold bleach had wide range of use and application it can easily available with less cost and can be used safely (Perelló et al., 2013).

Table 2. Effect of treatment on severity of covered smut and grain yield

Treatments	SFWGF	STWGF	SAH	Mean Severity	Panicle weight (g)	1000 seed weight (g)	Yield ton/ha
T1	3.66^{a}	5.667^{ab}	7.84^{a}	5.72	113.43^{a}	22.65^{a}	0.68^{a}
T2	3.00^{b}	5.00^{ab}	6.54^{ab}	4.84	117.38^{a}	22.88^{a}	0.68^{a}
T3	1.67^{c}	3.66^{cd}	5.67^{c}	3.66	131.50^{bd}	37.56^{b}	0.90^{b}
T4	2.47^{c}	4.33^{d}	5.49^{cd}	4.09	134.34^{bce}	39.47^{b}	1.02^{bc}
T5	0.52^{d}	3.00^{cd}	3.31^{e}	2.27	139.80^{e}	47.63^{c}	1.11^{c}
T6	0.67^{d}	2.33^{bcd}	3.05^{d}	2.01	137.40^{e}	48.03^{c}	1.06^{c}
T7	5.00^{a}	7.00^{a}	8.97^{ae}	6.99	101.26^{f}	21.13^{e}	0.47^{d}
LSD	1.32	2.02	2.64	1.99	5.23	10.82	153.13
CV	31.12	26.07	21.45	26.21	9.69	13.70	10.32

SFWGF: Severity at first week of grain filling; **STWGF:** severity at third week of grain filling: **SAH;** severity at harvest

Seed treatment alternative also affected important components including panicle and 1000 seed weight. According to the result in (Table-2) there was statistically significance variability among treatment on 1000 seed and panicle weights at $P<0.05$. Accordingly maximum 1000 seed weight and panicle weight was recorded from T6 and T5 respectively. The smallest panicle and 1000 seed weight was recorded on T7 (control) followed by T1 (hot water for 5 minute). The result indicted that treatment with high incidence and severity of covered smut exhibited with reduced yield components and grain yield. According to Mtui et al., (2010) chlorine seed treatments resulted reduction in disease severity in higher number of fruits per plant and increased yield compared the control.

Reduced 1000 seed, panicle weight and grain yield was also recorded from T1 and T2 and control (T7). This could be due to increase in covered smut incidence and severity that lead to the reduction in seed, panicle weight and then the grain yield. The decrease in 1000 seed and panicle weight recorded in this study due to the infection of covered smut is in agreement with that of Ashok et al., (2011) that reported linear decrease in pearl millet seed yield with the increase in smut infection.

Highest sorghum panicle weight was obtained from T5 and T6 and followed by T4 and T3 compared to the control (T7). In T5 and T6 covered smut incidence and severity was low therefore, it resulted in increase in panicle and 1000 seed weight by 57.6 and 55.66 %. Similarly grain yield increased by 56.7 and 55.2% on T5 and T6 respectively compared to the control. The increase in seed weight, panicle and grain yield could be resulted from of reduced covered smut infection due to seed treatment effect.

CONCLUSION AND RECOMMENDATIONS

Starting production with clean seed is a crucial step to achieve healthy crop stand and reduce disease intensity.

However clean and certified seeds are not in the reach of most distant farmers. Therefore disinfecting the seed with local available material could be a best remedy to reduce the impact of contaminated seed. Based on the result from this study it could be concluded that sodium hypochlorite (NaOCl 5.25%) pre-plant seed socking for 5 minute can be best, safe and easily available option to farmers in remote areas of eastern Ethiopia. However to make current finding more concrete similar study must be repeated in different locations and season where the problem is prevalent.

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