Effect of Certain Fungicides on the Development of Covered Kernel Smut and Long Smut Diseases and Yield Losses of Grain Sorghum

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Abstract

Sorghum plant (*Sorghum bicolor* (L). Moench) is an important grains crop for human being and animals in Upper Egypt, grain sorghum is attacked by certain smut diseases causing considerable losses in the grain yield. Covered kernel smut (CKS) and long smut (LS) diseases are one of the most significant diseases in sorghum production especially where untreated seed is planted. Sorghum cultivars Giza-15 and Dorado differed in their ability to infection with these two types of CKS and LS respectively. High rates of *Sporisorium sorghi* and *Sporisorium ehrenbergii* teliospores playing great factor to increasing the two smuts diseases infection and yield losses, while it was reduced the yield of grain for the tested cultivars. The tested fungicides and sulfur decreased the percentages of infection of CKS and LS diseases and increased grain yield in both seasons 2014 and 2015 compared with the control. Vitavax fungicide was the most effective one followed by sulfur and Bavastin.

Key words: Grain sorghum, Smuts, Fungicide, Yield losses.

Introduction:

In Egypt, grain sorghum (*Sorghum bicolor* (L) Moench) is ranked fourth in importance among cereal crops in the world after wheat, rice, and corn, it is one of the world's major food cereal crops **(**FA0, 2015). Global production of the small grain is estimated to be 40 million hectares (FAO, 2015). Sorghum is particularly important in areas of high temperatures and low rainfall as the crop is drought tolerant (Hayden, 2002). It is grown in more than 100 countries all over the world. In 2014, Egypt planted 141540 hectares of grain sorghum with an average yield of 843844 tons of grain (FAO, 2015). More than 80% of the area devoted to sorghum lies within El Fayoum, Assiut, Sohag and Qena governorates of middle and Upper Egypt. In the areas where sorghum is traditionally grown, plants may be attacked by different smut diseases. Three types of smuts are generally recognized. These are covered kernel smut, long smut and head smut. In Egypt, the first record of covered kernel smut (CKS) of sorghum caused by *Sporisorium sorghi* (syn. *Sphacelotheca sorghi* (Link) Clinton) was by Briton-Jones (1922 and 1925). The disease was found in Assiut, Aswan and Cairo governorates (Melchers, 1931). Later, it was found in all governorates of Upper Egypt (Abd El Hak and Abd El Rehim, 1950). Long smut caused by *Sporisorium ehrenbergii* Vánky (syn. *Tolyposporium ehrenbergii* (Kühn) Pat.) is a limiting factor in sorghum productivity in several African and Asian countries (Kumar and Nath, 1991a; Kollo and Frederiksen, 1998; Botros *et al.*, 1999; Marley and Aba, 1999; Prom *et al.*, 2007). Smuts are one of the most important diseases of sorghum especially where untreated seed is planted. Damage is confined almost entirely to the head or panicles, thus the reduction in yield is conspicuous and direct. The quality of the remaining yield is drastically reduced by the presence of the black smut spores on the surface of healthy kernels. Smut fungi seldom kill their hosts (biotrophs), but in some cases infected plants may be severely stunted (Agrios, 1997). As covered and long smut affecting dramatically yield production of grain sorghum in Egypt, present study dealt with these two diseases to the benefit of the crop. The specific objectives of this study were to study fungicides affecting the grain sorghum yield and yield losses in relation to smut infection.

Material and Methods:

1-Survey of covered kernel and long smut diseases of sorghum in Qena and Sohag governorates:

A field survey of covered kernel and long smut diseases on sorghum was conducted in the summer growing season 2012 in 12 governorates (Abu-Tesht, Nakada, Qeft, Qus, Deshna and Bndr Qena) and (Al-Margha, Al-Osyrat, Al-Baliana, Gerga, Dar El-Salam and Tahta) of Qena and Sohag governorates, respectively that listed in Table (1). Three villages from each governorate and five sorghum fields from each village were randomly chosen. The fields were only assessed if the sorghum crop was in the milk stage or later at maturity stage. Approximately, 500 plants were randomly selected from each field using a W-pattern of zigzag method described by Ngugi *et al*., (2002). Heads of growing plants were examined for both covered kernel and long smut infections, and then the percent of infected plants (infection) was calculated as described by Marley and Aba, (1999):

Disease infection%= infected plants ∕ Total number of plants x 100

In case of covered kernel smut the disease severity (DS) was calculated using five class scales, where 1= few flowers smutted, 2= 0.25-0.50 flowers smutted, 3= 0.50-0.75 flowers smutted, 4= few healthy, 5= all head smutted according to the method described by McKinney, (1923). The average number of sori per infected plant was also calculated in case of long smut.

2- Isolates collection and identification of the causal pathogens of covered kernel and long smut diseases:

Smutted panicles of sorghum plants infected with covered kernel and long smut diseases of each county of the 12 counties surveyed were collected in paper bags and sampled through the summer growing season 2012. Sori of smutted panicles were crushed to collect the teliospores. The resultant smut masses (teliospores) were passed through a sieve (100- mesh screen) to eliminate plant debris and stored at ambient temperature in the laboratory for further studies. Identification of collected isolates of *S. sorghi* and *S. ehrenbergii*, the causal pathogens of covered kernel and long smut diseases, respectively was carried out according to the morphological characteristics of teliospores and their germination on water agar as described previously by Tarr (1962), Longdon and Fullerton (1978), Gazar (1985), Frederiksen and Odvody (2000).

3-Pathogenicity tests:

Sorghum plants were inoculated with teliospores of 12 isolates each of *S. sorghi* and *S. ehrenbergii*) through 2013 growing season at the Experimental Farm of El-Mattana Agric. Res. Station, Luxor governorate. The sowing date was on 1st of June. Sorghum grains of Giza-15 cultivar were surface sterilized with 70% ethanol for 2 minutes, and soaked in sterile tap water for 6 hours, air dried and then thoroughly dusted with teliospores of each isolate of *S. sorghi* individually at the rate of 3g/kg of grains (Moharam, 2010). Disinfected grains treated with sterile distilled water (SDW) were served as control. Four grains were sown at a distance of 20 cm in two rows (60 cm a part) in plots of 2.0 × 3.5 m in a randomized complete block design with three replicates. After three weeks from sowing, the plants were thinned to two. The common cultural practices of sorghum at the field were followed. On other hand, grains of Dorado cultivar were also disinfected, soaked in sterile tap water, air dried and then thoroughly planted in the plots as described before.

Teliospores suspension containing 1×10^6 spores/ml SDW of each isolate of *S. ehrenbergii* it was prepared using Hemocytometer (Tzeng and De vay, 1989) as follow: one disk (1 cm diam.) from S. ehrenbergii was placed in 1 ml sterilized water in tube. Tubes were shaken for 2 min., then kept 1 hour. Hemocytometer slide was used for counting the spores, the number of spores was counted in 16 squares (1 ⁄ 400 mm^2), chosen at random and the average of three slides was calculated.

The teliospores suspension was filtered through a double-layered muslin cloth after incubation at room temperature for 20 hours (Prom *et al*., 2007). For inoculation of the plants at boot stage, 5.0 ml of spore suspension of each isolate was placed between the flag leaves and the panicles using a syringe. Inoculated boots and the bases of flag leaves were immediately covered with sterilized paper bags after inoculation (Ragab and Mahdi, 1966). Inoculated plants with SDW were served as control. Following full appearance of panicles, the bags were removed after 2 weeks. At end of the season, any plant exhibiting sori of covered kernel and long smut was scored as infected. The percentage of infection and disease severity and sori number per infected plant were calculated as described before. The results were analyzed according to the statistical procedures described by Gomez and Gomez, (1984).

4- Efficacy of fungicides on sorghum cultivars infection by CKS and LS

The grain smut of sorghum primarily is an external seed borne disease causing serious concern to the seed growers as they affect seed yield, quality and reduce the planting value of seed considerably. Seeds of Giza-15 cultivar were treated as per the treatments by 5 gm/seeds kg of *Sporisorium sorghi* teliospores spores the causal of covered grain smut of grain sorghum. Seeds were directly mixed with fungicide vitavax@ (3gm kg-1 of seeds), bavstin (3gm kg-1 of seeds), and sulphur (5gm kg-1 of seeds), two days after inoculation as described by Savitri *et al.,* (1994). Seeds were thoroughly mixed by shaking with the fungicide in glass bottle or in conical flask for about 15-20 minutes to ensure the uniform application of fungicide. In the control, seeds were treated only by the *S. sorghi* spores. And another control, seeds were treated by sterilized distilled water (SDW). In long smut disease the grain sorghum cultivar Dorado were injection by suspension teliospores of the isolate no. 5 of *S. ehrenbergii* isolates at the booting stage using concentrations of suspension 10^{10} (5ml/ head), and then covered with paper bags at the time of inoculation. Long smut inoculum for this study were collected from plants in October 2013. Sori were crushed to collect the spores, and a spore suspension (10^{10} spores ml-1) was made with distilled water. Hemocytometer slide was used for counting spores. (Tzeng and De vay, 1989). For inoculation of the plants at boot stage, 5.0 ml of spore suspension was placed between the flag leaves and the panicles using a Syringe. Inoculated boots were labeled and covered with paper bags at the time of inoculation. In control treatments, heads injected by distilled water (5 ml). Following full, the bags were removed after two weeks, and then the panicles were dusting by vitavax@ (3g/L), Sulfur (5g/L), and Bavistin (3g/L). In the control, Dorado *cv* seeds were treated only by the *S. ehrenbergii* spores (10^{10}). And another control, seeds were treated by sterilized distilled water (SDW). And the infection was considered to have taken place when the grain color appears as bright green, shiny and enlarged in shape.

Statistical analysis:

Data were subjected to statistical analysis of variance. The experimental design(s) of all studies was a completely randomized with three replications, analysis of variance of the data was performed with the MSTAT-C statistical package (A) micro-computer program for the design, management, and analysis of agronomic research experiments. Michigan State Univ., USA. Least Significant Difference (LSD) was used to compare treatment means (Gomes and Gomes, 1984).

Results:

1-Survey of covered kernel and long smut diseases of sorghum in Qena and Sohag governorates:

A field survey for the occurrence of covered kernel and long smut diseases of sorghum was conducted during the growing summer season 2012 in 12 counties of Qena and Sohag governorates. Data in Table (1) and Figure (1) indicate that sorghum was infected with covered kernel and long smut diseases with various degrees of infection. Covered kernel smut disease recorded (3.09% and 2.67%) with disease severity of (0.96% and 0.94%) in Qena and Sohag governorates, respectively. Long smut disease recorded (3.87% and 3.71%) with sori number per infected plant of (2.1 and 7.93) in Qena and Sohag governorates, respectively. The highest incidence of covered kernel and long smut diseases were observed in Naqada and Qeft counties, Qena governorate of 5.97% and 5.86 %, respectively. While the lowest incidence of both diseases was observed in Al-Margha and Deshna counties, Sohag and Qena governorates of 1.44% and 3.27%, respectively. The highest disease severity (1.44%) of covered kernel smut was observed in Qeft county, Qena governorate and Al-Baliana and Gerga counties, Sohag governorate. While the lowest disease severity (0.59%) was recorded in Al-Margha county, Sohag governorate. The highest sori number (9.77) per infected plant with long smut disease was recorded in Al-Baliana county, Sohag governorate. While the lowest sori number (1.55) per infected plant was recorded in Bndr Qena county, Qena governorate.

Table 1. Incidence of covered kernel and long smut diseases of sorghum assessed in 12 counties of Qena and Sohag governorates during survey performed in 2012 summer growing season.

Governorate	County	Village	Covered kernel smut		Long smut	
			Infection (%)	DS (%)	Infection (%)	Sori/plant
Qena	Abu-Tesht	Samhod	1.40*	0.89	3.33	2.14
		Abu-Shosha	3.33	0.75	3.67	1.50
		Al-Qara	3.16	0.61	3.16	2.00
	Mean		**2.63**	**0.75**	**3.39**	**1.88**
	Nakada	Al-Zawaida	7.88	2.11	3.50	1.00
		Tokh	5.80	1.16	2.48	2.63
		Al-Khatara	4.23	1.05	4.50	2.50
	Mean		**5.97**	**1.44**	**3.49**	**2.56**
	Qeft	Al-Brahma	4.00	1.22	6.33	2.00
		Al-Shikhia	3.16	1.13	5.50	2.33
		Al-Klahen	1.50	0.68	5.76	3.17
	Mean		**2.89**	**1.01**	**5.86**	**2.50**

	Qus	El-Meqrabia	2.40	0.91	4.16	2.50
		Hagza Qebli	3.16	0.97	3.50	3.00
		Khozam	2.50	0.94	3.33	2.16
	Mean		**2.69**	**0.94**	**3.66**	**2.55**
	Deshna	El-Sabryat	1.83	0.81	2.50	2.50
		Fao Qebly	1.44	0.77	4.16	1.33
		El-Samtaa Bhry	1.25	0.63	3.16	2.40
	Mean		**1.51**	**0.74**	**3.27**	**2.08**
	Bndr Qena	El-Mahrosa	3.66	1.14	3.11	1.50
		El-Manaa	1.83	0.50	4.16	2.00
		El-Deer Bahry	3.16	1.12	3.50	1.16
	Mean		**2.88**	**0.92**	**3.59**	**1.55**
Mean			**3.09**	**0.96**	**3.87**	**2.10**
Sohag	Al-Margha	Bani Helal	1.05	0.77	3.20	2.70
		Shandaweel	1.12	0.89	3.50	9.50
		Al-Heridia	1.25	0.13	3.53	4.50
	Mean		**1.14**	**0.59**	**3.41**	**5.57**
	Al-Osyrat	Al-Masaied	2.70	0.44	4.08	9.80
		Al-Rashaida	3.50	1.15	4.33	7.00
		Al-Gazera	2.67	0.95	3.05	4.60
	Mean		**2.96**	**0.85**	**3.82**	**7.13**
	Al-Baliana	Bani Hemail	3.50	1.20	2.44	8.80
		Pardis	4.16	1.66	4.83	9.80
		Barkhel	3.22	0.55	4.50	10.70
	Mean		**3.63**	**1.14**	**3.92**	**9.77**
	Gerga	El-Toad	1.88	1.11	4.11	8.14
		El-Khlfya	2.50	1.08	4.16	8.50
		El-Berba	2.33	1.23	3.50	6.67
	Mean		**2.24**	**1.14**	**3.92**	**7.77**
	Dar El-Salam	El-Blabesh	2.67	0.97	3.16	6.00
		El-Haraga	3.16	1.05	3.67	7.11
		El-Nagamesh	3.67	1.04	3.50	7.00
	Mean		**3.17**	**1.02**	**3.44**	**6.70**
	Tahta	Shatora	3.50	1.02	3.33	6.50
		El-Sawalem	2.83	0.89	3.60	6.23
		Banho	2.50	0.87	4.33	9.16
	Mean		**2.94**	**093**	**3.75**	**7.29**
Mean			**2.67**	**0.94**	**3.71**	**7.37**
General Mean			**2.88**	**0.95**	**3.79**	**4.74**

*** Values are means of five fields per each village.**

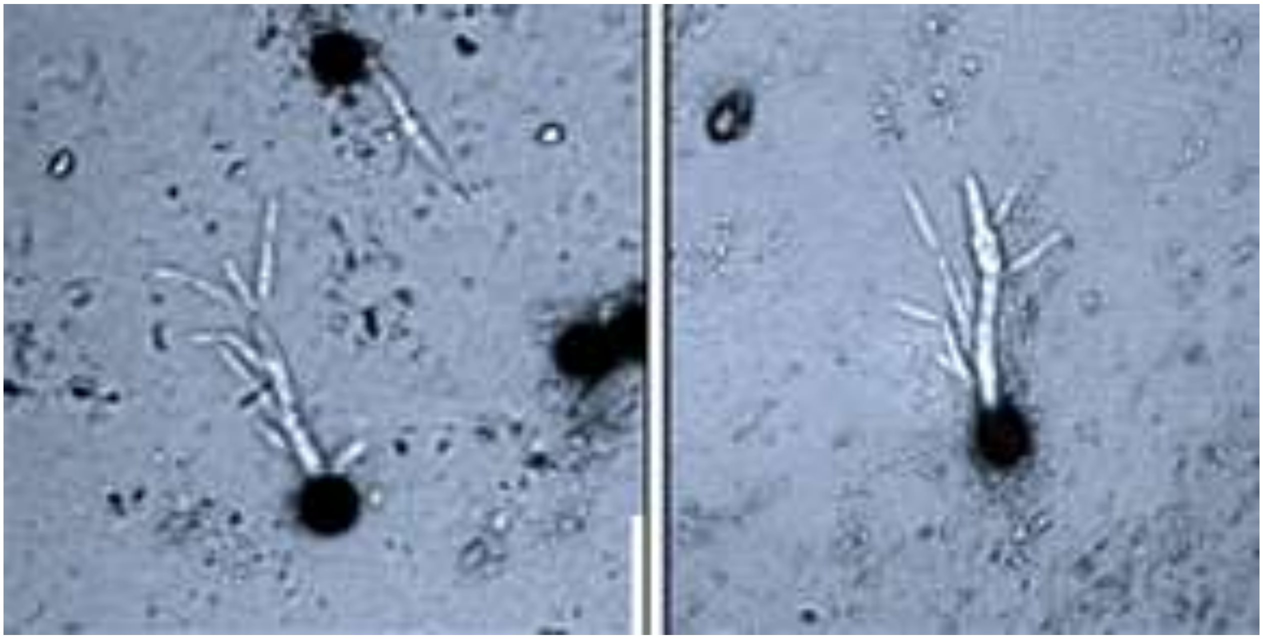
A

B

Fig. 1: Symptoms of covered kernel smut (A) and long smut (B) diseases of sorghum caused by *S. sorghi* and *S. ehrenbergii*, respectively in the field.

2- Identification of collected isolates of covered kernel and long smut pathogens:

Total 24 isolates were obtained from diseased sorghum plants showing typical covered kernel smut disease (12 isolates) and long smut disease (12 isolates) collected from 12 counties of Sohag and Qena governorates in 2012 season. Teliospores of each smut disease were examined microscopically according to their morphological characteristics and germination on water agar. The casual pathogen of covered kernel smut disease was identified as *Sporisorium sorghi* (syn. *Sphacelotheca sorghi* Lin. Clint.). Also, the casual pathogen of long smut disease was identified as *Sporisorium ehrenbergii* Vànky (syn. *Tolyposporium ehrenbergii* (Kühn) Pat.). The teliospores of *S. sorghi* are round or slightly oval, dark brown in masse, but brownish olive when single and the spore size is within the range of 4-9 µm in diameters. After germination of teliospores on water agar, promycelium bearing lateral sporidia was predominant. The teliospores of *S. ehrenbergii* are in spore balls which are dark brown, subglobose to oblong or irregular and 40-150 µm long. Outer spores are dark brown, varicose on the free surface and the inner spores are pale yellowish brown, thin-walled and smooth. Spore germination on water agar resulted in 3-6 cells predominant promycelium bearing laterally and terminally spindle sporidia.



A **B**

Fig.2: Germination teliospores forming a promycelium with lateral sporidia: (A) *S. sorghi*, (B) *S. ehrenbergii.*

3- Pathogenicity tests:

The pathogenic capabilities of *S. sorghi* and *S. ehrenbergii* isolates were tested on sorghum Giza 15 and Dorado cvs, respectively. Data in Table (2) indicated that all tested isolates of *S. sorghi* and *S. ehrenbergii* were pathogenic to sorghum plants. Isolate No.2 of *S. sorghi* was the highest pathogenic one (47.67% infection and 17.53% disease severity), whereas isolate No.1 and No.12 were the least pathogenic ones (22.53% and 4.11%) and (20.66% and 3.83%), respectively. (Figure 2). In case of *S. ehrenbergii*, isolate No.4 was the highest pathogenic one (83.50% infection and 45.22 sori per infected plant), whereas isolate No.7, No.10, No.11 and No.12 were the least pathogenic ones (73.23% and 42.50), (72.33% and 42), (72.83% and 42.16) and (72.75% and 42), respectively.

Table 2: Pathogenicity of *S. sorghi* and *S. ehrenbergii* isolates on Giza 15 and Dorado cultivars, respectively performed under field conditions in 2013 growing season.

Isolate		*S. sorghi* on Giza 15 cv.		*S. ehrenbergii* on Dorado cv.	
No.	Source	Infection (%)	DS (%)	Infection (%)	Sori/plant
1	Abu-Tesht	22.53	4.11	78.33	43.33
2	Nakada	47.67	17.53	75.16	44.16
3	Qeft	29.16	4.50	79.50	44.22
4	Qus	28.14	5.16	83.50	45.22
5	Deshna	26.50	5.11	77.67	43.16
6	Bndr Qena	34.83	10.16	78.33	43.23
7	Al-Margha	24.40	3.49	73.23	42.50
8	Al-Osyrat	26.33	3.83	74.50	42.53
9	Al-Baliana	32.50	10.08	74.15	42.63
10	Gerga	29.45	4.83	72.33	42.00
11	Dar El-Salam	35.16	12.19	72.83	42.16
12	Tahta	20.66	3.83	72.55	42.00
Control, sterile distilled water (SDW)		0.0	0.0	0.0	0.0
L.S.D. $_{at\ 0.05}$		2.42	1.27	1.94	1.55

4-2- Efficacy of fungicides on sorghum infection by CKS and LS:

Trials were done to control covered smut and long smut diseases of grain sorghum using vitavax (3gm/ kg seeds), bavstin (3gm/ kg seeds) and sulphur (5gm/ kg seeds) under artificial inoculation with teliospores of *S. sorghi* and with teliospores suspensions of *S. ehrenbergii* at inoculum density rates (10^{x6} , 10^{x8} and 10^{x10}). in two successive seasons, *i.e.* 2014 and 2015. Cultivar Giza-15 and Dorado were used. The experiment was performed in the field of Agricultural Experiment Station of El-Matana. The trial was designed, executed and cultural practices as described under Materials & Methods. Results, Tables (3) revealed that the fungicide vitavax positively affected the disease, *i.e.* disease incidence (D.I.) and disease severity (D.S.) compared with the control, generally. Yield per plot was found to be increased due to coating seed with vitavax fungicide. It was found that the fungicide could prevent infection when seed of G-15 were infested with the smut spores at the rate of 3gm /Kg seeds. Figure (2). Results obtained from the experiment in 2015 were found to be in consistence with those of 2014 (Table 4 and Figure 4). On another hand, data in Tables (5 and 6 Figures 5 and 6) indicate that the treatment by vitavax affected on the long smut incidence (D.I) and the number of sori per panicles after injection by *S. ehrenbergii* teliospores suspension (10^{x10}). Yield (kg) per plot was found to be increased due to dusting the panicles with vitavax fungicides compare with bavstin and sulphur and control in both seasons 2014 and 2015.

Table 3. Efficiency of treating *S. sorghi*-infested sorghum seed of Giza-15 *cv* with fungicidal treatments on infection with covered kernel smut, 2014.

Fungicide (recommended dose g/kg of seed)	Infection%	DS%	Yield (kg)/plot	Yield losses%
Vitavax (3g)	10.50	02.88	04.55	03.19
Sulfur (5g)	15.25	03.03	03.77	19.78
Bavistin (3g)	20.13	07.40	03.60	23.40
Control 1	71.50	24.34	02.90	38.29
Control 2	0.00	0.00	04.70	0.00
Mean	**23.47**	**07.53**	**03.90**	**16.93**
LSD at $_{0.05}$	2.01	0.92	0.12	1.52

Table 4. Efficiency of treating *S. sorghi*-infested sorghum seed of Giza-15 *cv* with fungicidal treatments on infection with covered kernel smut, 2015.

Fungicide (recommended dose g/kg seed)	Infection%	D.S%	Yield (kg)/plot	Yield losses%
Vitavax3 gm	11.50	03.16	04.52	04.84
Sulphur 5 gm	16.33	03.03	03.72	21.68
Bavistin3 gm	21.50	07.66	03.63	23.57
Control treat.	70.00	22.16	02.80	41.05
Control SDW	0.00	0.00	04.75	0.00
Mean	23.86	07.20	03.88	18.22
LSD at 0.05	3.65	0.91	0.21	2.76

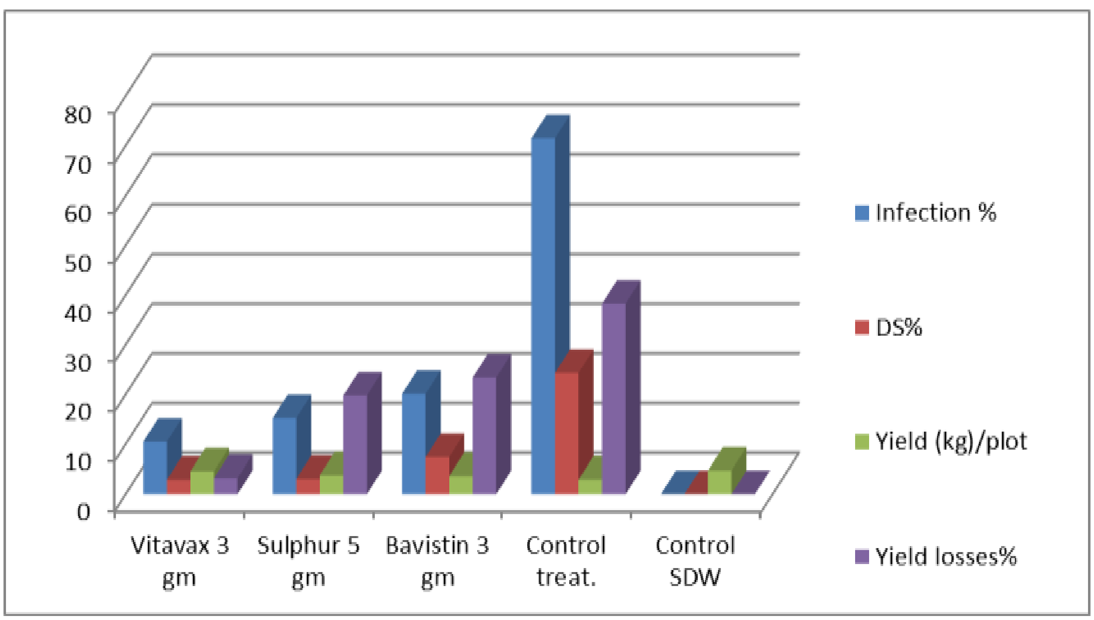


Fig. 2: Efficiency of treating *S. sorghi*-infested sorghum seed of Giza-15 *cv* with fungicidal treatments on infection with covered kernel smut, 2014.

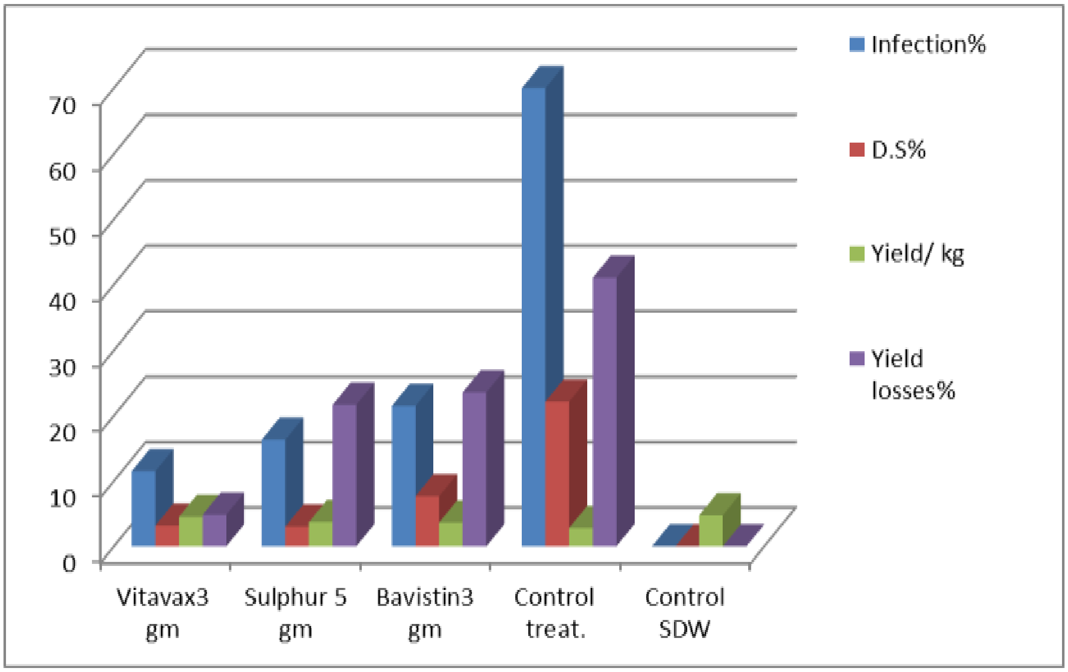


Fig. 3. Efficiency of treating *S. sorghi*-infested sorghum seed of Giza-15 *cv* with fungicidal treatments on infection with covered kernel smut, 2015.

Table 5. Efficiency of treating *S. ehrenbergii*-infested sorghum Dorado *cv* with fungicidal treatments on infection with long smut, 2014.

Fungicide (recommended dose g/L of DW)	D.I%	Sori per plant	Yield (kg)/plot	Yield losses%
Vitavax (3g/L)	05.50	01.75	03.74	04.10
Sulfur (5g/L)	10.16	02.67	03.37	13.58
Bavistin (3g/L)	15.33	04.33	02.90	25.64
Control 1	77.15	13.50	01.97	49.48
Control 2	0.00	0.00	03.90	0.00
Mean	21.62	04.45	03.17	18.56
LSD at 0.05:	3.32	0.89	0.13	2.56

Table 6. Efficiency of treating *S. ehrenbergii*-infested sorghum Dorado *cv* with fungicidal treatments on infection with long smut, 2015.

Fungicide (recommended dose g/L of DW)	D.I%	Sori per plant	Yield (kg)/plot	Yield losses%
Vitavax (3g/L)	06.25	02.00	03.70	05.85
Sulfur (5g/L)	11.33	03.25	03.33	15.26
Bavistin (3g/L)	16.16	04.50	02.87	26.97
Control 1	78.50	15.00	01.92	50.61
Control 2	0.00	0.00	03.93	0.00
Mean	**22.44**	**04.95**	**03.15**	**19.73**
LSD at 0.05:	**3.55**	**0.94**	**0.11**	**2.99**

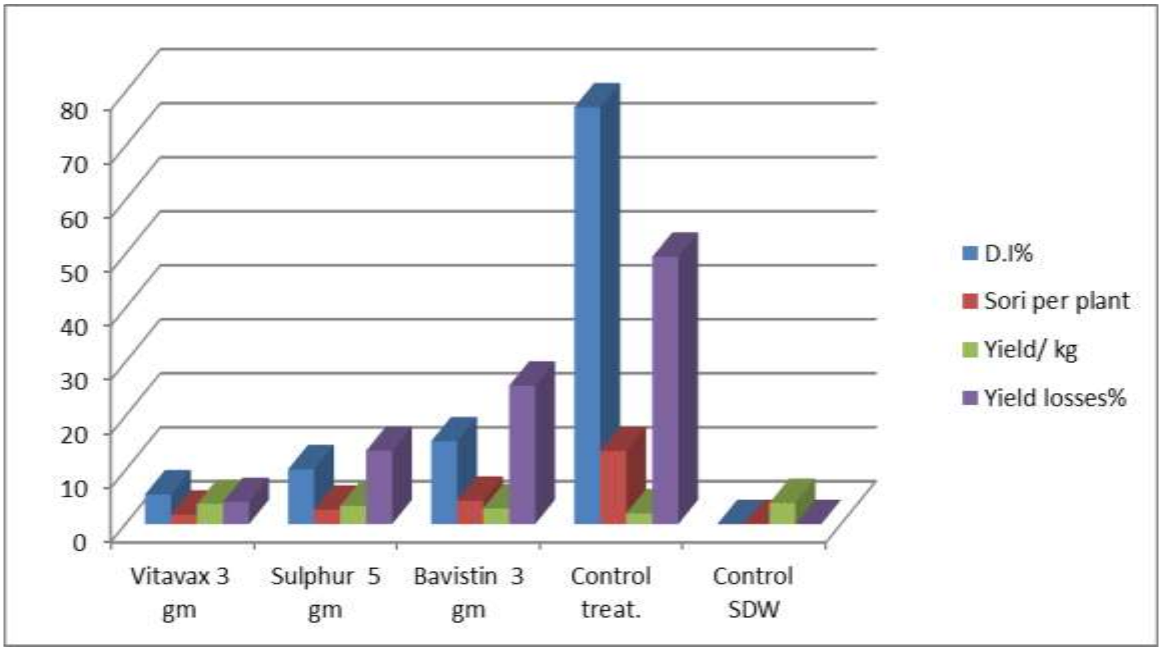


Fig. 4. Efficiency of treating *S. ehrenbergii*-infested sorghum Dorado *cv* with fungicidal treatments on infection with long smut, 2014.

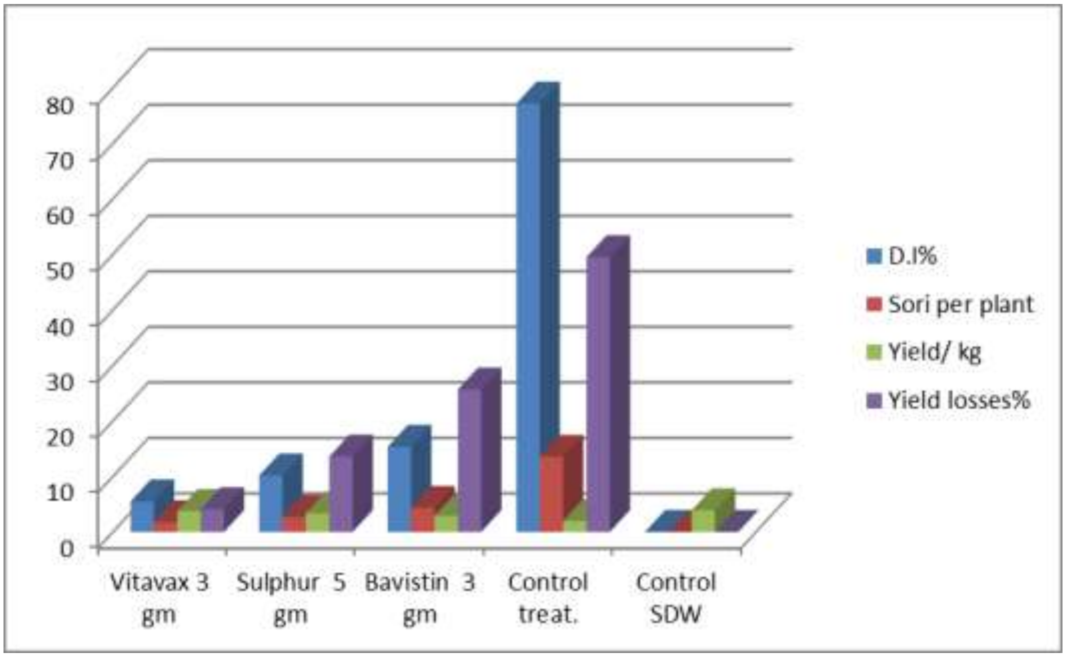


Fig. 5 Efficiency of treating *S. ehrenbergii*-infested sorghum Dorado *cv* with fungicidal treatments on infection with long smut, 2015.

Discussion:

Sorghum plants (*Sorghum bicolor* linn. Moench) the important grains crop for human being and animals in Upper Egypt, are attacked by certain smut diseases causing considerable losses in the grain yield (Botros, 1993). During the growing summer season of 2012, a field survey conducted at Qena and Sohag governorates showed that sorghum plants were infected with covered kernel smut and long smut with various degrees of infection. The results are in agreement with those reported by Botros (1993). The highest percentage of infection with long smut disease was in El-Brahma village- Qena (06.33%), the least percentage was in Bani-Hemail village-Sohag (02.44%). Whereas, covered smut was observed in higher degrees (07.88%) at Al Zawaida-Qena and showed at lowest degree at Bani-Helal village-Sohag (01.05%). Seed borne diseases are the main problems that affect sorghum plants because seed are the economic and edible part of the crop. In Egypt, seed are used as feed and food crop, especially at south Egypt. For this reason, current study threw the light on the importance of getting grains free from smut diseases to the benefit of man and animal. Smutted grain of sorghum plants collected from 12 counties of Qena and Sohag governorates in season 2012. The microscopic examination of teliospores revealed that the causal pathogen of covered kernel smut is *Sporisorium sorghi* Lin. Clint. And the causal pathogen of long smut is *Tolyposporium ehrenbergii* (*Sporisorium ehrenbergii*)(Kuhn) Patouillard. Like other crops, grain sorghum is subject to various infectious diseases which limit grain yield production in the agriculture sector (Vinceli and Hershman, 2011). These unusual diseases and the wide range of environments in which the crop is exposed to challenges of up to three smuts which are commonly namely, the covered kernel smut, loose kernel smut and head smut (Frederiksen *et al*., 2000). A different species of fungus *Sphacelotheca* or *Sporisorium* causes the mentioned smuts above. Smuts are one of the most significant diseases in sorghum production especially where untreated seed is planted. A total number of 12 new isolates of long and 12 new isolates of kernel smuts were recovered from sorghum grown fields of Qena and Sohag during the summer season of 2012. All of these isolates were shown to have the potency to infect the sensitive varieties of Giza-15 and Dorado. These two varieties are known to be susceptible to infection with smut diseases. Sorghum cultivar differed in their ability to infection with these two types of smuts. The most efficient isolates were selected for further study throughout the current work (isolate No. 2 and No. 4 in studying covered kernel smut and long smut, respectively). Present work was planned to assess the importance of these two smut diseases and identify the economic reduction of yield that may happened to grain production. Field trials were done to find out the effect of these smuts on different varieties and hybrids and findings revealed that the open pollinated varieties were more susceptible to infection than the newly produced hybrids. This finding could be explained as follows: The open pollinated varieties were produced by selecting the best candidates within the cultivated local population yielding the high grain production regardless their potential to be resistant to infection with smuts. But hybrids are produced through the breeding program, hence, the produced hybrids are evaluated starting from their inbred linens against several steps for several years to assure that they have the potential to have the high yield and yield components, in addition to be highly resistant to infection with major diseases of the crop. Results indicated that infection percent with grain smut was obviously higher in planting the crop late in the season comparable with planting early. This is may be due to the soil temperature that affects the efficiency of teliospores to attack the juvenile plant roots. Sorghum planted in warm (<30C) soil had the greatest incidence of covered kernel smutted panicles. Ramundo *et al*., (2000). Infection percent, in turn decreased the yield production and increased the yield losses. Yield reduction due to infection with the major diseases are well known in other cereal crops. Late wilt of, for instance reduced yield productivity of maize, estimated as 35 % (Fahmy *et al.*, 1974). yield losses of sorghum due to anthracnose might reach values higher than 70% (Costa *et al.,* 2009). Long smut caused significant decrease in the produced yield as compared with the uninfected plants, which in turn caused an obvious increase in yield losses. High rates of *S. sorghi* and *S. ehrenbergii* teliospores playing great factor to increasing the two smuts diseases infection and yield losses, while it was reduced the yield of grain for the tested cultivars and hybrids. The Toxicity of some certain fungicides on growth of *S. sorghi in vitro* showed significantly inhibited on the radial growth of *S. sorghi in vitro* over check. However, maximum inhibition (89.13%) of mycelial growth was achieved with vitavax (carboxin) followed by bavistin (Carbendazim) (88.73%) and Sulphur (71.04%) at 200 ppm. There are limited reports on the evaluation of fungicides against mycelial growth of *S. sorghi in vitro*, these results were agreement with those reported by (Singh 1987; Castaneda *et al.,* 2001). Vitavax effectively reduced the disease incidence of grain smut on grain sorghum artificially infested with teliospores of *S. sorghi* at the concentration lesser than 1&2 g/Kg seeds of G-15 and Dorado. Treating seeds caused reduction in infection with grain smut and increased the seed weight compared with the control. Vitavax-treated seed had positive effect decreasing the yield losses occurred by grain smut. Findings obtained throughout the current work explained the importance of applying the recommended fungicides to sorghum seeds before seeding. This is to manage infection with grain smut, which in turn decrease the yield losses to the benefit of the crop productivity.

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تأثير بعض المبيدات الفطرية في تطور الإصابة بمرضي تفحم الحبوب المغطى والتفحم الطويل والفاقد في المحصول في حبوب الذرة الرفيعة

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الملخص

نبات الذرة الرفيعة من محاصيل الحبوب الهامة للإنسان والحيوانات خاصة في صعيد مصر، تصاب الذرة الرفيعة بالعديد من امراض التفحمات التي تؤثر فعلياً على وجود خسائر في وزن الحبوب. مرض تفحم الحبوب المغطى (التفحم الحبى) ومرض التفحم الطويل من أكثر أمراض التفحمات إصابة للذرة الرفيعة والتي تؤثر في إنتاجية الحبوب، خاصة إذا كانت الحبوب غير معاملة بالمطهرات الفطرية قبل الزراعة. الصنفين جيزة-15 ودواردو أظهرا اختلافاً واضحاً في قابلية اصابتهما لمرضى التفحم الحبي، والتفحم الطويل على التوالي. المعدلات اللقاحية العالية للأبواغ التيليتية للفطر سبورسوريم سورجاى، والفطر سبورسوريم اهرنبرجياى، أثرت بشكل كبير في زيادة الإصابة بالمرضين، وفى خسارة المحصول، حيث سبّبت نقصاً واضحاً في وزن الحبوب للأصناف المختبرة. أظهرت المبيدات الكيماوية المختبرة تأثيراً واضحا في خفض نسبة الإصابة بمرضي تفحم الحبوب المغطى والتفحم الطويل، وتناقص الفاقد في المحصول للصنف جيزة- 15 والصنف دورادو خلال الموسمين 2014 و2015 مقارنةً بغير المعامل (الشاهد). كان المبيد الفطرى فيتافاكس أكثر تأثيراً ثم يليه الكبريت ثم البافستين.

الكلمات المفتاحية: الذرة الرفيعة، التفحمات، مبيد فطري، الفاقد في المحصول.