Tropical and Subtropical Agroecosystems, 17 (2014): 33 - 38

Short note [Nota corta]

INFLUENCE OF PLANTING DEPTHS ON THE INCIDENCE OF SORGHUM HEAD SMUT, CAUSED BY *Sporisorium reilianum*

[INFLUENCIA DE LA PROFUNDIDAD DE SIEMBRA EN LA INCIDENCIA DEL CARBÓN DE LA PANOJA CAUSADA POR *Sporisorium reilianum*]

Louis K. Prom[1]*, Noe Montes-Garcia[2], and Gary N. Odvody[3]

[1]USDA-ARS, Southern Plains Agricultural Research Center, Crop Germplasm Research Unit, 2765 F & B Road, College Station, Texas 77845. Tel. # (979) 260-9393. E-mail: louis.prom@ars.usda.gov
[2]Instituto Nacional de Investigaciones Forestales, Agricolas y Pecuarias, Centro de Investigación Regional del Noreste, Rio Bravo, Tamaulipas, Mexico.
[3]Department of Plant Pathology and Microbiology, Texas A&M University Agricultural Research and Extension Center, Corpus Christi, TX 78406
**Corresponding author*

SUMMARY

The study was conducted at the Texas A&M Experiment Station in Beeville, TX, to determine the effect of planting depths on the incidence of sorghum head smut. In both years, the incidence of head smut decreased with planting depth. In year 1, no significant difference in head smut incidence was noted in the different planting depths; whereas, in year 2, the number of smutted plants was two-fold and three-fold higher at 6 cm planting depth than at the 15 cm and 22 cm planting depths. The study suggests that planting depths greater than 6 cm could be used as an alternative to minimize the impact of sorghum head smut in the absence of other control methods.

Key words: *Sorghum bicolor*; head smut; cultural practices.

RESUMEN

El estudio fue realizado en la Estación Experimental de Texas A&M en Beeville, TX, para determinar el efecto de la profundidad de siembra en la incidencia del carbón de la panoja del sorgo. En ambos años, la incidencia del carbón de la panoja se redujo con la profundidad de siembra. En el año 2, el número total de plantas infectadas en la profundidad de 6 cm fue dos y tres veces mayor que la observada en la profundidades de 15 cm y 22 cm. El estudio sugiere que la siembra a profundidades superiores a 6 cm se puede utilizar para minimizar el impacto del carbón de la panoja en ausencia de otros métodos de control.

Palabras clave: *Sorghum bicolor*; carbón de la panoja; prácticas agrícolas.

INTRODUCTION

Monocropping and the planting of susceptible hybrids in the sorghum growing region of the United States have increased the incidence of head smut, caused by the soil borne fungal pathogen *Sporisorium reilianum* (Kühn) Langdon & Fullerton (syns. *Sphacelotheca reiliana* (Kühn) G. P. Clinton, and *Sorosporium reilianum* (Kühn) McAlpine) (Frederiksen, 1977; Torres-Montalvo *et al*., 1998; Frederiksen, 2000). Recently, a number of sorghum fields in south Texas, in USA, as well as Tamaulipas and Ocotlan in Mexico were found to be heavily infected with head smut. Head smut has been reported in all sorghum production areas. Once present in the soil, the pathogen is difficult to remove from the soil even by adopting crop rotation strategy (Frederiksen, 2000). The most conspicuous symptom of the disease is the smutted panicle (Figure 1). Sterile and occasionally phyllodied panicle, dwarfed and stunted plants due to the lack of peduncle elongation also are manifestation of *S. reilianum* infection (Wilson and Frederiksen, 1970a; Frederiksen, 2000). Yield losses ranging from 4 to 80% have been recorded in commercial fields (Frederiksen, 1977; Ngugi *et al*., 2002). Over the years, resistant hybrids have been successfully used to control the disease in many areas; however, the appearance of new races within the pathogenic population of *S. reilianum* has caused the breakdown of some of these resistant sources (Frederiksen *et al*., 1975; Frederiksen, 1977; Prom *et al*., 2011). Field evaluation for head smut resistance is costly and

inconsistent, partly due to factors such as teliospore dormancy and distribution within the field, as well as fluctuating soil temperatures (Christensen, 1926; Frederiksen and Rosenow, 1971; Craig and Frederiksen, 1992; Torres-Montalvo *et al*., 1998; Frederiksen, 2000).

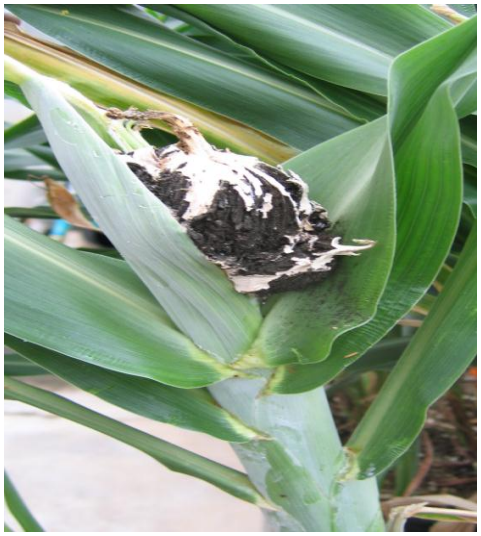

Figure 1. Head smut on sorghum [Sorus covered by a thick white membrane (peridium)]

Sorghum head smut cannot be controlled by fungicide seed treatment because the fungus lives in the soil and grows in respond to the germinating seed (Wilson and Frederiksen, 1970b; Omer and Frederiksen, 1992). Therefore, sustainability of sorghum production and productivity in the presence of head smut will require an integration of cultural practices and genetic resistance. Sorghum seeds can be planted at depths equal to or greater than 2.5 cm. However, studies have shown a reduction in yield at planting depths greater than 7.5 cm (Anonymous, 2013) which can be attributed to the depletion of the food reserve, i.e., the endosperm necessary for seed survival (Kelly, 2004). In the present study, we tested the hypothesis that planting depth determines the level of head smut incidence in sorghum.

MATERIALS AND METHOD

A head smut nursery was established at the Texas AgriLife Experiment Station at Beeville, TX. The experiment was conducted during the months of April to July in each growing season. Sorghum hybrid (A202-B1) obtained from the Texas AgriLife Reseach Center, Corpus Christi, Texas, USA was used in this experiment because of its high susceptibility to *S. reilianum*. This hybrid also is often used as boarder rows in the uniform head smut nursery.

Sorghum seeds treated with Concept to prevent herbicide damage were planted in 60 m rows with 0.31 m row spacing. There were three planting depths: treatment 1=6 cm planting, treatment 2=15 cm planting, and treatment 3=22 cm planting. Each treatment (planting depth) was replicated five times in 2000 and four times in 2001 in a randomized complete block design. The soils in this area are deep, reddish-brown or dark grayish-brown, neutral to alkaline loams and clays. The research site is located at 28° 24′ 20″ N 97° 45′ 3″ W and characterized by a subtropical and temperate environment. This location has a history of high incidence of head smut. Standard field operations in this study included fall plowing and incorporation of the compound fertilizer 60-40-40 ($N–P_2O_5–K_2O$) at 175 kg/ha N and 116.5 kg/ha P_2O_5, and K_2O before planting.

Disease assessment

Plants showing characteristic head smut symptoms which include smutted panicle (Figure 1), phylloidial leaves with smut galls to bleached sterile panicles were counted. Head smut incidence was based on the number of plants showing the characteristic symptoms of head smut out of 100 plants starting from the middle of the row (i.e., starting in the middle of each treated row and counting 50 plants going on opposite sides).

Statistical analyses

Data for head smut incidence were analyzed using PROC ANOVA (SAS version 8.1, SAS Institute, Cary, NC) to determine the effect of planting depth. Due to heterogeneity of the error variance, data for the two years were analyzed separately and not combined. Mean comparisons for the planting depths were conducted with Tukey-Kramer at the 5% probability level.

RESULTS

Incidence of sorghum head smut was significantly affected by planting depth in year 2 (F value = 67.5; P<0.0001), but not in year 1 (F value = 0.06; P=0.9379). In year 1, the level of head smut incidence was low, while higher level of the disease was detected in year 2. In year 2, the number of smutted plants was two-fold and three-fold higher at 6 cm planting depth than at the 15 cm and 22 cm planting depths, respectively (Table 1). Although, the main effect of planting depth was not significant in year 1, a higher disease level was noted at the 6 cm planting depth than the other planting depths.

Table 1. Effect of planting depth on the incidence of sorghum head smut caused by *Sporisorium reilianum*[1]

Planting depth (in cm)	Year 1 Head smut incidence[2]	Year 2 Head smut incidence[3]
6	2.9	29.9a
15	2.6	20.4b
22	2.4	10.4c

[1]Mean percent head smut incidence was based on the number of smutted plants out of 100 plants sampled from the middle of each replicate (five replications/planting depth in year 1 and four replications/planting depth in year 2).
[2]The main effect of planting depth was not statistically significant in year 1.
[3]Means within column with the same letter are not significantly different at the 5% probability level based on Tukey-Kramer test.

DISCUSSION

The study showed that the number of smutted sorghum plants decreased with planting depth from 6 cm to 22 cm. Although, in year 1 head smut incidence at the 6 cm planting depth exhibited little increased in head smut incidence, this level was not significantly different from the other planting depths. The level of head smut incidence also was markedly lower in year 1 than in year 2. Factors such as erratic distribution of the teliospores in the soil, the low rate of teliospores germination, soil temperature, and soil moisture may affect the level of head smut incidence annually (Frederiksen, 1977; Osorio and Frederiksen 1998; Prom *et al*., 2011). Christensen (1926) reported that high soil temperature and low soil moisture favor sorghum head smut infection. He noted that high soil temperature and low soil moisture are more influential to the pathogen than the host. One can safely assume generally that these factors which favor the pathogen are most likely to be encountered at the 6 cm planting depth than at either the 15 cm or 22 cm planting depths, resulting in a higher incidence of sorghum head smut in the shallower planting depth. Our preliminary data have shown higher quantities of teliospores at shallower depths than depths greater than 6 cm. Therefore, plants planted at shallower depths have more chances of encountering the pathogen. Mack *et al*. (1984) observed an increase in corn smut incidence with planting depths greater than 2.5 cm. In the same study, the incidence of smutted corn was significantly higher at 1.3 cm planting depth than at the 2.5 cm planting depth, and this increase in the number of diseased plants at the shallower plant depth was attributed to drier soil surface. However, the incidence of corn smut at the 1.3 cm planting depth was not significantly different from the incidence of corn smut at the other depths greater than 2.5 cm. This study also showed higher incidence of sorghum head smut at shallower depths. Halisky (1962) observed that the isolate that infects sorghum can also infect corn, whereas the isolate that infects corn is host specific. The infection process in both crops is similar. In sorghum, the teliospores in the soil germinate in response to the germinating seed to form a promycelium that bears the sporidia. The sporidia may form yeatlike spores, germinate to form germ tube or spores will fuse with opposite mating type to create a dikaryotic hyphae that penetrate the meristematic tissue of the sorghum seedling. The pathogen grows systematically in the plant and during the flowering stage of the plant replaces the panicle or ear with sori (Frederiksen, 1977; Little *et al*., 2012).

CONCLUSION

Cultural practices such as planting depth greater than 6 cm could be used to minimize the incidence of sorghum head smut in the absence of other management strategies.

DISCLAIMER

Mention of trade names or commercial products in this article is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the U. S. Department of Agriculture.

REFERENCES

Anonymous. 2013. Achieving target population in grain sorghum. Pacific Seeds. www.pacificseeds.com.au/info-and-tools/agronomy-topics/181-achieving-target-population-in-sorghum.html. Retrieved: October 29, 2013.

Christensen, J.J. 1926. The relation of soil temperature and soil moisture to the development of head smut of sorghum. Phytopathology 16:353-357.

Craig, J., Frederiksen, R.A. 1992. Comparison of sorghum seedling reactions to *Sporisorium reilianum* in relation to sorghum head smut resistance classes. Plant Disease 76:314-318.

Frederiksen, R.A. 1977. Head smuts of corn and sorghum. In: Proc. 32nd Annu. Corn Sorghum Res. Conf. H.D. Loden and D. Wilkinson, eds. American Seed Trade Association, Washington, DC. Pp: 89-105

Frederiksen, R.A. 2000. Head Smut. In: Compendium of Sorghum Diseases 2nd ed. R. A. Frederiksen and G. N. Odvody, eds. American Phytopathological Society, St. Paul, MN. Pp: 18-20.

Frederiksen, R.A., Rosenow, D.T. 1971. Disease resistance in sorghum. Proc. 26th Annual Corn & Sorghum Research Conference 26:71-82.

Frederiksen, R.A., Rosenow, D.T., Reyes, L. 1975. Races of *Sphacelotheca reiliana* on sorghum in Texas. Plant Disease Reporter 59:549-551.

Halisky, P.M. 1962. Prevalence and pathogenicity of *Sphacelotheca reiliana* causing head smut of field corn in California. Phytopathology 52:199-202.

Kelly, J. 2004. Cultural Practices. In: Grain sorghum production handbook M297. L. Espinoza, J. Kelley, eds. University of Arkansas, Cooperative Extension Service, MP297-3M-1-04R. Pp: 7-8

Little, C.R., Perumal, R., Tesso, T., Prom, L.K., Odvody, G.N., Magill, C.W. 2012. Sorghum pathology and biotechnology – A fungal disease perpective: Part1. Grain mold, head smut, and ergot. The European Journal of Plant Science and Biotechnology. 6:10-30.

Mack, H.J., Baggett, J.R., Koepsell, P.A. 1984. Effect of cultural Practices on the incidence of head smut in sweet corn. HortScience 19:77-78.

Ngugi, H.K., King, S.B., Abayo, G.O., Reddy, Y.V.R. 2002. Prevalence, incidence, and severity of sorghum diseases in western Kenya. Plant Disease 86:65-70.

Omer, E. H., Frederiksen, R.A. 1992. Sorghum Smuts. In: Sorghum and Millets Diseases: A Second World Review. W.A.J. de Milliano, R.A. Frederiksen, G.D. Bengston, eds. International Crops Research Institute for the Semi-Arid Tropics, Patancheru, India. Pp: 245-252.

Osorio, J.A., Frederiksen, R.A. 1998. Development of an infection assay for *Sporisorium reilianum*, the head smut pathogen on sorghum. Plant Disease 82:1232-1236.

Prom, L.K., Perumal, R., Erattaimuthu, S.R., Erpelding, J.E., Montes, N., Odvody, G. N., Greenwald, C., Jin., Z., Frederiksen, R., and Magill, C. W. 2011. Virulence and molecular genotyping studies of *Sporisorium reilianum* isolates in sorghum. Plant Disease 95:523-529.

Torres-Montalvo, H., McDonald, B.A., Magill, C.W., Frederiksen, R.A. 1998. Structure of Sporisorium reilianum populations from Mexico, USA, and Niger. International Sorghum and Millets Newsletter 39:110-113.

Wilson, J.M., Frederiksen, R.A. 1970a. Histopathology of the interaction of *Sorghum bicolor* and *Sphacelotheca reiliana*. Phytopathology 60:828-832.

Wilson, J.M., Frederiksen, R.A. 1970b. Histopathology of resistance in the *Sorghum bicolor-Sphacelotheca reiliana* interaction. Phytopathology 60:1365-1367.

Submitted October 01. 2012 – Accepted October 22, 2013
Revised received December 29, 2013