Interactions Between *Phymatotrichum omnivorum* and *Sorghum bicolor*

C. M. RUSH, Research Scientist, and T. J. GERIK, Assistant Professor, Texas Agricultural Experiment Station, Blackland Research Center, P.O. Box 748, Temple, TX 76503, and S. D. LYDA, Professor, Department of Plant Pathology, Texas A&M University, College Station 77843

ABSTRACT

Rush, C. M., Gerik, T. J., and Lyda, S. D. 1984. Interactions between *Phymatotrichum omnivorum* and *Sorghum bicolor*. Plant Disease 68:500-501.

Borescopic observations of sorghum roots grown in association with *Phymatotrichum omnivorum* revealed that the fungus causes small burgundy-colored lesions on the roots. After contact, however, the fungus does not continue to grow on the lesion as on cotton roots, and new strands do not develop from the point of root contact. Lesion development on sorghum roots resembles a hypersensitive resistance reaction. Sorghum plants grown in association with *P. omnivorum* showed no reduction in root or shoot weights compared with plants grown in the absence of the fungus. Sorghum plants were capable of supporting sclerotia formation. The number of sclerotia produced in association with grain sorghum was about half the number produced when cotton was host. It is suggested that sclerotial formation in association with grain sorghum may be a result of saprophytic survival of the fungus on root exudates as opposed to a parasitic interaction.

Phymatotrichum omnivorum (Shear) Duggar is indigenous to the Blackland soils of central Texas. Traditionally, the primary crops grown in this region have been cotton (*Gossypium hirsutum* L.) in rotation with grain sorghum (*Sorghum bicolor* L. Moench), although in recent years, corn (*Zea mays* L.) and wheat (*Triticum aestivum* L.) acreages have increased. Although *P. omnivorum* can severely reduce cotton yields, it has no obvious effect on monocotyledonous crops. Considerable research has been conducted to discover the mechanism of monocot resistance. Although most of these studies have concluded that monocots are resistant or immune to *P. omnivorum* (2,8), others have suggested that monocots are susceptible (4,9) and merely escape disease because of their fibrous root systems. This study was conducted to further characterize the interactions between *P. omnivorum* and monocotyledonous hosts. The two primary objectives of these studies were to determine 1) if *P. omnivorum* would reduce root or shoot weights of grain sorghum and 2) if sclerotia of *P. omnivorum* could form with grain sorghum as the test plant.

MATERIALS AND METHODS

Twelve 19-L containers were equipped for borescopic observation as described previously (6). The containers were filled with nonsterile Houston Black clay and inoculated with about 2 g of *P. omnivorum* sclerotia. Sorghum seeds were then planted and thinned to one plant per container after emergence. Observations of host-pathogen interactions were made at 3-day intervals.

To determine the effects of *P. omnivorum* on sorghum root and shoot growth, plants were grown in containers 10 cm wide and 60 cm deep containing nonsterilized Houston Black clay. Eighteen containers were inoculated with sclerotia of *P. omnivorum* at planting and 18 remained uninfested as checks. The experiment was replicated four times. Plants were harvested at three maturity stages: boot, anthesis, and maturity. At each date, root and shoot weights were determined for 24 inoculated and uninoculated plants.

Studies of host effect on sclerotial production were conducted in a temperature tank maintained at 28 C. Cotton or sorghum was planted in containers 10 cm wide and 60 cm deep containing nonsterile Houston Black clay. Soil in all containers was infested with about 2 g of sclerotia at time of planting. The experiment was replicated three times, with 18 containers used per host tested. Six weeks after emergence, the sorghum plants and any cotton plants that had not died were cut off at ground level. The containers remained in the temperature tank for an additional 10 wk. After this incubation period, the soil from each container was sieved through a 500-μm screen. Sclerotia were separated by floating them from the debris with a 2.5 M sucrose solution.

RESULTS

Borescopic observations revealed that strands of *P. omnivorum* grew profusely in association with roots of grain sorghum but never formed a fungal mantle around the root as described for cotton (4,6,7). Often when a young rapidly growing fungal strand of *P. omnivorum* came into contact with a sorghum root, a burgundy-colored lesion developed within 24 hr. These lesions were localized, usually not progressing more than 2–3 mm to either side from the point of fungal contact. The fungus did not proliferate on these lesions or send out new strands as is often observed with strands of *P. omnivorum* on cotton roots. The lesions described here on sorghum appear very similar to those reported by Rogers (5) on day lily.

Sorghum plants grown in association with *P. omnivorum* showed no reduction in root or shoot weight compared with check plants grown in the absence of the fungus (Table 1). Roots of plants grown in association with the fungus were

Table 1. Effects of *Phymatotrichum omnivorum* on root and shoot weights of *Sorghum bicolor*

	Harvest date 1[a]		Harvest date 2		Harvest date 3	
Sorghum	Root	Shoot	Root	Shoot	Root	Shoot
Inoculated[b]	0.81	2.95	1.68	7.63	5.12	14.59
Check	0.55	2.52	1.59	5.66	5.96	16.84
$LSD_{0.05}$	0.13	0.52	0.23	0.82	1.64	2.50

[a] Date 1 = boot stage, date 2 = anthesis, date 3 = maturity.
[b] Inoculated with 2 g of sclerotia of *P. omnivorum* at planting.

Table 2. *Phymatotrichum* sclerotial formation as affected by host

Host[a]	No. containers	No. containers with sclerotia	Total sclerotia recovered	Range	Avg. sclerotia/ container
Cotton	52	27	1,274	0–138	24.5
Sorghum	49	25	583	0–122	11.9
$LSD_{0.05}$					10.1

[a] Inoculated with 2 g of sclerotia of *P. omnivorum* at planting.

Accepted for publication 14 December 1983.

significantly heavier than roots from check plants at the first harvest. At the second harvest, plants grown with the fungus had a significantly ($P = 0.05$) heavier shoot weight. By the third harvest, there were no significant differences between the root and shoot weights of check plants and plants grown with the fungus.

Results of sclerotial formation as affected by host are presented in Table 2. New sclerotia were formed with both cotton and sorghum as test plants. There was no significant difference in the total number of containers in which sclerotia formed, but the average number of sclerotia per container planted to cotton was about twice that found in containers planted to sorghum.

DISCUSSION

The results from these studies indicate that grain sorghum is resistant to *P. omnivorum*. Borescopic observations showed definite lesion development when young strands came into contact with the sorghum root, but these lesions were restricted in size. Also, there was no obvious increase in fungal growth around the point of contact as reported with cotton (6,7). It appears that lesion formation by the sorghum root is a type of resistance reaction similar to a hypersensitive response. According to Taubenhaus (8), similar lesions are also caused by other soil fungi such as *Fusarium* and *Rhizoctonia*. Although *P. omnivorum* does form localized lesions on the roots, they are insignificant from a production standpoint. Sorghum plants grown in association with *P. omnivorum* had equal or greater root and shoot weights than plants grown without the fungus.

Despite the apparent lack of parisitism of sorghum roots by *P. omnivorum*, the fungus was still capable of producing new sclerotia with this host. This observation is in contrast to previous reports by Taubenhaus (8) and Rogers (5). Taubenhaus reported that monocotyledonous plants were neither hosts nor carriers of *P. omnivorum*, and Rogers stated that the presence of susceptible plant roots was necessary for continued sclerotial production.

It is unlikely that the sclerotia that formed in association with grain sorghum were the result of parasitism at the local lesions. An alternative explanation is that *Phymatotrichum* was acting in a saprophytic manner when in association with grain sorghum. It is well documented that many organisms survive on root exudates (1,3). It has also been reported that 80% of the total carbon released into the soil in a wheat rhizosphere was in the form of insoluble mucilaginous exudates (3). The large root biomass such as that produced by sorghum plants is capable of producing considerable amounts of root exudates. In view of the lack of evidence of a parasitic interaction between *P. omnivorum* and sorghum plants, saprophytic survival on host exudates is a feasible alternative explanation for the production of new sclerotia.

LITERATURE CITED

1. Dommengues, Y. R., and Krupa, S. V. 1978. Interactions Between Non-pathogenic Soil Microorganisms and Plants. Y. R. Dommengues and S. V. Krupa, eds. Elsevier, New York. 475 pp.
2. Ezekiel, W. N., and Fudge, J. F. 1938. Studies on the cause of immunity of monocotyledonous plants to Phymatotrichum root rot. J. Agric. Res. 56:773-786.
3. Hale, M. G., Moore, L. D., and Griffin, G. J. 1978. Root exudates and exudation. Pages 163-203 in: Interactions Between Non-pathogenic Soil Microorganisms and Plants. Y. R. Dommengues and S. V. Krupa, eds. Elsevier, New York. 475 pp.
4. Lyda, S. D. 1978. Ecology of *Phymatotrichum omnivorum*. Annu. Rev. Phytopathol. 16:193-209.
5. Rogers, C. H. 1942. Cotton root rot studies with special reference to sclerotia, cover crops, rotations, tillage, seedling rates, soil fungicides, and effects on seed quality. Texas Agric. Exp. Stn. Bull. 614. 45 pp.
6. Rush, C. M., Upchurch, D. R., and Gerik, T. J. 1984. In situ observations of *Phymatotrichum omnivorum* with a borescope mini-rhizotron system. Phytopathology 74:104-105.
7. Streets, R. B., and Bloss, H. E. 1973. Phymatotrichum root rot. Monogr. 8. American Phytopathological Society, St. Paul, MN. 38 pp.
8. Taubenhaus, J. J., and Ezekiel, W. N. 1932. Resistance of monocotyledons to Phymatotrichum root rot. Phytopathology 22:443-452.
9. Watkins, G. M., and Watkins, M. O. 1940. Experimental Phymatotrichum root rot of ratama and corn. Torrey Bot. Club Bull. 67:489-501.