Breakdown in Thielaviopsis basicola Root Rot Resistance in Cotton by Hydrocinnamic (3-phenylpropionic) Acid

R. G. Linderman and T. A. Toussoun

Department of Plant Pathology, University of California, Berkeley 94720.

Present address of R. G. Linderman: Crops Research Division, ARS, USDA, Beltsville, Maryland 20705.

This research was supported in part by NIH Grant No. EF 00576 and USDA Grant No. 1-440375-22455.

Seed of *Gossypium arboreum* was kindly supplied by Jack Otta, University of California, Davis, whose original source was J. Meyer, Geneticist, USDA Delta Branch Experiment Station, Stoneville, Mississippi.

We recently reported (4) the efficacy of certain crop residue decomposition products, identified by Toussoun et al. (7), to predispose cotton roots to increased root rot by *Thielaviopsis basicola* (Berk. & Br.) Ferr. The main compound with this predisposing capacity was hydrocinnamic (3-phenylpropionic) acid. Patrick and Koch (6) showed that resistance in tobacco to *T. basicola* root rot could be overcome by treating roots prior to inoculation with phytotoxic extracts of decomposing residues. The compound(s) responsible for this activity, however, was not known. The purpose of this study was to determine whether resistance in cotton to *T. basicola* root rot could be overcome with hydrocinnamic acid prior to inoculation.

Varieties of cotton (*Gossypium arboreum* L.), known to be susceptible (A-32) and resistant (A-25 and A-26) to *T. basicola* were grown for 3 days in U.C. mix (1) at 27 C in the greenhouse. These seedlings were removed and the tap roots treated for 2 hr in water or a 75-ppm solution of hydrocinnamic acid. The treated and control plants were then transplanted into plastic inoculation chambers (3), and the tap roots were inoculated at two loci with small units of field soil infested with chlamydospores of *T. basicola* (clone C isolated from cotton). This soil had been wet for several days for reasons presented elsewhere (2). After 5 days at room temperature (approximately 23 C) the inoculation sites were rated for disease severity based on the degree of tissue discoloration and the extent of fungus proliferation. Ratings of 0 for no infection to 10 for maximum infection were used. The results of these experiments, presented in Table 1 and Figure 1, show that hydrocinnamic acid treatment of resistant roots rendered them susceptible to attack by *T. basicola*.

Our observations on the resistant varieties A-25 and A-26 confirm those made by Mathre and Otta (5) that chlamydospores of *T. basicola* do germinate to a limited extent on the roots of resistant or tolerant varieties, and epidermis penetration by their germ tubes does occur. However, subsequent proliferation of the fungus is restricted. Proliferation of the fungus on varieties A-25 and A-26 treated with hydrocinnamic acid, on the other hand, was not restricted. In addition, a greater number of chlamydospores were observed to germinate and give rise to infection sites.

TABLE 1. Disease severity ratings on cotton roots of susceptible (A-32) and resistant (A-25, A-26) varieties treated 2 hr with water or 75 ppm hydrocinnamic acid and inoculated with small units of field soil infested with chlamydospores of *Thielaviopsis basicola*

	Disease severity ratings		
	Susceptible	Resistant	
Treatment	A-32	A-25	A-26
Water	6.63[a]	0.75	0.25
Hydrocinnamic acid (75 ppm)	9.61	3.04	3.32

[a] Average disease ratings from two experiments with 16 replications/treatment per experiment.

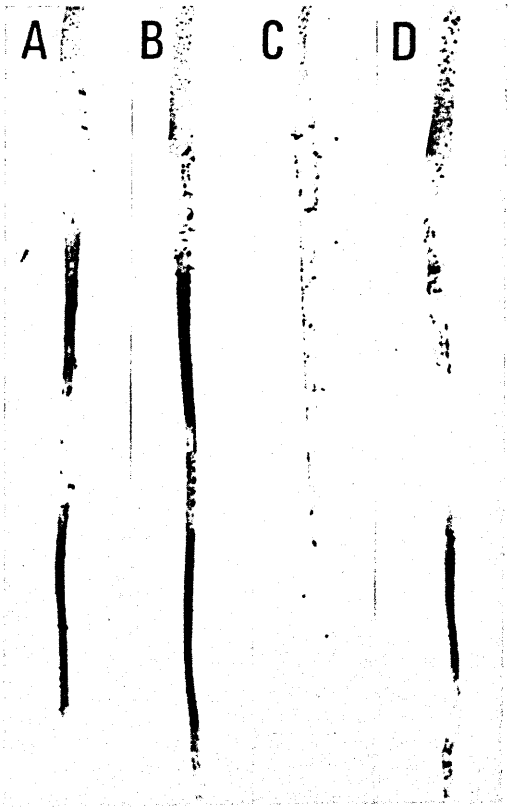

Fig. 1. Roots of cotton varieties resistant or susceptible to *Thielaviopsis basicola*. **A)** Susceptible variety A-32 treated 2 hr with water prior to inoculation with clone C of *T. basicola*. **B)** A-32 treated 2 hr with 75 ppm hydrocinnamic acid prior to inoculation. **C)** Resistant variety A-26 treated 2 hr with water prior to inoculation. **D)** A-26 treated 2 hr with 75 ppm hydrocinnamic acid prior to inoculation.

The significance of this report lies in the fact that hydrocinnamic acid, a compound occurring naturally during the breakdown of crop residues in soil, can bring about a breakdown of *T. basicola* root rot resistance. In addition to having potential field significance, this phenomenon may yield insight as to the nature of the resistance mechanism in this and other host plants.

Treatment of resistant roots with hydrocinnamic acid somehow increases the responsiveness of the fungus to stimulatory root exudates. In addition, when penetration did occur, the fungus was less restricted in a hypersensitive reaction. It is possible, then, that resistance of roots to attack by *T. basicola* involves some prepenetration mechanism as well as a post-penetration hypersensitive reaction. Hydrocinnamic acid may interfere with these mechanisms: (i) by removing or preventing formation of normally inhibitory substances which might be emitted from and present in resistant variety tissues, (ii) by increasing the exudation of stimulatory materials, or (iii) both.

LITERATURE CITED

1. Baker, K. F. (ed.). 1957. The U.C. System for producing healthy container-grown plants. Calif. Agr. Exp. Sta. Manual 23, 332 p.
2. Linderman, R. G., and T. A. Toussoun. 1967. The behavior of *Thielaviopsis basicola* in nonsterilized soil. Phytopathology 57:729-731.
3. Linderman, R. G., and T. A. Toussoun. 1967. Pathogenesis of *Thielaviopsis basicola*. Phytopathology 57: 1007. (Abstr.)
4. Linderman, R. G., and T. A. Toussoun. 1967. Predisposition to *Thielaviopsis* root rot by phytotoxins obtained from decomposing plant residues. Phytopathology 57:819. (Abstr.)
5. Mathre, D. E., and J. D. Otta. 1967. Sources of resistance in the genus *Gossypium* to several soilborne pathogens. Plant Dis. Reptr. 51:864-866.
6. Patrick, Z. A., and L. W. Koch. 1963. The adverse influence of phytotoxic substances from decomposing plant residues on resistance of tobacco to black root rot. Can. J. Bot. 41:747-758.
7. Toussoun, T. A., A. R. Weinhold, R. G. Linderman, and Z. A. Patrick. 1968. Nature of phytotoxic substances produced during plant residue decomposition in soil. Phytopathology 58:41-45.