Control of Fusarium Wilt of Mimosa with Benomyl and Thiabendazole

P. M. Phipps and R. J. Stipes

Department of Plant Pathology and Physiology, Virginia Polytechnic Institute and State University, Blacksburg 24061. Present address of the senior author: Department of Plant Pathology, North Carolina State University, P.O. Box 5397, Raleigh 27607.

Contribution No. 275 of Virginia Polytechnic Institute and State University.

Based on a portion of the M.S. thesis of the senior author.

We thank Merck and Company and The Virginia Academy of Science for grant-in-aid support, and Merck and Company and E. I. du Pont de Nemours and Company for gratis samples of thiabendazole and benomyl, respectively. We also thank Ms. Jean L. Ratliff for technical assistance.

ABSTRACT

Disease control in greenhouse-grown mimosa (*Albizia julibrissin*) seedlings was evaluated by applying root drenches of benomyl or thiabendazole at various time intervals, dosage levels, and frequencies before or after root dip spore suspension inoculation with the wilt fungus, *Fusarium oxysporum* f. sp. *perniciosum*. In all treatments, benomyl was more effective than thiabendazole in reducing symptom expression and fungous re-isolation. Only benomyl administered at the high level (500 μg/ml) either one week before or immediately after inoculation, and at the low level (100 μg/ml) at weekly intervals, resulted in disease prevention. Benomyl (500 μg/ml), applied at initial wilt symptoms, induced marked recovery. Thiabendazole treatments reduced disease development when applied before or immediately after inoculation. Phytotoxicity resulted after weekly and daily thiabendazole treatments, whereas benomyl was toxic after daily applications. Since both compounds failed to eradicate the parasite from inoculated roots, their practical implementation may be limited to periodic, preventive applications.

Additional key words: systemic fungitoxicants, prophylactic and therapeutic effects, soil drench, dosage-response effect.

Fusarium wilt of mimosa (*Albizia julibrissin* Durazz.) is one of the most destructive vascular wilt diseases of southern landscape trees. Initial studies (3) on the disease and the causal organism, *Fusarium oxysporum* f. sp. *perniciosum* (Hepting) Toole, revealed it to be a vascular disease having symptoms similar to Dutch elm disease, persimmon wilt, oak wilt, and tree wilts caused by *Verticillium* Nees. Although a selection program resulted in release of the two cultivars, 'Charlotte' and 'Tryon' (4), their resistance was reported as ineffective after 15 years (2).

In recent attempts to control vascular wilt diseases of trees, the systemic fungitoxicants, benomyl and thiabendazole, have appeared as the most attractive agents. Uptake and translocation of benomyl and thiabendazole were demonstrated in mimosa after application in a lanolin base to bark and wood tissues (7). The research reported herein was designed to determine the prophylactic and/or therapeutic effects on greenhouse seedlings of these fungitoxicants applied as root drenches either before or after fungous inoculation. Subsequent to our preliminary reports (6, 9), benomyl was reported to control mimosa wilt in greenhouse-grown seedlings when applied as a soil amendment (1). We selected the drench mode of application, since it has proven to be more practical and effective than mechanical soil incorporation techniques in field attempts to control Dutch elm disease (8, 10).

Six-week-old greenhouse seedlings for treatment were obtained from seeds planted in steamed Weblite (an expanded shale by-product, Webster Block Co., Roanoke, Virginia) which has little or no ion exchange capacity. Composite conidial inoculum was obtained from pathogenic isolates (F9, F13 = ATCC 24566, F17, F18, and F19) of *F. oxysporum* f. sp. *perniciosum*. The inoculum was washed three times by centrifugation and the density standardized to 3×10^5 conidia/ml with a haemocytometer.

In each experiment, three replicates of ten seedlings per 12 cm diameter plastic pot were treated in one of the following ways: (i) uprooted, dipped in sterile, distilled water then replanted; (ii) uprooted, dipped in sterile, distilled water, replanted then drenched immediately with a fungitoxicant; and (iii) uprooted, dipped in inoculum then replanted. The latter group included seedlings to be used in chemical treatments at various time intervals, levels and frequencies. Benomyl and thiabendazole, as 50% and 60% wettable powder formulations, respectively, were applied to the growth medium at various concentrations (100 μg/ml, 300 μg/ml, or 500 μg/ml active ingredient) in suspension. Approximately 330 ml of suspension were applied in each treatment. All phases of the experiment were repeated at least two times, and in some cases, four times.

Disease severity was monitored weekly by a modification of the McKinney index (5) whereby seedlings were placed in one of the following numbered classes: healthy-0, chlorotic-1, wilted-2, defoliated-3 and dead-4. Plants which produced small adventitious sprouts after defoliation were placed in class 2 until the syndrome changed. The disease severity index (DSI) for each treatment was computed by the equation:

$$\text{DSI} = \frac{\Sigma\ (\text{Class rating} \times \text{Class frequency})}{(\text{Total number of plants} \times 4)} \times 100.$$

At harvest, fresh weights of intact plants were determined and infection was metered by noting vascular discoloration in xylem tissues and isolation of the pathogen in culture. Isolations were attempted on chloramphenicol-amended glucose-yeast extract agar (cGYEA) constituted of 0.5% glucose, 0.1% yeast extract, 200 μg/ml chloramphenicol and 2% agar. Roots and shoots were rated individually for vascular discoloration by splitting the stem and tap root after surface sterilization in a 10% Clorox solution.

Growth (fresh wt) of uninoculated, treated control seedlings was not reduced by thiabendazole at 100 μg/ml or benomyl at all levels. Thiabendazole at 300 μg/ml and 500 μg/ml caused a significant (95% level of confidence) reduction in growth and resulted in marginal necrosis in

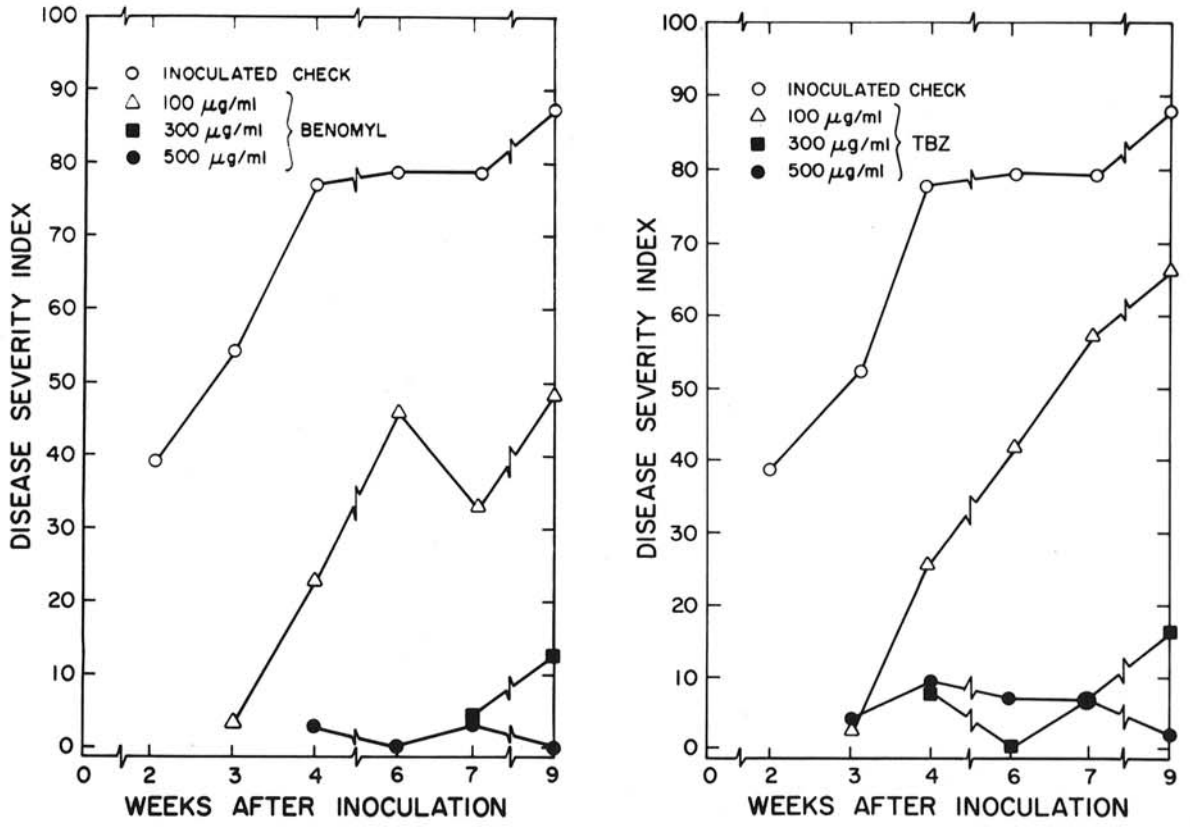

Fig. 1. Therapeutic effects on mimosa (*Albizia julibrissin*) seedlings of benomyl and thiabendazole drenches applied immediately after root-dip inoculation with *Fusarium oxysporum* f. sp. *perniciosum*.

leaflets. Daily benomyl treatments (100 μg/ml) moderately reduced plant growth, whereas thiabendazole treatments (100 μg/ml) caused severe injury in both weekly and daily treatments.

Single applications of either benomyl or thiabendazole were most therapeutic when applied immediately after inoculation and a positive dosage-response relationship was apparent (Fig. 1). Benomyl was superior to thiabendazole in prophylactic and therapeutic effects. At the 500 μg/ml level, benomyl completely prevented disease development when applied 1 week before inoculation and suppressed the DSI to a level below ten when applied 1 week after inoculation. A marked curative response was observed when symptomatic seedlings were treated with benomyl at the high level. Thiabendazole treatments were not therapeutic when applied 1 week after inoculation or at the time of initial wilt symptoms.

Benomyl treatments (100 μg/ml) at weekly intervals almost completely suppressed symptoms, whereas daily intervals produced chlorotic symptoms after 7 weeks. Thiabendazole treatments (100 μg/ml) at weekly or daily intervals were not therapeutic and plants exhibited symptoms of chemical injury.

The frequency of reisolation of the pathogen was least from seedlings treated with benomyl immediately after inoculation. Biopsy tissues from seedlings treated with the fungicides either weekly or daily failed to yield the pathogen in culture. Vascular discoloration was observed in all seedlings treated once, but was less intense in benomyl-treated seedlings. In seedlings treated more than once with benomyl, only occasional small flecks of discoloration were present in roots and stems.

The frequent reisolation of the pathogen from inoculated, treated seedlings suggested that the compounds may act primarily as fungistats in host tissues. Fungistatic effects on the parasite may effectively reduce or even prevent the release of toxic metabolites which block the host's general resistance mechanism against vascular invaders. The induction of a marked curative response observed as a temporary remission of symptoms lends support to this hypothesis in the case of benomyl. Since, in most cases, both compounds failed to eradicate the parasite in the host, their practical implementation in the field may be limited to periodic preventive applications.

LITERATURE CITED

1. ATTABHANYO, A., and G. E. KOLCOMB. 1972. Benomyl controls Fusarium wilt and is translocated in mimosa seedlings. Phytopathology 62:744 (Abstr.).
2. GILL, D. L. 1964. Wilt of mimosa-wilt resistant cultivars. Plant Dis. Rep. 48:648.

3. HEPTING, G. H. 1939. A vascular wilt of the mimosa tree (Albizzia julibrissin). U.S. Dept. Agric. Circ. 535. 11p.
4. HEPTING, G. H., and E. R. TOOLE. 1942. Mimosa wilt—A major problem. Pages 254-258 *in* Proc. 18th National (later renamed "International") Shade Tree Conf., 25-27 August 1942, Chicago, Illinois (within a section of the above reference titled: Proc. 5th Southern Shade Tree Conf., 19-21 February 1942, Miami, Florida). 398 p.
5. MC KINNEY, H. H. 1923. Influence of soil temperature and moisture on infection of wheat seedlings by Helminthosporium sativum. J. Agric. Res. 26:195-218.
6. PHIPPS, P. M., and R. J. STIPES. 1972. The curative effects of two systemic, fungitoxic benzimidazoles on "mimosa" seedlings exhibiting Fusarium wilt symptoms. Va. J. Sci. 23:122 (Abstr.).
7. STIPES, R. J. 1969. Uptake and translocation of thiabendazole and benomyl applied to phloem and xylem tissues of Albizzia julibrissin. Va. J. Sci. 20:100 (Abstr.).
8. STIPES, R. J. 1973. Control of Dutch elm disease in artificially-inoculated American elms with soil-injected benomyl, captan and thiabendazole. Phytopathology 63:735-738.
9. STIPES, R. J., P. M. PHIPPS, and D. R. ODERWALD. 1971. Prophylactic and therapeutic responses of Fusarium wilt of mimosa to benomyl and thiabendazole. Va. J. Sci. 22:108 (Abstr.).
10. STIPES, R. J., and K. E. WEINKE. 1972. Dutch elm disease: Control with soil-amended fungicides. Plant Dis. Rep. 56:604-608.