Soil Fumigation Effects on Early Blight of Tomato Transplants

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ABSTRACT

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Treatment of field plots with certain general-purpose fumigants for control of soil-borne plant pathogenic fungi and nematodes on tomatoes grown for transplants also significantly reduced severity of early blight caused by *Alternaria solani*. Vapam applied as a drench was more effective than methyl bromide and Vorlex in improving plant vigor and reducing severity of early blight. Sodium azide improved vigor slightly but did not significantly reduce early blight. Decreased disease severity on plants in fumigated plots was attributed to increased plant vigor rather than elimination of primary inoculum.

Additional key words: foliar pathogens, *Lycopersicon esculentum*.

Southern Georgia is a major production area for tomato transplants to be shipped to northern areas of the United States and southern Canada. Historically, these plants were produced on newly-cleared land to avoid plant pathogenic fungi and nematodes (4). As growers established permanent production sites in recent years, the incidence of diseases caused by soil-borne pathogens increased. Because of this increased disease severity, interest in soil treatment with general-purpose fumigants has also increased. We found that some of these fumigants not only controlled soil-borne pathogens but they also influenced the severity of early blight caused by *Alternaria solani* (Ell. & G. Martin) Sor., a major disease on transplants. This paper reports the incidence of early blight on transplants after soil treatment with four general-purpose fumigants.

MATERIALS AND METHODS

Field plots were established near Tifton, Georgia, in 1974. After land preparation, various chemicals were applied to 1.83 m × 10.7 m beds of soil. Treatments were: (i) methyl bromide (Dowfume MC-2, 490 kg/ha), applied under a 102-μm (4-mil) polyethylene film; (ii) Vapam (sodium methyl dithiocarbamate, 748 liters/ha), applied as a drench in 6,500 liters of water; (iii) Vorlex (20% methyl isothiocyanate + 80% 1,2-dichloropropane, 1,3-dichloropropene and related chlorinated hydrocarbons, 327 liters/ha), injected 15-20 cm deep on 23-cm centers; (iv) sodium azide (NaN_3, granular, 62 kg/ha), applied to the soil surface with a Gandy applicator and incorporated into the top 15 cm with a tractor-mounted rotary tiller; and (v) control (no chemical). All chemicals except methyl bromide were applied 3-4 weeks before seeding and were sealed into the soil with approximately 1.3 cm of water applied by overhead irrigation. Methyl bromide was applied 10 days before seeding and the polyethylene film was removed 3 days after application. Treatments were arranged in a randomized complete block design with four replications, each consisting of three beds. All beds were aerated with a rotary tiller 3 days before seeding.

Tomato (*Lycopersicon esculentum* Mill. 'Chico III') seeds (120/m) were planted in four rows 0.35 m apart on each bed. The seedbed was fertilized with 55, 47, and 44 kg/ha of N, P, and K, respectively, applied as complete fertilizer placed 2.5 cm under the seed in an 8-cm band. Diphenamid (*N*, *N*-dimethyl-2-diphenyl acetamide, Enide, 4.5 kg/ha active) was used for weed control. Plants were grown according to recommended cultural practices and plant height was regulated by scheduled clipping with a rotary mower (5). Maneb (manganese ethylenebisdithiocarbamate, Manzate D, 2.24 kg/ha) and carbaryl (1-naphthyl methylcarbamate, Sevin 80%, 2.24 kg/ha) were applied at 7- to 10-day intervals to control foliar pathogens and insects. However, a considerable amount of early blight developed, and plants were rated for disease severity on a 0 to 5 scale where 0 = no lesions evident and 5 = lesions abundant on most leaves with severe defoliation. Plants also were rated for vigor on a 1 to 5 scale where 1 = plants small, chlorotic, and nonvigorous; and 5 = plants large, dark-green, and vigorous. At the time disease severity and plant vigor ratings were made, soil samples were collected from plots that had received the various treatments and were assayed for common soil-borne fungi and nematodes. Populations of *Pythium* spp. were determined on modified Kerr's medium (3); *Fusarium* spp. on Nash and Snyder's medium (10); *Rhizoctonia solani* with Ko and Hora's selective medium (7); and nematodes by a modified centrifugal-flotation method (6). The root systems of representative plants from each plot were observed to determine size and any evidence of necrosis.

RESULTS

The routine maneb applications controlled early blight in all plots during the early part of the growing season. However, as plants reached marketable size, marked differences in severity of early blight occurred among plants grown in nontreated soil and soil treated with the general-purpose fumigants (Fig. 1). Early blight was so severe on the control plants that many were not marketable. Damage consisted of numerous lesions on older leaves, some defoliation, and lesions on stems. Plants grown in Vapam-treated soil had a few lesions restricted mainly to the older leaves. Disease severity also was reduced significantly on plants grown in Vorlex- and methyl bromide-fumigated soil but reductions were much less than in Vapam-treated beds. The soil fumigants, especially Vapam, resulted in a marked stimulation of vegetative growth (Fig. 1). Plants in Vapam-treated plots were vigorous, dark-green, and uniform in size. Plants grown in soil treated with methyl bromide, Vorlex, and sodium azide were more vigorous and uniform than plants in control plots but lacked the desirable growth characteristics evident in plants from Vapam-treated plots.

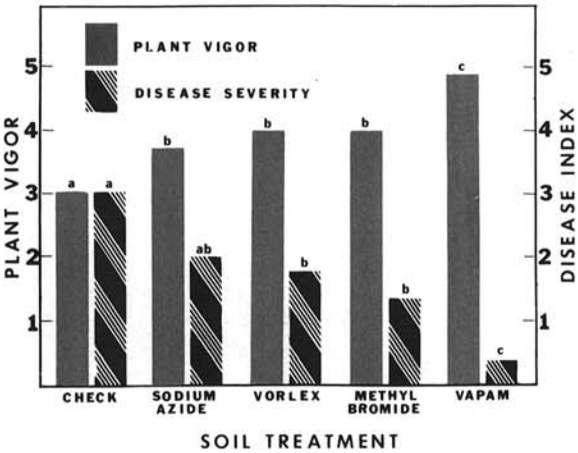

Fig. 1. Plant vigor and severity of early blight caused by *Alternaria solani* on tomato transplants grown in nontreated soil (check) and soil treated with four general-purpose fumigants. Disease severity is based on a 0 to 5 scale in which 0 = no lesions and 5 = lesions abundant on most leaves with severe defoliation. Plant vigor is based on a 1 to 5 scale in which 1 = plants small, chlorotic, nonvigorous; and 5 = plants large, dark-green, vigorous. Graph values followed by the same lower case letter are not significantly different as determined by Duncan's new multiple range test ($P = 0.05$).

Root growth was closely related to the vigor and size of the shoots. Root systems from plants grown in most fumigated plots were large, white, and generally free of necrosis. Root systems of plants from control plots were smaller, and had a brown discoloration, isolated lesions, and necrosis of the feeder roots. Populations of the soil-borne fungi and nematodes assayed were low to moderate in the plots (Table 1). Populations of these organisms generally were reduced by the fumigants. Sodium azide was less effective than the other chemicals in reducing populations. Counts of *Rhizoctonia solani* were too low for the control data to be meaningful for that organism.

DISCUSSION

Early blight continues to be a major disease of tomatoes grown for transplants despite the use of effective foliar fungicides, better spray equipment, and more adequate fertilization in recent years (4). Soil treatment with an effective general-purpose fumigant appears to be the most promising method for controlling several soil-borne fungi and nematodes that attack tomato transplants. Our results indicate that an added benefit with some fumigants is reduced severity of early blight, which should improve performance of foliar-applied fungicides. We believe the increased vigor of plants grown in fumigated plots was the main reason for decreased severity of early blight. Plants that are

TABLE 1. Populations of selected soil fungi and plant parasitic nematodes in control plots and plots treated with four general purpose fumigants[a]

	Genera of soil fungi[b]			Genera of plant parasitic nematodes[c]			
Treatment	*Fusarium* (ppg $\times 10^3$)	*Pythium* (ppg)	*Rhizoctonia* (%)	*Meloidogyne*	*Trichodorus* Number larvae per 150 cc soil	*Pratylenchus*	*Criconemoides*
Vapam	1.5	0.1	0.5	0.0	2.5	0.0	0.0
Methyl bromide	0.8	2.9	1.3	0.0	2.5	0.0	5.0
Vorlex	0.4	0.7	2.0	0.0	0.0	0.0	0.0
Sodium azide	1.5	27.0	0.3	2.5	2.5	2.5	15.0
Control (nontreated)	3.2	23.2	0.6	12.5	12.5	7.5	200.0

[a]Soil samples were collected 14 June 1974 at the time disease severity and plant vigor ratings were made. Each value is a mean of four replications.

[b]*Fusarium* populations were determined on Nash and Snyder's medium, *Pythium* on modified Kerr's medium, and *Rhizoctonia* by Ko and Hora's method expressed as percentage of soil plugs yielding the organism. The abbreviation ppg stands for propagules per gram of dry soil.

[c]Nematode counts were determined by a modified centrifugal-flotation method.

weakened by attack by other pathogens or are under physiological stress for any reason generally are more susceptible to *A. solani* (1, 8, 9, 11, 12). Basu (2) reported reduced incidence of primary infection of tomato by *A. solani* after fall fumigation of heavily infested soil with Vorlex and attributed control to reduced inoculum potential. Apparently, reduction of primary inoculum by the fumigants does not explain our results because our plots had not been planted to vegetable crops in past years; furthermore, inoculum easily could have been spread by wind from adjacent nontreated areas to our plots and produced many more lesions than we observed following Vapam treatment.

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