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CONTROL OF *PHYTOPHTHORA* CROWN ROT IN BELL PEPPER WITH DIRECTED SPRAYS OF METALAXYL

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Abstract. **Control of root rot diseases (*Phytophthora capsici* and *Fusarium* spp.) of bell pepper is normally achieved by a preplant use of methyl bromide under polyethylene mulch. As the crop matures, however, the soil-borne organisms increase in number to where serious root rotting and crown rotting can occur. Plant symptoms include wilting and sudden collapse of the entire upper plant followed by death. Affected areas of the lower stem show both a white and pink growth of mold. *Phytophthora capsici* has been diagnosed as the principal pathogen in the disease complex. Foliar sprays of metalaxyl have not been effective in controlling the disease. Significant control of the disease has been achieved through the use of sprays of metalaxyl which were directed at the lower stem of the plants. Two applications of either metalaxyl (7.5 oz. a.i. per 100 gal) or benomyl (8 oz. a.i. per 100 gal) were made at 10 day intervals. Sprays were applied using a backpack sprayer with a 4-nozzle boom which directed the material to the lower portion of the stem. The metalaxyl sprays were highly effective in limiting spread of disease while the benomyl sprays were only marginally effective. Disease incidence was monitored for 40 days following treatments. Since metalaxyl was specific for *Phytophthora* and benomyl was specific for *Fusarium*, the principal fungal pathogen appears to have been *Phytophthora*.**

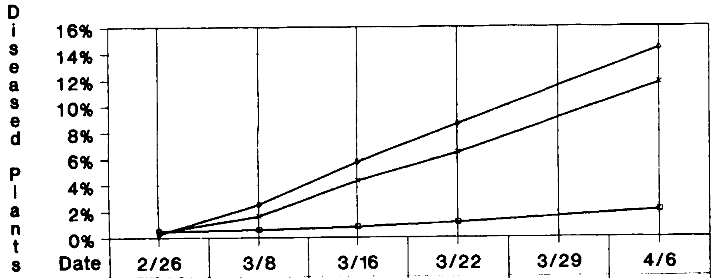
South Florida's hot, humid environment combined with its 60 inch annual rainfall make an ideal environment for the manifestation of soil-borne organisms. Root rot diseases would have severe impact on the early plantings of many vegetable crops were it not for the established practice of preplant fumigation during the laying of mulch. For bell pepper, fumigation is normally achieved through incorporation of a preplant soil disinfectant using either methyl bromide or metam-sodium. Principal root rot/stem canker pathogens in pepper (*Phytophthora capsici* and *Fusarium* spp.) are controlled during the early stages of crop development with this technique. The soil treatments do not prevent eventual development of soil-borne diseases, however. This happens frequently in pepper crops which have been under cultivation in excess of 6 months.

Although the principal symptoms of infection are collapse and death of pepper plants, all parts of the plant may be affected by the root rot/stem canker pathogens. On *older plants*, leaves may show initial spotting (circular or irregular in shape), leaf blight develops and defoliation often occurs. Affected areas of the lower stem turn brown, girdling the plant and both a pink and white growth of mold (diagnostic signs for *Fusarium* spp. and *Phytophthora capsici*, respectively) have been observed. Significant economic damage often results. Disease development is associated with warm weather and wetter (lower) sections within a field are most frequently affected. Large sections of the same fields are impacted year after year.

Attempts to isolate the principal pathogen in the disease complex carried out in Gainesville at the State diagnostic lab have indicated the presence of both *Fusarium* spp. and *Phytophthora capsici* with the latter organism being most frequently detected. Attempts to control the disease complex with foliar applications of the fungicide metalaxyl have been unsuccessful. The objectives of this experiment were to determine: 1) if a directed spray at the plant stem could have an impact on spread of the disease complex; and 2) whether the principal pathogen in the disease complex was *Phytophthora* (subject to metalaxyl) or *Fusarium* spp. (subject to benomyl).

Materials and Methods

A pepper field with a previous history of root rot on Ted Winsberg's Green Cay Farms, Inc. Boynton Beach, FL was chosen. An application of methyl bromide (150 lbs./acre) was applied during the bed preparation and laying of white polyethylene mulch (Aug. 1989). Fertilizer was incorporated preplant (100 lbs./acre 10-10-10) and on top of the bed (1,200 lbs./acre 18-0-23). Sidedressing with liquid injection (8-8-8) was applied as needed. The pepper field was direct seeded with bell pepper Early Cal cultivar. Seedlings were thinned to 1 plant per hole at the 2 leaf stage. Plants within a row were spaced 9 inches apart and grown 2 rows per bed. Beds were north-south for a length of 175 feet and were on 6 foot centers with a ditch every 9 beds. Pepper blocks consisted of 9 or 18 beds. No signs of the disease complex appeared during the fall or early winter months. In Feb. 1990 plants began developing symptoms of the disease complex (leaf wilting/leaf drop). A block of pepper which showed evidence of the disease complex (approximately 0.4% infection) was chosen. A randomized complete block design was laid out using 3 treatments replicated 4 times with 175 foot long plots. Treatments consisted of metalaxyl (Subdue 2E) 7.5 oz a.i. per 100 gal of water, benomyl (Benlate) 8 oz a.i. per 100 gal of water and unsprayed control. Each replication was comprised of 3 beds (6 rows of peppers) 175 feet long. The plant population per replication was approximately 1,400 plants. Thus each treatment utilized approximately 5,600 plants. Plants were sprayed twice at a 10 day interval (26 Feb. and 8 Mar. 1990). Spray material was targeted at the base of the pepper plant using a backpack sprayer (Echo) with a 4 nozzle spray boom and a spray pressure of 185 psi. Orange ceramic flat spray tips (Albuz APS 110°) were used. Plants were inspected and counted for symptoms of the disease complex 5 times over a 40 day period. Plants were categorized as having the disease complex by inspecting them for symptoms of leaf wilt, plant



Date	2/26	3/8	3/16	3/22	3/29	4/6
Control	0.27%	2.5%	5.74%	8.66%		14.38%
Benomyl	0.43%	1.65%	4.31%	6.44%		11.73%
Metalaxyl	0.48%	0.61%	0.82%	1.14%		2.07%

Treatments

Metalaxyl   Benomyl   Control

Fig. 1. Impact of metalaxyl/benomyl treatments on *Phytophthora casici/ Fusarium* spp. disease complex. Data expressed as percent diseased plants within a treatment.

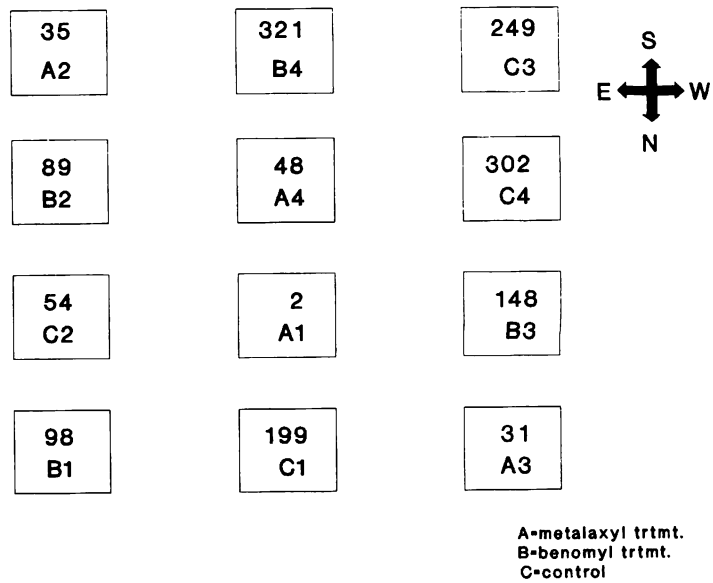


Figure 2. Spatial distribution of disease spread on 6 Apr. 90. All metalaxyl plots have lower incidence than benomyl, control plots.

defoliation or evidence of stem canker. Plants were inspected and counted for evidence of the disease complex on 26 Feb., on 8, 16, 22 Mar., and on 6 April.

Results and Discussion

On 26 Feb., the date of the first treatment application, infected plants comprised 0.48% with metalaxyl treatment, 0.43% with benomyl and 0.27% with the control treatment (Fig. 1). On 8 Mar. (second reading), disease with the control treatment had increased to 2.5%, 0.61% infection with metalaxyl and to 1.65% with benomyl treatment. Rate of spread with metalaxyl during this period was only 25.9% whereas disease with the control treatment increased 9.3 fold. Slower disease spread with benomyl (3.8X increase) suggests some impact of benomyl on the disease complex. At the final count (6 Apr.), 2.1% of the pepper plants with metalaxyl treatment manifested disease symptoms while infected plants within the control and benomyl treatments comprised 11.73% and 14.38%, respectively (Fig. 1).

Rates of spread of disease were essentially linear with all treatments (Fig. 1). This strongly suggests that there was very little secondary spread via aerial sporulation. Secondary spread should be reflected by a geometric rate of increase in disease. There were patches of infection which developed in the field, but these probably reflected failure of the initial fumigation to have provided uniform inoculum suppression over the entire field.

Distribution of the disease complex within the test area on the last count (6 Apr.), showed the highest disease incidence with metalaxyl treatment was lower than the lowest incidence in any of the plots for the check or benomyl (Fig. 2). Statistically, metalaxyl had a highly significant impact on the rate of disease spread $\chi^2 = 46.2$ $P = <.001$.

The final assessment of disease incidence showed that metalaxyl treatment provided an infection rate 6-7 times less than either the benomyl or control treatments. Since metalaxyl is specific for *Phytophthora* and benomyl is specific for *Fusarium* spp., the principal pathogen involved in the disease complex would appear to be *Phytophthora capsici.* Metalaxyl presumably mitigated spread because of its curative and systemic activity. By directing the spray of the material to the base of the plant, metalaxyl was able to: 1) impact root rotting by killing fungus in the soil around the pre-punched hole in the polyethylene mulch; 2) provide systemic protection to the plant's vascular system; 3) act as a curative in treating crown rot infection. *Fusarium* spp. appear to be involved in the disease complex as secondary organisms and are not the principal pathogens in the disease complex.

One of the most interesting observations resulting from this experiment relates to the use of directed sprays of metalaxyl for control of a crown rot disease. Efforts to use metalaxyl as a foliar spray by pepper growers for control of this disease have not been successful. The senior author has observed that *Fusarium* crown rot in melons can be controlled with sprays of benomyl which have been directed to the crown of the plants whereas foliar applications of benomyl were ineffective. It was the work in melons which led to the hypothesis that a similar approach might be useful in controlling crown rot in pepper.