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The effect of SoilGard (*Gliocladium virens*) as a biological amendment for the control of soilborne diseases on tomato and pepper transplant plugs and subsequent field performance.

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Introduction

In 1997-98 season, over 33,500 acres of tomatoes and 20,000 acres of peppers were grown in the state of Florida. Return on investment was good in 1997-1998, but in general competition from Mexico, increasing regulations, and environmental constraints have resulted in mostly unfavorable economics for FL vegetable growers over the last several years. To remain competitive, FL growers must increase yields and offset production costs.

Coupled with the current economic situation is the fact that vegetable growers in the United States will soon lose their right to use methyl bromide, a powerful weapon against soilborne disease, insects, and weeds. The pending loss of methyl bromide will certainly swing the pendulum of competition firmly on the side of the competition.

Finally, the cry for food safety voiced by the American public has hastened the loss of other chemicals used in vegetable production as the agriculture industry declines to re-register older chemistry. This has placed the US on the road to an agriculture of reduced chemical inputs and an increased reliance on biological control.

SoilGard (Thermal Trilogy, St. Louis, MO) is a soil amendment formulation of *Gliocladium virens* GL-21, an organism known to be biologically active against certain "damping off" and root rot pathogens. It has is proven in the ornamental and floriculture industries, but little is known of its effect on vegetable transplants either in the greenhouse or in the field. If effective, SoilGard may prove to be quite a useful tool in the systems approach to an alternative to methyl bromide.

Our fall 1997 objective was to apply SoilGard according to company protocol to the soilless media used in the production of tomato and pepper transplants and to raise these crops for planting to the field. Theoretically SoilGard, while providing protection during the seedling phase, would also establish well enough to provide additional protection in the field

Methods

A trial was established at the Southwest Fl Research and Education Center of the University of Florida in Immokalee, FL to test the effect of SoilGard 12G microbial fungicide on tomato and pepper transplant growth, growth response in the field and yield.
On August 8, 1997 twenty-one grams/cu ft. of SoilGard 12G were mixed with sufficient Metro Mix 220 (Scott's Co., Marysville, OH) to fill 6, 242 cell flats into which tomato (`FTE 30', PetoSeed, Saticoy, CA) or pepper (`Boynton Belle', Pepper Research, Boynton Beach, FL) were seeded. Three replications of SoilGard amended and control media were established for each crop.

Seedlings were grown for 5 (tomato) or 6 (pepper) weeks under standard FL transplant production procedures (Vavrina, 1996) and then five plants of each species were sampled to determine the greenhouse growth parameters of stem length and diameter, leaf area, dry weight of the leaf/stem/root/top, leaf:stem ratio, root:shoot ratio, and number of true leaves.

Following seedling sampling, additional tomato and pepper transplants were taken to the field and planted in a standard methyl bromide fumigated (320 lbs./A, broadcast), granular fertilized (220N-78P-300K), plastic mulched (white, 3 mil), seepage irrigated, 32" wide bed on Sept. 10 (tomato) or Sept. 17 (pepper). Fourteen tomato plants and 30 pepper plants were set for each treatment by replication. Six replications were set out in a randomized complete block design. Soil and air temperatures during that time ranged from the high 80s to low 90s.

Manzate, copper, and Bravo fungicides were applied to prevent the advancement of fungal diseases and bacterial spot. Various Bt's (insecticide) were also applied to reduce worm pressure. *Phytophthora capsici* was identified on the pepper, but did not develop until after final harvest.

Field data were taken on plant dry weight (1 tomato, 2 pepper plants) 30 and 45 days after planting (DAP), developing fruit (45 DAP), and yield (4 harvests of 10 tomato plants and 24 pepper plants). Yields were separated into red/breaker and mature green fruit and further subdivided into medium, large, and extra-large size categories for tomato and by extra-large, large and medium size for pepper. Data were analyzed by ANOVA (SAS) with mean separation via Fisher's Protected LSD at $p<0.05$.

Results

<u>Greenhouse Transplant Growth</u>

SoilGard (SG) had no impact on `FTE 30' tomato transplants when grown in the greenhouse for six weeks (Table 1) as there were no apparent difference noted in any transplant parameter measured. SG influence on `Boynton Belle' pepper transplants was slightly more evident (Table 2.) Plants treated with SG showed significantly greater root dry weights than the controls. Although this was the only parameter exhibiting statistical significance, SG treated peppers showed greater numeric values in every transplant parameter measured.

Table 1. SoilGard treated tomato transplant data at 5 weeks after seeding*.

	Stem Hgt. (cm)	Stem Dia. (mm)	Leaf Area (cm^2)	Dry Leaf (g)	Dry Stem (g)	Dry Root (g)	Dry Top (g)	Leaf Stem Ratio	Root Shoot Ratio	True Leaf (no)
SoilGard	13.2	2.59	22.15	0.094	0.077	0.040	0.171	1.22	0.234	3.5
Control	14.3	2.60	20.80	0.086	0.080	0.039	0.166	1.07	0.241	3.5
LSD $_{0.05}$	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

*NS was recorded for all parameters at P<0.1

Table 2. SoilGard treated pepper transplant data at 6 weeks after seeding*.

	Stem Hgt. (cm)	Stem Dia. (mm)	Leaf Area (cm^2)	Dry Leaf (g)	Dry Stem (g)	Dry Root (g)	Dry Top (g)	Leaf Stem Ratio	Root Shoot Ratio	True Leaf (no)
SoilGard	8.1	2.21	22.54	0.091	0.053	0.060	0.144	1.71	0.416	5.2
Control	7.6	2.11	19.70	0.074	0.043	0.047	0.116	1.72	0.403	4.5
LSD $_{0.05}$	NS	NS	NS	NS	NS	0.012	NS	NS	NS	NS

*NS was recorded for all parameters at P<0.1

Field Establishment Parameters

Tomato top growth (stems and leaves) and fruit set appeared to be unaffected by SG residence in the transplant plug once planted to the field (Table 3). Tomatoes treated with SG tended to show a slightly greater dry weight 30 DAP (P<0.08) but this response was ephemeral, and was not evident 45 DAP.

Table 3. SoilGard tomato transplant field sample data 30 and 45 DAP.

Treatment	Dry Top 30 DAT (g)	Dry Top 45 DAT (g)	Fresh Fruit 45 DAT (no)	Fresh Fruit 45 DAT (g)
SoilGard	17.2	77.4	3.2	7.2
Control	14.9	79.2	2.5	2.6
LSD $_{0.05}$	NS*	NS	NS	NS

* Parameter significant at P<0.08

Pepper plants appeared to lose the competitive edge gained by SG treatment in the transplant plug once planted to the field. Neither plant weight nor fruit set benefited from SG treatment at either 30 or 45 DAP (Table 4).

Table 4. SoilGard pepper transplant field sample data taken 30 and 45 DAP*.

Treatment	Dry Top 30 DAT (g)	Dry Top 45 DAT (g)	Fresh Fruit 45 DAT (no)	Fresh Fruit 45 DAT (g)
SoilGard	3.47	18.13	1.1	2.85
Control	3.72	13.91	1.4	3.50
LSD $_{0.05}$	NS	NS	NS	NS

*NS was recorded for all parameters at P<0.1

Yield Parameters

Tomato Use of SG in the transplant plug had an effect on tomato yield by size distribution (Table 5). While tomato average fruit weight was unaffected by treatment, extra-large fruit weight at first harvest was significantly lower where SG was used. Furthermore, SG use reduced the four harvest total weight of medium sized tomatoes. Total extra-large fruit weight favored the control as well (P<0.06).

Table 5. SoilGard tomato harvest data, average fruit weight and yield by size category in pounds per plot.

Harvest Treatment	Ave. Fruit Wt.	Medium	Large	Extra-Large
First				
SoilGard	0.547	0.0	0.8	20.0
Control	0.557	0.0	1.0	26.9
LSD $_{0.05}$	NS	--	NS	5.8
Second				
SoilGard	0.432	1.4	4.4	12.2
Control	0.439	2.0	4.1	13.9
LSD $_{0.05}$	NS	NS	NS	NS
Third				
SoilGard	0.406	5.5	5.8	11.8
Control	0.400	7.2	5.1	12.6
LSD $_{0.05}$	NS	NS	NS	NS
Forth				
SoilGard	0.299	20.4	8.2	5.8
Control	0.325	22.3	7.7	8.0
LSD $_{0.05}$	NS	NS	NS	NS
Total				
SoilGard	0.384	27.4	19.4	49.8
Control	0.403	31.6	17.9	64.5
LSD $_{0.05}$	NS	3.9	NS	NS*

* Sig. at P<0.06

Further investigation showed that the control treatment first harvest increase in extra-large fruit was the result of more green fruit by weight (Table 6) and number (Table 7.) Apparently, the application of SG, while not hastening or delaying fruit maturity (i.e., no impact on red/breaker fruit at first harvest), did appear to reduce the occurrence of extra-large size. This trend followed fruit development throughout the four harvests as suggested by the tendency toward more extra-large size in the control in the overall total (P<0.08).

Pepper SoilGard transplant treatment resulted in heavier individual pepper fruit at first and forth harvest (Table 8.) Furthermore, SG treated plants tended to produce a few more total fruit (P<0.08) at third harvest and extra-large fruit (P<0.08) at forth harvest (Table 9).

Table 8. SoilGard pepper harvest data: Pounds of fruit per plot (24 plants per plot, double row, 10 inch spacing between and within row).

Harvest Treatment	Extra Large	Large	Medium	Total	Average Fruit Wt.
First					
SoilGard	6.4	3.2	0.1	9.7	0.448
Control	5.8	3.4	0.3	9.5	0.426
LSD 0.05	NS	NS	NS	NS	0.018
Second					
SoilGard	3.6	8.8	1.2	13.6	0.350
Control	3.7	9.1	0.8	13.6	0.360
LSD 0.05	NS	NS	NS	NS	NS
Third					
SoilGard	0.8	3.5	0.5	4.9	0.327
Control	0.8	2.8	0.2	3.8	0.341
LSD 0.05	NS	NS	NS	NS	NS
Forth					
SoilGard	2.6	11.5	1.3	15.4	0.301
Control	2.0	9.9	1.6	13.5	0.281
LSD 0.05	NS	NS	NS	NS	0.013
Total					
SoilGard	13.4	27.1	3.1	43.6	0.344
Control	12.3	25.2	3.0	40.5	0.339
LSD 0.05	NS	NS	NS	NS	NS

Discussion

SoilGard microbial fungicide when used at the rate of 21 g per cubic ft of soilless medium appears to have no adverse effect on tomato or pepper transplants, and may in fact aid in the development of pepper roots. In this trial (unchallenged by soilborne pathogens) SG did not hinder or advance transplant field establishment and growth. SG treatment appears to be beneficial in pepper, lending to more and heavier fruit.

Table 9. SoilGard pepper harvest data: Number of fruit per plot (24 plants per plot, double row, 10 inch spacing between and within row).

Harvest Treatment	Extra Large	Large	Medium	Total
First				
SoilGard	12.2	9.3	0.3	21.8
Control	11.0	10.2	1.2	22.3
LSD 0.05	NS	NS	NS	NS
Second				
SoilGard	7.3	26.5	5.2	39.0
Control	7.5	27.0	3.5	38.0
LSD 0.05	NS	NS	NS	NS
Third				
SoilGard	1.7	11.2	2.0	14.8
Control	1.7	8.7	0.8	11.2
LSD 0.05	NS	NS	NS	NS*
Forth				
SoilGard	6.0	37.5	7.5	51.0
Control	4.5	34.5	9.0	48.0
LSD 0.05	NS*	NS	NS	NS
Total				
SoilGard	27.2	84.5	15.0	126.7
Control	24.7	80.3	14.5	119.5
LSD 0.05	NS	NS	NS	NS

* Sig. at P<0.08

Pepper growers sell by count rather than weight so additional fruit is advantageous. Heavier fruit may reflect increased wall thickness, also a characteristic sought by pepper growers, as thicker walls tend to bruise or crack less.

The response of tomato yield to SG transplant treatment was puzzling. The reduction in extra-large fruit, particularly at first harvest, is disadvantageous. Extra-large fruit is the “money” fruit for the tomato grower and hence a reduction in XL production means a loss of revenue. However, as this was an unchallenged trial no consideration was given to the possible in-field losses that might have been counteracted by the use of SG in the transplants. As SG did not compromise overall yield; one must consider the positive aspect of seedling disease prevention, especially with the pending loss of methyl bromide and the development of fungicide resistant strains of pathogenic organisms.

These data represent a single, fall trial with SG. Further testing is required to establish greenhouse and field performance across the varied environmental and cultural conditions found in FL. Testing under conditions of known pathogen pressure with and without the use of registered agricultural chemicals designed to prevent/reduce “damping off” and root rot organisms would be a positive step.

Table 6. SoilGard tomato harvest data: Pounds of fruit per plot (10 plants per plot at 18-inch spacing).

Harvest Treatment	Red Medium	Red Large	Red Extra-Large	Red Total	Green Medium	Green Large	Green Extra-Large	Green Total	Red and Green Total
First									
SoilGard	0.0	0.0	0.0	0.0	0.0	0.8	20.0	20.8	20.8
Control	0.0	0.0	0.0	0.0	0.0	1.0	26.9	27.9	27.9
LSD 0.05	--	--	--	--	NS	NS	5.8	6.3	6.3
Second									
SoilGard	0.0	0.0	0.0	0.0	1.4	4.4	12.2	18.1	18.1
Control	0.0	0.0	0.0	0.0	2.0	4.1	13.9	20.1	20.1
LSD 0.05	--	--	--	--	NS	NS	NS	NS	NS
Third									
SoilGard	0.3	0.1	0.8	1.1	5.2	5.8	11.1	22.1	23.2
Control	0.2	0.1	0.6	0.8	7.0	5.0	12.1	24.1	24.9
LSD 0.05	NS	NS	NS	NS	NS	NS	NS	NS	NS
Forth									
SoilGard	0.8	0.4	0.7	2.0	19.6	7.8	5.1	32.5	34.5
Control	0.7	0.4	0.9	2.0	21.6	7.2	7.1	35.9	38.0
LSD 0.05	NS	NS	NS	NS	NS	NS	NS	NS	NS
Total									
SoilGard	1.1	0.5	1.5	3.0	26.3	18.9	48.4	93.5	96.6
Control	0.8	0.6	1.5	2.9	30.7	17.3	60.0	108.1	111.0
LSD 0.05	NS	NS	NS	NS	3.8	NS	NS*	NS	NS

* Sig. at P<0.08

Table 7. SoilGard tomato harvest data: Number of fruit per plot (10 plants per plot at 18-inch spacing).

Harvest Treatment	Red Medium	Red Large	Red Extra-Large	Red Total	Green Medium	Green Large	Green Extra-Large	Green Total	Red and Green Total
First									
SoilGard	0.0	0.0	0.0	0.0	0.0	2.0	36.0	38.0	38.0
Control	0.0	0.0	0.0	0.0	0.2	2.3	47.7	50.2	50.2
LSD 0.05	--	--	--	--	NS	NS	10.9	NS*	NS*
Second									
SoilGard	0.0	0.0	0.0	0.0	4.3	11.3	26.2	41.8	41.8
Control	0.0	0.0	0.0	0.0	6.0	10.7	29.2	45.8	45.8
LSD 0.05	--	--	--	--	NS	NS	NS	NS	NS
Third									
SoilGard	0.8	0.2	1.2	2.2	15.5	15.0	24.5	55.0	57.2
Control	0.5	0.3	1.2	2.0	20.5	13.0	26.8	60.3	62.3
LSD 0.05	NS	NS	NS	NS	NS	NS	NS	NS	NS
Forth									
SoilGard	2.5	1.0	1.3	4.8	73.2	24.5	10.8	108.5	113.3
Control	2.2	1.2	2.0	5.3	74.8	19.2	18.2	112.2	117.5
LSD 0.05	NS	NS	NS	NS	NS	NS	NS	NS	NS
Total									
SoilGard	3.3	1.2	2.5	7.0	93.0	52.8	97.5	243.3	250.3
Control	2.7	1.5	3.2	7.3	101.5	45.2	121.8	268.5	275.8
LSD 0.05	NS	NS	NS	NS	NS	NS	NS	NS	NS

* Sig. at P<0.06