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Biological Suppression of Foliar Diseases of Ornamental Plants with Composted Manures, Biosolids, and *Trichoderma hamatum* 382

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Summary

Composted dairy and swine manures and municipal biosolids were tested as amendments in nursery container media to determine their effects on plant growth and health. These composts, when incorporated into nursery media at a volumetric amendment rate of 5 to 6 %, suppressed root rots and provided excellent growth on all but one of 40 plant species tested.

Viola, a low-fertility crop that did not respond well initially, recovered later in the season. One batch of composted manure naturally suppressed a foliar disease as well.

However, several other batches of composts, including several batches of composted dairy and swine manures and composted municipal biosolids tested in cooperating nurseries, did not suppress foliar diseases. Inoculation of these compost-amended media with *Trichoderma hamatum* 382, a biocontrol agent that induces systemic resistance to disease in plants, significantly reduced the severity of several different types of foliar diseases.

In conclusion, inoculation of compost-amended container media with *T. hamatum* 382 suppressed root as well as foliar diseases and supported excellent growth of nursery stock.

Introduction

Environmental problems caused by application of raw manures and biosolids have made composting an increasingly attractive process to municipalities and more recently also to farmers. Because costs associated with composting typically are higher, composts of high quality must be produced consistently so that they can be distributed into value-added markets.

The peat substitute aspect of composted manures and biosolids used in potting mixes is the most value-added property of composts. Biological suppression of root rots provided by composts has resulted in reduced pesticide use, and this is the second most value-added benefit associated with compost utilization. Composted biosolids and manures release essential micronutrients that can serve as excellent substitutes for mineral additives. This represents the third most valuable property of composted manures and biosolids.

It has been recognized for centuries that composts may suppress root rots. It was established recently, however, that composts may also suppress foliar diseases of plants (1, 4). Unfortunately, a survey of 80 different types of composted products performed from 1997 to 2001 revealed that only one of these composts naturally induced systemic resistance to foliar diseases even though all 80 compost-amended media suppressed Pythium root rot. Thus, suppression of foliar diseases with composts is a rare phenomenon with considerable unreliability for growers.

However, several different biocontrol agents were isolated from this rare batch of compost that induced resistance in plants. *Trichoderma hamatum* 382 (T382) was identified as the most active inducer of resistance. For that reason, it was included in demonstration trials with composted manures and biosolids on several different ornamental crops. In this report the authors present data from demonstration trials performed in Ohio nurseries in 2002.

Materials and Methods

Composts evaluated in this work included:

- A dairy sawdust-bedded composted cow manure produced at The Ohio State University, Ohio Agricultural Research and Development Center (OSU/OARDC), Wooster, Ohio.
- A swine manure amended with ground wood and shavings produced in a High Rise Hog® facility and composted at OSU/OARDC, Wooster, Ohio, according to Keener *et al.*, 2001 (2) or at Fresh Aire Farms, 1324 Wasson Road, Union City, Ohio.
- Composted municipal biosolids received from the Akron Composting Facility.

All composts had been stabilized to a stability level suitable for incorporation into potting mixes. The composted manures were incorporated into potting mixes at a volumetric amendment rate of 5% and the composted biosolids at 6%. The types and quality of lime and fertilizers added varied with the location of the test and the crop, but all crops were treated with slow-release fertilizer. The pH of all mixes ranged from 5.3 to 6.0. The air-filled pore space after saturation and drainage exceeded 25% in 1-gallon containers.

All trials were arranged as a randomized complete block design with at least four blocks. The number of replicates used per block depended on plant availability and varied among but not within plant species. Plant growth was expressed as dry weight, plant canopy size, or on the basis of a salability rating scale. Disease severity was based on severity ratings scales, area under disease progress curves, or percent of plants killed or symptomless, depending upon the species or the disease. Data were analyzed by ANOVA, and means were separated by Fisher's least significant difference test.

Results and Discussion

Suppression of Powdery Mildew of Begonia with Composted Dairy Manure and T382

The protective effects of the compost were tested in a light fibrous Sphagnum peat mix that is used widely for greenhouse crops. Data in Table 1 show that the severity of powdery mildew on

Begonia hiemalis 'Barbara' plants grown from rooted cuttings in a light fibrous H_2 - H_3 on the von Post peat decomposition scale Sphagnum peat mix (70% peat, 30% perlite, v/v) was controlled on plants sprayed with the fungicide Piperon.

Table 1: Systemic Control of Powdery Mildew of Begonia (Begonia Hiemalis **'Barbara') Provided by a Composted Cow Manure-Amended Potting Mix and** Trichoderma hamatum **382.**

Potting Mix[1]	Control Treatment[2]	Disease Severity[3] (AUDPC)	Dry Weight[4] (gm)	Salability[5]
peat	control	1,402.8 a	4.6 c	2.6 c
peat	Piperon	363.2 bc	7.1 ab	3.7 b
peat	T382	100.3 c	7.5 a	4.4 a
SD compost	control	347.3 bc	5.7 bc	3.9 ab
SD compost	Piperon	216.8 bc	7.6 a	4.1 ab
SD compost	T382	521.4 b	7.0 ab	3.8 ab

[1] Peat mix (Sphagnum peat, perlite; 7:3, vol./vol.). SD compost represents 5% of peat replaced with sawdust-bedded composted cow manure.
[2] Piperon applied biweekly as a topical spray to the foliage; T382 was incorporated into the potting mix at 3 oz. of a granular preparation of T382 per cubic yard of mix.
[3] Area under the disease progress curve based on mean disease severity ratings (n = 9); values followed by the same letters do not differ significantly based on Fisher's LSD test.
[4] Mean dry wt. (g) per plant (n = 9) determined 55 days after potting.
[5] Mean salability (n = 9) at flowering based on the following rating scale: 5 = healthy with 1 or more flower stalks with at least 1 flower open; 4 = with buds or flower stalks with minimal damage to leaves; 3 = no flowers or flowers with minimal damage; 2 = no flowers, small and/or damaged plants; 1= dead plant.

Furthermore, plant dry weights and the salability of plants also were significantly higher on plants sprayed with Piperon. Inoculation of the peat mix with the biocontrol agent T382 was at least as effective as the Piperon treatment. Amendment of the peat mix with 5% composted dairy manure also suppressed the disease. Both treatments increased plant dry weight and improved salability. Neither Piperon nor T382 added to the protective effect induced by this batch of composted dairy manure.

In conclusion, this specific batch of composted dairy manure naturally suppressed powdery mildew. This compost treatment and T382 were as effective as the fungicide Piperon. The effect is best explained on the basis of systemic-induced resistance. This effect is highly unusual because most composts do not induce this effect naturally.

Suppression of Botryosphaeria Stem Blight and Dieback on *Myrica pensylvanica* Induced by T382 in a Composted Biosolids-Amended Container Medium

Liners of *Myrica pensylvanica* (Northern Bayberry) were transplanted on March 20, 2002, in 1-gallon containers into a potting mix containing aged pine bark, light fibrous Sphagnum peat, composted biosolids, expanded shale, and sand at volumetric ratios of 9.0:1.5:0.75:1.0:0.33. The

same mix, but inoculated with 7 oz. granular inoculum of T382 per cubic yard of mix, served as a second treatment.

Shortly after transplanting, a stem blight and dieback disease caused by *Botryosphaeria dothidea* developed. Progress of this stress disease declined in early May, and on May 16, final disease severity values were determined.

Data in Table 2 reveal that inoculation of the composted biosolids-amended mix with T382 significantly affected the severity of this stress disease. In the compost amended mix, 20.8% of the plants were killed, and only 25% of the plants were symptomless. Most were stunted in growth. Only 6.3% of the plants in the T382-inoculated mix were killed, and 66.7% of the plants were symptomless.

Table 2. Suppression of Botryosphaeria Stem Blight and Dieback of Myrica pensylvanica **by** Trichoderma hamatum **382 (T382) in a Composted Biosolids-Amended Container Medium.**

Potting Mix[1]	**Mean Dieback Severity**[2]	**Mean % Plants Killed**[2]	**Mean % Symptomless Plants**
control	2.4	20.8	25.0
T382	1.5	6.3	66.7
LSD 0.05	0.4	14.1	20.4

[1] Liners potted on March 20, 2002, in 1-gallon pots in a container medium consisting of "aged" pine bark, sphagnum peat, composted biosolids, expanded shale, and sand (9:1.5:0.75:1:0.33; vol./vol.) (control) or inoculated with 7 oz. of T382 granular inoculum per cubic yard of mix (T382).
[2] Mean dieback severity based on four blocks of 12 plants per treatment (n = 48) determined on May 16, 2002, using a scale in which 1 = symptomless, 2 = slight stunting, 3 = severe stunting, and 4 = dead plant.

In conclusion, this batch of natural composted biosolids-amended mix did not provide control of the foliar and stem disease. In contrast, inoculation of the mix with T382 provided effective control of Botryosphaeria dieback. The results of this demonstration trial are in line with controlled greenhouse studies which showed that composts generally do not provide systemic effects against plant diseases unless inoculated with biocontrol agents that can activate systemic resistance.

Effects of Composted Cow Manure and T382 on Growth of Perennials and Ground Cover Plants

Liners of *Ajuga*, *Sedum*, and *Viola* were transplanted on June 14, 2002, into 1-gallon containers.

Container mix treatments were:

1. The grower medium (aged pine bark and composted rice hulls; 8:3, v/v).
2. The same mix but amended with composted dairy manure (5%; v/v).
3. This mix but inoculated with T382 using 3oz. of granular inoculum of T382 per cubic yard of mix.

The mean number of flower stalks per plant and canopy size were determined at the completion of the growing season for *Ajuga* 'Burgundy Glow.' A mean salability rating was determined for *Sedum* 'Autumn Joy' and *Viola* 'Purple Showers.' A randomized complete block design was used with four blocks of 12 plants per treatment.

Amendment of the grower mix with composted dairy manure significantly increased the number of flower stalks and canopy size on *Ajuga* 'Burgundy Joy' (Table3). Salability of *Sedum* 'Autumn Joy' also was drastically improved by amendment with the compost. *Viola* 'Purple Showers' was stunted in growth during the first six weeks after potting in the mix amended with composted cow manure.

Table 3. Effects of a Composted Cow Manure-Amended Potting Mix and of Trichoderma hamatum **382 (T382) on Growth and Flowering of** Ajuga **'Burgundy Glow,'** Sedum **'Autumn Joy,' and** Viola **'Purple Showers.'**

Potting Mix[1]	***Ajuga* 'Burgundy Glow'**[2]		***Sedum* 'Autumn Joy'**[3] **Salability Rating**	***Viola* 'Purple Showers'**[3] **Salability Rating**
	Canopy Size (L)	**# Flower Stalks per plant**		
Grower control mix	0.6	2.4	3.7	3.7
SD compost	1.5	3.0	4.2	3.9
SD compost+ T382	1.4	2.8	4.2	3.2
LSD 0.05	0.5	0.2	0.4	0.4

[1] Grower mix consisting of aged pine bark and composted rice hulls (8:3; vol./vol.) was amended with sawdust-bedded composted cow manure (5%; vol./vol.) (SD compost) or the same and inoculated with 100 g granular inoculum of T382 per cubic yard of mix.
[2] Planted on June 14, 2002. Mean number of flower stalks per plant (n = 48) determined on August 7, 2002, and canopy size determined on September 3, 2002.
[3] Planted on June 14, 2002. Mean salability (n = 48) determined on August 7, 2002, based on a scale in which:5 = full height, large flower; 4 = full height, small flower; 3 = slightly stunted, chlorotic; 2 = severe stunting and chlorosis with stem lesion caused by Phytophthora dieback; 1 = dead plant.

Symptoms suggested that the ammonium concentration in the mix at planting was too high and caused phytotoxicity. Towards the end of the 2002 growing season, *Viola* plants had recovered, and the mean salability did not differ from that in the mix not amended with the composted manure.

The 2002 summer was extremely dry where this demonstration test was performed. As a result, disease pressure was low, and foliar diseases did not develop. Root rots also were not observed on plants in any of the mixes even though fungicide drenches were not applied. Within days after potting, some *Sedum* plants randomly distributed across the treatments developed Phytophthora stem blight. Conditions were too dry for spread of the disease, however.

T382, as expected, had no major effect on *Ajuga* or *Sedum* because of low disease pressures. On *Viola* where phytotoxicity was observed, salability was affected negatively. The inducing effect of T382 may have interacted with the toxicity that apparently was caused by excessive ammonium concentrations early after potting in the composted cow manure-amended mix.

In conclusion, amendment of the grower mix with composted cow manure improved growth on two species and caused a temporary setback on *Viola*, a plant known to require low fertility conditions. Disease pressures were too low to allow observations on T382.

Suppression of Phytophthora Leaf Blight and Stem Dieback of *Pieris japonica* with T382

Liners of *Pieris japonica* (pint-sized pots) were transplanted into 1-gallon containers on June 3, 2002.

Container media included:

1. The grower's container medium consisting of aged pine bark, fibrous Sphagnum peat, composted dairy manure, expanded shale, and silica sand (65:15:5:13:2, v/v).
2. The same mix but inoculated with 4 oz. of a granular preparation of T382.

During a week of rainy weather in late July, 2002, a severe epidemic of Phytophthora dieback developed on *Pieris* on blocks of 525 plants produced in each medium. The percentage of plants with severe dieback or killed by the disease in the mix inoculated with T382 (4%) was considerably below the value observed on plants in the composted cow-manure-amended medium (26%).

In conclusion, this batch of compost did not naturally suppress this disease and that agreed with laboratory studies not presented here. Inoculation of the mix during its formulation in the cooperating nursery with T382 proved effective for suppression of Phytophthora dieback of *Pieris japonica*.

Results and Discussion

Preliminary Data on Growth in Composted Swine-Manure-Amended Media

Composted hog manure was amended into a container medium on May 17, 2002. Media used at this nursery included:

1. The grower's mix consisting of aged pine bark, composted rice hulls, Sphagnum peat, and pea gravel (41:25:13.7:12.3; v/v).
2. The same mix but amended with 5% composted swine manure.
3. This hog manure compost-amended mix inoculated with 3 oz. of granular inoculum of T382 per cubic yard of mix.

Eighteen different woody ornamentals, including cultivars highly susceptible to foliar diseases (e.g., bacterial leaf spots and blights, Phytophthora dieback diseases), were planted in each of the three mixes.

A randomized complete block design was used for each treatment utilizing four blocks of 12 2-gallon containerized plants per treatment.

The severity of foliar diseases was monitored throughout the summer. Fungicide drenches were not applied to the crops. Foliar diseases did not develop on any of the crops due to extremely dry weather conditions. In late September 2002, the severity of root rot and the canopy size were determined for each treatment.

Mean root rot severity and the mean canopy size values for each crop did not differ significantly among treatments. In conclusion, composted hog manure served as an effective alternative amendment in the container medium used at this nursery. Neither beneficial nor detrimental effects were observed. T382 did not provide a response, probably due to the extremely low disease pressures that prevailed during the dry summer of 2002 at this location.

Conclusions

Composted dairy and swine manures incorporated into container media served as effective substitutes for similar products such as composted biosolids used more widely in Ohio nurseries. One single batch of composted cow manure tested in this work naturally suppressed the severity of a foliar disease. However, several other batches of composts that were tested did not provide control of foliar diseases even though they suppressed root rots. In cooperating nurseries where wet weather conditions occurred for a week or longer and where disease pressures were high for that reason and foliar diseases developed, inoculation of these container media at potting with T382 significantly reduced the severity of the foliar diseases and/or stem blights.

Finally, the sporadic occurrence of natural suppression of foliar diseases on plants produced in compost-amended media agrees with earlier laboratory studies which showed that the nursery industry cannot rely on natural composts for control of foliar diseases. The effect of T382 was promising and requires further analysis.

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