

# Effect of Field Management Practices on Disease Development, Soil Chemistry and Yield in Organic Tomatoes

F. Baysal<sup>1</sup>, B. McSpadden-Gardener<sup>1</sup>, J. Cardina<sup>2</sup>, M. Kleinhenz<sup>2</sup> and S. Miller<sup>1</sup>  
Departments of Plant Pathology<sup>1</sup> and Horticulture and Crop Science<sup>2</sup>  
The Ohio State University, Ohio Agricultural Research and Development Center (OARDC)  
Wooster, OH 44691  
USA

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## Abstract

The effects of different strategies for transition to organic tomato production on timber rot (*Sclerotinia sclerotiorum*), early blight (*Alternaria solani*) and Septoria leaf spot (*Septoria lycopersici*) incidence and severity, soil chemistry and yield were studied. The four cropping strategies considered were 1) low input cover crop/fallow, 2) low input perennial mixed hay, 3) moderate input field vegetables, and 4) high input extended season vegetables under high tunnels. Each was considered with and without compost applications. Each cropping strategy was carried out for 3 years, and then all plots were cropped to fresh market tomato, cultivars Florida 47 and Mountain Spring in the fourth year. Annual applications of composted dairy manure during the 3-year transition and prior to tomato planting resulted in significantly less timber rot and early blight in high tunnels, and Septoria leaf spot in open field plots under the mixed hay transition strategy, than in the non-amended plots. Tomatoes in the mixed hay transition strategy tended to have less Septoria leaf spot than those in the open fallow and vegetable transitions. Septoria leaf spot was significantly higher in Mountain Spring than in Florida 47 in open-field plots. Transition strategy generally did not affect soil fertility, but, in all cases, compost amendment significantly increased soil C, N and other nutrients. Compost amendment in the each cropping strategy significantly increased total and marketable yield for green to pink and light red to red maturity stages of both cultivars. The high-tunnel vegetable cropping strategy significantly increased to total and marketable yield for both cultivars. There were no significant differences among cultivars in the total and marketable yield.

## INTRODUCTION

Ohio is an urban state with mid- to large-size population centers surrounded by rural areas. Organic farmers are particularly poised to take advantage of local demand for fresh produce through community supported agriculture (CSA), farm markets, restaurants, independent grocers and local or regional supermarket chains. These opportunities, as well as a commitment to farm stewardship, have raised interest in transitioning to organic production among traditional vegetable farmers. The 3-year period required for transition to certified organic production can be risky as farmers must substantially change tactics and strategies, sometimes resulting in yield losses without the compensation of price premiums (Oberholtzer et al., 2005). In tomatoes, diseases can significantly limit crop productivity by reducing yield and quality (Diver et al., 1999). We investigated four strategies for transition to organic production that differed in intensity: 1) low input cover crop/fallow; 2) low input perennial mixed hay; 3) moderate input field vegetables; and 4) high input extended season vegetables under high tunnels. To each of these strategies, the utility of compost amendments in building soil quality and increasing crop productivity and quality were also evaluated. We measured crop yield and quality, changes in soil chemistry and microbial activity, nematode population structure, plant health and economics under each of the transition strategies. In the fourth year of the study, all plots were cropped to fresh market tomato. Results of the 4<sup>th</sup> year study related directly to tomato health and crop productivity are presented.

## MATERIALS AND METHODS

A replicated factorial transition experiment was established at the OARDC in Wooster on a moderately well drained Wooster silt loam with 2.9% organic matter. The four primary treatment strategies were clean fallow, mixed species hay (red & white clover, alfalfa, timothy, chicory, orchardgrass, festulolium, and plantain), low-intensity vegetables and intensive vegetable production under high tunnels. The secondary treatments were related to fertility management during transition: application of composted dairy manure or no amendment. All strategies were arranged as split-plots with main plots replicated four times in a randomized complete block design. The high tunnels had four beds; 26 tomato plants were transplanted into each bed. The open field plots were had 12 beds; 28 tomato plants were transplanted into each bed. The 4x2 strategies were managed as a 3- year transition, and in the fourth year all subplots were cropped to tomatoes (cv. Mountain Spring and Florida 47). Half of each main plot received no organic amendment while the other half received an annual addition of composted dairy manure (7.5 T (dry weight)/A). The compost mix was incorporated in three summer additions in clean fallow, spread over the surface after hay harvests in mixed species hay, and incorporated prior to the main summer crop in low-intensity vegetables and intensive vegetable production under high tunnels. The same quantity of compost was incorporated prior to planting tomatoes in the fourth year.

Tomato foliar diseases were rated weekly throughout the growing season using a modified Horsfall-Barratt rating scale. Area under the disease progress curve values were calculated based on midpoints of the ratings. The incidence of timber rot was determined by counting symptomatic plants weekly throughout the growing season. The weights of total and marketable fruit were recorded. Data were analyzed by ANOVA using SAS statistical software and means were separated using Fisher's protected least significant difference test.

## RESULTS

Timber rot, caused by *Sclerotinia sclerotiorum*, appeared in the high tunnels in the spring. There was no difference between varieties in timber rot incidence, but disease incidence was significantly lower in plants grown in compost-amended soils than in non-amended soils (Table 1). Early blight appeared in high tunnels later in the season, but severity was relatively low. Nonetheless, early blight severity was less in plants grown in compost-amended than non-amended plots. In the open field plots (fallow, mixed hay, vegetable transitions), timber rot was not observed, but *Septoria* leaf spot pressure was moderate to severe (Table 2). Disease severity was lowest in the mixed hay transition in compost-amended plots, compared to the other transition strategies and non-amended mixed hay transition plots. *Septoria* leaf spot was significantly higher in Mountain Spring than in Florida 47 in open-field plots.

Three years of compost applications resulted in a significant increase in soil fertility regardless of transition strategy (Table 3). The compost application effect was greater in intensive vegetable production under high tunnels than in less intensive production strategies. In contrast, none of the transition strategies significantly affected any of the measured soil nutrient parameters. Soil pH was significantly higher under high tunnels than in open field plots. Compost amendment significantly increased the percentage of soil nitrogen and carbon compared to non-amended soils in all transition strategies.

Compost amendment in the each cropping strategy significantly increased total and marketable yield for green to pink and light red to red maturity stages of both cultivars (Table 4). The high-tunnel vegetable cropping strategy significantly increased total and marketable yield for both cultivars than the other strategies.

## CONCLUSION

It is not surprising that tomatoes produced in high tunnels developed different diseases than those in the open field. High tunnels protect plants from rain splash, thus diseases such as *Septoria* leaf spot are unlikely to develop. Since tomatoes are planted

into high tunnels several months earlier than the open field, when temperatures are relatively cool, timber rot may occur. High tunnels also maintain higher humidity, which favors timber rot. Annual applications of composted dairy manure during the 3-year transition and prior to tomato planting resulted in significantly less timber rot and early blight in high tunnels, and Septoria leaf spot in open field plots under the mixed hay transition strategy, than in the non-amended plots. Tomatoes in the mixed hay transition strategy tended to have less Septoria leaf spot than those in the open fallow and vegetable transitions. Transition strategy did not significantly affect soil nutrient composition, but compost amendment did increase soil C, N and other nutrients. The high-tunnel vegetable cropping strategy significantly increased total and marketable yield for both cultivars.

### Literature Cited

- Diver, S., Kuepper, G. and Born, H. 1999. Organic tomato production. Appropriate Technology Transfer for Rural Areas (ATTRA). <http://attra.ncat.org/attra-pub/PDF/tomato.pdf>.
- Oberholtzer, L., Dimitri, C. and Greene, C. 2005. Price premiums hold on as U.S. organic produce market expands. USDA Economic Research Service VGS-308-01.

### Tables

Table 1. Effect of compost application on Sclerotinia timber rot disease rate.

Treatment	Total number of infected plants
No compost	26.9 a*
Compost	5.8 b

\*Values are the means of four replications; means followed by the same letter are not significantly different at  $P \leq 0.05$ .

Table 2. Effect of different strategies with compost application on Septoria leaf spot and early blight diseases.

Treatment*	Septoria leaf spot (%)		AUDPC for Septoria leaf spot		Early blight (%)		AUDPC for early blight	
TF	35.6	a**	664.6	a	1.9	c	25.0	c
TF +C	26.9	ab	802.1	a	1.8	c	42.7	c
H	24.6	b	698.1	a	1.7	c	42.8	c
H +C	12.5	c	681.5	a	0.8	c	33.3	c
FV	33.5	ab	800.0	a	1.9	c	26.6	c
FV +C	26.9	ab	917.5	a	1.2	c	24.4	c
HTV	-	-	-	-	8.3	a	302.1	a
HTV +C	-	-	-	-	5.8	b	185.5	b

\*Organic transition treatments were tilled following (TF), hay cropping (H), field vegetable cropping (FV), or high-tunnel vegetable cropping (HTV). Each transition treatment included compost amended (+C) or non-amended sub-plots.

\*\*Values are the means of four replications; means followed by the same letter are not significantly different at  $P \leq 0.05$ .

Table 3. Soil nutrient status, fall 2005.

Treatment	Quantity of Nutrients (ug/g)										
	pH	N%	C%	P	K	Ca	Mg	Fe	Mn	Zn	
TF	6.3 e*	0.1 c	0.9 c	40 c	108 c	947 d	221 e	158 a	152 a	5.4 cd	
TF +C	6.8 cd	0.2 b	2.3 b	118 b	638 b	1493 c	370 cd	172 a	155 a	8.0 bc	
H	6.5 de	0.1 c	1.4 c	34 c	103 c	1112 d	226 e	160 a	158 a	7.1 bcd	
H +C	6.7 bc	0.4 a	4.2 a	143 b	859 b	2093 b	521 b	175 a	149 a	15.1 a	
FV	6.8 cd	0.1 c	0.9 c	37 c	101 c	1119 d	250 e	153 a	172 a	4.3 d	
FV +C	7.1 b	0.2 b	2.6 b	140 b	741 b	1633 c	432 c	168 a	169 a	9.2 b	
HTV	7.4 a	0.1 c	1.0 c	48 c	87 c	1524 c	338 d	165 a	192 a	4.8 cd	
HTV +C	7.5 a	0.4 a	4.5 a	255 a	1265 a	2401 a	700 a	167 a	158 a	13.9 a	

\*Values are the means of four replications; means followed by the same letter are not significantly different at  $P \leq 0.05$ .

Table 4. Effect of different strategies with compost application on yield in different tomato varieties.

Treatment	Variety	Total yield for green to pink maturity stages per plant (kg)	Total yield for light red to red maturity stages per plant (kg)	Marketable yield for green to pink maturity stages per plant (kg)	Marketable yield for light red to red maturity stages per plant (kg)
TF	Florida 47	0.4 fg*	1.8 f	0.2 ef	1.1 h
TF +C	Florida 47	1.1 def	5.4 cde	0.8 cde	3.2 efg
TF	M. Spring	0.2 g	3.0 ef	0.2 ef	1.6 gh
TF +C	M. Spring	0.3 fg	4.1 def	0.2 ef	1.9 gh
FV	Florida 47	0.4 fg	2.4 f	0.3 ef	1.4 gh
FV +C	Florida 47	0.8 efg	6.1 bcd	0.7 def	3.9 ef
FV	M. Spring	0.1 g	3.3 ef	0.1 f	1.6 gh
FV +C	M. Spring	0.3 fg	4.3 c-f	0.2 ef	1.9 gh
HA	Florida 47	0.3 fg	3.7 def	0.2 ef	2.1 fgh
HA +C	Florida 47	1.4 cde	6.6 bc	1.2 bcd	4.3 de
HA	M. Spring	0.3 fg	3.0 ef	0.2 ef	1.6 gh
HA +C	M. Spring	1.4 cde	6.2 bcd	1.2 bcd	3.8 ef
HTV	Florida 47	1.7 cd	8.2 b	1.2 bcd	6.1 cd
HTV +C	Florida 47	3.4 a	12.6 a	2.7 a	8.0 ab
HTV	M. Spring	2.0 bc	8.0 b	1.5 bc	6.5 bc
HTV +C	M. Spring	2.5 b	13.3 a	1.9 b	8.8 a

\*Values are the means of four replications; means followed by the same letter are not significantly different at  $P \leq 0.05$ .