

Effect of Commercial Biofumigant Cover Crops on Growth, Yield and Disease of Processing Tomatoes

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Abstract

Glucosinolate-producing cover crops are being marketed as biofumigants to reduce soil-borne diseases and increase yields. 'Caliente 119' (*Brassica juncea* and *Sinapis alba*), 'Caliente 99' and 'Caliente 61' (*B. juncea*) and 'Nemat' (*Eruca sativa*) were tested for their effects on growth, yield and incidence of anthracnose, blossom end rot and minor fruit rots of processing tomatoes at OARDC research stations in Fremont and Wooster, in 2006. Spring-seeded 'Caliente 119', 'Caliente 99' and 'Caliente 61' produced similar amounts of biomass, significantly higher than that produced by 'Nemat' in both locations. 'Caliente 119', 'Caliente 99' and 'Caliente 61' were significantly taller than 'Nemat' plants, but 'Nemat' population density was higher than recorded for the mustard varieties in Fremont. There were no differences among cover crops in germination in Wooster. In Fremont, there were no significant differences between plots with or without cover crops in tomato growth parameters, total or marketable yield, or percentage of fruits with anthracnose or blossom end rot. In Wooster, tomatoes following 'Caliente 119', 'Caliente 61' or 'Nemat' were shorter than plants not following a cover crop. Tomato plant width and number of leaves per plant were less in tomatoes following any cover crop than the non-cover control. Total fruit yield was lower in tomatoes following 'Caliente 119', 'Caliente 99' and 'Caliente 61' than the control, but there were no differences in marketable yield or yield of fruit with anthracnose. Minor fruit rots were lower in tomatoes following 'Caliente 99' and 'Nemat' than the control in Fremont. However, minor fruit rots were higher in tomatoes following 'Nemat' than the control in Wooster.

INTRODUCTION

Plants in the family Brassicaceae are commonly researched as biofumigant crops due to their production of secondary compounds from glucosinolate hydrolysis, sometimes referred to as allelochemicals, which can control or suppress weeds, nematodes, and fungi and improve soil characteristics and crop yield (McGuire, 2003; Kirkegaard et al., 1996; Buskov et al., 2002). Inhibition of mycelial growth of *Rhizoctonia solani*, *Fusarium graminearum*, *Bipolaris sorokiniana*, and *Pythium irregulare* (Sarwar et al., 1998) in the presence of isothiocyanates has been observed. Others have reported the effect of isothiocyanates on germination of *Botrytis cinerea* (Dawson et al., 1993) spores, and sporangia of *Peronospora parasitica* (Greenhalgh and Mitchell, 1976).

The aim of this study was to determine the effect of 'Caliente 119', 'Caliente 99' and 'Caliente 61' and 'Nemat' on growth, yield and incidence of anthracnose, blossom end rot and minor fruit rots of processing tomatoes.

MATERIALS AND METHODS

The experiment was conducted at OARDC research stations in Fremont and Wooster, OH in 2006. Plots were arranged in a randomized complete block design with four replications. Caliente brand varieties 119 (*Brassica juncea* and *Sinapis alba*), 99 and 61 (*B. juncea*) and Nemat (*Eruca sativa*) were seeded at the rate of 13.4, 13.4, 8.0, 8.0

lb/A, respectively on 30 March in Fremont and 11.0, 8.9, 5.5, and 5.5 lb/A, respectively on 3 April in Wooster, using a 3 ft fertilizer spreader. Control plots were not seeded for both locations. Germination data were recorded from three 10 in.² sections of each plot. ‘Peto 696’ tomato seeds were hot water-treated (10 min pre-soak at 100°F, then 25 min at 122°F) and sown into seedling mix. Plants were cut from a 1ft² sections from the outside beds of each variety and plant number, height, and fresh and dry weights were recorded. The cover crops were flail-mowed and chopped leaves, stalks, and stems were incorporated into the beds using a power bedded on 25 May in Fremont and 7 June in Wooster. Tomato seedlings were transplanted into single rows 1 ft apart on the beds on 6 June in Fremont and 21 June in Wooster. Each plot consisted of two rows of 25 plants spaced 1 ft apart, with 5 ft between rows and the two experimental rows (with cover crop) were alternated with one border row without a cover crop. One replication was lost due to flooding in Wooster. The height, width, and number of leaves of three tomato plants from the middle of the center plot row were recorded. Fruit were harvested from five plants in the middle of the center plot row and weights of marketable and unripe fruit and fruit with anthracnose, blossom end rot and other rots were determined. Data were analyzed by ANOVA using SAS statistical software. Means were separated using Fisher’s protected least significant difference test.

RESULTS

Evaluation of Cover Crops for Their Effect on Growth, Yield and Disease of Processing Tomatoes in Fremont

Caliente brand varieties produced similar amounts of biomass, which were significantly higher than that produced by Nemat (arugula) (Table 1). Caliente brand varieties were significantly taller than Nemat plants, but Nemat population density was significantly higher than recorded for the mustard varieties. There were no significant differences between plots with or without cover crops in tomato plant height or width, number of leaves/plant, total or marketable yield, or percentage of fruits with anthracnose or blossom end rot (Table 2). There was however, a trend toward higher marketable yield from tomato plots with a previous cover crop of Caliente 61 compared to the no-cover control, possibly as a result of the significantly lower percentage of unripe fruits in these plots than in the control. Minor fruit rots (*Rhizoctonia*, *Pythium* spp. etc.) were significantly lower in tomatoes following Caliente 99 and Nemat than in the no-cover control.

Evaluation of Cover Crops for Their Effect on Growth, Yield and Disease of Processing Tomatoes in Wooster

Caliente brand varieties produced similar amounts of biomass, which were significantly higher than that produced by Nemat (arugula) (Table 3). Caliente 119 and 99 were taller than Caliente 61 plants, and all were significantly taller than Nemat plants. There were no differences among cover crops in germination. In this location, tomatoes following Caliente 119, Caliente 61 or Nemat were shorter than plants not following a cover crop (Table 4). Tomato plant width and number of leaves per plant were less in tomatoes following any cover crop than in control tomatoes. Total fruit yield was lower in tomatoes following Caliente 119, 99 and 61 than the control, but there were no differences in marketable yield or yield of fruit with anthracnose symptoms. Marketable yield was low overall due to a large proportion of unripe fruit. Blossom end rot was significantly reduced compared to the control in tomatoes following any cover crop. Minor fruit rots were higher in tomatoes following Nemat than in control tomatoes.

DISCUSSION

Spring-seeded ‘Caliente 119’, ‘Caliente 99’ and ‘Caliente 61’ produced similar amounts of biomass, significantly higher than that produced by ‘Nemat’ in both locations. ‘Caliente 119’, ‘Caliente 99’ and ‘Caliente 61’ were significantly taller than ‘Nemat’ plants, but ‘Nemat’ population density was higher than recorded for the mustard varieties

in Fremont. There were no differences among cover crops in germination in Wooster. In Fremont, there were no significant differences between plots with or without cover crops in tomato growth parameters, total or marketable yield, or percentage of fruits with anthracnose or blossom end rot. In Wooster, tomatoes following ‘Caliente 119’, ‘Caliente 61’ or ‘Nemat’ were shorter than plants not following a cover crop. Tomato plant width and number of leaves per plant were less in tomatoes following any cover crop than the non-cover control. Total fruit yield was lower in tomatoes following ‘Caliente 119’, ‘Caliente 99’ and ‘Caliente 61’ than the control, but there were no differences in marketable yield or yield of fruit with anthracnose. Minor fruit rots were lower in tomatoes following ‘Caliente 99’ and ‘Nemat’ than the control in Fremont. However, minor fruit rots were higher in tomatoes following ‘Nemat’ than the control in Wooster. In this northern location, spring seeding of Caliente or Nemat may not be practical as the window between cover crop seeding and transplanting of tomatoes may not be sufficiently long. More research is needed to evaluate fall seeding and incorporation of these varieties for disease management in the subsequent tomato crop.

Literature Cited

- Buskov, S., Serra, B., Rosa, E., Sorensen, H. and Sorensen, J.C. 2002. Effects of intact glucosinolates and products produced from glucosinolates in myrosinase-catalyzed hydrolysis on the potato cyst nematode. *J. Agric. Food Chem.* 50:690-695.
- Dawson, G.W., Doughty, K.J., Hick, A.J., Pickett, J.A., Pye, B.J., Smart, L.E. and Wadhams, L.J. 1993. Chemical precursors for studying the effects of glucosinolate catabolites on diseases and pests of oilseed rape (*Brassica napus*) or related plants. *Pestic. Sci.* 39:271-278.
- Greenhalgh, J.R. and Mitchell, N.D. 1976. The involvement of flavour volatiles in the resistance to downy mildew of wild and cultivated forms of *Brassica oleracea*. *New Phytol.* 77:391-398.
- Kirkegaard, J.A., Wong, P.T.W. and Desmarchelier, J.M. 1996. In vitro suppression of fungal root pathogens of cereals by *Brassica* tissues. *Plant Path.* 45:593-603.
- McGuire, A.N. 2003. Mustard green manures replace fumigant and improve infiltration in potato cropping system. Online. *Crop Management* doi:10.1094/CM-2003-0822-01-RS.
- Sarwar, M., Kirkegaard, J.A., Wong, P.T.W. and Desmarchelier, J.M. 1998. Biofumigation potential of brassicas. III. In vitro toxicity of isothiocyanates to soil-borne fungal pathogens. *Plant Soil* 201:103-112.

Tables

Table 1. Comparison of germination, height and fresh weight data for different cover crops in Fremont.

Cover crop	Cover crop		
	Germination (plants/ft ²)	Height (in.)	Fresh weight (oz/ft ²)
Caliente 119	55.8 b*	24.0 a	21.1 a
Caliente 99	67.3 b	17.0 b	19.7 a
Caliente 61	78.6 b	18.8 b	18.6 a
Nemat	146.8 a	9.6 c	11.9 b

*Values are the means of four replicate plots; means followed by the same letter within a column are not significantly different at $P \leq 0.05$.

Table 2. Effects of different cover crop on the vegetative growth parameters yield and incidence of anthracnose, blossom end rot and minor fruit rots of processing tomatoes in Fremont.

Cover crop	Tomato plant height (in.)	Tomato plant width (in.)	Number of leaves/ tomato plant	Total yield (ton/A)	Marketable yield (ton/A)	% anthracnose	% blossom end rot	% minor fruit rots
Caliente 119	13.3 a *	29.7 a	9.3 a	24.3 a	6.1 a	18.9 a	1.8 a	14.2 ab
Caliente 99	13.7 a	32.1 a	9.4 a	28.6 a	6.5 a	16.5 a	2.1 a	10.7 b
Caliente 61	13.3 a	30.4 a	8.8 a	28.4 a	10.5 a	21.6 a	3.6 a	11.9 ab
Nemat	13.9 a	31.1 a	9.3 a	28.4 a	8.2 a	19.2 a	3.6 a	8.4 b
None	12.7 a	30.3 a	9.3 a	28.7 a	5.0 a	10.7 a	3.7 a	20.0 a

*Values are the means of four replicate plots; treatments followed by the same letter within a column are not significantly different at $P\eta 0.1$.

Table 3. Comparison of germination, height and fresh weight data for different cover crops in Wooster.

Cover crop	Cover Crop		
	Germination (plants/ft ²)	Height (in.)	Fresh weight (oz/ft ²)
Caliente 119	38.3 a *	28.1 a	22.3 a **
Caliente 99	36.5 a	25.4 a	22.8 a
Caliente 61	32.5 a	19.5 b	20.4 a
Nemat	40.0 a	14.4 c	12.5 b

*Values are the means of four replicate plots; means followed by the same letter within a column are not significantly different at $P\eta 0.05$.

** Average fresh weight data were square root transformed prior to analysis; non-transformed means are reported.

Table 4. Effects of different cover crop on the vegetative growth parameters yield and incidence of anthracnose, blossom end rot and minor fruit rots of processing tomatoes in Wooster.

Cover crop	Tomato plant height (in.)	Tomato plant width (in.)	Number of leaves/ tomato plant	Total yield (ton/A)	Marketable yield (ton/A)	% anthracnose	% blossom end rot	% minor fruit rots
Caliente 119	15.5 b *	24.2 b	41.4 b	21.0 b	5.3 a	18.0 a	1.6 b	11.3 ab
Caliente 99	16.5 ab	25.0 b	39.3 b	18.3 b	3.4 a	17.7 a	2.3 b	10.9 ab
Caliente 61	14.1 b	24.0 b	39.6 b	22.4 b	7.5 a	16.2 a	1.4 b	6.4 c
Nemat	15.9 b	23.5 b	36.8 b	25.2 ab	9.5 a	9.9 a	1.6 b	13.4 a
None	20.0 a	37.3 a	60.9 a	35.3 a	7.7 a	17.0 a	6.4 a	8.7 bc

*Values are the means of three replicate plots; treatments followed by the same letter within a column are not significantly different at $P\eta 0.1$.