Ohio Vegetable & Small Fruit Research & Development Program

Final Report

2019

Project Title: Integrated Management of Phytophthora Blight Using Grafted Peppers and Fungicides

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Why was this project funded? Phytophthora blight is very difficult to manage in peppers, despite the availability of partially resistant pepper varieties and Phytophthora-specific fungicides, and OVSFRDP members suggested research on improving Phytophthora control. An integrated approach including disease resistance, cultural practices, and fungicides is necessary to achieve adequate control. Recently two *Phytophthora*-resistant pepper rootstocks were identified by Clemson University and USDA ARS. These rootstocks have been successfully grafted with various commercial pepper varieties (scions). These and several Phytophthora-resistant pepper varieties were tested in field trials.

Project outline: We worked with Dr. Richard Hassel of Clemson University, who provided grafted peppers (two rootstocks, one scion variety) for 1) a one acre on-farm demonstration trial (scion variety was chosen by the grower (SV3255)) and 2) a replicated trial on the OSU North Central Agricultural Research Station (NCARS) in Fremont. In the replicated trial at NCARS, we established a split plot trial with four replications in a field with a history of *Phytophthora*. Plots were also inoculated with *Phytophthora capsici* according to standard procedures in the NCARS trial only. One main plot included grafted and non-grafted peppers that received foliar fungicide applications; the other main plot had the same pepper varieties, grafted and non-grafted, but was not sprayed with foliar fungicides. Varieties were: SV3255 + rootstock 1, SV3255 + rootstock 2, four partially resistant pepper varieties (Aristotle, Intruder, Mercer and Sequoia), and one susceptible bell variety (non-grafted SV3255). The fungicide program included a rotation of Orondis Ultra,

Ranman, and Presidio, which we have found to be most effective among the various fungicides for Phytophthora management. Plots were evaluated for Phytophthora blight weekly once symptoms appeared. Marketable yield and Phytophthora fruit rot were evaluated at harvest.

Take-home messages: Phytophthora blight disease pressure was low despite Phytophthora history in the test field and inoculation. Nonetheless there are a few take-home messages:

- The fungicide program reduced *Phytophthora* in pepper fruit to negligible levels.
- Grafting a susceptible scion on a *Phytophthora*-resistant rootstock may result in reduced *Phytophthora* fruit infection in the absence of fungicides, blossom end rot and other rots compared to the non-grafted scion.
- Pepper varieties with partial resistance to *Phytophthora* may yield fewer fruit diseased by *Phytophthora* compared to the non-grafted scion SV3255.

Impacts: Phytophthora blight causes significant economic loss in peppers if not managed. This research showed that use of an appropriate fungicide program can reduce the disease to low levels, especially if combined with resistant varieties, including grafting susceptible varieties onto blight-resistant rootstocks.

What was discovered?

- The grower trial was discontinued due to a high incidence of *Tomato spotted wilt virus.*
- All varieties and grafted plants had significantly less Phytophthora on fruit than the susceptible variety SV3255 in the non-fungicide treated plots.
- Phytophthora incidence on pepper fruit in fungicide-treated plots was negligible and there were no differences in fruit disease incidence among varieties.
- Marketable yield (tons/A) did not vary among varieties in the fungicide-treated or non-treated plots.
- In the fungicide-treated plots, the percentage marketable fruit was significantly higher for both grafted varieties (SV3255 + E1 rootstock and SV3255 + E3 rootstock) than for the scion SV3255.
- In the fungicide-treated plots, the percentage of fruit with blossom end rot was significantly lower in both grafted varieties (SV3255 + E1 rootstock and SV3255 + E3 rootstock) than in the scion SV3255.
- In the fungicide-treated plots, the percentage of fruit with other" rots was significantly lower in both grafted varieties (SV3255 + E1 rootstock and SV3255 + E3 rootstock) than in the scion SV3255.

Appendix: full report

PEPPER (*Capsicum annuum*)
Phytophthora blight; *Phytophthora capsici*

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Integrated management of Phytophthora blight using grafted peppers and fungicides, 2019.

The experiment was conducted at The Ohio State University's North Central Agricultural Research Station in Fremont, OH on Rimer loamy fine sand. Seeds were sown on 17 Apr into 200-cell plug trays. The herbicides Roundup PowerMAX (40 fl oz/A) and Choice Weather Master (8 fl oz/A) were applied to the test field on 8 May. On 15 May, the fertilizer's 46-0-0 (N-P-K; 250 lb/A), 10-52-0 (100 lb/A), 0-0-60 (500 lb/A), and 20% granular boron (7 lb/A) were broadcast and then the field was disked and tilled. On 17 May, beds were prepared on 5 ft centers. The herbicides Dual II Magnum (16 fl oz/A) and Command 3ME (8 fl oz/A) were applied on 24 May. Pepper seedlings were transplanted on 19 Jun.; the starter fertilizer (N-P-K 10-34-0; 0.7 qt/50 gal water) was applied in the transplant water. The experiment was arranged as a split plot in a randomized compete block design with four replications. Foliar fungicide programs were the main plot and grafted and non-grafted peppers were the sub-plots. One main plot consisted of foliar applications of fungicides and the other one did not receive foliar fungicide applications. Each sub-plot consisted of one row of 25 plants spaced 1 ft apart with 5 ft between rows and were alternated with non-treated border rows. Insecticides were applied as needed: Actara (3 oz/A; 24 Jun and 30 Aug), Warrior II with Zeon Technology (1.92 fl oz/A; 27 Jun), Mustang Maxx (4 fl oz/A; 2 and 19 Jul, 9 and 26 Aug, and 26 Sep), Exirel (13.5 fl oz/A; 11 Jul and 11 Sep), Radiant SC (5 fl oz/A; 19 Jul and 5 Sep), Avaunt (3.5 oz/A; 25 Jul and 19 Sep), Asana XL (9.6 fl oz/A; 1 and 15 Aug), Coragen (5 fl oz/A; 30 Aug and 8 Oct), Beleaf 50 SG (2.8 oz/A; 5 Sep), and Javelin (1 lb/A; 11 Sep). Fungicides were also applied as needed to control anthracnose on fruit: Quadris Top (8 fl oz/A; 25 Jul, 1 Aug, 5 and 19 Sep, and 8 Oct), Quadris Flowable (6.2 fl oz/A; 9 Aug), and Bravo Weather Stik (1.5 pt/A; 15, 26, and 30 Aug, and 11 and 26 Sep). The field was hoed and hand weeded on 26 Jun, and 9 and 29 Jul, and cultivated on 27 Jun, and 9 and 26 Jul. Foliar treatments were applied using a tractor-mounted CO_2-pressurized sprayer (55 psi, 42.3gal/A, 3 mph) beginning 3 Jul and ending 8 Oct for a total of 14 applications. On 27 Aug, plants were inoculated with *Phytophthora capsici*-infested millet (700 g sterilized millet autoclaved twice, 400 ml de-ionized water, 5 13-mm plugs of *P. capsici*). Infested millet (1.5 g) was placed into holes 0.5 in. deep and made 1 cm away from the plant crown. Plants were irrigated with 1.9 in. water on both 5 and 20 Sep. Incidence of *P. capsici* was evaluated weekly from 4 Sep to 18 Oct. Peppers were harvested from 15 plants from each row on 4 and 18 Sep, and 8 Oct. Pepper fruits were evaluated, and weights were taken for the following categories: healthy, diseased (Phytophthora), blossom end rot, and other minor fruit rots. Average maximum temperatures for 16-30 Jun, Jul, Aug, Sep, and 1-18 Oct were 83.2, 87.2, 81.7, 79.8, and 68.6°F; average minimum temperatures were 64.0, 66.7, 61.5, 59.1, and 46.1°F; and rainfall amounts were 0.7, 2.8, 4.2, 1.2, and 0.8 in., respectively. Arcsine transformation (arcsine $[\sqrt{(X/100)}]$) was performed on percent Phytophthora incidence and percent marketable yield. Analysis of variance was performed using the GLIMMIX procedure, means and transformed means were separated by Fisher's least significant difference test with SAS software.

Despite the use of a field with a history of Phytophthora blight and inoculation of each plant with *Phytophthora capsici*, disease incidence in plants (root/crown phase) and fruits was low (≤ 5%) in this trial. There were no significant differences in Phytophthora blight incidence on plants between varieties or between fungicide-treated and non-treated plants. Grafting did not influence total or marketable yield; the were no significant yield differences between non-grafted 'SV3255' and 'SV3255' scions grafted onto 'E1' or 'E3' rootstocks. However, "spray program" significantly affected the incidence of Phytophthora blight on fruit and the percent marketable yield. The interaction between "spray program" and "variety" was significant for the total weight and percentage of Phytophthora on pepper fruits. "Variety" significantly affected the incidence of Phytophthora blight on fruit, the percent marketable yield, and the incidence of blossom end rot and other fruit rots. Phytophthora blight on fruits was negligible in the fungicide-treated plots. In the fungicide-treated plots, there were no significant differences in total or marketable yield among grafted or non-grafted varieties, however the percentage marketable yield was significantly higher for 'SV3255' grafted on 'E1'or 'E3', 'Sequoia' and 'Aristotle' than for non-grafted 'SV3255'. The percentage of fruits with BER was significantly lower in "SV3255' grafted on 'E1", 'Mercer' and 'Sequoia' than in non-grafted 'SV3255' or 'Aristotle'. The percentage of "other rots" was lowest in 'SV3255' grafted on 'E3', 'Sequoia' and 'Aristotle'.

In the non-fungicide-treated plots, all varieties and grafted plants had significantly less Phytophthora blight on fruit than the susceptible variety 'SV3255'. 'Sequoia' and 'Aristotle' had significantly lower incidence of Phytophthora blight on fruit than 'Mercer', 'Intruder', and 'SV3255' alone or grafted onto rootstocks E1 or E3. There were no significant differences between varieties in the incidence of BER or other fruit rots in these plo

Summary of P-values

Effects	Incidence on plant (%)[z]	Total yield t/A	Market-able yield t/A	% Marketable yield	Phytophthora on fruits t/A	% Phytophthora on fruits	BER[z] t/A	% BER	Other t/A	% Other
Spray program	0.9206	0.7928	0.9473	0.0325	<0.0001	<0.0001	0.3213	0.5890	0.348	0.1899
Varieties	0.1026	0.3284	0.2239	0.0058	0.0002	0.0008	0.0089	0.009	0.033	0.0499
Spray program × Varieties	0.2096	0.5614	0.5505	0.8729	0.0008	0.0036	0.7682	0.5965	0.376	0.8265

[z] BER = blossom end rot.

Spray program: foliar fungicide applications[z]										
Variety	Incidence on plants (%)	Total yield t/A	Marketable yield t/A	% Marketable yield[yx]	Phytophthora on fruits t/A	% Phytophthora on fruits	Blossom ER t/A[x]	% Blossom ER[x]	Other t/A[x]	% Other[x]
SV3255 + E1	0.0	19.7	18.6	94.4 ab	0.0	0.0	0.0 c	0.2 b	1.1 abc	5.4 bc
SV3255 + E3	0.0	21.3	20.3	95.4 a	0.1	0.3	0.1 bc	0.6 b	0.8 dc	3.7 cd
Mercer	5.0	17.7	16.2	91.8 bc	0.0	0.0	0.5 a	2.5 a	0.9 bcd	5.7 bc
Intruder	0.0	17.5	15.6	89.1 c	0.0	0.2	0.3 abc	1.5 ab	1.6 a	9.1 a
Sequoia	0.0	20.9	20.0	95.4 a	0.0	0.2	0.1 c	0.3 b	0.8 cd	4.2 cd
Aristotle	3.3	18.0	17.2	95.4 a	0.0	0.0	0.4 ab	2.2 a	0.4 d	2.4 d
SV3255	3.3	20.0	18.0	90.3 c	0.0	0.2	0.4 ab	2.2 a	1.5 ab	7.2 ab
P-value	0.1392	0.3766	0.2274	0.0026	0.6437	0.6797	0.0499	0.0434	0.0306	0.0061

[z] Ranman + Kphite 7LP (2.75 fl oz/A, 1 gal/A; 3 and 26 Jul, 9 and 26 Aug, and 11 and 26 Sep), Presidio (4 fl oz/A; 10 Jul, 1 and 14 Aug, 5 and 19 Sep, and 8 Oct), Orondis Ultra (8 fl oz/A; 19 Jul and 30 Aug)

[y] Values are the means of four replicate plots; means followed by the same letter within a column are not significantly different at the indicated P value. Means were separated using Fisher's least significant difference test.

Spray program: no foliar fungicide applications										
Variety	Incidence on Plants (%)	Total yield t/A	Marketable yield t/A	% Marketable yield	Phytophthora on fruits t/A[z]	% Phytophthora on fruits[z]	Blossom ER t/A	% Blossom ER	Other t/A	% Other
SV3255 + E1	0.0	18.3	16.6	90.8	0.2 b	1.1 b	0.1	0.8	1.3	7.4
SV3255 + E3	0.0	20.5	18.8	91.7	0.2 b	0.9 bc	0.3	1.6	1.1	5.7
Mercer	0.0	20.0	18.3	91.8	0.2 bc	0.8 bcd	0.3	1.5	1.2	6.0
Intruder	5.0	16.2	14.5	82.9	0.1 bc	0.3 bcd	0.3	1.2	1.3	15.5
Sequoia	0.0	19.2	17.8	92.7	0.0 c	0.3 cd	0.2	1	1.1	6.1
Aristotle	1.7	22.3	20.9	94.0	0.0 c	0.0 d	0.4	1.9	0.9	4.1
SV3255	3.3	21.8	19.6	90.2	0.5 a	2.3 a	0.6	2.6	1.1	4.9
P-value	0.2165	0.4866	0.4754	0.3463	0.0008	0.0023	0.2481	0.3139	0.8207	0.3766

[z] Values are the means of four replicate plots; means followed by the same letter within a column are not significantly different at the indicated P value. Means were separated using Fisher's least significant difference test.