Plant Pathology Series No. 126 January 2005

Vegetable Disease Management Research Reports 2004

Tomato, Pepper, Squash, Radish, and Mustard Greens

Sally A. Miller, Melanie L. Lewis Ivey and Jhony R. Mera
Vegetable Disease Management Program
Department of Plant Pathology
The Ohio State University
Ohio Agricultural Research and Development Center (OARDC)
Wooster, Ohio

Table of Contents

Acknowledgments

This work was funded by The Ohio State University- Ohio Agricultural Research and Development Center, Ohio State University Extension, the Ohio Vegetable and Small Fruit Research and Development Program, and cooperating seed, agro-chemical, and biofungicide companies. This support is greatly appreciated.

Matt Hofelich, Rick Callendar, Bill Bardall, and the support staff of the North Central Agricultural Research Station, Muck Crops Research Station, and Department of Plant Pathology provided excellent technical assistance. Their cooperation and input is greatly appreciated.

Seeds used in these studies were provided by:

Harris Moran Seed Co.
Johnny's Select Seeds
Meyer Seed International, Inc.
SeedWay, Inc.
SeedWay, Inc. / Enza Zaden North America, Inc.
SeedWay, Inc. / Sutter Seed Co.
Semenis Vegetable Seeds
Siegers Seed Co.
Siegers Seed Co. / Vilmorin Seed Co.
Siegers Seed Co. / Sutter Seed Co.
Siegers Seed Co. / Enza Zaden North America, Inc.
Syngenta Seeds, Inc.

Fungicides and biologicals evaluated in these studies were provided by:

AgraQuest, Inc.
Agrichem
BASF Corp.
Cerexagri, Inc.
Diatect International
DuPont Crop Protection
Griffin L. L. C
GlycoGenesys, Inc.
Helena Chemical Company
Isagro
ISK Biosciences Corp.
Peaceful Valley Farm Supply
SoilSoup, Inc.
Syngenta Crop Protection
Valent U.S.A Corp.

TOMATO (*Lycopersicon esculentum* 'Peto 696')
Bacterial spot; *Xanthomonas campestris* pv. *vesicatoria*
Bacterial speck; *Pseudomonas syringae* pv. *tomato*
Early blight; *Alternaria solani*
Anthracnose; *Colletotrichum coccodes*

M. L. Lewis Ivey, J. R. Mera and S. A. Miller
The Ohio State University, OARDC
1680 Madison Ave.
Wooster, OH 44691

Evaluation of fungicides and bactericides for the control of foliar and fruit diseases of processing tomatoes, 2004.

The experiment was conducted at the North Central Agricultural Research Station in Fremont, OH on Colwood fine sandy loam. Potassium (210 lb/A K_2O), phosphorous (69 lb/A P_2O_5) and nitrogen (96 lb urea/A) were incorporated into the test field on 22 Apr. Cover crop (wheat) was chiseled plowed on 7 Oct 03 and plowed under on 12 Apr. The test field was disked and beds were prepared on 5 ft centers on 6 May. Dual II MAGNUM (1.25 pt/A), Sencor 75 DF (0.33 lb/A), and Roundup WEATHERMAX (1qt/A) were applied on 27 May. 'Peto 696' tomato seeds were hot water-treated (OSU Extension Bulletin 672, The Ohio State University, Columbus, OH) and sown on 13 Apr into 288-cell plug trays containing Metromix 360 seedling mix. Tomato seedlings were transplanted on 4 Jun; transplant water contained starter fertilizer (N-P-K 10-34-0) at 0.7 qt/50 gal water. Each plot was a double row of approximately 34 plants spaced 18 in. apart with 18 in. between rows. Treatments were arranged in a randomized complete block design with four replications. Treatment plots were alternated with untreated border plots. Asana XL (7 fl oz/A), tank mixed with Manex (2 qt/A) and alone was applied by aircraft on 18 Jun and 25 Jun, respectively. The field was cultivated on 24 Jun, Sencor DF (0.33 lb/A) was applied on 28 Jun and on 19 Jul the field was hand weeded. Plants were inoculated with approximately 10^7 CFU/ml *Xanthomonas campestris* pv. *vesicatoria* strain 767, race T1P3 on 29 Jun in the evening using a tractor-mounted CO_2 sprayer (55 psi, 39.3 gal/A). Plants were misted with water using an FMC sprayer with a PTO-driven pump (200 psi, 32.6 gal/A) prior to inoculation. Amistar 80WG (2 oz/A) was applied in alternation with Bravo Weather Stik (1.67 pt/A) as a cover spray to plots treated with Cuprofix 40DF and Actigard 50WG on a 7-10 day schedule, beginning 28 Jun and ending 25 Aug. Treatments were applied on a 7-10 day schedule beginning 24 Jun and ending 25 Aug using a tractor-mounted CO_2-pressurized sprayer (55 psi, 42.9 gal/A) for a total of 10 applications. The surfactant Biotune (QRD602, 0.125 %) was added to Serenade Max WPB treatments. Severity of bacterial leaf spot and early blight on foliage was evaluated on 16 Jul, 25 Aug and 2 Sep using a modified Horsfall-Barratt rating scale. Disease ratings were converted to midpoints (% disease) prior to statistical analysis. Fruit were harvested from all plants in each plot on 20-22 Sep and total weights were recorded. Weights of healthy red and green fruit, fruit with anthracnose, and fruit with bacterial spot and/or speck were recorded from a 50 lb sub-sample from each plot. Data for fruit with anthracnose were analyzed using log transformed values; data for bacterial diseases were analyzed by adding one to each data point before log transformation; the remaining data were analyzed without transformation, by ANOVA using SAS statistical software. Means were separated using Fisher's protected least significant difference test. Average maximum temperatures for 4-30 Jun, Jul, Aug and 1-22 Sep were 78.0, 81.1, 78.5 and 78.9 °F; minimum averages were 54.9, 58.7, 54.0, and 51.5 °F; and total rainfall was 5.0, 2.7, 4.0, and 0.5 in., respectively.

Disease pressure was moderate to high for foliar bacterial spot, moderate for early blight and anthracnose, and low for bacterial spot on fruit. All treatments resulted in significantly less foliar bacterial spot than the untreated control, but Cuprofix 40DF in combination with cover spray, Actigard 50WG in combination with cover spray, and Tanos 50DF (high rate) plus Kocide 2000 plus Manzate 75DF alternated with Manzate 75DF plus Kocide 2000 were the most effective. Foliar early blight was significantly reduced compared to the untreated control by all treatments except Serenade Max WPB plus Kocide 2000 and the 1.9 pt/A rate of Airone SC plus Manzate 75DF. The amount of fruit (ton/A) with anthracnose was significantly reduced by all treatments except those containing Serenade Max WPB. There were no significant differences among treatments and the control in marketable yield, healthy green fruit (range 3.8-6.3 ton/A; not shown) or mature fruit with bacterial disease (range 0.2-1.8 ton/A; not shown). However, all treatments except Serenade Max WPB plus Kocide 2000 alternated with Kocide 2000 plus Manzate 75DF significantly increased the percentage of marketable fruit compared to the control.

Treatment and rate/A (application time[z])	Foliar bacterial spot		Foliar early blight	
	% disease[y]	AUDPC[y]	% disease	AUDPC
Control	67.6 a[x]	1780.3 a	54.3 a	535.1 a
Kocide 2000 2 lb +[w] Manzate 75DF 2 lb (1-10)	21.4 cd	439.9 c-f	16.6 cde	384.6 a
Cuprofix 40DF 2 lb (1-10) + cover spray[v]	7.3 f	407.8 cde	19.0 cde	314.8 a
Cuprofix 40DF 2 lb (1-10)	28.5 bc	701.4 bc	16.6 cde	249.4 a
Serenade Max WPB (QRD 141) 1 lb + Kocide 2000 2 lb (1-8)	28.5 bc	716.0 bc	38.0 ab	433.9 a
Serenade Max WPB (QRD 141) 1 lb + Kocide 2000 2 lb (1,3,5,7) *alt.*[u] Kocide 2000 2 lb + Manzate 75DF 2 lb (2,4,6,8	19.0 cd	804.3 b	23.8 bcd	282.8 a
Actigard 50WG[t] (1-6) + cover spray	7.3 f	626.3 c-f	15.5 cde	409.4 a
Airone SC 2.5 pt + Manzate 75DF 2 lb (1-10)	19.0 cd	801.6 bcd	21.4 b-e	423.2 a
Airone SC 1.9 pt + Manzate 75DF 2 lb (1-10)	28.5 bc	471.3 cde	28.5 abc	393.8 a
Airone SC 1.3 pt + Manzate 75DF 2 lb (1-10)	14.3 de	336.4 def	16.6 cde	275.9 a
Tanos (KP481) 50WG 8 oz + Kocide 2000 2 lb + Manzate 75DF 2 lb (1,3,5,7,9) *alt.* Manzate 75DF 2 lb + Kocide 2000 2 lb (2,4,6,8,10)	17.9 de	249.6 ef	13.1 de	455.8 a
Tanos (KP481) 50DF 10 oz + Kocide 2000 2 lb + Manzate 75DF 2 lb (1,3,5,7,9) *alt.* Manzate 75DF 2 lb + Kocide 2000 2 lb (2,4,6,8,10)	14.3 de	309.6 ef	14.3 cde	421.1 a
Tanos (KP481) 50DF 10 oz + ManKocide 2 lb (1,3,5,7,9) *alt.* ManKocide 61WDG 3 lb (2,4,6,8,10)	44.3 b	769.3 bc	14.3 cde	256.6 a
Tanos (KP481) 50DF 12 oz + Kocide 2000 2 lb + Manzate 75DF 2 lb (1,3,5,7,9) *alt.* Manzate 75DF 2 lb + Kocide 2000 2 lb (2,4,6,8,10)	10.8 ef	252.5 f	10.8 e	324.9 a
Quadris 2.08SC 6.2 fl oz (1,3,5,7,9) *alt.* Manzate 75DF 2 lb + Kocide 2000 2 lb (2,4,6,8,10)	14.3 de	503.9 c-f	21.4 b-e	275.4 a
ManKocide 61WDG 3 lb (1-10)	14.3 de	659.0 bcd	16.6 cde	266.1 a

[z]Application times were: 1= 24-30 Jun; 2= 1-7 Jul; 3= 8-14 Jul; 4= 15-21 Jul; 5= 22-28 Jul; 6= 29 Jul-4 Aug; 7= 5-11 Aug; 8= 12-16 Aug; 9= 17-24 Aug; and 10= 25-31 Aug.

[y]Disease rating (2 Sep) and area under the disease progress curve (AUDPC) based on the midpoint values of a modified Horsfall-Barratt rating scale where 1=0%, 2= 1-3%, 3= 4-6%, 4=7-12%, 5= 13-25%, 6=26-50%, 7=51-75%, 8= 76-87%, 9=88-94%, 10= 95-97%, 11=98 99% and 12= 100% foliar bacterial leaf spot or early blight.

[x]Values are the means of four replicate plots; means followed by the same letter within a column are not significantly different at p□0.05.

[w]Treatments tank mixed.

[v]Amistar 80WG (2 oz/A) alternated with Bravo Weather Stik (1.67 pt/A) on a 7-10 day schedule.

[u]Treatment alternated with each other.

[t]Three rates of Actigard were applied: first application, 0.33 oz/A; second and third application 0.5 oz/A; remaining applications 0.75 oz/A.

Treatment and rate/A (application time[z])	Anthracnose (ton/A)	Marketable yield (ton/A)	% marketable fruit
Control	12.1 a[y]	24.3 a	49.3 e
Kocide 2000 2 lb +[x] Manzate 75DF 2 lb (1-10)	5.6 bcd	28.8 a	64.7 a-d
Cuprofix 40DF 2 lb (1-10) + cover spray[w]	0.8 fg	31.4 a	74.0 ab
Cuprofix 40DF 2 lb (1-10)	3.3 b-e	29.1 a	65.7 a-d
Serenade Max WPB (QRD 141) 1 lb + Kocide 2000 2 lb (1-8)	4.6 abc	27.0 a	61.8 cd
Serenade Max WPB (QRD 141) 1 lb + Kocide 2000 2 lb (1,3,5,7) *alt.*[v] Kocide 2000 2 lb + Manzate 75DF 2 lb (2,4,6,8)	5.4 ab	27.2 a	57.5 de
Actigard 50WG[u] (1-6) + cover spray	0.6 g	29.0 a	65.1 a-d
Airone SC 2.5 pt + Manzate 75DF 2 lb (1-10)	1.7 efg	32.2 a	71.6 abc
Airone SC 1.9 pt + Manzate 75DF 2 lb (1-10)	2.7 b-e	27.3 a	61.3 cd
Airone SC 1.3 pt + Manzate 75DF 2 lb (1-10)	2.9 b-e	27.6 a	64.5 a-d
Tanos (KP481) 50WG 8 oz + Kocide 2000 2 lb + Manzate 75DF 2 lb (1,3,5,7,9) *alt.* Manzate 75DF 2 lb + Kocide 2000 2 lb (2,4,6,8,10)	1.9 c-f	31.7 a	70.0 abc
Tanos (KP481) 50DF 10 oz + Kocide 2000 2 lb + Manzate 75DF 2 lb (1,3,5,7,9) *alt.* Manzate 75DF 2 lb + Kocide 2000 2 lb (2,4,6,8,10)	2.0 c-f	31.2 a	71.8 abc
Tanos (KP481) 50DF 10 oz + ManKocide 2 lb (1,3,5,7,9) *alt.* ManKocide 61WDG 3 lb (2,4,6,8,10)	3.0 b-e	31.4 a	67.0 a-d
Tanos (KP481) 50DF 12 oz + Kocide 2000 2 lb + Manzate 75DF 2 lb (1,3,5,7,9) *alt.* Manzate 75DF 2 lb + Kocide 2000 2 lb (2,4,6,8,10)	1.4 fg	31.5 a	75.2 a
Quadris 2.08SC 6.2 fl oz (1,3,5,7,9) *alt.* Manzate 75DF 2 lb + Kocide 2000 2 lb (2,4,6,8,10)	1.5 d-g	29.0 a	64.1 bcd
ManKocide 61WDG 3 lb (1-10)	1.6 c-f	26.4 a	63.0 cd

[z]Application times were: 1= 24-30 Jun; 2= 1-7 Jul; 3= 8-14 Jul; 4= 15-21 Jul; 5= 22-28 Jul; 6= 29 Jul-4 Aug; 7= 5-11 Aug; 8= 12-16 Aug; 9= 17-24 Aug; and 10= 25-31 Aug.

[y]Values are the means of four replicate plots; means followed by the same letter within a column are not significantly different at p□0.05.

[x]Treatments tank mixed.

[w]Amistar 80WG (2 oz/A) alternated with Bravo Weather Stik (1.67 pt/A) on a 7-10 day schedule.

[v]Treatment alternated with each other.

[u]Three rates of Actigard were applied: first application, 0.33 oz/A; second and third application 0.5 oz/A; remaining applications 0.75 oz/A.

PEPPER (*Capsicum annuum* 'Socrates X3R')
Anthracnose; *Colletotrichum acutatum*

M. L. Lewis Ivey, J. R. Mera and S. A. Miller
The Ohio State University, OARDC
1680 Madison Ave.
Wooster, OH 44691

Evaluation of fungicides for the control of anthracnose on immature pepper fruit, 2004.

The experiment was conducted at the Ohio Agricultural Research and Development Center, Snyder Farm in Wooster, OH on Wooster silt loam. On 26 May 400 lb/A of 19-19-19 (N-P-K) fertilizer was broadcast and incorporated into the field. The herbicides Dual II Magnum (1 pt/A) and Treflan EC 2 (1.5 pt/A) were tank mixed with the wetting agent George II (25 fl oz/A) and applied on 26 May. Prior to seeding 'Socrates X3R' pepper seeds were treated with sodium hypochlorite (1:4 v:v) for 1 minute and dusted with thiram 75WP (1 tsp/lb seed). Pepper seeds were sown on 8 Apr into 200-cell plug trays containing Fafard seedling mix. Seedlings were transplanted on 27 May; transplant water contained starter fertilizer (N-P-K; 9-45-15) at 1.7 lb/55 gal water. Ridomil Gold EC (1 pt/treated A) was applied immediately after transplanting to the base of each plant in all plots except those to be treated with Amistar 80WG alternated with Manex 37F and the untreated control. Treatments were arranged in a randomized complete block design with four replications. Each plot was a row of 20 plants spaced 1 ft apart. Rows were on 5 ft centers and treatment rows were alternated with untreated border rows. The field was cultivated on 3, 8 and 24 Jun for weed control. Plants were inoculated at the late flowering/early fruit set stage with spores (10^5 spores/ml) of *Colletotrichum acutatum* isolates AN1 and AN2 on the evening of 20 Jul, using a hand-held Herbi Sprayer (red nozzle) at a rate of 8.2 gal/A and an approximate walking speed of 0.6 mph. To control insects Provado 1.6F (3.8 oz/A) was applied on 2 Jul. Plants were overhead irrigated with 1 in. water on 21 Jul. Treatments were applied at 39.6 gal/A on a 7-10 day schedule beginning 19 Jul and ending 9 Aug using a tractor mounted CO_2-pressurized sprayer at 40 psi for a total of four applications. Fruit were hand-harvested from the center 15 plants of each row on 11 Aug, and mean disease incidence and mean fruit disease intensity were determined for each treatment. Data were analyzed by ANOVA using SAS statistical software. Means were separated using Fisher's protected least significant difference test. Average maximum temperatures for 27-31 May, Jun, Jul, 1-11 Aug were 74.0, 77.4, 81.4 and 79.4 °F; minimum averages were 49.4, 55.7, 60.8 and 56.7 °F and total rainfall was 1.1, 6.4, 3.6 and 0.1 in., respectively.

Disease pressure was severe. Symptoms first appeared on green fruit 6 days after inoculation. Amistar 80WG alternated with Manex 37F or Bravo Weather Stik, Manex 37F plus Kocide 2000, the high (12 oz) and medium (10 oz) rates of Tanos 50DF tank mixed and alternated with Manex 37F, and Cabrio EG alternated with Manex 37F significantly reduced anthracnose incidence and intensity compared to the untreated control. TD2470-01 70DF, Topsin-M 70WP or Tilt EC alternated with Amistar 80WG, and the low rate of Tanos 50DF (8 oz) tank mixed and alternated with Manex 37F and Kocide 2000 did not reduce anthracnose incidence, although all reduced anthracnose intensity relative to the untreated control. Tilt EC applied alone did not reduce disease incidence or intensity. Plants treated with Amistar 80WG alternated with Manex 37F produced the highest marketable yield, although all treatments except Tilt EC and TD2470-01 70DF or Topsin-M 70WP alternated with Amistar 80WG resulted in higher marketable yield than the control. All treatments except Tilt EC resulted in larger fruit than the control.

Treatment and rate/A[z]	Anthracnose		Marketable yield (ton/A)	Marketable fruit weight (oz/fruit)
	Fruit disease incidence (%)[y]	Mean fruit disease intensity[x]		
Tilt EC 4 fl oz (1-4)	94.8 a[w]	6.7 a	0.1 de	0.9 c
TD2470-01 70DF 1 lb (1,3) *alt*.[v] Amistar 80 WE 2 oz (2,4)	81.0 ab	4.7 b	0.5 cde	3.3 b
Control	75.8 abc	7.0 a	0.04 e	0.3 c
Topsin-M 70WP 1 lb (1,3) *alt*. Amistar 2 lb (2,4)	67.0 bcd	3.8 bc	1.5 b-e	4.1 ab
Tanos 50DF 8 oz +[u] Kocide 2000 2 lb + Manex 37F 1.6 qt (1,3) *alt*. Manex 37F 1.6 qt + Kocide 2000 2 lb (2,4)	62.5 bcd	3.5 bc	1.7 bc	4.1 ab
Amistar 80WG 2 oz (1,3) *alt*. Tilt EC 4 fl oz (2,4)	52.2 cde	2.4 cd	1.5 bcd	4.7 ab
Tanos 50DF 12 oz + Kocide 2000 2 lb + Manex 37F 1.6 qt (1,3) *alt*. Manex 37F 1.6 qt + Kocide 2000 2 lb (2,4)	50.2 def	2.8 cd	2.1 b	4.1 ab
Cabrio EG 0.75 lb (1,3) *alt*. Manex 37F 1.6 qt (2,4)	48.5 def	2.1 cd	2.0 b	3.9 ab
Tanos 50DF 10 oz + Kocide 2000 2 lb + Manex 37F 1.6 qt (1,3) *alt*. Manex 37F 1.6 qt + Kocide 2000 2 lb (2,4)	48.2 def	2.4 cd	2.0 b	4.7 ab
Manex 37F 1.6 qt + Kocide 2000 2 lb (1-4)	46.5 def	2.6 cd	1.9 bc	4.5 ab
Amistar 80WG 2 oz (1,3) *alt*. Manex 37F 1.6 qt (2,4)	31.5 ef	0.9 d	3.8 a	5.6 a
Amistar 80WG 2 oz (1,3) *alt*. Bravo Weather Stik 1.7 pt/A (2,4)	26.2 f	0.9 d	2.9 ab	4.8 ab

[z]Numbers in parentheses indicate the applications in sequence of the preceding product. Application timings were: 1= 19-25 Jul; 2= 26 Jul-1 Aug; 3= 2-8 Aug; 4= 9-16 Aug.

[y]Mean disease incidence = percent fruit with anthracnose.

[x]Fruit disease intensity calculated using the number of fruit in each of four categories and the midpoint value from the categories: 0 lesions, 1 lesion, 2-3 lesions, 4-10 lesions. Intensity = (Σ(category midpoint*number of fruit in category))/n where n = number of fruit sampled per replication.

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

[v]Treatments alternated with one another.

[u]Treatments tank mixed together.

PEPPER (*Capsicum annuum* 'Paladin')
Bacterial leaf spot; *Xanthomonas campestris* pv. *vesicatoria*

M. L. Lewis Ivey, J. R. Mera and S. A. Miller
The Ohio State University, OARDC
1680 Madison Ave.
Wooster, OH 44691

Evaluation of chemical and biological products for the control of bacterial leaf spot of bell peppers, 2004.

The experiment was conducted at the North Central Agricultural Research Station in Fremont, OH on Colwood fine sandy loam. Corn stalks planted in 03 were mowed off on 9 Apr and residue was disked and plowed under on 12 Apr. Potassium (210 lb/A K_2O), phosphorous (69 lb/A P_2O_5), nitrogen (96 lb urea/A) and granular boron (7 lb/A) were incorporated into the test field on 22 Apr. The test field was disked and beds were prepared on 5 ft centers on 6 May. The herbicides Dual II Magnum (1 pt/A) and Command ME (1.5 pt/A) were applied on 5 Jun. Ridomil Gold EC (1 pt/A) was applied and incorporated into the top 2 in. of the soil using a 5 ft Rotovator on 5 Jun. 'Paladin' pepper seeds were sown on 16 Apr into 200-cell plug trays containing Metromix 360 seedling mix. Pepper seedlings were transplanted on 5 Jun; transplant water contained starter fertilizer (N-P-K 10-34-0) at 0.7 qt/50 gal water. Treatments were arranged in a randomized complete block design with four replications. Each plot was a row of 25 plants spaced 1 ft apart. Treatment rows were alternated with untreated border rows. The insecticide Asana XL (7 fl oz/A) tank mixed with Manex 37F (2 qt/A), and alone was applied by aircraft on 18 Jun and 25 Jun respectively. The insecticide Mustang Max (4 fl oz/A) was applied on 30 Jul. For weed control the field was cultivated on 21 and 30 Jun, 8 and 13 Jul and hand weeded on 30 Jun and 8, 13, and 29 Jul. Plants were inoculated with approximately 10^6 CFU/ml *Xanthomonas campestris* pv. *vesicatoria* strain 110C (race T1P8, copper sensitive), in the evening of 1 Jul using a tractor mounted CO_2-pressurized sprayer (55 psi, 39.3 gal/A). Plants were misted with water using an FMC sprayer with a PTO-driven pump (200 psi, 32.6 gal/A) prior to inoculation. Plants were overhead irrigated with 1.0 in. of water on 23 Jul. Treatments were applied (55 psi, 42.9 gal/A) on a 5-10 day schedule beginning 27 Jun and ending 23 Aug using a tractor mounted CO_2-pressurized sprayer for a total of 10 applications. The surfactant Biotune (QRD602, 0.125%) was added to Serenade Max treatments. Severity of bacterial leaf spot on foliage was evaluated on 29 Jul, 8 and 25 Aug and 2 Sep using a modified Horsfall-Barratt rating scale. Disease ratings were converted to midpoints (% disease) prior to statistical analysis. Fruit were harvested from the center 10 plants of each treatment row on 16 Aug and 7 Sep, and mean disease incidence (# diseased fruit/total) and marketable yield were determined for each treatment. Means were separated using Fisher's protected least significant difference test. Average maximum temperatures for 5-30 Jun, Jul, Aug and 1-7 Sep were 78.2, 81.1, 78.5, and 82.7 °F; minimum averages were 55.1, 58.7, 54.0, and 56.4 °F; and rainfall was 5.0, 2.7, 4.0 and 0.0 in., respectively.

Disease pressure was moderate, and bacterial leaf spot developed relatively slowly throughout the season in the untreated control. All of the treatments significantly reduced bacterial leaf spot symptoms compared to the untreated control. The treatments most effective in reducing bacterial spot severity on foliage were Manex 37F + Kocide 2000 and all three rates of Tanos 50DF + Manex 37F alternated with Manex 37F + Kocide 2000. The proportion (incidence) and yield of fruit with bacterial spot were reduced significantly by all treatments except Serende Max + Kocide 2000 alternated with Kocide 2000 + Manzate 75DF. However, none of the treatments significantly affected marketable yield.

Treatment and rate/A (application time[z])	Bacterial leaf spot[y]			Bacterial spot	
	% disease 2 Sep	AUDPC	Marketable yield (ton/A)	Fruit disease incidence (%)	Diseased fruit yield (ton/A)
Control	79.3 a[x]	1182.6 a	8.8 a	18.6 a	2.6 a
Kocide 2000 2 lb +[w] Manzate 75DF 2 lb (1-10)	13.1 bc	139.0 bc	8.5 a	9.8 bc	1.3 bc
Tanos 50DF 8 oz + Manex 37F 1.6 qt + Kocide 2000 2 lb (1,3,5,7,9) *alt.*[v] Manex 37F 1.6 qt + Kocide 2000 2 lb (2,4,6,8,10)	7.3 cd	114.3 c	8.1 a	11.8 abc	1.4 bc
Tanos 50DF 10 oz + Manex 37F 1.6 qt + Kocide 2000 2 lb (1,3,5,7,9) *alt.* Manex 37F 1.6 qt + Kocide 2000 2 lb (2,4,6,8,10)	4.3 d	128.1 bc	10.1 a	10.4 bc	1.5 bc
Tanos 50DF 12 oz + Manex 37F 1.6 qt + Kocide 2000 2 lb (1,3,5,7,9) *alt.* Manex 37F 1.6 qt + Kocide 2000 2 lb (2,4,6,8,10)	8.4 cd	144.6 bc	9.3 a	6.6 bc	1.0 c
Manex 37F 1.6 qt + Kocide 2000 2 lb (1-10)	5.4 d	120.6 bc	9.1 a	6.7 bc	1.0 c
Serenade Max 1 lb + Kocide 2000 2 lb (1-8)	21.4 b	219.3 bc	7.0 a	5.1 c	0.7 c
Serenade Max 1 lb + Kocide 2000 2 lb (1,3,5,7) *alt*. Kocide 2000 2 lb + Manzate 75DF 2 lb (2,4,6,8)	21.4 b	217.9 b	10.2 a	13.9 ab	2.0 ab

[z]Application times were: 1= 6 Jun-1 Jul; 2= 2-8 Jul; 3= 9-15 Jul; 4= 16-22 Jul; 5= 23-29 Jul; 6= 30 Jul-8 Aug; 7= 9-12 Aug; 8= 13-17 Aug; 9= 18-22 Aug; 10= 23-30 Aug.

[y]Disease rating and area under the disease progress curve (AUDPC) based on the midpoint values of a modified Horsfall-Barratt rating scale where 1=0%, 2= 1-3%, 3= 4-6%, 4=7-12%, 5= 13-25%, 6=26-50%, 7=51-75%, 8= 76-87%, 9=88-94%, 10= 95-97%, 11=98-99% and 12= 100% bacterial leaf spot.

[x]Values are the means of four replicate plots; treatments followed by the same letter within a column are not significantly different at p□0.05.

[w]Treatments tank mixed together.

[v]Treatment alternated with each other.

SQUASH (*Cucurbita maxima* 'Buttercup')
Powdery mildew; *Sphaerotheca fuliginea*

M. L. Lewis Ivey, J. R. Mera, and S. A. Miller
The Ohio State University, OARDC
1680 Madison Avenue
Wooster, OH 44691

Evaluation of fungicides and a plant defense booster for the control of powdery mildew of winter squash, 2004.

The experiment was conducted at the Ohio Agricultural Research and Development Center Muck Crops Agricultural Research Station in Celeryville, OH. Fertilizer (17-17-17, 500 lb/A) was incorporated into the test field on 27 Apr. 'Buttercup' squash seeds were sown on 14 May into 76-cell plug trays containing Scott's Metro seedling mix. Seedlings were fertilized on 28 May and 8 Jun with 150 ppm and 250 ppm Peter's 20-20-20, respectively. Plots were disked, leveled and rolled on 8 Jun. Squash seedlings were transplanted on 9 Jun. Treatments were arranged in rows in a randomized complete block design with four replications. Each row consisted of 15 plants spaced 2 ft apart on 5 ft centers. Treatments were applied on 20 and 27 Jul, and 3, 11, and 18 Aug. Bravo Weather Stik, Procure 50WS, Elexa-4 (high volume), and two rates of V-10118 5EC (Valent USA Corp., Walnut Creek, CA) were applied at a rate of 35.4 gal/A (30 psi and 2 mph). A low volume Elexa-4 treatment was applied at a rate of 23.7 gal/A (30 psi and 3 mph). A 2.5% solution of Elexa-4 was used for both the high and low volume treatments. The following insecticides were applied: Sevin XLR Plus (1 qt/A) on 25 Jun, 13 Jul, and 2 and 21 Aug; Ambush 2EC (12.8 oz/A) on 30 Jun and 23 Jul; Spintor 2SC (8 oz/A) on 9 Jul; and Pounce EC (6 oz/A) on 11 Aug. Severity of powdery mildew was determined on 17 and 26 Aug using a modified Horsfall-Barratt rating scale. Disease ratings were converted to midpoints (% powdery mildew) prior to statistical analysis. Fruits were harvested from the entire row of each plot on 26 Aug and sorted into three categories: healthy, diseased culls and healthy culls. The number and weight of fruits in each category were determined. Data were analyzed by ANOVA using SAS statistical software. Means were separated using Fisher's protected least significant difference test. Average maximum temperatures for 9-30 Jun, Jul, and 1-26 Aug were 77.5, 81.1, and 76.8 ºF; minimum temperatures were 56.8, 60.5, and 55.2 ºF; and rainfall was 6.7, 3.8, and 3.0 in., respectively.

Powdery mildew pressure was moderate to high. Except for the two treatments of the plant defense booster Elexa-4, all treatments significantly reduced powdery mildew on squash compared to the untreated control. The experimental fungicide V-10118 5EC was most effective in reducing powdery mildew severity. Procure 50WS was as effective as V-10118 5EC early in the season but not later in the season. Plots treated with Procure 50WS, Bravo Weather Stik and the two rates of V-10118 5EC produced significantly higher marketable yield than untreated control plots. There were no significant differences in the proportion of marketable fruit produced among treatments. Treatment with the high rate of V-10118 5EC resulted in significantly larger fruit than in the untreated control.

Treatment and rate/A	% powdery mildew*		Marketable yield (ton/A)	% Marketable Fruit	Healthy weight/fruit (lb)
	17 Aug	26 Aug			
Control	50.5 ab**	72.3 a	1.4 c	51.4 a	2.6 cd
Elexa-4 23.7 gal.....	59.8 a	81.6 a	1.6 bc	54.2 a	2.8 bc
Elexa-4 35.4 gal.....	38.6 b	75.4 a	1.6 bc	63.8 a	2.4 d
V-10118 5EC 0.02 gal.....	0.5 d	0.5 c	2.1 a	62.5 a	3.1 ab
V-10118 5EC 0.05 gal.....	0.5 d	0.5 c	1.9 ab	63.9 a	3.2 a
Bravo Weather Stik 2.5 pt.....	6.1 c	5.0 b	2.0 ab	68.2 a	3.0 abc
Procure 50WS 6 oz.....	2.0 d	8.4 b	2.1 a	71.0 a	2.9 abc

*Disease rating based on the midpoint values of a modified Horsfall-Barratt rating scale where 1=0%, 2= 1-3%, 3= 4-6%, 4=7-12%, 5= 13-25%, 6=26-50%, 7=51-75%, 8= 76-87%, 9=88-94%, 10= 95-97%, 11=98-99% and 12= 100% powdery mildew coverage of leaves (upper surface).

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

SQUASH (*Cucurbita maxima* 'Buttercup')
Powdery mildew; *Sphaerotheca fuliginea*
Bacterial wilt; *Erwinia tracheiphila*

M. L. Lewis Ivey, J. R. Mera, and S. A. Miller
The Ohio State University, OARDC
1680 Madison Avenue
Wooster, OH 44691

Evaluation of biorational products for the control of powdery mildew on winter squash, 2004.

The experiment was conducted at the Ohio Agricultural Research and Development Center, Badger Farm near Wooster, OH in a transitional organic field with Wooster silt loam soil. Composted poultry manure (4-0-0, 15 123 lb/A, 75% moisture; Daylay Egg Farm Inc., West Mansfield, OH) was incorporated into the test field on 7 Jun. Certified organic squash seeds (cv. Buttercup) were sown on 19 May into 50-cell plug trays containing Paygro organic potting mix #423 (35% composted pine bark, 50% Canadian sphagnum peat, 15% perlite v/v/v; Paygro Co./Garrick Ind., South Charleston, OH). The field was cultivated, beds prepared and black plastic laid on 8 Jun. Squash seedlings were hand-transplanted on 9 Jun. Treatments were arranged in a randomized complete block design with two rows and four replications per treatment. Each row consisted of 15 plants spaced 2 ft apart on 5 ft centers. Treatment rows were alternated with untreated border rows. One of the two rows per treatment was covered with a floating row cover (Johnny's Selected Seed, Winslow, ME) on 10 Jun. Floating row covers were removed on 8 Jul. Pyrethrum (Diatect V (6 lb/A)) was applied to plots that previously had been covered, on 8, 16 and 30 Jul, and 6 Aug using a CO_2 backpack sprayer (146 gal/A, 40 psi). Treatments were applied on 22 and 29 Jul and 5, 12, and 19 Aug, using a CO_2 backpack sprayer (143 gal/A, 40 psi) for a total of five applications. The surfactants BioLink (0.5 fl. oz/gal) and Nu-Film-17 (12 fl. oz/A) were added to Armicarb 100 and Serenade Max treatments respectively. Severity of powdery mildew was determined on 3 and 18 Aug using a modified Horsfall-Barratt rating scale. Disease ratings were converted to midpoints (% powdery mildew) prior to statistical analysis. Fruits were harvested from the entire row of each plot on 25 Aug and sorted into three categories: healthy, diseased culls and healthy culls. The number and weight of fruits in each category were determined. Data were analyzed by ANOVA using SAS statistical software. Means were separated using Fisher's protected least significant difference test. Average maximum temperatures for 9-30 Jun, Jul, and 1-25 Aug were 77.7, 81.4, and 78.5 ºF; minimum temperatures were 56.5, 60.8, and 55.6 ºF; and total rainfall was 6.3, 3.6, and 3.8 in., respectively.

Heavy rains early in the season flooded one block. As a result transplants were killed and data were collected for three blocks only. Bacterial wilt pressure was low, and there were no significant differences in the number of plants killed between protected (with row covers followed by pyrethrum treatment) and non-protected plots. Powdery mildew pressure was moderate to high. Except for the two concentrations of SoilSoup compost tea, all treatments significantly reduced powdery mildew on squash compared to the untreated control. Serenade Max plus Kocide 2000 and the sulfur treatment were most effective in reducing powdery mildew severity, irrespective of the presence of row covers and treatment with pyrethrum. However, the protected control plots had significantly less powdery mildew on 18 Aug than the non-protected control plots. Protected plots treated with either rate of SoilSoup compost tea, the low rate of Armicarb 100 (2.5 lb/A), or the high rate of Serenade Max (2 lb/A) plus Kocide 2000, and non-protected plots treated with the high rate of Armicarb 100 (5.0 lb/A), sulfur or the low rate of Serenade Max (1 lb/A) plus Kocide 2000 produced significantly higher marketable yield than the non-protected, untreated control. The proportion of marketable fruit was significantly higher in the protected, untreated plots than in the non-protected, untreated plots. With the exception of Armicarb 100 (2.5 lb/A, non-protected; 5.0 lb/A, protected), SoilSoup compost tea (full strength, protected), and Serenade Max (1 lb/A + Kocide 2000, protected) all treatments resulted in significantly higher proportions of marketable fruit than in the untreated, non-protected control. Among the non-protected plots, those treated with the high rate of Armicarb 100, sulfur, both rates of Serenade Max plus Kocide 2000 or the low rate of SoilSoup compost tea produced more marketable fruits than the non-protected, untreated control. There were no significant differences among any of the treatments in the weight of marketable fruit produced (data not shown).

Treatment and rate/A	Row cover + pyrethrum	% powdery mildew[z]		Marketable yield (ton/A)	% marketable fruit
		3 Aug	18 Aug		
SoilSoup Compost Tea 1/3 strength	-	22.2 a[y]	89.5 ab	1.9 cd	63.3 a-e
Control	-	19.0 ab	96.0 a	1.5 d	42.1 f
SoilSoup Compost Tea full strength.....	-	12.7 abc	94.3 ab	2.1 bcd	55.6 def
Armicarb 100 2.5 lb.....	-	2.0 d	40.0 de	1.8 cd	52.2 ef
Armicarb 100 5.0 lb.....	-	3.0 cd	40.0 de	2.4 abc	67.6 a-e
Sulfur 16 lb	-	3.0 cd	15.8 ef	3.0 a	72.9 a-d
Serenade Max 2 lb +[x] Kocide 2000 2 lb.....	-	3.0 cd	15.8 ef	2.2 bcd	64.3 a-e
Serenade Max 1 lb + Kocide 2000 2 lb	-	3.0 cd	11.2 f	2.4 abc	67.6 a-e
SoilSoup Compost Tea 1/3 strength	+	19.0 ab	87.8 ab	2.4 abc	81.0 a
Control	+	11.2 bcd	70.2 bc	2.2 a-d	67.3 a-e
Sulfur 16 lb	+	5.5 cd	15.8 ef	2.3 a-d	79.1 ab
SoilSoup Compost Tea full strength.....	+	4.0 cd	87.8 ab	2.8 ab	66.8 a-e
Armicarb 100 2.5 lb.....	+	3.0 cd	48.3 cd	2.5 abc	77.7 abc
Armicarb 100 5.0 lb.....	+	2.0 d	46.2 cd	1.9 cd	58.3 c-f
Serenade Max 2 lb + Kocide 2000 2 lb	+	2.0 d	15.8 ef	2.4 a-d	69.8 a-e
Serenade Max 1 lb + Kocide 2000 2 lb	+	2.0 d	12.7 f	2.2 bcd	59.4 b-f

[z]Disease rating based on the midpoint values of a modified Horsfall-Barratt rating scale where 1=0%; 2= 1-3%; 3= 4-6%; 4=7-12%; 5= 13-25%; 6=26-50%; 7=51-75%; 8= 76-87%; 9=88-94%; 10= 95-97%; 11=98-99% and 12= 100% powdery mildew coverage of leaves (upper surface).

[y]Values are the means of three replicate plots; means followed by the same letter within a column are not significantly different at p□0.05.

[x]Treatments tank mixed together.

RADISH (*Raphanus sativus*)
Rhizoctonia hypocotyl rot; *Rhizoctonia solani*
Clubroot; *Plasmodiophora brassicae*
Soft rot; *Erwinia carotovora* subsp. *carotovora*

M. L. Lewis Ivey, J. R. Mera and S. A. Miller
The Ohio State University, OARDC
1680 Madison Ave.
Wooster, OH 44691

Response of radish cultivars to Rhizoctonia hypocotyl rot, clubroot, and soft rot, 2004.

Fifteen radish cultivars were evaluated for response to Rhizoctonia hypocotyl rot, clubroot and soft rot in a field trial at the Ohio Agricultural Research and Development Center Muck Crops Research Station in Celeryville, OH. Fertilizer (17-17-17, 500 lb/A) was incorporated into the field on 27 Apr. Plots were disked, leveled, and compacted, and radishes were direct seeded at a rate of 12 seeds/ft on 20 May. Cultivars were arranged in a randomized complete block design with four replications. Plots were 6 ft apart and consisted of three 20 ft rows with 18 in. between rows. Dual II MAGNUM (1.5 pt/A) was applied on 20 May for weed control. Plots were sprinkle irrigated with 0.5 in. water on 20 May. Radishes were harvested from a 10 ft section of the center row of each plot on 14 Jun, and mean clubroot disease severity, percent Rhizoctonia hypocotyl rot, and percent soft rot were determined. Data for percent Rhizoctonia hypocotyl rot was analyzed by adding one to each data point before log transformation; the remaining data were analyzed without transformation, by ANOVA using SAS statistical software. Means were separated using Fisher's protected least significant difference test. Average maximum temperatures for 20-31 May and 1-14 Jun were 78.1 and 77.7 °F; minimum averages were 54.2 and 59.0 °F and total rainfall was 2.7 and 5.2 in., respectively.

Disease pressure was low for Rhizoctonia hypocotyl rot and no differences in disease incidence were observed among cultivars. Clubroot severity was high and although all cultivars were susceptible, three ('CW93-222 F1', CW93-221 F1" and E61-7149 F1') had significantly lower clubroot severity than the most susceptible cultivars, including the standards 'Cherriette', 'Cabernet', 'Red Silk' and 'Crunchy Royale'. The incidence of soft rot was high in 'E61-7149 F1' and moderate in 'CW 93-221 F1'. Six cultivars ('CW93-222 F1', 'SSX17-9124', 'Cherriette', 'N1Z-34-46 F1', 'Red Silk' and 'Crunchy Royale') had negligible (< 2.5%) soft rot incidence.

Cultivar	Seed Supplier	Clubroot severity*	% Rhizoctonia	% Soft rot
CW93-222 F1	SeedWay Inc.	44.6 bcd**	4.0 a	2.0 ef
CW93-221 F1	SeedWay Inc.	44.4 bcd	2.0 a	11.0 bc
E61-7149 F1	SeedWay Inc.	41.0 d	1.0 a	30.5 a
SSX17-9124	Meyer Seed Int., Inc.	60.6 a	1.5 a	0.3 f
SSX17-9123	Meyer Seed Int., Inc.	54.6 a-d	2.3 a	4.5 def
SSX17-9122	Meyer Seed Int., Inc.	43.7 cd	5.5 a	13.5 b
Cherriette	Siegers Seed Co.	66.3 a	3.8 a	2.0 ef
Cabernet	Siegers Seed Co.	67.0 a	1.5 a	6.5 cde
N1Z-34-44 F1	Vilmorin Seed Co.	55.6 abc	2.5 a	7.8 cd
N1Z-34-45 F1	Vilmorin Seed Co.	62.0 a	5.8 a	8.3 cd
N1Z-34-46 F1	Vilmorin Seed Co.	64.0 a	2.0 a	1.3 f
Red Silk	Siegers Seed Co.	63.7 a	0.3 a	0.5 f
E61-119 F1	SeedWay Inc.	56.9 abc	2.8 a	10.8 bc
Crunchy Royale	Siegers Seed Co.	57.6 ab	2.8 a	2.3 ef

*Clubroot severity calculated using the number of radishes in each of five categories and the midpoint value from the categories: 1= 0% disease; 2= 1-20% disease; 3= 21-40% disease; 4= 41-60% disease; and 5= 61-100% disease. Severity = [$\sum$(category midpoint*number of radishes in category)]/n, where n = total number of radishes harvested.

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

RADISH (*Raphanus sativus* 'Cabernet')
Clubroot; *Plasmodiophora brassicae*

M. L. Lewis Ivey, J. R. Mera and S. A. Miller
The Ohio State University, OARDC
1680 Madison Ave.
Wooster, OH 44691

Evaluation of fungicides for the management of Clubroot on radish, 2004.

The experiment was conducted at the Ohio Agricultural Research and Development Center Muck Crops Agricultural Research Station in Celeryville, OH. Fertilizer (17-17-17, 500 lb/A) was incorporated into the field on 27 Apr. Plots were disked, leveled, and compacted, and radishes (cv. Cabernet) were direct seeded at a rate of 12 seeds/ft using a Stan-Hay vacuum seeder on 28 May. Treatments were arranged in a randomized complete block design with four replications. Each plot consisted of three 15 ft rows with 18 in. between rows. Dual II MAGNUM (1.5 pt/A) was applied on 28 May for weed control. Treatments were drenched into the row in a 10 in. band using a hand-held watering can on 28 May. Overhead irrigation (0.2 in.) was applied two hours after the treatments were applied. Radishes were harvested from a 10 ft section of the center row of each plot on 2 Jul, and mean clubroot disease severity was determined for each treatment. Data were analyzed by ANOVA using SAS statistical software. Means were separated using Fisher's protected least significant difference test. Average maximum temperatures for 28-31 May, 1-30 Jun, and 1-2 Jul were 72.7, 77.4, and 85.6 °F; minimum averages were 49.7, 56.9, and 56.9 °F and total rainfall was 1.3, 6.7 and 0.0 in., respectively.

Clubroot pressure was high. None of the treatments reduced clubroot compared to the untreated control.

Treatment and rate/1000 plants	Clubroot severity*
Omega 500F 1.7 fl oz	62.4 a**
Ranman 400SC 1.7 fl oz	64.6 a
Ranman 400SC 3.4 fl oz	66.8 a
Ranman 400SC 6.8 fl oz	67.3 a
Control	68.8 a

*Clubroot severity calculated using the number of radishes in each of five categories and the midpoint value from the categories: 1 = 0% disease; 2 = 1-20% disease; 3 = 21-40% disease; 4 = 41-60% disease; and 5 = 61-100% disease. Severity = [□(category midpoint*number of radishes in category)]/n, where n = number of total radishes harvested.

**Values are the means of four replicate plots; means followed by the same letter within a column are not significantly different at p□0.05.

RADISH (*Raphanus sativus* 'Cabernet')
Rhizoctonia hypocotyl rot; *Rhizoctonia solani*

M. L. Lewis Ivey, J. R. Mera and S. A. Miller
The Ohio State University, OARDC
1680 Madison Ave.
Wooster, OH 44691

Evaluation of the strobilurin fungicide Amistar 80WG for the control of Rhizoctonia root rot in radishes, 2004.

The experiment was conducted at the Ohio Agricultural Research and Development Center Muck Crops Agricultural Research Station in Celeryville, OH. Fertilizer (17-17-17, 500 lb/A) was incorporated into the field on 27 Apr. Plots were disked, leveled, compacted and radishes (cv. Cabernet) were direct seeded at a rate of 12 seeds/ft on 24 Aug. Treatments were arranged in a randomized complete block design with four replications. Each plot consisted of three 20 ft rows with 18 in. between rows. In-furrow treatments of Amistar 80WG (0.13 oz/1000 row ft) were applied at seeding using a Stan-Hay vacuum seeder (24.4 gal/A, 35 psi). Dual II Magnum (1.5 pt/A) was applied on 24 Aug for weed control. Overhead irrigation (0.4 in.) was applied on 25 Aug. Post emergence treatments of Amistar 80WG (3.9 oz/A) were applied on 2 Sep using a tractor mounted 3.5 hp Honda motor-driven sprayer (46.5 gal/A, 40 psi). Radishes were harvested from a 10 ft section of the center row for each treatment on 20 Sep and numbers of healthy radishes, radishes with Rhizoctonia root and hypocotyl rot symptoms, and culls were recorded. Data were analyzed by ANOVA using SAS statistical software and means were separated using Fisher's protected least significant difference test. Average maximum temperatures for 24-31 Aug and 1-20 Sep were 80.8 and 77.9 °F; minimum averages were 62.6 and 55.6 °F and rainfall was 2.0 and 1.2 in., respectively.

Rhizoctonia disease pressure was low. All of the radishes harvested had clubroot symptoms and were considered non-marketable. There were no significant differences among the Amistar 80WG treatments in controlling Rhizoctonia root rot compared to the untreated control.

Amistar 80WG treatment	% Rhizoctonia root rot
Untreated	2.4 a*
In-furrow	1.8 a
Post emergence	1.9 a
In-furrow and post emergence	2.7 a

*Values are the means of four replicate plots; means followed by the same letter within a column are not significantly different at p□0.05.

RADISH (*Raphanus sativus* 'Cabernet')
Downy mildew; *Peronospora parasitica*
Rhizoctonia hypocotyl rot; *Rhizoctonia solani*
Clubroot; *Plasmodiophora brassicae*

M. L. Lewis Ivey, J. R. Mera and S. A. Miller
The Ohio State University, OARDC
1680 Madison Ave.
Wooster, OH 44691

Evaluation of fungicides for the management of Rhizoctonia hypocotyl rot, clubroot and downy mildew in radishes, 2004.

The experiment was conducted at the Ohio Agricultural Research and Development Center Muck Crops Agricultural Research Station in Celeryville, OH. Fertilizer (17-17-17, 500 lb/A) was incorporated into the field on 27 Apr. Plots were disked, leveled, and compacted and radishes (cv. Cabernet) were direct seeded at a rate of 12 seeds/ft on 18 Aug. Treatments were arranged in a randomized complete block design with four replications. Each plot consisted of three 20 ft rows with 18 in. between rows. Dual II Magnum (1.5 pt/A) and Sevin (1 qt/A) were applied on 18 Aug and 30 Aug, respectively. Treatments were applied on 31 Aug using a tractor-mounted 3.5 hp Honda motor driven sprayer (46.5 gal/A, 40 psi). Foliar downy mildew was evaluated on 13 Sep using a modified Horsfall-Barratt rating scale. Radishes were harvested from a 10 ft section of the center row of each plot on 20 Sep, and mean clubroot disease severity, percent Rhizoctonia hypocotyl rot, and percent healthy roots were determined. Data for percent healthy plants and plants with Rhizoctonia hypocotyl rot symptoms were analyzed using square root transformed values; downy mildew ratings were converted to midpoint values; and the remaining data were analyzed without transformation, all by ANOVA using SAS statistical software. Means were separated using Fisher's protected least significant difference test. Average maximum temperatures for 18-31 Aug and 1-20 Sep were 78.3 and 77.9 °F; minimum averages were 60.0 and 55.6 °F and rainfall was 4.5 and 1.2 in., respectively.

Disease pressure was low to moderate for downy mildew, low for Rhizoctonia hypocotyl rot, and high for clubroot. Agri-Fos, Acrobat 50WP alone and tank-mixed with Ridomil Gold EC, and Amistar tanked mixed with Ridomil Gold EC were most effective in reducing downy mildew. Radish plants treated with Amistar or Sonata had significantly less downy mildew than the untreated control, but more than the most effective treatments. Cabrio, Pristine, and Ridomil Gold EC alone or tank-mixed with Cabrio did not reduce downy mildew severity. None of the treatments reduced clubroot severity and plants treated with Ridomil Gold EC had more clubroot than the untreated control. There were no significant differences between treatments in percentage of radishes with Rhizoctonia hypocotyl rot or healthy radishes.

Treatment and rate/A	% Downy mildew	Clubroot severity[z]	% Rhizoctonia
Amistar 3.5 oz	11.8 bc[y]	26.7 b-e	0.9 a
Acrobat 50WP 6.4 oz +[x] Ridomil Gold EC 2 pt	4.6 d	33.5 abc	2.5 a
Cabrio 10 oz	16.6 ab	26.2 cde	1.5 a
Amistar 3.5 oz + Ridomil Gold EC 2 pt	6.1 cd	26.1 cde	0.9 a
Acrobat 50WP 6.4 oz	6.1 cd	31.8 a-d	1.2 a
Pristine 18 oz	19.0 a	34.7 ab	0.3 a
Ridomil Gold EC 2 pt	13.1 ab	38.7 a	1.2 a
Sonata 2 qt	11.3 bc	23.2 e	2.0 a
Cabrio EG 10 oz + Ridomil Gold EC 2 pt	16.6 ab	32.5 abc	1.2 a
Agri-Fos 1.25 qt/100 gal	3.5 d	23.8 de	1.8 a
Control	19.0 a	29.1 b-e	1.1 a

[z]Clubroot severity calculated using the number of radishes in each of five categories and the midpoint value from the categories: 1 = 0% disease; 2 = 1-20% disease; 3 = 21-40% disease; 4 = 41-60% disease; and 5 = 61-100% disease. Severity = [Σ(category midpoint*number of radishes in category)]/n, where n = number of total radishes harvested.

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

[x] Treatments tank mixed together.

RADISH (*Raphanus sativus* 'Mister Red' and 'RS95617')
Rhizoctonia hypocotyl rot; *Rhizoctonia solani*
Clubroot; *Plasmodiophora brassicae*

M. L. Lewis Ivey, J. R. Mera, Brian McSpadden Gardener, Gabriela, Briceno-Montero, M. Dunlap, C. W. Hoy and S. A. Miller.
The Ohio State University, OARDC
1680 Madison Ave.
Wooster, OH 44691

Evaluation of cover crops for the management of Rhizoctonia hypocotyl rot and clubroot in radishes, 2004.

The experiment was conducted at the Ohio Agricultural Research and Development Center Muck Crops Research Station in Celeryville, OH. Seven cover crop treatments were established, for the third consecutive year, at a rate of 1 bu/A on 2 Oct 03 Treatments were planted in 25 ft by 12 ft strips and arranged in a randomized complete block design with five replications. Cover crops were mowed and disked under on 21 Jun. Fertilizer (17-17-17, 500 lb/A) was incorporated into the field on 27 Apr. Plots were disked, leveled, and compacted on 17 May. Radishes (cv. RS95617 and cv. Mister Red) were direct seeded at a rate of 12 seeds/ft on 17 May using a Stan-Hay vacuum seeder. Each plot consisted of three 25 ft rows (per cultivar) with 18 in. between rows. Plots were separated by 6 ft. Dual II MAGNUM (1.5 pt/A) was applied on 17 May for weed control. Radishes were harvested from a 5 ft section of the center row of each plot on 11 Jun, and the number of radishes per row, percent Rhizoctonia hypocotyl rot, and the number of radishes per row with clubroot were determined. Thrips were sampled by cutting all foliage in a one square foot area at the soil line, and extracting the thrips in Berlese funnels, which use the heat from an incandescent light bulb to drive the thrips down and out of the foliage and into a collecting jar filled with preservative. Thrips populations begin to increase early in the spring, and the series of samples provide an estimate of how quickly the populations increase. The initial sample tested for differences in late fall establishment and overwintering survival. Data were analyzed by ANOVA using SAS statistical software. Means were separated using Fisher's protected least significant difference test. Average maximum temperatures for 17-31 May and 1-11 Jun were 78.2 and 76.9 °F; minimum averages were 53.9 and 58.7 °F and total rainfall was 3.2 and 3.2 in., respectively.

The amount of Rhizoctonia root and hypocotyl rot that developed in the experiment was low, and there were no statistically significant differences among cover crop treatments in the amount of Rhizoctonia disease that developed. However, the stand count in 'RS95167' (number of radishes per row) was significantly higher ($p \leq 0.10$) for radishes grown in soil previously cropped to barley, oats, or oats/barley than for those in which the preceding crop was oats/rye. Clubroot was in plots cropped to oats/barley. There were strong block effects, probably the result of heavy rain that occurred during the trial and uneven drainage across the field. The oats were winter-killed in all treatments, and no foliage remained for thrips sampling during April. Thrips do not survive well on oats alone, or to increase on dead foliage during spring. Wheat, rye and barley did not differ in the number of thrips per square foot, regardless of whether they were grown together with oats. Previous studies had shown lower rates of thrips increase in rye compared with wheat, and a similar trend was observed in our study although the numbers were not significantly different even for the final sample date.

Treatment	Cultivar	Stand count (number radishes/100 ft)		% Rhizoctonia		Clubroot (number radishes/100 ft)	
		cv. Mister Red	cv. RS95167	cv. Mister Red	cv. RS95167	cv. Mister Red	cv. RS95167
Wheat	Hopewell	780 a*	936 ab	20.8 a	17.8 a	764 a	1084 a
Rye	Mixed cultivars	908 a	944 ab	27.0 a	25.8 a	904 a	1076 a
Oats	Ogle	868 a	1080 a	24.4 a	14.0 a	868 a	1048 a
Barley	Penco	888 a	1084 a	13.4 a	12.0 a	888 a	1004 ab
Oats:Wheat (1:1)	Ogle:Hopewell	792 a	1004 ab	19.8 a	16.2 a	792 a	936 ab
Oats:Rye (1:1)	Ogle:mixed	844 a	868 b	14.0 a	10.2 a	836 a	932 ab
Oats:Barley (1:1)	Ogle:Penco	944 a	1048 a	26.2 a	21.6 a	928 a	856 b
p value		0.23	0.10	0.81	0.65	0.23	0.07

*Values are the means of five replicate plots; means followed by the same letter within a column are not significantly different at p□0.10.

April 7

Cover crop	Avg no. thrips/ft2	Fresh weight	Dry weight
Wheat "Hopewell".....	0.9	24.6	5.6
Rye	1.2	36.3	8.6
Barley "Penco"	1.1	23.8	6.7
Oats:Wheat	1.7	21.2	5.8
Oats:Rye.....	1.1	28.3	6.7
Oats:Barley	0.9	17.9	4.8
Tukey's HSD (□=0.05)	1.8	14.4	1.8

April 21

Cover crop	Avg no. thrips/ ft2	Fresh weight	Dry weight
Wheat “Hopewell”.....	0.9	88.6	13.5
Rye	0.6	95.0	14.7
Barley “Penco”	1.3	70.6	10.3
Oats:Wheat	0.7	82.7	13.4
Oats:Rye.....	0.6	113.2	16.9
Oats:Barley	0.2	81.2	12.2
Tukey's HSD (□=0.05)	1.3	63.9	8.4

May 5

Cover crop	Avg no. thrips/ ft2	Fresh weight	Dry weight
Wheat “Hopewell”.....	2.1	118.3	23.3
Rye	0.4	196.6	33.1
Barley “Penco”	2.4	141.7	23.5
Oats:Wheat	1.0	143.2	28.4
Oats:Rye.....	0.9	156.2	28.1
Oats/Barley	3.2	101.3	17.6
Tukey's HSD (□=0.05)	2.9	102.1	15.7

RADISH (*Raphanus sativus* 'Mister Red' and 'RS95617')
Rhizoctonia hypocotyl rot; *Rhizoctonia solani*
Clubroot; *Plasmodiophora brassicae*

M. L. Lewis Ivey, J. R. Mera, Brian McSpadden Gardener, Gabriela, Briceno-Montero, M. Dunlap, C. W. Hoy and S. A. Miller.
The Ohio State University, OARDC
1680 Madison Ave.
Wooster, OH 44691

Three Year Experiment Summary - Effect of Cover Crops on Rhizoctonia Root and Hypocotyl Rot in Radishes and Thrips Overwintering.

Rhizoctonia solani is a soilborne fungus that causes disease in a wide range of crops, including vegetables. Rhizoctonia diseases have increased in incidence and severity over the past decade on vegetables grown on muck soils in northern Ohio, and no current methods adequately control these diseases. In particular, Rhizoctonia root and hypocotyl rot has become a limiting factor in radish production on these soils. In some areas farmers no longer produce radishes due to the risk of total crop loss due to this disease.

We hypothesized that the use of oat and rye winter cover crops, a practice adopted to reduce the overwintering populations of Thrips tabaci, may be a factor in this increase. Oats and rye may be more susceptible to R. solani than wheat, a previously used cover crop, and thus contribute to the buildup of the pathogen, or they may be less supportive of soil microbial communities that suppress the pathogen. We established a trial in which we compared the development of Rhizoctonia root and hypocotyl rot on radishes grown in plots planted to different cover crops or combination of cover crops. We intended to determine if cover crops influenced the incidence or severity of Rhizoctonia disease in the following radish crop. We also re-assessed the attractiveness of the different cover crops or combinations of cover crops to thrips.

Seven cover crop treatments were established on the Muck Crops Research Experiment Station in autumn 2001, 2002 and 2003. Plots were long strips on the north side of the station, arranged in a randomized complete block design with four replications. For each of the three years, the arrangement of plots remained the same. The treatments were 1) wheat 'Hopewell', 2) rye, 3) oats 'Ogle', 4) barley 'Penco', 5) oats/wheat 50:50, 6) oats/rye 50:50, and 7) oats/barley 50:50. Each spring, all but 10 ft of each cover crop treatment were removed and the area was prepared for radishes. The remaining cover crops were sampled for thrips. There were no significant differences in the seasonal total of thrips from different cover crops. Radishes were sampled 10 days after emergence, rated and cultured for Rhizoctonia and prepared for evaluation of bacterial colonists. In 2002, Rhizoctonia incidence was extremely low, probably due to very dry conditions. Radishes were planted again with the same result- lack of disease. In 2003 flooding destroyed the plots. In 2004, two radish varieties were evaluated: 'Mister Red' and 'RS95167'. The amount of Rhizoctonia root and hypocotyl rot that developed in the experiment was again relatively low, and there were no statistically significant differences among cover crop treatments in the amount of Rhizoctonia disease that developed. However, the stand count in 'RS95167' (number of radishes per row) was significantly higher ($p \leq 0.10$) for radishes grown in soil previously cropped to barley, oats, or oats/barley than in plots in which the preceding crop was oats/rye. There were strong block effects, probably the result of heavy rain that occurred during the trial and uneven drainage across the field. Thrips data indicated a slight trend toward higher populations in wheat cover crop, but there were no significant differences.

In summary, we were unable to demonstrate a consistent effect of cover crops on the succeeding radish crop in incidence of Rhizoctonia root and hypocotyl rot. The experiment was hampered by very dry weather in 2002 and heavy rainfall in 2003 and 2004 that flooded the plots. There was also no effect of cover crop on thrips populations. Farmers may consider planting the cover crop or combination of cover crops that best suits their needs, without consideration of potential effects on Rhizoctonia disease incidence.

MUSTARD GREENS (*Brassica juncea* 'Southern Giant Curled')
Clubroot; *Plasmodiophora brassicae*

M. L. Lewis Ivey, J. R. Mera and S. A. Miller
The Ohio State University, OARDC
1680 Madison Ave.
Wooster, OH 44691

Evaluation of fungicides for the management of clubroot in mustard greens, 2004.

The experiment was conducted at the Ohio Agricultural Research and Development Center Muck Crops Agricultural Research Station in Celeryville, OH. Fertilizer (N-P-K 17-17-17, 500 lb/A) was incorporated into the test field on 27 Apr. "Southern Giant Curled" mustard seeds were sown on 6 May into 200-cell plug trays containing Metromix 360 seedling mix. Plots were disked, rolled and leveled and seedlings were transplanted on 7 Jun. Treatments were arranged in a randomized complete block design with four replications. Each plot consisted of three 15 ft rows with 4 in. plant spacing and 18 in. row spacing. Plots were separated by 6 ft. Dual Magnum (1.5 pt/A) was applied on 7 Jun for weed control and Sevin (1 qt/A) was applied on 25 Jun for insect control. Transplants were overhead irrigated with 0.7 in. water on 8 Jun. Pre-planting treatments of Ranman 400SC were applied to seedlings in the greenhouse on 4 Jun. Post-planting treatments were applied as a drench to the base of transplants immediately after planting. Mustard plants were harvested from a 10 ft section of the center row for each treatment on 13 Jul and evaluated for clubroot disease severity and plant vigor. Data for clubroot disease severity were analyzed by ANOVA and means were separated using Fisher's protected least significant difference test. Data for plant vigor were analyzed by Kruskal-Wallis test and rank means were separated using Fisher's protected least significant difference test. Data were analyzed using SAS statistical software. Average maximum temperatures for 7-30 Jun and 1-13 Jul were 78.4 and 85.1 ºF; minimum temperatures were 57.6 and 62.6 ºF; and rainfall was 6.7 and 0.3 in., respectively.

Clubroot disease pressure was high. All three rates of Ranman 400SC significantly reduced clubroot disease severity compared to the untreated control when applied as a drench immediately after transplanting. A pre-plant application of Ranman 400SC followed by a post-plant drench with the product did not improve disease control compared to the post-plant drench of Ranman 400SC alone. Pre-plant application of Ranman 400SC alone did not reduce clubroot severity, nor did Omega 500 applied alone post-plant or following a pre-plant application of Ranman 400SC. All the treatments except Ranman 400SC (pre-plant) significantly increased plant vigor compared to the untreated control.

Treatment	Rate	Clubroot severity[z]	Plant vigor[y]
Omega 500F (post-plant)	1.7 fl oz/1000 plants	75.2 ab[x]	2.5 b
Ranman 400SC (post-plant)	1.7 fl oz /1000 plants	67.0 c	3.0 ab
Ranman 400SC (post-plant)	3.4 fl oz /1000 plants	66.6 c	3.0 ab
Ranman 400SC (post-plant)	6.8 fl oz /1000 plants	57.4 d	3.3 a
Ranman 400SC (pre-plant)	0.06 fl oz/flat	78.9 a	1.8 c
Ranman 400SC (pre-plant) + Omega 500F (post-plant)	0.06 fl oz /flat + 1.7 fl oz /1000 plants	74.4 ab	2.5 b
Ranman 400SC (pre-plant) + Ranman 400SC (post-plant)	0.06 fl oz /flat + 1.7 fl oz /1000 plants	69.3 bc	3.0 ab
Control		78.0 a	1.5 c

[z]Clubroot severity calculated using the number of plants in each of five categories and the midpoint value from the categories: 1 = 0% disease; 2 = 1-20% disease; 3 = 21-40% disease; 4 = 41-60% disease; and 5 = 61-100% disease. Severity = [Σ(category midpoint*number of plants in category)]/n, where n = number of total plants harvested.

[y]Plant vigor rated according to the following scale; 1=severe stunting, few small sized leaves, chlorosis; 2=stunting, few small-medium sized leaves, chlorosis 3=moderate stunting, medium-large leaves, reduced leaf number, chlorosis; 4=slight stunting, slight reduction in leaf number, mild chlorosis, mainly larger leaves; 5 =healthy plant, large leaves, no chlorosis.

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

For more information on this report or to receive copies of this or similar publications, please contact:

Dr. Sally A. Miller
Professor
Department of Plant Pathology
The Ohio State University-OARDC
1680 Madison Avenue
Wooster, OH 44691-4096
Phone: 330 263-3678
FAX: 330 263-3838
Email: miller.769@osu.edu

or

Melanie L. Lewis Ivey
Research Associate
Department of Plant Pathology
The Ohio State University-OARDC
1680 Madison Avenue
Wooster, OH 44691-4096
Phone: 330 202-3555 ext. 2704
FAX: 330 263-3838
Email: ivey.14@osu.edu

or

Jhony R. Mera
Research Assistant
Department of Plant Pathology
The Ohio State University-OARDC
1680 Madison Avenue
Wooster, OH 44691-4096
Phone: 330 202-3555 ext. 2704
FAX: 330 263-3838
Email: mera.1@osu.edu