**Ohio Vegetable & Small Fruit Research & Development Program**

**Final Report**

**2017**

**Project Title:** Alternaria Management in Cauliflower and Cabbage\*

**Principle Investigator(s)**: Sally A. Miller

**Phone Number**: 330-263-3678

**Fax**: 330-263-3841

**E-mail**: miller.769@osu.edu; ivey.14@osu.edu

**Cooperating Institution**: The Ohio State University (OARDC) Department of Plant Pathology

**Mailing Address**: 1680 Madison Ave., Wooster, OH 44691

**Other Key Personnel**: Jhony Mera, Carlos Saint-Preux, The Ohio State University – OARDC; Matt Hofelich, OARDC North Central Agricultural Experiment Station (NCARS)

**Objectives(s) of research proposal**: The objective was to develop programs to manage Alternaria

 leaf spot in cauliflower. We will evaluate fungicides and biological control products for efficacy in controlling black spots on heads (curds) of white cauliflower.

\*At the request of OVSFRDP, the cauliflower study was duplicated for cabbage. Results of both studies are included in this report.

**Evaluation of fungicides for the control of Alternaria leaf spot of cauliflower, 2017.**

The experiment was conducted at the Ohio Agricultural Research and Development Center’s North Central Agricultural Research Station in Fremont, OH on Rimer loamy fine sandy soil. Roundup Powermax (1 qt/A) and Choice (8 fl oz/A) were applied on 12 Apr to kill the cover crop and weeds. On 17 Apr the test field was plowed and disked, and potassium (300 lb/A K2O), phosphorous (78 lb/A P2O5), nitrogen (107 lb/A NH4NO3), and boron (7 lb/A) were incorporated. Raised beds were prepared on 5-ft centers on 19 Apr and reshaped on 15 May. Cauliflower ‘Synergy’ seeds were hot water-treated (10 min pre-soak at 100°F, soak for 25 min at 122°F) and sown on 6 Apr into 200-cell plug trays containing Metro-Mix 360 seedling mix. On 15 May, Dual II Magnum (1.0 pt/A) and Command (8 fl oz/A) were applied and incorporated into the test field for weed control. Cauliflower seedlings were transplanted on 16 May; the starter fertilizer (N-P-K 10-34-0; 0.7 qt/50 gal water) was applied in the transplant water. Plots were arranged in a randomized complete block design with four replications. Each plot consisted of 19 plants per row spaced 16 inches apart with 5 ft between rows. Treated rows were alternated with non-treated border rows. The insecticides Warrior II with Zeon Technology (1.9 fl oz/A), Assail 30SG (4.0 fl oz/A), Brigade 2EC (6.1 fl oz/A), Hero EC (6.0 fl oz/A) and Sevin 50W (2.0 lb/A) were applied on 25 May and 19 Jul; 14 Jun and 26 Jul; 21 Jun; 28 Jun; and 5 Jul, respectively. Fungicide treatments were applied using a tractor-mounted CO2-pressurized sprayer (55 psi, 43.8 gal/A, 3 mph) beginning 3 Jul and ending 31 Jul for a total of four applications. The field was cultivated on 13 and 18 Jun and 20 Jul and hand weeded and hoed on 14 and 27 Jun and 24 Jul. Plants in treated and non-treated control rows were inoculated with approximately 105 spores/ml *Alternaria brassicicola* strain SM1756-16, on 10 and 20 Jul using a backpack CO2-pressurized sprayer. Plants were overhead irrigated with 1 in. of water on 22 Jun. The severity of Alternaria leaf spot was evaluated on 25 Jul and 1 and 8 Aug using a scale of 0-100% foliage affected. On 9 Aug, cauliflower heads were harvested from the middle 15 plants on each treatment row. Weights of marketable heads, heads with Alternaria symptoms, heads with soft rot and “other” rots (minor fungal fruit rots) were measured. Average maximum temperatures for 16-31 May, Jun, Jul and 1-9 Aug were 76.3, 82.2, 82.2 and 80.2°F; average minimum temperatures were 57.0, 60.6, 63.7 and 59.0°F; and rainfall amounts were 1.6, 3.6, 4.5 and 2.2 in., respectively. Analysis of variance was performed using the GLIMMIX procedure and means were separated by Fisher’s least significant difference test with SAS software.

Alternaria leaf spot severity was moderate on foliage in this trial, reaching 27.3% in the non-treated control by the last evaluation date (8 Aug). Treatment with Quadris Top 2.72SC, Endura 70EG, Inspire Super 2.8SC and Fontelis 1.67SC significantly reduced disease progress (AUDPC) and the final disease rating compared to the non-treated control and Serenade Optimum, Double Nickel and Regalia. Symptoms of Alternaria were widespread on cauliflower heads, affecting 93% of the heads in the non-treated control. With the exception of plots treated with Serenade Optimum, total yield of cauliflower heads did not differ significantly between treated and non-treated plots. However, marketable yield and percentage of healthy heads was significantly higher in plots treated with Quadris Top, Endura, Inspire Super or Fontelis than in non-treated plots and plots treated with Serenade Optimum, Double Nickel or Regalia. The presence of other fungal head rots was very low (<2%) and there were no significant differences between treated and non-treated plots (data not shown).

|  |  |
| --- | --- |
| Treatment application and rate (application timingz) |  % Foliar *Alternaria*y |
|  (8 Aug) |  AUDPCx |
| Quadris Top 2.72SC 14 fl oz/A (1-4) | 9.3 cw | 103.3 b |
| Endura 70EG 9 oz/A (1-4) | 11.0 c | 130.4 b |
| Inspire Super 2.8SC 20 fl oz/A (1-4) | 9.5 c | 105.9 b  |
| Fontelis 1.67SC 24 fl oz/A (1-4) | 6.8 c | 69.1 b |
| Serenade Optimum 20 oz/A (1-4) | 31.3 a  | 290.5 a |
| Double Nickel 6 qt/A (1-4) | 24.5 b | 257.3 a |
| Regalia 4 qt/100 gal (1-4) | 24.3 b | 249.4 a |
| Non-treated control | 27.3 ab | 247.6 a |
| P value | <0.0001 | <0.0001 |

zApplication dates: 1= 3 Jul; 2= 17 Jul; 3= 24 Jul; 4= 31 Jul.

yDisease ratings and area under the disease progress curves (AUDPC) were based on the percent foliar disease.

xArea under the disease progress curves values were calculated according to the formula: Σ ([(xi+xi-1)/2](ti-ti-1)) where xi is the rating at each evaluation time and (ti-ti-1) is the number of days between evaluations.

wValues are the means of four replicate plots; treatments followed by the same letter within a column are not significantly different at P≤0.05. Means were separated using Fisher’s least significant difference test.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Treatment application and rate (application timingz) | % Cauliflower headswith Alternaria y  | % Healthy headsy  | Total yield (t/A)x | Marketable yield (t/A)x |
| Quadris Top 2.72SC 14 fl oz/A (1-4) | 66.9 b | 24.2 a | 13.4 ab | 3.3 a |
| Endura 70EG 9 oz/A (1-4) | 59.6 b | 22.2 a | 12.6 abc | 2.8 a |
| Inspire Super 2.8SC 20 fl oz/A (1-4) | 52.8 b | 22.4 a | 12.8 ab | 2.9 a |
| Fontelis 1.67SC 24 fl oz/A (1-4) | 62.9 b | 23.2 a | 14.2 a | 3.3 a |
| Serenade Optimum 20 oz/A (1-4) | 93.1 a | 6.9 b | 9.5 d | 0.7 b |
| Double Nickel 6 qt/A (1-4) | 93.7 a | 6.4 b | 10.4 cd | 0.7 b |
| Regalia 4 qt/100 gal (1-4) | 93.8 a | 4.2 b | 11.6 bcd | 0.5 b |
| Non-treated control | 93.0 a | 6.0 b | 12.1 abc | 0.8 b |
| P value | <0.0001 | 0.0051 | 0.0098 | 0.0017 |

zApplication dates: 1= 3 Jul; 2= 17 Jul; 3= 24 Jul; 4= 31 Jul.

yBased on the percentage weight of healthy heads per plot.

xMarketable yield and total yield (ton/A) values were calculated based on 6550 plants/A.

wValues are the means of four replicate plots; treatments followed by the same letter within a column are not significantly different at P≤0.05. Means were separated using Fisher’s least significant difference test.

**Evaluation of fungicides for the control of Alternaria leaf spot of cabbage, 2017.**

The experiment was conducted at the Ohio Agricultural Research and Development Center’s North Central Agricultural Research Station in Fremont, OH on Rimer loamy fine sandy soil. Roundup Powermax (1 qt/A) and Choice (8 fl oz/A) were applied on 12 Apr to kill the cover crop and weeds. On 17 Apr the test field was plowed and disked, and potassium (300 lb/A K2O), phosphorous (78 lb/A P2O5), nitrogen (107 lb/A NH4NO3), and boron (7 lb/A) were incorporated. Raised beds were prepared on 5-ft centers on 19 Apr and reshaped on 15 May. Cabbage ‘Cheers’ seeds were hot water-treated (10 min pre-soak at 100°F, soak for 25 min at 122°F) and sown on 6 Apr into 200-cell plug trays containing Metro-Mix 360 seedling mix. On 15 May, Dual II Magnum (1.0 pt/A) and Command (8 fl oz/A) were applied and incorporated into the test field for weed control. Cabbage seedlings were transplanted on 16 May; the starter fertilizer (N-P-K 10-34-0; 0.7 qt/50 gal water) was applied in the transplant water. Plots were arranged in a randomized complete block design with four replications. Each plot consisted of 19 plants per row spaced 16 inches apart with 5 ft between rows. Treated rows were alternated with non-treated border rows. The insecticides Warrior II with Zeon Technology (1.9 fl oz/A), Assail 30SG (4.0 fl oz/A), Brigade 2EC (6.1 fl oz/A), Hero EC (6.0 fl oz/A), Sevin 50W (2.0 lb/A) and Mustang Maxx (4.0 fl oz/A) were applied on 25 May and 19 Jul; 14 Jun and 26 Jul; 21 Jun; 28 Jun; 5 Jul; and 9 Aug, respectively. Fungicide treatments were applied using a tractor-mounted CO2-pressurized sprayer (55 psi, 43.8 gal/A, 3 mph) beginning 3 Jul and ending 8 Aug for a total of five applications. The field was cultivated on 13, 26 and 28 Jun and 20 Jul and hand weeded and hoed on 14 and 27 Jun and 24 Jul. Plants in treated and non-treated control rows were inoculated with approximately 105 spores/ml *Alternaria brassicicola* strain SM1756-16, on 10 and 20 Jul using a backpack CO2-pressurized sprayer. Plants were overhead irrigated with 1 in. of water on 22 Jun. The severity of Alternaria leaf spot was evaluated on 3, 10 and 15 Aug using a scale of 0-100% foliage affected. On 16 Aug, cabbage heads were harvested from the middle 15 plants of each treatment row. Weights of marketable heads, heads with Alternaria leaf spot and “other” rots (minor fungal fruit rots) were measured. Average maximum temperatures for 16-31 May, Jun, Jul and 1-16 Aug were 76.3, 82.2, 82.2 and 81.3°F; average minimum temperatures were 57.0, 60.6, 63.7 and 59.2°F; and rainfall amounts were 1.6, 3.6, 4.5 and 2.5 in., respectively. Analysis of variance was performed using the GLIMMIX procedure and means were separated by Fisher’s least significant difference test with SAS software.

Alternaria leaf spot severity was low in this trial, reaching 15.8% of foliage affected in the non-treated control by the final evaluation date (15 Aug). Treatment with Quadris Top 2.72SC, Endura 70EG, Inspire Super 2.8SC and Fontelis 1.67SC significantly reduced disease progress (AUDPC) and the final disease rating compared to the non-treated control and Serenade Optimum, Double Nickel or Regalia. Symptoms of Alternaria leaf spot were widespread on harvested cabbage heads, affecting 73.4% of the heads in the non-treated control. Total yield of cabbage heads did not differ significantly between treated and non-treated plots, however the percentage of heads with Alternaria leaf spot symptoms was significantly lower and in plots treated with Quadris Top, Endura, Inspire Super, or Fontelis than in non-treated plots and plots treated with Serenade Optimum, Double Nickel or Regalia. Marketable yield was highest in plots treated with Quadris Top, Fontelis or Endura, although marketable yield in plots treated with Inspire Super and Double Nickel were also significantly higher than in the non-treated control. The presence of other fungal head rots was very low (<2%) and there were no significant differences between treated and non-treated plots (data not shown).

|  |  |
| --- | --- |
| Treatment application and rate (application timingz) | % Foliar *Alternaria*y |
| (15 Aug) | AUDPCx |
| Quadris Top 2.72SC 14 fl oz/A (1-5) | 0.5 cw | 3.9 b |
| Endura 70EG 9 oz/A (1-5) | 1.0 c | 7.3 b |
| Inspire Super 2.8SC 20 fl oz/A (1-5) | 1.5 c | 13.1 b |
| Fontelis 1.67SC 24 fl oz/A (1-5) | 0.8 c | 5.0 b |
| Serenade Optimum 20 oz/A (1-5) | 15.3 ab | 134.5 a |
| Double Nickel 6 qt/A (1-5) | 12.8 b | 111.6 a |
| Regalia 4 qt/100 gal (1-5) | 16.5 a | 144.3 a |
| Non-treated control | 15.8 ab | 135.3 a |
| P value | <0.0001 | <0.0001 |

zApplication dates: 1= 3 Jul; 2= 17 Jul; 3= 24 Jul; 4= 31 Jul; 5= 8 Aug.

yDisease ratings and area under the disease progress curves (AUDPC) were based on the percent foliar disease.

xArea under the disease progress curves values were calculated according to the formula: Σ ([(xi+xi-1)/2](ti-ti-1)) where xi is the rating at each evaluation time and (ti-ti-1) is the number of days between evaluations.

wValues are the means of four replicate plots; treatments followed by the same letter within a column are not significantly different at P≤0.05. Means were separated using Fisher’s least significant difference test.

|  |  |  |  |
| --- | --- | --- | --- |
| Treatment application and rate (application timingz) | % Heads with Alternariay  | Total yield (t/A)x | Marketable yield (t/A)x |
| Quadris Top 2.72SC 14 fl oz/A (1-5) | 10.0 cx | 33.8 | 30.8 a |
| Endura 70EG 9 oz/A (1-5) | 20.0 c | 32.7 | 25.9 ab |
| Inspire Super 2.8SC 20 fl oz/A (1-5) | 28.3 c | 31.2 | 22.5 b |
| Fontelis 1.67SC 24 fl oz/A (1-5) | 13.3 c | 33.4 | 28.9 a |
| Serenade Optimum 20 oz/A (1-5) | 76.7 a | 31.1 | 6.2 d |
| Double Nickel 6 qt/A (1-5) | 56.7 b | 33.8 | 14.5 c |
| Regalia 4 qt/100 gal (1-5) | 75.0 ab | 31.3 | 6.6 d |
| Non-treated control | 73.4 ab | 31.5 | 7.6 d |
| P value | <0.0001 | 0.9332 | <0.0001 |

zApplication dates: 1= 3 Jul; 2= 17 Jul; 3= 24 Jul; 4= 31 Jul; 5= 8 Aug.

yBased on the percentage number of heads with Alternaria leaf spot per plot.

xMarketable yield and total yield (ton/A) values were calculated based on 6550 plants/A.

wValues are the means of four replicate plots; treatments followed by the same letter within a column are not significantly different at P≤0.05. Means were separated using Fisher’s least significant difference test.