Farm Innovation Program

Final Reporting Templates

Please note that the Knowledge Transfer Plan and Translation section may require input from both the commodity association and the researcher, if both parties are undertaking knowledge transfer activities.

Farm Innovation Program - Final Report

Please note that the final payment for projects will not be released until a final report has been submitted and accepted by the AAC. Final Reports must be a minimum of two pages and should answer all of the questions outlined below and be **submitted by the completion date of the project and/or no later than December 1st, 2012.**

Applicant Name:	Fresh Vegetable Growers of Ontario
Project Title:	Management strategies for foliar and bacterial diseases of fresh market tomatoes and peppers
FIP Project Number:	FIP 1061
Reporting Period:	January 1 2010 to April 30, 2011
Date of Submission:	March 29, 2011
AAC Program Coordinator:	Daryl Vermey

Executive Summary

Executive Summary should be one page maximum and include a brief summary of activities to date, objectives or goals accomplished and highlights of achievements and reach of project to date and/or issues that have affected success of the project to date:

Bacterial (speck, spot and canker) and fungal (late blight *Phytophthora infestans*, early blight *Alternaria solani*) diseases are common problems on tomatoes and peppers in Ontario, with few options for control available. All of these diseases may be on foliage or fruit at some stage of the plant development. Fruit infection reduces fruit quality and may render large portions of the crop unsalable. Field trials were conducted to evaluate the efficacy of fungicides and bactericides in controlling bacterial spot, caused by *Xanthomonas gardneri*, a very aggressive bacterium on tomatoes and peppers. Plants were artificially inoculated after fungicide and bactericide applications, and disease assessments were carried out weekly. Despite two inoculations with bacterial spot, disease pressure throughout the season was low. Bacterial infection was higher on tomato compared to the two pepper cultivars tested. Among the pepper cultivars evaluated, bacterial spot was more severe on bell pepper plants and on fruit of sweet banana peppers. Performance of the fungicides and bactericides evaluated on bell and banana peppers and on tomato was similar, with KOCIDE, KASUMIN and ACTIGARD slightly reducing bacterial spot progress and fruit infection and slightly increasing total and marketable yields. Although tomato late blight, caused by *Phytophthora infestans,* was kept at low levels with sprays with non registered fungicides, tomato marketable yield was highly reduced in part due to a great number of fruit infected with late blight.

Detailed Description of the Project

1. Identify overall project objectives reached:

Develop management strategies for foliar blights and bacterial diseases on fresh market tomatoes and peppers in Ontario by:

i) Evaluating efficacy of standard available fungicides and bactericides
ii) Evaluating efficacy of new compounds as available from manufacturers

All objectives have been completed

2. Identify <u>all activities</u> undertaken to reach the project objectives (link these activities to the Milestone Performance as per Schedule "B" Part III of the Agreement):

Milestone 1: Gather and review of literature, design plant, manage plots

Field trials were conducted in 2010 at the Simcoe Research Station – University of Guelph. Peppers (cv. Redstart, Sweet Banana) and tomatoes (cv. Celebrity) were seeded on 30 April into 128 cell plastic plug trays filled with a commercial soil-less mix. Plants were raised in a greenhouse under ambient light and temperature conditions. Transplants were planted into separate trials in the field on 1 (tomatoes) and 10 June (peppers). Plots were 7 m long and 3 m wide with 3 rows per plot for tomatoes and 4 rows per plot for peppers (2 rows of each cultivar). Rows were spaced 0.75 m apart and plants were spaced 0.45 m apart in the row for peppers and spacing in the tomato trial was 1.0 m between rows and 0.50 m between plants. Soil type was a Scotland sandy loam (1.8% organic matter, pH 7.2). Fertilizers were applied according to Ontario recommendations. Weeds were controlled according to OMAFRA recommendations. The fungicides BRAVO 500 (4 L/ha; 29 July 2010), CURZATE 60 DF ((225g/ha) + BRAVO 500 (2.4L/ha) 6 and 11 August) and PRESIDIO (280mL/ha; 17 August) were applied to the tomato trial to control late blight caused by *Phytophthora infestans*.

The bacterial spot causal agent, *Xanthomonas gardneri* strain DC00T7A, was provided by Dr Diane Cupples, Agriculture and Agri-food Canada, London Ontario. Plants were inoculated in the field on 8 and 23 July with bacterial cells produced on sterile Luria-Bertani (LB) broth, pelleted by centrifugation and re-suspended in 2500 mL of sterile distilled water to a concentration of 5 x10^8 CFU/mL. Bacterial inoculum was misted to the foliage using spray bottles (750 mL) until leaves were visibly wet.

Treatments were: KOCIDE 2000 (3.2 kg/ha), ALIETTE (2.8 kg/ha), SERENADE ASO (10 L/ha), ACTIGARD 50WG (52.5 g/ha) and KASUMIN (1.167 L/ha) + ENHANCE (0.25%) plus an untreated non-inoculated check and an untreated inoculated check. Treatments were arranged in a randomized complete block design with four replications for tomatoes. Pepper treatments were replicated four times and arranged in a split plot design with fungicide as the main plot and cultivar as subplots. Treatments were applied on 7, 14, 21, 28 July, 5, 11 Aug. using a CO_2 backpack sprayer equipped with two (tomatoes) or three (peppers) XR8004VS nozzles spaced 50 cm apart and calibrated to deliver 300 L/ha water at 220 kPa. Weather conditions at the time of application are shown in Appendix A. Monthly weather summaries are in Appendix B.

The foliage of bell, sweet peppers and tomato in each treatment was rated and assessed weekly up to harvest for bacteria spot severity on 13, 21, 27, July, 5, 10 and 18 August, and for tomato late blight on 5, 10 and 18 August. Plots were assigned a rating of 0-10 with 0 = healthy, 1 = 2 to 10 lesions/leaf/plant ... 9 = 80 lesions /leaf/plant/and or 50-75% lesions on petioles/stems/ flowers/fruit, 10 = dead leaves and or > 75% lesions on fruit. Weekly disease ratings were used to calculate the area under the disease progress curve (AUDPC) using the equation:

$$\textbf{AUDPC=} \sum_{j=1}^{nj-1} \left(\frac{yj+yj+1}{2}\right)(t\,j+1-tj)$$

Where: *y*= leaf blight severity at *j*th observation, *t*= time (days) since the previous rating at *j*th observation and *n*= total number of observations.

A 5 m section of the centre row of each plot was harvested on 26 Aug. (tomatoes) and 31 Aug. (peppers). Numbers and weights of marketable and unmarketable fruit were recorded. At harvest, the severity of disease symptoms on 50 fruit per plot were also recorded using a 0 to 5 scale: 0= No lesions, 1= < 10% of fruit area with lesions, 2= 10-25% of fruit area with lesions, 3= 26-50% of fruit area with lesions, 4= 51=75% of fruit area with lesions, 5=> 75% fruit area with lesions. Fruit disease severity index (FDSI) was calculated using the equation:

$$\textbf{FDSI=}\ \frac{[(\text{class no.})(\text{ no.of fruit in each class})]}{(\text{total n0.fruit per sample})(\text{no.classes}-1)}\ \text{x}100$$

Milestone 2: Analyses and interpretation of data

Data were analyzed using the General Linear Model procedure of SAS ver. 9.2. Means separation was obtained using Fisher's Protected LSD test at *P*= 0.05 level of significance. Data analysis is complete

Milestone 3: Reports, articles

A final report was submitted to the Fresh Vegetable Growers on 2 Dec. Articles for grower publications will be written and published by 31 April, 2011.

3. Identify the outputs created as a result of the activities undertaken (if materials are produced, a sample should be included in the report):

See Appendix A for results of the research trials.

4. Explain changes or issues affecting completion of activities:

No changes to the project were necessary. The research trials were completed as proposed.

5. Identify the project inputs used to complete the activities and during the course of the project (include: farmer(s) involved, funding level, financial contributions, staff resources, other resources, etc.). If you did not access all of the FIP funding, or If your actual budget is different from the approved budget, please explain why and outline the reason(s) for those variances. All categories that are over/under budget should be discussed:

Two staff members and three summer students were involved in this project. All FIP funding has been utilized. A full accounting of the project's financial status will be sent by the University of Guelph – Office of Research.

Benefits & Impact

6. Compare final project results with the expected short term results and explain any differences:

Results of this project are consistent with the expected short term results.

7. Explain if the final project results are satisfactory:

Final project results were satisfactory.

8. Identify the public good/benefit of the project to date:

Bacterial diseases of tomatoes and peppers are common problems in Ontario and have a significant negative impact on yield and quality. However, few products are registered for control of these diseases. Copper products are commonly used to control bacterial diseases but repeated applications can raise soil copper levels resulting in negative impacts on the environment and soil fertility. This project evaluated 5 products for efficacy in controlling bacterial diseases. Products were identified that may have potential for registration. This will be of great benefit to tomato and pepper growers by providing more options for controlling bacterial diseases thus increasing yield and quality.

9. Explain how many on farm technologies the project has assessed:

N/A

10. Explain how the project success will be measured in the long-term (include the indicators outlined in Schedule "B" of the Agreement):

Long term success is difficult to measure for a project like this one. Products were identified with efficacy in controlling bacterial diseases and data was collected that would aid in obtaining registration of these products. However, the decision to register pesticides lies with the PMRA and manufacturers of the pesticides. If new products are registered, this would improve productivity and profitability of fresh market tomatoes and peppers.

11. If applicable, indicate how this initiative will be economically viable and self-sustaining from this point forward. Explain what the next steps are for this initiative:

N/A

12. Indicate the current actual financial impact to farmers who may adopt the technology versus the estimated impact (see question '6.e.' in the application):

Financial benefits are difficult to estimate. Bacterial diseases are a common and damaging disease in tomatoes and peppers. Estimates from OMAFRA indicate that yield reductions can be as high as 60% under optimal conditions for the spread of the disease. Severe infections have caused complete crop failure in the US. Farm gate value of peppers and tomatoes in Ontario in 2009 was estimated as $96,222,000 so the potential financial impact of bacterial diseases is considerable. Efficacious products that can be used as an alternative to copper fungicides would improve yield and profitability.

13. Indicate the target audience and the total number of people reached by this project:

Results of this project will be of use to growers, agri-business and government personnel. A conservative estimate would be around 300-500 people.

Knowledge Transfer Plan & Translation

14. Indicate how information has been communicated with industry for the duration of the project (refer to the plan developed as part of question 7 in the final funding application):

Information Requested	Commodity Association Activities	Researcher Activities
Indicate the type and number of communication materials that were developed (i.e. brochure, display, CD/DVD, poster, website, handbook, etc.) and how they were distributed:		- A poster was presented at the OFVC in February 2011 - Results will be posted on the FVGO website - Results will be posted on the University of Guelph website - A copy of the report has been submitted to the manufacturers of pesticides used in the trial
Indicate the number of presentations that were made and the total audience reached:		- 16 December 2010, FVGO annual meeting, estimated audience of 50 people
Indicate the number of scientific and popular press articles that were developed and how they were distributed:		- One year of data is not sufficient for scientific publications
Identify any other communication activities, including but not limited to internet publications, advertising, billboards, radio and television broadcasts:		N/A
Indicate if any project materials have been made available for use in the French language:		N/A

15. Indicate when AAFC/OMAFRA/AAC were identified as a supporter throughout the period of the project:

AAFC, OMAFRA and AAC were identified as supporters on all written material.

Conclusion & Final Comments

16. Provide a discussion of lessons learned, recommendations and overall perception of project success:

Levels of bacterial disease were low, despite two separate inoculations. This is likely due to extremely high temperatures which made it difficult to establish the disease. Although the trials were inoculated twice, levels of bacterial spot were low. Bacterial infection was higher on tomato plants compared to bell and sweet banana peppers. On peppers, bacterial spot was severe on bell peppers plants and on fruit of sweet banana peppers. The performance of the fungicides and bactericides evaluated on bell and banana peppers and on tomato was similar, with KOCIDE, KASUMIN and ACTIGARD slightly reducing bacterial spot progress and fruit infection and slightly increasing yields.

Tomato late blight, caused by *Phytophthora infestans,* was found on tomato early August. Despite the fact that the disease was kept at low levels with sprays of non registered fungicides, tomato marketable yield was reduced because most of the rejected fruits were infected with late blight. Late blight on tomato occurred in a similar trial in 2009 and severely infected tomatoes, destroying most of the plants within a few days after infection and obscuring bacterial spot symptoms. Infected tomato leaves from the 2009 trial were sent to a laboratory for pathogen identification. Preliminary results indicate that the *P. infestans* that infected tomatoes in our research plot was a new type and was similar to a *P. infestans* isolated from infected potato leaves from Ontario and from infected tomato leaves from New York. More laboratory studies are ongoing to develop more conclusive results. To reduce the tomato late blight in 2010 we applied fungicides that are not registered in Canada for use on tomatoes. Therefore, we suggest that studies be conducted to evaluate the efficacy of these and other new chemicals, in controlling this new late blight and to support product registration.

Media Coverage – *If possible please provide a copy of the media coverage for our files*

Date	Source	Title	Reach	FIP Recognition (Yes/No)

(Add additional rows if needed)

APPENDIX A: Results and Discussion

1. Fungicides and bactericides on bacterial disease of peppers

Bacterial inoculum was needed to induce disease on peppers and tomato, which was achieved with two bacterial inoculations of both crops. Despite repeated bacterial inoculations, disease pressure was low as shown by the low values for AUDPC recorded. Extremely high temperature conditions that occurred early in the season and after both pathogen inoculations, might have contributed to the low disease levels recorded. The occurrence of bacterial spot on the non inoculated controls of all crops evaluated, suggests that some bacterial inoculum might have occurred naturally.

For bell peppers**, t**here were no significant differences in bacterial spot progress and intensity between bell peppers treated with SERENADE, ALIETTE, KOCIDE and KASUMIN and the inoculated control, as shown by the AUDPC records (Table 1). Similarly, there were no significant differences in AUDPC of peppers treated with KOCIDE, KASUMIN, ACTIGARD and the non inoculated control. The lowest AUDPC was recorded on the non inoculated control and the highest on the inoculated control (Table 1). Bacterial spot progress on sweet banana peppers over the growing season was low and similar for all treatments, as shown by the AUDPC values (Table 2).

Fruit infection by bacterial spot was low for both bell and sweet banana peppers. For bell peppers, there were no significant differences in fruit bacterial spot incidence for all treatments (Table 3). For sweet banana peppers fruit disease incidence was similar for peppers treated with KASUMIN, ACTIGARD, and the inoculated and non inoculated controls (Table 4). Also, there were no significant differences in the percent of infected fruits between the inoculated, non inoculated control ALIETTE, SERENADE and KOCIDE treatments, with treatments with KOCIDE resulting in the lowest percent of bacterial spot infected fruit. Fruit disease severity was similar among sweet banana peepers treated with KASUMIN, ACTIGARD and the inoculated and non inoculated controls. Sweet banana pepper fruit treated with KASUMIN resulted in significantly higher bacterial disease than the fruit of pepper treated with ALIETTE, SERENADE and KOCIDE, with SERENADE having the lowest fruit disease severity. Fruit from the non inoculated and inoculated controls resulted in similar fruit disease severity.

Treatments did not affect total and marketable yields of bell and sweet banana pepper, since there were no significant differences in total and marketable yields between treatments. However, bell peppers treatments with KASUMIN, and KOCIDE and the non inoculated control, and sweet banana peppers treatments with KOCIDE and the non inoculated control, resulted in slightly numerically high total and marketable yields (Tables 1&2).

Table 1. Effects of fungicides and bactericides on the severity of *Xanthomonas gardneri* strain DC00T7A bacterial spot over the growing season as determined by the area under disease progress curve (AUDPC) and total and marketable yields for Redstart bell peppers grown at the Simcoe Research Station in 2010.

Treatment	Rate/ha	AUDPC[1]	Yield (t/ha)	
			Total	Marketable
CONTROL – inoculated	--	17.9 a[2]	32.0 ns[3]	30.6 ns
SERENADE	10 L	15.7 a	35.6	29.2
ALIETTE	2.5 kg	14.5 ab	34.5	29.5
KOCIDE	3.2 kg	11.5 abc	37.3	30.9
KASUMIN+ Enhance	1.167 L 0.25%	11.4 abc	38.8	32.0
ACTIGARD	52.5 g	6.4 bc	29.9	24.1
CONTROL – non-inoculated	--	4.6 c	37.4	31.4

[1] AUDPC (Area Under Disease Progress Curve) = $\sum_{j=1}^{nj-1} \left(\frac{yj+yj+1}{2}\right)(t\,j+1-tj)$ Where: *y*= leaf blight severity at *j*th observation, *t*= time (days) since the previous rating at *j*th observation and *n*= total number of observations.
[2] Numbers in a column followed by the same letter are not significantly different at P=0.05, Fisher's Protected LSD Test;
[3] ns indicates no significant differences were found among the treatments.

Table 2. Effects of fungicides and bactericides on the severity of *Xanthomonas gardneri* strain DC00T7A bacterial spot over the growing season as determined by the area under disease progress curve (AUDPC) and total and marketable yields for Sweet Banana peppers grown at the Simcoe Research Station in 2010.

Treatment	Rate/ha	AUDPC[1]	Yield (t/ha)	
			Total	Marketable
CONTROL – inoculated	--	11.1 ns[2]	28.7 ns	22.9 ns
ALIETTE	2.5 kg	9.6	30.1	23.8
KOCIDE	3.2 kg	9.0	32.3	26.5
SERENADE	10 L	8.3	29.3	24.6
KASUMIN+ Enhance	1.167 L 0.25%	6.0	30.9	24.7
ACTIGARD	52.5 g	4.8	28.6	22.3
CONTROL – non-inoculated	--	3.3	33.2	26.5

[1] AUDPC (Area Under Disease Progress Curve) = $\sum_{j=1}^{nj-1} \left(\frac{yj+yj+1}{2}\right)(t\,j+1-tj)$ Where: *y*= leaf blight severity at *j*th observation, *t*= time (days) since the previous rating at *j*th observation and *n*= total number of observations.
[2] ns indicates no significant differences were found among the treatments.

Table 3. Effects of fungicides and bactericides on the incidence and severity of *Xanthomonas gardneri* strain DC00T7A bacterial spot on fruit of Redstart peppers grown at the Simcoe Research Station in 2010.

Treatment	Rate/ha	Disease Incidence (%)	Fruit Disease Severity Index[2]
CONTROL – non-inoculated	--	1.4 ns[1]	0.7 ns
CONTROL – inoculated	--	3.1	1.2
ACTIGARD	52.5 g	1.7	0.7
ALIETTE	2.5 kg	1.1	0.5
KASUMIN + Enhance	1.167 L 0.25%	2.4	1.0
KOCIDE	3.2 kg	0.8	0.5
SERENADE	10 L	3.2	1.3

[1] ns indicates no significant differences were found among the treatments.
[2] Disease Severity Index (DSI) = $\frac{[(\text{class no.})(\text{no.of fruit in each class})]}{(\text{total no.fruit per sample})(\text{n0.classes}-1)}$ x100

Table 4. Effects of fungicides and bactericides on the incidence and severity of *Xanthomonas gardneri* strain DC00T7A bacterial spot on fruit of Sweet Banana peppers grown at the Simcoe Research Station in 2010.

Treatment	Rate/ha	Disease Incidence (%)	Fruit Disease Severity Index[2]
KASUMIN + Enhance	1.167 L 0.25%	3.8 a[1]	3.5 a
ACTIGARD	52.5 g	3.5 a	3.2 ab
CONTROL – inoculated	--	2.3 ab	2.6 abc
CONTROL – non-inoculated	--	2.0 ab	2.2 abc
ALIETTE	2.5 kg	1.6 b	1.9 bc
SERENADE	10 L	1.5 b	1.2 c
KOCIDE	3.2 kg	1.2 b	1.5 c

[1] Numbers in a column followed by the same letter are not significantly different at P=0.05, Fisher's Protected LSD Test.
[2] Disease Severity Index (DSI) = $\frac{[(\text{class no.})(\text{no.of fruit in each class})]}{(\text{total no.fruit per sample})(\text{n0.classes}-1)}$ x100

2. Fungicides and bactericides on bacterial and fungal diseases of tomatoes

2.1 Tomato bacterial spot.

Tomato bacterial spot progress and intensity was affected by the treatments applied as shown by the AUDPC results (Table 5). Bacterial spot AUDPC was significantly lower with KOCIDE and ACTIGARD treatments. There were no significant differences in AUDPC between the inoculated control and tomatoes treated with SERENADE and KASUMIN, with the inoculated control resulting in the highest AUDPC. Similar bacterial spot control was obtained with treatments with SERENADE, KASUMIN and ALIETTE.

There were no significant differences in percent of tomato fruit infected with bacterial spot (Table 6).
Fruit disease severity was lowest for the non inoculated control, and highest for the inoculated control. There were no significant differences between the inoculated control and fruit of pepper treated with SERENADE, ALIETTE and KASUMIN. Treatments with SERENADE, ALIETTE and KASUMIN resulted in similar fruit disease severity that was not significantly different from the non inoculated control. The lowest fruit disease severity among all treatments was obtained from the non inoculated control and the highest from the inoculated control (Table 6).

None of the treatments improved total and marketable yields, since no significant differences were observed in total and marketable yields among treatments (Table 5).

2.2 Tomato late blight

Tomato late blight symptoms caused by *Phytophthora infestans* were first recorded on 5 August after a preventive spray with BRAVO on 29 July. Subsequent fungicide applications consisted of two sprays of CURZATE + BRAVO and one spray with PRESIDIO, kept late blight progress and spread at low levels. Although there were no significant differences in tomato late blight AUDPC, fruit late blight incidence and severity, fruit disease severity of tomato was numerically low with KOCIDE, ALIETTE and ACTIGARD treatments (Table 7). Tomato fruit late blight infection was a major factor in tomato in reducing tomato marketable yield.

Table 5. Effects of fungicides and bactericides on the severity of *Xanthomonas gardneri* strain DC00T7A bacterial spot over the growing season as determined by the area under disease progress curve (AUDPC) and total and marketable yields for Celebrity tomatoes grown at the Simcoe Research Station in 2010.

Treatment	Rate/ha	AUDPC[1]	Yield (t/ha)	
			Total	Marketable
CONTROL – inoculated	--	100.6 a[2]	70.2 ns[3]	38.3 ns
SERENADE	10 L	86.7 ab	57.8	31.2
KASUMIN+ Enhance	1.167 L 0.25%	83.4 ab	54.8	28.0
ALIETTE	2.5 kg	79.1 b	59.1	39.1
CONTROL – non inoculated	--	70.4 bc	64.5	39.1
KOCIDE	3.2 kg	58.6 c	64.7	43.3
ACTIGARD	52.5 g	51.0 c	55.8	28.4

[1] AUDPC (Area Under Disease Progress Curve) = $\sum_{j=1}^{nj-1} \left(\frac{yj+yj+1}{2}\right)(t\,j+1-tj)$ Where: *y*= leaf blight severity at *j*th observation, *t*= time (days) since the previous rating at *j*th observation and *n*= total number of observations.
[2] Numbers in a column followed by the same letter are not significantly different at P=0.05, Fisher's Protected LSD Test; ns = not significant
[3] ns indicates no significant differences were found among the treatments.

Table 6. Effects of fungicides and bactericides on the incidence and severity of *Xanthomonas gardneri* strain DC00T7A bacterial spot at harvest on fruit of Celebrity tomatoes grown at the Simcoe Research Station in 2010.

Treatment	Rate/ha	Incidence of Bacterial spot on fruit (%)	Fruit Disease Severity Index[2]
CONTROL – inoculated	--	5.8 ns[1]	5.8 a[3]
SERENADE	10 L	5.4	5.2 ab
ALIETTE	2.5 kg	4.3	3.8 abc
KASUMIN+ Enhance	1.167 L 0.25%	4.1	3.2abc
ACTIGARD	52.5 g	3.9	2.3 bc
KOCIDE	3.2 kg	2.2	2.2 bc
CONTROL – non-inoculated	--	2.5	2.0 c

[1] ns indicates no significant differences were found among the treatments.

[2] Fruit Disease Severity Index (FDSI) = $\frac{[(\text{class no.})(\text{ no.of fruit in each class})]}{(\text{total no.fruit per sample})(\text{n0.classes}-1)}$ x100

[3] Numbers in a column followed by the same letter are not significantly different at P=0.05, Fisher's Protected LSD Test

Table 7. Effects of fungicides and bactericides on the severity *Phytophthora infestans* late blight during the growing season as determined by the area under disease progress curve (AUDPC), disease incidence, disease severity index, number and weight of fruits infected only with *P. infestans*, on fruit at harvest for Celebrity tomatoes initially inoculated with *Xanthomonas gardneri* strain DC00T7A and grown at the Simcoe Research Station in 2010.

Treatment	Rate/ha	AUDPC[1]	Incidence of Late Blight on fruit (%)	FDSI[3]
CONTROL – non-inoculated	--	33.1 ns[2]	4.1 ns	13.9 ns
CONTROL – inoculated	--	40.4	6.3	28.3
ACTIGARD	52.5 g	16.7	4.8	8.8
ALIETTE	2.5 kg	20.4	2.5	6.2
KASUMIN + Enhance	1.167 L 0.25%	38.5	6.1	13.4
KOCIDE	3.2 kg	22.9	2.3	5.1
SERENADE	10 L	24.6	4.2	11.2

[1] AUDPC (Area Under Disease Progress Curve) = $\sum_{j=1}^{nj-1} \left(\frac{yj+yj+1}{2}\right)(t\,j+1-tj)$ Where: *y*= leaf blight severity at *j*th observation, *t*= time (days) since the previous rating at *j*th observation and *n*= total number of observations.

[2] ns indicates no significant differences were found among the treatments.

[3] Fruit Disease Severity Index (FDSI) = $\frac{[(\text{class no.})(\text{ no.of fruit in each class})]}{(\text{total no.fruit per sample})(\text{n0.classes}-1)}$ x100