Journal of the American Pomological Society 65(2): 39-46 2011

Evaluation of Alternative Management Options for Gray Mold on Field Grown Raspberries

Graham Q. Sanders[1], Elsa S. Sánchez[2] and Kathleen Demchak[3]

Abstract

Fungicides are commonly used for managing gray mold of raspberries (*Rubus ideaus*) caused by *Botrytis cinerea*. In 2006-07, we studied the efficacy of MilStop (potassium bicarbonate), Endorse (polyoxin D zinc salt), lime sulfur (calcium polysulfide), Phostrol (mono- and dibasic-sodium, potassium, and ammonium phosphates), and tank mixtures of Oxidate (hydrogen dioxide) and MilStop combined, Oxidate and Vigor Cal Phos (phosphorous salts of calcium and copper) combined and Shemer (*Metschnikowia fruitcola*) and MilStop combined (2007 only) for managing gray mold. Phostrol resulted in the highest phytotoxicity. Rotating Captan (captan) and Elevate (fenhexamid), a commercial standard, was the most effective for yield and in-season gray mold management. Generally no material was more effective for postharvest gray mold management than spraying water on the plants. Applying these treatments generally provided no yield benefit or control of gray mold.

Raspberries are an important cash crop in Pennsylvania. While initial investment in a planting is relatively high, good management skills are needed to produce a quality product and substantial labor is required, financial returns generally outweigh costs (3). Most raspberry plantings do not reach their full productive potential due to disease. Gray mold caused by *Botrytis cinerea* is one of the most economically important diseases of raspberries (8). When conducive conditions exist, *B. cinerea* can cause over 90% infection of fruit (12).

Chemical controls are the most common method for gray mold management (8). In addition to traditional chemical products, many alternative products have become commercially available, including options allowable in organic farming. Plant-defense boosters such as nutritional supplements are also commercially marketed for disease management. The efficacy of many alternative products and nutritional supplements has not been established, yet they are aggressively advertised to growers as viable management options. The objective of this study was to determine the efficacy of several of these materials for managing gray mold. The basis of evaluation of these materials was disease suppression, fruit yield, postharvest losses and phytotoxic effects.

Materials and Methods

Raspberry Planting

This study was conducted in 2006-07 on a 2-year-old 'Nova' and 'Prelude' summer bearing red raspberry (Nourse Farms, South Deerfield, MA) plantings located at the Russell E. Larson Research and Education Center, Rock Springs, PA (lat. 40°42'45.04"N, long 77° 57'12.44"W). Canes were supported by an I trellis system (2). Overhead irrigation supplemented natural rainfall and was applied at a rate of 6.2 to 12.4 cm per week

Use of trade names does not imply endorsement of the products named or criticism of similar ones not named.

The authors wish to acknowledge the United States Department of Agriculture's Northeast Sustainable Agriculture Research and Education program, the State Horticultural Association of Pennsylvania, the North American Bramble Growers Association and the United States Department of Agriculture IR-4 project for funding this project. The authors also would like to thank their families for their support.

[1] Former graduate research assistant
[2] Associate professor of horticultural systems management
[3] Senior extension associate
Department of Horticulture, Pennsylvania State University, University Park, PA 16802

during vegetative growth and 12.4 to 18.5 cm per week during reproductive growth, following commercial recommendations (2). Overhead irrigation was used to facilitate *Botrytis cinerea* development by increasing relative humidity levels within the plant canopy and replaced the more typically used drip irrigation.

Treatments

Seven treatments for managing gray mold were evaluated during the 2006 growing season. Eight treatments were evaluated in 2007. MilStop (BioWorks, Inc., Fairport, NY) can be used in organic farming and was applied at a rate of 4.2 $kg \cdot ha^{-1}$. A lime sulfur solution (Miller Chemical and Fertilizer Corp., Hanover, PA) was applied at a spray volume of 1%. Lime sulfur may be used at 10% spray volume during the dormant season (2). Its potential for in-season gray mold management was tested. Phostrol (Nufarm Americas, Inc., Burr Ridge, IL) was applied at a rate of 5.9 $l \cdot ha^{-1}$. Additionally, a combined MilStop and Oxidate (Biosafe Systems, Glastonbury, CT) tank mixture was used. MilStop was applied at a rate of 4.2 $kg \cdot ha^{-1}$ and Oxidate was applied at a spray volume of 1% for the first three applications and then at a 0.3% of spray solution volume for the remaining applications. A combined Oxidate and Vigor Cal Phos (Agro-K Corp., Minneapolis, MN) tank mixture was tested with Oxidate applied at a spray volume of 1% for the first three applications and then at 0.3% of spray solution volume for the remaining applications and Vigor Cal Phos applied at a rate of 9.3 $l \cdot ha^{-1}$. Oxidate is allowed in organic farming under the restricted category requiring documented need (1). Endorse (Arvesta Corp., San Francisco, CA) was applied at a rate of 2.0 $kg \cdot ha^{-1}$. Endorse is not currently labeled for raspberries. However, its efficacy in managing *B. cinerea* in geraniums (13) and creeping bentgrass in combination with Spectro (chlorothalonil plus thiophanate methyl) (7) has been established. In 2007 only, Shemer (Agro-Green Minrav., Ashdod, Israel) and MilStop were applied as a tank mixture. Shemer was applied at a rate of 0.2% spray solution volume and MilStop was applied at a rate of 0.1% spray solution volume. Company representatives recommended applying Oxidate, Vigor Cal Phos and Shemer in combination with other materials. With the exception of lime sulfur, all chemical application rates were based on manufacturer recommendations for gray mold management. The lime sulfur rate was based on the recommendation of plant pathologist, J. Travis (personal communication). The majority of the treatments were selected by an advisory board consisting of bramble producers in the mid-Atlantic region. Endorse and Shemer were evaluated at the request of the United States Department of Agriculture's IR-4 program.

Two experimental controls were used: a water only spray, and a standard fungicide rotation of Elevate 50 Water Dispersible Granules (Arvesta Corp., San Francisco, CA) applied at a rate of 1.7 $kg \cdot ha^{-1}$ and Captan 50 Wettable Powder (Arvesta Corp., San Francisco, CA) applied at a rate of 4.5 $kg \cdot ha^{-1}$.

Each plot was hand sprayed using three passes per application for maximum plant coverage: once on either side of the hedgerow and once over the top. All chemical treatments were applied in a volume of water equivalent to 469 $l \cdot ha^{-1}$ using a compressed CO_2 sprayer operated at 276 kPa. Chemical treatments were initiated at 10 to 15% bloom (early bloom). They were then applied twice more on 5- to 7-day intervals, corresponding to 45 to 50% bloom (mid bloom) and 75 to 80% bloom (late bloom). Treatments were discontinued briefly and resumed when harvested fruit counts reached 10 to 15% (early harvest) and continued on 5- to 7-day intervals corresponding to 45 to 50% fruit (mid harvest) and 75 to 80% fruit (late harvest).

Data Collection

Phytotoxicity symptoms in each plot were evaluated following each spray application. A visual rating scale of 0 to 100% using 10% increments was used. When less than 10% of leaf area or canes were affected, a rating of 5% was assigned. Ratings were taken weekly, with the final observations taken within one week after the last treatment application.

Fruit was harvested by hand three times weekly from 22 June to 28 July 2006 and 22 June 22 to 25 July 2007. Fruit were sorted into marketable and unmarketable categories. Unmarketable fruit displayed blemishes or disease. Most blemishes were due to insect and mechanical damage. A small amount of diseased fruit was also observed. Subsamples consisting of 25 random fruit and total fruit were weighed.

Postharvest evaluations were performed on fruit collected on four harvest dates each season: 30 June, 3, 7 and 17 July 2006 and 25 and 27 June, 3 and 6 July 2007. Following these harvests, 13 or 16 ripe fruit in 2006 and 2007, respectively, were placed in 28-celled plastic trays (Gardner's Candies, Tyrone, PA). Trays were then placed in moist chambers consisting of 3.8 l plastic slider bags lined with two-layers of paper towels that were moistened with tap water. To facilitate gray mold incidence, in 2006, moist chambers were stored at room temperature (21 to 24 °C) for 4 days followed by 3 days at 4 to 7 °C. In 2007, they were stored at 16 to 18 °C for 4 days followed by 3 days at 4 to 7 °C to slow disease development. Disease incidence was recorded daily for 1 week. Fruit were maintained for up to 2 months to verify disease-causing pathogens by analysis of morphological characteristics using a 30x dissecting microscope.

Statistical Design and Analysis

Treatments were arranged in a 2 (cultivars: 'Nova' and 'Prelude') x 9 or 10 (treatments and 2 controls in 2006 and 2007, respectively) factorial in a randomized complete block design with 4 replications. Numerical data were analyzed with General Linear Model Analysis of Variance. When differences were detected at $P \leq 0.05$, data were subjected to Duncan's Multiple Range Test using Statistical Analysis System 9.1.3 (SAS Institute Inc., Cary, NC).

Table 1. Percent phytotoxicity on *Rubus ideaus,* cultivars 'Prelude' and 'Nova', resulting from chemical treatments for gray mold (caused by *Botrytis cinerea*) in 2006-07.

Cultivar	Treatment	Phytotoxicity rating (% leaf tissue affected[y]) 2006	2007
'Prelude'	Water only spray (control)	0.00 b[z]	0.00 b
	Captan and Elevate rotation (control)	0.00 b	0.00 b
	MilStop	3.50 b	1.00 b
	Endorse	0.00 b	0.00 b
	Lime Sulfur	0.00 b	0.00 b
	Phostrol	26.00 a	21.00 a
	Oxidate and MilStop	2.80 b	0.50 b
	Oxidate and Vigor Cal Phos	0.75 b	0.00 b
'Nova'	Water only spray (control)	0.00 d	0.00 c
	Captan and Elevate rotation (control)	0.00 d	0.00 c
	MilStop	9.80 bc	5.80 b
	Endorse	4.80 cd	1.00 c
	Lime Sulfur	0.00 d	1.00 c
	Phostrol	54.00 a	43.00 a
	Oxidate and MilStop	11.00 b	9.00 b
	Oxidate and Vigor Cal Phos	5.80 bcd	1.00 c

[y]Mean of weekly phytotoxicty ratings for four replications
[z]Letters indicate significant differences within a column at $P \leq 0.05$

Results and Discussion

Phytotoxicity

In both years, 'Nova' was more susceptible to phytotoxicity than 'Prelude'. With 'Prelude', in both years, applying Phostrol resulted in the highest percent phytotoxicity (Table 1). All other treatments with 'Prelude' resulted in negligible phytotoxity ratings similar to the water only spray.

With 'Nova', in both years, applying Phostrol resulted in the highest percent phytotoxicity compared to all other treatments (Table 1). Applying Captan and Elevate in rotation, Endorse, lime sulfur, and Oxidate/Vigor Cal Phos tank mixture resulted in a similar percent phytotoxicity as the water only spray. Applying MilStop and the MilStop/Oxidate tank mixture resulted in similar and higher phytotoxicity ratings than the water only spray.

Applying Phostrol resulted in phytotoxicity regardless of cultivar. Phytotoxic symptoms from Phostrol applications were a uniform marginal and veinal necrosis as reported previously (9, 10). On floricanes, symptom severity increased with each treatment application. Primocanes outgrew phytotoxic symptoms as the leaves expanded and new ones emerged. Additionally, applying MilStop and the MilStop/Oxidate tank mixture, resulted in phytotoxicity on 'Nova'. Generally, these ratings were similar, although lower than observed when applying Phostrol. Symptoms from these products were usually not prevalent throughout plots and consisted mainly of leaf chlorosis. Research has shown phytotoxic effects of leaf stunting and deformation from MilStop application on hydrangea (5). Based on analysis of yield data, phytotoxicity as a result of applying any product was not statistically correlated with yields indicating plant compensation or that levels were not sufficient to affect yields.

Yields

Throughout the study no treatment by cultivar interactions existed.

In 2006, marketable and unmarketable yields and the percent of fruit infected with gray mold were not affected by treatment (Table 2). Using Captan and Elevate in rotation resulted in the largest fruit. Water only sprays resulted in fruit similar in weight to those sprayed with the Oxidate /Vigor Cal Phos tank mixture, lime sulfur, Phostrol and Endorse. MilStop applications resulted in

Table 2. Marketable and unmarketable yields of *Rubus ideaus* fruit treated with alternative options for managing gray mold (caused by *Botrytis cinerea*); 2006.

Treatment	Marketable yield[w] ($g \cdot plot^{-1x}$)	Marketable fruit wt ($g \cdot fruit^{-1}$)	Unmarketable yield ($g \cdot plot^{-1}$)	Unmarketable fruit due to gray mold (%)
Water only spray (control)	2045	2.4 b[y]	668	24
Captan and Elevate rotation (control)	2553	2.6 a	629	10
MilStop	1600	2.2 c	534	20
Endorse	1765	2.4 b	445	12
Lime Sulfur	1998	2.4 b[y]	658	19
Phostrol	1773	2.4 b	704	22
Oxidate and MilStop	1264	2.1 d	426	18
Oxidate and Vigor Cal Phos	2225	2.4 b	654	21
Significance[z]	NS	*	NS	NS

[w]Mean of four replications and two cultivars: 'Prelude' and 'Nova'
[x]Plot size is 3.7 m by 0.61 m hedgerow
[y]Letters indicate significant differences within a column
[z]NS = not significant; * = significant at $P \leq 0.05$

Table 3. Marketable and unmarketable yields of *Rubus ideaus* fruit treated with alternative options for managing gray mold (caused by *Botrytis cinerea*); 2007.

Treatment	Marketable yield[w] ($g \cdot plot^{-1x}$)	Marketable fruit wt ($g \cdot fruit^{-1}$)	Unmarketable yield ($g \cdot plot^{-1}$)	Unmarketable fruit due to gray mold (%)
Water only spray (control)	3791 b[y]	2.3	1265	13.0 bc
Captan and Elevate rotation (control)	5221 a	2.4	1347	8.4 d
MilStop	2701 bc	2.2	983	18.0 a
Endorse	3564 b	2.4	1099	10.0 cd
Lime Sulfur	3100 bc[y]	2.3	1276	18.0 a
Phostrol	3870 b	2.4	1307	14.0 abc
Oxidate and MilStop	2240 c	2.2	1013	14.0 abc
Oxidate and Vigor Cal Phos	3817 b	2.4	1362	16.0 ab
Shemer and MilStop	3424 b	2.4	1204	17.0 ab
Significance[z]	*	NS	NS	*

[w]Mean of four replications and two cultivars: 'Prelude' and 'Nova'
[x]Plot size is 3.7 m by 0.61 m hedgerow
[y]Letters indicate significant differences within a column
[z]NS = not significant; * = significant at $P \leq 0.05$

smaller fruit than water only sprays. Oxidate/MilStop tank mixture sprays resulted in the smallest fruit. 'Nova' plots had higher marketable and unmarketable yields and larger fruit than 'Prelude' (data not shown). However, no differences were detected between cultivars with respect to fruit infected with *B. cinerea*.

In 2007, treatments did not influence marketable fruit weight or unmarketable yields (Table 3). The Captan and Elevate rotation resulted in the highest marketable yields. All remaining treatments, except the Oxidate/MilStop tank mixture, resulted in marketable yields not different from the water only sprays. MilStop/Oxidate tank mixture sprays resulted in marketable yields lower than from water only sprays, although similar in weight to those from plots sprayed with MilStop, lime sulfur, and the Shemer/MilStop tank mixture. MilStop and lime sulfur sprays resulted in more fruit infected with gray mold than the water only spray. Applications of Endorse, Phostrol and the tank mixtures of Oxidate/MilStop, Oxidate/Vigor Cal Phos and Shemer/MilStop resulted in a similar percentage of fruit infected with gray mold which was not different than the water only spray. Applying Captan and Elevate in rotation resulted in fewer fruit infected with gray mold compared to the water only spray, although similar to plots sprayed with Endorse. 'Nova' plots had larger marketable yields than 'Prelude' (data not shown). 'Prelude' plots had more fruit infected with gray mold than 'Nova.' However, no differences appeared between cultivars regarding marketable fruit weight and unmarketable yields. In 2006, applying Captan and Elevate in rotation resulted in the largest fruit and, in 2007, the highest yields. Captan and Elevate applications in rotation also resulted in the fewest fruit affected with gray mold in 2007. There were similar trends (P=0.0774) in 2006. None of the remaining treatments resulted in increased yields or decreased gray mold incidence over the water only sprays.

The application of the Oxidate/MilStop tank mixture resulted in the smallest fruit in 2006. In 2007 fruit weight was not affected by treatment; however, the application of the Oxidate/MilStop tank mixture also resulted in the lowest marketable yields in 2007. Oxidate and MilStop as a tank mixture does not appear to have been tested previously. However, applying Oxidate alone, using similar timings and rates, resulted in marketable yields of strawberries and gray mold incidence that were not different than an untreated control (6). In another study, the application of Kaligreen (same a.i. as MilStop), did not deter gray mold infection in strawberries when compared to an untreated control (11). In this study, the combination of Oxidate and MilStop resulted in reduced marketable yields in 2007 and fruit size in 2006 compared to the water only sprays. The application of MilStop alone was also ineffective, resulting in yields and fruit size similar to or smaller than the water only sprays.

Applying Captan and Elevate in rotation was the most effective treatment for plant productivity and managing gray mold. The application of the alternative gray mold products provided no yield benefit or control of gray mold.

Postharvest Disease Incidence

Predominant identifiable postharvest diseases were gray mold, blue mold (caused by *Penicillium expansum*) and rhizopus rot (caused by *Rhizopus stolonifer*). All other diseases observed were unidentifiable. All fruit were generally diseased by four days after harvest. Data from each cultivar were analyzed separately because of different fruiting and chemical control spray schedules. In general very few differences among treatments were observed; therefore, only data corresponding to the 7 July 2006 'Nova' and 25 June 2007 'Prelude' harvests are presented.

Disease incidence was not different regardless of treatment on 'Nova' fruit on the second and third days after the 7 July 2006 harvest (Table 4). One day after harvest, fruit sprayed with Captan and Elevate in rotation, Endorse or Phostrol displayed no disease symptoms. The remaining treatments resulted in disease incidence similar to the water only sprays. Four days after harvest, the application of Endorse resulted in more dis-

Table 4. Postharvest infection of *Rubus ideaus* fruit treated with alternative options for managing gray mold (caused by *Botrytis cinerea*); 2006.

Treatment	Days after harvest[w]				Pathogen identification on Sept. 1			
	1	2	3	4	*Botrytis cinerea*	*Penicillium expansum*	*Rhizopus stolonifer*	Unidentifiable
	No. of infected fruit[x]							
Water only spray (control)	1.8 a[y]	1.5	9.3	0.5 b	9.8	0.3	0.0	12.8
Captan and Elevate rotation (control)	0.0 b	3.3	8.5	1.0 b	7.5	0.8	3.0	10.3
Endorse	0.0 b	1.5	7.5	4.0 a	12.0	0.0	0.0	12.5
Lime Sulfur	1.8 ab	3.0	7.8	0.5 b	10.0	0.3	0.3	12.5
MilStop	1.5 ab	4.0	7.3	0.3 b	11.0	0.0	0.5	12.5
Oxidate and MilStop	1.0 ab	5.8	5.8	0.5 b	7.5	0.0	0.3	12.8
Oxidate and Vigor Cal Phos	1.3 ab	3.3	8.3	0.3 b	11.0	0.0	0.0	12.5
Phostrol	0.0 b	1.0	12.0	0.3 b	11.0	0.0	0.0	11.7
Significance[z]	*	NS	NS	*	NS	NS	NS	NS

[w]newly infected fruit each day after harvest
[x]Mean infection of 13 ripe fruit and four replications
[y]Letters indicate significant differences within a column
[z]NS = not significant; * = significant at P≤0.05

Table 5. Postharvest infection of *Rubus ideaus* fruit treated with alternative options for managing gray mold (caused by *Botrytis cinerea*); 2007.

	Days after harvest[w]				Pathogen identification on Aug. 7			
	1	2	3	4	*Botrytis cinerea*	*Penicillium expansum*	*Rhizopus stolonifer*	Unidentifiable
Treatment	No. of infected fruit[x]							
Water only spray (control)	2.00	4.5	6.5	3.0	4.8	0.00	0.3 b[y]	15.8
Captan and Elevate Rotation (control)	0.00	3.5	6.5	6.0	3.0	0.50	0.0 b	16.0
Endorse	0.75	4.5	4.8	6.0	4.3	1.30	0.3 b	16.0
Lime Sulfur	2.50	4.0	8.0	1.5	4.8	0.50	0.0 b	15.8
MilStop	2.50	7.0	3.5	3.0	5.3	0.25	0.0 b	16.0
Oxidate and MilStop	1.80	6.5	5.8	2.0	4.3	0.25	0.0 b	16.0
Oxidate and Vigor Cal Phos	2.30	3.3	6.0	4.5	3.0	0.50	0.8 a	15.8
Phostrol	2.50	3.8	7.3	2.5	5.5	0.50	0.0 b	16.0
Shemer and MilStop	2.00	3.5	8.0	2.5	3.8	0.25	0.0 b	16.0
Significance[z]	NS	NS	NS	NS	NS	NS	*	NS

[w]newly infected fruit each day after harvest
[x]Mean infection of 13 ripe fruit and four replications
[y]Letters indicate significant differences within a column
[z]NS = not significant; * = significant at $P \leq 0.05$

eased fruit compared to all other treatments. Upon disease identification on 1 Sept., no differences were observed among treatments for the incidence of gray mold, blue mold, rhizopus rot or unidentifiable diseases.

Disease incidence of 'Prelude' fruit was not different, regardless of treatment after the 25 June 2007 harvest (Table 5). Upon disease identification on 7 Aug., no differences among treatments were observed regarding incidence of gray mold, blue mold or unidentifiable diseases. Applying the Oxidate/Vigor Cal Phos tank mixture resulted in a slightly higher disease incidence of rhizopus rot compared to all other treatments.

Generally none of the treatments were more effective for managing post harvest incidence of gray mold than the water only spray. Postharvest evaluation protocols were designed to favor gray mold development. *Botrytis cinerea* infection occurs prevalently when temperatures of 15 to 25 °C are maintained (14) and the postharvest storage temperatures used were within this range. Also, high relative humidity was maintained because *B. cinerea* development favors levels around 94 percent (4). Rapid colonization of the fruit and evaluations occurring only once daily may have caused some differences between treatments to be missed. In future postharvest studies on gray mold, protocols extending the infection period or increasing the number of daily observations are suggested.

The application of the standard rotation of Captan and Elevate in rotation generally resulted in larger yields and the fewest unmarketable fruit due to gray mold. None of the alternative treatments generally managed gray mold more effectively than using Captan and Elevate in rotation or the water only spray. Environmental conditions in the field can change rapidly. As the season progressed, temperatures and humidity levels fluctuated and thus disease inoculum likely varied. Applications of alternative controls in tank mixtures and/or combined with cultural controls may act in synergy and are offered as an area for future research.

Literature Cited

1. AMS-USDA. 2002. The National Organic Program.http://www.ams.usda.gov/nop/indexIE.htm <Accessed 1 Dec. 2007>
2. Demchak, K. (Coordinator). 2006. The Mid-Atlantic Berry Guide for Commercial Growers.

The Pennsylvania State University. College of Agriculture. University Park, PA. Cooperative Extension Publication AGRS-97.
3. Demchak, K., J.K. Harper and L.F. Kime. 2005. Agricultural alternatives: red raspberry production. Penn State Cooperative Extension Publication CAT UA431.
4. Ellis, M. A., R. H. Converse, R. N. Williams and B. Williamson (Editors). 1991. Compendium of Raspberry and Blackberry Disease and Insects. APS Press, St. Paul, MN.
5. Hagan, A. K. 2004. Effect of application rate and spray interval on the control of powdery mildew by and phytotoxicity of MilStop on bigleaf hydrangea, 2003. Fungicide and Nematicide Tests 59:OT036.
6. Louws, F. J. and J. G. Driver. 2004. Evaluation of fungicides for anthracnose fruit rot and gray mold management, 2003. Fungicide and Nematicide Tests 59:SMF048.
7. Mitkowski, N. A., K. Jordan and B. Boesch. 2005. Preventative fungicide applications for the control of gray snow mold on Creeping Bentgrass, 2003-2004. Fungicide and Nematicide Tests 60:T030.
8. Rosslenbroich, H. J. and D. Stuebler. 2000. *Botrytis cinerea* – History of chemical control and novel fungicides for its management. Crop Protection 19:557-561.
9. Schilder, A. M. C., J. M. Gillet and R.W. Sysak. 2006a. Evaluation of fungicides for control of anthracnose fruit rot in 'Jersey' blueberries, 2005. Fungicide and Nematicide Tests 61:SMF025.
10. Schilder, A.M.C., J. M. Gillet and R. W. Sysak. 2006b. Evaluation of fungicides for control of mummy berry in blueberries, 2005. Fungicide and Nematicide Tests 61:SMF024.
11. Turechek, W. W. and M. C. Heidenreich. 2005. Evaluation of fungicides for control of botrytis and anthracnose fruit rots on strawberry, 2004. Fungicide and Nematicide Tests 60:SMF021.
12. Walter, M., K. S. H. Boyd-Wilson, J. Stanley, P. Harris-Virgin, C. Morgan and N. B. Pyke. 1997. Epidemiology of *Botrytis cinerea* in boysenberry (*Rubus* spp.). N.Z. Plant Prot. 50:93-100.
13. Webster, B. J. and M. K. Hausbeck. 2005. Evaluation of reduced risk fungicides and biopesticides for control of Botrytis blight of geranium, 2004. Fungicide and Nematicide Tests 60:OT009.
14. Wilcox, W. F., R. C. Seem and M. P. Pritts. 1994. Influence of cultural practices on development of strawberry gray mold. Phytopathology 84:1376.

Properties of Regional Portuguese Apple Cultivars Produced in Conventional and Organic Modes

The physical and chemical attributes of seven regional Portuguese apple cultivars, produced using either conventional or biological methods, were examined. The chemical properties: moisture content, total and reducing sugars, protein, and ash were influenced in different ways depending on the cultivar. For textural properties, the cultivar 'Lila' was the most similar one under the two production systems. The production method did not significantly impact on dietary fiber content. There was no consistent pattern amongst cultivars within the results and overall the differences were small between the two production methods. Paraphrased from R.P.F. Guiné et al., 2010. International Journal of Fruit Science 10(4): 416-424.