Management of Sour Rot and Volatile Acidity in Grapes

Ontario Grape and Wine Research Incorporated, Project # 000400

Pillar 1

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Executive Summary

Trials were conducted in two commercial vineyards to evaluate the efficacy of different control strategies including loosening clusters, improving resistance to splitting and reducing the pathogen population on the surface of fruit. The effects of environmental conditions (temperature and rainfall) and fruit maturity on sour rot development were explored in the vineyard and under lab conditions.

Detailed description of the Project:

Objectives and Project Input

1. Assess effectiveness of cultural and chemical treatments to reduce cluster tightness, thereby reducing physical injury during berry swelling which acts as an entry point for bunch rotting organisms
2. Assess effectiveness and optimum timing of chemical treatments in reducing the development of sour rot and Botrytis bunch rot and elevated volatile acidity
3. Relate leaf removal timing and severity of sour rot and Botrytis bunch rot.

All treatments were replicated 4 times at each site in a randomized complete block design. Maintenance fungicides and insecticides were applied by the cooperator as required. Spray treatments were applied to the fruiting zone using a CO_2 backpack sprayer at 600 L/ha. At commercial maturity (Sept 18), we collected 25 arbitrarily selected clusters per plot, rated each for severity of sour rot and Botrytis bunch rot. The weight, soluble solids (Brix), pH, and volatile acidity from the bulked sample per rep were determined.

1. Reducing cluster tightness to reduce sour rot

One of the ways to reduce sour rot is to loosen the cluster so that berries do not push against each other causing splitting.

In **prebloom leaf removal plots**, the basal 6 leaves were removed by hand from fruitful shoots before first capfall (June 11 in Pinot noir and June 7 in Riesling).

Desikote anti-transpirant was applied to the basal 6 leaves before first capfall (June 11 in Pinot noir and June 7 in Riesling). This treatment prevents photosynthesis from occurring in the leaves to simulate the effect of leaf removal.

Gibberellic acid (GA) was applied at 3 different rates (5, 10 and 20 ppm) at 80% bloom (June 12 in Pinot noir and June 11 in Riesling). Additional treatments of GA at the 3 concentrations received **fruit set leaf removal** as described below in the Riesling block.

Prohexidione-Ca was applied at low (45 g a.i./ha), medium (90 g a.i./ha) and high (180 g a.i./ha) rates at 80% bloom (June 12 in Pinot noir and June 11 in Riesling).

In the **fruitset leaf removal** plots, the basal 6 leaves were removed by hand from fruitful shoots at fruit set (June 21 in Pinot noir and June 20 in Riesling).

In the remaining plots, leaf removal was done in the fruiting zone at pea-size berry stage (July 6 in Pinot noir and June 29-July 3 in Riesling). The severity of leaf removal in these plots was not as extensive as that done at prebloom or fruit set.

Pinot noir with 8 basal leaves removed immediate prebloom (June 11)

Riesling with 8 basal leaves removed immediate prebloom (June 7, 2012)

It rained after the application of two treatments in the Pinot noir block so the pea-size leaf removal plot was substituted for one of the Prohexidione-Ca treatments so there was no pea size leaf removal treatment. Since growers commonly start leaf removal at fruit set in order to complete the process by pea size berry, fruit set leaf removal treatment became the commercial standard for harvest assessments.

At cluster closure (July 12 in Pinot noir and July 19 in Riesling), we collected 10 clusters from each treatment plot. We rated each cluster for looseness, using a 1-6 scale (as reported previously with 1 being extremely tight and 6 being very loose, optimum 3-4) and counted the number of berries on the main rachis and shoulder. We weighed berries from the rachis and measured the length of the rachis. From this information, we determined the average number of berries per cm of rachis and the average weight of berries per cm of rachis as additional measures of cluster architecture.

2. Treatments to reduce the population of sour rot-causing organisms and VA

Several treatments were tested for their ability to reduce sour rot-causing organisms in 2012. All treatments were applied to the fruiting zone at 600 L/ha. Treatment dates for Pinot noir were Aug. 9 (50% veraison), Aug 23 (4 wk pre-harvest), Sept. 5 (2 wk preharvest), Sept. 12 (1 wk preharvest), Sept 16 (3 days preharvest). Treatment dates for Riesling were Aug 13 (50% veraison), Aug 29 (4 wk preharvest), Sept 7 (3 wk preharvest), Sept 15 (2 wk preharvest), Sept 22 (1 wk preharvest), Sept 27 (3 days preharvest).

BlightBan A506, a biocontrol product, was applied to both Pinot noir and Riesling plots at the timings above. This product has given good control of sour rot in previous years. In 2012, it was pre-weighed from a 3-year old bag and stored at room temperature, while in previous years it was kept refrigerated until the day of application.

In Riesling plots, 5 applications of Milstop (potassium bicarbonate) alone or in combination with

For the past 3 years we've been trying to identify the optimum rate and timing of potassium metabisulphite (KMS). Previous years' studies indicated that 2.5 kg KMS/1000 L was not effective. Rates of 5, 10 and 20 kg KMS/1000 L (20 kg only at the Riesling site) were applied starting at 50% veraison and applied for the remainder of the season at the timings listed above.

In order to determine the optimum timing for KMS treatments spray treatments of KMS at 5 kg/1000 L were started progressively closer to harvest. The following table shows the timing of applications:

Timing study for KMS in Riesling, 2012

# KMS applications	Aug 13 50% veraison	Aug 29 (4 wk PHI)	Sept 7 (3 wk PHI)	Sept 15 (2 wk PHI)	Sept 22 (7 d PHI)	Sept 27 (3 d PHI)
5	x	x	x	x	x	
4		x	x	x	x	
3			x	x	x	
2				x	x	
1						x

BlightBan A506, MilStop (alone and in combination with 5 or 10 kg KMS) were applied at both vineyards. Sanidate and Regalia Maxx were also applied at these timings at the Riesling vineyard.

Other products tested for activity against sour rot and Botrytis bunch rot, 2012

	Active ingredient	Rate/600 L in fruiting zone	Mode of action
Milstop	Potassium bicarbonate	5.6 kg	Desiccates surface organisms
Milstop + KMS		5.6 kg + 3 kg	
Sanidate	Dihydrogen peroxide	6 L	Disinfectant
BlightBan A506	*Pseudomonas fluorescens*	370.7 g	Biological Control
Regalia Maxx	Extract from *Reynoutria sachalinensis*	1.25 L	Plant health promoter

3. Treatments to reduce berry splitting

Calcium was applied as **InCa** at 1.5 L/600 at fruit set (June 21 in Pinot noir and June 20 in Riesling), pea size berry (July 5 In Pinot noir and July 4 in Riesling) and berry touch (July 18 In Pinot noir and July 18 in Riesling) and veraison (Aug 1 in Pinot noir and Aug 13 in Riesling). In an additional treatment, f**ruitset leaf removal** was combined with Inca sprays at both sites as well.

Raingard, a non-ionic sticker spreader, and **Desikote**, an anti-transpirant, were applied weekly in the fruiting zone for 4 weeks starting 4 weeks pre-harvest in the Riesling plots.

In a preliminary investigation of the effect of crop load on sour rot development, crop load was adjusted to **1 cluster per shoot** in the Riesling plots at veraison (Aug 14). The rest of the plots retained an average of 2 clusters per shoot.

4. Determine organisms causing sour rot and effects of environment on development of sour rot.

Tracking microbial population on berries
Fruit was sampled from untreated plots between veraison and harvest from the Pinot noir and Riesling vineyards used in the previous sections. Five clusters were collected from 4 replicated plots which were used throughout the sampling period. From each cluster, 50 berries were washed and the rinsate onto media selective for bacteria or yeast. Colonies were counted after 5 days of growth. The relative frequency of each type of microbial colony was calculated.

Temperature Pathogenicity Assay
The purpose of this experiment was to determine the effect of temperature on infection and development and severity of sour rot symptoms. Five injured Thompson seedless grapes for each type of inoculum: Acetic Acid Bacteria (AAB), *Hanseniaspora*, and the complex of both. Inoculated berries were incubated at 6-10ºC, 10-15ººC, 15-20ºC or 20-25ºC. Visual symptoms of sour rot were assessed each day for a 7-day period using a rating scale of 0-4 (0=0% infected, 1=<10% infected, 2= 10-25% infected, 3=25-75% infected, 4=>75% infected). The treatments were replicated 3 times.

Sour rot Development under Vineyard Conditions

Temperature and rainfall were monitored throughout the growing season in the Pinot noir and Riesling vineyards where trials were conducted. Fruit maturity (Brix) and sour rot severity were monitored weekly.

Results

1. Reducing cluster tightness to reduce sour rot

Pinot noir
As measured at **bunch close**, all of the treatments reduced the number of berries per cluster. Prebloom leaf removal reduced berry set more than the GA treatments. The greatest reduction in berry set occurred with Prohexidione-Ca applied at 90 g a.i/ha. The two higher rates of Prohexidione-Ca also doubled or tripled the proportion of small berries per cluster. None of the treatments increased cluster length. The reduced number of berries set resulted in lower cluster weights in all but the GA treatments with the greatest reduction in cluster weight as well as berries per cm rachis and cluster looseness from Prohexidione-Ca at 90 and 180 g a.i./ha. In an oversight, no data were collected at bunch close for Desikote foliar treatments.

Effect of early season treatments on total number of berries per cluster, percentage of small berries, cluster weight, rachis length and berries/cm rachis at bunch close, Pinot noir, 2012

	Mean Total Berries per Cluster [% decrease]	Mean % Small Berries [% increase]	Mean Berry Wt/Cluster g [% decrease]	Mean Rachis Length (cm)	Mean Full size Berries/ cm Rachis [% decrease]	Mean Cluster Looseness [% increase]
Pea size berry leaf removal	72.2	5.9	27.75	5.59	12.6	4.0
Fruit set leaf removal	68.1 [6]	4.5	26.45 [5]	5.24	12.4 [2]	4.0
Prebloom leaf removal	65.7 [9]	5.7	24.37 [12]	5.12	12.3 [2]	3.8
GA 5 ppm	67.9 [6]	5.8	29.36	5.17	12.7	4.0
GA 10 ppm	68.3 [5]	4.2	30.82	5.35	12.4 [2]	4.1 [3]
GA 20 ppm	67.4 [7]	8.3	29.84	5.87	10.4 [18]	4.2 [5]
Prohexidione-Ca 45 g a.i./ha	66 [9]	7.6	26.92 [3]	5.43	11.5 [9]	3.8
Prohexidione-Ca 90 g a.i./ha	59.5 [18]	11.9 [101.7]	19.47 [30]	5.18	10.6 [16]	4.8 [20]
Prohexidione-Ca 180 g a.i./ha	65.6 [9]	19.6 [232]	18.8 [32]	5.53	9.8 [22]	4.4 [10]

All treatments except Desikote foliar application at bloom reduced the severity of sour rot and all treatments reduced the severity of Botrytis rot at harvest. While the VA was below the threshold of 0.2 g/L in the commercial standard (fruit set leaf removal), all treatments except Desikote foliar and Prohexidione-Ca at the high rate reduced VA compared to fruit set leaf removal, despite the fact that Prohexidione-Ca at the high rate loosened clusters the most. Cluster size was reduced the most by GA at 20 ppm and Prohexidione-Ca at 90 g. Brix was highest in Desikote foliar prebloom, all of the Prohexidione-Ca rates and heavy fruit set treatments.

Effect of early season treatments on Sour rot and Botrytis rot severity, Volatile acidity, Cluster weight and Brix, Pinot noir, 2012

	Mean Sour rot Severity % [% control]	Mean Botrytis Rot Severity % [% control]	Mean Volatile Acidity g acetic acid/L [% decrease]	Cluster Looseness [% increase]	Mean Cluster Weight (g) [% decrease]	Mean Brix
Fruit set leaf removal	3.6	4.9	0.15	2.3	106.46	21.78
Pre-bloom leaf removal	1.1 [69]	1.1 [77]	0.09 [40]	2.2	98.34 [8]	21.48
Desikote foliar prebloom	4.1	3.6 [26]	0.19	2.1	118.26	22.05
GA 5 ppm	1.0 [72]	1.9 [61]	0.08 [49]	2.5 [7]	112.65	20.95
GA 10 ppm	0.8 [78]	2.7 [44]	0.06 [61]	2.5 [10]	112.25	22.10
GA, 20 ppm	1.4 [61]	1.3 [72]	0.06 [60]	2.7 [19]	56.91 [47]	21.73
Prohexidione-Ca 45 g a.i./ha	1.1 [69]	1.2 [59]	0.05 [68]	2.5 [10]	81.56 [23]	22.00
Prohexidione-Ca 90 g a.i./ha	0.8 [78]	1.7 [66]	0.03 [78]	2.7 [20]	57.04 [46]	22.30
Prohexidione-Ca 180 g a.i./ha	1.8 [50]	2.4 [51]	0.19	2.9 [27]	75.29 [29]	22.63
Heavy Fruit set leaf removal	0.7 [81]	1.1 [77]	0.05 [66]	2.7 [18]	93.35 [12]	22.48

Riesling

All treatments reduced the number of berries per cluster at bunch close. The effect of fruit set leaf removal on berry set was negligible. Combining GA sprays with fruit set leaf removal did not increase the effectiveness compared to GA sprays alone for the lower rates of GA but increased the effect at the high rate of GA. The proportion of small berries was highest in the GA treatments. All treatments reduced the weight of berries with prebloom leaf removal, and the 3 rates of GA and Prohexidione-Ca having the most effect. The number of berries per cm rachis was reduced by all treatments except Desikote foliar with GA having the most effect. This was reflected in higher cluster looseness ratings in these plots as well. Prohexdione-Ca at 45 and 180 g a.i./ha also looser clusters.

Effect of early season treatments on total number of berries per cluster, percentage of small berries, cluster weight, rachis length and berries/cm rachis at bunch close, Riesling, 2012

	Mean Total Berries per Cluster [% decrease]	Mean % Small Berries [% increase]	Mean Berry Wt/Cluster g [% decrease]	Mean Rachis Length (cm)	Mean Full size Berries/ cm Rachis [% decrease]	Mean Cluster Looseness [% increase]
Pea size berry leaf removal	93.5	31.3	36.25	6.14	10.4	3.7
Prebloom leaf removal (May 28)	75.2 [20]	31.6 [1]	30.22 [17]	5.80	9.0 [14]	4.3 [16]
Prebloom leaf removal (Jun 6)	73.4 [22]	31.9 [2]	27.05 [25]	5.38	9.3 [11]	4.1 [11]
Desikote foliar prebloom	87.3 [7]	32.1 [3]	33.22 [8]	5.67	10.5	4.1 [11]
GA 5 ppm	83.2 [11]	49.0 [57]	24.29 [33]	5.68	7.5 [28]	4.9 [32]
GA 10 ppm	88.9 [5]	52.6 [68]	26.44 [27]	5.74	7.4 [29]	4.5 [22]
GA 20 ppm	86.7 [7]	57.2 [83]	21.68 [40]	5.76	6.4 [39]	5.2 [41]
Fruit set leaf removal	92.0 [2]	31.8 [2]	34.65 [4]	6.30	9.9 [5]	4.1 [11]
GA 5 ppm + fruit set leaf removal	80.6 [14]	44.0 [41]	23.83 [34]	5.56	8.0 [23]	4.8 [30]
GA 10 ppm + fruit set leaf removal	89.0 [5]	50.7 [62]	27.00 [26]	6.28	7.0 [33]	4.8 [30]
GA 20 pppm + fruit set leaf removal	78.4 [16]	42.5 [36]	26.84 [26]	5.16	8.4 [19]	4.1 [11]
Prohexidione-Ca 45 g a.i./ha	75.9 [19]	31.3	26.19 [28]	5.53	9.3 [11]	4.6 [24]
Prohexidione-Ca 90 g a.i./ha	79.8 [15]	31.3	25.53 [30]	5.71	9.7 [7]	4.4 [19]
Prohexidione-Ca 180 g a.i./ha	80.7 [14]	34.3 [10]	22.95 [37]	5.83	9.2 [12]	4.7 [27]

Desikote applied to foliage at prebloom, all 3 rates of GA and the three rates of Prohexidione-Ca reduced the severity of sour rot and Botrytis bunch rot. While prebloom leaf removal did not reduce sour rot, it did reduce the severity of Botrytis. The treatments that reduced sour rot also reduced VA, with the exception of Desikote prebloom foliar. Only clusters treated with GA were looser than the pea sized berry leaf removal commercial standard. Cluster weights were reduced in both prebloom leaf removal dates and the 3 rates of GA with Prohexidione-Ca at 90 and 180 g being less effective. All treatments except fruit set leaf removal increased Brix with the highest Brix in GA at 20 ppm and Prohexidione-Ca at 90 and 180 g.

Effect of early season treatments on Sour rot and Botrytis rot severity, Volatile acidity, Cluster weight and Brix, Riesling, 2012

	Mean Sour rot Severity % [% control]	Mean Botrytis Rot Severity % (% control)	Mean Volatile Acidity g acetic acid/L (% decrease)	Cluster Looseness (% increase)	Mean Cluster Weight (g) (% decrease)	Mean Brix
Pea sized berry leaf removal	17.5	9.0	0.32	3.4	117.55	18.8
Fruit set leaf removal	16.4 [6]	6.9 [23]	0.22	3.0	99.19 [16]	18.6
Prebloom leaf removal (May 28)	18.4	6.7 [26]	0.29	2.6	115.61 [20]	19.8
Prebloom leaf removal (Jun 6)	17.2 [2]	6.8 [24]	0.20	3.0	92.58 [21]	19.8
Desikote foliar prebloom	6.2 [64]	4.3 [52]	0.18	2.2	125.20	19.5
GA 5 ppm	7.1 [60]	4.4 [51]	0.09	3.6 [6]	96.26 [18]	19.9
GA 10 ppm	5.0 [71]	2.6 [71]	0.11	3.6 [5]	91.92 [22]	19.9
GA 20 ppm	4.8 [73]	2.0 [77]	0.08	4.1 [19]	83.59 [29]	20.6
Prohexidione-Ca 45 g a.i./ha	4.0 [77]	3.3 [63]	0.10	3.1	123.25	19.5
Prohexidione-Ca 90 g a.i./ha	7.9 [55]	5.1 [43]	0.14	3.1	107.24 [9]	20.7
Prohexidione-Ca 180 g a.i./ha	4.5 [74]	4.3 [51]	0.08	3.2	108.08 [8]	21.1

2. Treatments to reduce the population of sour rot-causing organisms and VA

Pinot noir

KMS applied at 5 or 10 kg/1000 L, Milstop and BlightBan reduced the severity sour rot. KMS at 10 kg/1000 L, Milstop and BlightBan reduced Botrytis bunch rot severity. The combination of Milstop with KMS at 5 kg/1000 L improved control compared to KMS alone but was not as effective as MilStop alone. KMS at 10 kg/1000 L plus Milstop provided the best control of Botrytis. None of the treatments reduced VA compared to fruit set leaf removal nor was there any consistent effect on Brix. All treatments had higher cluster weight than fruit set leaf removal.

Effect of post-veraison treatments compared to the commercial standard (fruit set leaf removal) in Pinot noir at harvest, 2012

	Mean Sour rot Severity % [% control]	Mean Botrytis Rot Severity % [% control]	Mean Volatile Acidity g acetic acid/L	Cluster weight	Brix
Fruit set leaf removal	3.6	4.9	0.15	106.46	21.8
KMS 5 kg	2.8 [22]	4.9	0.23	110.61	22.0
KMS 10 kg	2.4 [33]	2.7 [45]	0.14	116.85	20.5
Milstop	2.9 [19]	1.0 [80]	0.12	106.48	21.4
KMS 5 kg + Milstop	6.0	1.6 [67]	0.22	118.66	15.6
KMS 10 kg + Milstop	5.3	0.8 [84]	0.16	105.37	21.6
BlightBan	3.1 [14]	4.4 [10]	0.19	118.21	21.4

With a 3 day preharvest interval, the free and total SO2 levels in juice were well below what would routinely be added to juice in the winery (20-50 mg/L).

Residual SO_2 in juice with 3 day pre-harvest interval, Pinot noir, 2012

	Free S02 (mg/L)	Total SO2 (mg/L)
Fruit set leaf removal	0.000	0.100
KMS 5 kg	0.000	0.600
KMS 10 kg	0.180	0.320
KMS 5 kg + Milstop	0.000	0.483
KMS 10 kg + Milstop	0.000	0.780

Riesling
All treatments reduced the severity of sour rot and Botrytis rot. The most effective treatments for sour rot were KMS 10 kg/1000 L, Sanidate and thinning fruit to 1 cluster per shoot. The most effective treatments for Botrytis rot were MilStop (with or without KMS), Regalia Maxx, Desikote fruit spray and Sanidate. All of the treatments except Raingard and Desikote reduced VA below 0.2 g acetic acid/L. The most effective treatments for reducing VA were KMS at 10 and 20 kg/1000 L, Sanidate and thinning to 1 cluster per shoot, the latter having the greatest effect on VA. The lowest cluster weights were in KMS20 kg/1000 L and BlightBan. Brix was 0.3 to 1.0º higher in all treatments than in the peasized leaf removal standard. The highest Brix was in plots thinned to 1 cluster per shoot.

Effect of post-veraison treatments compared to the commercial standard (pea-sized berry leaf removal) in Riesling, 2012

	Mean Sour rot Severity % [% control]	Mean Botrytis Rot Severity % [% control]	Mean Volatile Acidity g acetic acid/L	Cluster weight	Brix
Pea-sized berry leaf removal	17.5	9.0	0.32	117.55	18.8
KMS 5 kg	7.7 [56]	4.5 [50]	0.18	135.92	19.2
KMS 10 kg	4.5 [74]	4.2 [53]	0.10	132.12	19.1
KMS 20 kg	12.4 [29]	7.2 [20]	0.13	109.68	19.7
Milstop	9.1 [48]	1.1 [88]	0.17	133.30	19.8
KMS 5 kg + Milstop	9.0 [49]	1.3 [86]	0.16	129.05	19.5
KMS 10 kg + Milstop	7.2 [59]	2.4 [73]	0.15	128.48	18.6
Regalia Maxx	7.9 [55]	2.7 [70]	0.23	146.90	19.2
BlightBan	10.1 [42]	4.8 [47]	0.19	109.88	19.4
Desikote veraison fruit	5.7 [67]	2.2 [76]	0.21	129.41	19.5
Raingard	10.4 [41]	4.7 [48]	0.24	150.23	19.5
Sanidate	4.1 [77]	1.9 [79]	0.12	126.14	19.3
1 cl/shoot	4.4 [75]	3.2 [64]	0.07	114.89	20.8

All treatments reduced sour rot severity as well as volatile acidity at harvest. The most effective treatments for sour rot were 5 kg/1000 L at 1 week and 3 days pre-harvest and 10 kg/1000 L applied 5 times.   These treatments also had the lowest VA. All treatments except 5 kg applied 1 week pre-harvest only and 10 kg applied at first appearance of sour rot.

Effect of timing and rate of KMS on sour rot and Botrytis severity and VA at harvest, Riesling, 2012

	Mean Sour rot Severity % [% control]	Mean Volatile Acidity g acetic acid/L	Cluster weight	Brix
Pea-sized berry leaf removal	17.5	0.32	117.5	18.8
KMS 5 kg	7.7 [56]	0.18	135.9	19.2
KMS 5 kg, after 1st Sour Rot	6.7 [62]	0.15	121.6	19.7
KMS 5 kg, 1 wk pre-harvest	11.3 [35]	0.25	127.4	19.2
KMS 5 kg, 3 days pre-harvest	8.3 [53]	0.19	131.7	20.0
KMS 5, 1wk and 3 days pre-harvest	4.1 [77]	0.11	131.6	19.1
KMS 10	4.5 [74]	0.10	132.1	19.1
KMS 10 1st SR	10.6 [39]	0.22	118.0	19.3
KMS 10 1 wk	7.5 [57]	0.13	142.4	19.9
KMS 10 1wk and 3d	5.9 [66]	0.17	155.44	19.5

With a 3 day pre-harvest interval, there was no free SO_2 detected and total SO_2 levels in juice were well below what would routinely be added to juice in the winery (20-50 mg/L).

Residual SO_2 in juice with 3 day pre-harvest interval and 1, 2 or 5 applications of KMS, Riesling, 2012

	Free SO_2 (mg/L)	Total SO_2 (mg/L)
Pea-size berry leaf removal	0	0.520
KMS 5	0	0.000
KMS 5 1st SR	0	0.380
KMS 5 1 wk	0	0.340
KMS 5 3 d	0	0.280
KMS 5 1 wk/3 d	0	0.540
KMS 10 6X	0	0.220
KMS 10 1st SR	0	0.620
KMS 10 1 wk	0	0.620
KMS 5 1 wk/3 d	0	0.540

3. Treatments to improve resistance to infection

Pinot noir
The combination of leaf removal at fruit set and 4 sprays of InCa reduced the severity of sour rot and Botrytis compared to fruit set leaf removal or 4 sprays of InCa with pea-size leaf removal. This treatment also resulted in higher Brix.

Effect of calcium (InCa) applications in combination with leaf removal at fruit set or pea-sized berry on Bunch rots, volatile acidity and Brix, Pinot noir, 2012

	Mean Sour rot Severity (%)	Mean Botrytis rot Severity (%)	Mean Volatile Acidity (g acetic acid/L)	Brix
Fruit set leaf removal	3.6	4.9	0.15	21.8
InCa pea-size leaf	3.3	3.6	0.11	20.7
Fruit set leaf removal + InCa	0.8	0.3	0.05	22.2

Riesling
Early leaf removal reduced the severity of sour rot and Botrytis bunch rot, with fruit set leaf removal having more effect on sour rot. For each leaf removal date, InCa reduced the severity of sour rot and Botrytis bunch rot compared to leaf removal alone. The effect was greater for sour rot (44-49% reduction) than for Botrytis (23-35% reduction). However, the reduction in disease was not reflected in reduced Volatile Acidity, nor was there any effect on Brix..

Effect of leaf removal timing and calcium (InCa) applications and Raingard surfactant on Bunch rots, Volatile acidity and Brix, Riesling, 2012

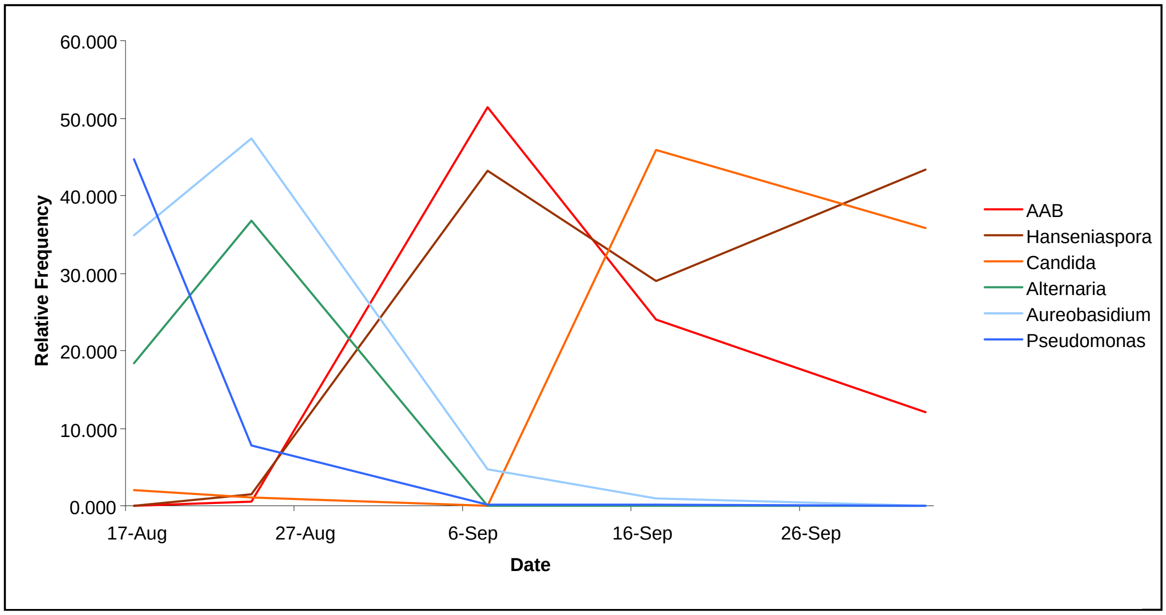
	Mean Sour rot Severity (%) [% control]*	Mean Botrytis rot Severity (%) [% control]*	Mean Volatile Acidity (g acetic acid/L)	Brix
Peasized berry leaf removal	17.5	8.9	0.23	19.5
InCa	9.5 [46]	4.5 [49]	0.23	19.5
Prebloom leaf removal	17.2 [2]	6.8 [24]	0.23	19.6
Prebloom leaf removal + InCa (4 apps)	9.7 [44]	6.2 [9]	0.23	19.5
Fruit set leaf removal	16.4 [6]	6.9 [23]	0.23	19.5
Fruit set leaf removal+ InCa (4 apps)	8.4 [49]	4.5 [35]	0.23	19.6
Raingard	10.4 [41]	4.7 [47]	0.23	19.5

*Values in [ ] for InCa treatments represent % reduction compared to leaf removal at that growth stage. Values in [ ] for leaf removal represent % reduction compared to pea-size berry leaf removal.

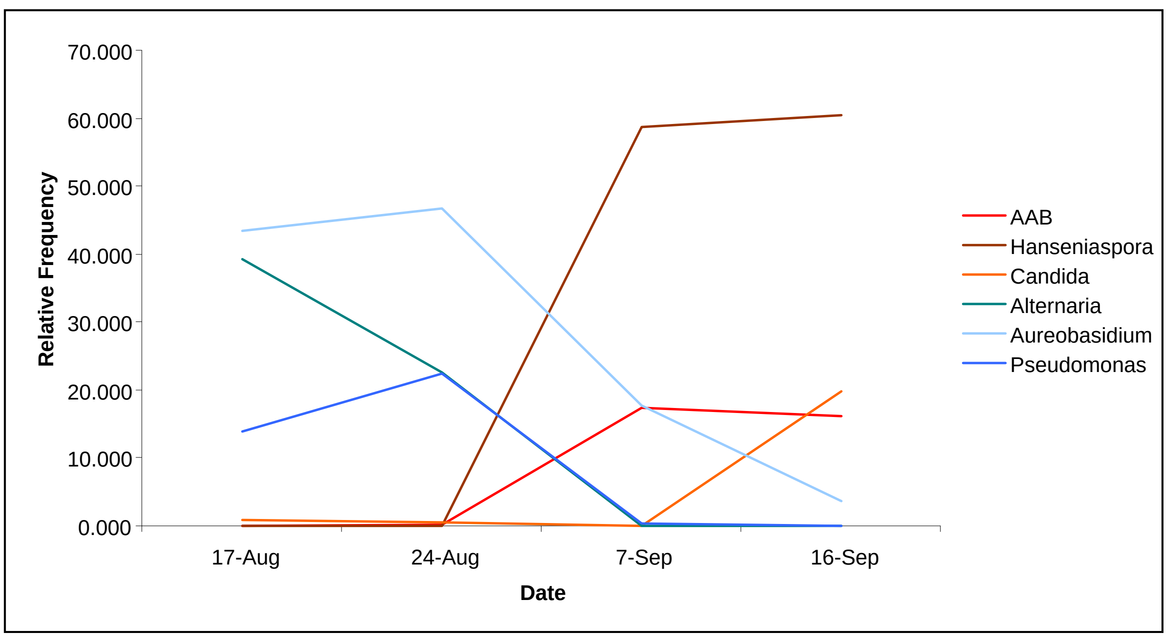
4. Determine organisms causing sour rot and effects of environment on development of sour rot.

Sour rot was first detected in Pinot Noir and Riesling grapes on September 7th, and this observation corresponds to a change in the microbial population of the grapes. Before the detection of sour rot, the population on grapes was dominated by epiphytic microbial species, particularly *Alternaria* fungi, *Aureobasidium* yeast and *Pseudomonas* bacteria. After sour rot symptoms started to develop, the population was dominated by microbial species shown to be associated with the disease in previous experiments and laboratory assays, particularly the acetic acid bacteria (AAB) *Gluconobacter* and *Acetobacter*, and the yeasts *Hanseniaspora* and *Candida*. *Candida* is usually associated with the sour rot complex in field populations yet it does not produce sour rot symptoms in laboratory assays

Relative frequency of microbes contributing to the population of grape surfaces, over time during the ripening of Pinot Noir, 2012.

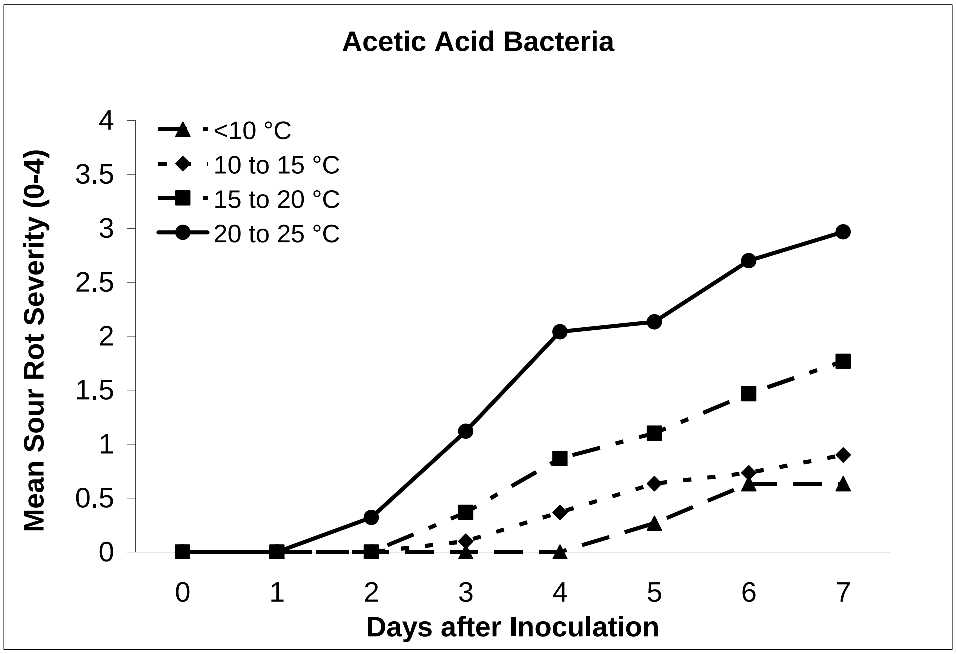


Relative frequency of microbes contributing to the population of grape surfaces, over time during the ripening of Riesling grapes.

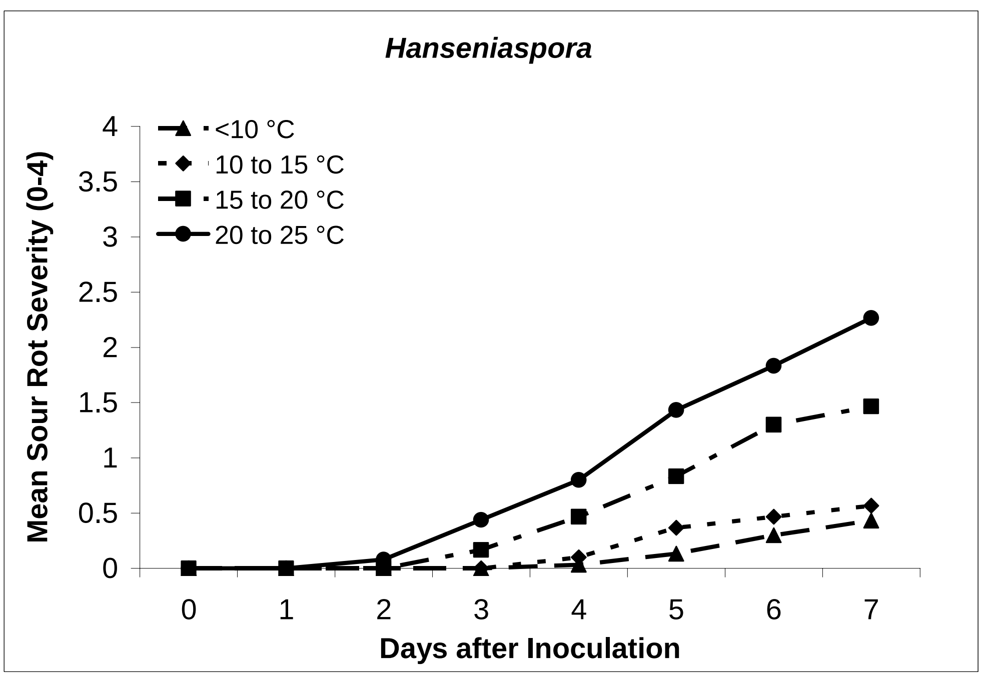


Temperature Pathogenicity Assay

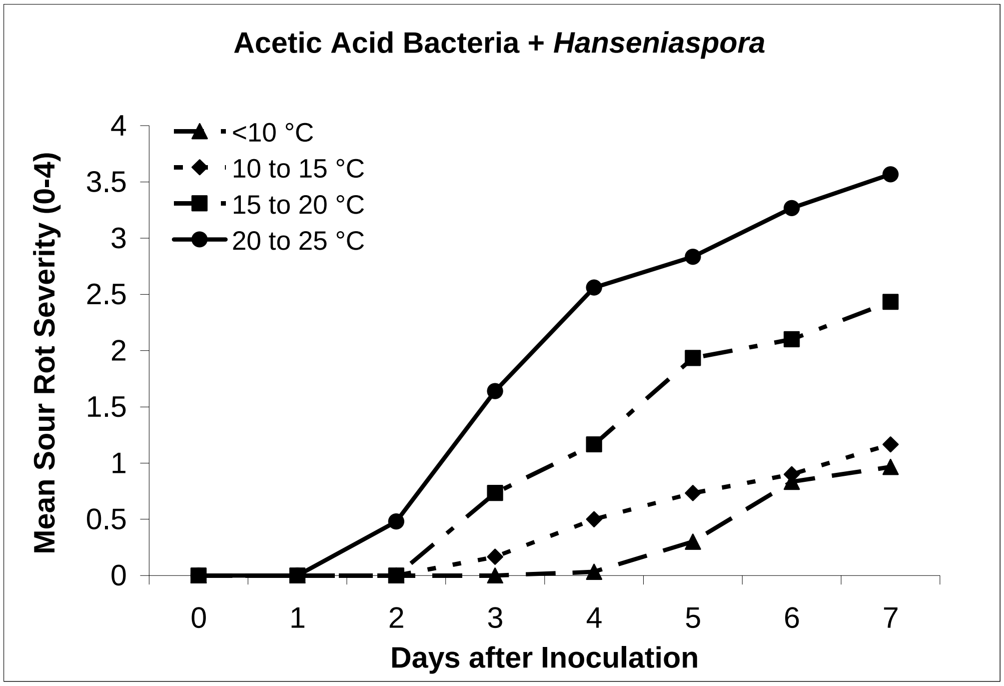
Acetic acid bacteria caused sour rot symptoms at temperatures as low as 10ºC. Disease development started as early as 2 days after inoculation at 20-25ºC and it was more severe at this temperature than the lower temperatures.



Hanseniaspora produced symptoms at the lowest temperature but symptoms did not develop until 4 days after inoculation. Disease development started first at 2 days after inoculation and developed most rapidly and resulted in the greatest disease severity at 20-25ºC.



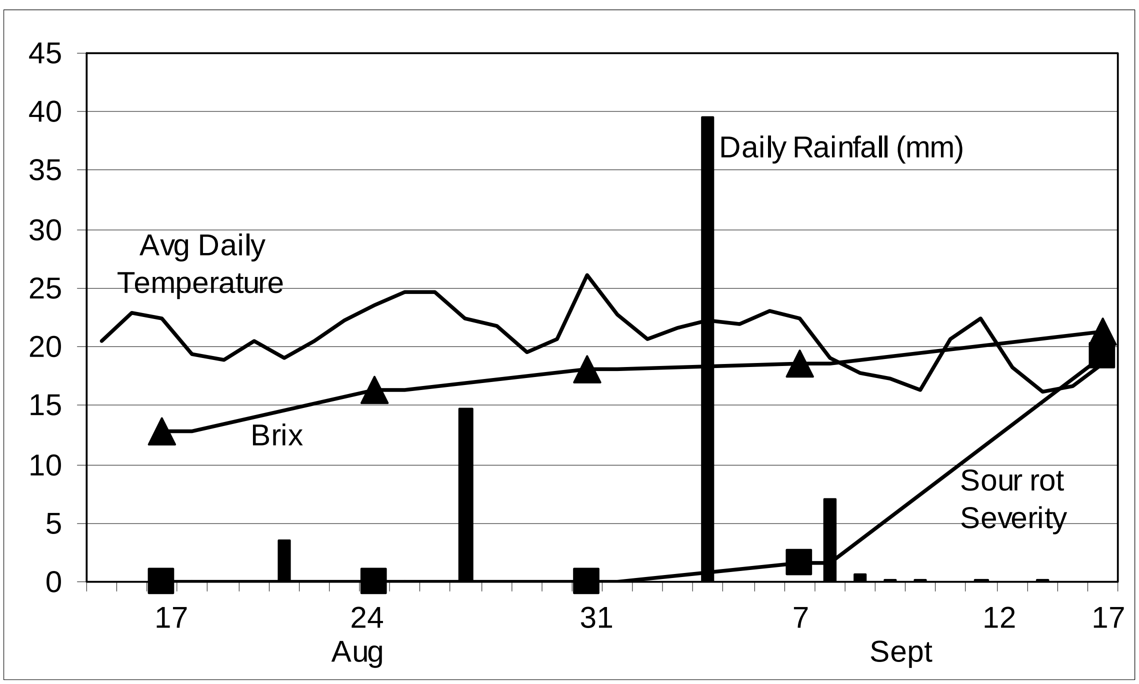
The combination of Acetic Acid Bacteria and *Hanseniaspora* resulted in faster, more severe development of sour rot symptoms than either organism alone.



Sour rot Development under Vineyard Conditions

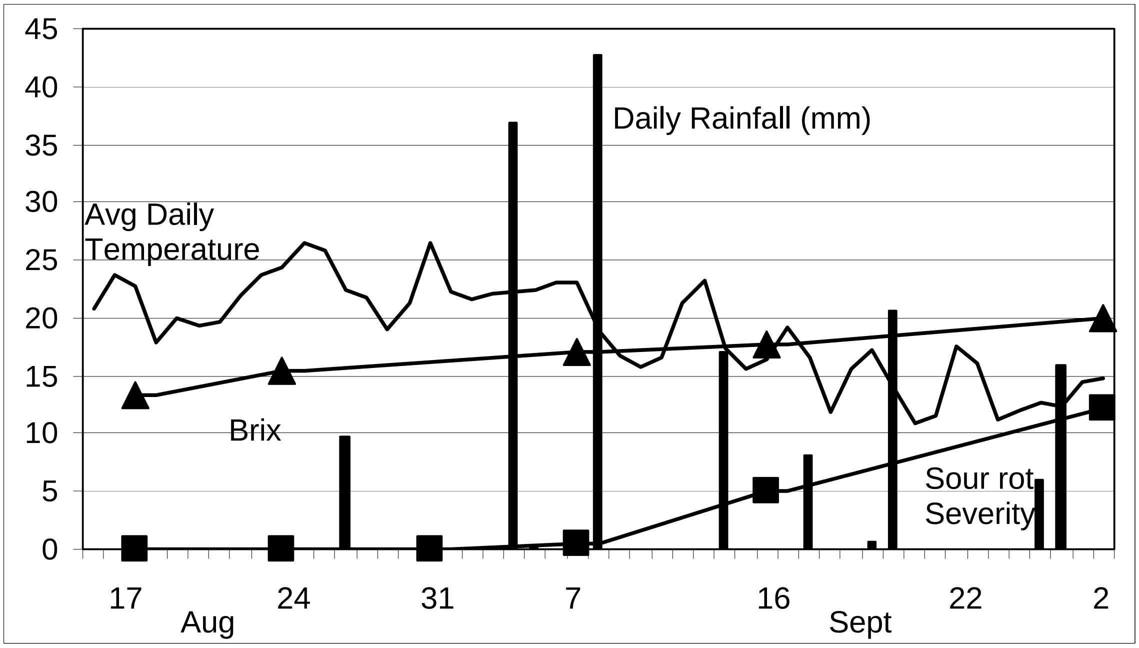
Pinot Noir

Sour rot was first detected in early September, when Brix was 18º, after a heavy rainfall on September 4. Sour rot severity increased over the next 10 days until harvest on September 17.



Riesling

Sour rot was first detected on September 7 following heavy rainfall on September 4. Fruit maturity was at 17.1º Brix. No sour rot was detected on the preceding sampling date when Brix was 15.4º.



Outreach and Communications:

Long Island Agricultural Forum, January, 2012
Dirty Rotten Scoundrels – Sour Rot And What We've Learned About it

CCOVI Lecture, March 14, 2012
What we've learned about sour rot: An update on research

Grape Tailgate Tour, August 2012.
Visited plot and distributed handout
50 growers and industry in attendance
Copy attached

Presentation at Ontario Fruit and Vegetable Convention, Feb 20-21, 2013:
Sour rot management strategies

Poster at Ontario Fruit and Vegetable Convention, Feb 20-21, 2013

Invited presentation at Eastern Wine Exposition by C. Huber (Ph.D. student)
Strategies for sour rot Reduction/Avoidance

Invited presentation at the Pennsylvania Wine Workshop, March 2012.
Understanding and managing sour rot in wine grapes

Article in The Grower
Sour rot -- working to find a solution

Interview in Grapevine Magazine
Black Rot and Summer Bunch Rot (Sour Rot) interview by Cynthia Rosi

Results cited in Grape Disease Control, 2013 by Dr. W.F, Wilcox, Cornell University

Conclusions

In Pinot noir, the most effective treatments for reducing sour rot and volatile acidity were Prohexidione-Ca at 45 and 90 g a.i./ha, fruit set leaf removal plus four sprays of InCa, Gibberellic acid at 10 ppm and heavy fruit set leaf removal. Prebloom leaf removal and GA at 5 and 20 ppm also reduced sour rot and VA. KMS treatments, regardless of the concentration, did not work as well. Prohexidione-Ca 90 g a.i./ha, GA at 20 ppm, prebloom leaf removal, heavy fruit set removal, fruit set leaf removal plus InCa and Milstop significantly reduced the severity of Botrytis.

In Riesling, the most effective treatments for reducing sour rot and volatile acidity were Sanidate, Prohexidioine-Ca at 45 and 180 g a.i./ha, Gibberellic acid at 10 and 20 ppm, GA at 5 and 10 ppm plus fruit set leaf removal, fruit thinning to 1 cluster per shoot, KMS 5 kg/1000 L applied twice at 1 week and 3 days preharvest and KMS 10 kg/1000 L applied 5 times. The most effective treatments for controlling Botrytis were MilStop, Sanidate, Gibberellic acid at 10 and 20 ppm, Regalia Maxx, KMS at 5 kg/1000 L applied twice at 1 week and 3 days preharvest and Desikote applied to the fruit.

The acetic acid bacteria, *Gluconobacter* and *Acetobacter*, are responsible for initiating sour rot but the presence of *Hanseniaspora* exacerbates symptoms. Disease development was fastest at 20-25ºC but it could develop at temperatures as low at 10ºC.

Sour rot developed in early September in both Pinot noir and Riesling after a rainfall of 39 mm.

Over-all conclusions for the 3-year study

Over the course of the 3-year study, GA at 20 ppm and the low rate of Prohexidione-Ca (45 g a.i./ha) consistently reduced sour rot. BlightBan A506 reduced sour rot in Riesling in the first two years of the study. The reduced activity in year 3 (2012) was likely due to the age of the product that was used combined with the fact that it was pre-weighed and not kept refrigerated in 2012. Regalia Maxx looks promising for Botrytis bunch rot.

Removing the basal 6 leaves prebloom reduced the severity of sour rot and VA in Pinot noir but not in Riesling. This treatment was more effective than removing the basal 4 leaves as was done in previous years.

KMS applications were more effective for sour rot control in Riesling than in Pinot noir. There does not appear to be a benefit of increasing the concentration of KMS above 5 kg/1000 starting 1 week prehavest. Lab tests show that KMS reduced the population of acetic acid bacteria for up to 24 hours after application.

MilStop reduced Botrytis consistently every year in both varieties and cluster loosening as a result of GA and Prohexidione-Ca applications also reduced Botrytis severity.

Leaf removal should be done at fruit set rather than waiting for pea-size berry if at all possible. A combination of early leaf removal at fruit set and InCa calcium spray reduced both sour rot and Botrytis. Other calcium formulations used in previous years were not as effective.

The relationship between sour rot severity and volatile acidity is fairly strong with a correlation coefficient of 0.72. The development of sour rot is dependent on temperature, rainfall and berry maturity. The exact relationship has not yet been completely elucidated.