DETERMINING ACTIVITY PATERNS OF MULTICOLOURED ASIAN LADY BEETLE IN NIAGARA TO OPTIMIZE CONTROL PRACTICES

OGWRI FINAL REPORT
PROJECT #: 0005000

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1.0 EXECUTIVE SUMMARY

A significant challenge to the production and processing of premium wine grapes is the impact of an infestation by Multi Coloured Asian Lady Beetle (MALB) close to harvest. Due to the uncertainty of population size each year and zones of infestation, many growers are unsure if protective treatment to control MALB is necessary. Populations of MALB are erratic with no two growing seasons having the same numbers of MALB present during the harvest period or which specific grape cultivars may be affected or infested. It has been documented in prior research studies that wine quality may be adversely affected and it has been published that the best control strategy for MALB must take place at the vineyard level.

Prior work by Pickering, Inglis, Ker as part of Brock University NSERC grant (2005-2008) demonstrated the impact of MALB on wine quality and periods when this appears to occur. It has been shown that the period of most impact by MALB on final wine quality occurs at the processing level and removal of MALB taint after bottling is extremely difficult and requires further research. The MALB taint occurs during the processing cycle and prevention of MALB at injurious levels must be maintained prior to harvest. Some success on a small scale has been achieved with hand sorting of clusters but this technique has not proven reliable for large volume machine harvested grapes.

This project was initiated to assess the population of MALB at area vineyards across the Niagara region beginning in prior to harvest (early September) until final harvest of grapes for processing (not including ice wine grapes) by mid November. Data was collected to assess regional site differences and numbers of MALB present in specific cultivars within the Niagara region.

Since 2005, KCMS has investigating the variability of MALB populations in Niagara area vineyards throughout the harvest period. As part of the NSERC project, the same vineyard locations were monitored for 2005-2008 harvest periods and were selected to complement harvest season vineyard data (KCMS) with collected Soybean Aphid (SBA)/MALB data collected in Niagara area soybean fields by Dr. Mark Sears and Christie Bahlai of the University of Guelph. Very similar vineyard locations were used for this project plus two additional locations were added in response to MALB presence documented in 2008.

During fall 2009, findings were released weekly to provide assistance to growers and producers about MALB presence and activity to allow for decision making. Long term, this project will provide 2009 harvest season data for additional research into the behaviour and biology of MALB under Ontario climatic conditions.

MALB populations were moderate to high in 2009 relative to previous seasons captures. All grape growing areas in Niagara had documented MALB presence in vineyards at harvest time. However population densities varied across the region from vineyard to vineyard and area to area. This season, the majority of the beetles were observed on the leaf canopy structure of the vines while in previous harvest seasons MALB were mainly found on clusters. The MALB populations observed this season were similar to the levels experienced in 2005. With winery thresholds for MALB presence being very low, growers were better able to enact control practices in the vineyard prior to harvest to ensure they would meet winery targets. It should be noted however, that many growers opted to apply registered chemical strategies regardless of population levels.

2.0 DECRIPTION OF PROJECT

2.1 OBJECTIVES AND PROJECT INPUT

The primary objective of this project was to provide in season (2009) assistance to grape growers and producers about the presence and activity patterns of MALB in local vineyards. This would allow for better decision making by growers and processors with respect to the need for chemical controls. In addition, this data can be added to the prior activity pattern data to begin establishing a historical database of MALB activity patterns and populations observed in Niagara area vineyards at harvest.

Researchers heading up the project included Dr. Kevin Ker, Ryan Brewster and Charlene Yungblut. The authors like to recognize and thank Ontario Grape and Wine Research Incorporated (OGWRI) for funding this project and all of the cooperating vineyards for their support.

2.2 PROJECT ACTIVITIES AND OUTPUTS

2.2.1 VINEYARD MONITORING LOCATIONS

Vineyard monitoring was conducted during the 2009 harvest period at twelve commercial vineyards across the Niagara region (see Figure 1).

Location descriptions:

1. The first vineyard (Winona) was positioned west of Grimsby situated directly at the base of the Niagara escarpment with a wide array of vinifera and hybrid cultivars (see Figure 2).

2. The second vineyard (West Lakeshore 1) was located just west of Beamsville along the South service road. Only two cultivars are grown at this location (see Figure 3) and have had prior history of high MALB levels at and before harvest.

3. The third vineyard (Beamsville Bench Vineyard 1) was found on the bench portion of the Niagara escarpment between Beamsville and Grimsby (see Figure 4).

4. The fourth vineyard (Bench Vineyard 2) was again situated on the bench portion of the Niagara escarpment between Vineland and Beamsville (see Figure 5).

5. The fifth vineyard (Vinemount) was located on the top portion of the escarpment between Vineland and Beamsville and consists of a wide array of vinifera and hybrid cultivars (see Figure 6).

6. The sixth location consisted of two neighbouring vineyards (Bench Vineyards 3a & 3b) located just west of Vineland on the bench portion of the Niagara escarpment (see Figure 7a & 7b). The first vineyard is a single block of Baco Noir. Once this block was harvested, we moved to the second vineyard location which contains a wide range of vinifera cultivars.

7. This vineyard (St. Catharines Bench) was positioned just south of highway 8 on the lower portion of the escarpment bench area between St. Catharines and Jordan (see Figure 8).

8. This vineyard (Short Hills) was found just West of St. Catharines and has an array of vinifera and hybrid cultivars (see Figure 9).

9. The ninth vineyard location (West Lakeshore) was situated along the north service road just west of St. Catharines (see Figure 10). This vineyard has had previous history of MALB presence at and before harvest in early ripening cultivars.

10. The tenth vineyard was in the Niagara-on-the-Lake growing region and was located approximately mid way between Virgil and the Welland canal (see Figure 11). In recent seasons, this area has shown an increase in MALB presence around the harvest period.

11. This location was another vineyard found in the Niagara-on-the-Lake growing area however this vineyard was located along 4 Mile Creek Road about mid way between Virgil and St. David’s (see Figure12). This vineyard grows many different hybrid and vinifera cultivars and is located within close proximity to soybean fields in 2009.

12. The final location monitored for MALB activity is found in Niagara-on-the-Lake located on the north side of York Rd. This vineyard has a wide range of red and white vinifera cultivars (see Figure 13).

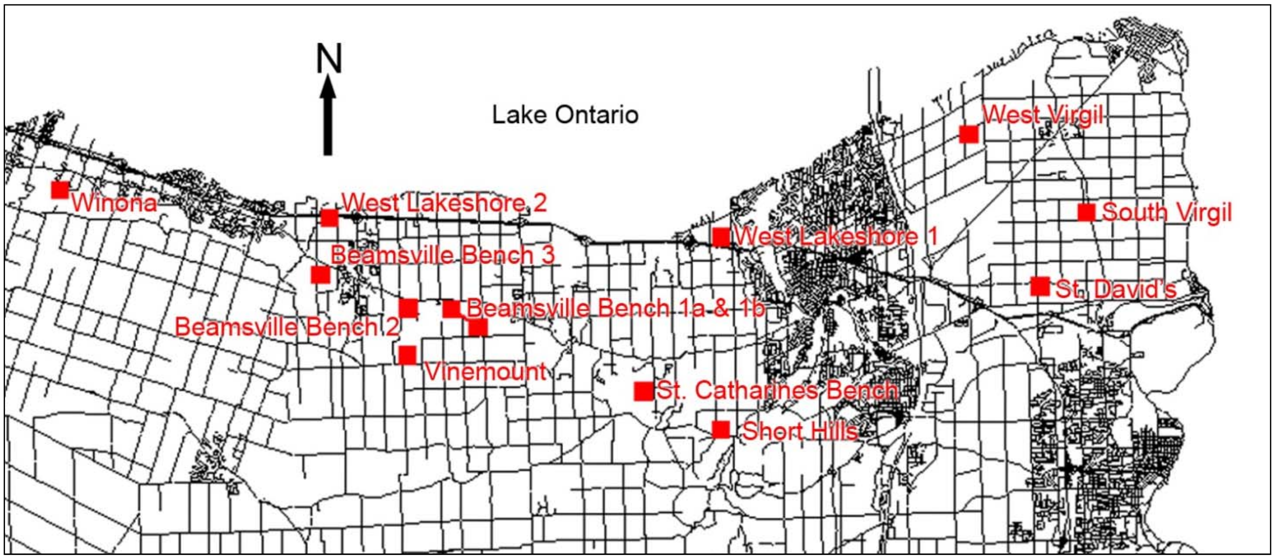

Figure 1 – Regional map of 2009 harvest season MALB monitoring vineyard locations.

2.2.2 GPS MAPS OF DATA COLLECTION LOCATIONS

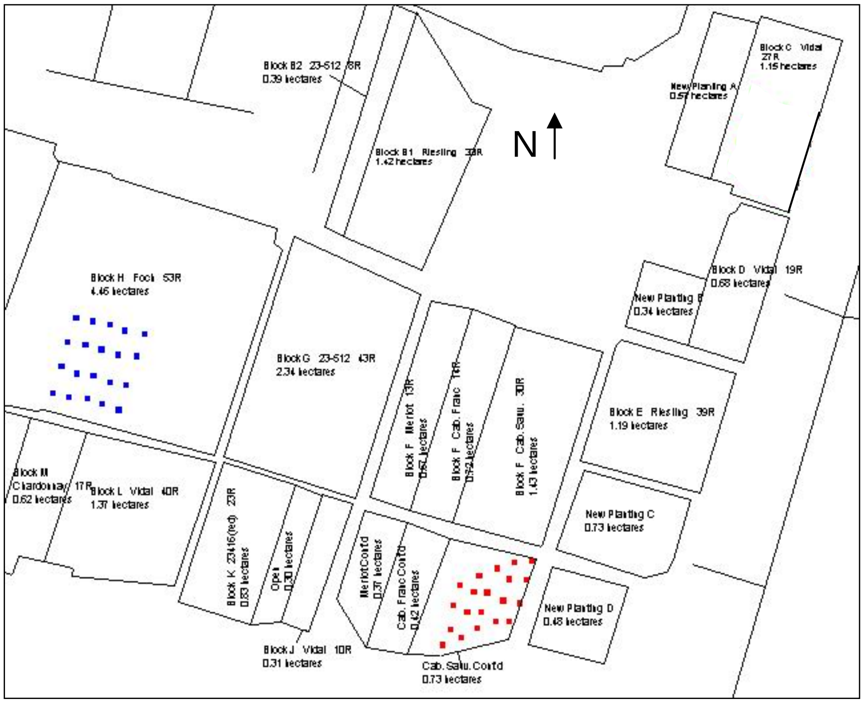

Figure 2 – Geo-Referenced map of the Winona Vineyard including the locations of the first group of sample vines (blue) and the second group of sample vines (red). Sample groups were changed as the block was harvested.

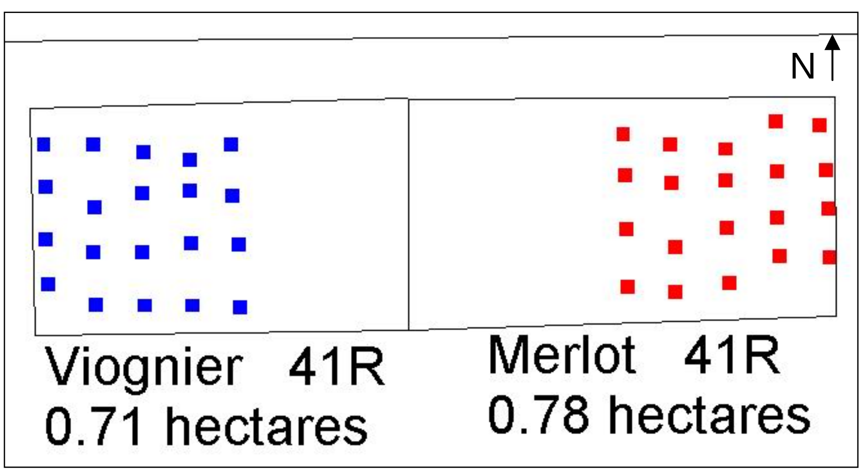

Figure 3 - Geo-Referenced map of W. Lakeshore Vineyard 1 including the locations of the first group of sample vines (blue) and the second group of sample vines (red).

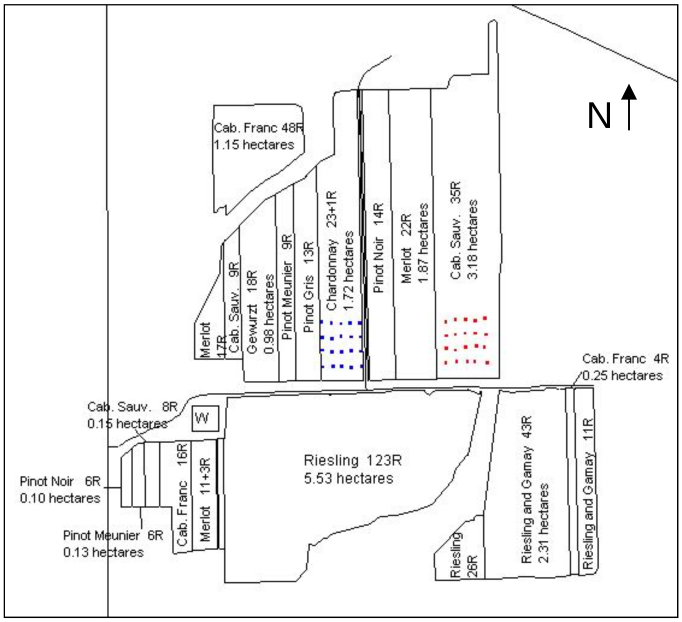

Figure 4 - Geo-Referenced map of Beamsville Bench Vineyard 1 including the locations of the first group of sample vines (blue) and the second group of sample vines (red).

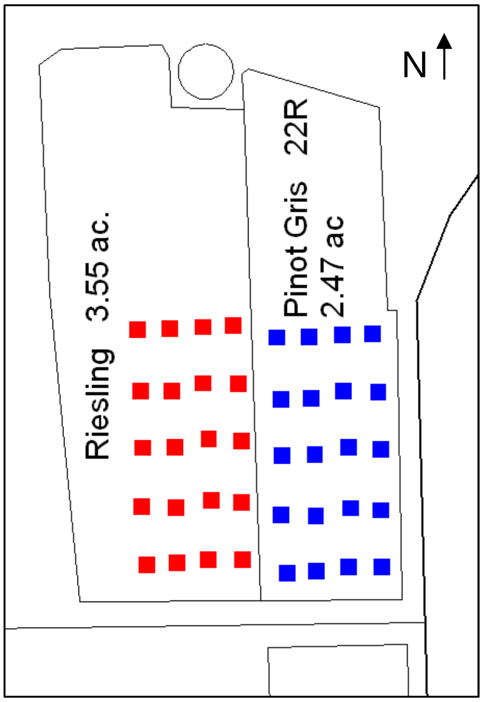

Figure 5 - Geo-Referenced map of Beamsville Bench Vineyard 2 including the locations of the first group of sample vines (blue) and the second group of sample vines (red).

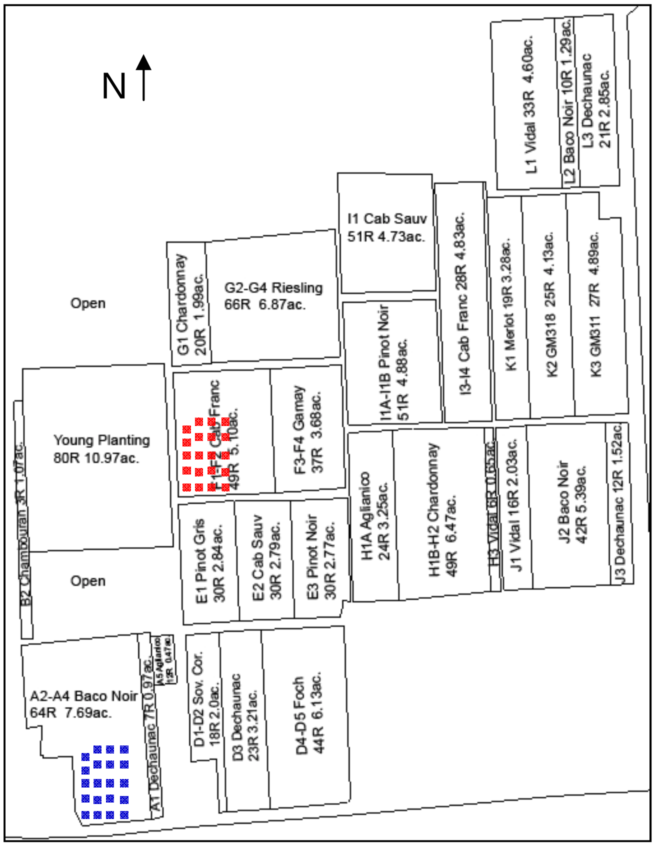

Figure 6 - Geo-Referenced map of the Vinemount Vineyard including the locations of the sample vines (blue) and the second group of sample vines (red).

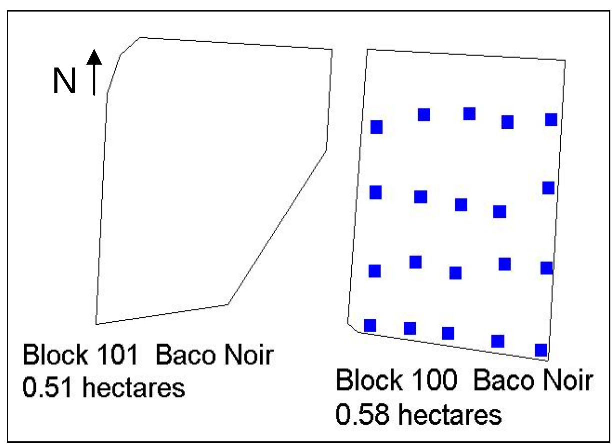

Figure 7a - Geo-Referenced map of Beamsville Bench Vineyard 3a including the locations of the sample vines (blue).

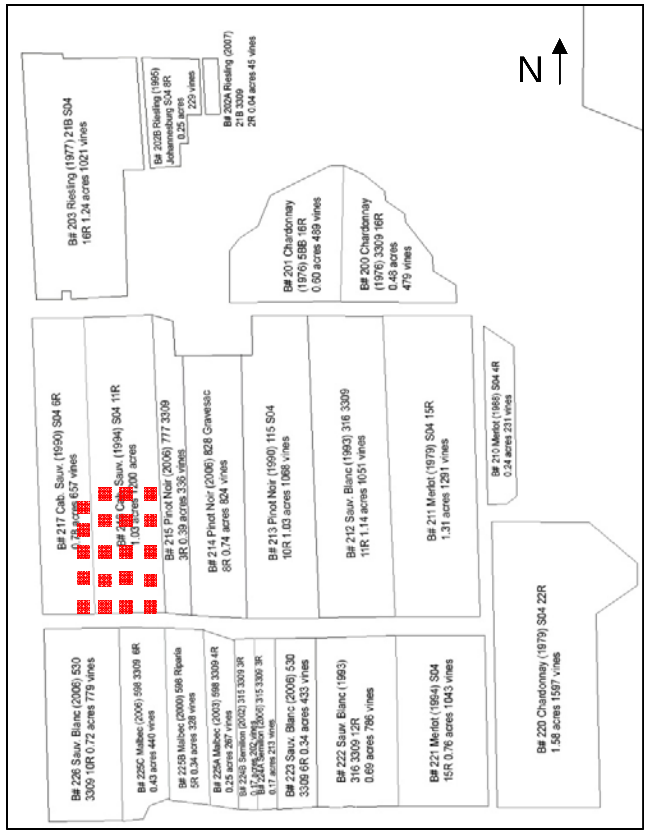

Figure 7b - Geo-referenced map of the Beamsville Bench Vineyard 3b including the second group of sample vines (red) for this vineyard group.

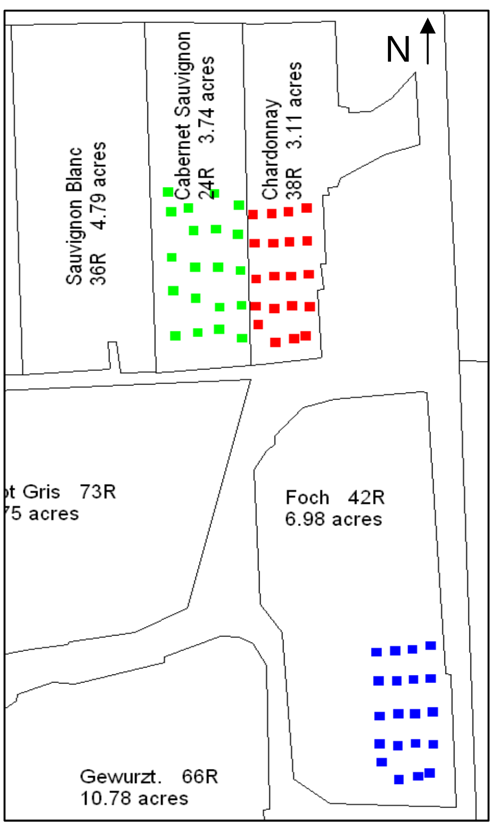

Figure 8 - Geo-referenced map of the St. Catharines Bench Vineyard including locations of the first group of sample vines (blue), the second group of sample vines (red) and the final group of sample vines (green).

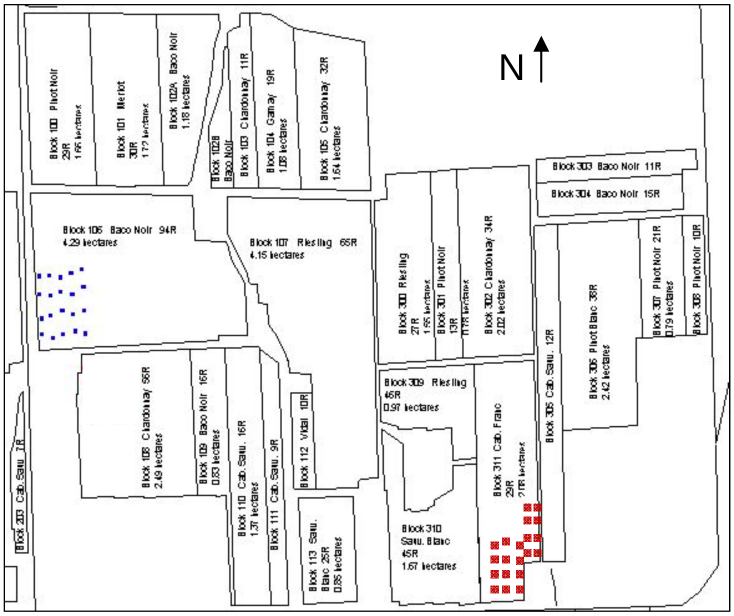

Figure 9 – Geo-referenced map of the Short Hills Vineyard including locations of the first group of sample vines (blue) and the second group of sample vines (red).

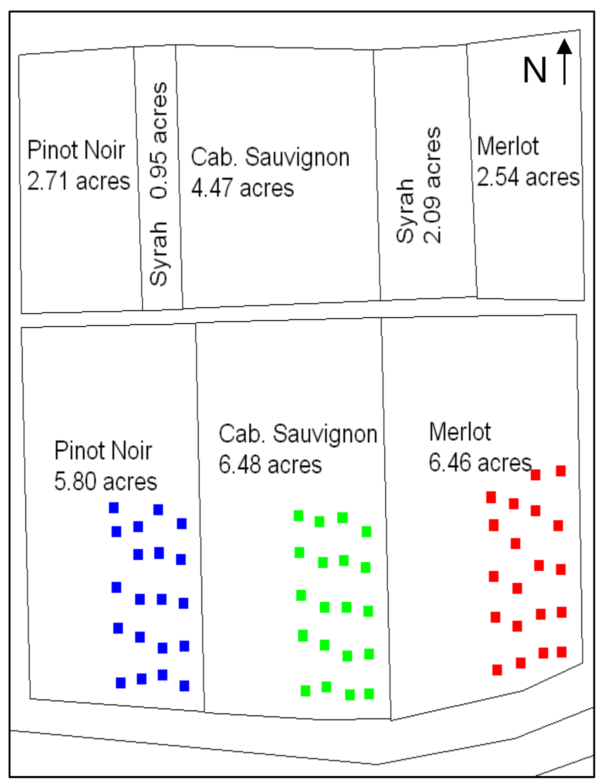

Figure 10 - Geo-referenced map of the W. Lakeshore Vineyard 2 including locations of the first group of sample vines (blue), the second group of sample vines (red) and the final group of sample vines (green).

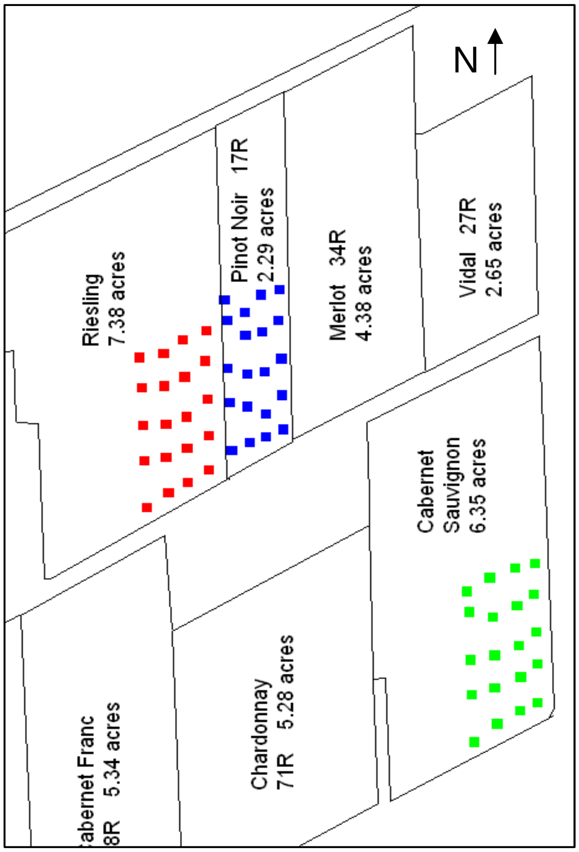

Figure 11 - Geo-referenced map of the W. Virgil Vineyard including locations of the first group of sample vines (blue), the second group of sample vines (red) and the final group of sample vines (green).

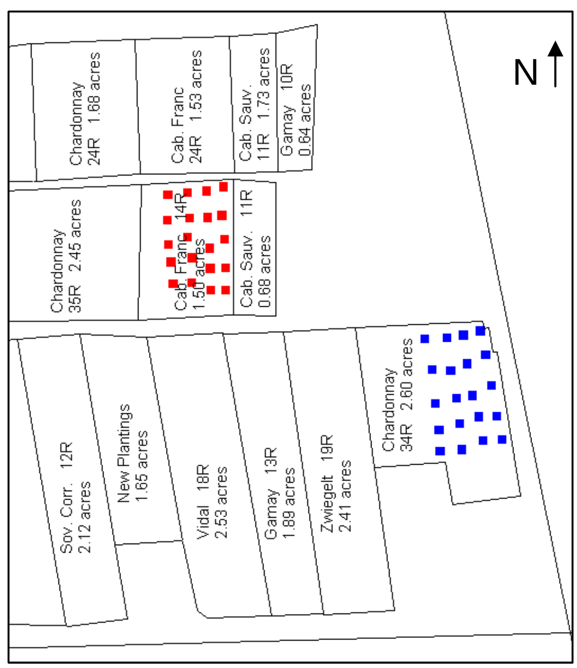

Figure 12 - Geo-referenced map of the South Virgil Vineyard including locations of the first group of sample vines (blue), the second group of sample vines (red).

Figure 13 - Geo-referenced map of the St. David's Vineyard including the first group of sample vines (blue), the second group of sample vines (red) and the final group of sample vines (green).

2.2.3 SAMPLE VINE LOCATIONS

At all vineyard locations, the position of the specific sample vines and the orientation of the sample blocks were geo-referenced using a Garmin GPS 18 OEM (Olathe, KS) handheld GPS unit. Vines were selected using a standardized grid pattern to ensure consistent spacing between sample vines. These vines were used to establish if MALB were uniformly distributed throughout the sample area or only located in specific areas of the sample block. A buffer zone of 2 rows on either side of the block and at least 1 panel (5 vines or approximately 20ft.) from each end was used to eliminate any irregular border effects that may be observed. One vine was chosen in panels 3, 6, 9, 12 and 15 resulting in five vines inspected per row. This was replicated four times every fifth row (beginning at row 2) for a sampling total of twenty vines per location.

If the size of the sample block did not allow for this specific layout pattern, one of two alternatives was utilized. Firstly, if the number of rows is the limiting factor, we reduced the total number of rows sampled and added one vine to each applicable row. Secondly, if the row length is limiting, we reduced the number of vines sampled per row and added more rows. In all cases we utilized twenty vines per block using this procedure (see Figures 2 to 13).

To add to the prior research data base, where possible, the vines examined were the same or nearby those used by prior research projects.

2.2.4 SAMPLING METHOD AND DATA COLLECTION

MALB populations were estimated by in-situ vineyard sampling and species identification was undertaken. At each location the specific sample vines (20 per site) were examined twice per week beginning 08 September 2009. Early season cultivars were examined first, then sample vines were reselected with mid and late season cultivars after early maturing blocks were harvested. This allowed us to monitor MALB in blocks that still had fruit present.

For reliability of data collection, the same two field technicians examined the sample vines for presence of MALB throughout the 2009 sample period. The technicians worked in tandem looking at the same vine, one on either side, recording data together. This system increased accuracy and efficiency by limiting the potential for double counts. All MALB found on selected vines were categorized into four groups depending on where the insect was observed; foliage (leaf blades and leaf petiole), clusters (fruit and rachis), canes/trunks (all the 'woody' areas of the vines) and/or understory (any vegetation located under the vines) (Figure 14a-d).

(a) (b) (c) (d)

Figure 14(a-d) – Observed MALB were categorized into one of four groups; foliage (a), clusters (b), canes/trunks (c) and/or understory (d).

2.2.5 TRIAL DURATION

Sample vines were flagged in the locations during the week of 31 August 2009. Monitoring began 08 September 2009 and continued bi-weekly until 18 November 2009 when all blocks at each location were harvested.

2.3 OUTREACH AND COMMUNICATION

Weekly update statements based on the most recent monitoring observations were included on the recorded Grape Crop Alert message which is sponsored by the Grape Growers of Ontario and prepared by KCMS Applied Research and Consulting Inc. All members of the grape and wine industry (growers, processors, retailers, institutions and research) have free access to this telephone system at (905) 708-6620. Grower clients of KCMS received the same MALB update statements in addition to other proprietary client information in weekly email messages. Statements included general MALB activity observed in the different viticultural areas, any weather patterns that may be influencing MALB presence and any correlations between fruit integrity/maturity and MALB activity in vineyards. The support of Ontario Grape and Wine Research Incorporated (OGWRI) was identified at the beginning of each released update statement specific to MALB.

3.0 PROJECT OUTCOMES

3.1 2009 DATA SUMMARY

MALB were detected in all of the twelve monitored locations throughout the 2009 harvest period (Tables 1-3). Overall, MALB populations were considerably higher than what was reported in 2006, 2007 and 2008. The MALB activity patterns observed in 2009 were comparable to the MALB populations observed in 2005 (Figure 15).

The highest numbers of MALB observed were found during the months of September (29%) and October (68%) when the majority of the crop is approaching optimal maturity levels (Table 1 & 2).

In previous studies, more MALB were observed in September. However, due to the cool temperatures experienced in the 2009 growing season all cultivars experienced a delay in reaching full maturity and this may have delayed the presence of MALB. In some cases, harvests of specific cultivars were up to 3 weeks behind the 10 year average. In 2009, more MALB were observed in October when the majority of the cultivars were mature and about to be harvested. The greatest population of MALB was found at the W. Lakeshore Vineyard 1 that comprised of 65% of the total number of MALB observed in 2009.

As November approached, eleven of the twelve locations still had grape blocks to be harvested. As displayed in Table 3, the only locations to have documented MALB activity through November were the Beamsville Bench Vineyard 1, the Vinemount Vineyard and the Short Hills Vineyard locations. However, the numbers of MALB observed at these three locations in November were very low (only 3% of all the MALB observed in 2009).

Table 1 – Weekly MALB observations conducted in September 2009. Counts were completed twice each week (A / B). 'H' indicates that all cultivars at that location were harvested and '*' indicates a cultivar change. (Total # beetles per 20 vines)

Vineyard Name	**Sep-09**						
	W1	**W2**		**W3**		**W4**	**Total**
	B	**A**	**B**	**A**	**B**	**A**	
Winona	0	2	1	0	1	0	4
West Lakeshore 1	0	39	20	16	62	53	190
Beamsville Bench 1	0	6	0	1	1	5	13
Beamsville Bench 2	0	0	0	0	0	0	0
Vinemount	0	4	0	2	2	4	12
Beamsville Bench 3	0	0	0	0	4	6	10
St. Catharines Bench	0	2	1	0	1	0	4
Short Hills	0	1	0	0	0	0	1
West Lakeshore 2	0	1	0	0	4	0	5
West Virgil	0	1	0	0	*0	0	1
South Virgil	0	0	0	0	0	0	0
St. David's	0	0	0	0	0	0	0
Total	**0**	**56**	**22**	**19**	**75**	**68**	**240**

Table 2 - Weekly MALB observations conducted in October 2009. Counts were completed twice each week (A / B). 'H' indicates that all cultivars at that location were harvested and '*' indicates a cultivar change. (Total # beetles per 20 vines)

Vineyard Name	**Oct-09**									
	W4	**W5**		**W6**		**W7**		**W8**		**Total**
	B	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**	
Winona	0	0	0	0	0	0	0	0	0	0
West Lakeshore 1	81	94	166	0	*0	0	0	0	0	341
Beamsville Bench 1	0	2	7	1	*0	0	2	2	8	22
Beamsville Bench 2	2	0	*9	0	0	0	H	H	H	11
Vinemount	11	4	4	0	0	*2	1	5	3	30
Beamsville Bench 3	17	88	18	0	0	*1	1	3	3	131
St. Catharines Bench	1	*0	0	0	0	*0	0	0	0	1
Short Hills	0	1	0	*0	0	0	2	6	2	11
West Lakeshore 2	*0	0	0	0	0	*0	2	1	0	3
West Virgil	0	4	1	0	0	*0	1	0	0	6
South Virgil	0	1	0	0	0	0	*0	0	0	1
St. David's	0	*0	1	0	0	4	0	0	0	5
Total	**112**	**194**	**206**	**1**	**0**	**7**	**9**	**17**	**16**	**562**

Table 3 - Weekly MALB observations conducted in November 2009. Counts were completed twice each week (A / B). 'H' indicates that all cultivars at that location were harvested and '*' indicates a cultivar change. (Total # beetles per 20 vines)

Vineyard Name	**Nov-09**				
	W9		**W10**		**Total**
	A	**B**	**A**	**B**	
Winona	*0	0	0	0	0
West Lakeshore 1	0	0	0	0	0
Beamsville Bench 1	6	0	0	0	6
Beamsville Bench 2	H	H	H	H	0
Vinemount	1	0	0	0	1
Beamsville Bench 3	0	0	0	0	0
St. Catharines Bench	0	0	0	0	0
Short Hills	21	0	0	0	21
West Lakeshore 2	0	0	0	0	0
West Virgil	0	0	0	0	0
South Virgil	0	0	0	0	0
St. David's	*0	0	0	0	0
Total	**28**	**0**	**0**	**0**	**28**

During the sampling for MALB observations for other ladybeetle species on non-sample vines or in the understory between sample vines were also recorded. Observations included any ladybeetle larvae or pupae observed on and between sample vines. As discussed previously, the W. Lakeshore Vineyard 1 had the highest numbers of observed MALB in 2009.

Table 4 outlines the numbers of MALB observed on the 20 sample vines at the W. Lakeshore Vineyard 1 location. This table also includes any pupae or other ladybeetle species observed at this location.

Table 5 outlines all of the MALB adults, pupae and other ladybeetle species observed by the technicians between sample vines (non-sample vines).

Prior studies reported, a number of ladybeetle pupae/larvae at this location. No other monitored location had as many ladybeetle pupae/larvae observed. These observations indicates a valuable need and importance for historical documentation and block monitoring prior to harvest to be aware of potential ladybeetle pressure at harvest.

Table 4 – Total number of MALB observed on sample vines at the West Lakeshore Vineyard 1 throughout the 2009 harvest season

W. Lakeshore Vineyard 1 2009 Total # MALB Observed - Sample Vines						
Week	**Foliage**	**Clusters**	**Wood**	**Understory**	**Pupae**	**Other Species**
1	0	0	0	0	2	0
2	55	0	2	2	1	5
3	60	3	1	14	1	1
4	89	27	5	13	0	6
5	125	80	20	35	0	2
6	0	0	0	0	0	0
7	0	0	0	0	3	0
8	0	0	0	0	0	0
TOTAL	329	110	28	64	7	14

Table 5 - Total number of MALB observed on non-sample vines at the West Lakeshore Vineyard 1 throughout the 2009 harvest season

W. Lakeshore Vineyard 1 2009 Total # MALB Observed - Non-Sample Vines						
Week	**Foliage**	**Clusters**	**Wood**	**Understory**	**Pupae**	**Other Species**
1	15	0	0	2	20	0
2	17	0	0	9	11	0
3	142	30	5	72	23	15
4	141	119	16	63	6	8
5	141	65	20	32	2	0
6	0	0	0	0	0	0
7	0	0	0	0	0	0
8	0	0	0	0	4	0
TOTAL	456	214	41	178	66	23

3.2 REVIEW OF MULTI-YEAR (2005 – 2009) MONITORING DATA

For comparative purposes of Figures 13 and 14, the same 10 vineyards were monitored from 2005 – 2008. However, in 2009 two additional vineyards (both located in NOTL) were included into each monitoring period.

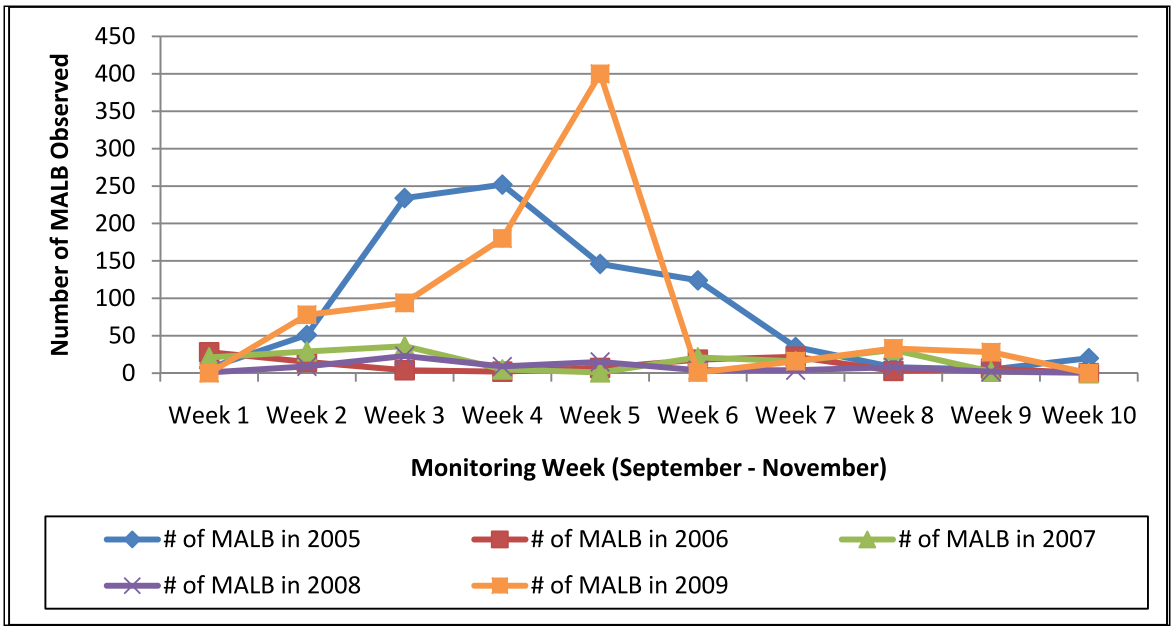

Figure 15 – Total number of **MALB** observed on monitored vines throughout the harvest season from 2005 – 2009 (Week 1 is the first week in September). The same 10 vineyards were monitored from 2005 – 2008.

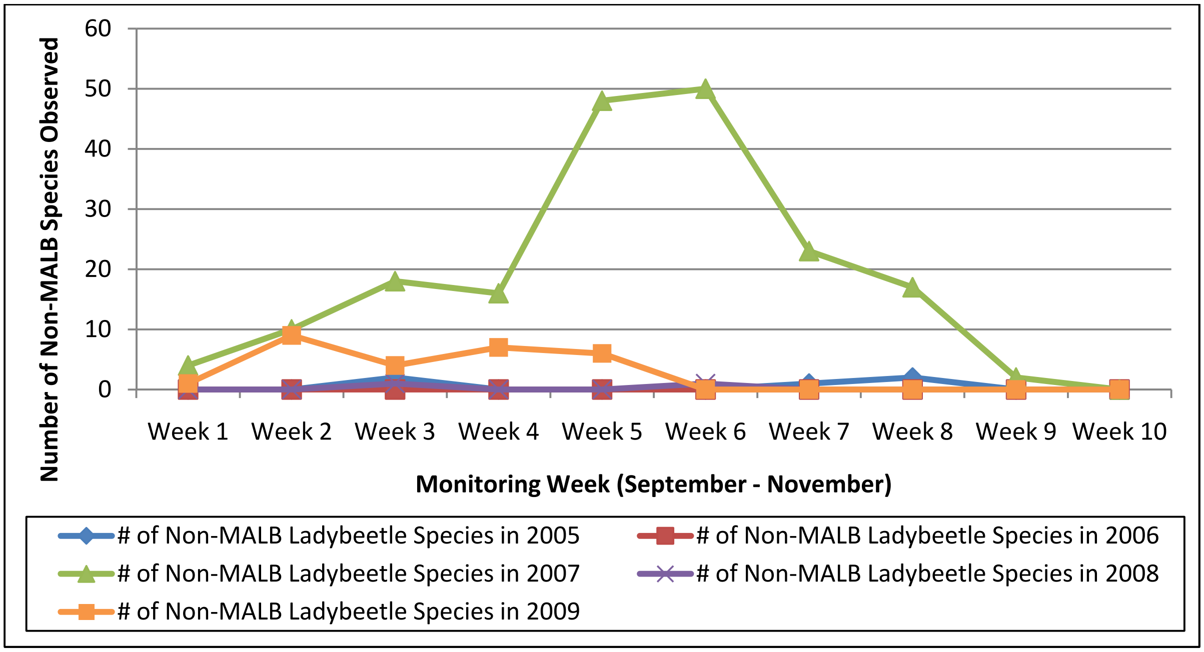

Figure 14 - Total number of **Non-MALB Ladybeetle Species** observed on monitored vines throughout the harvest season from 2005 – 2009 (Week 1 is the first week in September).

Table 6 – Percentage of MALB observed on each of the four designated area of a vine. Clusters include fruit and rachis, foliage includes leaf blades and leaf petiole. The canes and trunks are all the 'woody' areas of the vines and the understory includes any vegetation located under the vines.

	Clusters	Foliage	Canes/Trunk	Understory
MALB Observed 2005	57%	35%	6%	2%
MALB Observed 2006	46%	47%	6%	1%
MALB Observed 2007	52%	20%	8%	20%
MALB Observed 2008	44%	29%	4%	23%
MALB Observed 2009	19%	59%	7%	15%
Average (2005 – 2009)	44%	38%	6%	12%

It is important to recognize that MALB may be present in all parts of the canopy and vineyard, however consistently the higher numbers are noted in the cluster and foliage zones. Surprisingly in 2009, more MALB were observed in the foliage than specifically on the clusters as had been noted for 2005, 2007 and 2008.

4.0 FINAL COMMENTS AND CONCLUSIONS

4.1 DISCUSSION

The grape growing areas of the Niagara Region experienced another challenging growing season in 2009. Temperatures were relatively cool from May through to August with frequent precipitation events resulting in greater mildew and black rot pressures and slightly larger than average berries/clusters. However, the almost perfect weather conditions throughout the harvest period resulted in a reasonable 2009 vintage. September and October experienced higher than average daytime temperatures and practically no precipitation. These factors resulted in very few botrytis bunch/sour rot infections and acceptable maturity standards for most cultivars. Even the majority of the tight clustered, thin skinned early ripening cultivars maintained excellent cluster integrity and had very low VA levels at harvest.

In 2009, a large percentage of growers with contract grapes applied some sort of chemical control strategy based on very low winery MALB thresholds and concern over potential MALB presence and possible crop rejection. Conversely, in 2008, only a handful of growers faced making critical pest management decisions at harvest time to deal with the presence of MALB. There continues to be high variability in numbers of observed MALB in Niagara vineyards year to year (Figure 13). Yet, based on increased grower concern for crop marketability, vineyards that were not affected in prior years are receiving treatment if any beetles are observed nearby.

The highest numbers of observed MALB in research studies occurred in 2005 (Figure13). Many loads of grapes were rejected by processors and many applied pre-harvest insecticide applications to reduce the overall number of MALB present in the vineyard. Unfortunately, some vineyards experienced a re-infestation of MALB between insecticide applications and harvest in 2005. Similar to 2005, during 2009 it was observed that Malathion formulations provide a good initial knock-down of target beetles but still had re-infestation between the application time and the end of the associated pre-harvest interval (PHI), which is 3 days. However, Ripcord 400EC continued to provide a good initial knock-down of the resident beetle population and provided a repellent effect for up to 14 days. Ripcord 400EC currently is registered with a 7 day pre harvest interval.

The majority of the beetles observed in vineyards during the 2009 harvest period were identified as MALB. Only 3% of the recorded beetles were non-MALB species in 2009. These non-MALB ladybeetle species were predominantly *Coccinella sp.* (7-

spotted Ladybeetle) but also included *Hippodamia Sp., Propylea sp.* and *Coleomegilla sp.* It is important to be aware that research conducted by Dr. Pickering's lab at Brock University, CCOVI concluded that the 7-spotted Ladybeetle is as potent as the MALB for resulting in ladybeetle taint in the finished product. Local processors are not differentiating between ladybeetle species when making decisions on acceptance or rejection of loads delivered by growers. To the processors, more species than MALB are considered to produce similar taint effects as MALB and result in negative impact on wine quality.

Every MALB observed on sample vines were recorded as being located in one of four vine sectors; clusters, foliage, cane/trunk or understory (Figure 12a-d). The majority of the MALB recorded in 2009 were observed on the foliage (59%) while in previous years there was much greater presence on the cluster (Table 6).

One potential explanation for this activity pattern may be due to the fact that berry skins were not compromised and maintained low degradation and kept low volatile acid (VA) levels that have been hypothesized to act as a beetle attractant at higher concentrations. Secondly, aphid populations were very high in most agricultural (fruit and field) crops grown in Niagara. Aphids are the primary food source for many ladybeetles. We recorded higher than average green peach aphid levels in tender fruit orchards all across the area and observed many additional colonies of differing aphid species on other plants including on weeds present in many area vineyards. The MALB that were observed on the foliage were typically alone and appeared to be exhibiting foraging behaviours (Figure 15). The greatest MALB numbers in our sample blocks were found where weed growth was allowed to grow directly underneath vines and/or in vineyards where aphid colonies were present on the actual vines themselves. MALB presence on weed growth was typically observed with aphids colonizing the weeds (Figure 16).

Figure 15 – *H. axyridis* (MALB) observed on a grapevine leaf on a sample vine. Notice the aphid presence feeding on the softer tissues around the shoot tip.

Figure 16 – *H. axyridis* observed underneath vines on lambs' quarters (*Chenopodium album*). Notice the black bean aphids (*Aphis fabae)* in the background.

Vineyard blocks were monitored based on expected maturation and harvest dates for each cultivar. Shifts in sample locations within a vineyard site occurred as specific blocks/cultivars were harvested. Therefore, as a particular cultivar/ block was harvested, monitoring continued in an adjacent block that still had fruit present to be harvested at a later date. In previous harvest seasons, the highest numbers of MALB were observed as the specific cultivar reached full maturity. This suggests that MALB could be attracted to volatile compounds released from grape berries at the end of the maturation phase or by degrading or damaged fruit releasing specific volatiles. This trend was not observed as frequently in 2009. As discussed earlier, VA levels remained very low as grapes approached harvest and most cultivars were harvested before significant cluster breakdown or direct berry injury/damage occurred. As well, a large number of growers applied registered chemical control products as harvest approached. This practice significantly reduced beetle presence at harvest depending on product selection, adequate drying time after application and observance of the required interval before harvest. The use of pre-harvest insecticides to protect against MALB was not widely practiced in previous years.

4.2 GENERAL OBSERVATIONS

These are general observations recorded from this study (2009) and prior studies (regional monitoring period 2005-2008) and rapid-response evaluations (2005-2007).

1. Majority of MALB, at each location, were observed on vines located close to the perimeter of the block (first panel or outside rows) and mainly on the upper wire growth (if applicable).

2. MALB activity was greatest on clusters during the mid-day hours. Damaged or degrading clusters showed the greatest amount of MALB activity. MALB were present in the morning and evening hours but were much less active.

3. MALB activity is lowered immediately after a rain event. This statement does not suggest that MALB has left the vineyard, just that the activity of MALB is reduced resulting in less beetles being easily visible. During these conditions, MALB were observed aggregating within clusters with minimal movement.

4. Vineyards located along the Beamsville Bench area, examined as part of the rapid response survey, revealed high numbers of MALB in 2005 and 2007. The Niagara-on-the-Lake (NOTL) growing area has traditionally seen low numbers of MALB with some areas revealing a slightly greater degree of MALB activity than others. The NOTL vineyard continually monitored for this project historically has experienced very low numbers of MALB throughout the harvest season. Geographic location along with sample cultivar selection (primarily ice wine cultivars that are less prone to rapid fruit degradation) may have some influence on the number of MALB observed in this sample area.

5. There appears to be potential for MALB re-infestation after day 3 of a Malathion 500E or Malathion 85E application. Trials suggest that Ripcord 400EC has a residual effect that will provide MALB control for approximately 14 days (Pogoda, 2005).

6. Many growers that have historically observed MALB presence in their vineyards chose to apply a pre-pick Ripcord 400EC treatment 7 days before anticipated harvest on all blocks. This practice resulted in adequate control of MALB for the desired period.

4.3 CONCLUSIONS

Due to the wide range of MALB numbers observed year-to-year and the insect behaviours associated with crop condition and weather events, additional harvest season data is required to obtain a better understanding of the behaviours and movement patterns associated with MALB in Niagara area vineyards at harvest. Once the behaviours and possible attractants are better understood, alternative bio-control strategies can begin to be evaluated with the goal of limiting chemical product usage so close to harvest.

Blocks should be monitored for developmental life-stages and mature MALB from post-veraison up to the pre-harvest period. Blocks that have elevated numbers of MALB larvae and pupae observed in late August will most likely be faced with high levels of mature MALB when harvest time approaches.

Good weed and cover crop management is one way growers can reduce the attractiveness of their vineyard towards MALB.

It is suspected that compounds released from fully or over-mature grape berries (including but not exclusive to ethyl acetate and acetic acid) may be important in MALB attraction (KCMS prior research studies 2005-7). This may explain why MALB adults are frequently found on split or physically damaged grape berries that have already begun the deterioration process and why MALB adults are not found on clean, intact berries.

Presence of the 7-Spotted Ladybeetle (*Coccinella sp.)* in the vineyard at harvest time has been shown to be as potent as MALB in terms of causing ladybug taint in finished wines. (Pickering, 2008)

Temperature appears to have an effect on the movement and activity patterns of MALB. MALB activity is increased during the warmest periods of the day and lowered during cooler periods or with weather episodes usually correlated with cooler weather. The aggregation behavior within clusters during cooler conditions is very similar to the hibernation behavior displayed by MALB where aggregation occurs as a survival instinct to help regulate their body temperature.

Under experimental conditions, Ripcord 400EC appears to be a more effective product for MALB control at harvest when compared to Malathion 500E and Malathion 85E. Growers will be more willing to use this product if the pre-harvest interval (PHI) is lowered. Label review is currently underway by the PMRA with the effort to reduce the PHI interval of Ripcord 400EC to 3 days on grapes.

With a better understanding of MALB behaviour and dispersal patterns, just prior to or during grape harvest, the Ontario grape and wine industry will be better equipped in formulating and evaluating IPM based control options.

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