NGWB GRANT FINAL REPORT

CONTRACT#: 18-13-060

CONTACT INFORMATION

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ISSUE OF INTEREST

Finding techniques that can be effective on our cultivars in Nebraska could make the difference between devastating damage, which negates any profitability and a consistent, quality wine and grape industry. Nebraska winters can be harsh, even brutal, and are certainly damaging to grapevines. This damage can result from several reasons, which are noted below:

- Ambient temperatures can be among the coldest in the country. While average winter temperatures are above zero degrees Fahrenheit (F), ambient temperatures can consistently fall into the sub-zero range. It is not unusual for temperatures in our vineyard to plummet to the -10°F to -25°F range for one night to one week. Obviously, damage to grapevines can occur at these temperatures; however, if growers carefully select appropriate cultivars for these temperatures, damage can be minimized or avoided (e.g., Frontenac, Lacrosse, Brianna, etc.). Thus, ambient temperatures do not have to be a serious problem for Nebraska vineyards.
- Volatile temperatures frequently cause, heretofore, unavoidable damage. While many appreciate the January or March early thaw, it is the last thing grape growers wish to see for our vines. An early thaw can lead to an early break of dormancy and an early push of buds, which are only to be followed by deadly plunges in temperatures. The winter of 2004 was no exception. The winter saw 50 – 60°F for two weeks in late March, followed by 19°F in mid-April. Damage to primary buds during this period was extensive.
- Late frosts/freezes are a way of life in central Nebraska and they annually take their toll on row crops, such as corn and grape crops. Such frosts are expected in early and even mid-May. However, the late-May freeze, which occurred during the third week of the month, and its extent at 22°F, was devastating. This event resulted in grape crop loss in our vineyard at over 95 percent loss with primary, secondary, and tertiary bud loss, as well as approximately ten-percent loss of plants.

Thus, the problem is not one of a lack of cultivars that can withstand winter temperatures in Nebraska. The problem is one of minimizing winter damage from extensive temperature swings, which can result in an early dormancy break and early bud break, which can be accompanied by a late frost or freeze. Therefore, the purpose of this multi-year research is to evaluate techniques designed to enhance grapevine cold hardiness, specifically, effects of late winter spraying of dormant vines with products designed to delay bud break from two to four weeks.

APPROACH TO THE PROBLEM

This is the fourth year of a continuing research project.

1st Year – it was determined that multiple applications of Amigo Oil (a vegetable oil based product) resulted in significant bud break delay (up to 20 days) as compared to non-treated control group. Also, it was determined that the effectiveness among the Alginate gel and the Amigo oil treatment groups were equal.

2nd Year –Investigated the effectiveness of multiple applications of Amigo oil as compared to non-treated controls (i.e. replication / validation of year one project). Secondly, this portion of the study also investigated the effectiveness of multiple applications of Amigo oil via backpack sprayer methods as well as air blast sprayer methods of application. It was determined that both methods of application were effective, and that backpack application was more effective.

3rd Year – Investigated the effectiveness of multiple applications of Amigo Oil (i.e. replication of years one and two), and, expands to two additional vineyard sites representing very different microclimates as compared to Mac's Creek's microclimate. The sites included one vineyard from eastern Nebraska and one vineyard from slightly farther west in Nebraska. This third year extension also included Edelweiss as a newly researched cultivar. Significant effects of Years 1-3 were generalized to three separate vineyards research blocks, and to an additional cultivar, i.e., Edelweiss. Moreover, Air Blast application equaled Backpack in terms of significant effects when comparable gallons of spray/acre were applied.

4th Year – Investigated the effectiveness and practicality of wide-scale (i.e., spraying of an entire seven acre vineyard) commercial application of Amigo Oil (replication of Years 1, 2, and 3). With four years of data, extent of bud delay over the past three years ranging from nearly 20 days to six or seven days (depending upon the winter), and no two winters being alike in Nebraska, we have evaluated longitudinal effectiveness of Amigo Oil application across four years and several cultivars (e.g. average length of bud delay across four years for Brianna or Marechal Foch). This longitudinal evaluation is essential and is more accurate in terms of what a grower might expect, as opposed to unique single year fluctuations.

Moreover, a second purpose of this study was to be able to provide growers the analysis essential to help them determine, not only effectiveness, but cost/benefit potential across the four year average. This will enable growers to determine whether the cost of treatment is justifiable and sustainable.

Small blocks of two to four vines of each of four cultivars (Marechal Foch, Lacrosse, Edelweiss, Brianna) were systematically selected and receive no Amigo Oil treatment (i.e., Control Group). The remaining seven acres (approximately 3000 vines) were treated (Treatment Group). All vines will be pruned prior to the first application of Amigo Oil. Twenty-five vines from the Treatment group for each of the four cultivars (N=100) were systematically selected for bud ratings. The initial treatment was applied on or about March 1, 2011 and reoccurred approximately once every two weeks after, until bud break (i.e., approximately May 1, 2011).

GOALS/ACHIEVEMENT OF GOALS

1. To compute cultivar specific longitudinal bud delay averages across two to four years. What are the cultivar specific longitudinal bud delay averages across two to four years? Bud delay (# of days) was computed for Year 4 (2011). This delay was combined with respective bud delay days for each of the past one to three years, and an "average bud delay (# of days) was computed for each cultivar (i.e., a four year average was computed for Brianna and Marechal Foch; a two year average was computed for Lacrosse and Edelweiss).

2. To evaluate practicality (sustainability) of wide-scale application (treat an entire seven acre vineyard) to determine/estimate cost/benefit average across all four years. What is the practicality of generalizing the Year 1-3 results to an entire seven acre commercial application? Actual cost of Amigo Oil, labor, fuel expenses, time, etc. were computed and compared to actual yields realized over the past four years. The overall average cost/benefit was computed.

RESULTS, CONCLUSIONS, LESSONS LEARNED

YEAR 1

Marechal Foch: Means of bud development at each of the three data recording dates for Marechal Foch were plotted (see Figure 1). As shown in Figure 1, mean bud development for the Amigo Oil group on May 20 (*M* = 2.8) is less than mean development for the Control Group on May 8 (*M* = 3.35). Thus, it can be determined that bud development has been delayed by at least 12 days. Extrapolation of this trajectory results in an estimation of bud delay being between 14 and 21 days.

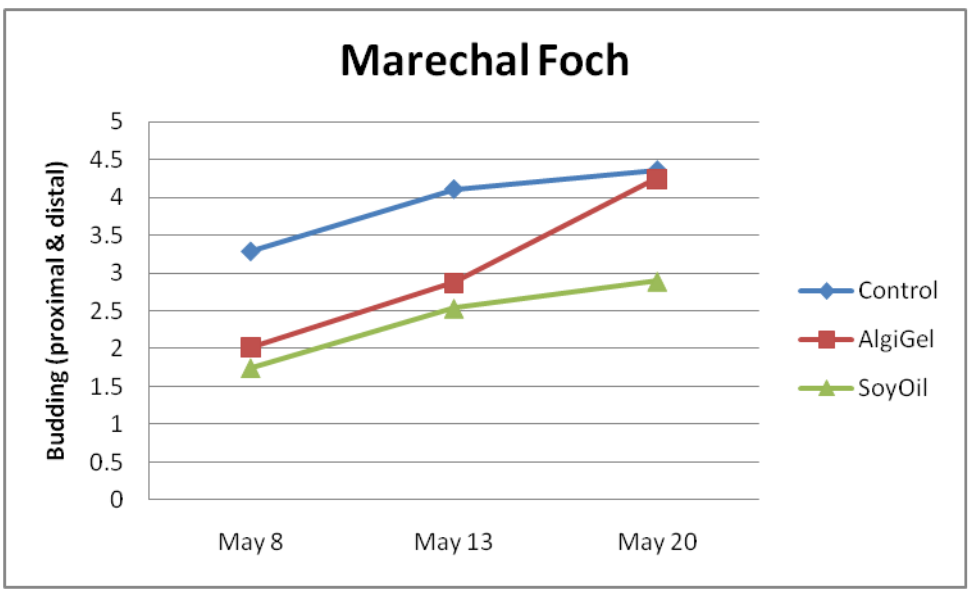


Figure 1. Mean bud development for Marechal Foch grapevines.

St. Croix: Mean bud development for the data recording dates for St. Croix are plotted (see Figure 2). As shown in Figure 2, mean bud development for the Amigo Oil group on May 20 (*M* = 3.0) is less than mean development for the Control Group on May 13 (*M* = 3.9). Thus, it can be determined that bud development has been delayed by at least seven days. Extrapolation of this trajectory results in an estimation of bud delay being between 14 and 21 days.

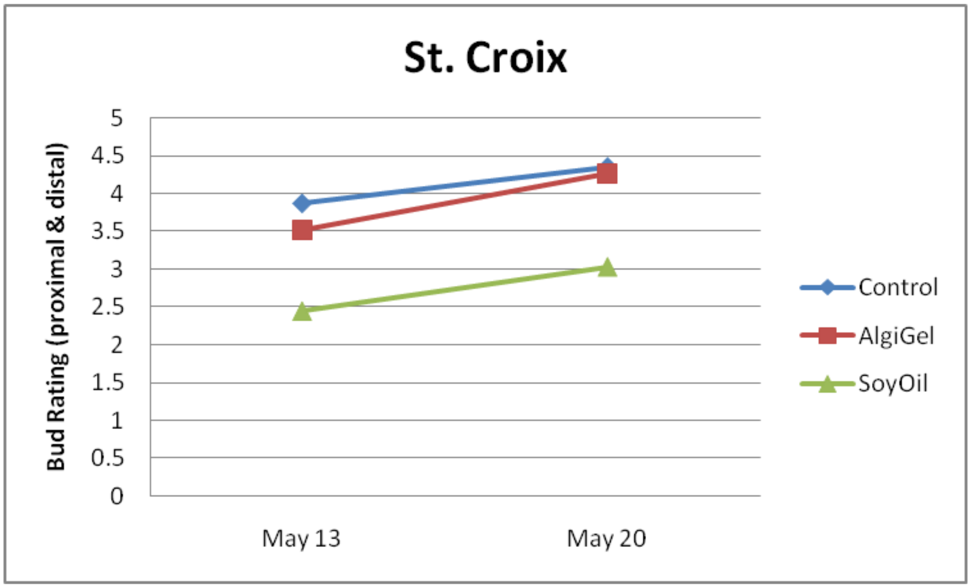


Figure 2. Mean bud development for St. Croix grapevines.

Brianna: Mean bud development for the data recording dates for Brianna are plotted (see Figure 3). As shown in Figure 3, mean bud development for the Amigo Oil group on May 20 (*M* = 3.2) is less than the mean development for the Control Group on May 13 (*M* = 3.4). Thus, it can be determined that bud development has been delayed by at least seven days.

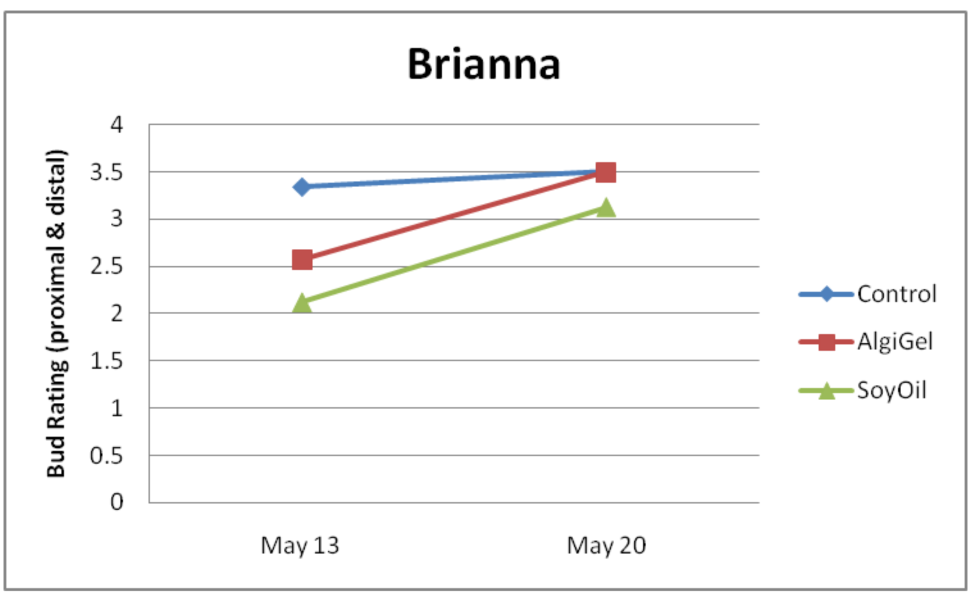


Figure 3. Mean bud development for Brianna grapevines.

<u>Year 2</u>

Marechal Foch: Means of bud development at each of the four data recording dates for Marechal Foch were plotted (see Figure 1). As shown in Figure 1, by extrapolation it can be determined that mean bud development of the Backpack group on May 11 (M=2.25) is approximately equal to the mean bud development of the Control group on May 2. Thus, it can be determined that bud development has been delayed by at least nine days. Mean bud development of the Air Blast group on May 11 (M=4.25) is approximately equal to the mean bud development of the Control group on May 6. Thus, it can be determined that bud development has been delayed by at least five days.

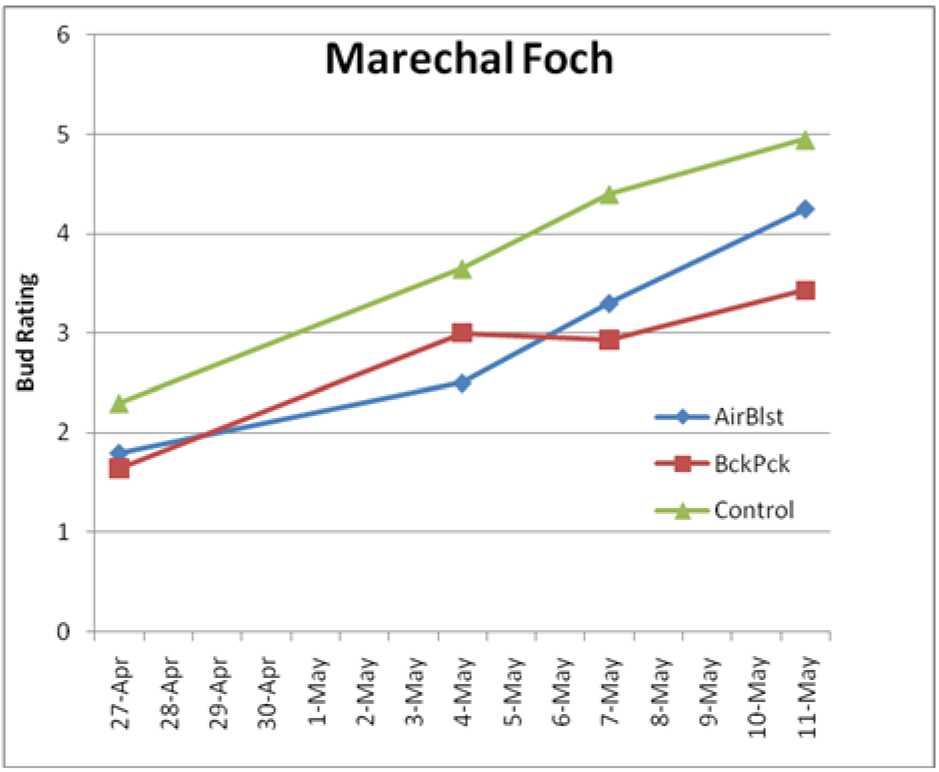


Figure 1. Mean bud development for Marechal Foch grapevines.

St. Croix: Mean bud development for the data recording dates for St. Croix are plotted (see Figure 2). As shown in Figure 2, mean bud development for the Backpack group on May 11 (M = 3.5) is approximately equal to the mean of the Control group on May 3. Thus, it can be determined that bud development has been delayed by at least eight days. The mean bud development for the Air Blast group on May 11 (M=3.75) is approximately equal to the mean of the Control group on May 6. Thus, it can be determined that bud development has been delayed by approximately five days.

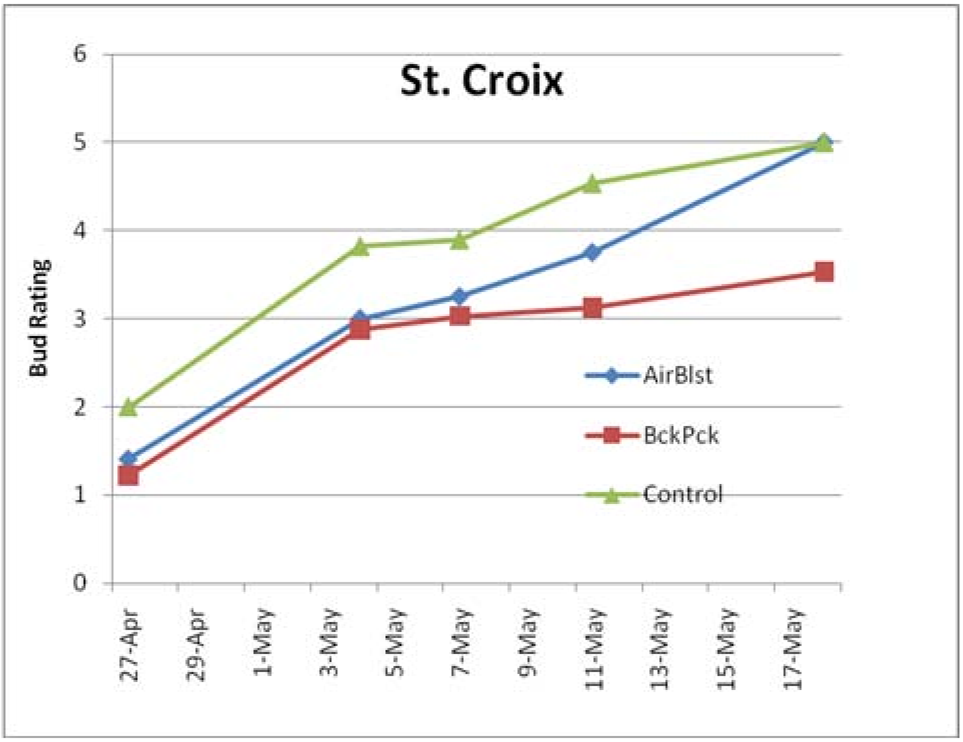


Figure 2. Mean bud development for St. Croix grapevines

Brianna: Mean bud development for the data recording dates for Brianna are plotted (see Figure 3). As shown in Figure 3, mean bud development for the Backpack group on May 17 (M = 3.0) is approximately equal to the mean development for the Control Group on May 4). Thus, it can be determined that bud development has been delayed by at least 13 days. The mean bud development of the Air Blast group on May 17 is equal to the Control group. However, mean bud development of the Air Blast group on May 11 is approximately equal to the Control group on May 4. This would indicate an approximate seven day delay in mean bud break at that point in time.

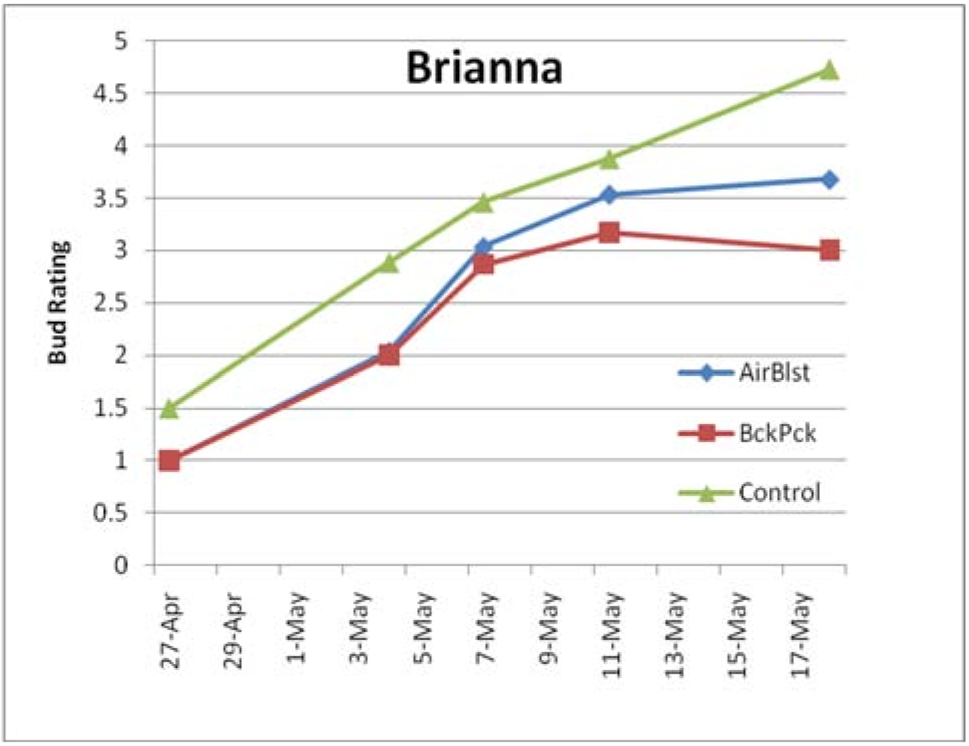


Figure 3. Mean bud development for Brianna grapevines.

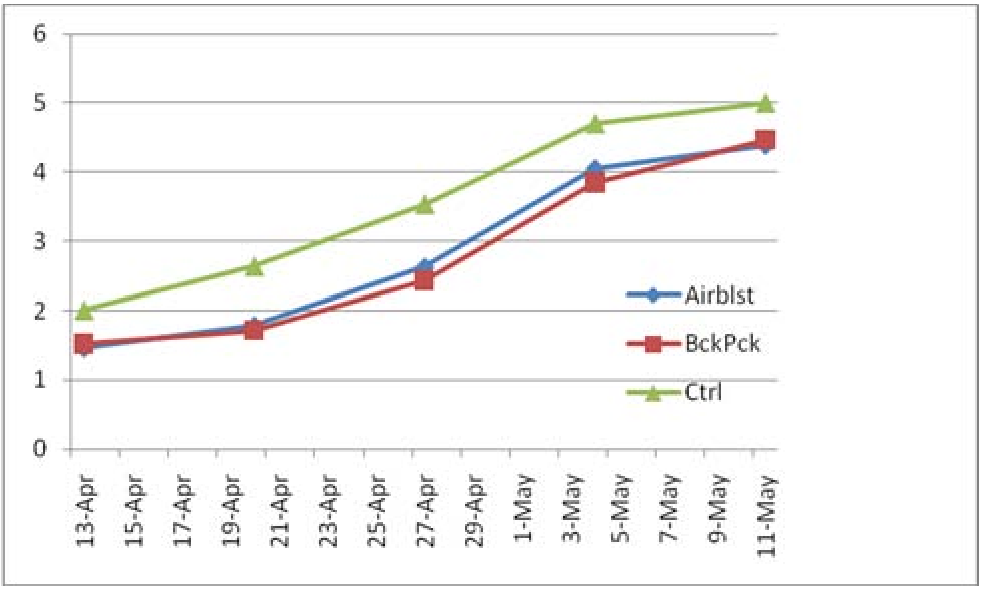
<u>YEAR 3</u>

Mac's Creek Site:

Marechal Foch:

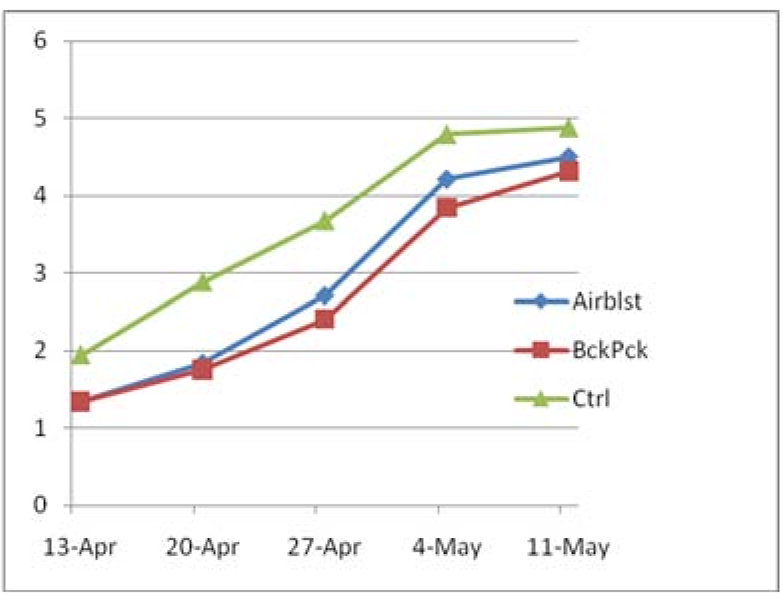
(Note: 4-7 day delay in bud break)

Brianna:



(Note: Approx. 5 day delay in bud break)

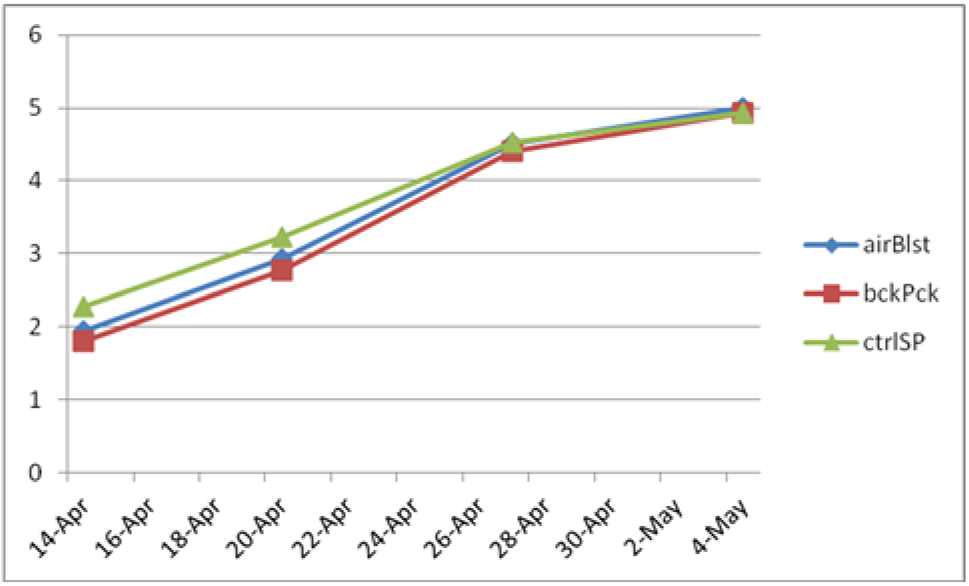
Edelweiss:



(Note: Approx. 6 day delay in bud break)

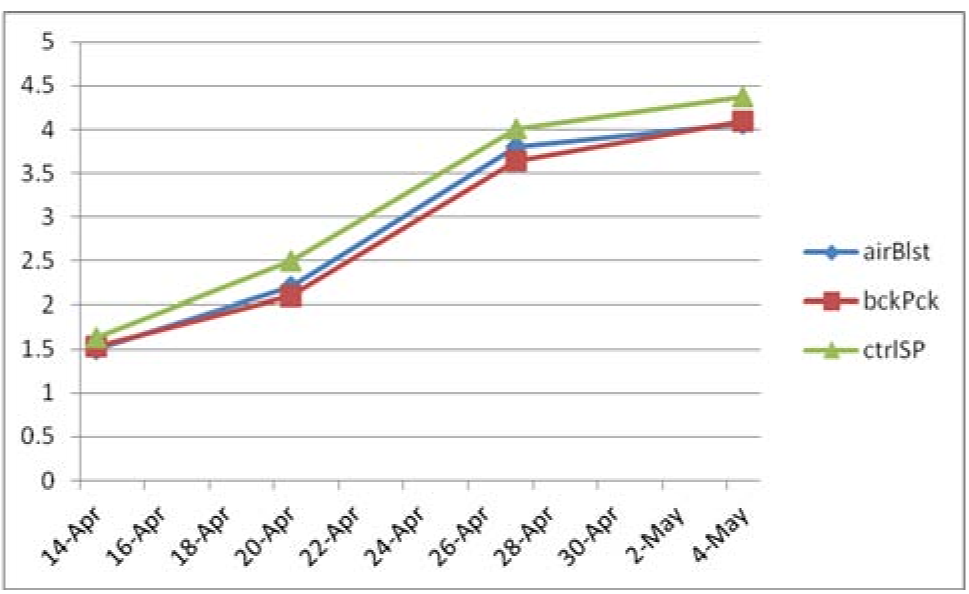
Reno Ridge Site: (18 miles S.W. of Mac's Creek Vineyards & Winery)

Marechal Foch:



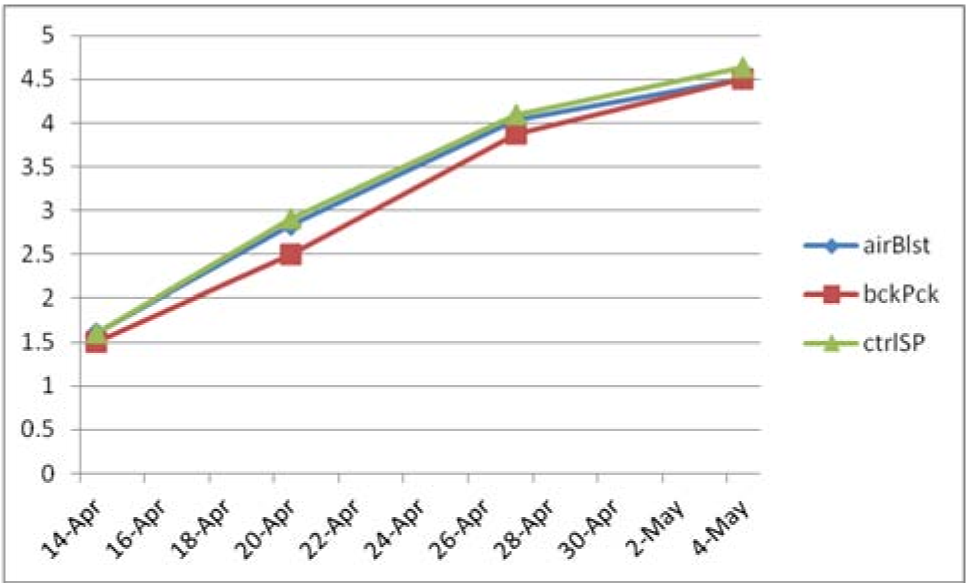
(Note: Approx. 2 day delay in bud break)

Brianna



(Note: Approx. 4 day delay in bud break)

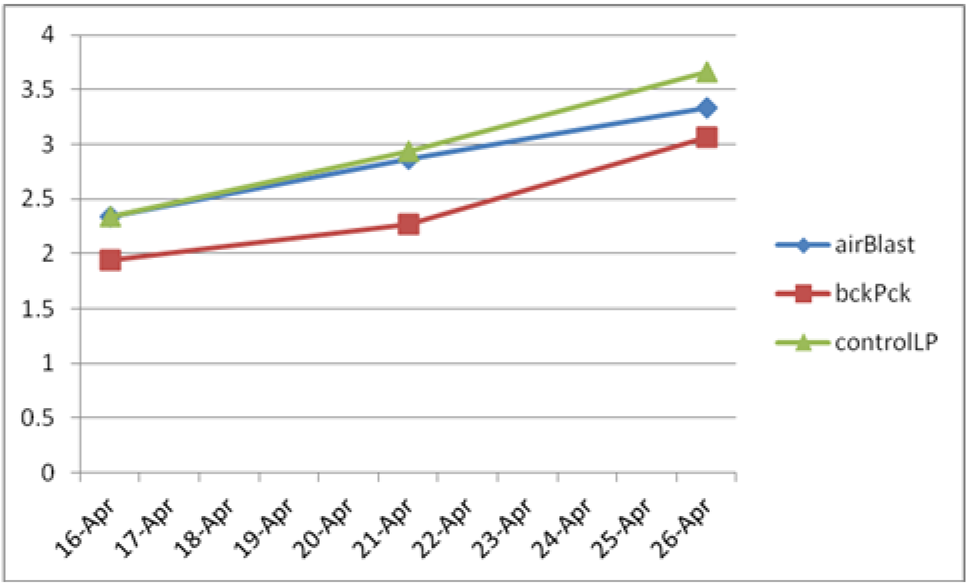
Edelweiss



(Note: Approx. 3 day delay in bud break)

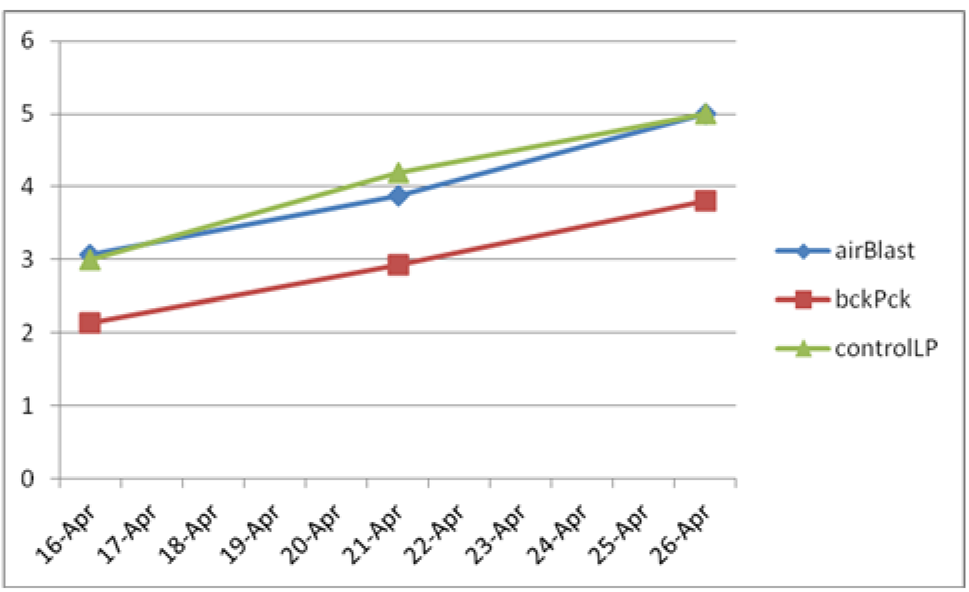
Nelson Site: (Eastern NE-north of Lincoln)

Lacrosse



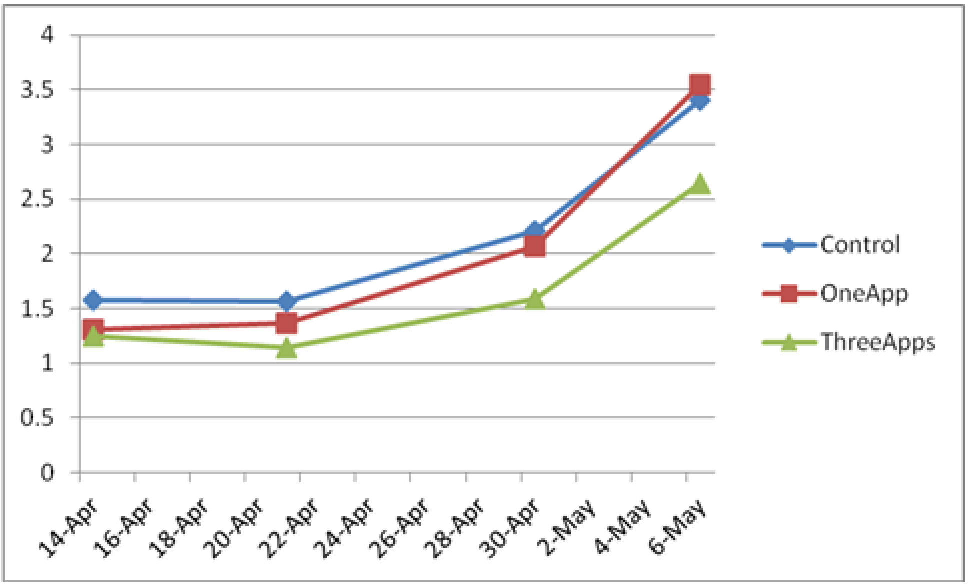
(Note: Approx. 5-6 day delay in bud break)

Edelweiss



(Note: Approx. 6 day delay with back pack sprayer; approx. 2 day delay with air blast; approx. 4-5 day delay of bud break with backpack delayed significantly compared to airblast.)

YEAR 4



Goal #1

Summary:

When considering the cultivar specific data across four years of this study (six years when you include an initial pilot study and preliminary data from the current year study) the following averages have been computed:

	Cultivar	Average Delay in Bud Break (days)	Range
1.	Marechal Foch	9.60	4 – 21
2.	St. Croix	12.75	8 – 21
3.	Brianna	8.33	5 – 13
4.	Lacrosse (one year only)	5.5	5 – 6
5.	Edelweiss (one year only)	6	6

It can be seen that the efficacy of applying Amigo Oil to dormant plants is significant and unequivocal. Each year studied yielded significant delay when compared to controls. Moreover, these results are quite impressive considering that the delays are documented across multiple winters/springs in Nebraska (no two of which are the same). These winters/springs range from mild to bitterly cold, early spring thaw to no early spring thaw, to extremely early spring thaw resulting in bud break occurring 30 days earlier than ever recorded in this vineyard.

It should also be noted that the extent of delay seems to be somewhat cultivar specific with average delays ranging from 5.5 days (Lacrosse) to 12.75 days (St. Croix).

Perhaps even more interesting is the extent of delay ranges, i.e., delays ranging from 4 days (Marechal Foch) to 21 days (Marechal Foch and St. Croix). Thus, depending on the year and the specific cultivar, delays of one to three weeks are quite common.

Goal #2

Overall cost/benefit specific to this vineyard will be computed by considering the following variables:

Benefit:

Yield: Average yield is quite difficult to compute. Even though Amigo Oil treatment can minimize or eliminate spring frost damage, there are still the challenges of hail, wind, poor fruit set, intense summer heat, etc. Thus, yields will vary greatly depending on these extraneous variables as well. The results of this study will be projected assuming no impact on yield from these variables. Thus, when looking at average yield potential on primary buds across all of the above cultivars, an average of 20lbs of fruit per vine can be projected. Assuming approximately 550 vines per acre, this yields 5.5 tons per acre. At the 2011 typical price of grapes being sold to wineries (i.e., $1200 / ton), this equates to $6600.00 per acre gross sales. At Mac's Creek Vineyards & Winery, this would be equivalent to approximately $46,200 total gross revenue for seven acres.

Obviously, the more typical scenario (and the reason for this research) is that due to late spring frost combined with early bud break, most all vines produce on secondary buds at best. Conservatively estimating at least a 33% reduction in production because of being on secondary buds, this leads to a yield estimate of 3.85 tons/acre @ $1200/ton = $4620 gross revenue per acre, or, $32,340 estimated gross revenue from the entire seven acre vineyard. This results in a $13,860 loss of revenue in just one year. Extended out to five years (length of this study), this results in a $69,300 loss, if the vines would produce on secondary buds every year.

Even with the use of Amigo Oil, one out of these five years (20%) still resulted in significant spring frost damage (2012). Due to the unusual extremely warm late winter and spring, vines budded out three to four weeks earlier than ever recorded on this site. The Amigo Oil treatment did significantly delay bud break (nearly two weeks on Marechal Foch) yet this was still not enough to avoid the damage of four significant freeze events, post bud break (i.e., 26, 28, 28, and 30 degree F nights).

Thus, even with treatment, these longitudinal results indicate that with one out of five years (20%) one can still expect to harvest on secondary buds. Factoring this finding into the projections yields the following: $46,200 per year (primary bud yields) for the entire seven acre vineyard; across five years = $231,000. Considering one of those years (i.e. 20%) to still be on secondary buds reduces the revenue by $13,860 for a Total Five Year Estimated Revenue = $217,140.

Considering monetary "benefit" only, these results indicate the estimated revenue could = $217,140 compared to the five year estimate without Amigo Oil treatment (i.e., producing on secondary buds each year) = $161,700 Total Revenue, or, a $55,440 difference.

In summary, the one year difference in estimated revenue on the Mac's Creek seven acre site, across five cultivars = $13,860. The five year difference = $55,440.

Cost

Longitudinal costs of the application of Amigo Oil in this study are as follows:

1) Amigo Oil: 10% solution = approximately 26 gallons per application. Number of applications varied from year to year (again weather related) and ranged from five applications to two applications. Using an average of four applications: 26 gallons/application for four applications = 104 gallons @ $20 = $2080 per year.

2) Labor: 4 hours /application X 4 applications = 16 hours @ $12 = $192

3) Equipment: 4 hours @ $100/hour (if you leased a tractor and sprayer) = $400

TOTAL Cost per year =$2672
TOTAL Cost across five years = $13,360

Cost/Benefit Comparisons:

One Year: Revenue = $46,200
Cost = $2,672
TOTAL NET BENEFIT = $43,528
Expected Revenue with no treatment = 32,340
Total difference = -($11,188) loss from no treatment

Five Year: Revenue = $231,000
Cost = 13,360
Net Benefit = 229,664
Expected Revenue with no treatment = 161,700
Total difference = -($67,964) loss from no treatment

PROGRESS ACHIEVED ACCORDING TO OUTCOME MEASURES

Outcome measures have consistently been addressed throughout this multi-year study. The data show that significant delay in bud break can in fact be obtained with the applications of Amigo Oil as detailed in the studies. These delays are documented across several years of Nebraska winter/springs, across different vineyards representing differing microclimates throughout the state, across different vineyard operators, across multiple cultivars, and, perhaps equally important, these results have been obtained and replicated in commercial vineyards under actual grape growing conditions incurred routinely by grape growers.

The above benefits have described only the monetary benefits based on yield production. With more cultivars producing on primary buds, additional benefits can be realized, including uniformity of ripening of fruit and most certainly enhanced quality of fruit. Additional intangible loss from frost damage i.e., consistency of crop quality (i.e., ripeness, maturity of vines, length of growing season being hampered by late bud break of tertiary buds) is even more profoundly felt by the winemaker trying to produce quality wine from questionable grapes.

Further, countless additional vineyard management hours are incurred in retraining new shoots, trellis positioning, weed control, etc., as many of these plants come back from the roots after 100% bud kill on the trellis. Finding techniques that can be effective on our cultivars and in our part of the country could make the difference between devastating damage which negates any profitability and, a consistent, quality, profitable wine/grape industry which is sustainable.