NGWB GRANT FINAL REPORT

2012-2013

Contract Number

18-13-214

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Issue of Interest

The Small Fruit/Orchard industry is beginning to grow in the state of Nebraska as a value added product utilized in juice and wine production as well as supplying burgeoning Farmer's Market outlets. As such, horticulture practices must be scrutinized closely to assure the industry is sustainable while minimizing environmental impact. This study will investigate the feasibility of eliminating/reducing chemical usage in disease control via the usage of ozone technology, thereby enhancing sustainability, reducing environmental carbon footprint, enhancing the positive image of the Nebraska industry and protecting the consumer. Ozone technology and engineering have reached levels which enable commercial application in vineyards to be researched.In fact, in a preliminary study (Mac's Creek, 2012) application of ozone has been found to reduce the need for pesticide application in order to control disease in the vineyard. While this is only the first year of such a study, the results are promising. The focus of this proposal is to expand this promising research from the vineyard to an orchard application, thereby applying this technology to small fruits in Nebraska, such as apples and pears. In an increasing effort to assure sustainability of orchard horticulture with minimal carbon footprint and maximum public safety, Year 1 of this project will be a pilot study. Year 1 results will be used to guide the replication of a larger , more wide scale commercial application project, i.e., Year 2. It is hoped that this Year 2 study will lead to a USDA proposal for Year 3. The potential impact for Nebraska horticulture is huge. While the preliminary data show a tremendous amount of promise in the vineyard application (Mac's Creek, 2012), the researcher was unable to determine that this technology has been used in an orchard application.

Approach to Problem

1. Sample: Two cultivars were selected for study, i.e., Crabapples and Pears. Each cultivar was divided into three groups; Control Group (no spray - N=3); Treatment Group 1 (normal chemical spray as per Cardinal Orchards usual spray program, N=3); Treatment Group 2 (Ozone spray, N=3). Each group was selected by rows in a block style method. All trees were managed in a

manner consistent with normal growing season care for commercial orchards (i.e. pruning, irrigation, etc.) prior to and during any treatment.

2. Procedures: 2. Procedures: After the sample was identified, normal spray schedules were adhered to, i.e., approximately twelve applications per the growing season. Disease presence was monitored for each group. Each time chemical spray was applied, so too was ozone applied to Tx Group 2. Data were collected weekly by using a five point rating scale (1 = no signs of disease; 5 = High disease presence).Type of disease was also recorded. Spray was applied with a hand wand sprayer attached to the ozone sprayer and for equal gal/acre rate of application as compared to the backpack sprayer application of chemical pesticides (i.e., approx.40 gal/acre).

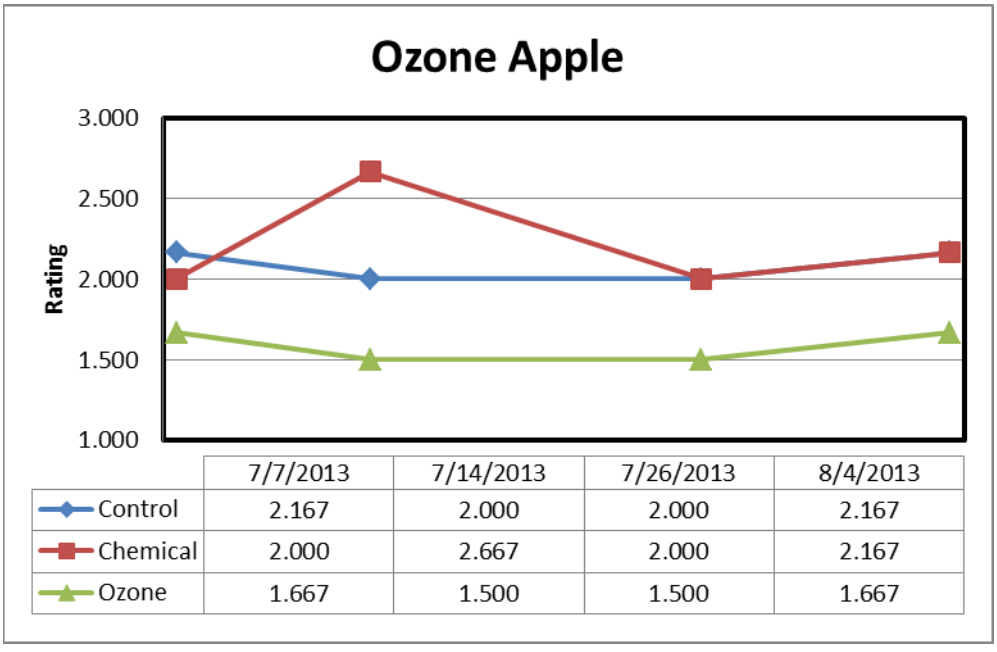
Goals/Achievement of Goals

Goal # 1: To investigate the efficacy of ozone application to control disease in a commercial ORCHARD application:

Is there a difference in disease control among groups when comparing the Control Group to Tx1 to Tx2 ***within*** each cultivar?

Results, Conclusions, Lessons Learned

Average ratings on all trees within each of the three groups (Control, Tx1,Tx2) for each of the two cultivars (Crab Apple and Pears) were analyzed (ANOVA) and compared weekly (see graph below).



	7/7/2013	7/14/2013	7/26/2013	8/4/2013
Control	2.167	2.000	2.000	2.167
Chemical	2.000	2.667	2.000	2.167
Ozone	1.667	1.500	1.500	1.667

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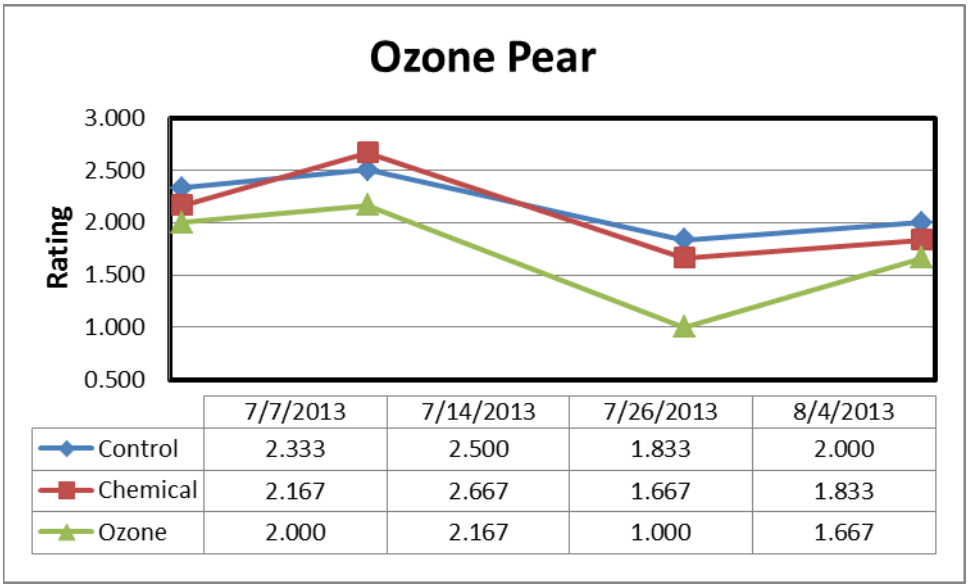

	7/7/2013	7/14/2013	7/26/2013	8/4/2013
Control	2.333	2.500	1.833	2.000
Chemical	2.167	2.667	1.667	1.833
Ozone	2.000	2.167	1.000	1.667

Each weekly data point on the graph represents statistically significant differences between ozone group and controls, and, between ozone group and pesticide group; $p<.001$, i.e., significantly less disease.

1) Tx2 (ozone) trees were consistently rated as having significantly less observable disease than Control (no treatment group).
2) Tx2 (ozone) trees were consistently rated as having significantly less observable disease than Tx1 (pesticide sprayed) vines.
3) Tx1 (chemical) trees were rated as having no observable difference in disease pressure when compared to Control (no treatment group), with the exception of Week 2 Crab Apple ratings (Week 2 ratings indicate higher disease pressure on chemically treated trees than on trees receiving no treatment at all).

Conclusions

These data should be considered as preliminary at best. This spring and summer of 2012 was one with intense heat, low moisture, and low humidity and thus, disease pressure in the orchard was much less than usually seen. That said, these results are extremely encouraging. Ozone treatment consistently, i.e., in each of the weeks rated, document significantly less disease pressure than did the untreated controls and, the trees sprayed with pesticides. Even during the time span of the most observable disease pressure (early July) as observed with both the

Controls and Tx1 (pesticide treated) trees, the ozone treated trees continued to exhibit minimal presence of disease ranging from no disease to very low disease pressure.

Progress Achieved According to Outcome Measures

As stated earlier, the **potential impact for small fruit horticulture in the state of Nebraska** is huge:

a. Preliminary data from a vineyard application (Mac's Creek, 2012) has documented that the usage of ozone results in significantly less disease pressure when compared to controls, and, even more importantly, significantly less disease pressure when compared to normal chemical usage. This limited trial reports control of mildew, phomopsis, and insect control. No research has been found which evaluates the efficacy of ozone in an orchard application. This research could be one of the first such studies which systematically evaluates the effects of ozone.

b. If the data are supportive, then it is hoped that this study can be expanded and replicated via a second or third year grant (USDA).

c. Should ozone prove to effectively control disease, the grower could eliminate a substantial portion of their chemical spray program.

d. Problems of disease control, the build-up of chemical resistance, not being able to spray at, or during, harvest could be minimized or eliminated.

e. Improved safety/ image of safety for the consumer could significantly impact the marketing/sales of Nebraska fruit products.

f. Major strides could be taken to enhance sustainability of the small fruit industry while also enhancing the Producers' stewardship of the environment.

Benefits to Nebraska Small Fruit Producers could also be multifaceted and include the following:

a) Move more closely to organic production: With the elimination or reduction of the use of chemicals in the production of the food product (apples, pears peaches) the producer will move more closely to an "organic" method of production.
b) Safer raw product. The industry has done a good job of training/informing growers such that hopefully all products being used are labeled for usage with small fruits and the application of the products are within safety and legal parameters. However, even with these safeguards in place, there is an ever-increasing concern with potential harmful impact on the raw product, environmental impact, and, potential public/consumer impact resulting from the continued and increasing usage of these practices.
c) Flexibility for disease control at the time of harvest: Each of the pesticides used recommend "harvest intervals", i.e., the amount of time the grower must wait after application until the fruit can be safely harvested. When the disease pressure is heavy, this can result in diseased fruit being harvested, which can lower production and potentially even result in fruit that is rejected because of poor quality. The other possible outcome is that the fruit is sprayed and must be left hanging until the harvest interval has passed which again can result in poor fruit quality (e.g., wait too long to harvest and the ph is too high/acidity too low, etc.). Using ozone could mean that spraying or disease

control can be done immediately prior to harvest with no harvest interval being necessary.

d) Improved food product safety for the consumer could directly also significantly impact the marketing/sales of the Nebraska fruit/wine product.

Benefits to the Ecology could be equally as positive and significant. These benefits could include:

a) Reduced build-up of disease resistance to chemicals. The build-up of disease resistance to currently used chemicals is a major problem today in production agriculture. Even with recommended alternating of the usage of different pesticides, resistance continues to build up including herbicides, fungicides, and insecticides. The use of ozone will not result in any such known build-up of resistance.
b) Reduced usage of toxic chemicals
c) Reduced negative environmental impact and chemical residual build up in soil and/or water supply.
d) Increased consumer safety. This study could result in improved food product safety for the consumer.

Therefore, major strides could be taken via this project to enhance sustainability of the small fruit production industry all across Nebraska while also enhancing the Growers' stewardship of the environment

Summary

These results are profound. Additional research is necessary to replicate these findings across multiple years (i.e., differing weather conditions from summer to summer), multiple orchard sites (and thus microclimates throughout Nebraska), and across multiple cultivars. Moreover, while the methodology in this study controlled for variability of application of pesticides and ozone (i.e.,approximate.same volume applied per tree, spraying at exact same time /days and intervals), research is needed to investigate varying volumes of application and intervals needed to realize equal disease control.

Financial Report

Grant expenditures aligned with projected budget and were expended as follows:

Research Consultant	500
Research Assistant	2700
Plant Pathology Consultant	1200
Data Entry/Statistical Analysis	1000
Sprayer Consultant	3500
Site Manager	500
Total:	$9400