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Submitted by:
Karen Reichek, Director, Contracts & Grants
Texas Department of Agriculture
Trade & Business Development
Karen.Reichek@TexasAgriculture.gov or Grants@TexasAgriculture.gov
Phone: (512) 936-2450
Fax: (888) 223-9048
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Table of Contents

PROJECT 1: IDENTIFYING SUPERIOR PIERCE'S DISEASE RESISTANT GRAPE VARIETALS AND ROOTSTOCKS FOR TEXAS

Partner Organization: Primary – Texas Hill Country Wineries Association; Partner – Texas A&M AgriLife Extension Services
Project Manager: January Weise (THCW) James Kamas (AgriLife)
Contact Information: j-kamas@tamu.edu, 512.216.9897
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Summary
Pierce's Disease (PD) of grape is a devastating and major limiting factor to further development of grape production in Texas. The use of susceptible traditional (*Vitis vinifera*) varieties in areas which have moderate PD pressure represents a financial risk for producers. Current methods of disease management rely heavily on chemical control of the vector insect population, a costly strategy and one that could have negative environmental impacts. In regions with high PD pressure, grape production is limited to a small number of hybrid grape varieties with limited market appeal.

The work completed through this project complemented and enhanced previous efforts funded through the Specialty Crop Block Grant Program by continuing the evaluation of existing and newly-bred PD resistant grape varieties and by facilitating the impact of properly selected rootstocks on the health and productivity of scion varieties.

The project initially selected 32 potentially high quality, PD resistant varieties among known heirloom varieties, in addition to, selection from multiple, conventional breeding programs across the U.S. Of the initial 32 varieties, 9 varieties were identified and evaluated through this project. Additionally, 4 new varieties from the University of California, Davis breeding program were evaluated for disease tolerance and fruit quality.

Project Approach
Superior plot management was practiced during the 2015 growing season in three rootstock trial blocks and three PD resistant/tolerant variety trial blocks in Austin, Gillespie and Real Counties. These duties included pruning and training of grapevines, insect and fungal disease management, vineyard floor management, fertilization and proper timing and placement of supplemental irrigation water. These duties were performed to exacting standards on a timely basis in order to minimize variability within test sites in order for treatment differences to be accurately assessed.

Rootstock Trial
After pruning, 2014 grown pruning weights were taken, recorded and analyzed. These measurements are taken to compare vigor imparted by the twelve different root systems present in each of the three rootstock plots. Petiole samples were taken and submitted for analysis at bloom and véraison to compare the ability of each root system to forage for and assimilate nutrients among these three vastly different growing locations. Fruit maturity was monitored

through the summer and at mean peak maturity, fruit samples were taken to assess the impact of these rootstocks to impact fruit chemistry. Initial acidity, pH and soluble solids were assessed at harvest, but fruit samples were frozen to run complex analysis of color and flavor components. The growing conditions at the Real County location represent an extreme location in the Texas Hill Country with a high concentration of fractured limestone. These Spartan conditions quickly sorted out the twelve root systems with five of the twelve performing at a satisfactory level. 5BB, 5C, 1103P, Salt Creek and Dogridge (rootstock varieties) all provided sufficient vigor to at least grow and produce fruit. The other seven root systems did not perform well enough to support vine growth and productivity and there was an increasing percentage of death due to a variety of causes including cotton root rot infection and winter injury. To some degree both of those causes simply represent a lack of sufficient vigor to support vine growth and productivity at this site. The Real County rootstock block will be dropped for the 2016 growing season because project staff has the information needed for this location. The other two blocks in Gillespie and Austin counties are now at full maturity and will provide valuable knowledge on these rootstocks ability to impact date of bud-break, winter hardiness and influence on fruit quality.

PD Resistant/Tolerant Variety Trial

The Pierce's disease resistant/tolerant variety trial blocks have confirmed the existence of five selections, four from California and one from Florida with the confirmed ability to produce high quality wine grapes under high Pierce's disease pressure. California selections that have performed well include U0502-20 (white), U0502-38, U0505-35 and U0502-10 (reds). The Florida selection that continues to perform well is A-24-6-6 (white). While these selections perform well over a wide variety of climatic conditions, the California selections are more susceptible to downy mildew than other varieties traditionally grown in the Gulf Coast region, so growers will need to adapt more rigorous spray programs to manage this pathogen in wet seasons.

This variable resistance to downy mildew makes some selections more adaptable to the Gulf Coast and others to the southwestern part of the Texas Hill Country, but wine quality among all of these selections make them suitable candidates for commercial production. Once again, in 2015, grapes from our research plots and other larger scale plots established in grower vineyards were used for small lots of wine for evaluation by a panel of Hill Country winemakers in early 2016. Research staff also saw first fruit of the U.C. Davis 94% *V. vinifera* selections this year from the Fredericksburg planting and collected initial data on fruit chemistry. Staff anticipate that larger blocks of the 94% selections in Industry and Leakey, Texas will be on-line for production in 2016 and there will be enough fruit to produce wine lots for evaluation. In anticipation of public release of the 88% selections, larger blocks of these selections have been propagated and established at the Fredericksburg Vineyard and Fruit Lab to be able to supply Texas growers with a source of propagation wood once these selections have been released.

Problems and Delays

An excessively wet spring presented high fungal disease pressure at all plot locations. To deal with this, increased fungicide sprays were applied and fruit quality was maintained. However, fruit from the Austin County rootstock trial was compromised by excessively high soil moisture and little valuable information was obtained. Fruit quality data was collected from the other rootstock plots, but record rainfall in the Gulf Coast, combined with the early ripening characteristics of 'Blanc du Bois' were problematic. While it is not possible to address uncontrollable factors such as weather conditions in a scientific field trial, these weather conditions presented problems outside the recognizable norm for this region. While additional fungicide sprays can help to alleviate fungal disease pressure, it is not possible to mitigate the effects of excessive soil moisture on fruit quality. Unusual weather patterns present unforeseeable and uncontrollable hazards to any field trial. The risk that excessive soil moisture presents for fruit quality is one that is simply an uncontrollable assumed risk of crop production. With that in mind, it is not anticipated that this level of rainfall will repeat itself in subsequent trial years allowing for more sufficient evaluation of fruit quality in this region.

Goals and Outcomes Achieved

The over-arching goal of this project is the identification of superior grape varieties resistant to PD and finding improved rootstocks which will support the superior PD resistant varieties. More specifically, to improve plant health through the development of better long-term, sustainable approaches to the management of PD, to reduce vine losses, to increase the number of adapted varieties available to growers, and ultimately to expand the profitability of commercial grape production in Texas. Grower adoption of the cultivation of new varieties will be the ultimate way to document project success.

In 2014 research staff made plans to establish larger commercial size blocks of some of these selections within grower run commercial vineyards across a wide geographic area with high PD pressure this season. This move was blocked by the intellectual property attorneys at U.C. Davis. While they do not intend to patent the 88% selections, they have insisted further propagation and distribution of these selections to commercial sites be suspended pending the release of at least one of the 94% selections. Lengthy discussions with attorneys and the breeder have resulted in the preliminary decision to release 88% selections into the public domain, but that did not happen in 2015. Staff continues to work with both the breeder and legal team to obtain permission to expand evaluation at the earliest possible date. Jim Kamas, PI on this project is in regular and ongoing contact with both the breeder of these varieties, Andy Walker and the IP attorneys for U.C. Davis assigned this case. It is our collective agreement that once the 94% varieties being released under patent are released, the intention is to release the 88% varieties utilized in our current studies into the public domain. At this point we will be free to propagate, expand testing of and eventually distribute selected varieties from this trial.

Beneficiaries

The direct beneficiaries of the project are the approximate 220+ family-owned vineyards and the numerous prospective growers of winegrapes in the state. Identifying superior PD resistant varieties and rootstocks that could effectively support the scions plus providing recommendations of these varieties/rootstocks to existing prospective growers could add significant economic benefit. The use of PD resistant varieties would result in reduced risk of financial loss due to PD, reductions in environmental pesticide load, reductions in the risk of insecticide tolerance of vector species and the expansion of the existing range of areas capable of producing high quality grapes.

Additional Information

Staff will continue to maintain all plots (except the Real County rootstock plot) for the 2016 growing season. Continued evaluation of fruiting scion varieties over time will allow evaluation of wine potential over a variety of climatic conditions from year to year. In addition, the four 94% *vinifera* selections should be in production at all locations in 2016 allowing full evaluation of fruitfulness, differences in fruit quality and resistance to fungal pathogens across testing sites.

Rootstock trials, by their nature need time to mature in order for research staff to have a thorough understanding of their influence on vine performance. Striking differences have been seen in nutrient uptake between rootstocks at the Austin County location which have helped staff to understand some of the canopy health issues that commercial 'Blanc du Bois' growers are facing. In addition, rootstock evaluations at this site will provide long-term information on date of bud-break, vigor, crop maturity date, and wine quality components facing Gulf Coast grape growers.

The highly homogenous soils at the Gillespie County location have provided the ideal location to evaluate the influence of rootstocks on a wide array of color and flavor components that impact wine quality. Continued evaluations will provide Texas grape growers with specific information on how rootstock selection will impact numerous viticultural traits over time.

The PI and staff on this project will continue to provide program updates to growers, researchers and other interested parties at Agrilife Extension and grower organization sponsored events. It is anticipated that on completion of this study, specific information with regard to rootstock and variety recommendations will be made to current and new growers through individual consultation and public meeting.

PROJECT 2: CONSERVING WATER IN RURAL AND URBAN VEGETABLE FARMING – YEAR 2

Partner Organization: Primary – Uvalde County Underground Water Conservation District
Partner – Texas A&M AgriLife Extension Services
Project Manager: Vic Hilderbran (UCUWCD), Co-PI Dr. Daniel Leskovar (AgriLife)
Contact Information: Vic Hilderbran (830) 278-8242, Daniel Leskovar, 830.278.9151 x.249; d-leskovar@tamu.edu
Type of Report: Final
Date Submitted: May 5, 2016

Project Summary

The production of leafy green crops has increased in the major vegetable growing regions in Texas, such as the Wintergarden, the Lower Rio Grande Valley and central Texas. The increased demand for these crops in major urban areas, especially the large metro cities of San Antonio, Austin, Dallas and Houston, as well as peri-urban municipalities create new opportunities for emerging, small, and large farmers to enhance their competitive advantage by increasing their availability to traditional retail outlets, farmers markets and restaurants. Production of leafy greens in open fields is often limited due to environmental conditions, such as high temperatures, drought and extreme heat during the growing season. In addition, due to the limited water supplies and strict water restrictions for water resources, growers, consumers and retailers are increasingly interested in water conservation approaches that lead to high crop water use efficiency (WUE). Despite the increased statewide demand for leafy greens there is a relative low contribution of Texas-grown products in the market, with most coming from western states such as California or Mexico. This gap, at the same time represents a huge opportunity for emerging, new or established farmers to increase their shares and thus profitability. The production of leafy greens in hydroponic systems is less sensitive to the environmental limitations and can produce crops almost year-round. This system is also very attractive as it does not need soil resources, field rotations, and reduces the pesticide load to the environment as compared to open field cultivation. Studies in hydroponics were performed to determine WUE and product quality of the most popular lettuce types in the market, Romaine, Bibb and Loose-leaf types. Complementary field studies were designed to compare yield, production cycles and quality of lettuce and other leafy greens under conventional and organic practices. Results, experiences and pitfalls from these trials were integrated and used in growers' forums and educational science-based programs for emerging, established and potential new farmers in Texas. The data has shown that hydroponic lettuce can be grown in 48 days from seeding to harvest to reach a mature size, with the highest WUE in the order of Romaine > Bibb>Loose-leaf types. The most WUE cultivars were 'Sunbelt' (Romaine), Buttercrunch (Bibb) and Pearl Gem (Loose-leaf). The project identified best lettuce cultivars with less tip burn at low calcium (Ca) concentration in the nutrient solution. The effect of tipburn was significantly reduced by doubling the Ca level in seven lettuce cultivars. In the field, the same lettuce cultivars used in the NFT, Swiss chard, collards and kale were compared under drip in conventional and organic, and linear sprinkler (conventional). Cultivars were grouped and ranked for bolting (a negative response that makes heads unmarketable) no bolting (0%), low bolting (up to 25%) and high bolting (up to 100%). The best lettuce cultivars with less bolting were 'Aerostar', 'Sunbelt', and

‘Dragoon’, ‘Salad Bowl’. This project complemented a previously funded Specialty Crop project in refining irrigation and fertility practices (Ca) leading to the improvement in production and quality of leafy greens.

Project Approach

The following activities and tasks were achieved during the grant period: evaluation of water use efficiency, yield and quality of lettuce cultivars under hydroponic culture systems, screening lettuce cultivars for ‘tip-burn’ resistance, growth evaluation of leafy greens under conventional and organic fields under irrigation, consumer preference for leafy greens and educational programs. Six NFT recirculating systems were assembled in the greenhouse. Four cycles of ten lettuce varieties were replicated and evaluated using the NFT recirculating system. In addition, two Swiss Chard, two collards, four kale cultivars and eleven lettuce cultivars were tested in field environments under drip irrigation (conventionally and organic managed) and Low Energy Precise Application (LEPA) irrigation (conventionally managed). For all crop and cultivars, growth and quality parameters were measured at the harvesting stage.

WUE and quality of leafy greens in hydroponic culture

Seeds were sown on October 22, 2014 (first cycle), December 26, 2014 (second cycle), February 1, 2015 (third cycle) and March 15, 2015 (fourth cycle). Seedlings were grown in a greenhouse environment in propagation trays and transplanted into the hydroponics channels on November 12, 2014 (cycle 1), January 12, 2015, (cycle 2), February 18, 2015 (cycle 3) and on April 3, 2015 (cycle 4). Lettuce plant productivity (fresh and dry weight), number of leaves, stem diameter, chlorophyll content (SPAD), leaves length, and sugar (Brix) values were recorded at harvest for each cycle. Growth and quality data for each cycle was grouped by the three lettuce types (Bibb, Romaine and Loose-leaf). Overall, WUE under hydroponic culture ranged for 0.22-1.1 L/g dry weight (DW) for Bibb lettuce, 0.27-2.08 L/g DW for Loose-leaf and 0.28-0.91 L/g DW for Romaine type. When considering the total water use per plant those were: 1.3-3.4 for Bibb, 1.3-4.0 for Loose-leaf and 1.3-3.4 L/plant for Romaine lettuce. The best cultivars based on all four cycles were ‘Buttercrunch’ (Bibb), ‘Sunbelt’ (Romaine) and Pearl Gem’ Loose-leaf. ‘Ezatrix’, ‘Caipira’, ‘Progreen’ and ‘Kremlin Red Leaf’ had WUE from 0.5 to 0.66 $L.g^{-1}$ DW and moderate productivity. The cultivars ‘Belatrix’, ‘Ezfrill’ and ‘Ezfilan’ had poor WUE – 0.9-1.2 $L.g^{-1}$ and the lowest productivity of all lettuce types grown in the NFT system.

Hydroponic cultivars Pearl Gem (PEAG, left) Bibb and Buttercrunch (BUT, right)

Screening for tip-burn in lettuce: Effects of supplemental calcium

Thirteen Romaine lettuce cultivars ('Aerostar', 'Parris Island', 'Dragoon', 'Fenberg', 'Holon', 'Green Forest', 'Coastal Star', 'Sparx', 'Annapolis', 'Outredgeous', 'Rouge D'hiver', 'Chabi', 'Sunbelt') and seven Bibb lettuce types ('Deer Tongue', 'Spretnak', 'Bambi', 'Winter Density', 'Buttercrunch', 'Rhazes', 'Bibb', 'Chabi', and 'Sunbelt') were grown under three calcium levels: (187, 280, and 373 $mg.L^{-1}$) using the Original Hydroponics Formula CNS 17. The influence of increasing calcium levels (187, 280, and 373 $mg.L^{-1}$) in reducing tipburn injury was further investigated. Lettuce seedlings were grown in greenhouse conditions under the nutrient film technique hydroponics and in open field environments for multiple growing cycles during 2015-2016. Significant differences in tipburn injury were found between cultivars grown in the greenhouse with nutrient film technique. Annapolis, Fenberg, Green Forest, Outredgeous and Sparx cultivars were more resistant to tipburn as compared to Aerostar, Coastal Star, Holon, and Paris Island. Bibb had the highest rate of tipburn. Increased calcium concentration from 187 (recommended by growers) to 280 $mg.L^{-1}$ reduced tipburn damage in Paris Island by 20% and Bibb by 60% in two out of three cycles. However, Dragoon, Holon and Paris Island showed inconsistent results. Higher levels of calcium (373 $mg.L^{-1}$) eliminated the grade of serious damage in Fenberg and Bibb, in one out of three cycles, but had no effect in increasing tipburn resistance in Aerostar, Dragoon, and Holon. While higher than the recommended calcium concentration reduced tipburn in some cultivars, screening for genetic resistance to tipburn appears to be the best strategy as shown in this lettuce study

Severe tip burn in Bibb (left) and Romaine (right) lettuce types.

Leafy greens: response to irrigation systems, conventional and organic fields

Four leafy green types namely lettuce, Swiss chard, collards and kale were evaluated for growth, quality and bolting tolerance under three irrigation systems, hydroponics NFT in the greenhouse, subsurface drip irrigation in conventional and organic fields, and linear sprinkler irrigation (LEPA). Bolting (premature flower stalk development) is a negative response under hot and stressful environments. Therefore screening for this trait is critical to selecting the best low-bolting varieties in Texas. Lettuce cultivars with no bolting were: 'Aerostar', 'Sunbelt', 'Dragoon'; intermediate bolting were: 'Buttercrunch'; and high bolting were: 'Bibb', 'Dear Tongue', 'Rhazes', 'Salad Bowl', 'Spretnak', 'Sparx', and 'Coastal Star'. None of the Swiss Chard, collards, and kale cultivars performed well during the summer production, especially in the organic fields.

Consumer preference for leafy greens: Demographic and Behavioral Characteristics

This experiment produced a total of 201 responses. Although a typographical error resulted in a loss of observations, several pieces of information were recovered and proved useful in the analysis. One of the goals of this experiment was to elicit consumers' willingness to pay for lettuce, thus the type of consumer targeted by the experiment's advertisement was a household's primary grocery shopper. Table 1 provides a description of the demographic and behavioral characteristics of the participants. It can be seen that roughly 84% of the participants were the primary grocery shopper for their household and over 57% of the sample was female. Nearly 44% identified with being married. Caucasians (73%) and Hispanic individuals (12%) largely made up the sample. Generally speaking, individuals were educated. The highest level of educational attainment was at least some college or a Bachelor's degree for over 58% of the sample and over 34% had at least taken some graduate course. The average participant was approximately 41 years old, earned around $51,599 per year, and lived in a household of 2.54 individuals. On average, participants spent $126 on food per week, of which around $29 was spent on fruits and vegetables. Moreover, fresh vegetables composed of more than a third of the average participant's full stock of food.

Table 1. Demographic and behavioral characteristics of experiment participants

Variable	Category	Sample		U.S. Population(a)		Texas Population(a)	
		Mean	Percent	Mean	Percent	Mean	Percent
Age (years)		40.94		37.40		33.90	
Household Size (individuals)		2.54		2.64		2.84	
Education	High School Diploma or Less		6.74		41.70		43.80
	Bachelor's Degree or at least some college		58.43		47.50		47.20
	Graduate Courses or More		34.83		10.90		9.00
Gender	Female		57.59		50.80		50.30
	Male		42.41		49.20		49.70
Marital Status	Married		43.72		48.00		49.40
	Not Married		56.28		51.90		50.50
Yearly Household Income ($)		51,599		71,317		70,730	
Race	Asian/ Pacific Islander		4.05		5.17		4.11
	African American		4.62		12.52		11.74
	Caucasian/ White		72.83		64.20		44.99
	Native American/ Indigenous		1.16		0.68		0.24
	Hispanic		12.14		17.24		38.79
	Other		5.20		0.20		0.12
Primary Shopper	Primary Shopper		84.08				
	Secondary Shopper		15.92				
Household Weekly Expenditures on Food ($/week)		125.87					
Household Weekly Expenditures on Fruits and Vegetables ($/week)		29.29					
Fresh Vegetables on Hand (out of full stock)			35.51				

(a)Source: U.S. Census Bureau 2012 American Community Survey 1-year Estimates

In addition to questions about basic demographic information and vegetable purchasing habits, subjects were asked to rate the relative importance of nine attributes that play a part in decisions when buying lettuce. This was included as a means of gaining information about the different factors that may contribute to an individual buying a specific lettuce product in the grocery store. Factors represented physical characteristics (i.e. size, visual appearance, and freshness), and product information (i.e. nutrition, growing location, and certified production practices), as well as marketing attributes (i.e. price and convenience) and experience features (taste). The scale of importance ranged from 1 to 4, with 1 representing "Not Important at all" and 4 being "Very Important." Table 2 displays a list of all factors, as well as their mean rating and an interpretation of each factor's importance.

Participants rated freshness (3.871) as the most important factor, followed by taste (3.706) and visual appearance (3.677). Relative to the other factors, participants, on average, cared least about where or how lettuce is grown, as they rated growing location (2.226) and certified production practices (2.585) as the least important factors when buying lettuce. An interesting result can be found when taking a closer look at the factor of convenience. It is worth noting that participants had very distinct views regarding certified production practices, as a large amount of variability can be seen in responses. Although a more in-depth analysis is warranted, knowing which factors consumers view as most important when buying lettuce presents significant value to the lettuce industry.

Table 2. Rated relative importance of factors in lettuce purchases [a]

Factor	Mean	Std. Dev.	Interpreted Level of Importance
Freshness	3.871	0.365	Very Important
Taste	3.706	0.488	Very Important
Visual Appearance	3.677	0.538	Very Important
Nutrition	3.452	0.686	Somewhat Important
Price	3.313	0.637	Somewhat Important
Size	3.237	0.705	Somwhat Important
Convenience	3.125	0.820	Somewhat Important
Certified Production Practices	2.585	0.958	Somewhat Important
Growing Location	2.226	0.813	Not Very Important

[a] Subjects were asked to rate the factors on a scale of 1 to 4; 1 = Not Important at all, 2 = Not Very Important, 3 = Somewhat Important, 4 = Very Important

WTP Models with Experimental Auction Bids

Participants' bids from the auction rounds were pooled for all treatments and resulted in a total of 3,193 willingness to pay (WTP) observations. The eight products used were heads of lettuces that varied in color and production method: organic green lettuce, organic red lettuce, hydroponic red lettuce, hydroponic green lettuce, hydroponic mixed lettuce (red and green), conventional red lettuce, and conventional green lettuce. The conventional and organic heads of lettuce, as well as one bunch of spinach were purchased simultaneously at a local Kroger grocery store, while the hydroponic heads of lettuce were grown by the Texas A&M AgriLife Research and Extension Center in Uvalde, Texas. Spinach was included in the product mix as a control.

Nine sessions of participants were split up into two groups. Group A (Sessions 1, 2, 3, 4, and 9) participated in a baseline auction round and received a blind tasting as the treatment, whereas Group B (Sessions 5, 6, 7, and 8) submitted bids in a baseline round and received hydroponic production information as the treatment. Participants' baseline bids for each product are described in Table 3, as well as the bids for each treatment group. The experiment produced bids that ranged in value from $0.00 to $5.50. Organic green lettuce received the highest average bid of $1.58 in the baseline round across all participants and hydroponic mixed lettuce was valued second highest at $1.55. Group A signaled a preference for organic green lettuce after the blind tasting treatment and gave it the highest average bid of $1.66. Additionally, subjects exhibited relatively high WTP for conventional green lettuce and hydroponic mixed lettuce in the blind tasting round. In Group B's information round, hydroponic mixed lettuce and organic green tied for the highest valued product, as they both received the highest average WTP of $1.90.

A graphical representation of the mean bids for each product by treatments is provided in Figure 1. The blind tasting treatment increased mean WTP for most products, but decreased mean WTP for organic red lettuce. This indicates that some participants disliked the taste of the organic red leaf lettuce. From the baseline to the blind tasting, Figure 1 shows the largest jumps in average WTP among conventional varieties. Alternatively, organic varieties, as well as hydroponic red and hydroponic mixed lettuces showed visible increases in WTP from the baseline to the information treatment. It is unclear as to why the hydroponic green lettuce did not follow this trend.

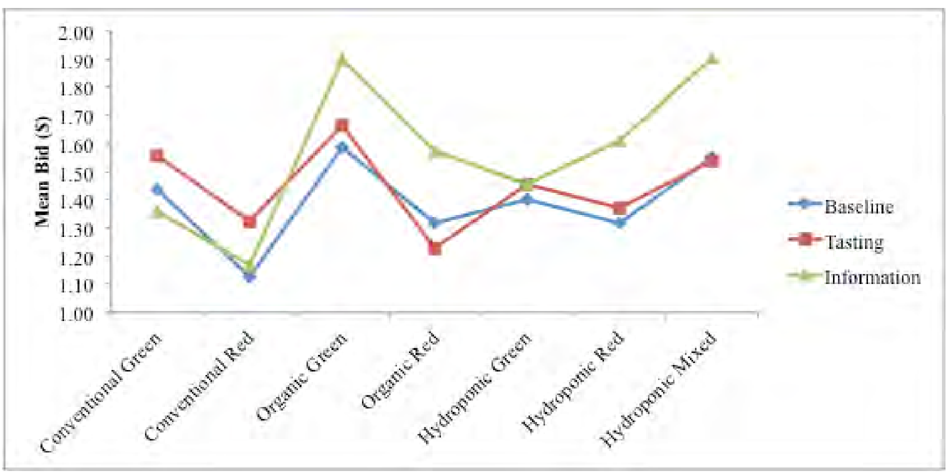

Figure 1. Mean bids for lettuce products by treatment

One of the goals of this analysis was to investigate whether production method is valued by consumers. Table 4 shows the mean WTP by production method and treatment for the lettuce products. It is clear that on average, over the course of the experiment, participants valued organic products highest, followed by hydroponics, and lastly conventional products. Overall, average bids for conventional varieties ($1.33) were in line with the average local retail price for conventional leafy lettuce at the time of the experiment ($1.38). However, mean bids for organic ($1.55) and hydroponic ($1.51) varieties were well below the average retail prices of $2.29 and $3.00, respectively.

Table 4. Mean WTP bids by production method and treatment

	Baseline	Tasting	Information	Total Average
Conventional	1.28	1.44 ***	1.26	1.33
Organic	1.45	1.45	1.74 **	1.55
Hydroponic	1.42	1.46	1.66	1.51

Null Hypothesis: $WTP_{baseline}=WTP_{treatment}$

Note: *, **, ***, indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

On average, participants expressed a premium for conventionally produced products after the blind tasting, while average bids for organic and hydroponic varieties either remained steady or only slightly increased after the blind tasting treatment. In the information treatment, participants learned about hydroponic production and, prior to bidding, also learned the production method and color of each auction product; therefore, it was expected that average bids during the information round would not be equal to average bids during the baseline round. Relative to the baseline, conventional products minimally decreased in average WTP and, as expected, large increases in average WTP for organic and hydroponic varieties were detected after learning about hydroponic production.

Educational programs

Another important objective if this work was to provide urban and rural educational programs on production, water saving technologies and benefits of hydroponic systems. About 50 participants were educated in the NFT and open field production systems of leafy greens during a Spring field day. Lettuce heads harvested from the hydroponic culture were provided to the Uvalde Nutrition Center, where consumers (mostly elderly and socially disadvantage) not only gained knowledge on the nutritional value for a healthy diet but also tested the freshness and flavor of the locally grown products as well. The project was promoted to current/potential vegetable growers interested for the establishment of hydroponic systems in Texas as well as members of water agencies such as the Uvalde County Underground Water Conservation District and Texas Agriwomen. The project attracted a major company from Houston interested in establishing a large hydroponic facility (plans for 2017) to serve the main metro areas of Texas. Similarly an emerging farmer visiting the progress of our project was inspired to set up a new facility with vertical and horizontal hydroponics (Organiponic, Rockdale TX). A presentation was delivered and published at the Annual conference of the American Society for Horticultural Science, 2015 (Leskovar and Cerven, HortScience 50(9):S321) and a short course on 'Hydroponics 101' was delivered via WebEx to small farmers, Master gardeners and County Agents in Texas.


Leafy greens growing in vertical hydroponics, Rockdale, Texas.

Goals and Outcomes Achieved

A major long term goal of this project is to contribute to the production of high-value leafy greens in Texas, through efficient water conservation strategies and improved management systems for both hydroponics and open field cultivation following conventional and/or organic practices. Significant progress has been made in 2015. The project screened additional leafy greens crops and varieties, evaluated them for the two major limitations when growing under hot conditions (bolting and tipburn) as well as evaluating further the consumer preferences for these products. Results continue to serve as the basis to attract new growers (3) or to modify existing technologies through discussions with major hydroponic growers (Seguin, San Antonio, Rockdale, Houston).

Most greenhouse growers (tomato and leafy crop producers) employ hydroponic or soilless cultivation systems to reduce the issues associated with intensive cultivation and to increase productivity and water use efficiency. Other advantages of greenhouse hydroponic production include 1) higher and consistent quality, 2) reduced water and nutrient use, and 3) year-round production (and employment) opportunity. To achieve theses outcomes, evolving integrated technologies in balance with the use of production resources are needed. The project proved that hydroponic production utilizes about 10% of the water required to produce an equivalent amount of crop in the field. Modifying plant nutrient composition such as supplemental calcium provided additional advantages in the lettuce quality, reducing losses due to tipburn. Compared to field production, the uptake of plant nutrients is more efficient in circulating (closed loop) hydroponic system, with minimum losses to the environment.

Beneficiaries

The project provided educational activities to new, small- and large-scale farmers, reaching over 300 individuals through field days, seminars, panels and scientific exchanges. Together with the primary partner and Uvalde County, the project created awareness and provided lettuce varieties to numerous disadvantage people served at the Uvalde Nutrition Center. The project provided new ideas for the system design, cultivar selection and disease prevention when growing high-value leafy crops.

Lessons Learned

One of the major limitations when growing leafy greens in open fields is the low quality of the harvested product due to environmental stress, such high temperatures and low humidity experienced during late spring and summers. The prevalence of tip-burn, a physiological disorder associated with the low mobility of calcium in the transpiration stream, especially during hot summers can reduce yield up to 70% compared to growing them in the fall and winter production. Designing an irrigation system that can deliver nutrients properly for commercial scale hydroponic systems could be one of the biggest challenges.

PROJECT 3: STRATEGIES TO PROMOTE NEW VARIETALS AND GRAPE GROWING ACREAGE OF TEXAS WIND GRAPES – SPECIALTY CROP PRODUCERS CONTINUING EDUCATION

Partner Organization: Primary – Texas Wine and Grape Growers Association. Partners – Texas A&M AgriLife Extension Services, High Plains Winegrowers Association, and Botanical Research Institute of Texas.
Project Manager: Debbie Reynolds
Contact Information: 624 S. Dooley Street, Grapevine, TX 76051; 817-421-3201; debbie@twgga.org
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Project Summary

Texas grape growers had two devastating years of grape damage due to late Spring freezes – 2012 and 2013. Damage ranged from 50 percent to 100 percent of individual vineyards in the Texas High Plains. This was not a regional problem because the freezes dipped down as far as the Texas Hill Country. The damage was widespread.

In 2014, the Texas Wine and Grape Growers (TWGGA) helped deliver educational seminars on frost protection with the use of many methods from wind machines to advanced water coverage and burning. This new project was timely as grape growers looked to new, heartier varietals and ensuring the sustainability of their vineyards. Complimenting past projects from previous years that directed the education toward vineyard management, this project focused on continuing education, both classroom and online, to promote the increased production of wine grapes in Texas. With the partnerships included in this project – Texas A&M AgriLife Extension Services, Botanical Research Institute of Texas and High Plains Winegrowers Association – we created a strong foundation to build upon in future years.

This project had three key concentrations: (1) Create and host an annual educational conference with programming geared toward Viticulture and Enology using educators and speakers whose expertise provides a clear path toward introducing new varietals in Texas. (2) Upgrade and launch www.txwines.org, the Association's website. The upgrade will allow more opportunities to link to reports, videos presentations, research and other information essential to Texas grape growers. (3) In partnership with the Botanical Research Institute of Texas, help Texas grape growers understand and implement sustainable winegrowing practices.

Project Approach

The activities relating to the annual educational conference included contracting for the venue and audio/visual equipment rental; creating a well-rounded program and securing the speakers; developing and printing materials, handouts, and signage; hosting the conference; conducting post-conference surveys; and communications via the website, e-newsletters, and social media.

The annual education program is divided into four tracks - Viticulture, Enology, Legal, and Marketing. Under each track, the following classes were offered:

Viticulture

- Frost Damage Prevention and Protection Strategies

- Integrated Approaches to Irrigation Management
- Developing a Vineyard Fungal Pest Management Program
- How Management Practices and Environmental Factors Affect Quality
- Harvest Parameters to Ensure Quality Grapes
- Vineyard Soil Fertility and Vine Nutrition

Enology
- BioThermal Cooling
- Blanc du Bois Symposium – Why This Varietal is Vital to Texas
- Barrel Management Regimes
- Yeast Fermentation Techniques
- Blending and Understanding Wine Chemistry
- Are You Selecting the Right Cork for Your Wine?
- Tartaric Stabilization: Modern Approach to Ensure Stable Wines in the Bottle

Legal
- How Grape Growers Can Avoid Lawsuits and Save Taxes
- Employment Law
- Managing Your Legal Path to Becoming a Permitted Winery
- Crop Insurance and Financing Vineyards and Wineries

Marketing
- Increasing Retail Sales with Wine Label Design
- Creative, Diverse, Easy, Tried and True Marketing Ideas for Your Winery
- Using Social Media to Connect with Consumers
- New Winery Management Software
- The Hispanic Wine Consumer

The conference, spread over three days, mixed educational sessions with wine tastings and 13 hours of interaction with vendors in the Trade Show.

The activities relating to the txwines.org website upgrade included distributing three requests for proposals; meeting with the website companies to select the final vendor; creating the design, outlining the budget, and signing the agreement; conducting design reviews throughout the project; testing the new website and reviewing the analytics; launching the new website; and communication via e-newsletters and social media. The website upgrade is an ongoing project which will extend beyond the scope of this grant project.

The activities relating to sustainable practices included understanding wine grape sustainability worldwide; educational seminars, meetings, and studying materials; monitor vineyards and wineries using the International Award of Excellence in Sustainable Winegrowing Evaluation Rubric developed by the Botanical Research Institute of Texas.

TWGGA has maintained their due diligence to ensure budgets were strictly followed and communication was continual. The annual educational conference has experienced a 10 percent increase in attendance per year for the past three years. The greatest accomplishment has been the increased awareness of Texas wine and grapes because of the new website and social media activity. Staff tracked the reach of social media posts and see an average of 250 percent increase week over week. All communications drive visitors to the TWGGA website where they are gaining more information.

Throughout the grant project we have worked side by side with partners who have benefitted from increased awareness of the surveys they distribute to the research they fund. The Texas A&M AgriLife researchers and instructors serve as the primary pool of speakers used for educational forums throughout the year. Their contributions are valuable to the continued growth of Texas wine and grapes.

Goals and Outcomes Achieved:

1. 10 percent increase in attendance at the annual educational conference. The new website, social media, and larger distribution of the e-newsletter brought greater awareness of the education being offered. In 2014, the attendance was less than 550 and in 2015, the attendance grew to 602.
2. 10 percent increase in attendance at other educational seminars throughout the year hosted by TWGGA. There is a renewed interest in expanding grape growing because of the success growers have experienced in 2014 and 2015. The 2015 harvest is the largest ever is the history of Texas grape growing.
3. 250 percent average increase week over week on social media posts. TWGGA has created a small budget for social media and outsourced the tasks to a branding company. Monthly conference calls show this expense is paying off in increased Association membership and attendance at educational seminars.
4. 80 percent increase in the number of visitors to www.txwines.org. This increase exceeded the goal for the first year of the new website. We attribute the increase to a more modern look, easy to find the information quickly, and the increased interest in Texas wine and grapes. As a marketing tool, the website has been a direct influence on the increased number of attendees to educational events.
5. While website maintenance and hosting fees have doubled since 2013 – from $2,500 to $5,000. This cost increase was expected but is in line with other industry and education-focused websites. An added benefit is the website has become a bigger marketing tool than expected.
6. Increased number of e-newsletters distributed from 3,506 to 4,993 emails. Individuals from all around Texas, including consumers and people outside of Texas, sign up for the e-newsletters.
7. Texas vineyard sustainability practices were not widely present before 2010 except in less than 3 Texas vineyards. However, with this grant, TWGGA visited nine Texas vineyards and wineries to review sustainable practices that have been put in place. Working with the Botanical Research Institute of Texas, we completed the 20-point Rubric used internationally to grade a vineyard/winery sustainable program. While great strides have been made, in three of the nine studied, it will take approximately 10 years or more to reach the level of sustainability achieved in California.
8. Three of the nine vineyards/wineries whose sustainability practices were studied during this project have made tremendous gains:

a. Red Caboose Winery
    i. Using drought and calcium tolerant rootstock
    ii. Grapevine rows are positioned to allow southern winds to blow parallel rather than perpendicular for better airflow and sunlight
    iii. Recycle and harvest rainwater storing in tanks onsite that can hold up to 20,000 gallons
    iv. Use organic oils instead of chemicals for pest management. Insects do not live in an oily environment.
    v. Use photovoltaics to generate electricity
    vi. 100% geo-thermal for cooling/refrigeration
b. Bending Branch Winery
    i. Minimize carbon footprint with energy conserving vehicles – electric club cars and diesel based vehicles
    ii. Use of wood and stone from the surrounding land to build the winery, laboratory, and storage facilities
    iii. Use misprinted, juice cartons that are biodegradable as vineyard grow tubes
    iv. Plant drought tolerant and late ripening rootstock to avoid waste of water
    v. Apply water stress tactics to the vineyard to maximize the varietal flavors
    vi. Can store up to 100,000 gallons of rainwater
    vii. Use cover crops, canopy management, composting and the introduction of beneficial insects to control the vines and ensure a healthier crop. No chemicals are used for pest management.
c. Bingham Family Vineyards
    i. Plant vines four feet apart on rows spaced eight feet apart to yield more plants per acre. This method also promotes low vigor and helps keep the plants from getting too growth.
    ii. Eight foot spacing allows for smaller, more energy efficient tractors
    iii. This vineyard began growing grapes in 2003 with 5 acres. In 2016, using sustainability methods, this vineyard has over 180 acres of grapes planted.

All of the goals established for this project were met and exceeded. There are so many businesses that rely on a healthy, robust Texas grape growing industry. More vendors are moving part of their operations to Texas to help support their customer base. The Trade Show hosted by TWGGA each February will be the largest to date in 2016 and the booth space sold out 120 days before the Trade Show.

Beneficiaries:

1. The number of overall beneficiaries of this grant is hard to calculate. Stakeholders include:
    a. Texas Tech University, Texas A&M University, and Grayson College who show increased enrollment in their Viticulture and Enology programs of at least 10% present.
    b. AgriLife Extension and Research Services who has hired five new viticulture program specialists to be based in regions all over the state.

c. Twenty-seven vendors, located outside of Texas, have created sales and service offices in Texas because of business possibilities with Texas grape growers. For all of these businesses Texas is a new business venture for them.
d. The number of Texas winery permits increased by 20% in 2015 as a direct result of the grape growing success Texas has experienced. During the grant period this equates to a growth in permits from approximately 302 to 374.
e. Texas Tech University and TWGGA partnered with the US Department of Agriculture to release the first grape survey to be distributed in five years. This information will allow up to 32 wine grape varieties to be certified and receive crop insurance. For the over 225 grape growers this certification provides assurance in the case of crop devastation due to disease and weather.
f. The countless consumers who visit Texas wineries each year benefit from the growth of the industry and the quality of the wine produced.

2. The economic impact of the Texas wine and grape industry is expected to top $2B by the end of 2015 (the release of the economic impact through 12/31/15 will be in late 2016).
    a. The economic impact filters throughout the State of Texas benefitting manufacturers, suppliers, shippers, real estate brokers, lawyers, consulting companies, building and construction trades, transportation companies, ad agencies, PR firms, printing and graphic design firms, web developers, social media companies, accountants, hotels, restaurants, and attractions.
    b. City and County governments are beneficiaries of increased taxes.

Additional Information:
Bingham Family Vineyards in Meadow, TX has grown to over 200 acres of grape growing in the Texas High Plains AVA. Their 2015 harvest yielded a stellar Viognier crop, a grape that is becoming one of Texas' best white wines.

Publications/News:

- *The Courier of Montgomery County.* "Predictions for the Texas Wine Industry for 2015", January 1, 2015.
- *CraveDFW.* "Expressions of Blanc du Bois in Texas", February 15, 2015.
- KFYO News Talk Radio 790. "Texas Wine Industry Has Grown Dramatically", March 4, 2015.
- *Wall Street Journal.* "Texas Farmer's Turn to Grapes As State's Wine Industry Grows", March 16, 2015.
- *CraveDFW.* "Three Interesting New Texas Wines", March 23, 2015.

- *Houston Chronicle.* "As Cotton Struggles, Texas Farmers Turn to Winemaking", March 17, 2015.
- *Snooth.* "Cowboy Country Class: Texas Farmers Turn to Grapes", March 24, 2015.
- *Texas Standard.* "Texas Is Set to Become a Leading Wine Producer", April 10, 2015.
- *The Courier of Montgomery County.* "Bingham Vineyards Evolves Into A Winery", May 22, 2015.
- *My San Antonio News.* "Hill Country Makes International Best List for 2015 Travel", June, 2015.
- KXAN TV. "Texas Winemakers Trying to Keep Up With Demand", August 13, 2015.
- KBTX TV. "Local Wineries Growing at Record Rates", August 12, 2015.
- CBS 19 TV. "Radical Weather Brings Quality Crop to Texas Wineries", August 25, 2015.
- "2015 Harvest Report" from Fall Creek Vineyards in Tow and Dripping Springs.
- CBS DFW. "West Texas Winery Ripe With Success", November 25, 2015.

PROJECT 4: PECAN SCREENING NURSERY FOR COTTON ROOT ROT RESISTANCE

Partner Organization: Primary – Texas Pecan Growers Association. Partner – Texas A&M AgriLife Extension Service.
Project Manager: Dr. David Appel (with Dr. Mark Black, retired volunteer and Dr. Kimberly Cochran, Extension Plant Pathologist appointed September 1, 2015)
Contact Information: Department of Plant Pathology & Microbiology, 2132 TAMU, College Station, TX 77843-2132 or P. O. Box 1849, Uvalde, TX 78801-1849
Type of Report: Final
Date Submitted: May 6, 2016

Project Summary

Texas pecan growers lack control techniques for cotton root rot disease, caused by *Phymatotrichopsis omnivora*. Extension specialists estimate statewide income loss at $435,000 per year, with the highest losses in warmer calcareous high pH soils of Texas. The disease also kills pecan trees in regions of New Mexico, Arizona and northern states in Mexico which have similar soils and high temperatures. Varieties grafted on resistant rootstock would reduce direct losses, allow replanting and improve competiveness. Pecan co-evolved with *P. omnivora* because the ranges of native pecan *(Carya illinoinensis)* and the cotton root rot fungus overlap in large areas of Texas and northeast Mexico. Scientists hypothesize that some native pecan genotypes have useful resistance to *P. omnivora*. During the first two years of this project (funded by 2012-13 & 2013-14 SCBG), a pecan screening nursery with conditions favorable for cotton root rot disease compared diverse populations. The third year of evaluation further challenged each population; provided site maintenance, mowing susceptible alfalfa (*Medicago sativa*) planted to increase disease intensity and uniformity, and intensive plot evaluations.

<u>Project Purpose</u>

Profits are decreased in warmer parts of Texas, New Mexico, Arizona and northern Mexico because pecan *(Carya illinoinensis)* trees often die after infection by *Phymatotrichopsis omnivora* (syn. *Phymatotrichum omnivorum*; hereafter, *P.o.*), an endemic high-temperature soil borne fungal pathogen causing root and crown decay in more than 2,000 dicotyledonous plant species. Climate change is bringing higher temperatures and increasing pecan acreage at risk of this disease. Monocots are highly resistant or immune. Common names of the disease include cotton root rot (CRR); Phymatotrichopsis root rot, and Texas root rot. Grafting pecan varieties on a resistant rootstock at high risk sites would reduce tree losses and improve profits. No technique was previously available to evaluate pecan germplasm for reaction to *P.o.*

The center of origin for pecan is in Texas and/or northeastern Mexico and pecan co-evolved with *P.o.* Native pecans are considered moderately resistant (Taubenhaus and Ezekiel, 1936), but losses in improved variety pecan orchards can be significant (Besbitt, 1992). Commercially available rootstocks for Texas could be more susceptible than some native populations located in hyperthermic climates in the southern part of the center of origin (native geographical range) for this tree species. Populations from lower (southern) latitudes may have more resistance to *P.o.* than populations from higher (northern) latitudes. Rare or near zero mortality in native pecan stands may be due to less fruit load as well as partial resistance, so documentation of resistance variation is needed under controlled plot conditions. Dr. L.J. Grauke previously collected germplasm from southern (south Texas, northeast Mexico), western (New Mexico, West Texas), northern (Kansas, Oklahoma, Illinois), and eastern (Louisiana, Georgia, Alabama, Florida) parts of the native and current cultivated range. In other plant species, early senescence seems to be associated with CRR susceptibility. Late leaf senescence phenology, frequent among provenances from lower latitudes, may be a useful indicator of CRR resistance.

Attempts to screen pecan, grape, cotton and other plant species for *P.o.* resistance in greenhouse containers have failed because the disease is very difficult to induce in container grown plants. Plant breeding and variety improvement projects that select only for horticultural traits (yield, grade, winter hardiness, etc.) typically develop varieties susceptible to disease. Currently, no labeled fungicide is effective for control in pecan, although flutriafol field trials are underway after a section 18 exemption for Topguard use in Texas was granted in February 2012. Various soil amendments, fumigation, and plant manipulations are sometimes used for replants after disease losses, but have not provided long term control and are prohibitively expensive. Replanted trees on traditional rootstocks usually die from the same disease. High average temperature in recent years has favored growth of this high-temperature fungus for more weeks of each year, and in more Texas pecan acres. Researchers expect that pecan rootstocks with improved CRR resistance will be better adapted to warmer parts of Texas and therefore help mitigate rising temperatures associated with climate change.

Vacant places in affected orchards decrease production efficiency because irrigation and other inputs often continue on surviving trees. Growers are encouraged by recent periods of high prices for pecan nuts and need strategies to bring heavily diseased blocks back into full and efficient production.

Short term objectives are a) to maintain and evaluate a high-density disease screening field nursery established in 2013 at the Uvalde, Texas site at high risk of CRR, thereby comparing diverse pecan germplasm for *P.o.* survival, and b) to inform growers of early disease ratings among entries. A robust and relative rapid (for a tree crop with >50 years longevity) screen will reduce time required for new rootstock development from decades to a few years. Seeds of commercially available rootstocks (control treatments) and diverse pecan populations (half-sib families from single trees) from a range of latitudes and longitudes were gathered, germinated, and transplanted in replicated field plots. The long term objective is to develop an adapted high quality resistant pecan rootstock. Clonal micropropagation techniques have recently shown promise for pecan and could soon be used to increase unique and superior individuals selected from low-disease families. Currently, named rootstocks are deployed as half-sib families with various male parentage.

This project follows a study in Maverick County, Texas funded in part by Robert Ackerley, Rio Grande Organics, L.P., Houston, Texas. In that study, stratified seeds planted 18 inches from recently seeded alfalfa resulted in *P.o.* infection and dying pecan seedlings within 4 months. That trial was abandoned because of excess animal damage and weed control issues.

Pecan rootstocks resistant to *P.o.* will be available at similar cost as currently used rootstocks to commercial growers, socially disadvantaged groups or beginning farmers. Improved production efficiency from new rootstocks, useful only for pecan production, will enhance competitiveness of farmers markets, general buy local, etc. because even small scale plantings will benefit. Rootstocks will also be used by organic producers.

Pecan is a perennial crop that requires long term experimental protocols for rootstock improvement. This project built on two previously funded projects with the SCBGP. This project was Year 3 of an effort to develop and publicize results from a pecan seedling disease screening nursery.

Project Approach

Activity	**Activity, accomplishment, or work conducted 2014-15**
Irrigate and fertilize plots	Staff irrigated via subsurface drip irrigation (SDI) lines multiple times as needed in 2015. Pekacid was used to clear minerals from SDI lines and emitters and provide phosphorus (P) and potassium (K) (12.5 lb/ac of commercial product, 0-60-20 N-P-K ratio 18Feb15, mid-summer 2015, 6Oct15, 25March16) Addition of P and K was based on 2014 foliar symptoms, petiole tissue analysis, and soil tests. Foliar application of Zinc (Zn) occurred multiple times after budbreak in 2015.
Control weeds and other pests, exclude wildlife	Staff hand weeded and spot-treated with glyphosate or grass-specific herbicide as needed. Alfalfa was cut back on multiple occasions with string weeder, lawn mower, and/or sickle mower.
Measure plant growth, evaluate other phenology	Pecan seedling heights and stem diameters at 2-cm above soil surface were recorded for statistical analysis (Tables 1,2). Alfred Sanchez, L.J. Grauke, and Mark Black estimated growth stage for ranking bud break (Tables 3,4). The pattern of growth initiation is consistent with expectations: seedstocks from the Southern provenance (Mexico) are the first to initiate growth, and those from the North are last. The Mixed, Eastern and Western provenances are intermediate, but the natives from the West are generally slower to begin growth than those from the Mixed provenance, which includes the cultivar seedstocks commonly being used in the high desert areas of Arizona and New Mexico, which includes VC1-68.
Evaluate disease in pecan and the interplanted alfalfa to indicate disease occurrence at the site, patchiness/uniformity of disease	Pecan mortality was recorded through June 30 and September 2015 (Tables 5,6) and roots of all dead plants were dug and examined under the microscope to confirm presence of *Phymatotrichopsis omnivora*

among plots and replications and to increase intensity of challenge to young pecan seedlings. Representative dead pecan seedlings will be dug and examined under magnification for unique P.o. fungal strands.	and estimate percent of root surface with *P. omnivora* mycelium (four classes: 0%, 0.1%, 1.0%, ≥10%, data not presented). Alfalfa mortality again occurred throughout warm months, but no detailed notes were recorded in 2015 because essentially all of the test area has had some cotton root rot since planting. Alfalfa self re-seeded well in winter except below groups of the larger trees where there was more shade.
Plant evaluation including seedling survival over time, senescence, minor-element deficiency symptoms	There was a good response among almost all entries to P & K fertilizer through irrigation system, and to Zn foliar applications. Combination of more nutrients and more rainfall in 2015 increased pecan growth rate for surviving seedlings and/or inferior seedlings eliminated from the nursery resulted in larger increases in surviving plant size in 2015.
Present findings at the annual Pecan Growers Convention and regional grower educational meetings	Larry Stein summarized progress to date at Texas Pecan Short Course January 26-30, 2015 in College Station, Texas, at regional grower meetings in 2015, and at the TPGA annual conference in Frisco, Texas in July 2015. Scientists communicated results 1-on-1 with several growers. Data were summarized in 21 PowerPoint slides by M. Black for an oral report by Larry Stein at TPGA meeting. In addition to current usage of Apache, Burkett, and Riverside for pecan rootstocks where CRR is a problem in Texas and the southwest, Frutoso and Ideal may be useful alternatives compared to approximately 15 other entries tested. Using resistant pollen sources in stock seed production has potential to further increase resistance.
Write quarterly and annual reports	K. Cochran revised the previously submitted 2014-15 annual report as requested by reviewers. Required Quarterly reports were prepared and submitted to TPGA and TDA.
Evaluation of each population outside 3-year grant period and reporting to Texas growers with partial funding from other donors and grants	Cindy Wise (TPGA), Larry Stein and L.J. Grauke were funded for Year 4 funding by TDA for continuation of CRR tracking and preliminary genetic analysis of surviving seedlings. Additional activities will include genetic characterizations of individual plants to compare to the phenotype (i.e., survival after cotton root rot).

Significant contributions and role of project partners in the project were as follows. Cindy Wise, TPGA, College Station, Texas submitted the proposal on behalf of Texas A&M AgriLife Extension Service and facilitated communications and financial transactions. M. C. Black volunteered time on phenotype evaluations, diagnosis of dead seedlings, data analysis, and reporting. K. Cochran provided reporting assistance and hired a student worker to assist Mr. Sanchez. A.M. Sanchez, T. Reed, and Alex Sanchez provided technical services. L. A. Stein provided guidance on fertility. L.J. Grauke provided valuable suggestions and evaluated bud break in 2015.

Goals and Outcomes Achieved

Goal: Inform pecan growers of early cotton root rot reactions and other evaluations among pecan germplasm being evaluated.

The knowledge of more than 150 pecan growers was increased concerning cotton root rot evaluations to date. Specifically, growers were informed about how rootstocks ranked for resistance and other traits, and their comprehension was quantified after one presentation (see table below). Larry Stein summarized progress to date at Texas Pecan Short Course January 26-30, 2015 in College Station, Texas and at multiple regional grower meetings in 2015, and at the state TPGA meeting in Frisco. Scientists also communicated results 1-on-1 with several growers. Data were summarized in 21 PowerPoint slides by M. Black for an oral report by Larry Stein to growers and TPGA at their annual conference in Frisco, Texas in July 2015. The total unique growers reached in 2015 was approximately 250.

Texas Pecan Growers Annual Meeting 12 - 16 July, 2015 Frisco, Texas		
Survey questions; 150 Total in Attendance	**Before**	**After**
Have you read or heard about cotton root rot?	71	118
Have you ever lost trees and suspected cotton root rot?	28	35
Today, do nurseries sell trees with improved resistance to cotton root rot?	0	12
Do you expect nurseries to sell trees with improved CRR tolerance in the future?	37	101

The long term objective of this project is to facilitate development and delivery of improved resistance in pecan rootstocks to Texas growers at risk of cotton root rot. That risk is increasing and expanding in area due to climate warming. Progress includes ranking 23 cultivars for cotton root rot disease in a high density nursery, indicating possibilities for rootstock improvement with further work.

Accomplishments were met or exceeded for the goals of this reporting period.

There were no benchmark data available when this project began, or when Year 3 funding began. Commercial pecan rootstocks and natives were not previously being evaluated for the long term for this disease before 2013, so Texas pecan growers at risk for CRR had near zero knowledge of rootstocks for mitigating CRR on this long-lived perennial tree crop. Grower knowledge of the problem has increased after presentation of results from this project. Testimonial indications were that growers in Southwestern U.S.A and Mexico and are now using seeds from local native pecan groves for replants and for new orchards.

Performance Measure: Attendees at the pecan short course, county/regional pecan meetings, and the state pecan meeting were made aware of CRR in pecan and gained knowledge about how commercial rootstocks perform in an intense disease situation. Many are now willing to use improved pecan rootstocks when available.

Monitoring Plan: Compile attendance/registration counts from county, regional, and statewide pecan grower meetings, where progress reports on pecan *P. omnivora*-resistance development are delivered. Surveys during meetings determined beginning knowledge of the disease problem, change in awareness after training, and future intentions whether to use future improved pecan rootstocks.

Beneficiaries

For all Texas pecans in 2012, there were an estimated 5,300 pecan producing farms across 164,000 acres in Texas. Utilized production was about 55 million pounds valued at $74.6 million. Additionally, Texas A&M Agrilife estimated the total impact on the Texas economy of pecan production to be $209 million in 2013. Approximately 500 pecan growers producing on 15,000 acres at highest risk in the warmer production regions of Texas would significantly benefit from a CRR resistant root stock. Growers will see increased yields and quality, improved production efficiency due to more uniform stands, and reduced replanting costs. Abandoned orchards will potentially be replanted. Root stock development for a perennial tree crop is a long term project because new varieties must be evaluated over time at multiple locations. Cooperating pecan growers willing to test promising populations could receive superior seeds after two years for replanting skips in existing production blocks. Availability for planting entire production blocks would occur in four to ten years. Project staff estimates that replanting two to three percent of trees every year due to CRR losses incurs an additional cost to growers of $65 an acre. Assuming two to three percent mortality rate each year on 15,000 acres in the U.S., staff estimates $975,000 per year benefit when a superior resistant rootstock is available to growers at risk for CRR. Losses to P.o. are probably underestimated because some infected trees survive, but with reduced yield and quality due to compromised root systems. Assuming a resistant rootstock will improve yield and quality on trees with sub-lethal P.o. infections, production would improve by five percent a year (800 lb/ac, $2/lb retail) on 15,000 acres, for an additional $1,200,000 per year benefit. Total impact would be $2,175,000 per year. There would be additional impact in Arizona and New Mexico.

Lessons Learned

There was some mower damage (weed control and mowing of alfalfa) and cottontail rabbit damage on pecan seedlings. Shredding adjacent tall vegetation allowed improved cottontail predator access to reduce the problem. Grounds maintenance relied on hand trimming and a push mower instead of sickle mower. The smallest seedlings that could be concealed at peak alfalfa growth were marked with bamboo stakes for increased visibility. Small seedlings were at higher risk of mower and string-weeder damage than the larger seedlings.

With the September 1, 2015 hiring of a new extension plant pathologist, Dr. Kimberly Cochran, continuation of this project was ensured. In the last quarter of 2015, she hired a part time student worker to assist with labor intensive duties.

Additional Information
Staff will continue removing dead pecan seedlings from the test site as mortality occurs in 2016. Roots will be examined for presence of the pathogen and estimating percent root surface area covered by *P. omnivora.* Plant height and stem diameter will be recorded in winter of 2016-17 or when the trial is terminated.

For this trial, only the female parent of each seedling was known. Continuing work is testing tissue from surviving seedlings in hopes of determining paternity of superior as well as inferior seedlings. Delivery of improved pecan rootstocks may depend on controlling both the male and female parents for nuts planted for rootstock production. Pairing resistant and appropriately heterodichogamous parents in isolated blocks for crossing should provide improved CRR resistance and more uniform rootstocks.

L. J. Grauke and Xinwang Wang, USDA Pecan Station, Somerville, Texas are interested in the genetics of seedlings in the Uvalde nursery. Leaf tissue was collected from surviving seedlings in late April 2016 for DNA extraction and genetic analysis. This may enable workers to determine male parentage of surviving seedlings and perhaps indicate superior male parents for improved pecan rootstocks for Texas growers.

Table 1. Surviving pecan seedlings height December 15, 2014 and stem diameter at 2 cm above soil surface January 20, 2015 in a cotton root rot nursery at Uvalde, Texas.

Entry	Provenance	Height, cm 15Dec14		Diameter, mm[y] 20Jan15	
VC-168	M	36	a[z]	6.2	a
Apache	M	30	b	5.4	bcd
87MX4-5.5	S	30	b	5.5	bcd
87MX5-1.7	S	28	bc	4.3	hi
Elliott	E	28	bc	5.3	bcde
Frutoso	S	27	cd	4.7	g
87MX1-1.2	S	27	cde	5.3	bcde
Ideal	W	26	cdef	5.6	b
Sioux	M	26	cdef	5.3	bcde
Shoshoni	M	26	cdef	6.1	a
A-93	E	26	cdefg	5.5	bc
Baker	E	26	cdefg	5.1	e
Riverside	W	25	defg	5.3	cde
Burkett	W	25	defgh	5.3	cde
SanFelipe	W	25	efgh	5.2	de
Wichita	M	25	efgh	5.1	ef
Barton	E	24	fghi	5.4	bcd
Curtis	E	23	ghij	4.7	fg
Allen4	W	23	hij	4.3	hi
Stein	W	23	hij	4.7	g
Choctaw	M	22	hij	5.2	cde
Giles	N	22	ij	4.7	g
Major	N	22	ij	4.5	gh
Moore	E	21	j	4.0	ij
97CAT11.3	E	21	jk	4.2	hi
Peruque	N	17	kl	4.7	fg
Colby	N	16	kl	3.5	jk
Allen3	W	16	l	3.1	k
Pr>F		<.0001		<.0001	
Provenance					
North		20	c	4.5	d
West		23	b	4.8	c
East		24	b	4.9	b
Mixed		28	a	5.6	a
South		28	a	4.9	b
Pr>F		<.0001		<.0001	

[y]Estimated with digital caliper at 2 cm above soil surface.
[z]Least squares means followed by the same letter are not significantly different.

Table 2. Pecan seedling height and diameter after the third season of a cotton root rot nursery at Uvalde, Texas.

Entry	Height, cm 14Dec15		Diameter, mm 15Jan16	
87MX4-5.5	93	a	18	a
VC-168	69	b	13	b
SanFelipe	56	c	13	bc
A-93	55	cd	12	bcd
Frutoso	53	cde	11	cdef
Apache	52	cdef	12	bcd
Riverside	49	cdef	11	cde
Shoshoni	49	cdef	11	cde
Elliott	46	defg	10	def
87MX5-1.7	46	efg	8	ghij
87MX1-1.2	46	efg	10	efg
Baker	46	efgh	10	efg
Burkett	44	fghi	10	efgh
Sioux	43	fghij	10	efg
Giles	39	ghij	10	efg
Ideal	39	ghij	8	hij
Barton	38	ghij	9	fghi
Moore	37	hij	7	j
Curtis	37	ij	8	ghij
Wichita	36	ij	8	hij
Allen4	35	j	7	hij
Stein	35	j	8	hij
97CAT11.3	32	j	7	j
Peruque	30	jk	7	hij
Choctaw	29	jk	7	ij
Major	28	jk	6	j
Colby	26	jk	5	j
Allen3	20	k	5	j
Pr>F	<.0001		<.0001	
Provenance				
North	33	d	8	d
West	41	c	9	c
East	42	c	9	c
Mixed	49	b	11	b
South	60	a	12	a
Pr>F	<.0001		<.0001	

[z]Least squares means followed by the same letter are not significantly different.

Table 3. Pecan bud break after the second season of a cotton root rot nursery at Uvalde, Texas.

Entry	Bud break[xy] 13Mar15		Bud break[y] 1,2Apr15	
87MX4-5.5	2.2	bc[z]	5.5	a
Elliott	2.3	b	5.4	ab
VC-168	2.3	bc	5.3	ab
A-93	1.8	d	5.1	abc
87MX1-1.2	2.4	b	4.9	abcd
Baker	1.5	ef	4.8	bcde
Apache	1.5	ef	4.8	cdef
87MX5-1.7	3.1	a	4.6	cdefg
Burkett	1.6	de	4.5	cdefg
Shoshoni	1.3	f	4.5	defg
Riverside	1.6	de	4.5	defg
Frutoso	2.1	c	4.4	defg
Curtis	1.6	de	4.4	defgh
Stein	1.5	ef	4.3	efgh
Wichita	1.3	f	4.2	fghi
SanFelipe	1.5	ef	4.2	ghi
Sioux	1.6	de	4.1	ghi
Giles	1.2	f	3.8	hij
Moore	1.5	ef	3.8	hij
Choctaw	1.2	f	3.5	ijk
Allen4	1.2	f	3.5	jk
Ideal	1.1	f	3.2	k
Barton	1.2	f	3.0	kl
Allen3	1.1	f	2.9	kl
Peruque	1.1	f	2.9	kl
97CAT11.3	1.1	f	2.6	kl
Colby	1.0	f	2.6	kl
Major	1.1	f	2.4	l
Pr>F	<.0001		<.0001	
Provence				
North	1.1	d	3.1	d
West	1.4	c	3.9	c
East	1.6	b	4.2	bc
Mixed	1.6	b	4.5	ab
South	2.4	a	4.9	a
Pr>F	<.0001		<.0001	

[x]Bud break assessments protocol from http://cgru.usda.gov/carya/Manual/BUDBRK.html.
[y]A. M. Sanchez recorded bud break on March 13, 2015. L. J. Grauke recorded bud break on April 1 and 2, 2015.
[z]Least squares means followed by the same letter are not significantly different.

Table 4. Pecan bud break in the fourth season of a cotton root rot nursery at Uvalde, Texas.

Entry	Bud break[xy] 14Mar16		Bud break 31March16	
Allen3	1.6	jkl[z]	6.5	a
87MX1-1.2	3.7	b	5.4	ab
87MX5-1.7	4.0	a	5.3	bc
Elliott	2.9	cd	5.0	bcd
Frutoso	2.7	de	4.9	bcde
87MX4-5.5	3.0	c	4.9	bcde
VC-168	2.7	cde	4.8	bcde
Apache	2.4	ef	4.8	bcde
A-93	2.4	ef	4.8	bcde
Baker	2.2	fg	4.7	bcdef
Curtis	2.4	f	4.6	bcdef
Riverside	2.3	fg	4.5	bcdef
Wichita	2.2	fg	4.3	cdefg
Burkett	2.1	ghi	4.3	cdefg
SanFelipe	2.2	fgh	4.3	cdefg
Stein	2.3	fg	4.3	cdefg
Sioux	1.9	hijk	4.1	defg
Moore	2.3	fg	4.1	defg
Shoshoni	1.9	hij	3.9	efg
Choctaw	1.5	kl	3.6	efg
Giles	1.8	ijkl	3.6	fg
97CAT11.3	1.6	kl	3.6	fg
Peruque	1.7	ijkl	3.4	fg
Barton	1.6	kl	3.2	g
Allen4	1.5	l	3.0	g
Ideal	1.5	l	3.0	g
Major	1.4	l	2.9	g
Colby	1.3	l	2.4	g
Pr>F	<.0001		<.0001	
Provenance				
North	1.6	d	3.2	c
West	1.9	c	4.1	b
East	2.2	b	4.3	b
Mixed	2.2	b	4.4	b
South	3.3	a	5.1	a
Pr>F	<.0001		<.0001	

[x]Bud break assessment protocol from http://cgru.usda.gov/carya/Manual/BUDBRK.html.
[y]M. C. Black recorded bud break on March 14 and 31, 201.
[z]Least squares means followed by the same letter are not significantly different.

Table 5. Pecan seedling total mortality, cotton root rot (% plants), and area under disease progress curve as of June 30, 2015 in a disease nursery at Uvalde, Texas.

Entry	Number	Provenance[y]	Mortality		Entry	CRR, %		Entry	AUDPC
Burkett	68	W	1	e	Burkett	1	f	Riverside	4
Riverside	80	W	4	de	Riverside	3	ef	Burkett	4
A93	80	E	4	de	A93	3	ef	A93	5
Ideal	78	W	4	de	Ideal	4	def	Ideal	6
Apache	80	M	5	de	Apache	5	def	Frutoso	13
Frutoso	80	S	6	cde	Frutoso	6	cdef	Apache	15
Baker	80	E	6	cde	Baker	6	cdef	87MX4-5.5	17
87MX4-5.5	80	S	9	bcde	87MX4-5.5	9	bcdef	Baker	19
87MX1-1.2	80	S	10	bcde	87MX1-1.2	10	bcdef	87MX5-1.7	21
Stein	80	W	10	bcde	97CAT11.3	10	bcdef	87MX1-1.2	29
97CAT11.3	80	E	13	bcde	Stein	10	bcdef	Stein	31
Moore	78	E	13	bcde	Moore	11	bcdef	97CAT11.3	32
Allen4	80	W	14	abcde	87MX5-1.7	11	bcdef	Moore	36
Shoshoni	80	M	14	abcde	Allen4	14	abcdef	Curtis	36
87MX5-1.7	80	S	15	abcde	Shoshoni	14	abcdef	SanFelipe	39
Wichita	80	M	15	abcde	Wichita	15	abcdef	Shoshoni	39
Elliott	80	E	16	abcd	Curtis	16	abcde	Allen4	39
SanFelipe	77	W	16	abcd	Elliott	16	abcde	Elliott	40
Curtis	80	E	18	abcd	SanFelipe	16	abcde	Wichita	42
VC168	80	M	18	abcd	VC168	18	abcd	VC168	45
Barton	80	E	20	abc	Barton	20	abc	Sioux	52
Sioux	80	M	23	ab	Sioux	23	ab	Barton	65
Allen3	79	W	28	a	Allen3	28	a	Allen3	79
P>F			0.0345				0.0273		0.0692, N.S.[z]
Provenance[y]									
South			10			9			20
West			11			11			29
East			13			12			33
Mixed			15			15			39
P>F			0.5261, N.S.			0.4271, N.S.			0.3613, N.S.

[y]Northern provenance and Choctaw (mixed) omitted from analysis because of low plant numbers (<65 plants) and fewer replications resulted in apparent disease escapes.

[z]N.S. indicates P>0.05, non-significant differences.

Table 6. Pecan seedling total mortality, cotton root rot (% plants), and area under disease progress curve as of September 30, 2015 in a disease nursery at Uvalde, Texas.

Entry	Provenance[y]	Mortality	Entry	CRR, %	Entry	AUDPC
Burkett	W	4	Burkett	4	Burkett	6
Apache	M	6	Apache	6	Riverside	8
Ideal	W	7	Riverside	6	Ideal	11
Frutoso	S	8	Ideal	7	A-93	12
Riverside	W	8	Frutoso	8	Frutoso	19
Baker	E	10	Baker	10	Apache	20
Stein	W	11	A-93	11	Baker	26
A-93	E	13	Stein	11	87MX4-5.5	28
87MX1-1.2	S	14	97CAT11.3	13	87MX5-1.7	35
97CAT11.3	E	15	87MX1-1.2	14	87MX1-1.2	40
87MX4-5.5	S	15	Moore	14	Stein	41
Shoshoni	M	15	87MX4-5.5	15	97CAT11.3	42
Wichita	M	16	Shoshoni	15	Moore	47
Moore	E	16	Wichita	16	Shoshoni	52
Curtis	E	20	Curtis	19	Curtis	52
Elliott	E	21	87MX5-1.7	19	Allen4	55
VC-168	M	21	Allen4	21	Wichita	56
Allen4	W	21	Elliott	21	SanFelipe	57
Barton	E	23	VC-168	21	Elliott	58
87MX5-1.7	S	23	Barton	23	VC-168	63
SanFelipe	W	23	SanFelipe	23	Sioux	76
Sioux	M	29	Sioux	29	Barton	84
Allen3	W	31	Allen3	31	Allen3	106
P>F		0.0811 N.S.[z]		0.084 N.S.		0.0541 N.S.

Provenance[y]	Mortality	CRR, %	AUDPC
South	15	14	31
West	15	15	41
East	17	16	46
Mixed	18	18	53
P>F	0.8489, N.S.[z]	0.8131, N.S.	0.4087, N.S.

[y]Northern provenance omitted from analysis because low plant numbers (<65 plants) and fewer replications apparently resulted in disease escapes.

[z]N.S. indicates P>0.05, non-significant differences.

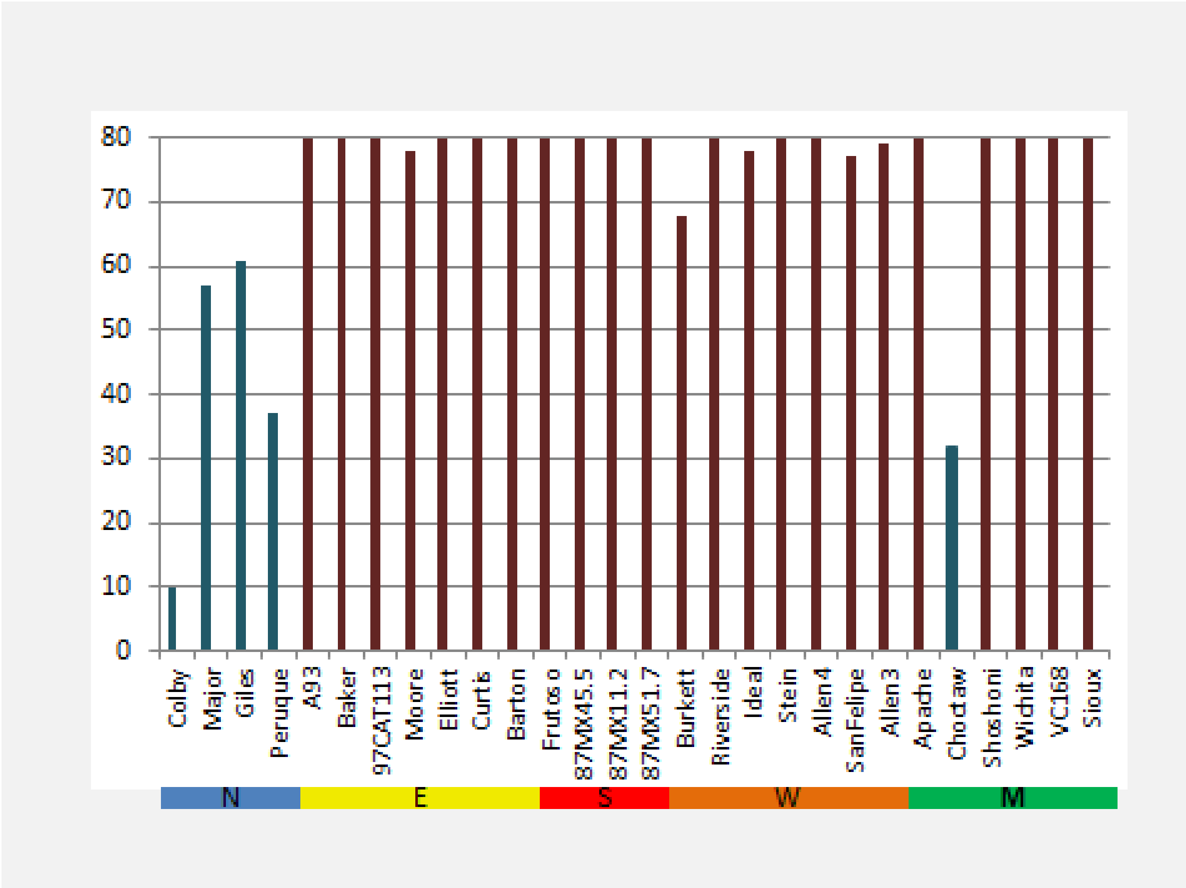

Fig. 1. Original number of pecan entry seedlings established in replicated plots at Uvalde, Texas in 2013. Provenance (north, east, south, west, mixed) is indicated. For disease analyses, entries with <65 seedlings were deleted (aqua bars).

Project 5: Expanded Production of Fruit and Seed for New Enhanced Quality, TAMU Tomato Cultivars

Partner Organization: Primary - J&D Produce Partner – Texas A&M AgriLife Extension Service
Project Manager: Carlos Lazcano
Contact Information: J&D Produce, P.O. Box 1548, Edinburg, TX 78540
956-380-0353, clazcano@littlebearproduce.com
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Date Submitted: September 14, 2016

Project Summary
Tomato production in Texas has declined while consumption is rising, leading to more imported tomatoes. This collaborative project seeks to increase production of fresh market, processing and organic tomatoes in Texas with Texas A&M University (TAMU) elite cultivars that were identified through a 2013 Specialty Crop-funded project. Through this project, both fruit and seed production of the new tomato cultivars with high level virus resistance, crack resistant, and flavorful fruit was expanded. Integration of elite lines from the TAMU breeding program, coupled with optimal nutrition practices can allow growers to expand production and capture more market share for Texas grown tomatoes. Production of these new lines in multiple field locations provided opportunities for quality and performance assessment, as well as handling characteristics in the packing process. Data collected will improve the capacity of the TAMU breeding program to deliver seed of new, uniform cultivars for commercial production. A workshop conducted by TAMU will contribute to the promotion of cultivars with consumer appeal as well as yield and stress resistance. Expansion of tomato production in Texas should be possible with the highly virus resistant materials from TAMU and dedicated attention to nutrition and irrigation for optimal fruit quality. Results from the project will be applicable to all growers in Texas with virus and fruit quality problems, including organic producers with less pesticide options.

Project Approach
Prepare seed and transplants
During December-January hybrid seed was harvested from the Texas A&M greenhouse by Dr. Kevin Crosby and his students. More than 4,000 seed of the new hybrid 'TAM Hot-Ty' and several thousand seed of 30 additional, experimental hybrids were produced. This was planted in seedling trays and raised according to conventional or organic protocols. An additional 2,000 seed were sent from TAMU to Tropical Star greenhouse in Alamo, TX to produce transplants for several Rio Grande Valley trials.

Plant and grow field plots at Edinburg and Donna
At the J&D Produce farm in Edinburg, a large trial of TAMU experimental hybrids and breeding lines as well as seven acres of commercial hybrids were planted on February 21. All transplants were placed in rows with plastic mulch and drip irrigation. To prevent wind and cold damage, all rows were subsequently covered with small, fabric hoop-tunnels. A nutrition program was implemented through the drip system, including some beneficial soil microbes to improve

nutrient absorption. Excessive cold and rainy weather following transplanting slowed the growth of the plants until mid-March.

At Alamo, transplants of 15 TAMU processing tomatoes and 'TAM Hot-Ty' were established on a 5 acre bare soil plot with furrow irrigation during mid-March. A 40 acre seed production field established near Harlingen for an advanced, virus resistant processor line was destroyed by frost in late January. An additional fruit and seed production field (about 30 acres) was planted near Weslaco in March.

Fruit began to mature in late May at the J&D Produce farm in Edinburg. 'TAM Hot-Ty' and three other experimental TAMU hybrids were exceptionally early to mature. Between 50-70% of the fruits were red by late May, while no fruits of Charger, Tycoon, Tasti-Lee or Myconos were turning red. Tycoon and Charger did not have red fruit until mid-June. Some performance data was collected but excessive rains destroyed many of the fruit so both quality and yield were poor. More than 12 inches of rain fell on the field during the harvest period from mid-May to mid-June. Due to the rain causing reduced quality, HEB and other large retailers rejected the crop. The 8 acre field was then turned over to peddlers and a total of 2,547 boxes were harvested for between 5 and 10 cents per lb. This was well below the break-even price, resulting in a substantial loss. Fruit samples were analyzed by the Vegetable and Fruit Improvement Center (VFIC) for lycopene, acid and sugars. The new 'TAM Hot-Ty' cultivar had high levels of lycopene, sugars and acids. At 172 ppm, it had lycopene exceeding the commercial cultivars Tasti-Lee (148 ppm) and Myconos (128 ppm). Average soluble solids were also higher at 4.9 Brix in 'TAM Hot-Ty' versus Tycoon at 4.3, Charger at 4.1 and Myconos at 4.4.

At Alamo, the late transplanting of multiple TAMU processing tomatoes was slow to develop, then heavy rains in June reduced yields and quality. Three harvests yielded only 10 tons/ac. The seed production field planted near Weslaco received so much rain (over 20 in) that only about 20% of the plants survived. Hand harvest of fruits allowed about 10 lbs of seed to be extracted (much less than the 50 lbs desired for the Fall crop).

Plant and grow field plots in central Texas locations

At Texas AgriLife Research Center Uvalde, a field trial with 90 experimental TAMU hybrids and breeding lines was planted on March 16. The transplants were established on black, plastic mulch with subsurface, drip irrigation. Some signs of Stemphylium and botrytis diseases were present, so an appropriate fungicide was applied (Quadris). Despite excessive rains in April and May, the Uvalde trial produced some good quality fruit in June, though disease (alternaria and bacterial leaf spot) was a problem for all entries. Again, 'TAM Hot-Ty' and several TAMU experimental hybrids matured at least 10 days before Tycoon, Charger, Tasti-Lee and Valley Cat. Severe fruit splitting was evident on many entries due to excessive rains just a day before harvest. Table 1 summarizes some of the quality data from the best performing new TAMU hybrids and commercial checks.

At Johnson's Backyard Garden near Austin, transplants of eight elite, TAMU hybrids were planted into plastic mulched rows on March 27 in a 4 acre plot. Drip irrigation and organic production practices were followed, including pre-plant application of feather meal fertilizer. In this trial, 'TAM Hot-Ty' and 3 other TAMU hybrids, including two with pink, heirloom type fruit, were the first cultivars to mature. Severe bacterial leaf spot and tomato spotted wilt virus (TSWV) were evident in the field. Some fruit splitting was evident. In early July, bacterial leaf spot damage was very severe on all entries, so fruit were not harvested, but maturity and average fruit size were recorded.

At College Station, excessive rain also damaged the trial. More than 20 inches of rain fell on the field from mid-April through mid-June. This stunted many of the plants and caused fruit rotting. Dr. Crosby collected yield and phytochemical data from the entries which survived. Again, ‘TAM Hot-Ty’ and three TAMU experimental hybrids matured very early in the second week of June, compared to Tycoon, Charger and Valley Cat, which matured in the last week of June. Some TSWV and Fusarium wilt were evident in this trial. Lycopene and sugars were lower across all entries at College Station, though acidity was higher. ‘Tam Hot-Ty’ had 132 ppm lycopene and 5% acidity while ‘Tasti-Lee’ had 141 ppm lycopene and 4% acidity.

At Fredericksburg, Dr. Crosby planted a trial of 10 TAMU elite hybrids and three check cultivars in mid-April in a 20 acre commercial field (David White). This trial was very late due to cloudy and cool weather. Heavy rains caused extensive early blight and verticillium wilt. One evaluation was made by Dr. Crosby in early August. ‘TAM Hot-Ty’ and 2 other TAMU experimental hybrids had much less disease damage than the commercial checks ‘Tycoon’ and ‘Tasti-Lee.’ Hybrid 5 had the largest fruit but was slightly late maturing.

Trials at Waller (1 acre) and Plantersville received flooding rains and we were unable to evaluate them. The grower at Waller (Sonny Springer) lost the entire trial and the grower at Plantersville (Jollisant Farms) harvested a few plots. They indicated that ‘TAM Hot-Ty,’ Hybrid 5 and Hybrid 10 had good early yields before flooding rains destroyed the remainder of the crop. A fall trial at Waller was planted in August and plants were evaluated in November after more than 30 inches of rainfall. Two TAMU hybrids, ‘Hot-Ty’ and Hybrid 2 exhibited excellent resistance to bacterial leaf spot compared to the two field cultivars, ‘Tycoon’ and ‘Red Deuce.’ All fruit were harvested by Sonny Springer and sold as green tomatoes.

Implement nutrition programs

The first application of high potassium and micronutrient soluble fertilizer was applied through the drip irrigation in early March at Edinburg. Foliar fertilizer (Action 2-17-17) was applied bi-weekly at Edinburg. At Alamo, a standard formulation of granular fertilizer was applied pre-plant. The Uvalde trial utilized drip irrigation and complete, soluble fertilizer with chelated iron and zinc. At Waller and Fredericksburg, the commercial grower collaborators (Springer and White) applied complete granular fertilizers at planting and followed with fertigation through their drip systems.

Harvest seed plots

Dr. Crosby and his students harvested field seed from 54 breeding lines and 4 elite parent inbreds at Edinburg and Uvalde during the spring of 2015. Due to very wet conditions and fruit rot, seed quality was not very good and germination rates ranged between 20-100%. All seed was cleaned and treated with trisodium phosphate or bleach solutions to kill bacteria and fungal pathogens, then dried at room temperature for 5 days prior to packaging and storage in a -20 °C chest freezer. An additional selection for virus resistance was made at Edinburg during the Fall season. Heavy rains resulted in below average fruit quality, but high virus pressure (TYLCV) made selection for resistant lines successful. More than 40 breeding lines and 12 hybrids exhibited good resistance and these included beefsteak, processing, Roma and cherry types. In addition, two beefsteak hybrids and three cherries exhibited much better resistance to bacterial leaf spot than everything else. Seed was harvested in December and treated as described above.

Collect performance data

Dr. Crosby and his students collected some maturity, yield, disease resistance and quality data from the Edinburg and Uvalde trials, which are presented in Table 1. Basically, the heavy rains caused bacterial leaf spot on all entries at levels not previously observed by Dr. Crosby in Texas. Alternaria and TSWV were also severe on many entries at all locations. TAMU Hybrids 5, 10, 11, 14, 15 and 20 and ‘Tycoon’ had the healthiest foliage at Uvalde, but some TYLCV was evident in ‘Tycoon’ compared to the TAMU hybrids. All entries without tomato yellow leaf curl virus (TYLCV) resistance at Edinburg showed symptoms of this virus. This included ‘Tasti-Lee’, ‘Valley Cat’, and some TAMU lines without any TY genes. At all locations, ‘TAM Hot-Ty’ and several TAMU hybrids (hybrids 5, 15 and 18) were substantially earlier to mature than any commercial cultivar. Plant size was also smaller on these TAMU lines and fruit set was more concentrated.

Table 1. Fruit traits of TAMU and commercial tomato hybrids at Uvalde trial.

Entry	Fruit Wt (g)	Fruit Diam (cm)	Firmness (lbs)	Comments
TAM 1	159	7.3	3.1	Very early
TAM 2	188	8.0	4.0	Very attractive
TAM 3	252	8.5	na	Very large
TAM 5	191	8.6	3.5	Very early
TAM 6	137	7.2	3.7	Very high yield
TAM 7	125	7.5	4.5	Very early
TAM 8	188	8.0	5.8	Very high yield
TAM 9	212	8.3	6.0	Very firm
TAM 10	134	7.0	4.0	Very healthy
TAM 12	177	7.5	4.4	Very high yield
TAM 13	172	7.1	6.1	Very firm
TAM 14	189	7.8	3.1	Very healthy
TAM 15	150	7.6	2.4	Very healthy
TAM 16	194	7.9	4.5	Very high yield
TAM 18	225	7.6	3.9	Very high yield
TAM 20	202	8.0	4.7	Very attractive
TAM 21	170	7.5	2.9	Very healthy
TAM 26	190	8.2	4.6	Dwarf plant
TAM Hot-Ty	202	8.1	4.9	Very attractive
Tycoon	199	8.0	5.1	Very late
Charger	277	9.1	6.4	Very large and firm
Tasti-Lee	182	7.2	2.6	Very attractive
Valley Cat	253	8.2	7.8	Latest in trial

Produce experimental seed in GH

More than 200 Controlled pollinations between 22 elite inbred lines were conducted by Dr. Crosby and his students from December 2014-April 2015. Fruit from these crosses were harvested between February and June and seed cleaned by fermentation for 5-6 days. This included 45 new hybrids and larger volumes (5-10 g) of seed from 6 elite hybrids which performed best in 2014 trials. All seed was dried, packaged and placed in a -20 °C freezer for storage. Another greenhouse crop was produced at College Station during the Fall-Winter of 2015. Students Chi and McIntyre, along with Dr. Crosby conducted cross-pollinations to generate 60 new hybrids and increase seed of Hybrids 2, 5 and 7. These seed were harvested from February until April and used for 2016 field trials.

Host field day at La Feria
This was cancelled due to flooding rains which made entry to the field unrealistic and severely damaged the tomato plants. The same conditions were present at Uvalde until July, when remaining fruit were past maturity and not suitable for observation. Two seed company representatives and several growers did visit with Dr. Crosby individually and observe some fruit samples from Edinburg and Uvalde. Lycopene and fruit quality attributes were discussed with regards to appearance and consumer acceptance. During the project extension period in 2016, Dr. Crosby hosted a Tomato Workshop at College Station on August 5. More than 70 people attended to learn about production practices, diseases and quality attributes being researched at Texas A&M. Grafting demonstrations were carried out and free plants of ‘TAM Hot-Ty’ were given out.

Disseminate Information
Dr. Crosby met with the following growers and arranged trials of new TAMU hybrids: Rene Garza, Sonny Springer, David White, Jollisant Farms, Brenton Johnson and Andrew Dewey. In addition, he attended the TOFGA conference in San Antonio and presented a talk about breeding tomatoes for Texas production environments. This led to interactions with additional, organic growers in north and east Texas. The official release of ‘TAM Hot-Ty’ through TAMU was initiated and 150 flyers for this cultivar were prepared and distributed to commercial and urban growers at the Ft. Bend County Vegetable Conference and Texas A&M Tomato Workshop at College Station.

Goals and Outcomes Achieved
Increase production of vine-ripe Texas tomatoes on both conventional and organic farms:

Planting of both vine-ripe and processing tomatoes was increased (total of more than 160 acres at all locations) with both commercial and TAMU hybrids, but terrible weather resulted in a decrease in the total harvest at all locations.

Increase awareness and seed availability of new TAMU virus and heat resistant tomato cultivars:
Dr. Crosby participated in multiple events (described above) to promote TAMU tomato cultivars and educate growers about quality and production practices. These events at College Station, Rosenberg and San Antonio included more than 500 participants.

An increase of 80-100 acres of vine ripe round and processing tomato types by 2015 with better adapted TAMU cultivars:

About 70 acres of processing TAMU tomato lines and 20 acres of beefsteak types were planted in south Texas, while mostly commercial hybrids were produced at the other locations. However, many of the plants were lost to heavy rains so less than 40 total acres were harvested.

Increase seed production and availability of 2-3 best TAMU cultivars for at least 100 acres of production:

About 40 lbs of seed of the TAMU processor lines was produced by Rio Valley Canning in Donna for 2016 production. Seed of more than 60 experimental hybrids were produced in the TAMU greenhouse. Just under 3 lbs of seed was produced on contract by Lark Seeds of the new hybrid cultivar 'TAM Hot-Ty' for distribution to nurseries and small growers in 2016.

Acreage assessments will be estimated periodically through the grant by direct contact with growers:

Dr. Crosby visisted with all growers at planting and throughout the season to acquire accurate acreage assessments. Unfortunately, more than half of all acres planted were ruined by flooding rains.

Beneficiaries

The beneficiaries of this project included 6 grower/packers, a processor, multiple retailers, consumers, two graduate students, the TAMU tomato research program, a seed company, and agribusinesses which served the growers. Specific growers and packers include J&D Produce, Sonny Springer, Rene Garza, Johnson's Backyard Garden, San Antonio Food Bank, and Neuman Farms. Rio Valley Canning benefitted from the increased seed for TAMU processing tomato lines. Emerald and Lark Seeds stand to benefit from additional hybrid seed sales of new TAMU cultivars. Attendees (more than 500) of the numerous educational events benefitted from production and disease control advice. These included small growers, master gardeners, and backyard growers. Finally, every consumer in Texas or elsewhere who purchased canned or vine ripe product from these producers benefitted from the quality, freshness and affordability.

The estimated economic impact from fresh and canned tomatoes produced was roughly $400,000, based on roughly 75 acres harvested in the Rio Grande Valley, Hill Country and at Waller, during 2015. This is just the retail value of the products and does not include any additional impacts from agribusiness products, labor wages, etc. The potential impact of TAMU heat and virus resistant cultivars, if weather would be favorable, could exceed $2 million in Texas. This is based on more than 400 acres among the various growers collaborating with this project, and should expand with additional seed availability.

Lessons Learned

The main lesson learned, was that heavy rains will destroy tomato crops in Texas regardless of the location. The 2014-2015 seasons were severely hampered by bad weather, making some growers invest in protected culture. This may be a much more stable alternative to open-field production in much of Texas.

Another lesson learned was that educational events attract more participants than field days, possibly due to aversion to hot weather. Thus, future events organized by Dr. Crosby will likely be indoors and/or during the cooler seasons.

One additional lesson learned, was that even terrible environmental conditions can produce some positive results. Resistance to bacterial leaf spot and cracking was revealed in some TAMU tomato lines after excessive rains.

Additional Information
The following publication about tomatoes was from a poster presentation at the annual meeting of the American Society for Horticultural Sciences in New Orleans by Dr. Crosby's graduate student:

Xie, L., Crosby, K., and J. Jifon. 2015. Estimates of Genetic Variance for Drought Tolerance Traits in Tomato. HortSci 50(9): S300.

Attendees at TAMU Tomato Workshop and TAMU experimental hybrid 10 with resistance to TYLCV, Fusarium1-3 and bacterial leaf spot.

PROJECT 6: INCREASING PROFITABILITY AND REDUCING INSECTICIDE USE IN TEXAS SOD PRODUCTION THROUGH MONITORING OF DESTRUCTIVE INSECT PESTS

Partner Organization: Primary - Turfgrass Producers of Texas; Partner - Texas A&M Agrilife Extension.
Project Manager: Brent Batchelor, Executive Director, Dr. Casey Reynolds, Assistant Professor & Extension Turfgrass Specialist
Contact Information: b_batchelor86@att.net (979) 282-9305
Type of Report: Final
Date Submitted: April 29, 2016

Project Summary

Healthy, harvestable turfgrass sod provides numerous benefits to the citizens of Texas and its economy. According to a recent economic analysis for Texas sod production, there were 19,282 acres of turfgrass grown in over 35 counties in Texas during 2014 (Reynolds, 2015). This study indicated that turfgrass production generated 2,128 jobs and $263 million in economic output while a 2005 survey placed its estimated production cost at $2,304.50 per acre (Falconer, 2006). As growers produce high-quality turfgrass for harvest and sale, it is often attractive to numerous, destructive insect pests that can cause considerable damage and reductions in profitability. In order to maximize the effectiveness of insecticides, while also minimizing costs, it is important that applications are properly timed based on insect emergence and life cycle. Furthermore, their emergence timing and abundance can vary by location, temperature, soil type, etc. Proper monitoring of turfgrass insects enhances the speed and reliability of detection of these potentially devastating pests and improves insecticide efficacy by targeting their most vulnerable stage. This type of specific application based on monitoring is both environmentally and economically beneficial because it reduces the cost associated with insecticide application, thus increasing profitability, as well as minimizes any off-target impacts.

There are at least 471 species of scarab beetles in Texas. Of these species, there are at least ten that can produce larvae that are pests of turfgrasses by feeding on roots during various times of year. Scarab beetles capable of damaging turfgrasses include Phyllophaga sp. (May/June beetles), Cyclocephala species (Masked chafers), Hybosorus sp. (Scavenger beetles), Ataenius sp. (Turfgrass ataenius beetles), and Tomarus sp. (Carrot beetles).

It is the subterranean larval stage of these pests that are problematic and as a result, damage from their feeding is not visible aboveground until much of the damage has already occurred. This makes the importance of proper application timing paramount in controlling these pests prior to the occurrence of damage levels above an acceptable threshold. The purposes of this research study of scarab beetles in Texas sod production included the following:

1) To determine the specific species of scarab beetles that occur in turfgrass production areas throughout Texas
2) To determine when beetle flights are at their maximum levels in order to determine proper treatment timings that will be the most effective
3) To examine variations in beetle species and peak flights based on location

Moths were not included in this study, because so few were caught in the traps and those actually caught were unidentifiable after sitting in the traps for a few days due to heat and moisture. The primary goal of this study was to monitor beetle flights, which worked well.

Project Approach

This project was implemented during the late-winter early spring months of 2015 after all of the necessary research and monitoring equipment required to perform this project had been acquired. One of the pieces of equipment purchased as a component of this grant included an Olympus SZX7 Stereomicroscope, which was used for identification and photographing of various scarab beetles (Figure 1) captured in the monitoring traps.

Figure 1. *Phyllophaga* sp. (left) and *Cyclocephala* sp. (right) beetles collected in insect monitoring traps during 2015 and photographed with an Olympus SZX7 Stereomicroscope.

These beetles were collected in light traps that were placed throughout Texas from March until December of 2015. Insect monitoring equipment and weather data loggers were set in place at seven monitoring locations throughout Texas during the spring of 2015. These locations included Austin, Bryan, College Station, Dallas, Pilot Point, Wharton, and the Woodlands. Soil and air temperature were monitored daily using Onset HOBO ProV2 data loggers set to collect daily average, minimum, and maximum soil and air temperatures. The light trap at each of the seven monitoring locations consisted of a Bioquip universal black light trap with a circline bulb mounted over a 3.5 gallon bucket (Figure 2). This trap is designed to attract beetles and other flying insects to the bulb at night where they fall into the bucket and remain trapped until harvested. Traps at each location were harvested weekly throughout the duration of the experiment from March until December 2015.

Figure 2. Bioquip Universal Black Light Trap

After weekly harvests at each location, the contents of each trap were sorted and anything in the trap that was not of interest was removed. This included various other insects such as moths, caterpillars, and non-scarab beetles as well as water or anything else that may have fallen into the traps. The scarab beetles of interest were then taken to a laboratory in the Soil and Crop Sciences Department at Texas A&M University in College Station and placed into a freezer until sorted.

Scarab beetles from each of the locations were identified and sorted into the various species of interest with help from Texas A&M Entomology faculty and graduate students. The total number of beetles collected, identified, and sorted are presented in Table 1.

Table 1. Population counts of various genuses of scarab beetles collected at seven monitoring locations throughout Texas during 2015.

Location	*Phyllophaga*	*Cyclocephela*	*Hybosorus*	*Tomarus*	*Serica*	*Ataenius*
Austin	278	82	4	1	0	0
Bryan	438	419	46	1	2,691	79
College Station	703	159	216	14	61	280
Dallas	5,174	191	0	0	0	0
Pilot Point	1,101	179	946	1,312	0	0
Wharton	6,121	872	1,242	2	13	34
Woodlands	119	420	79	0	35	33
Species Total	13,934	2,322	2,533	1,330	2,800	426
Overall Total	23,345					

As indicated by the results in Table 1, there were at least five species of scarab beetles present at the various monitoring locations during 2015. *Phyllophaga* sp. was the most prevalent with 13,934 total beetles. This was followed by *Serica sp.* (2,800), *Hybosorus* sp. (2,533), and *Cyclocephela* (2,322). In addition to varying populations based on location, there were also varying populations based on date within each location (Figures 3 through 9).

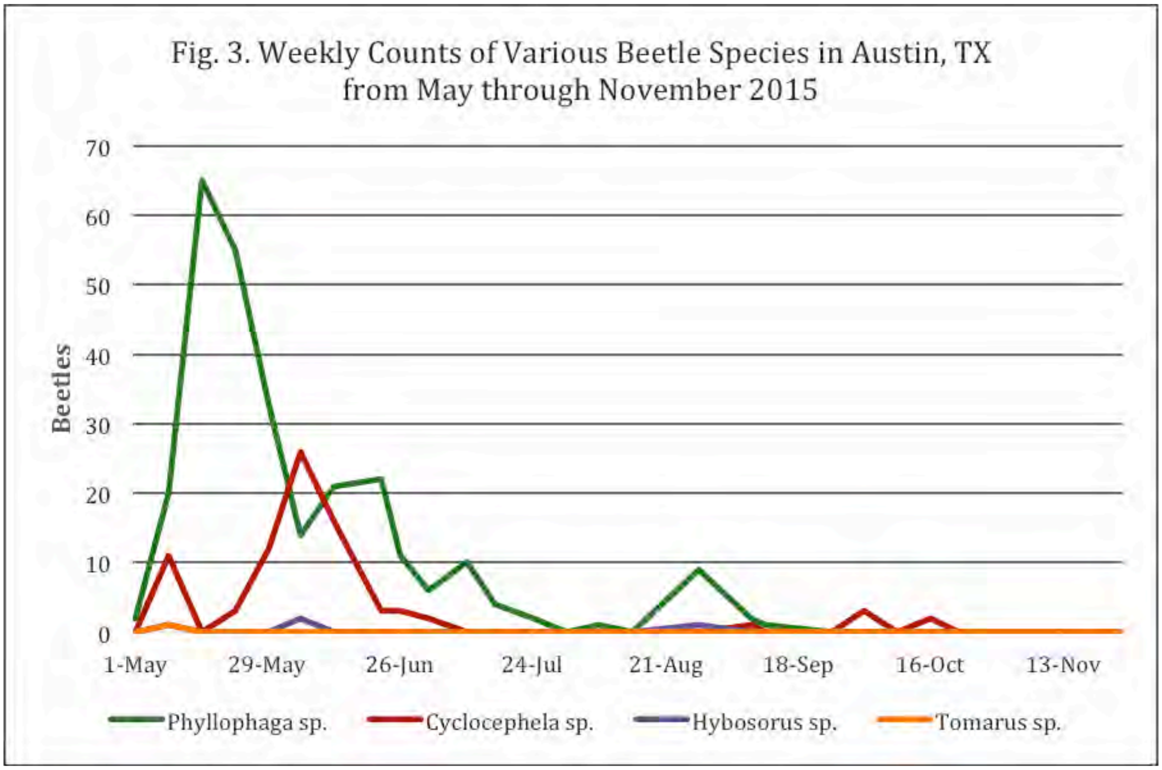


Fig. 3. Weekly Counts of Various Beetle Species in Austin, TX
from May through November 2015
Beetles
70
60
50
40
30
20
10
0
1-May
29-May
26-Jun
24-Jul
21-Aug
18-Sep
16-Oct
13-Nov
Phyllophaga sp.
Cyclocephela sp.
Hybosorus sp.
Tomarus sp.

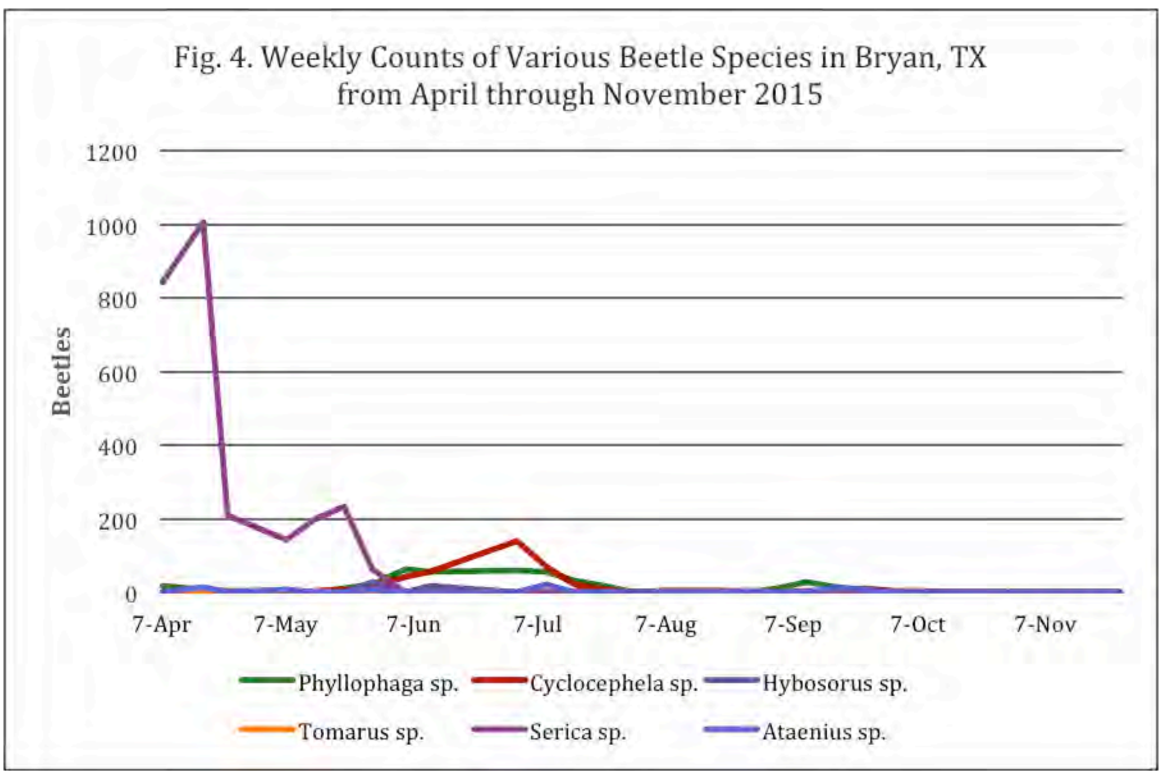


Fig. 4. Weekly Counts of Various Beetle Species in Bryan, TX
from April through November 2015
Beetles
1200
1000
800
600
400
200
0
7-Apr
7-May
7-Jun
7-Jul
7-Aug
7-Sep
7-Oct
7-Nov
Phyllophaga sp.
Cyclocephela sp.
Hybosorus sp.
Tomarus sp.
Serica sp.
Ataenius sp.

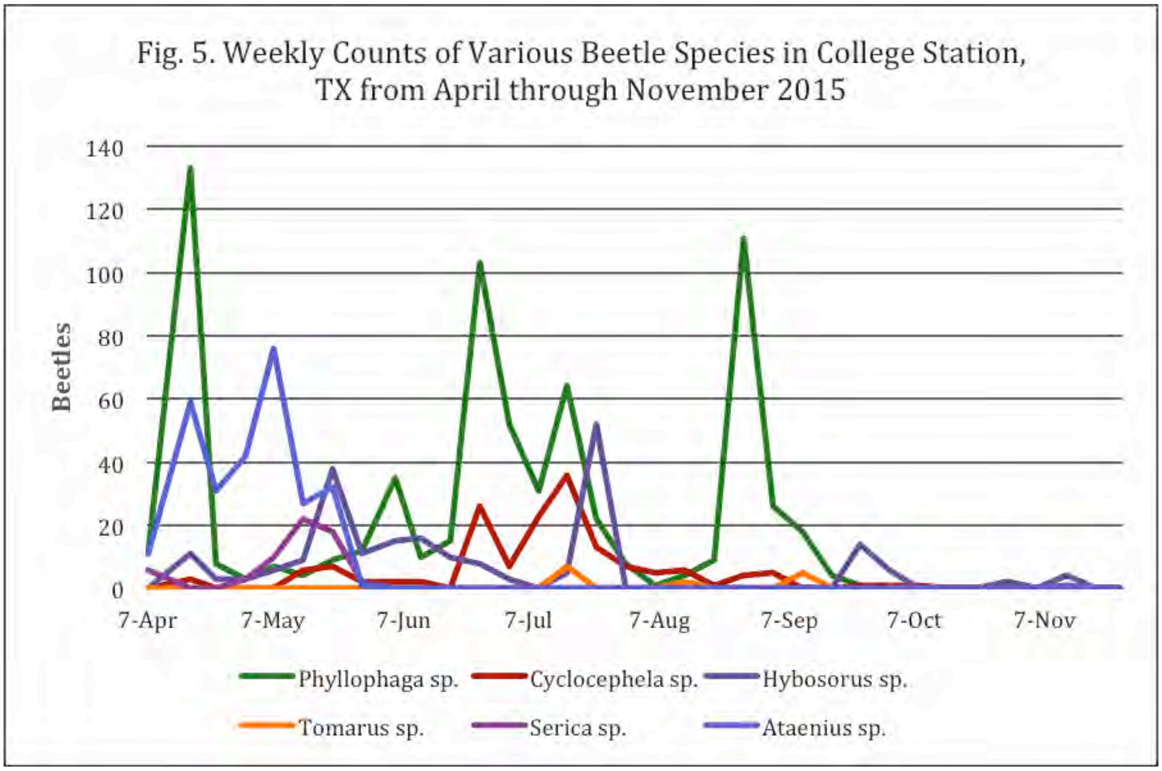


Fig. 5. Weekly Counts of Various Beetle Species in College Station, TX from April through November 2015
Beetles
140
120
100
80
60
40
20
0
7-Apr
7-May
7-Jun
7-Jul
7-Aug
7-Sep
7-Oct
7-Nov
Phyllophaga sp.
Cyclocephela sp.
Hybosorus sp.
Tomarus sp.
Serica sp.
Ataenius sp.

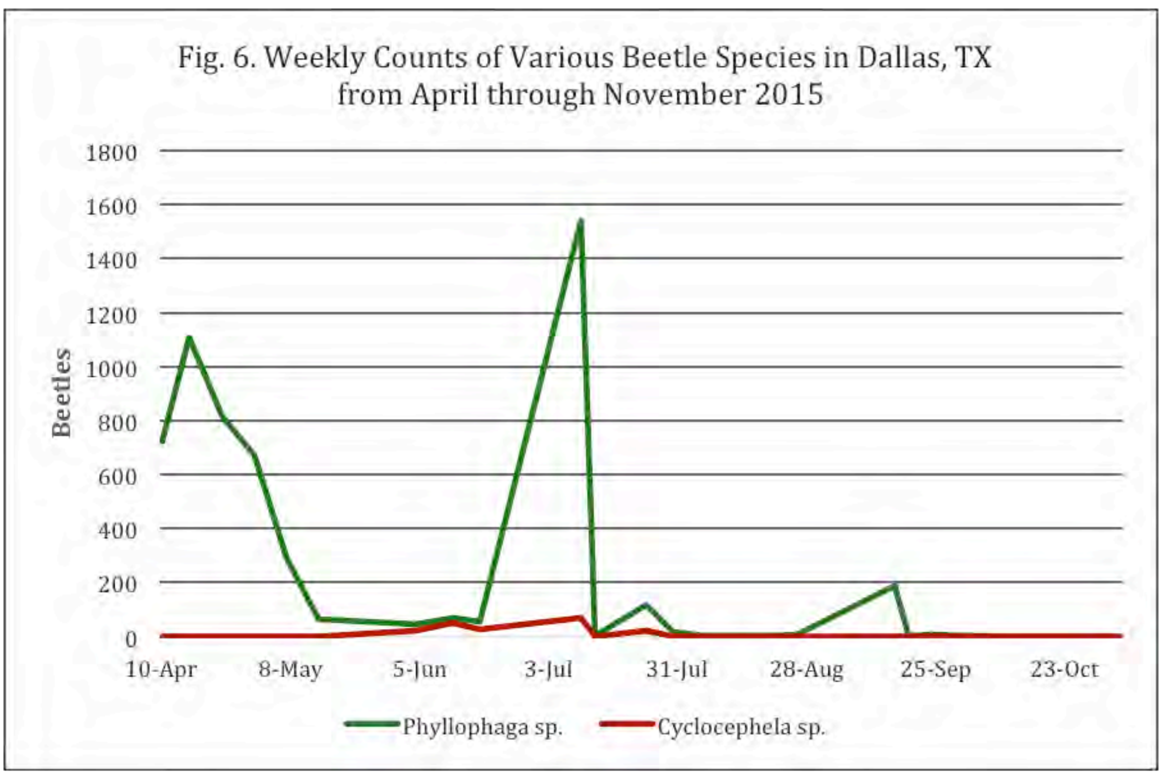


Fig. 6. Weekly Counts of Various Beetle Species in Dallas, TX from April through November 2015
Beetles
1800
1600
1400
1200
1000
800
600
400
200
0
10-Apr
8-May
5-Jun
3-Jul
31-Jul
28-Aug
25-Sep
23-Oct
Phyllophaga sp.
Cyclocephela sp.

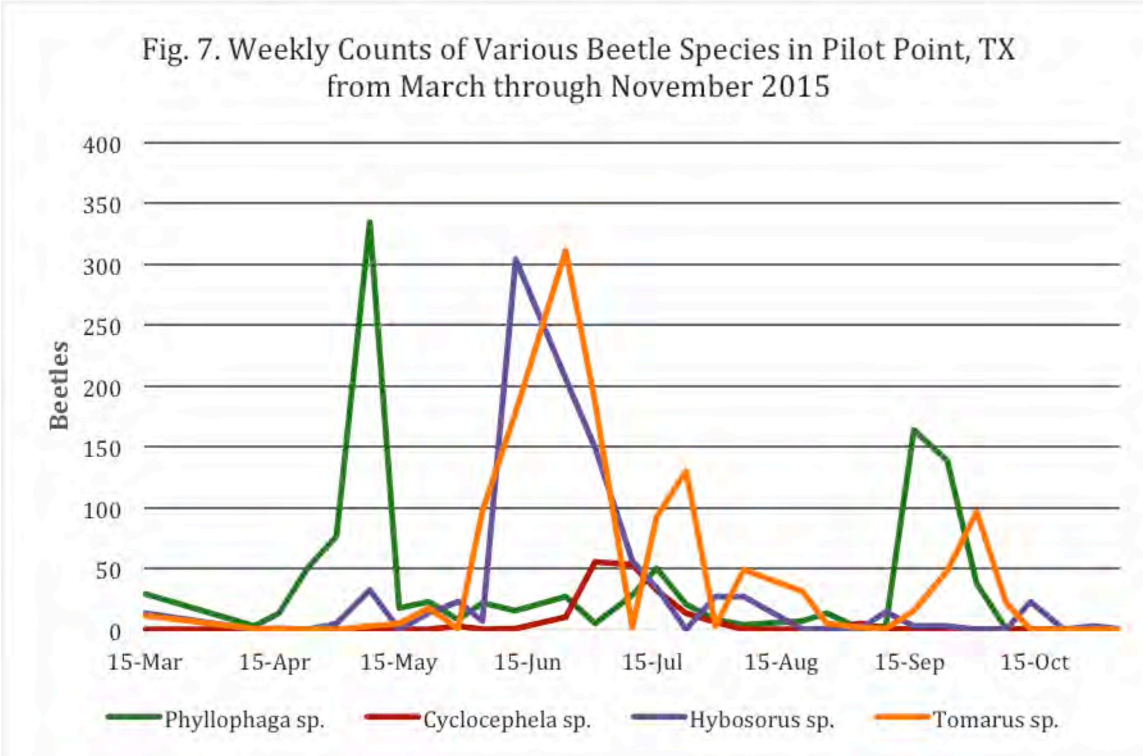


Fig. 7. Weekly Counts of Various Beetle Species in Pilot Point, TX
from March through November 2015
Beetles
400
350
300
250
200
150
100
50
0
15-Mar
15-Apr
15-May
15-Jun
15-Jul
15-Aug
15-Sep
15-Oct
Phyllophaga sp.
Cyclocephela sp.
Hybosorus sp.
Tomarus sp.

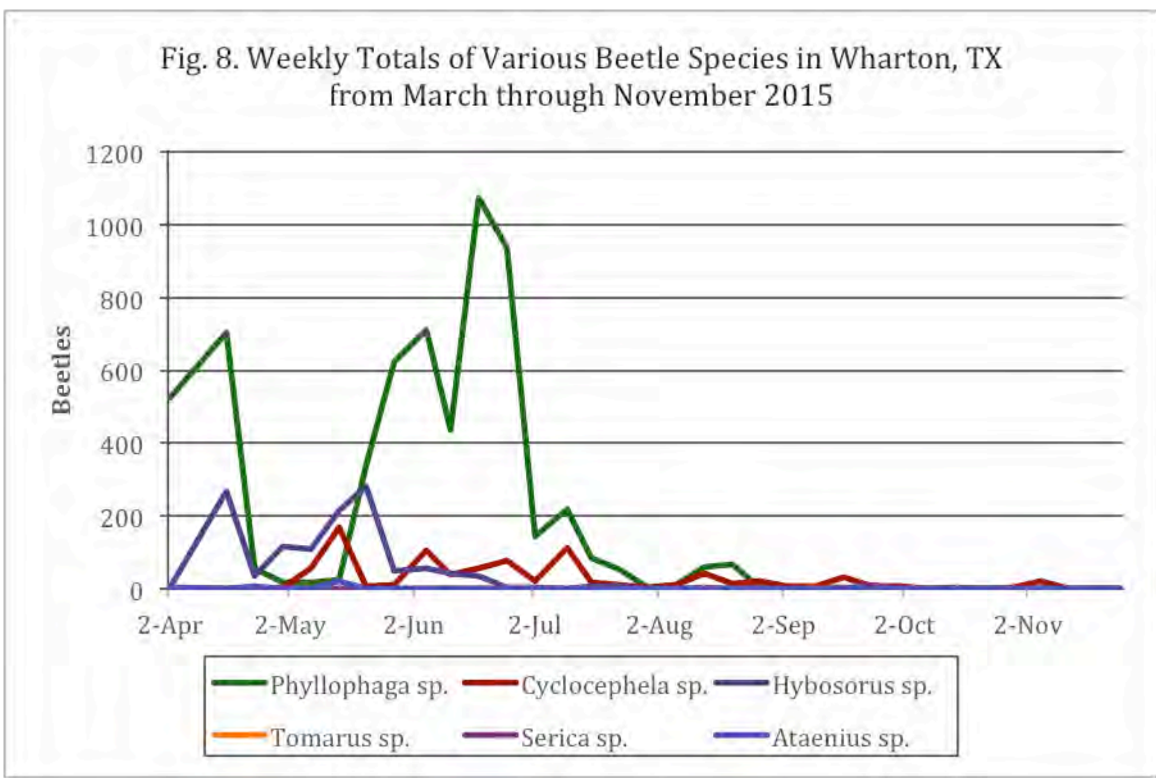
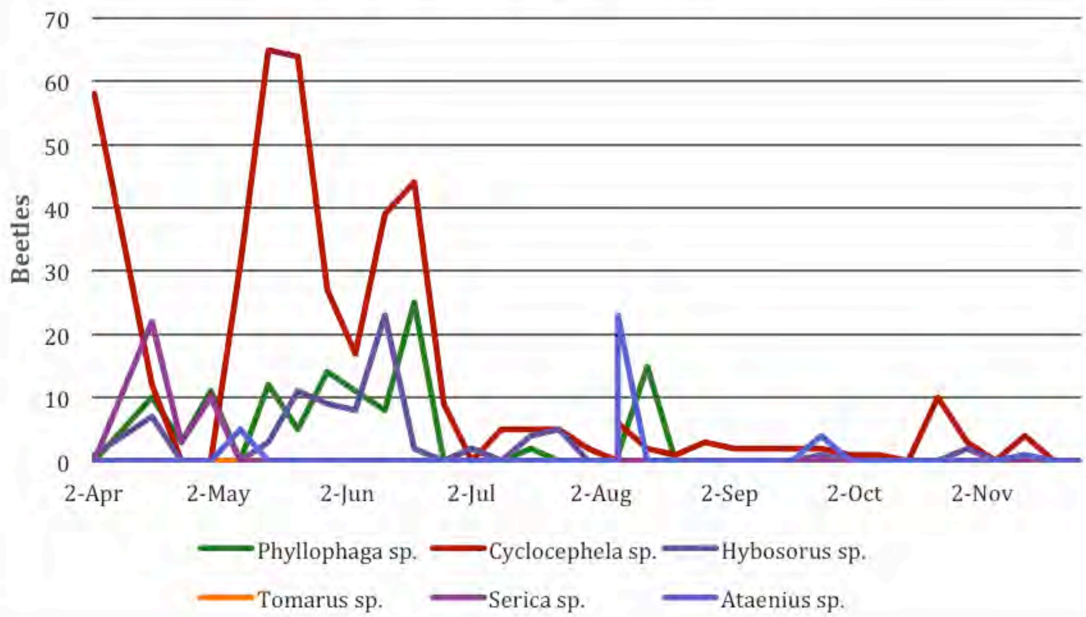


Fig. 8. Weekly Totals of Various Beetle Species in Wharton, TX
from March through November 2015
Beetles
1200
1000
800
600
400
200
0
2-Apr
2-May
2-Jun
2-Jul
2-Aug
2-Sep
2-Oct
2-Nov
Phyllophaga sp.
Cyclocephela sp.
Hybosorus sp.
Tomarus sp.
Serica sp.
Ataenius sp.

Fig. 9. Weekly Counts of Various Beetle Species in the Woodlands, TX from March through November 2015



The variation that exists in beetle species and populations present at different locations and times of year throughout Texas indicates the importance of monitoring prior to insecticide application. For example, *Phyllophaga* sp. (May/June Beetles) exhibited one peak flight during May in Austin, but had two peak flights in Dallas and Wharton during April and July, and three peak flights in College Station during April, July, and September. The most predominant population at the Bryan location was *Serica* sp., which exhibited a peak flight in late April. This location, along with the Woodlands location was the only site where *Phyllophaga* sp. was not solely the predominant species. Cyclocephela lurida (Masked chafers) was the predominant species at the Woodlands location while Pilot Point exhibited large populations of *Phyllophaga* sp., *Hybosorus* sp., (Scavenger beetles) and *Tomarus* sp. (Carrot beetles).

Soil and air temperature were not predictable variables that could be used to monitor beetle populations and peak beetle flights. No significant trends were apparent in the data, and it was noted that once beetle flights began in April/May, the peaks of their populations were dependent on species, not environmental conditions. As a result, it is much simpler for turfgrass producers to scout and/or collect beetles for identification at their individual facility, rather than to depend on soil and air temperature data.

This information will be used to help turfgrass producers more appropriately select and time their insecticide applications, which will decrease their production cost due to reduced application costs and increased duration of control. It is worth pointing out that turfgrass sod producers are not the only group in Texas that benefit from this data. Anyone managing turfgrasses including homeowners, landscapers, golf course superintendents, and athletic field managers can use this data to their advantage when selecting and applying preventative or curative insecticides for controlling larvae of scarab beetles. However, no funds committed to this project were used outside the scope of benefitting turfgrass producers.

The Turfgrass Producers of Texas were vital in contributing to this project by hosting monitoring sites, allowing for harvests, and coordinating the delivery of information. Texas A&M Agrilife Extension faculty and staff also played an integral role in taking the lead on placing the monitoring traps, collecting and sorting the beetles, and analyzing the data. These two groups will also continue to work together to deliver this information to turfgrass producers during 2016 and beyond in a timely manner that allows them to appropriately select and apply insecticides for controlling scarab beetle larvae.

During 2016, these data were presented at multiple Texas A&M AgriLife Extension and Industry Events as highlighted in Table 2. Polling of these audiences indicate that turfgrass managers often spray at least one and often two curative insecticide applications when white grubs are present. These are often high-use rate products as indicated in Table 3.

Table 2. AgriLife Extension and Industry Events

Event	Audience	Number of Attendees
Turfgrass Producers of Texas Annual Meeting	Turfgrass producers	35
Turfgrass Ecology Workshop	Turfgrass professionals	64
Grounds Maintenance Seminar	Turfgrass professionals	77
Texas A&M Agrilife Agent Training	County extension agents	8
Texas A&M IPM Workshop	Texas Public School Field & Grounds Managers	58
	Total	242

Furthermore, research data collected in this trial was used to update and/or produce Texas A&M AgriLife Fact Sheets and placed on the AggieTurf.tamu.edu website for green industry members, as well as homeowners, to access for use in identifying and treating white grub larvae in Texas Turfgrasses. This research was also published in the peer-reviewed academic journal Southwestern Entomologist so that it can be accessed by the worldwide academic and research community.

Goals and Outcomes Achieved

Due to the year-long cyclical nature of scarab beetle life cycles, this research was not complete until December 1, 2015 when beetle flights ceased due to cold weather. Beetle sorting and counting began immediately after that by Texas A&M Agrilife faculty and staff in the Entomology and Soil and Crop Sciences department. The process of sorting and counting 23,345 beetles (Table 1) was certainly time-consuming and was not complete until the end of March 2016. Texas A&M faculty will continue to work with the Turfgrass Producers of Texas staff to distribute this information to producers and survey their patterns of insecticide use.

A list-serve of Texas Turfgrass Producers has been produced and the distribution of this monitoring information to its members will allow one expected measurable outcome to be calculated, which is to reduce insecticide applications through monitoring and proper application timing.

Many products historically used for controlling larvae of scarab beetles are applied in a curative manner, meaning that they are applied only after damage has occurred. While this strategy limits insecticide use to affected areas only, these products are often applied at high-use rates (8 to 10 qts/A). This monitoring experiment shows that you can apply newer, lower-use rate products (0.25 to 0.5 qts/A) after peak beetle flights in areas with a history of infestation. This strategy will often provide season-long control of scarab beetles with much less reliance on curative, high-use rate products. This is particularly true in locations with multiple peak flights that would typically require repeated curative applications. Only two of the seven locations had one peak beetle flight while two locations had two peak flights, and three locations had three peak flights. Using this information from this 2015 insect monitoring research, some basic application reductions can be calculated on a per-acre basis to illustrate the value of this project.

Table 3. Potential Reductions in Insecticide Use when applying Season-long Preventative Treatments Based on Monitoring versus Conventional Curative Treatments

	Curative Treatments		Preventative Treatments		
Location	Applications (#)[1]	Yearly Rate (lbs ai/A)	Applications (#)[2]	Yearly Rate (lbs ai/A)	Percent Reduction
Austin	1	8.0	1	0.2	97.5%
Bryan	1	8.0	1	0.2	97.5%
College Station	3	24.0	1	0.2	99.1%
Dallas	2	16.0	1	0.2	98.8%
Pilot Point	3	24.0	1	0.2	99.1%
Wharton	2	16.0	1	0.2	98.8%
Woodlands	3	24.0	1	0.2	99.1%

[1]Curative product included for comparison is carbaryl at 8.0 qts/acre (8 lbs ai/A)
[2]Preventative product included for comparison is chlorantraniliprole at 0.5 qts/acre (0.2 lbs ai/A)

According to a recent economic analysis for Texas sod production, there were 19,282 acres of turfgrass grown in over 35 counties in Texas during 2014. Insecticide use-rate reductions of 97 to 99 percent per acre would almost certainly meet the target goal of a 25 percent reduction in insecticide applications. Furthermore, when measuring percent reduction based on application number (as opposed to use rate and loading), this research indicates that in areas with more than one peak beetle flight the application number can be reduced from two or three curative applications to one properly timed preventative application. This would result in a 50 to 67 percent reduction, which also hits the target goal of a 25 percent reduction.

Major, successful outcomes of this insect monitoring research include:

- At least five genuses of scarab beetles that can potentially damage turf were identified in various regions of Texas.
- Many of these beetles had multiple flights, illustrating the importance of long-lasting, residual insecticides as opposed to short-lived, curative insecticides.
- Newer, lower-use rate insecticides can reduce the reliance on older, high-use rate insecticides if applied at the proper time of year based on beetle flight monitoring.
- This could result in 97 to 99 percent reductions in insecticides based on active ingredient/acre calculations and/or 50 to 67 percent reductions based on number of applications.

Beneficiaries
Turfgrass producers treating for white grub larvae of various beetle species in Texas using traditional curative products such as Dylox at high use rates may spend up to $200/acre for each application while using a preventative product such as Acelypryn at $35/acre could save up to $165/acre over the 19,282 acres or reported turfgrass production in Texas. In addition to reducing cost and adding value to the Turfgrass Producers of Texas, this insect monitoring research is beneficial to other Texans who manage high-value turf as well. Golf course superintendents, landscapers, athletic field managers, and homeowners can all benefit from a better understanding of scarab beetle life cycles. This is particularly true in urban areas of Texas where lights, trees, bushes, flowers, and garden plants attract the adult stage of the scarab beetle. Homeowners and landscapers often find themselves treating for this pest stage (beetle) without any thought of the impact they may have when they lay their eggs into surrounding turfgrasses. Furthermore, they are also habitually reliant on curative, high-use rate products because they often take a much more reactive than preventative approach.

Information from this insect monitoring project can be used by these clientele to impact a much larger amount of Texas acreage simply due to the fact that there are vastly more acres of home lawns, landscapes, and recreational turf than production farms. One recent survey placed this acreage at 1.6 million acres of lawns and landscapes and over 115,000 acres of golf courses, as opposed to less than 20,000 acres of turfgrass production facilities. Therefore, this research can potentially have a much larger impact in terms of acreage treated with insecticides and subsequent reduction in use.

Lessons Learned
Lessons learned from this insect monitoring project include:

- Beetle flights begin early in South and Central Texas and when they do it occurs rapidly. Beetle collecting began in March-April, and due to the warm, wet spring of 2015 beetles were in the traps earlier than expected.
- Counting over 23,000 dead beetles is a long, arduous task that is best performed over several months.
- It is difficult to obtain high participation rates in surveys, as is often the case. The initial plan was to survey the Texas Turfgrass Producers, but these surveys were never completed due to lack of feedback from producers. This was perhaps due to the fact that a Turfgrass Producers of Texas Economic Impact survey had just been completed in 2014, which also received very little response. The ability to gather input for this project so soon after the economic impact survey was possibly an issue for producers. Producers are sometimes not willing to share their management information due to the perceived risk of compliance issues, competitors, misapplication, etc. This is especially true with pesticide applications and their records. Based on these factors, it is unlikely that pre and post monitoring benchmarks will be completed. However, the estimates calculated in Table 32 with regard to application rates per acre are an indicator of this research project's potential.

Additional Information
Information from this insect monitoring research will be developed into a Texas A&M Agrilife Extension publication in 2016 and made available on the AggieTurf.tamu.edu website. It will

also be distributed on social media, to County Agents, Master Gardeners, and industry personnel at various conferences throughout the state such that as many Texans as possible can benefit from this research.

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Falconer, L. and M. Niemeyer. 2006. Economic Analysis, Impact and Agronomic Profile of Sod Production in Texas. Texas A&M Cooperative Extension. College Station, TX. http://www.txsod.com/docs/ecoanaylasisrpt.pdf (accessed 5/17/16)

Reynolds, W.C. M. Elmore, D.S. Reynolds, and M. Palma. 2015. Texas Turfgrass Crop Profile and Pest Management Strategic Plan. Southern IPM Center. Raleigh, NC.
https://ipmdata.ipmcenters.org/documents/pmsps/TX%20Turfgrass%20PMSP%202015.pdf (ACCESSED 3/8/17)

PROJECT 7: SUSTAINABLE PRODUCTION OF MELON AND ARTICHOKE USING ECO-POLYMERS: DOES IT MATTER TO CONSUMERS?

Partner Organization: Primary – L&L Farms, LLC; Partner - Texas A&M AgriLife Research
Project Manager: Brandon Laffere
(Co-PI Dr. Daniel Leskovar, 830.278.9151 x.249; (d-leskovar@tamu.edu)
Contact Information: lafferefarms@gmail.com
Type of Report: Final
Date Submitted: July 1, 2016

Project Summary

This project focuses on two high-value crops, globe artichoke and specialty melons, grown in water-limited regions of Texas. Mixed melons produced in western states like Arizona and California are increasing in the market; however, production in Texas has decreased dramatically in the last 5 years. Water, diseases, seed and labor costs are the main factors limiting mixed melons production in Texas. Improper irrigation practices can cause water loss and plant diseases such as sudden wilt, a serious disease in cucurbits. Selecting disease resistant and drought tolerance cultivars can potentially increase the production value of mixed melons. Artichoke is a popular crop in the U.S. with an increasing demand not only in the U.S. but worldwide, offering potential opportunities for this commodity. The value for imported prepared artichokes was $124 million in 2013. The leading supplier was Peru, followed by Spain, and distantly by Mexico. U.S. also has a small export market, $4.0 million, with Canada and Mexico being the main markets. In California artichoke was grown in 7,300 acres with a value of $55.5 million in 2014. However, severe droughts and new regulations restricting water use for agriculture particularly in southern California may have an impact in acreages in the near future. Therefore, these scenarios offer opportunities for Texas. The crop has high profitability potential to grow in semiarid regions of southwest Texas (Wintergarden) to sub-humid regions (Lower Rio Grande Valley) to central Texas, near Austin. Biodegradable-biopolymer mulches could be a key component for sustainable production of high value vegetable crops (such as melons and artichokes) that use plasticulture systems. During the growing season the exposed mulch is exposed to UV light, and the buried portion to soil microbial activity (bacteria, fungi, and algae), which combined these two processes decompose the mulch in a relatively short time. The technology has evolved in such a way that it is now possible to design eco-polymers with specific additives in their formulation based on the climatic conditions of the growing region, type of crop and characteristics of the cropping systems.

The aim of this project is to evaluate the performance of new TAMU and commercial artichoke and melon varieties under conventional and organic systems as well as management practices in southwest Texas. The objectives are: a) evaluate new artichoke varieties under conventional and organic production fields, b) determine the benefits of biodegradable plasticulture c) compare water use efficiency, growth, productivity, earliness, and quality, and d) conduct educational activities to transfer results to growers and consumers. This project complemented a previously funded SCBGP in refining practices for the production of different artichoke with red, mixed green/red and green head types. The project provided educational programs and demonstrations, presenting results to emerging, small-scale and large-scale commercial farmers in Texas.

Project Approach

The following activities and tasks were achieved during the grant period: In artichokes, the project evaluated transplant and direct seeded systems, shading management, cultivars, and organic soil amendments. The project also evaluated biodegradable plasticulture systems for melons and screened melon cultivars. The final two components of the project were to evaluate consumer preferences of artichoke products and conduct educational programs to growers and consumers.

Artichoke

Transplant quality to improve stand establishment

Effective nutrition and irrigation are important nursery strategies to produce high quality seedlings able to withstand heat and drought stress in the field. In this study we first identified the influence of two nitrogen (N) levels (75 and 150 $mg{\cdot}L^{-1}$) and two fertigation methods, overhead (OH) and flotation (FL) of artichoke cv. Green Globe Improved transplants on root/shoot growth and leaf physiology during the nursery period. A repeated greenhouse experiment was conducted and morpho-physiological measurements determined at 4 and 7 weeks after seeding (WAS). The second part was to determine the impact of the nursery treatments (fertigation method and N level) on the subsequent crop growth and yield under three field irrigation methods [(surface drip, subsurface drip, and overhead linear system (OH-L)]. Field measurements were conducted at 50 and 150 d after field transplanting (DAT) during the fall-winter period. Transplants fertilized with 75 $mg{\cdot}L^{-1}$ N (low N) had improved root components as compared to those with 150 $mg{\cdot}L^{-1}$ N (high N), especially 4 WAS. The low N transplants had higher root surface area, root length, root branching, thinner root diameter, higher pulling force and less shoot area than the high N transplants (Tables 1 and 2). Wilting for low N transplants was 13.5% less than at high N at 5 DAT, with a total yield similar or slightly higher than those from high N. Although growth of OH and FL transplants was statistically similar at transplanting, those irrigated with OH (greenhouse) had a 10% higher yield than FL irrigated transplants, regardless of the field irrigation method evaluated. Overall, low N level (75 $mg{\cdot}L^{-1}$ N) applied with OH irrigation in the nursery positively improved the artichoke transplant root system and transplant quality of artichoke seedlings.

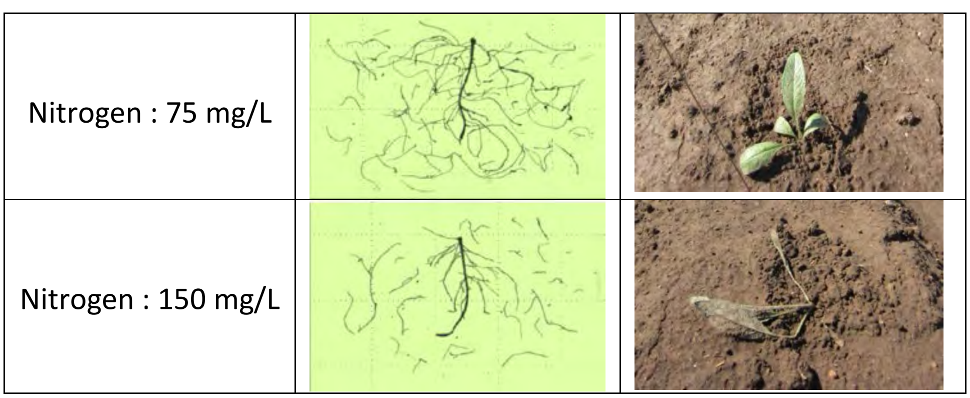

Figure 1. Artichoke roots and transplants grown with 75 and 150 N $mg{\cdot}L^{-1}$.

Table 1. Root components of artichoke transplants fertigated with 75 and 150 mg·L^{-1} N and with flotation and overhead systems measured in two experimental cycles.

Cycle no.	Week	Treatment		Root components: Length (cm)	Surface area (cm^2)	Avg diam (mm)	Forks no.
I	4	Nitrogen	75	152	19.3	0.41	380
			150	96.3	13.2	0.44	230
			P value[z]	<0.0001	0.0001	<0.0001	0.02
	7		75	843	90.7	0.34	2,101
			150	607	70.4	0.37	1,460
			P value	0.003	0.010	0.01	0.02
II	4		75	227	29.9	0.42	563
			150	159	23.2	0.46	394
			P value	0.039	0.080	0.001	0.08
	7		75	768	86.5	0.36	1,824
			150	716	82.7	0.37	1,659
			P value	0.360	0.580	0.41	0.46
I	4	Fertigation	Flotation	129	16.7	0.42	313
			Overhead	120	15.9	0.43	296
			P value	0.220	0.430	0.30	0.76
	7		Flotation	729	79.6	0.35	1,866
			Overhead	721	81.6	0.36	1,695
			P value	0.890	0.760	0.24	0.44
II	4		Flotation	179	24.7	0.44	431
			Overhead	206	28.4	0.44	526
			P value	0.360	0.300	0.830	0.30
	7		Flotation	686	75.3	0.35	1,551
			Overhead	798	93.9	0.38	1,932
			P value	0.060	0.020	0.030	0.11

[z]Irrigation × nitrogen level interaction was not significant ($P = 0.05$).
N = nitrogen.

Table 2. Abaxial stomatal number, shoot and root total nitrogen (N) and pulling force of artichoke transplants fertigated using 75 and 150 mg·L^{-1} N and with flotation and overhead systems.

Treatment		Stomatal no. (mm^{-2})	Shoot N (%)	Root N (%)	Pulling force (N)
Nitrogen	75	83.13	1.67	1.73	–1.23
	150	71.58	2.47	2.21	–1.021
	P value[z]	0.090	<0.0001	<0.0001	0.0003
Fertigation	Flotation	85.25	1.95	1.86	–1.11
	Overhead	63.33	2.19	2.08	–1.14
	P value	0.0002	0.0020	<0.0001	0.4800

[z]Fertigation × N level interaction was not significant ($P = 0.05$).

Screening, shading and stand establishment

From the artichoke screening the best varieties based on yield and quality during the harvesting period were the new hybrids from Big Heart Seed: 12-179, Lulu and Deserto. Additional three varieties, the new hybrid Romolo, Green Globe Improved and Imperial Star were also screened using direct seeding vs. containerized transplants. Overall best marketable yields were obtained for cv. Romolo as compared with the standard OP cultivars, and the best establishment system was for containerized transplants. The practice of adding shade cloth 'shading' to reduce canopy temperature and extend the harvesting period of artichoke cultivars did not provide a beneficial effect on extending the production season. Shading significantly limited canopy light (reduced the plant photosynthetic activity). In addition shading increased pest intensity and reduced the beneficial insects as compared to unshaded plants.

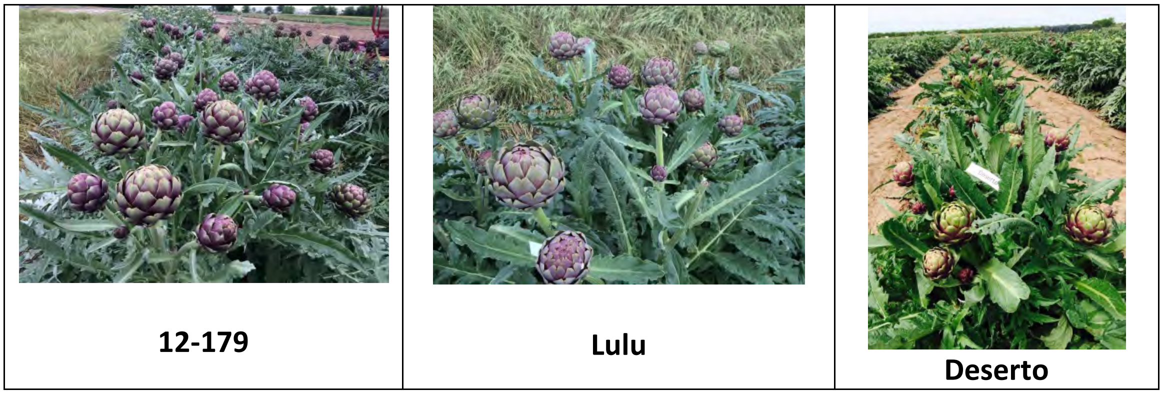

Figure 2. New highly productive artichoke hybrids tested in the Wintergarden and Rio Grande Valley.

Organic soil amendments

The project evaluated soil amendments based on four organic fertilizer sources (chicken manure, plant, blood, and fish meals) in the certified organic field at Texas A&M AgriLife Uvalde. The experiment used the cv.12-179. Soil amendment organic fertilizers improved soil respiration over the experimental period 2014-2016. After two years of soil amendment using different sources of organic fertilizers, the application of plant-base fertilizer (alfalfa) increased soil respiration CO_2 by 30-fold, blood meal by 9-fold, chicken manure by 10-fold and fish meal by 11-fold compared to the baseline soil respiration from 2014 (Fig. 3). Although alfalfa, fish meal and chicken manure showed consistent increase in soil respiration over the study period, blood meal soil respiration CO_2 was inconsistent. While it had the highest soil respiration in 2015, it significantly decreased in the 2016 growing season. Overall, the plant-based organic fertilizer (alfalfa) was better in improving soil respiration compared to the animal-based fertilizers (fish meal, blood meal and chicken manure).

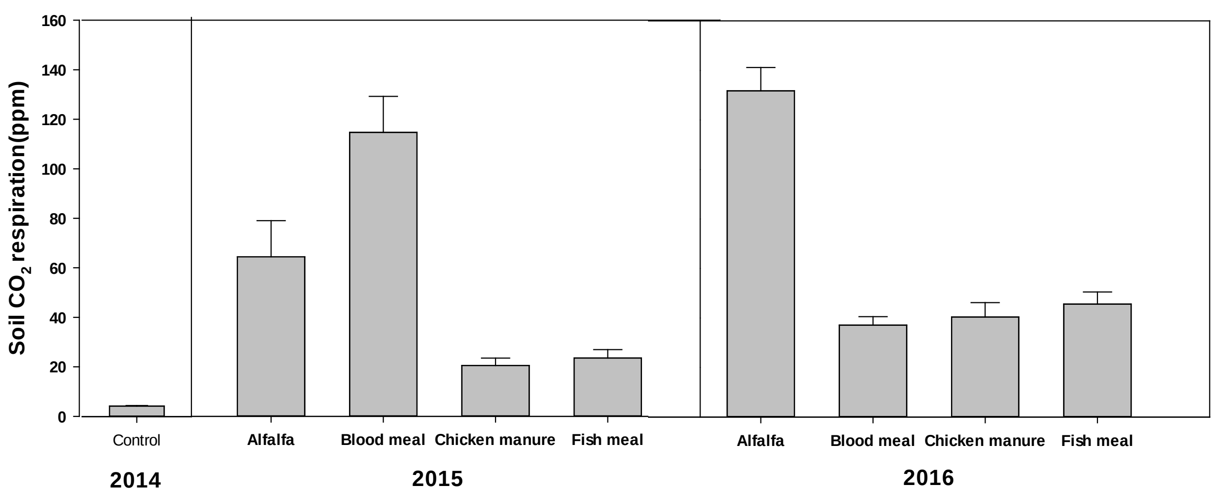

Figure 3. Soil CO_2 respiration over the 2014-2016 growing seasons under different soil organic fertilizers.

Marketable yield was significantly lower in 2015 compared to the 2016 growing season (Table 3). This might be due to the low soil fertility and poor soil microbial activity during the first year. Soil amendment fertilizer treatments significantly improved soil transpiration, an indicator of total soil health. In both growing seasons, chicken manure and fish meal fertilizers had the highest marketable yield. Although plant-based fertilizer (alfalfa) had lower yield than animal sources in both growing seasons, the percent increase in marketable yield over year 1 was 688% and soil health (soil respiration) was significantly higher than chicken manure and fish meal. Therefore, adopting plant-based organic fertilizer could potentially improve soil quality variables and yield over a long period of time.

Table 3. Marketable and unmarketable yield of artichoke (cv. 179) grown in different organic soil amendment fertilizers over the growing seasons 2015 and 2016.

	Marketable yield (t.ha^{-1})		Unmarketable yield (t.ha^{-1})	
	2015	2016	2015	2016
Alfalfa	1.94 b	15.3 b	0.0 b	0.23
Blood meal	0.90 b	14.6 b	0.0 b	0.28
Chicken	7.47 a	19.4 a	0.42 a	0.15
Fish meal	6.84 a	17.1 ab	0.04 b	0.35
P-value	<0.0001	0.01	0.011	0.11

Although yield and soil quality was significantly different under different fertilizer sources (plant-base vs. animal-base), there were no significant difference between soil amendment fertilizers in morphology and physiology across the growth stages and over the growing seasons 2015 and 2016 (Table 4).

Table 4. Plant morphology and physiology of artichoke (cv. 179) grown in different organicsoil amendment fertilizers over the growing seasons 2015 and 2016.

Season	Stage		Plant Length (cm)	Plant Width (cm)	SPAD	LAI	Pn	gs	E
2015	Vegetative	Alfalfa	23.3	74.6 ab	50.8	1.33	26.50	0.39	2.64
		Blood meal	22	63.9 b	51.4	1.34	26.60	0.39	2.64
		Chicken	22.8	83.6 a	53.2	1.49	28.40	0.44	2.89
		Fish meal	21.9	79.4 a	51.25	1.53	27.40	0.44	2.81
		P-value	**0.91**	**0.05**	**0.73**	**0.71**	**0.6**	**0.61**	**0.36**
	Harvesting	Alfalfa	64.4	136	52.1	3.39	16.5	0.23	2.61
		Blood meal	67.3	140	51.2	3.62	19.7	0.26	2.76
		Chicken	70.5	136	48.8	3.44	18.9	0.24	2.73
		Fish meal	67.6	133	52.4	3.36	19.4	0.24	2.32
		P-value	**0.34**	**0.62**	**0.31**	**0.94**	**0.74**	**0.99**	**0.95**
2016	Vegetative	Alfalfa	77.1	147	49.8	3.64 ab	19.3	0.42	5.58
		Blood meal	74.3	153	53.4	3.75 a	18.9	0.39	5.31
		Chicken	75.7	151	54.1	2.71 b	17.9	0.38	5.27
		Fish meal	74.6	146	53.4	3.61 ab	19	0.37	5.31
	Harvesting	**P-value**	**0.97**	**0.77**	**0.52**	**0.05**	**0.92**	**0.55**	**0.88**
		Alfalfa	96	167	49.7	3.92 ab	17.2	0.23	2.44
		Blood meal	92.5	166	55.1	4.2 a	16.2	0.24	2.63
		Chicken	87.6	158	49.6	3.46 b	20.1	0.32	3.08
		Fish meal	93.8	166	51.7	3.42 b	18.2	0.34	2.91
		P-value	**0.32**	**0.57**	**0.43**	**0.04**	**0.73**	**0.27**	**0.38**

Biodegradable mulches

Biodegradable polymer products were tested for their ability to decompose after 6 and 12 months. Biodegradable mulches such as the exp. 4032 almost completely degraded after 1 year in the soil. The degradation of biodegradable mulches was 90% to 95% 12 months after field transplanting (Fig.4).

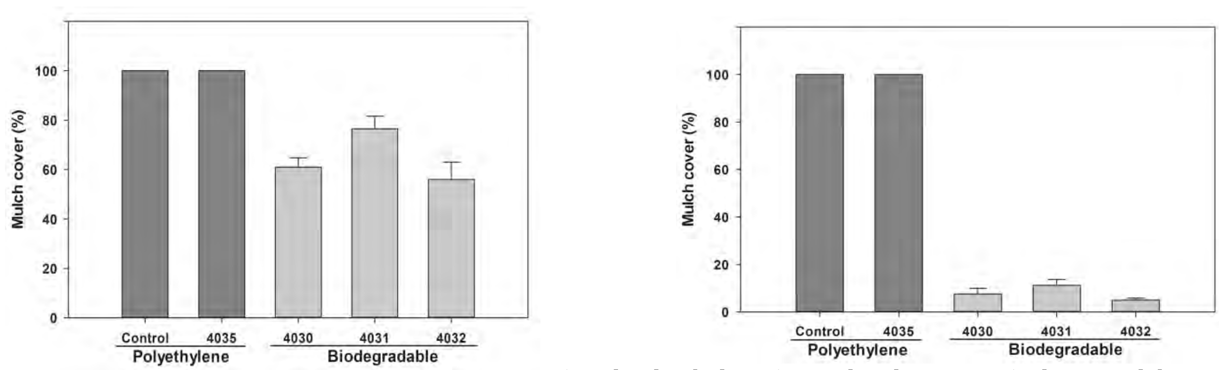

Figure 4. Biodegradable (exp. 4030, 4031, and 4032) and polyethylene (control and exp. 4035) plastic mulches cover % 6 months after transplanting (left) and 1 year after transplanting.

Screening melons for production and quality

At two south Texas locations (Uvalde and Edinburg) experimental hybrids and commercial checks were planted to assess melon quality. Very heavy rainfall had a negative impact on quality and yield, as many fruits rotted from fusarium and gummy stem blight. Three fruits were harvested from each hybrid at each location. Average total soluble solids and firmness measurements differentiated the hybrids, though not all had acceptable appearance or fruit size. Powdery mildew resistance was also rated and there were clear differences among the hybrids. A few hybrids demonstrated strong genotype x environment interaction, as they performed well at one location, but not the other. Hybrids 2, 12 and 15 demonstrated the greatest variation between the two locations (Table5). Hybrids 3, 7 and 17 demonstrated the best quality across environments and all three had acceptable appearance, but none were highly resistant to powdery mildew. Cruiser had a good appearance, but poor fruit quality. Hybrid 2 demonstrated excellent quality, attractive fruit and high resistance to powdery mildew at Uvalde, but poor quality at Edinburg.

Table 5. Quality attributes and Powdery Mildew response of TAMU melon hybrids at Edinburg and Uvalde, TX.

Hybrid	**Edinburg**		**Uvalde**		
	TSS (%)	Firmness (lbs/in^2)	TSS (%)	Firmness (lbs/in^2)	Powdery^z Mildew
1	6.5	0.4	12.1	9.5	4
2	7	0.4	12.2	9.6	1
3	10.5	2	11.5	8.8	3
4	8	1.5	11.0	8.0	1
5	6	0.5	10.3	7.9	2
6	8	1.75	10.9	14.1	1
7	10	1.75	12.3	7.7	5
8	7.3	4	na	na	2
9	6	0.5	10.2	9.1	3
10	5.5	1	10.6	4.3	2
11	5	1	8.0	11.2	2
12	10.3	1	8.6	6.8	2
13	8.5	1.5	12.7	10.0	3
14	9.5	2	8.1	14.0	1
15	6	1	11.7	9.1	1
16	8.5	3	10.9	9.1	1
17	11	1	13.1	7.6	3
18	8	1	na	na	3
Cruiser	7.4	1.8	8.6	7.6	3
Mission	na	na	10.5	8.2	2

^{z}Rating scale of 1=complete resistance, to 5=highly susceptible on all surfaces.

Eye Tracking Technology as tool for consumer choices

Consumers (n=101) were presented with 12 choice sets, each consisting of three artichoke varieties and a "no product" alternative, which gave them the option of not choosing any of the artichoke products. The artichoke varieties differed in five key attributes including color, presentation, production method, size, and price. While consumers evaluated the alternatives, their eye movement was recorded using an eye-tracking device. This device, which was embedded in the computer screen, utilizes near-infrared technology along with a high-resolution camera to track gaze direction at a sampling rate of 120 Hz.

As shown in Table 6, the fixation duration and fixation count were calculated for each attribute level. Those measures, which were obtained using the eye-tracker, represent the number of times consumers glanced each attribute level and the total amount of time (in seconds) they spent looking at each level. The results show that the consumers were more attracted towards medium, fresh, purple, pesticide free artichokes priced at $3. This is evident from the fact that the fixation count and fixation duration were the highest for those attribute levels. On the other hand, the consumers displayed the lowest attention towards small, green, canned, conventional artichokes priced at $1. Since artichokes are not as common in the market as other produce, consumption of this vegetable might be considered a luxury, which explains the higher interest towards premium characteristics.

Table 6. Fixation count and duration by attribute level.

Attribute	Atttribute Levels	Fixation Count			Fixation Duration (sec)		
		Mean	Min	Max	Mean	Min	Max
Color	Green	3.736	0	27	0.911	0	7.72
	Purple	4.277	0	25	1.083	0	7.96
	Mixed	3.778	0	38	0.948	0	11.78
Presentation	Fresh	3.938	0	24	0.979	0	7.35
	Canned	3.481	0	34	0.868	0	8.36
	Glass	3.611	0	44	0.908	0	14.25
Production Method	Conventional	2.401	0	18	0.536	0	4.54
	Organic	2.555	0	36	0.609	0	11.62
	Pesticide free	3.132	0	34	0.766	0	8.2
Size	Small	2.864	0	26	0.706	0	6.39
	Medium	3.699	0	24	0.939	0	8.49
	Large	3.325	0	21	0.832	0	8.96
Price	$1.00	1.186	0	37	0.273	0	11.76
	$2.00	1.370	0	16	0.327	0	4.22
	$3.00	1.416	0	24	0.324	0	8.1

Consumers' Choice Decisions

The frequency (percentage) of choices, which represent the total number (percentage) of times each attribute level was chosen, is presented in Table 7. Among the product attributes, consumers placed the highest weight on presentation, production method, and price when choosing among artichoke products. This is evident from the fact that the fresh, pesticide free, and $2 attribute levels were chosen the highest number of times compared to all other attributes and attribute levels. Moreover, although results over presentation and production method are consistent across choices and eye-tracking, there were some slight differences concerning color, size, and price. That is, while consumers fixated the most on medium, green varieties priced at $3, they actually preferred the large, mixed color varieties priced at $2 based on their choices. On the other hand, the results concerning the least preferred attribute levels were more consistent between eye-tracking and choice. This can be seen from the fact that not only did consumers fixate the least on small, canned, green, conventional artichoke varieties, they also displayed the lowest preferences for those attributes based on their choices.

Table 7. Consumer choices over attribute levels.

Attribute	Attribute Levels	Freq.	Percent
Color	Green	326	29.83
	Purple	365	33.39
	Mixed	402	36.78
Presentation	Fresh	520	47.58
	Canned	232	21.23
	Glass	341	31.19
Production Method	Conventional	181	16.56
	Organic	394	36.05
	Pesticide free	518	47.39
Size	Small	248	22.69
	Medium	409	37.42
	Large	436	39.89
Price	$1.00	364	33.30
	$2.00	520	47.58
	$3.00	209	19.12

Educational activities

Scientific and technology transfer presentations/publications, field day demonstration and growers' exchanges were conducted to a variety of audiences. Topics included stand establishment, irrigation management, variety selection, crop rotations, pests and disease control (see publication outputs below). Specifically, an oral presentation on artichokes and poster presentation on bioplastics use for melon crops at the American Society for Horticultural Sciences attracted 35 individuals; a winter field day to Research and Extension administrators and farm managers attracted 50 participants; a field day/workshop at Texas A&M AgriLife Research and Extension Center in Uvalde during spring 2015 attracted 40 participants (Fig. 5). Through our industry collaborator (EcoPoly solution), the bioplastic technology was introduced to 2 major watermelon growers in south Texas and will continue in the future. Another farmer from Seguin introduced organic artichokes in farmers market in San Antonio.

Publications/presentations

Leskovar D., and Othman Y. 2015. Low-level nitrogen fertilization improved root growth components and quality of containerized artichoke transplants. American Society for Horticultural Science annual conference, U.S. *HortScience* 50 (9).

Leskovar D., and Othman Y. 2015. Biodegradable plastics as alternative to polyethylene mulch for watermelon production systems. American Society for Horticultural Science annual conference, U.S. *HortScience* 50 (9).

Martin E., Leskovar D., Cravero V., Zayas A.,Cointry E. Detection of QTLs for Yield in Globe Artichoke. American Society for Horticultural Science annual conference, U.S. *HortScience* 50 (9).

Leskovar D., and Othman Y. 2015. Morpho-physiological characteristics and yield of early and mid-season globe artichoke. International Society for Horticultural Science annual conference *Acta Horticulturae*.
Leskovar D., and Othman Y. 2015. Pre-transplant conditioning to mitigate heat, drought and biotic stresses in artichoke. International Society for Horticultural Science annual conference *Acta Horticulturae*.


Figure 5. Field day/workshop at Texas A&M AgriLife Research, Uvalde

Goals and Outcomes Achieved

We completed the five major activities set out in our plan of work: We established variety trials with artichokes in conventional and organic fields, and melons in conventional fields in key vegetable regions of Texas and evaluated them for their internal and external quality, disease resistance, and marketable yield (Objectives 1 and 2). We selected improved artichoke varieties, growing with diverse cropping strategies based on stand establishment, transplant quality, shading, and organic amendments. We also compared biodegradable mulches for use on cucurbit crops and identified experimental materials more adaptable to southern Texas environments (Objective 3). In conjunction with the Economic team, the project conducted consumer experiments using eye-tracking technology reaching over 100 people. The study determined best marketing strategies based on consumer choices and product attributes (Objective 4). The projected conducted field day demonstrations and workshops to highlight variety selection and cultural strategies for these specialty crops (Objective 5). Research results and the new knowledge developed through the project were transferred to growers, shippers, industry and consumers. Additional details and outcomes from these educational activities were summarized above.

Targets: We estimate that as part of the project we increased the number of growers to 8 (initial benchmark of 5 growers) and the combined area grown with artichoke and specialty type melons to 120 acres (initial benchmark of 30 acres).

Beneficiaries

The project benefitted emerging growers interested in both conventional and organic production, as well as established small and large commercial growers. Specifically, more than 30 Texas emerging or current growers and +100 consumers interacted with project staff on various aspects of production, technology, product quality, marketing and consumption. They were provided new information on specialty melons, globe artichokes and the use of biodegradable mulches.

The new commercial artichoke hybrids and open-pollinated melon cultivars developed by Texas A&M will benefit Texas growers due to their better adaptability to the stressful climatic conditions of south and southwest Texas as well as for the improved quality and disease resistance. The artichoke results from the consumers' tests are quite valuable to concentrate future efforts on fresh and large, mixed color varieties priced moderately ($2 each) instead of the medium green priced higher ($3 each) or small canned green color imported-products.

Lessons Learned

The contribution of regionally-grown vegetable products, namely specialty melons and artichokes, continue to be very low in the Texas markets. Growers are limited in the seed choices for regionally adapted varieties since most commercial cultivars are developed for the west coast, primarily California. Linking growers with retailers interested in the local and consistent supply of these commodities continues to be a challenge to maintain stable markets. The project has developed new techniques and integrated cropping strategies for growers to trial on-farm. The results using soil amendments for organic production of artichoke are promising; however, to make viable recommendations these studies need to be long-term since changes in soil properties and nutrition are typically seen over the course of several years.

PROJECT 8: NORTH TEXAS WINE GRAPE CULTIVAR & ROOTSTOCK EVALUATION

Partner Organization: Primary - Denison Development Alliance, Grayson College, Partner - Texas A&M AgriLife
Project Manager: Dr. Justin Scheiner
Contact Information: Janis Thompson, Grant Specialist, Grayson College 903-463-8766
Dr. Justin Scheiner, Project Coordinator, Texas A&M AgriLife Extension Service, 979-845-1870
Type of Report: Final
Date Submitted: April 28, 2016

Project Summary

The wine industry in Texas has grown at a rapid rate over the previous ten years. In 2005, there were just 110 wineries in the state (Frank, Rimerman + Co LLP, 2008) and that number has since increased to approximately 380 wineries in 2016 (Texas Alcoholic Beverage Commission, 2016). In 2012, over 1.4 million cases of wine were produced in Texas and the total state economic impact of the wine industry was more than $1.83 billion (Frank, Rimerman + Co LLP, 2013). Vineyard acreage has expanded as well, but has not kept pace with wine production. In 2001, Texas accounted for 2,900 bearing acres (USDA-NASS, 2011) and increased to 4,052 in 2012 (USDA-NASS, 2014).

The major challenges of commercial wine grape production in Texas include pests, diseases, and climate. Growers seek to find well-adapted, high yielding cultivars to maximize their profit potential, but information regarding the performance of many cultivars is only observational as formal research trials are lacking. The purpose of this project was to establish a research vineyard to evaluate the performance of ten winegrape and two rootstock cultivars that are grown in the North Texas region and have a history of producing high quality wine. The ultimate goal is to identify cultivar/rootstock combinations that most consistently produce acceptable yields of high quality fruit by collecting and analyzing data on vine growth (pruning weight), yield components (total yield, cluster weight, berry weight), fruit composition (brix, titratable acidity, pH, yeast assimilable nitrogen), phenology dates (bud break, version, harvest), and pest and disease tolerance. The research vineyard is located in the T.V. Munson Memorial Vineyard on the Campus of Grayson College, and is also utilized as a teaching tool for the Viticulture and Enology Program at Grayson and the Texas wine industry.

Project Approach

The research vineyard was established within the T.V. Munson Memorial Vineyard which reduced the effort required to prepare the site for planting. However, removal of old grapevines was necessary, in addition to retrofitting the existing trellis and irrigation system. The trellis was converted from a 3-wire system to a mid-wire cordon system with Vertical Shoot Position and the above ground irrigation accessories were replaced (Figure 1).

Figure 1. Trellis conversion to mid-wire cordon training system with VSP.

The spring, 2015 planting was significantly delayed by record rains in the months of April, May, and June. Planting during the summer months was avoided to reduce vine mortality from drought stress. Over the summer months weed control was carried out and equipment for the project was secured. Although delayed from the initial target date due to the rain events, an irrigation injector and proper backflow prevention was installed for fertigation capabilities (Figure 2).

Figure 2. Backflow prevention device and fertilizer injector (inside valve box).

Planting was carried out in October, 2015 and students from the Viticulture and Enology Program at Grayson College assisted (Figure 3). The students learned about the cultivars and rootstocks under study (Table 1) and participated in planting. However, the nursery that supplied the grapevines was unable to supply all of the plant material needed. In January 2016, plant material was ordered from Foundation Plant Services, University of California Davis and rootstock rooting were acquired. The cultivar/rootstock combinations needed to complete the research vineyard were grafted by Dr. Scheiner and students at Texas A&M University for planting in May 2016.

Figure 3. Preparing grapevines for planting.

Table 1. Wine grape and rootstock cultivars planted at the research vineyard.

White wine cultivars[a]	Red wine cultivars
Albarino/1103P	Aglianico/1103P
Albarino/5BB	Aglianico/5BB
Albillo Mayor/1103P	Malbec/1103P
Albillo Mayor/5BB	Malbec/5BB
Rousanne/1103P	Syrah/1103P
Rousanne/5BB	Syrah/5BB
Vermentino/1103P	Tannat/1103P
Vermention/5BB	Tannat/5BB

Viognier/1103P	Tempranillo/1103P
Viognier/5BB	Tempranillo/5BB

[a]grapevines were planted in a randomized, replicated design.

The process of site preparation, planting, and first year training was documented for the development of an educational video on vineyard planting. The video is available to the public on the Aggie Horticulture website (http://aggie-horticulture.tamu.edu/tips-for-planning-a-commercial-vineyard-in-texas/), which received an average 15 million hits a month in 2015.

Goals and Outcomes Achieved

The ultimate goal of this project is the adoption of winegrape cultivar/rootstock combinations identified as having the greatest profit potential through consistent production of high quality fruit. Data collected in this research trial will serve to guide new growers and those who wish to expand their acreage. However, vineyards generally do not bear fruit until three to four years after planting. Thus, this performance evaluation is a long-term project that must be carried out for several years before significant conclusions can be drawn. In 2015, a winegrape acreage, cultivar, and production survey was conducted in North Texas indicating a total of 450 bearing and 200 non-bearing acres of grapes (USDA-NASS, 2015). Acreage was reported for four of the cultivars under study (Tempranillo, Malbec, Syrah, and Viognier), but no acreage was reported for the other six. In 2016, another survey was initiated with an anticipated completion in 2017. Non-bearing acreage of the cultivars under study in North Texas will be compared with 2015 data to determine new acreage.

The research vineyard serves as a great teaching tool for students and grape growers in Texas. The students at Grayson College utilize the research vineyard during lessons on pruning, training, irrigation, and pest management. In 2014, the Texas A&M AgriLife Extension Service and Grayson College held a prospective winegrower workshop at the T.V. Munson Viticulture and Enology Center to provide information on the important aspects of planning and developing a commercial vineyard in Texas. The ten prospective growers that attended gave very positive feedback on the program's ability to prepare them for entering the industry. This research has been presented at grape grower field days in Pittsburg and Saint Jo in January and March 2016, respectively. In total 86, current and prospective grape growers attended these programs. Future programs on pruning, pest management, and grapevine training have been tentatively planned as well.

Data collection on grapevine growth and development began in fall, 2015 and will continue through 2020 to gather important information regarding the cultivar's and rootstock's abilities to meet the needs of Texas vineyards and wineries. The information gathered will continue to be made available to current and future grape growers at regional and statewide meetings such as the North Texas Grape Growers Workgroup and the Texas Wine and Grape Growers Association Grape Camp, through industry publications.

The educational video on vineyard planting was developed and is available on the Aggie Horticulture website (http://aggie-horticulture.tamu.edu/), which receives an average of more than 10 million hits a month.

Beneficiaries

The North Texas Grape Growing Region consists of 56 counties with over 100 commercial vineyards. The information will allow the 100 plus growers in the region and new growers to more confidently expand their acreage with high profit potential cultivars, thus improving the long term sustainability of grape growing in Texas. Wineries across the state will benefit by having an expanded opportunity to produce wines from Texas grown grapes, furthering the growth and maturity of the industry.

The instructional video produced during this project will serve as a guide for grape growers in Texas and elsewhere by providing sound, detailed information on wine grape vineyard establishment. The impact of such an educational resource will be immediate and have a potential to save growers significant costs associated vineyard establishment mistakes.

Lessons Learned

Planting did not take place according to the original timeline in the proposal; however this did not impact the scope or completion of the specified project activities. With unusual and excessive flooding occurring in this area during months of May, June and July, the grapevines would have potentially been destroyed if it had been planted based on the original timeline. The grapevines planted in early October properly acclimated for winter, and losses were minimal, but fall plantings are less desirable than in the spring.

Additional Information

Vines grafted at Texas A&M University to finalize the planting of the research vineyard.

North Texas Winegrape Cultivar and Rootstock Test site.

Vine in research plot on April, 2016

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PROJECT 9: INCREASING CONSUMER AWARENESS OF THE HEALTH AND ECONOMIC BENEFITS OF BUYING TEXAS VEGETABLES

Partner Organizations: Texas Vegetable Association
Project Manager: Bret Erickson
Contact Information: Bret Erickson- President & CEO, Texas International Produce Association, bret.erickson@texipa.org (956) 581-8632
Type of Report: Final
Date Submitted: April 22, 2016

Project Summary
The value of consuming local produce cannot be emphasized enough. Locally sourced is typically fresher and more nutritious than imported produce. However, because the food system works to cater to the convenience of the consumer, a disconnect can exist between the consumer's knowledge and understanding of how to best support their local agriculture economy while enriching their overall health at the same time. The Texas Vegetable Association (TVA) has sought to provide a resource for Texans to understand what kind of vegetables are grown in Texas and when they are available. For these reasons TVA completed a marketing campaign focused in Austin and San Antonio with the goal of increasing sales and consumer knowledge of Texas vegetables.

TVA serves the vegetable industry in dealings with key agencies and legislative bodies on vegetable production issues, including pesticides, labor, water, and related issues. This marketing campaign was completed to not only promote the health benefits of fresh Texas vegetables but to increase the gross sales by $10,000 at targeted stores where TVA promoted Texas veggies.

Project Approach
TVA's approach to this campaign is centered around developing a strategic message that catches consumers and grabs their attention while at the same time educates and motivates them to act. The message and theme centered on a few ideas promoted during the campaign: locally sourced fresh vegetables grown in Texas are available; they are good to include in your diet; and purchasing them supports our producers in their mission to support us as consumers.

The "You Can Thank Us Later" tag line was created to illustrate consumer connection to the producer. This message was taken a step further by developing a theme around a mother and son's relationship at the dinner table. The child's reluctance to eat his vegetables leaves the mother frustrated, exhausted and almost ready to give up, but then something happens. The mother sees her son as a young man; a firefighter; a professional athlete; and thinks beyond that moment she was stuck in to the place she is trying to go. TVA felt these themes would resonate with moms and kids in a fun yet serious way and bring the farm to table concept to life. By including the tagline, the message conveys a sense of gratitude to the producers similar to that of a young healthy man who feels the same sense of appreciation for a mother who raised him on a healthy diet.

In-store demonstrations were conducted showing various dishes and samplings of fresh Texas grown vegetables. This was an important factor in increasing store sales because it gets the consumer thinking about consuming vegetables right where they can purchase them. Moreover, by providing dishes rather than information on individual vegetables, consumers can consider buying multiple vegetable types. This is always a fun and educational way to show people how to creatively pair different foods and teach them to not be so intimidated by whole foods.

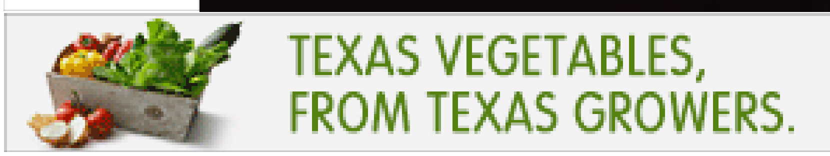
A variety of other media was used to further promote them campaign, including: television commercials, updates to the TVA consumer-facing website, on line video pre-roll, online ads, and home page takeovers. TVA believed these media would be the best ways to push the campaign to the targeted demographic, Women 25-54 (mothers). A new partnership was also formed during this 2015 campaign to help further promote TVA's efforts.

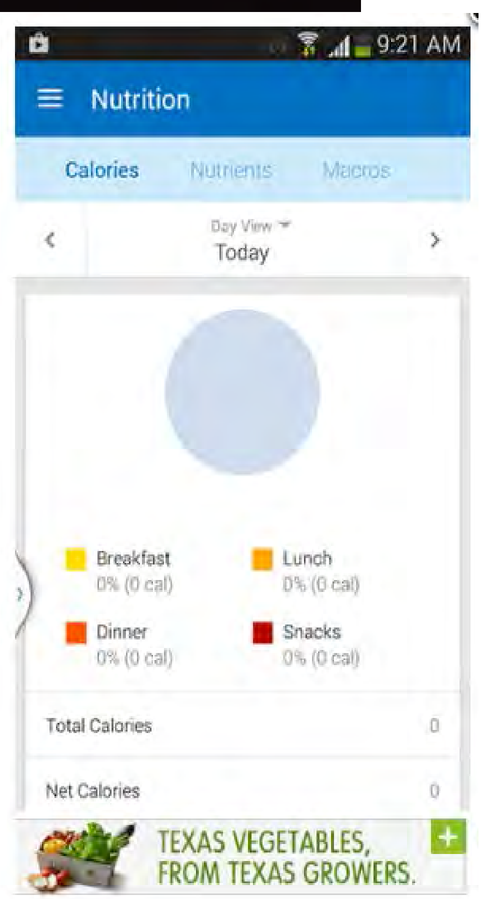
Under Armor partnered with TVA on this campaign by providing ad space on their MyFitnessPal application to further promote the campaign messages. The MyFitnessPal is a free smartphone app and website that tracks diet and exercise and personalizes the information for the user. This advertising platform targets users engaged in healthy lifestyles and those that enjoy sharing their experiences with like-minded Texans, providing an incredible place to promote Texas vegetables.

Examples of different media utilized throughout the project are provided below:

<u>Online Advertising in Austin and San Antonio- TV websites</u>
TVA identified top media websites in each market (KVUE, the ABC affiliate in Austin and KSAT, the ABC affiliate in San Antonio) and created animated banner ads. Over 430,000 Impressions were served. Additionally, TVA ran online video pre-roll utilizing television spots.
Here are a few of the banners that were utilized.

<u>KSAT and KVUE TV Website with the
TVA Banner ad to reflect TV Ad.</u>

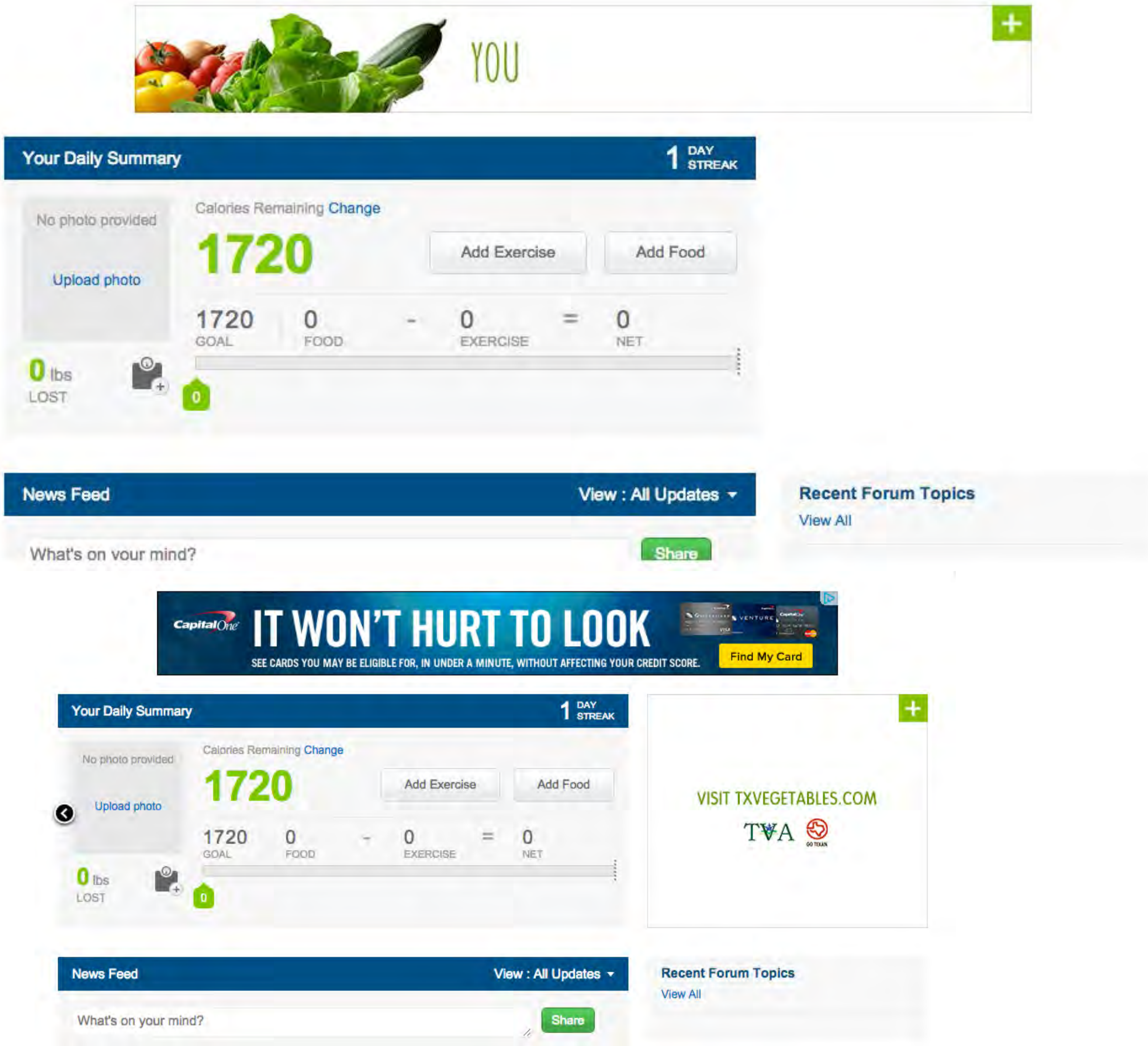




<u>On Line ads in Map My Fitness App</u>

TVA expanded its presence by being advertised on the Map My Fitness app. All creative featured our, "You Can Thank Us Later" campaign. TV A received over 1 million impressions with banner ads and the TVA TV video. Over 1 Million Impressions were served

Screen Shots of the TVA ads on the Map MyFitness App



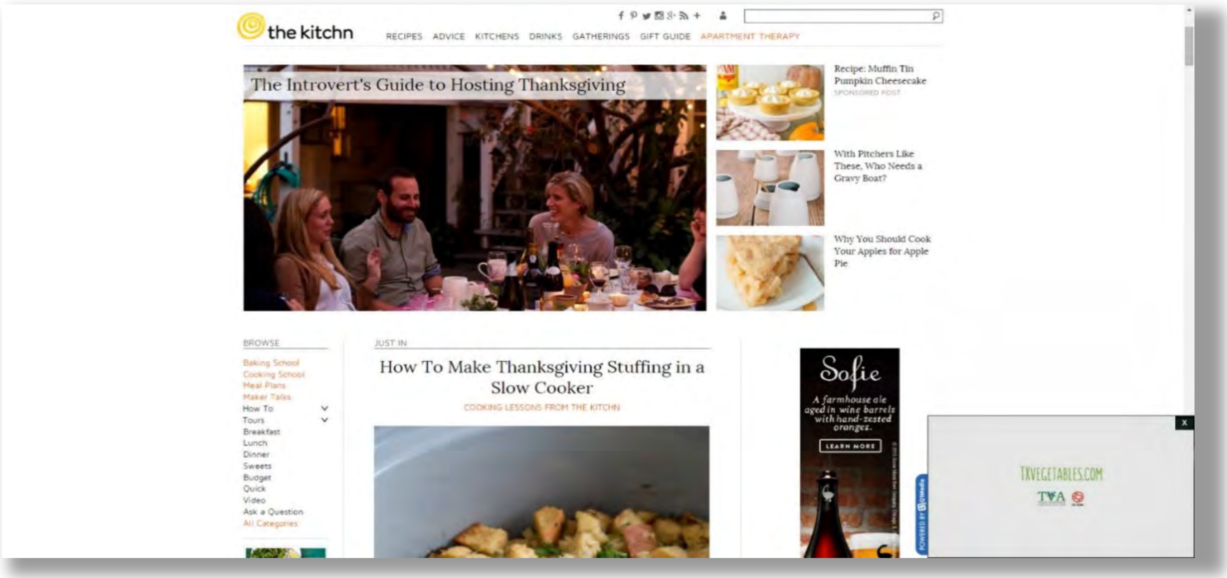
<u>On Line Ads Targeting Women and Moms</u>

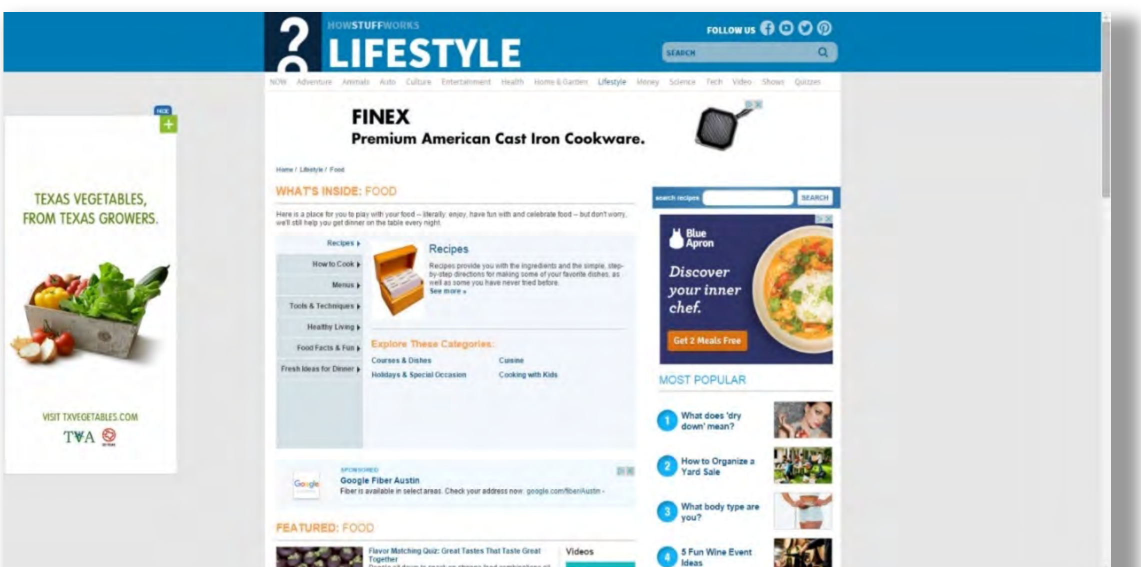
TVA ran an on line campaign dedicated to reaching women and moms. The keyword search categories such as food, healthy, cooking, recipes, and fitness were used. Desktop display, video and mobile were all used in the campaign. Not only did consumers see our ads on TV they saw them again on line and in social applications. Over 1.5 million impressions were delivered to the core target during the campaign.

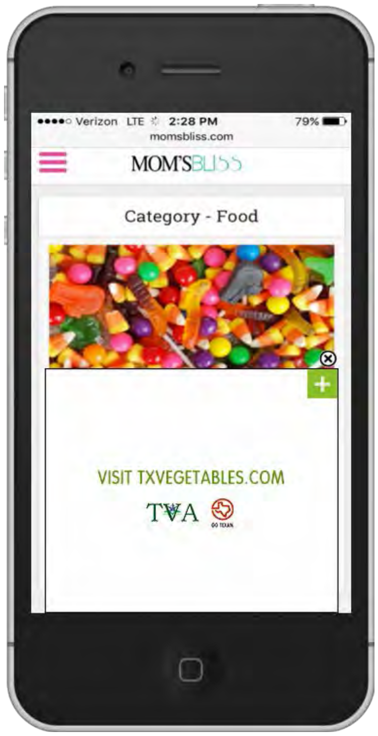

Verizon LTE
4:24 PM
answers.com
Answers
Beautiful Skin Begins in the...
Olay Ultra Moisture Body W...
Sponsored Olay Body
Are cooked vegetables as healthy as uncooked vegetables?
Ayersdy
TEXAS VEGETABLES,
FROM TEXAS GROWERS.

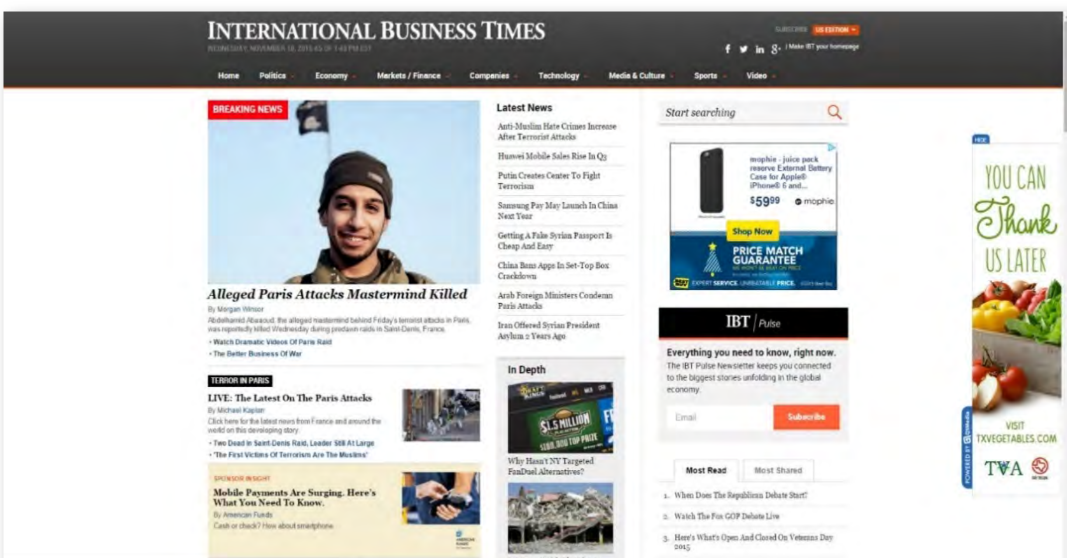
mommyathlete.com
9 Tips to Reach Your Fitness Goals This Year
Read More Watch Video
IT'S OK MOM, THEY'LL THANK YOU LATER.

<u>Examples of websites where the banner ads ran</u>






Verizon LTE 2:28 PM 79%
momsbliss.com
MOM'S BLISS
Category - Food
VISIT TXVEGETABLES.COM
TVA

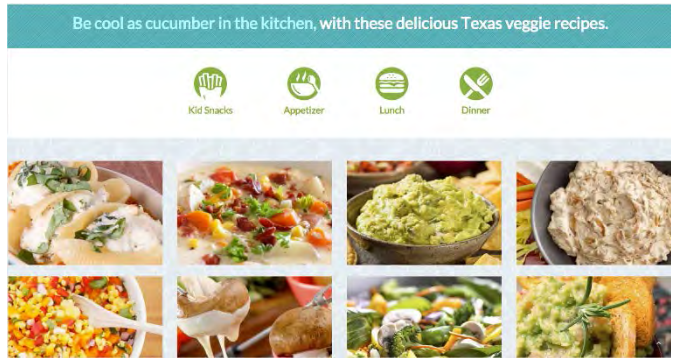

INTERNATIONAL BUSINESS TIMES
Home Politics Economy Markets / Finance Companies Technology Media & Culture Sports Video
BREAKING NEWS
Alleged Paris Attacks Mastermind Killed
TERROR IN PARIS
LIVE: The Latest On The Paris Attacks
Mobile Payments Are Surging. Here's What You Need To Know.
Latest News
Anti-Muslim Hate Crimes Increase After Terrorist Attacks
Huawei Mobile Sales Rise In Q3
Putin Creates Center To Fight Terrorism
Samsung Pay May Launch In China Next Year
Getting A Fake Syrian Passport Is Cheap And Easy
China Bans Apps In Set-Top Box Crackdown
Arab Foreign Ministers Condemn Paris Attacks
Iran Offered Syrian President Asylum 2 Years Ago
In Depth
Why Hasn't NY Targeted FanDuel Alternatives?
Start searching
Shop Now
PRICE MATCH GUARANTEE
IBT Pulse
Everything you need to know, right now.
Subscribe
Most Read
Most Shared
When Does The Republican Debate Start?
Watch The Fox GOP Debate Live
Here's What's Open And Closed On Veterans Day 2015
YOU CAN Thank US LATER
VISIT TXVEGETABLES.COM
TVA

TV Ads in San Antonio and Austin
TVA identified television stations in each market that performed best with the target audience. These stations were KVUE, the ABC affiliate in Austin and KSAT, the ABC affiliate in San Antonio as well as MeTV an affiliate of KSAT. TVA negotiated :30 :15 commercials featuring the "You Can Thank Us Later" campaign promoting how Texas vegetables ensure a healthier and brighter future for children. The two flights corresponded with the digital campaign

TVA ran over 255 :30 :15 and :10 second commercials featuring the "You Can Thank Us Later" campaign promoting how Texas vegetables are healthy and fresh. No matter how long kids hold out, eating Texas Vegetables is the best option. The flights corresponded with the digital campaign on line and Map My Fitness.

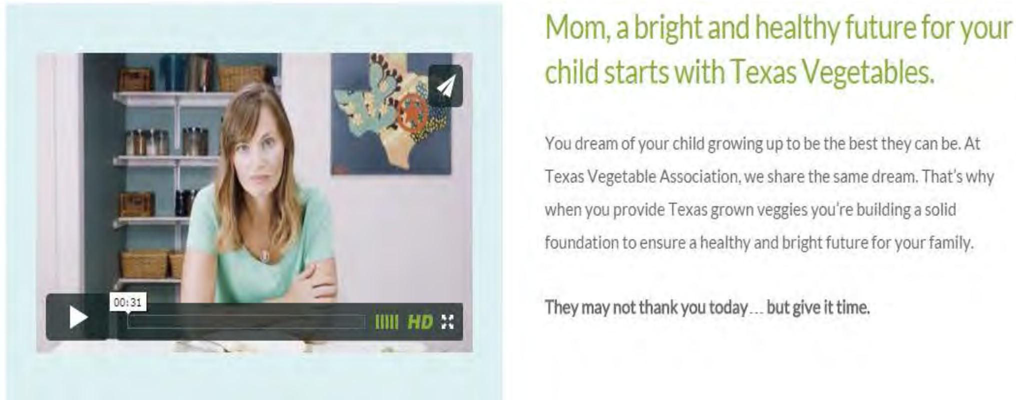
Dedicated Texas Vegetable Association Consumer Website

TVA designed and updated the website to provide consumers with more information about Texas vegetables. Elements of the site include the TVA commercial, various recipes for kids' snacks, appetizers, lunch, and dinner, a vegetable calendar that details when certain vegetables are in season, information about TVA, and a page featuring the current "You Can Thank Us Later" campaign. The site is responsive, allowing it to be clearly viewed on all mobile and tablet devices. It also has a user-friendly content management system for quick and easy updates and edits. The full site can be viewed at www.txvegetables.com.



Texas Vegetable Association Website activity during the Campaign. There was a tremendous increase in traffic to the TVA website during our fall campaign. This shows people were interested in the campaign messaging and wanted to learn more.

www.txvegetables.com.



In-Store Demonstrations

TVA partnered with the Texas Department of Agriculture (TDA) and Whole Foods to perform 25 in-store demonstrations and taste tests at locations throughout Texas. For greater impact, the demonstrations were scheduled to coincide with our marketing campaign. On-site chefs prepared various dishes and samplings using fresh Texas Vegetables. The Go-Texan mark was implemented at every demonstration.

<u>Photos from the 25 demonstrations at various Whole Foods in Texas</u>


GO TEXAN.

GO TEXAN.

GO TEXAN.

GO TEXAN.

TRY THIS

Beneficiaries
The TVA media plan evidently gathered interest in healthy eating and Texas vegetables as evident by the increase of the traffic to the TVA website and interaction on the social media platform used and at the 25 in store demonstrations.

The 2015 campaign benefitted consumers that learned about Texas produce as well as sampling some delicious prepared vegetables. Over 1.5 million impressions were served, 255 ad units, 1 million social app impressions and nearly 8000 sessions on the TVA website. TVA also completed 25 instore demonstrations with Whole Foods.

The 2015 campaign benefitted over 400 growers and producers of Texas vegetables across the state of Texas by promoting the health benefits of eating vegetables. We did however experience issues with the harvest from heavy rains that resulted in a decrease of overall production and sales.

Goals and Outcomes Achieved
The goal of this campaign was to increase sales and consumer awareness of the quality of taste and nutrition of Texas Vegetables. Specifically, the goal was to increase instore sales from $8200 to $10,000. We encouraged consumers to visit retailers and purchase vegetables, and we promoted the health benefits of individual vegetables and replacing unhealthy foods with vegetables at home, work or at a restaurant. Based on the number of impressions and reach achieved by the media plan awareness increased among our target audience. Our most important goal of increasing sales at the retailers was hindered by the harvest or lack thereof. Texas recorded a value of production of principal fresh market vegetables at $162.7M for 2015. This was a 23.7% decrease from 2014 due to the decrease in overall harvest, which came out to a 6.09% decrease. The decrease in harvest was due to heavy rainfall during the season.

Expected Measurable Outcomes
The Texas Vegetable Association worked with the Texas Department of Agriculture to establish a benchmark based on sales from previous produce demonstrations conducted by both entities. TVA hoped to increase the sales an average of 18% at each event or increase it to $10,000. Results were not as expected because the heavy rainfall had a severe effect on the production of Texas Vegetables.

The following is a breakdown of individual vegetables and their value of production for 2015 and the change witnessed from 2014. These changes indicate the severe effect the heavy rainfall had on crops in 2015 and the goals for this campaign.

Vegetable	Value of Production	decrease or increase from 2014
Cabbage	$30.9M	-7.41% decrease
Cantaloupe	$6.9M	-16.38% decrease
Chile peppers	$14.3M	+47.89% increase
Cucumbers	$2.1M	- 59.23% decrease
Honeydew	$2.8M	- 1.78% decrease
Onions	$19.7M	-64.96% decrease
Spinach	$5.5M	- 44.21% decrease
Sweet Corn	$7.1M	-15.88% decrease
Tomatoes	$4.9M	+ 8.75% increase.

Lessons Learned

TVA knows that through the activity of the website the campaign was performing, we cannot control the outside elements that contributed to the decrease in production therefore not allowing us to achieve our goals for the retailers.

One thing that could be improved on was the demonstrations, we felt that it could have been a great idea to get some actual producers at the demonstrations to further reflect fresh Texas Vegetables.

We did see some great reactions to the Map My Fitness application. This was an addition to the plan after we had been approached by the vendor. We felt this was a great way to tie in fitness and healthy eating to the TVA campaign.

We felt the demonstrations were successful but felt it would have been great to have more signage, posters, banners in the stores. We will consider this for future demonstrations.

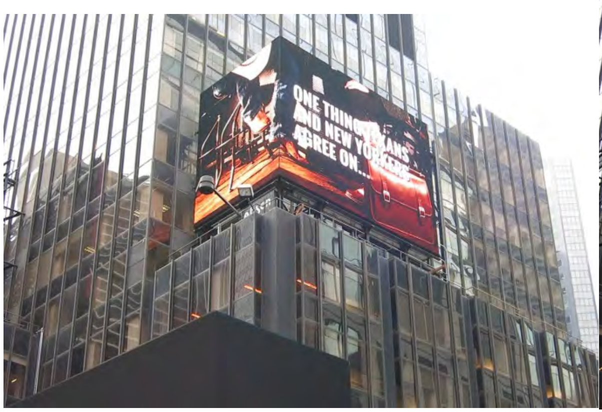
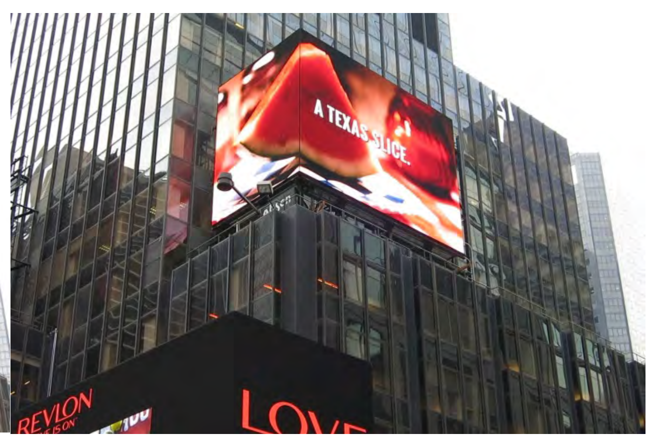
PROJECT 10: INCREASING SALES AND BRAND AWARENESS THROUGH MARKETING THE QUALITY AND NUTRITION OF TEXAS GROWN WATERMELON

Name of Organization: Texas Watermelon Association
Name of Project Manager: Ward Thomas; t) 512-463-6908;
(e) ward@majesticproduce.com
Type of Report: Final
Date Submitted: November 2, 2015

Project Summary
The Texas Watermelon Association (TWA) identified a key market outside Texas with potential to increase sales by gaining market share by increasing the overall demand for watermelons New York is a major market for watermelon from many southern states including Texas. The purpose of this project was to give Texas Watermelon Association an edge and increase sales of Texas watermelon by increasing consumer knowledge of the excellent taste and juicy flavor. The Texas Watermelon association focused efforts to raise awareness in New York City and the Northeast region. Texas exports the highest volume of watermelons to that region in May and June, so consumers will be most likely to purchase a Texas melon at that time. The Texas watermelon industry achieved sales growth by communicating the nutrition benefits and quality of Texas watermelons through high impact advertising when the most Texas watermelons are available in stores (May and June 2015).

Project Approach
TWA utilized the following marketing tactics to reach our target demographic –Women (Mothers), ages 25-54 in the Northeast region:

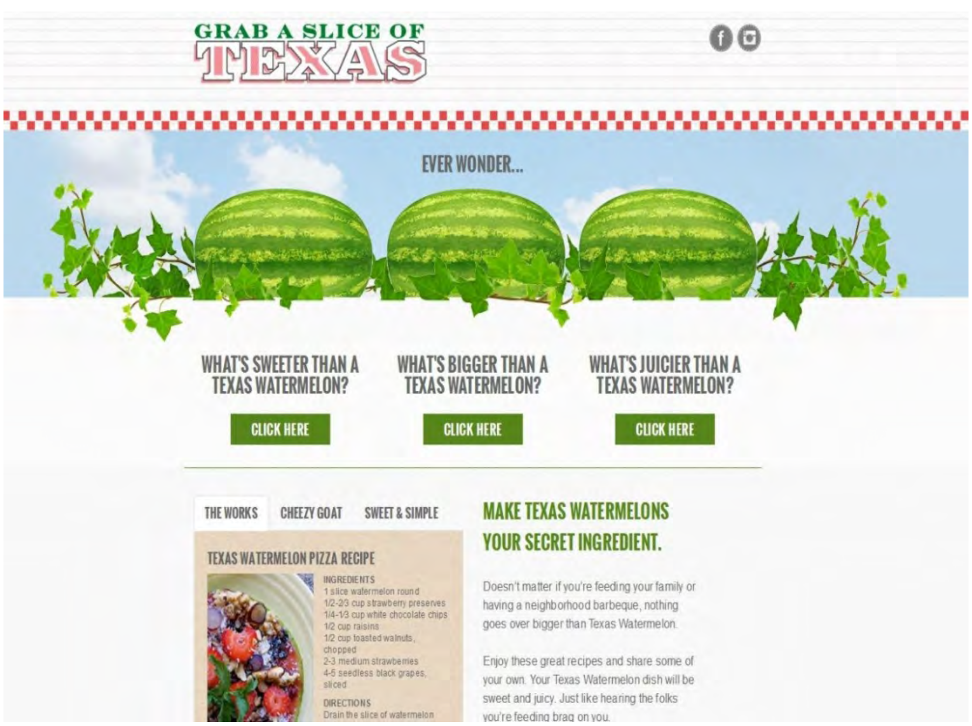
High-Impact Out of Home: TWA used a contractor to plan, create negotiate and buy Purchase of two 15-second full-motion, full color display in Times Square for 91 days during April, May and June. Ads ran twice per hour for 18 hours every day. This delivered in 16, 1322,570 impressions in New York City -right in the heart of Times Square.

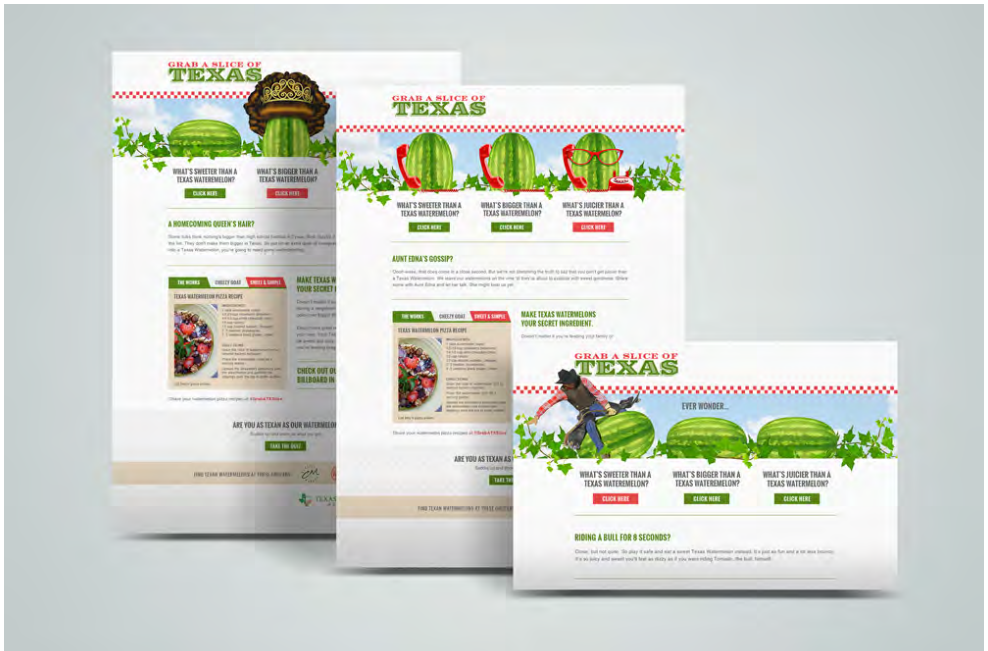



Online advertisements: We ran standard display ads sizes including 300x250 , 728x90, 160x600 and mobile 320x50 on a custom channel of websites with a high ComScore ranking with our target audience. This resulted in 1,407,560 targeted impressions. Additionally, we engaged in behavioral targeting within the custom channel which resulted in 566,667 impressions to online mobile users exhibiting behaviors similar to our target audience. Finally, we ran 15-second pre-roll video within a vertical channel of sites focused on women's lifestyle, parenting and local media to gain another 920,215 impressions.

Our online efforts resulted in a total of 4,676,808 impressions and 46,612 clicks to the TWA website. Online ads asked the consumer to "Look for the GO TEXAN mark when purchasing your next watermelon

Consumer-Facing Website: We created a consumer-facing website to educate consumers on the sweetness and nutritional value of Texas watermelons. The interactive site also featured Texas trivia and watermelon recipes.





Product Demonstrations

Marketing Matters went to New York City to promote the best watermelons in the United States – Texas grown Watermelons. The activation consisted of three groups of foot soldiers, spreading the good word about Texas Watermelons and how they are bigger, juicer and sweeter than New Yorkers could find anywhere else. We wanted to give knowledge to the people and our goal was to have New Yorkers' ask for Texas Watermelons by name at their local grocer.

In tune with the billboard creative placed in Times Square, New York, our activation consisted of handing out ‘Texas Slices’ which where slices of fresh Texas Watermelons inside informative pizza boxes about Texas and Texas Watermelon Association.

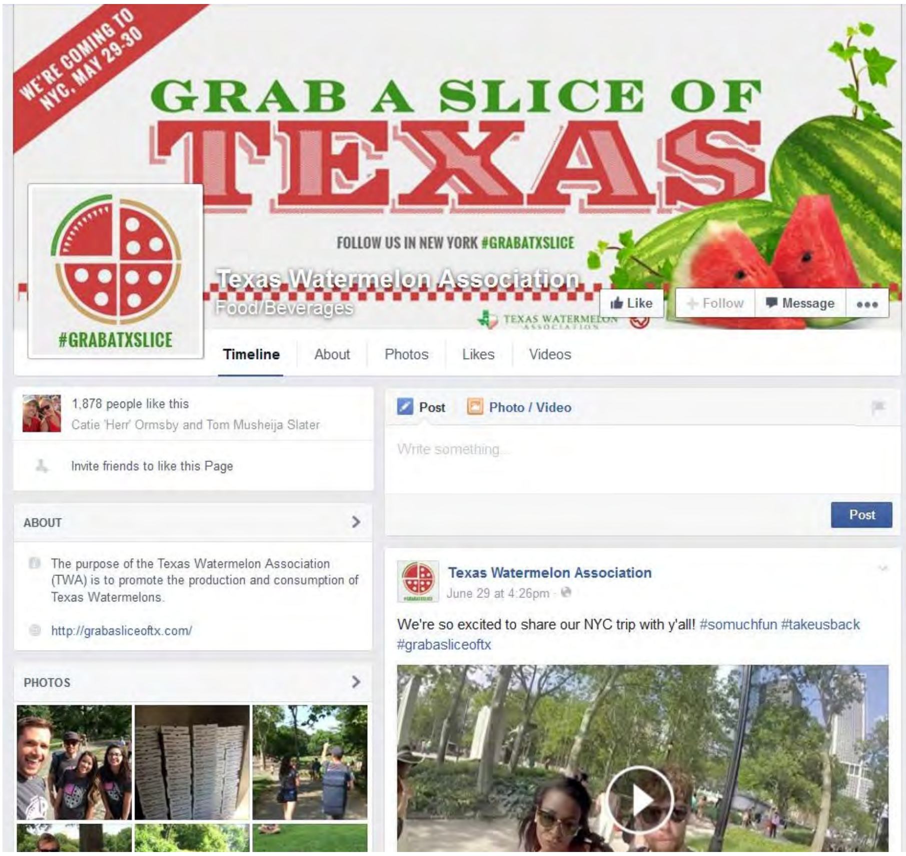
For three days of the activation we targeted high traffic areas within New York City: Times Square, Washington Square Park, Greenwich Village, Central Park, The Bowery and Financial District. The days of the activation were in the high-heat of summer and the response of people wanting fresh Texas Watermelon was overwhelming. Within our time in NYC we handed out over 450 slices of Texas Watermelon and over 400 T-shirts, all while capturing the responses of New Yorkers’ reaction to the campaign on camera. TWA partners provided t-shirts for distribution during the promotion in New York. No specialty crop funds were used to purchase the t-shirts.

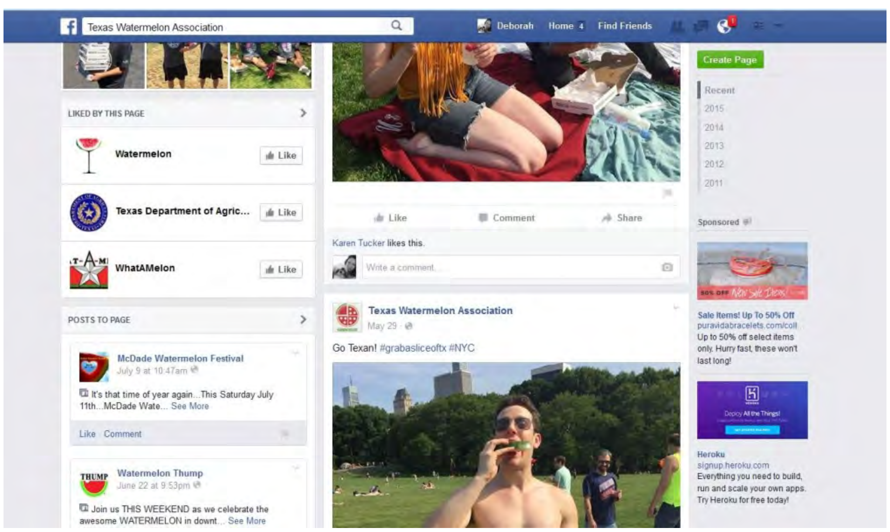
Grab a Slice T-Shirts

Watermelon Slice Boxes – replicating a New York Pizza Box

Social Media

We created a Facebook page dedicated to the Grab a slice of Texas Campaign with posts and shares of the activations in New York. The hashtag #GRABATXSLICE was used during the campaign. Over 1800 likes were achieved on the page.





Beneficiaries
There are 125 Watermelon Producers and 22 Handlers in the TWA that benefited from this campaign. In a normal year Texas growers and shippers sell approximately 15% of Texas watermelons in the New York market.

Goals and Outcomes: The qualitative goal of this campaign was to increase consumer awareness of the quality of taste and nutrition and product availability of Texas watermelons in the Northeast region of the US, New York specifically thereby increasing sales. Based on the number of impressions and reach achieved by the media plan, demonstrations and on-line placements, TWA is confident that awareness increased among our target audience. Unfortunately a late start to the season due to weather issues had a critical effect on our goals of increasing sales and they were not met.

Not only was the crop late and smaller than normal, but this is usually the time for the best prices of the season. In fact, later volume offset what was beginning to look like an even worse season, though the increased volume did not come with substantially increased prices. This leads to not only a down year for movement (supply), but also leads to a lower price per pound despite the law of supply and demand dictating converse movement between these two aspects.

Marketable volumes did not come on until roughly a month later than the average of the previous four years. This caused Texas to miss, nearly entirely, the first big demand spike of the year centered on the Memorial Day holiday after our marketing was in place. Similar short supplies heading into Independence Day (the most important week of the year) brought solid pricing following the holiday, but the damage was done by then. Supply picked up to normal levels through the end of August and a very strong West Texas crop saw well above average supplies through the end of the season however this was after our promotional efforts in New York
Here's a look at the bottom-line figures:

	2011	2012	2013	2014	2015	2011 - 14
Movement	596,280,000	499,780,000	513,260,000	557,630,000	438,370,000	541,737,500
Revenue	$85,984,672	$84,880,224	$94,549,093	$89,686,364	$66,176,272	$88,775,088
FOB	$0.144	$0.170	$0.184	$0.161	$0.151	$0.164

Lessons Learned
You cannot control Mother Nature. This campaign had some incredible elements that were used for targeting consumers in the North. Tremendous awareness was being generated through the millions of impressions being delivered. Unexpected was the harsh weathers in Texas effecting the crops. Fortunately for growers and producers supplies picked back up to normal levels through the end of the selling season. If we had known about the weather before things were set placed and running we could have postposed the launch. Other than this obstacle we felt this promotion was executed extremely well and set the stage for success.

Additional Information
TWA was also featured in a spread for Texas Produce Magazine. We promoted our shippers as well as our "Grab a Slice of Texas" campaign.

STARRING: TEXAS WATERMELONS

TEXAS IS ONE OF THE TOP FOUR WATERMELON PRODUCERS IN THE COUNTRY, GROWING 15% OF THE TOTAL DOMESTIC CROP. LAST YEAR, TEXAS PRODUCED OVER 596 MILLION LBS OF WATERMELON.

Texas Agriculture Matters! Texas watermelons contribute almost $90 million annually to our state's economy. Grown on farms stretching from the Rio Grande Valley up to the High Plains and from East Texas to the Trans-Pecos, watermelons nourish Texans and the Texas economy – enabling our producers and state to continue to be recognized leaders in the global marketplace.

– Sid Miller, Agriculture Commissioner

BUILDING ON WATERMELON AWARENESS

The Texas Watermelon Association successfully increased awareness in the state of Texas through marketing campaigns in 2011, 2012 and 2014. This year, TWA will focus on increasing awareness and market share in the Northeast Region by utilizing high-impact tactics in New York City. The campaign is the first of its kind and demonstrates TWA's innovation and commitment to growing demand for Texas produce.

The overall goal of this campaign is two fold: 1) increase consumer awareness of the sweetness and nutritional benefits of Texas Watermelons; and 2) increase overall sales of Texas watermelons in the Northeast.

The message will be conveyed primarily through a digital billboard in Times Square and supported by online and in-person tactics. New creative this year is tailored to the New York audience and encourages the metropolitan to "Grab a Slice of Texas" by eating Texas Watermelons. The campaign will run for 10 weeks through April to July.

The Texas Watermelon Association was established in 1966 to promote the production and consumption of Texas watermelons. The TWA seeks to improve the growing, grading, handling, transportation, distribution and sales of Texas grown watermelons. The association works to enhance efficiency within the industry and provide consumers with the best tasting watermelons every year. The TWA is a proud member of the Texas Department of Agriculture's GO TEXAN® program and the National Watermelon Association. This promotional campaign is made possible through the USDA Specialty Crop Bock Grant administered by the Texas Department of Agriculture.

TEXAS WATERMELON ASSOCIATION

TWA SHIPPERS

Bagley Produce
Edinburg, TX • (956) 874-7712

Farmers Marketing Service Linn, TX • (956) 381-9811

Hinojosa & Sons
Mission, TX • (956) 585-3831

M & P Produce
San Antonio, TX • (210) 227-6070

Majestic Produce
McAllen, TX • (956) 928-0300

McWhirter Farms
Plains, TX • (806) 456-7565

Nat Coleman Produce
Palestine, TX • (903) 729-7335

Nowell Borders Co.
Edinburg, TX • (956) 383-0712

Palmer Farm & Ranch Inc.
Arlington, TX • (817) 787-6070

Ronnie Borders Co.
Center, TX • (936) 590-1888

Sandia Depot
Edinburg, TX • (956) 386-1083

Texas Melon Exchange
McAllen, TX • (956) 272-1076

Wade Pennington & Sons Co.
Grapeland, TX • (936) 687-4312

Warren Produce
Edinburg, TX • (956) 287-2253

Watermelons Unlimited
Uvalde, TX • (830) 486-0424

Wiggins Watermelons
Snook, TX • (979) 272-1076

#GRABATXSLICE

#GRABATXSLICE

#GRABATXSLICE

#GRABATXSLICE

PROJECT 11: FEASIBILITY STUDIES FOR THE USE OF FLUTRIALFOL AND DIFFERENT ROOTSTOCKS TO CONTROL COTTON ROOT IN TEXAS WINEGRAPE

Partner Organization: Primary – Texas Hill Country Wineries. Partner – Texas A&M AgriLife Extension Services.
Project Manager: January Weise, Dr. David N. Appel
Contact Information: january@texaswinetrail.com; appel@tamu.edu
Type of Report: Final
Date Submitted: June 26, 2017

Project Summary: Texas wine grape growers are searching for solutions to the cotton root rot (CRR) pathogen, *Phymatotrichopsis omnivora.* The death of vines caused by this soil borne fungus takes a significant toll on the demand for Texas grapes needed to produce Texas wines. Cotton root rot, along with other stressors, is an impediment for new producers to invest in the Texas winegrape industry. A potential solution was a fungicide that proved effective in controlling the same disease in cotton. We began testing the fungicide on CRR in grapes, named flutriafol and marketed as Topguard®, in 2011 under previous SCBGP projects (TDA #s SCBGP-1112-011, and 1213-036). This research generated a great deal of grower interest. Results from the previous projects were sufficient to obtain TDA approval to apply the fungicide to winegrapes under a "special needs" 24c label and a new name, Topguard®-Terra, in 2015. There were, however, a number of issues needing to be addressed to obtain consistent, reliable control of CRR in Texas vineyards. These issues included application methods, residues of the compound in vines and fruits, interactions with different grape and rootstock varieties, and further analyses of research plots. A significant outreach effort was needed to instruct growers on the proper use of the treatment and how it fit with other measures needed to mitigate the disease, such as potentially tolerant rootstocks. This project complimented and enhanced previously completed work in a number of ways. Based on the Topguard Terra label, and due to grower education efforts, the treatment has been incorporated into standard vineyard management practices where CRR is prevalent. The current project, answered an important question by the growers, whether the fungicide persists in the soil and/or grapes. The absence of residues in the grapes and failure to accumulate in soils can now give growers the confidence to practice continued use without negative impacts. The current project also provided additional time to demonstrate reliable and consistent suppression of CRR with flutriafol.

Project Approach: Activity I. Determine whether flutriafol suppresses cotton root rot in vineyards. Test plots in three vineyards established in the previous SCBGP projects **(SCBGP-1112-011, and 1213-036)** were re-treated in 2015, as proposed. Disease progress was measured and analyzed in the treated plots and compared to the numbers of diseased vines in the untreated, control plots. Of the three vineyards, the success of treating with Topguard® could be best seen at the commercial operation in Burnet County, Hoover Valley Vineyards. The disease pressure was greatest at Hoover Valley, where treated plots had 50% fewer symptomatic vines than in the untreated control plots (Fig. 1 below). The successful 1X dose is the same as the recommended dose on the Topguard-Terra® label. The following year in 2015, there was a 100% survival rate in the treated plots but there were over 60 dead vines in the untreated control plots (Figure 2).

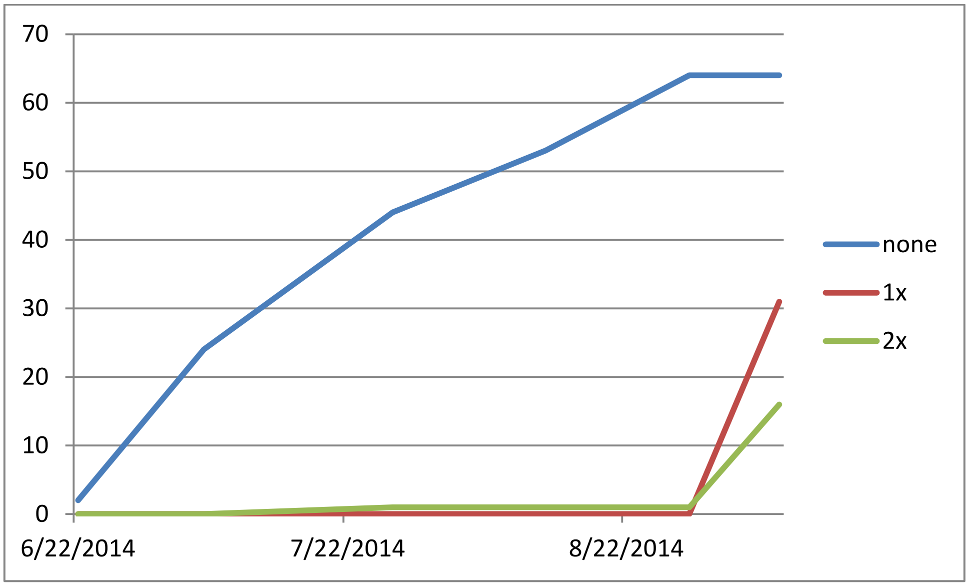


Fig. 1. Disease progress in plots treated with two rates of Topguard® and untreated control plots at Hoover Valley Vineyards. The two rates were 1X (.26/lbs a.i./acre) and 2X (.52/lbs a.i./acre).

Fig. 2. A vine dying of cotton root rot and adjacent locations where dead vines previously killed by the same disease were removed in an untreated row at Hoover Valley Vineyards.

The evidence at the other two vineyards was less compelling due to low disease pressure in the treated and untreated plots. However, other critical observations were made. One was the lack of phytotoxicity observed in the plots, even at very high flutriafol doses. This observation is important, because grower contacts made for the purposes of this project indicate that phytotoxicity may occur when the fungicide is misapplied. Common errors are poor timing or improper application method, and will be discussed in other sections of this report. Another important observation made at the other two locations (Flat Creek Estates in Travis County and the Leakey Experimental Vineyard in Real County) relates to a non-target, unintended response of vines to the treatments. One of these responses was delayed senescence in the fall, where vines in treated plots were greener and less blemished then vines in untreated plots. The second observation was that vines in the treated plots had lower levels of infection by common foliar grapevine pathogens, including the fungi causing powdery mildew (*Erysiphe necator*) and black rot (*Guignardia bidwellii*) (Fig.3).

Fig. 3. Vineyard row at Flat Creek Estates where vines treated with Topguard® exhibited lower infection rates by foliar pathogens (indicated by arrows).

Grower contacts during the current reporting period indicate that Topguard-Terra® is successful in controlling CRR in grapes**.** Although the scope of the current project did not allow for an accurate, thorough accounting of the total number of growers applying the fungicide, anecdotal comments and discussion with various growers indicated that the treatment has been well received.

Activity II. Determine whether fungicide residues are present in treated vines. Samples were collected from vineyard soils and treated vines and prepared for processing by a commercial testing lab. The vine samples consisted of grapes and foliage, while soil samples were taken with a probe at two locations on either side of the vines. These experiments were conducted to gain a better understanding of the distribution and persistence of the fungicide in soils and treated vines.

Objective 1. Accumulation in grapes.

The EPA tolerance for residues of flutriafol in grapes is 1.5 ppm (40 CFR 180.629, see website https://www.law.cornell.edu/cfr/text/40/180.629). Berries were collected from vines at Flat Creek Estates from treated vines on two dates for quantifying pesticide residues (Table 1). At both sample dates, the levels of flutriafol in grapes increased with increasing dosage of the treatment. None of the levels exceeded the tolerance limits.

Table 1. Fungicide levels in grapes sampled on two dates from vines growing at Flat Creek Estates and treated at three rates of flutriafol for control of cotton root rot.

		Sample Date June 4, 2014			Sample Date Aug. 6, 2014	
Dose		No.	Ave. (ppm)		No.	Ave. (ppm)
1X		4	0.04		3	0.01
2X		N/A	N/A		N/A	N/A
10X		4	0.15		3	0.24
20X		5	0.52		3	0.49
Control		4	0		3	0

Ripe fruit was also collected from treated and untreated vines at Hoover Valley Vineyards for analysis, with results similar to those obtained from the fruit at Flat Creek (Table 2). The highest level of flutriafol was found in the highest treatment dosage (0.67 ppm).

Table 2. Fungicide levels in grapes on one sample date (Aug.6, 2014) from vines at Hoover Valley Vineyards treated with two rates of flutriafol for control of cotton root rot.

		Grapes	
Dose		No.	Ave. (ppm)
1X		3	0.24
2X		3	0.67
Control		3	0

Fungicide levels in all samples were extremely low at the labelled rate (1X). These results provide the information necessary to recommend flutriafol for control of CRR with confidence the treatment will be safe for human consumption as well as the winemaking process.

Objective 2. Persistence in soil2.5 years post treatment.

Soil samples were collected in spring of 2017 from test plots in the experimental vineyard near Leakey, TX, and analyzed for the amount of flutriafol that could be detected. There were three levels of flutriafol tested at Leakey, and the last application was made in spring, 2014. Therefore, the results in Table 3 represent the persistence in soil for approximately 2.5 years after the last application was made. At the commercially recommended rate, there was no detectable

Table 3. Fungicide levels in soil from plots treated with 2 doses of flutriafol 2 years after application in an experimental vineyard in Leakey, TX.

Plot No.	Dose	No. Vines	Ave. ppm
Plot 1	1X	2	0
Plot 2	1X	2	0
Plot 3	10X	2	0.01
Plot 4	10X	2	0.015

level of fungicide found in the soils. At 10 times the labelled rate (10X), there were very low, negligible levels of fungicide, very near the level at which the testing service could detect flutriafol (0.01 ppm).

Objective 3. Accumulation of flutriafol in soils with repeated applications at commercial rates.

Topguard - Terra® may be applied annually, leading to the question as to the accumulation of the fungicide in vineyards requiring regular, repeated treatments. At two locations, Flat Creek Estates and Hoover Valley Vineyards, Topguard - Terra® was applied according to label rates throughout the entire vineyard, including the experimental plots from the current project. The levels of fungicide in soils taken from the plots in 2017, 2 years after the final experimental application, are depicted in Figure 3. The average levels for each treatment were derived from 10 vines/rate, with a composite of 4 sample points/vine. There was a miniscule level of fungicide detected in the soils located in the control plots, and the highest level (0.081 ppm) was found where the soil was treated experimentally at 20X the labeled commercial rate (Fig. 3). Even at the highest level of detection, the acceptable limits for flutriafol in soils were not exceeded.

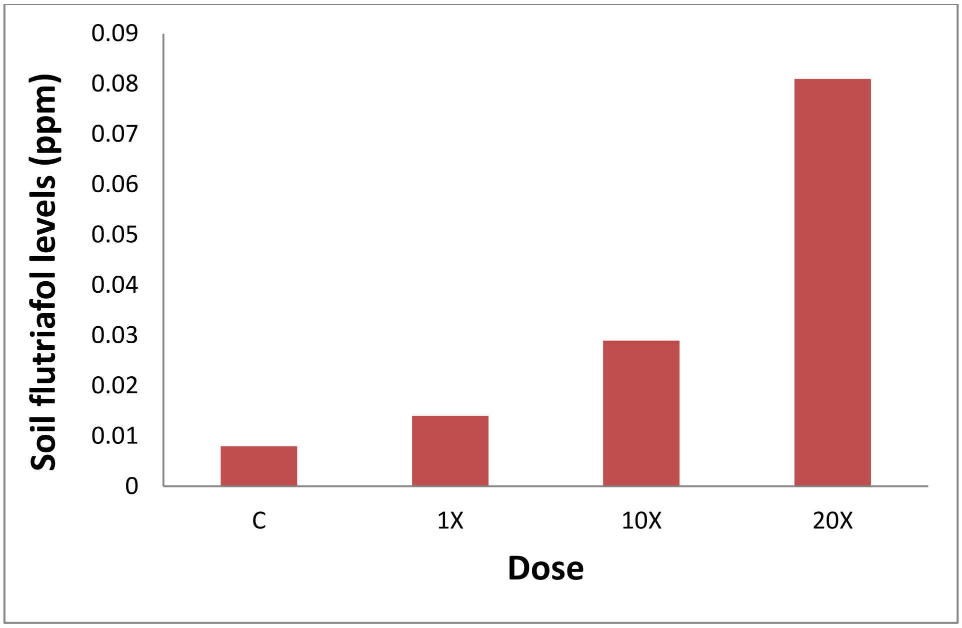


Fig. 3. Soil flutriafol levels in four treatment categories in a commercial vineyard, Flat Creek Estates.

A similar situation was found in treated soils at the commercial Hoover Valley Vineyards (Table 4). Treatment plots consisted of rows, of which there were 10 rows/rate. As with the soils in the Flat Creek plots, the highest average levels of accumulation occurred in the highest rate, at two times the commercial rate. Again, negligible levels of flutriafol were found in the rows previously in the untreated control groups.

Table 4. Soil fungicide levels for composite samples from vineyard rows treated with flutriafol for control of cotton root rot at Hoover Valley Vineyards.

Control			1X			2X	
Row No.	ppm		Row No.	ppm		Row. No.	ppm
1	0.06		2	0.09		3	0.06
5	0.12		6	0.08		4	0.07
9	0.08		7	0.05		8	0.07
10	0.05		12	0.08		11	0.2
13	0.04		14	0.09		15	0.29
16	0.07		18	0.12		17	0.09
21	0.06		19	0.1		20	0.07
24	0.04		23	0.11		22	0.11
25	0.01		27	0.05		26	0.17
30	0.01		28	0.04		29	0.07
Ave.	0.054			0.081			0.12

Activity III. Utilize mini-rhizotrons to reduce the time needed to refine CRR. As explained in previous reports, the mini-rhizotrons were designed to grow grapevines in a box container with a clear, plexiglass front so that root growth could be observed. The front could be removed for directly inoculating the growing roots of the cotton root rot pathogen and observing disease development. Although initially vigorous, long-term vine survival in both inoculated plants as well as the untreated, uninoculated plants was poor. This experiment was terminated and the information obtained can be used to modify the containers and future opportunities to continue with this activity.

Activity IV. Outreach.

- A formal presentation on the results of this project was made to Texas winegrape growers during "Grape Camp" sponsored by the Texas Wine and Grape Growers Association and the Texas A&M AgriLife Extension Service. This meeting was held on Nov. 2, 2015 and the title of the presentation was "Restricted Use of Flutriafol in Vineyards" as presented by Sheila McBride.

- The results of the project were featured in an article by the news team for the Texas A&M AgriLife Extension Service. This article was sent to local, national and international media outlets and can be viewed at http://today.agrilife.org/2015/11/08/researchers-discover-control-for-devastating-disease-in-texas-vineyards/.

- D. Appel was invited to present an update on the research with flutriafol for CRR control in winegrapes at the 2016 Grape Camp sponsored by the Texas Wine and Grape Growers Association in Fredericksburg, TX, on Nov. 6, 2016. There were 250 current and prospective Texas winegrape growers in attendance. Emphasis during this presentation and other grower contacts was on proper application of the fungicide and the consequences of misapplication.

- TAMU AgriLife Ext Viticulture Texas Winegrower newsletter (see newsletter pertaining to flutriafol application in Item 1 of the Additional Information section)
  Testimonial from a Texas hill country grape grower-- "You are to be greatly congratulated for this Volume I issue I Hill Country Viticulture notes. It is excellent with very good information that should be put into every Texas Growers library. Thanks to all of you and please keep up the great work – God knows we all need the help!" Rick Naber and our Team at Flat Creek Estate
- Texas Plant Disease Diagnostic Lab website with a bulletin containing some background information on how to use flutriafol as well as some expectations for control when properly applied. Also included is the link to the 24c Topguard label grape growers need

in order to apply flutriafol in their vineyards. http://plantclinic.tamu.edu/2016/01/21/new-treatment-crr/ 43 likes, 1 share

Goals and Outcomes Achieved: During the course of these investigations, and based on the results, the fungicide flutriafol was commercially labelled for control of cotton root rot of grapes. Due to grower education efforts as part of the project outreach, the treatment has been well received and incorporated into standard vineyard management practices where CRR is prevalent. Some important aspects of soil treatments with Topguard® were studied. For example, flutriafol levels in grapes were found to be negligible, below the EPA limits. This result is extremely important. Besides food safety issues, residual fungicides in winegrapes could have a negative impact on the fermentation and winemaking process. Another important consideration, the potential for persistence and accumulation of the fungicide in treated soils was also analyzed,. Within the time limits of the project, flutriafol, at label rates, does not appear to be accumulating at levels that would cause concern for the vines or the safety of the environment. Through grower contacts and site visits, some consequences to misapplication of the fungicide were observed, including phytotoxicity on plants where the method and timing of applications exceeded the tolerances on the label. The details of this episode were included in a previous report, and will not be repeated here. However, when the soil and tissue analyses from the vineyard where the fungicide was misapplied were compared to the same tests in the experimental plots, some very important observations could be made regarding the dangers of misapplication as well as the potential levels of flutriafol in soil and vines that lead to direct phytotoxicity and compromised vines (See Table 1 in the Additional Information section at the end of this report).

Beneficiaries: All facets of the Texas wine and grape growing industries will benefit from this research. Winegrape growers with vineyard soils infested by *P. omnivora* will now have a proven method for reducing losses of vines to this recalcitrant pathogen. There are 350 grape growers in Texas, farming about 4000 acres. The "full economic impact" of wine and winegrapes in Texas is $2.27 billion (see website of the Texas Wine and Grape Growers association, https://www.txwines.org/texas-wine/texas-wine-industry-facts/). Beyond the direct benefit of saving vines, the industry as a whole will also be a beneficiary of the project. There is great value to producing Texas wine from Texas –grown grapes, and during some years they are in short supply. Growing winegrapes in Texas is a challenging undertaking, and the ability to control cotton root rot will give confidence to those potential growers considering whether they want to invest in the expense of vineyard establishment and the uncertainties of growing grapes.

Lessons Learned:

There were very few parts of the project that did not go as expected. Growth of the grape plants in the mini-rhizotrons was acceptable, but inoculation of roots with *P. omnivora* did not yield any useful results. If this experiment would be repeated, additional time and resources would be needed to overcome some limitations to the experiment. The mini-rhjzotron concept is a good one, so opportunities to repeat the work in the future will benefit from the activities of the current project. There are many aspects of the treatment that would benefit from the use of the mini-rhizotrons to study the application of flutriafol to winegrapes.

The success of the project could be attributed, in great part, to the close working relationship established with the Hill Country Wine and Grape Growers and the use of commercial vineyards for most of the test plots. These connections stimulated the goal of providing rapid relief to numerous vineyards with an effective solution to the CRR problem in the shortest amount of time. In addition, the interactions with growers also provided for a means to communicate the results of the research to the growers needing the information most.

Contact Information: Dr. David Appel, Professor, Dept. of Plant Pathology and Microbiology, Texas A&M University, College Station, TX 77843, (appel@tamu.edu) and, Sheila McBride, Diagnostician, Texas Plant Disease Diagnostic Laboratory, Texas A&M AgriLife Extension Service, TAMU, College Station, TX 77843 (s-mcbride@tamu.edu)

Additional Information:

Item 1: Newsletter of the Texas A&M AgriLife Extension Viticulture and Enology Program describing the use of flutriafol for control of cotton root rot in grapes.

TEXAS A&M AGRILIFE EXTENSION

February 15th 2017

Volume I, Issue 2

Texas Winegrower

A Quarterly Publication of the Texas AgriLife Extension Viticulture and Enology Program

In this issue:

Inside this issue:

Upcoming Events:

Feb 16-18– TWGGA Annual Conference, San Marcos TX

Feb 25- Dallas County Hybrid Pruning Demonstration

Feb 28- Frost: "Understanding and Minimizing the Damage" Narra Family Vineyard Brownfield TX.

March 2- Hybrid Grape Pruning and Vine Propagation Workshop Myers Park in Mckinney 9-4 pm RSVP required

March 3 - East Texas Grape Growers Field Day Time and Cost TBD

March 4 - North Texas vinifera pruning and training demonstration T.V. Munson Memorial Vineyard in Denison

March 10 - Fungicides & Sprayer Calibration at Eden Hill Winery in Celina 9:30-3:30pm Cost for lunch TBD

April 21-Field Day Vineyard s at Grandview Richards TX

April 28– Newsom Field Day, Newsom Vineyards Plains TX

June 19-Advanced Grape Growers Workshop Fredericksburg TX

For more information on times, locations or costs please contact your regional Viticulture Program Specialist.

Thank you for taking the time to read the second issue of Texas Winegrower. We hope you are enjoying this winter as we all gear up for spring and another great growing season. Here in the Hill Country pruning is underway and bud break is just around the corner.

In lieu of Regional Updates, for this winter edition we have chosen to do a special section dedicated to new and potential growers. Your Extension Program Specialists have each prepared an article that will be of special interest to those of you who are just joining our growing community as well as those still in the planning stages of starting a vineyard business. We do hope however that even some of our experienced growers will find something in these articles of interest, especially if you are considering expanding your operation.

In addition, Extension Viticulture Specialist Justin Scheiner will be giving an overview of available information on herbicide drift. We recognize this is a growing concern in all regions of the state and hope to serve as a resource to our growers in both preventing and coping with the consequences of unintended herbicide contact in your vineyards.

Also of interest to New and Prospective growers, Jim Kamas will be doing a talk on The 10 Most Common Mistakes Made in Grape Growing at the TWGGA Annual Conference. New growers can learn about these mistakes before making them, experienced growers can better understand some of the mistakes they may be making.

Treatment to Manage Cotton Root Rot in Winegrapes

Jacy Lewis

Many of you have heard about the work on use of flutriafol for control of cotton root rot (CRR), being carried out by Dr. David Appel and Sheila McBride of the TAMU Dept. of Plant Pathology and Microbiology and the TPDDL, and have inquired as to the availability of this product for mitigation of this disease in vineyards. A request by TDA for a 24c registration for this product for use on winegrapes was approved. The product is sold commercially as TOPGUARD® Terra and can be obtained from your local chemical supplier.

This label is exclusively for control of CRR through a soil drench application. No other application method is approved and it is not approved for any other uses. This means in order to make an application you must have a chemical injector that will allow you to apply the product through an above ground drip irrigation system with appropriate backflow prevention.

An important note, the current label for TOPGUARD® Terra does not include winegrapes. In order to be in compliance with Federal and State regulations, you must obtain and keep on hand a special FIFRA Section 24c label for the product. The current label is valid through Oct 31, 2018 and can be obtained at www.cdms.net/ldat/ldC5C001.pdf .

Item 2. Table containing results of the soil and plant samples analyzed for flutriafol levels from a vineyard where the treatment was misapplied, resulting in symptoms of phytotoxicity on grapevines.

Table 1. Results of soil and tissue analyses for flutriafol in samples removed from a commercial vineyard in Lorena, TX.

Sample No.	Sample type	Amt. (ppm)	Sample type	Amt. (ppm)
R33 V1-4	-	-	Plant (old)	40
R33 V5-8	-	-	Plant (old)	74
R37 V1-8	Soil	0.05	Plant (old)	62
R37 V9-16	Soil	0.06	Plant (old)	62
R38 V1-8	Soil	0.38	Plant (old)	72
R38 V9-16	Soil	0.46	Plant (old)	112
R36 V1-5	Plant (new)	10.9	Plant (old)	59
R36 V6-10	Plant (new)	10.7	Plant (old)	64
Composite	Grape	0.8	-	-

PROJECT 12: EXPANDING ADVISEMENT AND SERVICE ROLES INSIDE THE TEXAS CITRUS INDUSTRY: GROWER OUTREACH IN PSYLLID CONTROL AND HLB EARLY DETECTION

Partner Organization: Texas Citrus Pest and Disease Management Corporation
Project Manager: Raina King
Contact Information: 901 Business Park Drive
Mission, TX 78572
(956)580-8004
Type of Report: Final
Date Submitted: September 30, 2016

Project Summary

The Texas citrus industry, in alliance with the Texas Department of Agriculture (TDA)-Agricultural Consumer Protection Division, has adopted a new operational structure designed to streamline and focus stakeholder efforts at mitigating the spread of Citrus Greening Disease, or Huanglongbing (HLB), in the state's largest citrus production area. A key component to the new Texas Citrus Pest & Disease Management Corporation's (TCPDMC) overall plan is to augment the capabilities of both the existing area wide psyllid control program and early detection efforts with additional personnel and resources. These resources will provide a grower with timely, personalized and accessible information essential to slowing the disease's spread.

Introduction of the Asian Citrus Psyllid (ACP) in Texas has brought with it the detrimental phloem disease, HLB. ACP is the vector of Citrus Greening Disease or HLB. Once a citrus tree has become infected with HLB it becomes a reservoir for the inoculum. Foraging psyllids obtain the inoculum and can spread the bacterium both short and long distances. This bacterium (*Candidatus liberibacter asiaticus*) will eventually clog the phloem elements and infect the citrus tree by producing small, lopsided, bitter fruit and eventually succumbing to the disease. There is not a known cure at this time for citrus greening.

Citrus greening was detected in Texas on January 13, 2012. Since the initial finding there have been several positive detections. It is estimated that the Texas citrus industry supports approximately $250 million economically and widespread detections of HLB could possibly devastate the industry. Loss and replacement of all mature citrus trees could cost the industry $538 million. If just 60 percent of the mature fruit bearing grapefruit required replacement, the industry would lose approximately $256 million. Replacement of oranges alone would cost the industry approximately $67 million. As a result of the detection of HLB, the Texas Citrus Pest and Disease Management Corporation has provided positive, proactive steps to decelerate the spread of citrus greening and possibly save the Texas Citrus Industry.

The Texas Citrus Industry is adapting to the reality of HLB. Specifically, managing groves in a way that slows the spread of this incurable disease is an absolute necessity for the long-term prognosis of commercial citrus production in Texas. Effective management of groves in this regard can be expressed as 1) what is being done to prevent the disease's occurrence in the grove (e.g., control of vector) and 2) what is being done to mitigate further spread once it is detected (e.g., infected tree removal, periodic sampling). Since HLB was initially found in January

2012,its incidence has steadily progressed so that most (75%) of the State's citrus production area (Cameron and Hidalgo Counties) were recently quarantined by TDA. Indications are strong that the remaining commercial acreage will likely fall into the regulated area in the near future. While the regulations imposed by quarantine expansion lead to additional production costs, the industry understands the value of having safeguards in place to help mitigate further spread.

Starting in November of 2015, the first quarantine for Mexican Fruit Fly was put into place. This was the earliest that Mexican Fruit Fly quarantine had been placed in the lower Rio Grande Valley in many years. Mated Mexican fruit flies lay their eggs in the rind of whole ripe fruit. This makes the fruit inedible and nonmarketable. Each mated female has the potential of creating larger quarantines depending on the location of the find compared to the current quarantine border. Each quarantine pushes the harvest date for each producer in the area back an additional 30 days if they have been certified through a bait spray program. If the grove has not been certified for the bait spray program, then the fruit is not harvestable. Since the first quarantine was placed at the beginning of the harvest season, the citrus industry deemed this to be priority number one for the Corporation to render aid.

Citrus canker was also detected in November of 2015. This is the first detection since the 1940s. It had been considered eradicated in the Rio Grande Valley. Citrus canker is extremely spreadable through wind, water and even touch. This bacterial disease infects trees causing leaf spotting, rind blemishing, tree defoliation and fruit drop. Tropical storms provide the perfect breeding ground for this bacterium. The fall and winter of 2015-2016 was extremely tropical for the Rio Grande Valley. Temperatures reached the 90 degree mark for Christmas. These temperatures and the increased risk of spread due to growers harvesting caused great alarm for the citrus industry. Luckily, the strain of bacterium that was discovered has only been found on lemon and lime trees. Removal of the inoculum had to be immediate since more tropical storms were reported for the area.

Project Approach

One of the keys to this program has been pest and disease monitoring: in the form of a pilot baseline effort (2010-2012) and more recently as a real-time service for select growers. In only its first full year of existence, this initiative proved to be an invaluable asset in the fight against HLB by simultaneously reducing ACP levels and building awareness among growers of what commitment level is necessary to effectively keep their populations in-check. Two technicians monitor psyllid levels in approximately 100 groves throughout the production area at 2-week intervals and then relay this information same day (in person or by phone) to the 40 individual growers who own or manage them. While similar efforts exist on a large scale in Florida, Texas faces something of a different situation, thus making this personalized contact more effective. For instance, the average age of a Texas citrus producer (approximately 60 years of age) means that a disproportionate number of them are generally not willing to access the internet on a regular basis which would preclude disseminating this kind of information on the web (as is done in Florida) only.

The other key to this project is the removal of inoculum from the surrounding areas. This includes trees that are infected with HLB or citrus canker and removal of abandoned groves that are considered a source of inoculum and pests for commercial and residential citrus growers alike.

Goals and Outcomes Achieved

The main goals of this project were to reduce ACP, HLB, Mexican Fruit Fly, and Citrus Canker infestation levels in the Texas citrus production area by expanding the area-wide ACP control program to include additional monitored groves and removing infected trees as needed.

ACP monitoring continued throughout the project. Spikes of ACP levels were consistent with flush cycles as expected. Figure 1 shows average ACP levels throughout the term of this project. When levels were above the threshold of 10 ACP per grove, producers were notified that treatment was needed for that grove. The mid-valley area averaged higher levels of ACP than the rest of the monitored areas. This area has more "interface" or urbanized citrus areas which has a higher number of colonias and RV parks with untreated residential citrus.

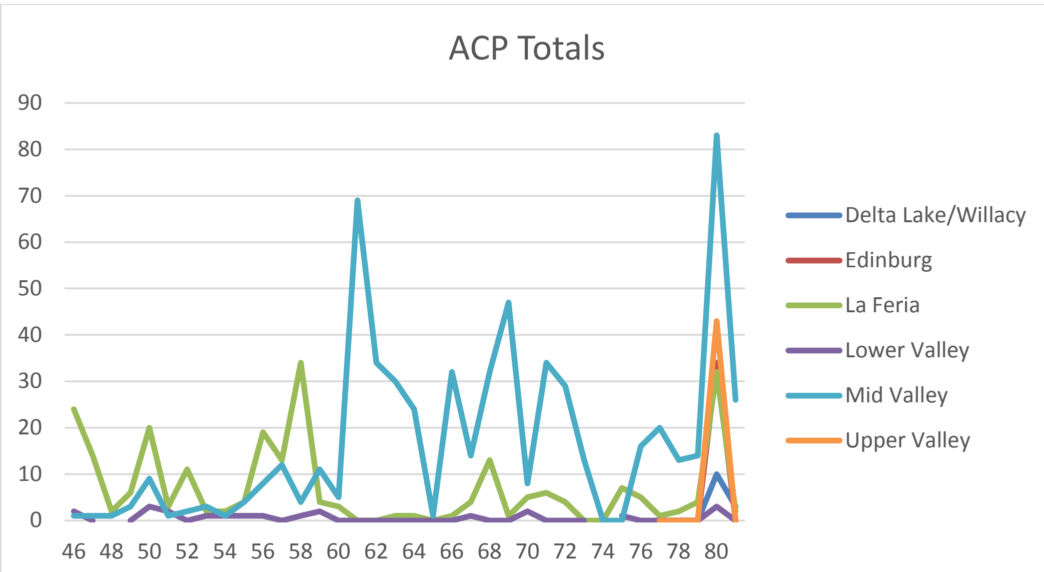


Figure 1. Average ACP levels across the Lower Rio Grande Valley

Starting in October of 2015, the USDA identified 152 residential trees infected with citrus canker. The strain that was detected only affects lemons and limes. This project helped remove 25 of the remaining infected trees. This removed the remaining inoculum from the area. This protected the industry from the spread of citrus canker from residential citrus to the commercial groves.

Abandoned groves that were considered high risk source for pests and diseases were also removed. These groves had been neglected for years and considered to harbor Mexican fruit fly, citrus canker and HLB. These groves were in close proximity to productive commercial groves. Permission from the grove owners were obtained before removal of the groves. A total of 148 acres were procured for removal.

Target: The industry expects to monitor an additional 100 groves and anticipates a minimum 10% reduction in mean ACP count for monitored groves. The industry also anticipates a minimum reduction of Mexican Fruit Fly by 5%. Citrus Canker is to be detected and removed from population.

Benchmark: Currently, the mean ACP count in commercial groves that are enrolled in the area wide monitoring program over the last 12 month period is 32. The Mexican Fruit Fly counts are at 52.

Performance Measure: ACP and Mexican Fruit Fly data will be collected and analyzed by Texas Citrus Mutual and/or Citrus Pest & Disease Management personnel. Data will be provided directly to the growers through phone messages, emails and continually updated interactive maps posted on the internet (http://www.texascitrusgreening.org/quarantine-map/). Agency Stakeholders will receive the data through shared access to the USDA APHIS database. The number of individuals receiving this information will be tabulated based on internet "hits" for the map pages and also through follow-up emails & text messages to confirm receipt of results among individual growers. Citrus Canker finds will be reported to the USDA-Aphis-PPQ immediately due to quarantine restrictions.

Monitoring Plan: Performance will be tracked through quarterly assessments of ACP, Mexican Fruit Fly and Citrus Canker levels in all monitored groves. All information will be shared with TDA in a timely and efficient manner.

Beneficiaries

This project benefited a high percentage of the Texas Citrus Industry, directly and indirectly. The direct beneficiaries would be the growers themselves, especially the multitude of growers who own or manage less than 100 acres. Through the monitoring program, a total of 40 growers were provided real-time data to ensure proper and timely applications of treatments to reduce ACP levels and the spread of HLB throughout the LRGV.

While the project has had the most undeniable impact on the citrus industry itself in South Texas, consumers throughout the state and elsewhere are reaping the benefits. For those directly employed by the industry (e.g., industry principles, growers, grove care managers) the project provided a continuing assessment of HLB's spread. The project also benefited existing efforts by federal agencies in biological ACP control, since the HLB Command Center location in Weslaco will likely include space for USDA researchers to stage predatory *Tamarixia* wasps prior to field distribution in interface situations.

Lessons Learned

Throughout this project, the cycle of ACP has been consistent with flush cycles. The real-time data that is delivered to the producer provides the potential for fast and timely treatment for pests and diseases. This reduces the spread of pests and diseases to other producers and slows the spread from one location to the other. The reduction of pests and diseases increases the possibility of citrus to be exported both domestically and internationally.

Removal of inoculum is key in keeping the Texas production thriving. Reduction of inoculum decreases the negative potential of spreading pests and diseases from production areas and across state lines.

Additional Information

A growing number of grove owners in the production area are either part-time residents from Mexico or are recent immigrants that in many cases have acquired 5 to 10-acre parcels which continue to feature all or part of a commercial grove that occupied the site previous to subdivision. Personalized contact with these individuals is important as most initially have either no or a very basic understanding of grove management and, despite their strong desire to keep the trees in production, they can become a liability to the industry very quickly if they do not adopt sufficient ACP control practices. The industry experience is that these newer growers do not generally choose to attend larger area wide meetings when invited and there is no reason to assume that this will change in the short-term. However, TCM has also found that these same individuals, when approached/educated independently, adopt satisfactory ACP control measures. A number of them are participants in the existing monitoring program which is a reflection of their desire to persevere as growers.

This scenario goes hand-in-hand with a final reality that sets the ACP monitoring experience in Texas apart from much of Florida, which is that the groves of smaller growers are in most cases now islands in an urbanizing landscape. Growers who are now hemmed in by development on two, three or all four sides are faced with ACP pressure originating from untreated residential citrus trees in adjacent neighborhoods. Here again, personalized contact where monitoring is concerned is invaluable since many of these growers will become participants in an “interface” program being developed to supplement the grower’s ACP treatment regimen with bio-control strategies in the surrounding neighborhoods. These demographic and geospatial realities underscore the need to reach additional growers by providing year-round ACP monitoring.

PROJECT 13: FROM ARTISANAL TO MASS MARKET: GROWING AWARENESS, TRIAL, AND PURCHASE OF TEXAS GROWN OLIVE OIL

Partner Organization: Texas Association of Olive Oil
Project Manager: Josh Swafford
Contact Information: Josh Swafford, joshua@txolivetrees.com, (512) 630-7085
Type of Report: Final
Date Submitted: December 1, 2017

Summary
The initial purpose of this project was to increase awareness about the Texas Olive Oil Industry within the State by promoting Olive Oil Growers and Producers through marketing and education. Texas producers face the challenge of how to introduce new artisanal brands or Texas-grown olive oil without having to engage in every aspect of vertically integrated production efforts. To provide opportunities for all Texas producers to sell their olive oil a producer showcase was established online that offers a high profile friendly site to promote products with links to producer sales venues. The importance of this project is dire to our industries growth and stability to promote awareness and provide education about the Texas Olive Oil Industry. The timeliness of this project is necessary as we, as an industry, are substantially growing every year.

Project Approach
The activities performed within this grant period were mainly website design and updates along with educational supplies for events. With these main activities, we were able to increase awareness and education for our industry. Specifically by growing our membership base, and providing those members with much needed materials and information for their current and future successes with their operations.
The following activities were completed:

- Web Design and Website rebranding.
- Daily social media promos on Facebook and Twitter
- Advertising – TXAOO completed three ad designs advertising Texas olive oil and the new association.
- Designed and produced physical Texas Olive Oil banners for marketing kits.
- Texas Highways 1/6 page ad design & Production.
- Texas Ag Mag page ad design & production.
- Create producer showcase profile sections on website.
- Web & Social Media Advertising Campaigns – TXAOO has been very active promoting the Texas olive oil industry through both Facebook and Twitter. The following links have been provided to review some of their posts.
    - Facebook: https://www.facebook.com/txaoo/
    - Twitter:https://twitter.com/txaoo
- Ongoing: website and database integration and maintenance – This is an ongoing activity. TXAOO is actively working on database/website integration as mentioned above. Website and database maintenance will be an ongoing activity.

Goals and Outcomes Achieved

The activities that were completed in order to achieve our performance goals was to develop a working and professional website to aid and assist our current and future members with much needed assistance to grow within the industry. Through this project, we were able to double our membership; and because of that, host a conference in June of 2017 that was attended by over 250 people interested in Olive Oil Production in Texas. This caught the much deserved attention of major growers and producers out of California, who also attended the conference in San Antonio. This directly influenced the decision, by the Board of Directors of the American Olive Oil Producers Association, to host their Annual Conference in San Antonio as well. Most of our attainable goals through this project were, and continue to be, long term. This project provided a jump start and a solid base for the Texas Association of Olive Oil to promote our industry, grow our membership base, and create education and awareness about our product. Our goals that we established through this project were to create awareness. We know that we accomplished these goals, through the funding of this project, by increasing our membership base and by hosting well attended events. Our new website provided much needed insight for our members, and created a great start to hosting an informational portal to promote this industry. Since the beginning of this project, our online presence has been well received. We have quadrupled our following, and on average, increase our social media followers by 15%-20% each month.

Other significant contributions completed by the previous grantee, Texas Olive Oil Council include the following:

- Product demonstrations at Farmers Markets and Community Events – Since the beginning of the grant period, Texas olive oil demos were conducted at 822 events and farmers markets, with an average of 245 sample demos per event day, for a total of 201,390 0.5-oz samples given (763 total gallons).
- Significant Contributions: During 2015, educational seminars were presented in cooperation with Texas A&M AgriLife Extension, the San Antonio Rodeo & Livestock Show, the University of Texas at Austin, and other, local church and community events. Abbie Rutledge of Next Door Pantry provided ongoing educational presentations and product demonstrations. Barbara Wardlow, Ron Johnson, Josh Swafford, Roxi Vandermark, Jim Henry, Sandy Stewart, Gerald Smallwood, Maria Castro, Jose Castro, and Dr. Karen Lee provided educational presentations, product demonstrations, online responses to consumer queries, and ongoing coaching and support for olive oil education and sales, and the GoTexan Program. Jaleah Colon provided recipes and cooking blogs, linked to the Texas Olive Oil Facebook page.
- Google AdWords Promotion: The Google AdWords program captured consumers searching for information on olive oil in the popular search engine. Using this tactic, TOOC created an average of 981 impressions per day for Texas olive oil searches including “Texas olive oil,” “Texas olive trees,” “Texas olive,” “olive oil,” and “olive orchard.” This tactic yielded an average click-through rate of 0.31%.
- Expected Measureable Outcomes: Across all activities and tactics, results were strong. Unique visitors increased 26% and remained higher throughout the year for a total result of 1,026,338 hits, an 11% increase on a month-to-month basis over 2014. This increase is on target with the 10% goal set for this grant period. Daily average hits for the past twelve months are 2594, up from 2320 the previous 12 months (2014 versus 2015).

Website statistics are from AWSTATS, a statistical analytics package provided by TOOC's domain hosting service, Bluehost, as well as Facebook Ads Manager, and Google Analytics. o The goal was to increase total Texas olive oil sales by 10% over estimated 2014 retail sales of $2.4 million. With an average unit price of $11.94, this represents approximately 183,000 bottles sold. For the last 12 months, December 2014-November 2015, total retail sales of Texas grown olive oil is estimated at $2.81 million, based on sales venue reports from participating resellers and Texas olive oil brands distributed through retail channels including Texas Olive Ranch, Texas Hill Country Olive Company, Sandy Oaks Olive Orchard, First Texas Olive Oil, Lone Star Olive Farm, and Charta Olive Farm. Converting sales dollars to bottles sold at the 2015 weighted average unit price of $13.25, this represents approximately 212,000 bottles sold.

Beneficiaries

The main beneficiaries of this project are the members of the newly formed Texas Association of Olive Oil. Along with them, we are also able to provide much needed assistance to other growers and producers, as well as potential growers and producers, through our marketing and educational efforts. Since this project has elevated our State Association, it has also directly benefitted Olive Oil growers and producers around the country, and through the American Olive Oil Producers Association, captured the attention of Olive growers and producers from around the world. The number of beneficiaries has positively affected over 400 growers and producers in the State of Texas, over 3,000 members of the American Olive Oil Producers Association, and countless numbers of interested parties around the world who have contacted the Texas Association of Olive Oil. The current economic impact that this project has on our Association has allowed us to increase our membership base, increase the interest in this industry, and increase the awareness and health benefits of our products. The potential economic impact this project has for us is unknown, but we know that it is going to continue to dramatically increase. Most importantly, this project has created a unity for the Olive Oil Industry in the State of Texas.

Lessons Learned

A major lesson that was learned during the entirety of this project is that we could not have accomplished our goals without this project. The Texas Olive Oil Industry has been struggling for years, and this project allowed this industry to elevate itself so we may be leading producers in the world. The main unexpected outcome during this project was to find out that we, the Texas Olive Oil Industry, are receiving national recognition through our efforts. Now that we are able to properly market ourselves, we are able to grow our membership, and increase awareness. A major lesson learned that did not go well was our first and primary web developer became aware of this project, and drastically increased their rates. This caused major issues between the Texas Association of Olive Oil and the Web Design Firm, as we saw it as a waste of money once they started increasing rates and decreasing productivity. We were able to come together with a new firm, design an operable budget that fit within the parameters of this project to achieve a desired, successful outcome.

Additional Information

In 2015, the Texas olive industry developed a significant issue with more than one crop association competing for the resources available to a very small group of producers. Efforts were refocused on unification strategies with entities merging in early 2016. Some of the marketing initiatives were postponed to ensure that the new brand carried forward the benefits designed herein to accrue to Texas olive growers. The original grantee, Texas Olive Oil Council relinquished project oversight to the newly formed Texas Association of Olive Oil (TXAOO).

www.txaoo.org
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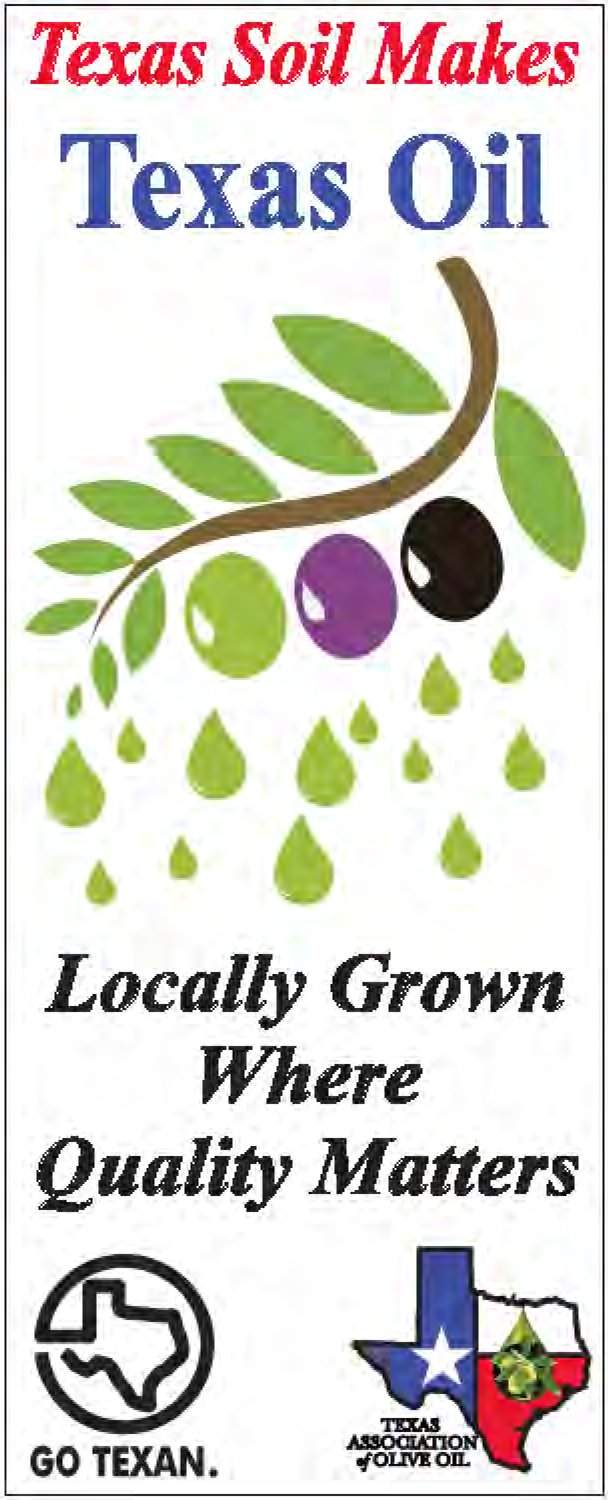
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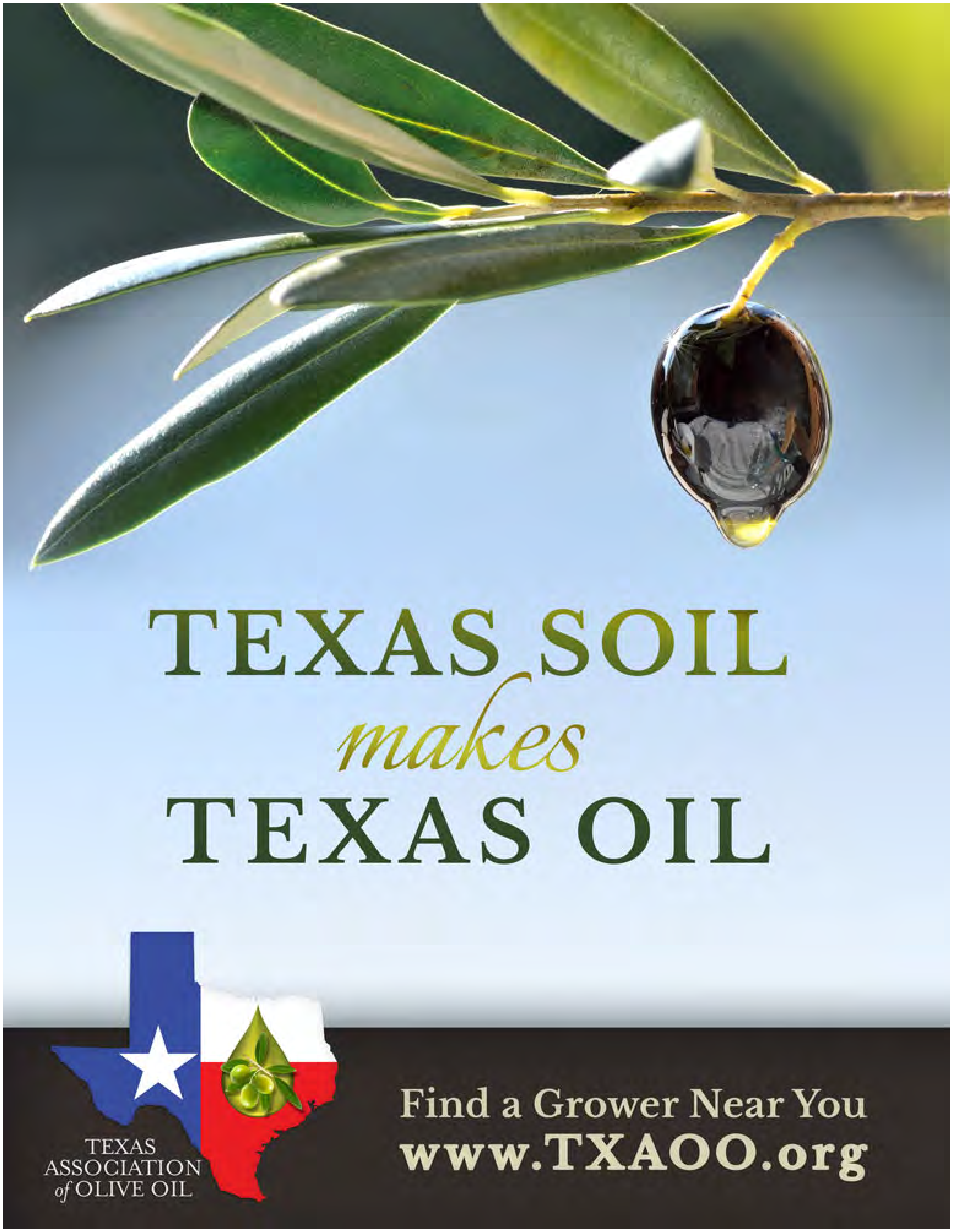
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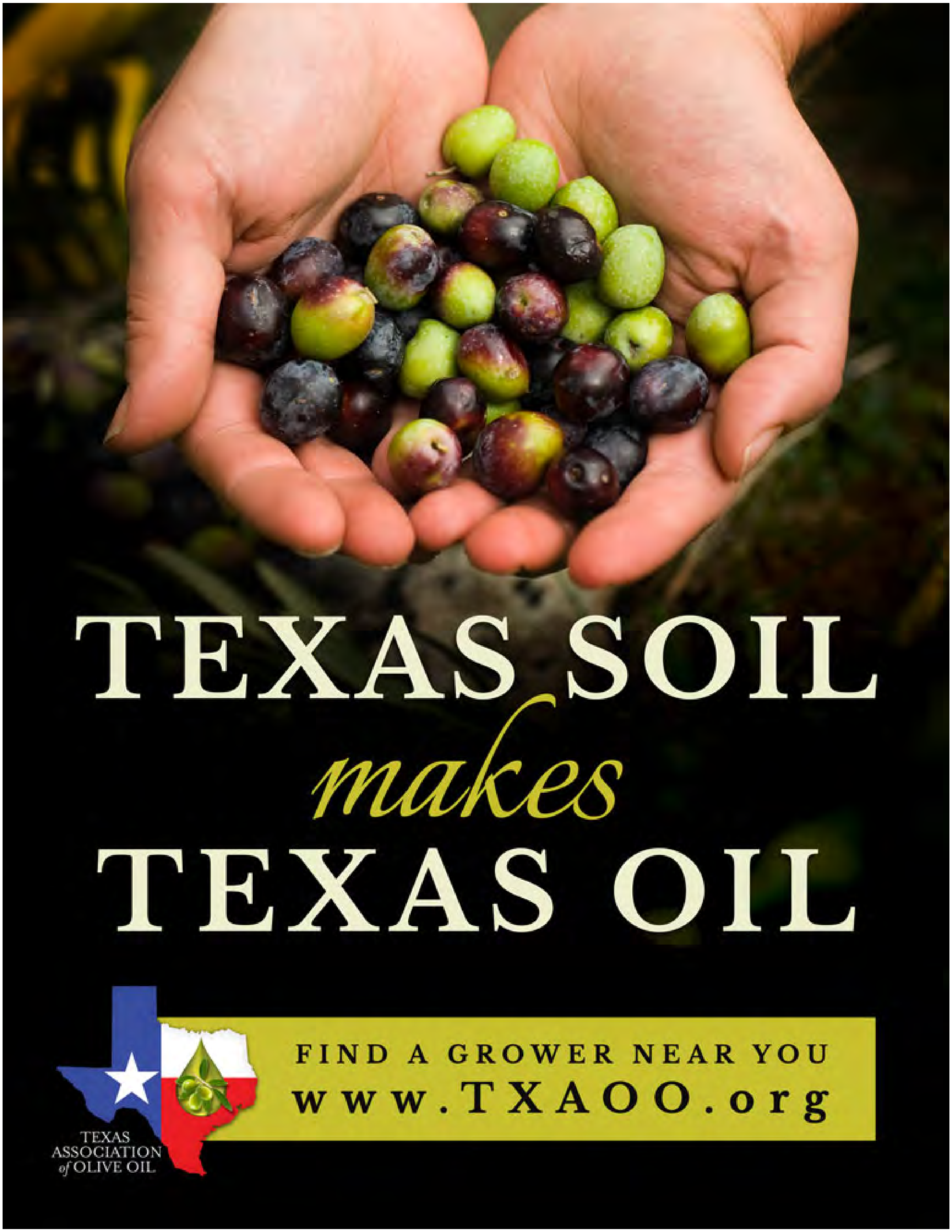
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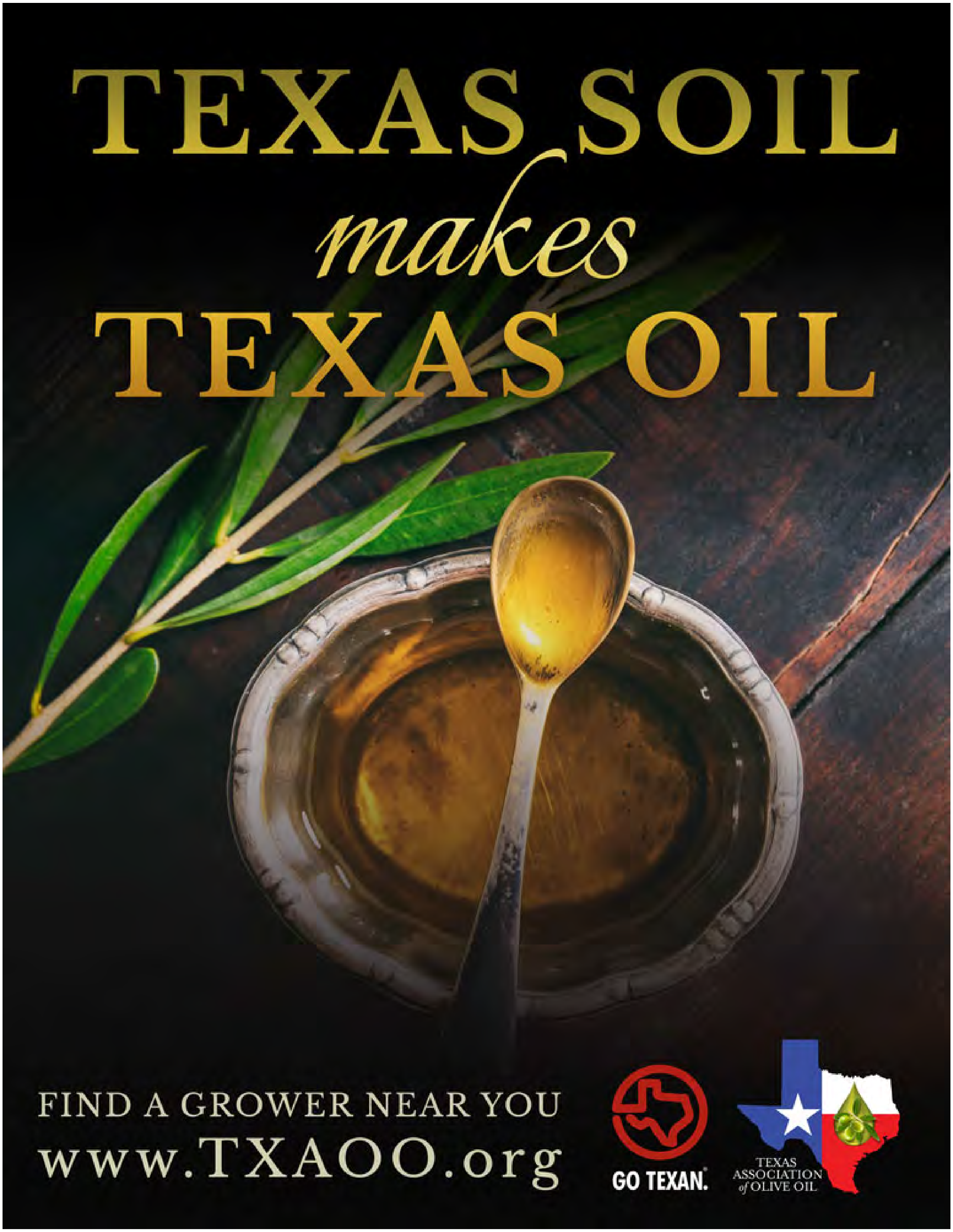
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Project 14: Investigating Management Practices and Varietal Selection for Improving Olive Orchard Productivity and Quality of Fruit

Partner Organization: Primary - Texas Olive Oil Council (TOOC); Partner – Texas AgriLife Extension Services
Project Manager: Karen Lee (TOOC), Monte L. Nesbitt (AgriLife)
Contact Information: klee@texasoliveoilcouncil.org, 512-761-0011; MLNesbitt@tamu.edu, 979-862-1218
Type of Report: Final
Date Submitted: March 17, 2017

Project Summary

Funds from this project subcontract were used to establish the Texas coordinated olive variety trial (COVT). The COVT is now a network of variety research test plots that encompass ten diverse growing locations spanning east to west from Liberty County to Val Verde County, and north to south from Williamson County to Hidalgo County. Nine of these ten plots were established in privately-owned cooperative grower sites, and one plot was established at the Texas A&M AgriLife Research & Extension Center at Weslaco, Texas. Each plot was established with the same group of olive varieties replicated six times and randomized to allow for statistical analysis of growth, cold hardiness, fruit production and fruit quality. It was explained in the proposal that the COVT project would be a multi-year project with results delivered to the olive industry over several years. Funds from this grant were expended in 2015 and 2016 to prepare plots, plant trees, provide basic tree care and make initial observations of growth and survival.

The COVT plot layout and number of trees varied slightly at each site in order to achieve appropriate inclusion of guard trees, so that every test tree under evaluation had uniform sunlight exposure and tree-to tree crowding. Trees at some sites were laid out in single rows. Other sites were planted in a multi-row plan. The number of trees planted at each site in 2015 and the number of trees identified that were weak and required replanting in 2016 are shown in Table A.1.

Sustainable growth of the Texas olive oil industry is partially dependent on identification and implementation of varieties of olive trees that are adapted to the unique challenges of the climate. New and existing orchards need varieties with substantial cold hardiness to resist erratic severe winter freezes as well as flower bud resistance to high spring temperatures. Growers are exploring many commercial varieties, but lack of proper planting design and absence of coordination prevent the unbiased discovery of varieties that can overcome constraints to production and move the industry forward. Research studies were conducted to determine suitable fertilization practices to accelerate establishment and early canopy and root growth of newly planted olive trees.

Project Approach

A two-year study was established in a container experiment under a screen house to evaluate the impact of N rate and fertilizer source based on different proportions of N sources, ammonium, nitrate and mix of ammonium and nitrate.

Olive seedlings were planted in May, 13, 2015 (Figure A.1). During the study period, the following 9 treatments was evaluated: control (no N), nitrate source applied as calcium nitrate (CN) at 20 and 40 kg/ha, nitrate-ammonium applied as ammonium nitrate (AN) at 20 and 40 kg/ha, ammonium applied as urea at 20 and 40 kg/ha, and the slow release Osmocote (OSC) applied at 20 and 40 kg/ha. The experiment was designed as a complete randomized block design with 4 replications containing 2 plants per replication (8 total per treatment) in the first year and 1plant per replication (4 total per treatment) in the second year (2016). For each treatment, 4 trees were used for destructive measurements (root and shoot analysis) each year. The total Osmocote fertilizer was applied once at planting, while the other three sources were applied through fertigation over a 20 week period every year. In order to balance the nutrients content (Ca, P, K) between treatments, calcium sulfate, rock phosphate and potash were applied once at the time of planting and the beginning of the second year.

The field location at the Uvalde Center was prepared to establish the plantings following a 12’ x 10’ (between rows x between plants) planting arrangement for two seasons (Figure A.2). Prior to planting, the field was deep-plowed, disked and roto-tilled. Thereafter a trellis system was installed following a typical commercial orchard design used for olives in southwest Texas. Then, seedlings were transplanted on May 20, 2015. During the experimental period, the following 7 treatments were evaluated: control (no N), nitrate source applied as calcium nitrate at 20, 40 and 60 kg/ha, and ammonium applied as urea at 20, 40 and 60 kg/ha. The field experiment was laid out as a complete randomized block design with 8 replications containing 2 plants per replication (16 total per treatment). During the first season, 40% of all fertilizers were applied in a dry form at planting, while the remaining 60% of fertilizers were added 30 days after planting. The same fertilizer application scheme was repeated during the second season; starting on February, 2015. Calcium sulfate was added to urea treatments to adjust the calcium concentration every year.

Nutritional health of eight of ten COVT test plots was assessed by leaf analysis in August, 2016 (Table B.1). Plots generally exhibited good nutrition when compared to the benchmarks for each element, indicating that the test plots have been grown with good culture. Other than one plot (Sutherland Springs) showing sub-optimal levels for calcium, the only other element observed to be deficient was iron at Granger, Stonewall and Del Rio. These identified deficiencies are not deemed to be of any serious consequence and appropriate fertilization will be made in the Spring of 2017 at all test plots.

The 19 varieties of olives in the COVT have diverse provenances (Spain, Italy, France, Greece, Tunisia, California). Growth and tree development were assessed with visual ratings and trunk caliper measurements. Summarizing these two indices as a “vigor index”, revealed the following ranking of varietal growth differences (Table B.2). It remains to be seen in upcoming growing seasons (2017-2018) how vigor correlates to yield. Grower experience with vigorous varieties like ‘Frantoio’ has been that they produce very little in Texas, so this will be important to monitor in upcoming years. A small number of olives were produced in 2016 from 'Koroneiki' trees in the COVT plot at Stonewall, Texas (Fig. B.1) The overall best tree growth among the 10 COVT plots was at Del Rio, Texas (Fig. B.2). 'Oliana' is a new variety distributed by AgroMillora Nursery in California. It is a very slow growing and developing variety.

Nutrient research on container grown olive trees in Lubbock has been completed (research was collaborated and replicated with Uvalde researches). Several collaboration meetings were held in Uvalde during 2015 and 2016. During these meetings researchers discussed experimental plans (container sizes, fertilizers treatments, growing media, experimental design, irrigation management and design, etc.). Irrigation supplies were purchased and received at each site. Containers, potting mix, and trees (Olea europaea 'Arbequina') were purchased, received, and Phase I of the Lubbock greenhouse experiment was initiated in April, 2016 (Fig. B.3). Five fertilization treatments (Fig. B.4) were initiated through a fertigation system: water soluble ammonium nitrate (21-0-0) applied at 20 kg/ha, water soluble calcium nitrate (15.5-0-0) applied at 20 kg/ha, granular urea (45-0-0) applied at 20 kg/ha, granular urea (45-0-0) applied at 40 kg/ha, and Scotts Customblen (35-0-0) slow release fertilizer applied at 20 kg/ha. Gas exchange measurements (photosynthetic rate, stomatal conductance, and transpiration rate) (Fig. B.5), container leachate electroconductivity (salinity) (Fig. B.6) were collected on a regular basis until mid-August, 2016. At that time, half the plants (45) were destructively measured for root and stem weight, and leaf area.

Data was exposed to analysis of variance appropriate for a randomized block design (three blocks with three trees of each fertilization treatment randomized in each block (15 plants in each block)). If differences were found, means were separated by Fisher's least significance difference procedure (LSD, $P \leq 0.05$). Phase II of the research project was a repeat of Phase I using remaining research plants (45 total plants). Phase II concluded mid-December 2016. Thus, the experiment was replicated twice within an eight month period. Because Phase I and Phase II data followed similar trends, all data were pooled, and statistically analyzed together.

Gas exchange data indicate photosynthetic rate, transpiration rate, and stomatal conductance did not differ between fertilization treatments (Fig. B.7). Mean photosynthetic rate for all treatments was approximately 23 umol m-2 s-1. Transpiration rate means were near 13 mmol m-2 s-1, and mean stomatal conductance for all fertilizer treatments was roughly 450 mmol m-2 s-1. These data indicate plants were not stressed, and that gas exchange was occurring at a high rate. Electroconductivity data (Fig. B.8) signify greater leachate salinity was found in water soluble ammonium sulfate, granular urea applied at 20 kg / ha, and Scotts slow release Cutomblen. Stem height increase for containerized 'Arbequina' plants was greatest for plants fertilized with water soluble ammonium sulfate, granular urea applied at 40 kg / ha, and Scotts slow release Cutomblen (Fig. B.8). In addition, stem diameter increase was greatest on plants fertilized with water soluble ammonium sulfate (Fig. B.8). Stem diameter increase was approximately 18% greater for plants grown with water soluble ammonium sulfate when compared to plants grown with other fertilizer treatments. Stem and root weights followed similar trends (Fig. 7). Greatest stem weight and greatest root weights were found on plants fertilized with water soluble ammonium sulfate, and Scotts Customblen. Total tree leaf area data indicate trees with the greatest leaf area were grown on plants fertilized with water soluble ammonium nitrate. Leaf area for water soluble ammonium nitrate plants was 25 to 35% greater when compared to other fertilizer treatments (Fig. B.9).

Observations from commercial olive growers in Texas indicate that within the first two growing seasons establishing trees struggle to develop strong root systems, and trunk diameters. This delay in establishment often leads to postponed maturation and fruiting. Although selection of olive cultivars more adapted to the region (climate) and soils will exert a major effect on early tree growth and establishment, water and fertilization management also play a critical role. Fertilization requirements in crop-bearing (mature) olive orchards is considered low compared to other fruit crops, a well-managed, enhanced nitrogen (N) fertilization regime could be used as a tool to accelerate vegetative and root growth, and thus improve tree nutrient status as trees become established in the field. In an experiment comparing growth of newly planted, containerized 'Arbequina' olive trees exposed to five fertilizer treatments, this experiment indicates greater stem, root, and leaf growth of young trees was attained using water soluble ammonium sulfate (20 – 0 – 0) applied at a rate of 20 kg / ha over two, four month growing periods.

At present, information regarding establishment practices for newly planted orchards are largely anecdotal, or acquired from other countries or states. Producers are in need of replicated, scientific data to support economic decisions for improved outcomes and upgrades in orchard management practices. As growers in Texas establish new olive orchards, information from this experiment could prove valuable to accelerate olive tree growth and development. Rapid post-transplant establishment, and vigorous, well-balanced canopy and root growth are essential to future yield performance of olive orchards in Texas. Along with the selection of the most suitable cultivars, proper management of irrigation and fertilization programs will have a major impact on the successful expansion of this industry in the state.

During the study period (2015-2016), plant morphology (plant height, diameter, branch number, leaf area and fresh weight) and physiology (photosynthesis, stomatal conductance and transpiration) from the 20 kg/ha rate was similar to those plants from 40 kg/ha –N (Table B.3). In 2015, AN fertilizer had higher leaf area and fresh weight than other fertilizers. Additionally, AN and CN had higher plant height, stem diameter, branches, and leaf area than OSC and urea (Table B.3). Plants fertilized using the high N dose (40 kg/ha –N) had higher shoot (Table B.4) and root N% (Table B.5) when compared to the low dose N (20 kg/ha –N) across the study period (2015-2016). While AN source had the highest N% in shoot and root across the study period, OSC (slow release fertilizer) had the lowest N% over the growing seasons when compared to other N sources (Tables B.4 and B.5).

Root analysis of olive transplants reveled significant differences between fertilizer sources (Table B.6). In 2015 (November 15), AN and urea fertilizer sources had higher root length, surface area, volume and fork number than CN and OSC sources. But AN and urea had lower root diameter than other fertilizers. However, root dry weight, length, surface area and fork number were lower for urea as compared to AN and CN sources after two years of planting. Interestingly, OSC and AN root variables were similar in 2016. Except for root dry weight and root diameter in 2015, both high (40 kg/ha –N) and low (20 kg/ha –N) fertilizer levels had similar root variable responses.

Overall, **AN source was the best fertilizer source for olive transplants in terms of root quality**. This is because the AN source showed consistent results across the growing seasons (2015 and 2016).

During the first growing season, olive transplants that did not received N fertilizer (control) had higher plant height, stem diameter and branch number than olive trees that received 40 or 60 kg/ha-N (Table B.7). This is because the soil had adequate N levels at the beginning of the experiment (Table B.8); soil NO3 at the time of planting was 25 ppm. However, in the second year soil NO3 was low (< 3 ppm) in the control and low (20 kg/ha) N treatment, which exhibited higher plant height, stem diameter and branches number than 40 or 60 kg/ha-N treatments (Table B.7). Across the study period, both N-sources (urea and calcium nitrate) had similar plant morphology and physiology (Table B.7). Additionally, no significant difference in plant physiology (Table A6) and soil mineral analysis (Table B.8) between treatments were noticed, except for NO3. Shoot mineral analysis revealed that control treatment (0 kg/ha-N) had higher P and Cu and less Na, Mg, Ca and Fe concentration than 60 kg/ha-N in 2015 (Table B.9). But, shoot K concentration were similar in both years.

> **Overall, little to no N is required to establish young olive trees in the field. N application may not be needed if pre-plant soil N levels are normal. High rates of N in the soil during establishment of young trees may negatively affect growth.**

Goals and Outcomes Achieved

The stated goal of the Texas A&M AgriLife Extension subcontract of the above-titled project was to 1) "establish olive variety trials at ten cooperative test sites in Texas, with each test plot containing ten varieties randomized and replicated for statistical analysis of data; and 2) "install automated weather stations at each plot". The stated target for this goal was "95% tree survival at each test plot location". To date we have achieved 100% tree survival at seven of 10 test plot sites, and 100% tree survival is expected at three remaining sites (Industry, LaGrange, Devers) by 12/31/2016. We have exceeded our measurable outcome by establishing 12 varieties in the main planting at each test plot, rather than ten as proposed. Seven additional varieties beyond these were planted at each test plot as guard trees or pollinators. While these seven varieties were not randomized and replicated, they do offer observational data that may be useful to olive growers in the future. Thus the evaluation of olive varieties encompassed by the COVT is more robust than planned.

The Plan of Work states that Texas A&M AgriLife Extension investigators (Nesbitt, Stein, Kamas) will engage in outreach efforts on behalf of this project by reporting results at the Texas Fruit Conference in October, 2015. While we did not report on this project at that event due to lack of space on the program, we did provide a thorough presentation of the project's mission and status at a Texas Olive Oil Council-Texas A&M AgriLife Extension olive meeting, held in San Antonio, Texas, on November 30th, 2015. This project was also discussed with olive growers at the TDA Olive Grower's bus tour and educational program, held on August 8th and 9th, 2016.

Beneficiaries

The olive industry in Texas is estimated from field-level surveys, commodity organization membership records, and attendance at public meetings to encompass approximately 4,500 acres in the southern half of the state of Texas, from Beaumont to Del Rio, and from Georgetown to Weslaco, as of January 1, 2018. The number of farm owners attempting to produce olives on a commercial scale is approximately 150. There is currently one commodity organization serving this industry (Texas Association of Olive Oil, www.txaoo.org), with approximately 65 active members. TXAOO is represented nationally by the American Olive Oil Producers Association.

Using California olive oil production data, the current acreage of olives in Texas represents a potential production of 36 Million pounds of olives or 360 thousand gallons of extra virgin olive oil, which could conservatively generate $9 Million in revenue for olive oil growers and the Texas economy. This industry generated essentially no revenue from Texas-grown olives in 2017, due to weather factors, specifically severe winter freeze and lack of chilling. The COVT funded in this grant has the potential to identify better-adapted varieties of olives for Texas. In 2017, the French variety 'Aglandau', which has not been planted much in Texas, demonstrated good freeze tolerance in the COVT plots and a potential improvement over varieties like Arbosana and Koroneiki, which have been planted heavily, and represent approximately 30% of the acreage. Replacement of Arbosana and Koroneiki with a more cold tolerant variety like Aglandau, has a potential economic impact of $2.7 Million dollars in revenue per year for the Texas olive industry.

The olive fertility research refined working knowledge of the role of nitrogen in tree growth, optimal forms of nitrogen to apply, and the importance of field monitoring to improve the efficiency of fertilization rates. Field studies at Uvalde revealed that nitrogen fertilizer could be withheld on young trees if soil levels were adequate. This represents a potential savings of approximately $200,000 per year in nitrogen fertilizer cost for the Texas olive industry (excluding labor/fuel costs).

The COVT is a long-term project that will assess trees annually in an effort to collect and catalog olive varietal differences in cold hardiness, vigor, yield and fruit quality. The project investigators are committed to serving the Texas olive industry with this study beyond its present funding timeline by engaging county extension agents and grower cooperators as partners in the data collection effort that will be needed. We plan to make annual reports of findings at annual educational programs conducted by Texas A&M AgriLife Extension or the Texas Association of Olive Oil.

Only preliminary data has been presented to growers, and publication of research in peer-reviewed journals has not yet begun. We will present data to growers and other researchers at upcoming meetings, and work to publish the results in journals in the next two years.

Olive oil investors and producers in Texas are constantly searching for basic scientific data to support the olive industry, promote best management practices, and optimize sustainable production. This research provides quantifiable data for best management practices and economic decisions for current and future olive growers in Texas.

Lessons Learned
The work plan for this project was delayed as initial tree planting had to be shifted from January 2015 to April of 2015 due to shipping delays of nursery stock in California. Further delays on the project were incurred as a result of unusually wet weather and field conditions. The first effort of planting was completed in October, 2015. Some losses of trees (as described above) were accounted for in the spring of 2016, with replanting efforts made or planned to be made in October and November, 2016.

We obtained extra olive trees in April of 2015, and planted these into containers in a greenhouse facility to increase their size and hold them in reserve as replants. This strategy has allowed us to maintain the original planting scheme for each COVT test plot. Although slightly behind schedule in terms of overall tree growth and development for the project as a whole, the scientific integrity and potential of this project has not been compromised.

Additional Information
Since the application period for funding of this project in 2014, the Texas olive industry has grown in acreage, and growers continue to develop best management practices. Thus it is both an exciting and challenging time for this new specialty crop industry in Texas. Funding of this project has been instrumental to the development of new partnerships among olive growers as well as partnerships with growers and the land grant system. The researchers engaged in this project are grateful for the funding and believe the work performed during the study period will continue to add to the body of knowledge of olive growing in Texas going forward.

Table A.1. COVT locations and tree inventory status as of December, 2016.

Site/Cooperator	City, County	Total trees in plot design	Number of trees planted in 2015	Number of trees weak, missing and replanted in 2016
Central Texas Olive Ranch,	Granger, Williamson	94	94	6
Hendrichson-Texana Ranch,	Cotulla, LaSalle	100	100	2
Welch Farms	Placedo, Victoria	94	94	11
Val Verde Winery	Del Rio, Val Verde	74	74	0
Bugg Orchard	Sutherland Springs, Wilson	112	112	7
Southeast Texas Olive Co.	Devers, Liberty	96	96	2
Stonewall Olives	Stonewall, Gillespie	112	112	9
Texas A&M Research & Extension Center- Weslaco	Weslaco, Hidalgo	112	112	30
M.B. Glasscock Orchard	LaGrange, Fayette	88	88	14
Price Orchard	Industry, Austin	104	104	30

Figure A.1. Screen house pot experiment, May 2015.

Figure A.2. Field experiment, May 2015.

Table B.1. Leaf nutritional comparison of eight test plots in the COVT

.	N	P	K	Ca	Mg	Na	Zn	Fe	Cu	Mn	S	B
Test Plot Location	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Sutherland Springs	1.42	1235	11452	5485	1260	634	22	69	10	24	1609	32
LaGrange	1.87	1264	12709	9093	863	480	26	47	7	43	1619	35
Cotulla	1.80	1442	12203	10464	1031	433	21	89	7	38	1894	36
Granger	1.88	1686	9302	9085	1087	278	22	36	5	30	1488	28
Devers	2.15	1328	8696	7025	1099	452	24	50	13	29	1900	20
Placedo	2.21	1681	7612	9956	1368	1999	19	92	9	27	1858	29
Stonewall	2.06	1379	9080	8229	1064	114	14	33	5	27	1458	19
Del Rio	2.19	1658	8744	12294	1500	258	13	39	6	55	1826	29
Benchmark	1.40	1000	7000	6000	800.00	<2000	10	40	2	20	1000	19

Figure B.1. Koroneiki variety, COVT plot, Stonewall, Texas, showing small number of olives borne in 2016.

Fig B.2. Tree vigor and development at Val Verde Vineyards, Del Rio, Texas.

Table B.2. Overall growth index scores; 1-5; 5=best; COVT plots 2015-2016

Frantoio	Italy	5
Leccino	Italy	5
Empeltre	Spain	5
Koroneiki	Greece	5
Arbosana	Spain	4
Pendolino	Italy	4
Coratina	Spain	4
Chemlali	Tunisia	4
Arbequina	Spain	4
Tosca	Italy	3.5
Picqual	Spain	3.5
Mission	U.S.	3.5
Hojiblanca	Spain	3.0
Sikitita	Spain	3.0
9806-10	Spanish x Italian	2.5
Aglandau	France	2.5
Picholine	France	2.5
Manzanilla	Spain	2.5
Oliana	Spain	1.5

Figure B.3. Containerized ‘Arbequina’ olive trees (*Olea europaea*) in greenhouse at Texas Tech University.

Figure B.4. Irrigation and fertilizer injection system for containerized ‘Arbequina’ olive trees (*Olea europaea*) in greenhouse at Texas Tech University.

Figure B.5. Measuring gas exchange on containerized ‘Arbequina’ olive trees (*Olea europaea*) in greenhouse at Texas Tech University.

Figure B.6. Measuring electroconductivity of container leachate from ‘Arbequina’ olive trees (*Olea europaea*) in greenhouse at Texas Tech University.

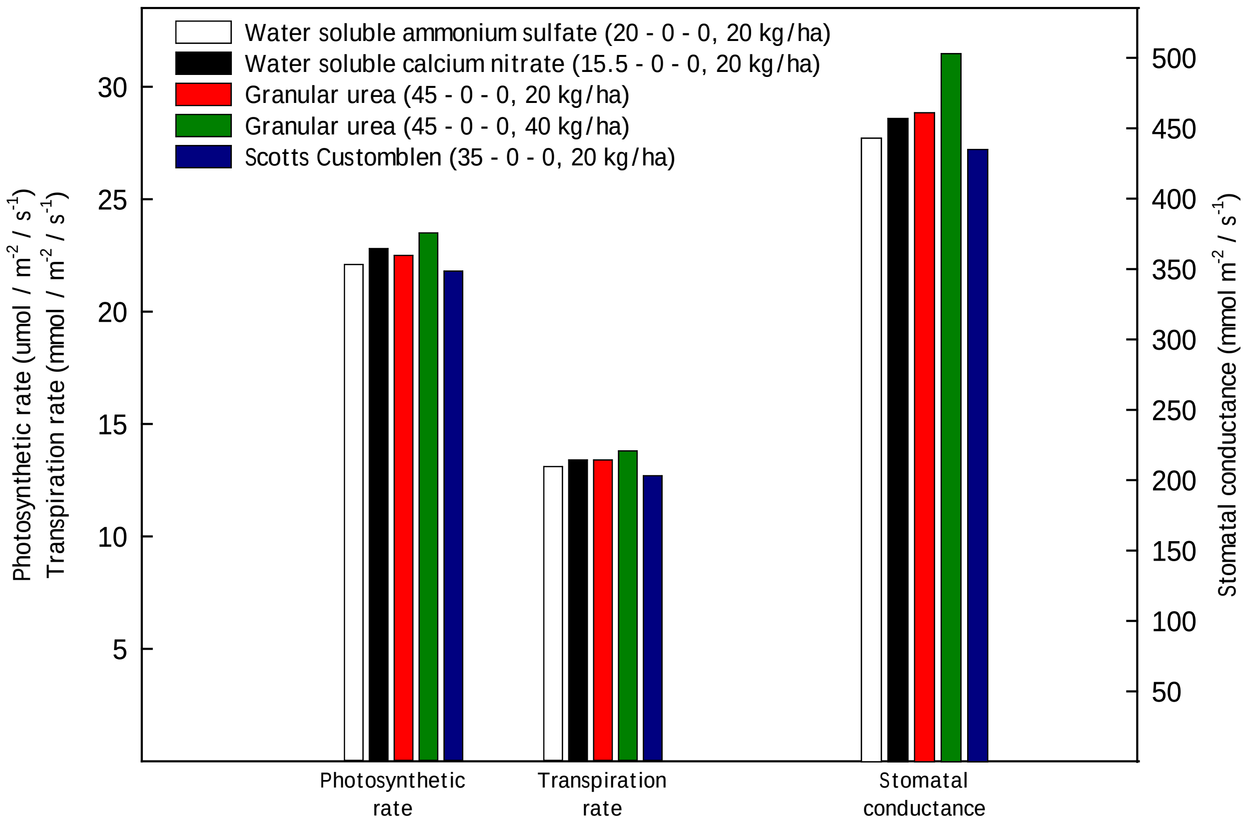

Figure B.7. Gas exchange for greenhouse grown, containerized 'Arbequina' olive trees (*Olea europaea*) exposed to five fertilizer regimes over two, five month growing periods (data are means for both growing periods): water soluble ammonium nitrate (21-0-0) applied at 20 kg/ha, water soluble calcium nitrate (15.5-0-0) applied at 20 kg/ha, granular urea (45-0-0) applied at 20 kg/ha, granular urea (45-0-0) applied at 40 kg/ha, and slow release (35-0-0) applied at 20 kg/ha. Different letters indicate effect of fertilization regime on leaf photosynthetic rate, transpiration rate, and stomatal conductance (Fisher's least significance difference procedure, $P \leq 0.05$).

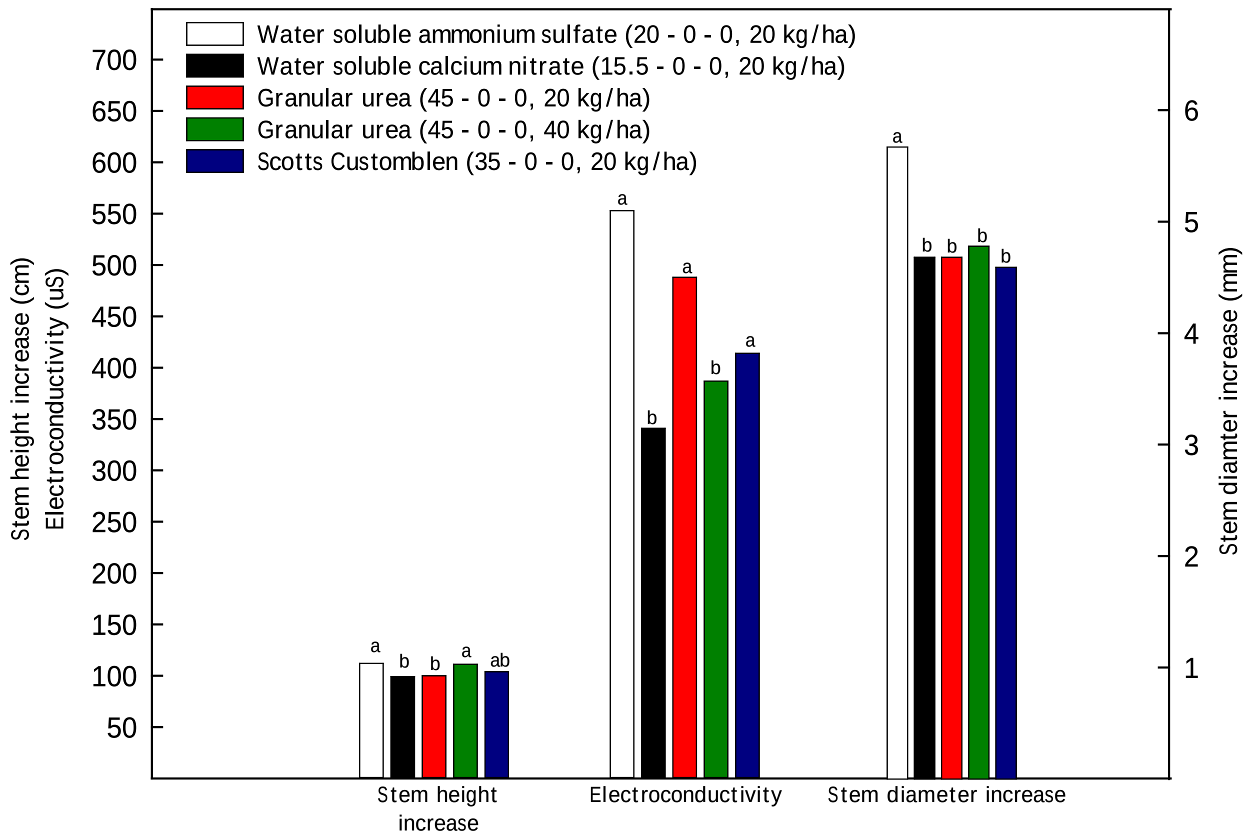

Figure B.8. Stem height increase, electroconductivity, and stem diameter increase for greenhouse grown, containerized 'Arbequina' olive trees (*Olea europaea*) exposed to five fertilizer regimes over two, five month growing periods (data are means for both growing periods): water soluble ammonium nitrate (21-0-0) applied at 20 kg/ha, water soluble calcium nitrate (15.5-0-0) applied at 20 kg/ha, granular urea (45-0-0) applied at 20 kg/ha, granular urea (45-0-0) applied at 40 kg/ha, and slow release (35-0-0) applied at 20 kg/ha. Different letters indicate effect of fertilization regime on stem height increase, electroconductivity, and stem diameter increase (Fisher's least significance difference procedure, $P \leq 0.05$).

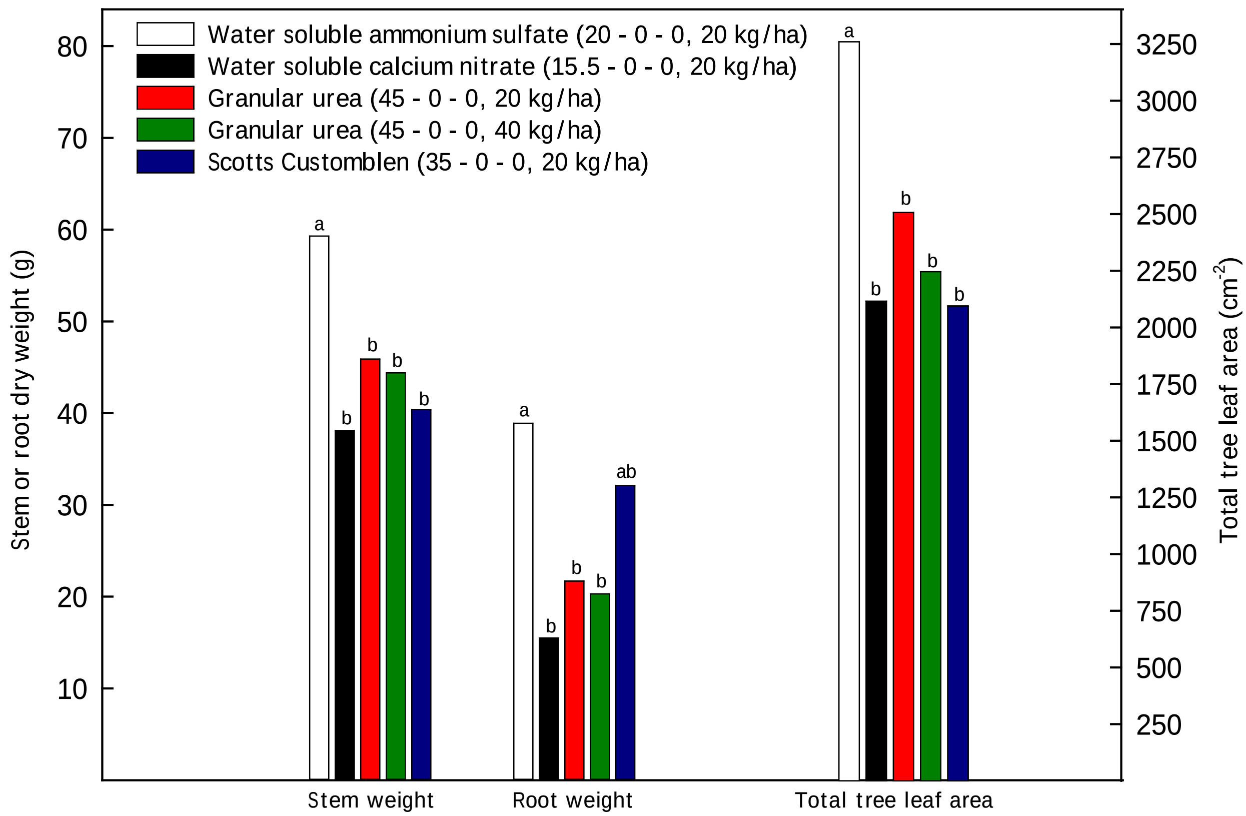

Figure B.9. Stem weight, root weight, and total tree leaf area for greenhouse grown, containerized 'Arbequina' olive trees (*Olea europaea*) exposed to five fertilizer regimes over two, five month growing periods (data are means for both growing periods): water soluble ammonium nitrate (21-0-0) applied at 20 kg/ha, water soluble calcium nitrate (15.5-0-0) applied at 20 kg/ha, granular urea (45-0-0) applied at 20 kg/ha, granular urea (45-0-0) applied at 40 kg/ha, and slow release (35-0-0) applied at 20 kg/ha. Different letters indicate effect of fertilization regime on stem weight, root weight, and total tree leaf area (Fisher's least significance difference procedure, $P \leq 0.05$).

Table B.3. Plant morphology (plant height, stem diameter, branches number, leaf area and fresh weight) and physiology (photosynthesis *Pn*, stomatal conductance gs, and transpiration E) of olive transplants grown under different N-source and levels for two growing seasons; 2015 and 2016; Texas A&M AgriLife Research & Extension Center, Uvalde, Texas.

YEAR		Plant height (cm)	stem diameter (mm)	Branch (no/plant)	leaf area (cm2)	leaf Fwt (g/plant)	*Pn*	gs	*E*
	SOURCE								
2015	Control	93	8.4 b	42.5	737 c	31.0 c	6.03 c	0.08	2.47
	AN	118	11.2 a	59.4	2526 a	102.8 a	8.69 ab	0.08	2.74
	CN	118	11.2 a	53.6	2109 b	89.3 b	9.16 ab	0.08	2.79
	OSC	113	10.8 a	59.1	2066 b	84.3 b	9.46 a	0.09	3.07
	UREA	117	11.0 a	53.8	2109 b	86.3 b	8.31 b	0.09	2.98
	LEVEL								
	Control (0.0)	93 b	8.4 b	42.5 b	737 b	31.0 b	6.03 b	0.08	2.47
	40 kg/ha	112 a	10.7 a	59.4 a	2226 a	91.3 a	9.14 a	0.09	3.07
	20 kg/ha	121 a	11.4 a	53.5 a	2178 a	90.1 a	8.67 a	0.08	2.72
P-value	Source (S)	0.700	0.05	0.14	0.001	0.002	0.05	0.52	0.59
	Level (L)	0.004	<0.0001	0.001	<0.0001	<0.0001	<0.0001	0.19	0.09
	S×L	0.380	0.21	0.17	0.19	0.54	0.15	0.85	0.57
2016	SOURCE								
	Control	89 c	8.4 c	54.5	916 c	45.7 c	9.52	0.09	2.25
	AN	127 ab	13.4 a	98.1	4034 ab	195.9 ab	12.80	0.11	2.57
	CN	131 a	13.3 a	105.1	4205 a	210.0 a	12.35	0.10	2.39
	OSC	119 b	12.3 b	97.1	3666 b	175.0 b	13.16	0.11	2.66
	UREA	121 b	12.4 b	102.1	3652 b	178.4 b	12.50	0.11	2.54
	LEVEL								
	Control (0.0)	89 b	8.4 b	54.5 b	916 b	45.7 b	9.52 b	0.09	2.25
	40 kg/ha	124 a	13.1 a	98.5 a	3910 a	190.2 a	12.33 a	0.10	2.33
	20 kg/ha	125 a	12.6 a	102.8 a	3868 a	189.4 a	13.07 a	0.11	2.75
P-value	Source (S)	0.03	0.01	0.15	0.05	0.04	0.64	0.58	0.71
	Level (L)	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.001	0.10	0.06
	S×L	0.32	0.37	0.05	0.08	0.09	0.06	0.31	0.18

Table B.4. Leaf N% of olive transplants grown under different N-source and levels for two growing seasons; 2015 and 2016; Texas A&M AgriLife Extension Center, Uvalde, Texas.

		Sept. 2015	Oct. 2015	Nov. 2015	Feb. 2016	July 2016
SOURCE	Control	0.86 c	1.36 c	1.31 d	1.05 c	0.71 d
	AN	1.98 a	2.61 a	2.72 a	2.25 a	1.70 a
	CN	1.84 ab	2.35 b	2.50 b	2.13 a	1.51 ab
	OSC	1.69 b	2.22 b	2.03 c	1.56 b	1.16 c
	UREA	1.86 a	2.62 a	2.68 ab	2.12 a	1.47 b
LEVEL	Control (0.0)	0.86 c	1.36 c	1.31 c	1.05 b	0.71 c
	40 kg/ha	1.94 a	2.55 a	2.58 a	2.09 a	1.59 a
	20 kg/ha	1.74 b	2.36 b	2.39 b	1.94 a	1.34 b
P-value	Source (S)	0.003	<0.0001	<0.0001	<0.0001	0.002
	Level (L)	0.001	<0.0001	<0.0001	<0.0001	0.0001
	S×L	0.02	0.08	0.65	0.14	0.06

Table B.5. Root N% and NO3 of olive transplants grown under different N-source and levels for two growing seasons; 2015 and 2016; Texas A&M AgriLife Research & Extension Center, Uvalde, Texas.

YEAR			N %	NO3-N %
2015	SOURCE	Control	0.79 c	0.008 b
		AN	1.49 a	0.047 a
		CN	1.31 b	0.031 ab
		OSC	1.20 b	0.034 ab
		UREA	1.31 b	0.038 ab
	LEVEL	Control (0.0)	0.79 c	0.008 b
		40 kg/ha	1.42 a	0.045 a
		20 kg/ha	1.23 b	0.030 a
	P-value	Source (S)	0.03	0.05
		Level (L)	<0.0001	0.04
		S×L	0.08	0.31

2016	SOURCE	Control	0.74 c	0.003 c
		AN	1.31 a	0.023 b
		CN	1.21 a	0.041 a
		OSC	1.00 b	0.010 bc
		UREA	1.23 a	0.019 b
	LEVEL	Control (0.0)	0.74 c	0.003 b
		40 kg/ha	1.30 a	0.029 a
		20 kg/ha	1.08 b	0.018 a
	P-value	Source (S)	<0.0001	0.001
		Level (L)	<0.0001	0.02
		S×L	0.22	0.59

Table B.6. Root dry weight, length, surface area, diameter, volume and forks number of olive transplants grown under different N-source and levels for two growing seasons; 2015 and 2016; Texas A&M AgriLife Research & Extension Center, Uvalde, Texas.

YEAR		Root dry wt (g/plant)	Root length (cm/plant)	Root surface area (cm^2/plant)	Root Diameter (mm)	Root Volume (cm3)	Forks No/plant
	SOURCE						
2015	Control	8.6 a	8652 b	1689 c	0.66 ab	27.7 c	20854 d
	AN	12.7 b	13238 a	2494 a	0.63 c	38.7 a	39358 a
	CN	12.4 b	9426 b	1938 bc	0.67 a	32.6 bc	29190 bc
	OSC	12.0 b	9353 b	1842 c	0.65 abc	29.9 bc	23088 dc
	UREA	13.9 b	11691 a	2215 ab	0.63 bc	34.5 ab	35366 ab
	LEVEL						
	Control (0.0)	8.6 c	8652 b	1689 b	0.66 a	27.7 b	20854 b
	40 kg/ha	11.3 b	11728 a	2177 a	0.62 b	33.1 a	34287 a
	20 kg/ha	14.2 a	10126 ab	2067 a	0.67 a	34.7 a	29214 a
P-value	Source (S)	0.04	0.0001	0.01	0.007	0.02	0.004
	Level (L)	<0.0001	0.004	0.03	<0.0001	0.07	0.005
	S×L	0.34	0.006	0.02	0.21	0.06	0.11
2016	SOURCE						
	Control	18.6 c	13892 c	2583 c	0.69	55.7 b	23784 c
	AN	42.5 a	21049 a	3728 a	0.67	75.6 a	38099 a
	CN	40.6 a	20468 a	3635 a	0.71	75.4 a	36935 a
	OSC	37.9 ab	19677 ab	3508 ab	0.70	69.9 a	35354 ab
	UREA	33.9 b	18482 b	3317 b	0.66	69.4 a	32964 b
	LEVEL						
	Control (0.0)	18.6 b	13892 b	2583 b	0.69	55.7 b	23784 b
	40 kg/ha	40.0 a	20310 a	3610 a	0.66	73.3 a	36621 a
	20 kg/ha	37.4 a	19528 a	3484 a	0.71	71.8 a	35056 a
P-value	Source (S)	0.04	0.03	0.04	0.39	0.05	0.04
	Level (L)	<0.0001	<0.0001	<0.0001	0.16	<0.0001	0.001
	S×L	0.001	0.001	0.001	0.88	0.002	0.01

Table B.7. Plant morphology (plant height, stem diameter, branches number) and physiology (photosynthesis *Pn*, stomatal conductance gs, and transpiration *E*) of olive transplants grown in the field under different N-source and levels for two growing seasons; 2015 and 2016; Texas A&M AgriLife Research & Extension Center, Uvalde, Texas.

YEAR			Plant height (cm)	stem diameter (mm)	Branch (no/plant)	*Pn*	Gs	*E*
2015	LEVEL	Control	129 a	15.6 a	144 a	18.	0.1	3.5
		20 kg/ha	121 ab	15.2 a	124 b	19.	0.2	4.0
		40 kg/ha	120 b	13.5 b	108 bc	18.	0.1	3.6
		60 kg/ha	112 b	13.1 b	103 c	18.	0.1	3.7
	SOURCE	Control	129 a	15.6 a	144 a	18.	0.1	3.5
		CN	116 b	14.0 b	108 b	18.	0.1	3.8
		UREA	119 b	13.9 b	115 b	18.	0.1	3.6
	P-value	Source (S)	0.05	0.05	0.04	0.7	0.2	0.3
		Level (L)	0.01	0.005	0.0003	0.6	0.3	0.3
		S×L	0.77	0.28	0.03	0.7	0.8	0.7
2016	LEVEL	Control	199 a	42.2 ab	422 ab	22.	0.2	6.7
		20 kg/ha	196 ab	44.2 a	460 a	21.	0.2	6.6
		40 kg/ha	191 ab	40.1 b	374 bc	22.	0.2	6.7
		60 kg/ha	188 b	39.7 b	324 c	21.	0.3	6.8
	SOURCE	Control	199	42.2	422	22.	0.2	6.7
		CN	192	41.5	390	21.	0.3	6.7
		UREA	191	41.2	382	22.	0.2	6.7
	P-value	Source (S)	0.91	0.84	0.68	0.3	0.6	0.9
		Level (L)	0.07	0.02	0.0001	0.6	0.7	0.9
		S×L	0.1	0.24	0.06	0.6	0.8	0.9

Table B.8. Soil mineral analysis for olive transplants grown in the field before planting (Base analysis) and at the beginning of the second season; Texas A&M AgriLife Research & Extension Center, Uvalde, Texas.

YEAR			pH	EC	NO3 (ppm)	P (ppm)	K (ppm)	Ca (ppm)	Mg (ppm)	S (ppm)	Na (ppm)
2015		*Base analysis*	8.30	431	25.00	44.5	726	12861	280	15.8	16.7
2016	LEVEL	Control (0.0)	8.10	346	2.50 b	50.5	684	10827	253	13.8 b	51.5
		20 kg/ha	8.10	357	2.63 b	52.3	576	10593	277	18.4 ab	45.4
		40 kg/ha	8.15	371	3.50 ab	51.8	614	10754	243	19.6 a	42.5
		60 kg/ha	8.13	424	5.00 a	49.1	577	10482	243	17.5 ab	40.0
	SOURCE	Control	8.10	346	2.50	50.5	684	10827	253	13.8	51.5
		CN	8.15	364	3.92	51.0	602	10414	245	15.5	44.1
		UREA	8.10	404	3.50	51.1	576	10805	264	21.5	41.2
	P-value	Level (L)	0.83	0.25	0.008	0.18	0.33	0.87	0.31	0.29	0.4
		Source (S)	0.38	0.41	0.67	0.62	0.59	0.48	0.49	0.02	0.73
		S×L	0.71	0.75	0.48	0.27	0.87	0.82	0.27	0.35	0.24

Table B.9. Leaf mineral analysis of olive transplants grown in the field under different N-source and levels for two growing seasons; 2015 and 2016; Texas A&M AgriLife Research & Extension Center, Uvalde, Texas.

YEAR			N (%)	P (ppm)	K (ppm)	Ca (ppm)	Mg (ppm)	Na (ppm)	Zn (ppm)	Fe (ppm)	Cu (ppm)	Mn (ppm)	S (ppm)	B (ppm)
2015	LEVEL	Control	2.19	2558	13770 a	8894 b	1164 b	130 b	19.3	35.1 b	6.5 ab	83.5	1829	30.1
		20 kg/ha	2.30	2312	14016 a	9260 ab	1180 b	114 b	19.2	35.5	6.6 a	82.3	1941	28.9
		40 kg/ha	2.21	2223	12238	10237 a	1798 a	283 a	18.1	42.6 a	5.7 c	82.9	1902	27.1
		60 kg/ha	2.25	2274	13074	9774 ab	1640 a	291 a	17.6	42.5	5.9 bc	77.4	2031	27.6
	SOURC	Control	2.19	2558	13770	8894 b	1164 b	130 b	19.3	35.1 b	6.6	83.5	1829	30.1
		CN	2.29	2186	13420	9293 ab	1410	190 b	18.1	37.5	6.1	77.8	1975	27.7
		UREA	2.22	2354	12799	10221 a	1668 a	269 a	18.5	42.8 a	6.1	83.9	1941	28.0
	P-value	Source (S)	0.14	0.04	0.08	0.04	0.09	0.004	0.63	0.05	0.84	0.13	0.58	0.69
		Level (L)	0.35	0.06	0.002	0.15	0.007	0.0001	0.46	0.05	0.01	0.61	0.17	0.09
		S×L	0.15	0.03	0.24	0.81	0.17	0.29	0.36	0.65	0.06	0.57	0.94	0.1
2016	LEVEL	Control	2.57	1960	10350 a	9384	598 b	99	32.6	56.0	7.7	81.3	1787	17.9
		20 kg/ha	2.77	1983	10153	9796	648 ab	103	33.5	56.1	7.8	84.8	1830	18.3
		40 kg/ha	2.78	1954	9480 b	9622	643 ab	89	32.7	55.5	7.6	83.3	1791	17.7
		60 kg/ha	2.86	2059	10149	9946	688 a	105	35.0	54.2	7.6	86.4	1887	18.1
	SOURC	Control	2.57	1960	10350	9384	598 b	99	32.6	56.0	7.7	81.3	1787	17.9
		CN	2.80	1995	9994	9893	658 a	98	33.7	53.9	7.5	84.9	1840	18.1
		UREA	2.80	2002	9860	9683	661 a	100	33.7	56.7	7.8	84.8	1831	18.0
	P-value	Source (S)	0.05	0.92	0.05	0.44	0.89	0.83	0.98	0.06	0.15	0.95	0.86	0.67
		Level (L)	0.000	0.61	0.09	0.51	0.05	0.23	0.56	0.71	0.71	0.54	0.35	0.55
		S×L	0.21	0.43	0.29	0.06	0.53	0.62	0.70	0.41	0.1	0.06	0.18	0.78

PROJECT 15: DEVELOPING EFFICIENT SCIENCE BASED IRRIGATION PROGRAMS FOR THE TEXAS CITRUS INDUSTRY

Partner Organization: Texas International Produce Association
Project Manager: Bret Erickson,
Contact Information: bret.erickson@texipa.org 956-581-8632
Type of Report: Final
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Project Summary

The Texas International Produce Association (TIPA) is an international and domestic agricultural association that prides itself on staying connected to the industries it serves and has a very clear view of the challenges that their members face. In 2014, Texas was in the strong grip of a historic drought across the entire state. Just three years prior according to the Texas Farm Bureau, the drought had cost the state $7.6 billion dollars. The impacts of persistent drought on the Rio Grande Valley (RGV) agricultural industry was becoming abundantly clear with most irrigation districts receiving very limited irrigation allocations. The Rio Grande Valley citrus industry, that annually contributes $65 million to Texas' economy each year, has historically coped with drought without catastrophic loss, but with the current population of 6 million RGV residents and projected growth estimating an increase to approximately 12 million by 2030, the industry began to view the drought of 2011-2014 differently. The industry realized that in the future it would have to compete against a fast growing populace for its much needed irrigation water. With Paramount's (now Wonderful Citrus) arrival in the RGV and accrual of 50 percent of the citrus acres in the RGV, they voiced interest in partnering with TIPA and Texas AgriLife Research to explore ways to increase their irrigation efficiency and substantiate those methods to share with the rest of the citrus industry.

Project Approach

TIPA, Wonderful Citrus, and Texas AgriLife Research agreed that a comprehensive project was needed to investigate different methods of potential irrigation efficiencies. The areas that were investigated were: 1) Analyzing and quantifying different irrigation delivery method effects on soil moisture;

2) Developing a crop coefficient for citrus and making it easily accessible to growers; and
3) Analyzing the viability of measuring plant moisture stress as a means to trigger irrigation.

Different delivery methods

Wonderful Citrus provided Texas AgriLife Research access to mature citrus groves that were irrigated by drip, micro sprinkler, and flood methods. AgriLife technicians purchased and installed soil moisture probes that would measure and catalogue soil moisture in each of the experimental groves. The goal was to collect data on how the different methods impacted soil moisture and then derive scientific evidence of the unique efficiencies supposed by each method.

Crop Coefficient

Texas AgriLife scientists developed a Texas specific evapotranspiration crop coefficient for citrus. A crop coefficient is a mathematical equation that figures the amount of water transferred from a specific crop to the atmosphere. The use of crop coefficients allow scientists and growers a simple mathematical means to calculate water demand estimates of a crop during different seasons. Crop coefficients are not a silver bullet but a simple estimation to help guide grower's expectations of when and how much to irrigate with. Texas A&M AgriLife scientists also developed a water balance chart for different canopy covers of citrus (70%, 50%, and 20%). The different percentages of canopy covers account for different ages of trees. Younger trees would have less canopy i.e. 20 % or 50 % and older trees would have the most canopy cover i.e. 70%. The water balance chart further simplifies irrigation estimate needs. The chart has been made accessible online and can easily guide a grower through determining the estimated amount of water needed to irrigate their citrus crop. The website url is http://southtexasweather.tamu.edu/.

Plant tissue moisture stress

The plant moisture stress (PMS) rating is derived by measuring the pressure potential in plant tissue and reportedly has been used in West Coast tree crops like almonds and pistachios. No previous work has been done investigating whether it has a viable fit in the Texas citrus industry. Texas AgriLife scientists purchased the pressure chamber (the tool required to measure pressure potential in leaf tissue) and collected weekly readings of young and old leaves from March 2015 to December 2015. The scientists investigated if irrigation methods (i.e. drip, micro sprinkler, or flood) had any influence on water potential. Ultimately, there were no correlations between increased water potential from one irrigation method vs another.

Goals and Outcomes Achieved

The broad goal of the project was to gather empirical data assessing different irrigation methods to determine its efficiency or inefficiency. That goal was accomplished successfully with both Texas AgriLife and Wonderful Citrus satisfied with the data and implications of the projects findings. Originally, the project was hoping to find existing efficiencies already in use within the citrus industry that could be exploited quickly and easily. None were found to exist. Using soil moisture monitors proved to be the most effective method but the installation of drip or micro sprinkler systems require a high capital investment and yield studies will need to be conducted to develop realistic ROI's (return on investment) for growers to consider. Additionally, so little was known about the existing systems that the project's target of gaining 10-15% water use efficiency by the end of the project has been proven to be too lofty. In order to obtain that goal this project's data needs to be used to create irrigation guidelines and test whether those new guidelines can achieve a 10-15 % increase in water use efficiency without negatively impacting yield. An example scenario would investigate what influence maintaining a 2 ft moisture level at 20 cenitbars (cbs) would have on crop yield. Additionally, the projects performance measure was to compare total irrigation water used during the project to average amounts of irrigation applied by other South Texas citrus growers but the area received above average rain fall. Average rain fall for the RGV is 23 inches and most areas of the RGV recorded over 40 inches of rain fall for 2015. Ideally, the drought would have continued through the duration of the project.

Texas AgriLife Synopsis:

All of the evaluated methods present some advantages and disadvantages. The method we recommend the least to schedule irrigation is the use of the pressure chamber technology. One of the problems was that it did not detect differences between wetting and drying of the soil. There were also no differences between the irrigation methods using the pressure chamber. Another technology that was studied was the use and incorporation of soil water sensors. The only disadvantage to this technology is that some fields may have some soil variability and more than two stations may be needed per plot. However, this technology could be used to determine when to irrigate. In this study, drip irrigation was triggered when the sensors reached 30 cb and when micro sprinkler reached 50 cb. It may be necessary to conduct future studies and trigger irrigation at different soil water levels to evaluate the yield and quality response to different water amounts.

Beneficiaries

The primary beneficiaries of the project are Wonderful Citrus and the remainder of the RGV citrus industry. Wonderful Citrus farm managers that have been involved in the project have had access to the information generated by the project and have found it very valuable. Wonderful is in the process of planting 500 acres of new citrus groves a year for the next few years and then pushing and replanting their existing 10,000 acres of groves. They have already invested in micro sprinkler irrigation in all of the newly planted groves which is a major efficiency gain compared to the old standard of flood irrigation. Due to the information provided by this project they are evaluating drip irrigation as a possible option for their new groves. They are also preparing to incorporate more soil moisture sensors to assist in their irrigation techniques. Wonderful citrus also plans on sharing information from this project and educating their outside citrus growers on how to incorporate these methods into their citrus operations during their upcoming grower meetings this offseason. RGV citrus growers also benefited from this project by now having online access to the citrus crop coefficient and water balance table. Growers are able to easily calculate irrigation needs based on the current weather patterns and crop demands. Secondary beneficiaries include Texas A&M AgriLife Research, Texas International Produce Association, RGV residents, and Texas produce consumers. Through this project Texas A&M AgriLife Research scientists were given new opportunities to further their exposure and knowledge of irrigation efficiencies in citrus. They will continue honing their expertise and further refine their future irrigation experiments that will indefinitely benefit RGV growers. TIPA has benefited from this project by helping accommodate grower's needs through addressing water conservation and on farm efficiency. TIPA will champion the results from this project to their members and encourage their growers to incorporate these methods on their farms. Due to the sustainability of increasing irrigation efficiency it is very likely that by saving irrigation water citrus producers will be able to keep their groves in production and keep jobs in the RGV. Texas produce consumers will also benefit by the sustainability provided by on farm irrigation efficiency.

In this project we used 33.3 percent less water than regular commercial operations, 32 ac-inches of water compared to 48 ac-inches in commercial operations. Yields were not significantly different between both irrigation regimes. If the citrus industry adopts the micro sprinkler irrigation regime and schedule irrigation using citrus ET and the internet based program http://southtexasweather.tamu.edu/ the potential savings in water usage would be approximately 34,666 ac-ft annually, valued around $900,000 and helping to increase the availability of water for human and industrial usage as well as for other agricultural commodities.

Lessons Learned

Executing a grower meeting during harvest season proved to be very difficult especially when coordinating with the packing house that is involved in the project. Growers kept communicating that they were too busy for a grower meeting and Wonderful Citrus had their own conflicts. Wonderful Citrus still plans on presenting the project information to their outside growers during the summer months when everyone will have more time to commit to a joint meeting.

PROJECT 16: TEXAS SPECIALTY CROPS IN INTERNATIONAL MARKETS

Partner Organization: Texas Pecan Growers Association (TPGA)
Project Manager: Carlos J. Guerrero
Contact Information: Carlos.Guerrero@TexasAgriculture.gov
Type of Report: Final
Date Submitted: 12/5/2017

Summary
The Texas Department of Agriculture's Marketing and International Trade division promotes Texas agriculture, businesses and communities on a state, national and international level. TDA's International Marketing Program assists experienced and novice exporters alike and can help with export readiness training opportunities, links to a wide variety of federal, state and regional resources, and a staff of seasoned export marketing professionals.

TDA focused efforts on the pecan export industry and the emerging and increasing interest by oversea buyers in both in-shell and shelled pecans. U.S. pecan exports were valued close to $500 million in 2012, a 30 percent increase from the previous year.

The purpose of this marketing project was to increase awareness of Texas specialty crops and tree nuts, with an initial focus on pecans, among international buyers.

Project Approach
The Texas Department of Agriculture (TDA) focused on two International activities that helped increase awareness of Specialty Crop (Pecans) including a Chinese Pecan Roaster Reverse Trade Mission to Texas and an Outbound Trade Mission to China.

With the help of TDA, producers were able to develop a new marketing strategy and have helped provide information to Chinese buyers emphasizing the quality of Texas pecans. As a result of creative trade structures, Texas pecan producers were able to close some trade deals and export Texas pecans to China. TDA has developed a reporting method which is working very well and has contacted all the producers that participated in the trade missions as well as those that were not able to attend. Producers and exporters have responded with results.

The following activities were completed to accomplish the project:

- TDA Staff & International Marketing Team Coordinated Inbound and out bound trade missions to and from China.
- The Texas Pecan Growers Association (TPGA) supported with outreach to farmers, producers, and sheller's about the international activities. Additionally TPGA, helped with the promotion and recruitment of participants.
- The Foreign Agricultural Service (FAS) China supported with vetting delegates before traveling to Texas for trade missions, supported with outbound trade mission agenda.
- Chinese Delegations supported with following guidelines for the project, procurement of Pecans, demonstrating flexibility in negotiations with producers, and reporting purchases made.

- TDA led a Texas Pecan Growers Trade mission to Shanghai, China. TDA collaborated with the Texas Pecan Growers Association and the FAS Agricultural Trade Office ATO (Shanghai).
- The China FAS Executive Office, ATO Director gave a country team briefing to the Texas Pecan Delegation.
- Networking and discussions about trade were accomplished and Texas Pecan Growers Association hosted a dinner for both importers and the Texas pecan growers.
- Delegates traveled to Hangzhou, China and visited the West Lake area to meet with Chinese Pecan roasters.
- Trade Mission Delegates visited a Chinese Roasted Nuts Food Mall - a multibillion yen, multi-use complex providing services to the growing Lin'an nut industry. Topics of discussion included attempts to implement importing standards and collaboration with Texas producers.
- Delegates Toured Pecan Roasters Plants.
- TDA leadership met with Local Government Officials including Linan Mayor and local government officials at the China Roasted Nuts Food Mall in Linan, China.
- The China Roasted Nuts Food Mall is a good place for Pecan roasters to understand about the Chinese interest in Pecans.

Goals and Outcomes Achieved
Goal: Establish foreign sales for Texas pecans through collaboration with TPGA and Texas pecan producers

Target: $300,000-$400,000 in export sales.

Benchmark: $2.5 million in sales based on multiple trade missions in the last three years

Performance Measure: TDA will work with TPGA and other GO TEXAN pecan producer members to track and measure the success of international buyer meetings and promotional efforts. These figures will be calculated and reported as future benchmarks to highlight the impact made possible through these connections and marketing strategies.

Monitoring Plan: Progress will be monitored on a monthly and annual basis to ensure proper and timely establishment of these international market relationships.

Through review and evaluation of the Chinese market through GAIN Reports, EUROMONITOR reports, interviews with the FAS in China, and Texas Pecan producers $1.5 million in sales were reported. This far surpasses the original target of achieving $400,000 in export sales.

Summary of long term the progress made towards achievement. The total value of U.S. pecan exports to mainland China grew by 72.9% to $24.1 million in 2016. This is not an isolated trend: over the past several years, U.S. pecan exports to mainland China have shown signs of strong and consistent growth. In 2014, these exports were valued at only $2.4 million, but by 2015 this had increased by 470% to nearly $14 million with little sign of substantially slowing down. Shelled U.S. pecans are also seeing increased export to mainland China, having increased 28.8% in 2016 to 304 tons valued at $2.9 million.

Beneficiaries
Beneficiaries include Texas Pecan Producers that received invaluable exposure to international buyers. Those that directly benefited included nine farmers who pooled their crops to make sales to the Chinese roasters-for a total of $1.5 million in sales.

Lessons Learned
Preparing the small producers for large orders is the biggest challenge. We need to have more discussions about consolidation with more farmers.

Geopolitical and economic trade policies between the United States are the major unknown. Chinese Currency was devaluated making the dollar stronger which makes U.S. imports from China more expensive.

To overcome these obstacles exporters were encouraged to:

- Emphasize the quality of Texas pecans to foreign buyers
- Share knowledge, trends amongst producers
- Invest in the market "Sampling, Social media, PR" in Foreign markets
- Invest in retailer "push" programs
- Encouraged to seek dependable buyers
- Make attractive deal structure
- Remind producers that importers need to make money too

Additional Information
Currency Devaluation – Chinese Currency was devaluated making the dollar stronger which makes U.S. imports from China more expensive.

These issues did not have an effect on the outcome of this project, but exporters will continue to experience problems like this.

PROJECT 17: RETAIL PLANT AND PRODUCT PROMOTIONS AND CONSUMER EDUCATION

Primary Organization – Texas Department of Agriculture
Partner Organization – Texas Nursery & Landscape Association & Texas State Florists' Association
Project Manager – Lindsay Baerwald
Contact Information –

P.O. Box 12847
Austin, Texas 78711
(512) 463-7591
Lindsay.Baerwald@TexasAgriculture.gov

Type of Report – Final Report
Date Submitted – December 2017

Summary
The purpose of these marketing projects is to expand Texas specialty crop visibility at the consumer level and to increase consumption and sales through producer-driven and TDA executed projects. TDA's marketing coordinators continued to coordinate activities that increased the marketability and competitiveness of Texas produce and other specialty crops. TDA's Marketing Coordinator, whose primary purpose is to develop and maintain relationships with the industry sectors and expand the GO TEXAN Specialty Crop awareness campaign, served as a liaison and resource for the industry and coordinated program activities. Additional staff contributed to the projects including assistance with media buys, retail promotions and social media. TDA, in partnership with Texas Vegetable Association and Texas International Produce Association, have used previous SCBGP funds to create kid friendly recipes. Those recipes were utilized in this project as take home materials for students and families. Under our new wine & floral initiative, retail signage was created for certain florists identifying them as a source for Texas flowers and plants, as well as, local Texas wines.

Project Approach –
Let's Get Growing Pilot Program – TDA partnered with HEB on the printing of materials used for this program which is designed to make eating fruit and vegetables fun. It was a 12-week program that taught 2nd graders the fundamentals of agriculture in modern day society and ways to improve eating habits. TDA printed bilingual nutrition and agriculture lessons to incorporate into the science curriculum. Each participant also received an interactive activity booklet, printed by TDA, which had coupons for fresh produce on the back. The Let's Get Growing pilot program ended its first year by impacting more than 1,200 2nd graders and their families in 12 elementary schools in the Texas Valley. TDA will be partnering again with HEB for an expanded Year 2.

Wine & Floral Initiative – Texas State Florists Association promoted and conducted four Floral Showcases for florists on the subject of creating floral arrangements in combination with Texas Wines and ease of getting a TABC license. A special breakout session and wine tasting was also conducted at the summer EXPO, where TABC a wine marketer and TDA attended to promote the option to get a license to sell Texas Wine with their flowers.

Social Media Campaigns & Retail Demos - The demos drew attention to the produce department as a whole and we received a lot of good feedback from the events. Single grapefruits had a sale of 2,079 units, 1,442 units of 5 lb. bag oranges sold. The social media campaigns caused a big buzz and reached 187,954 impressions.

The Specialty Crop Program Coordinator and other regional staff attended the Texas Pecan Growers Association Conference and Trade Show, Texas Nursery and Landscape Association EXPO, The Texas State Florists EXPO, Produce Marketing Association Conference, Viva Fresh Expo, Texas Forestry Annual Conference and the Ellison Chair for International Floriculture Annual Meetings to inform producers and retailers of the opportunities available to increase sales of Texas specialty crops by building brand awareness.

Goals and Outcomes Achieved

Goal: Increase Texas produce, horticulture and floriculture sales by increasing consumer confidence through increased product visibility and awareness through TDA and partner-executed marketing projects.

Completed Activities:

- Produced and distributed signage for retail nurseries and florists identifying them as a source for Texas plants.
- Developed and distributed plant stakes and hang tags.
- Retail campaigns focusing on increasing sales of Texas produce were expanded to include florist and landscape nurseries.
- TDA worked with retailers to conduct retail promotions to educate consumers on seasonal produce.
- Distributed information on plant selection for drought areas and tips for caring for landscape and floriculture plants after purchase.
- Printed bilingual nutrition and agricultural lesson materials for “Let’s Get Growing” project with HEB Grocers.
- Materials were distributed to 1,200 students and produce coupons distributed to the families of those students.
- Provided participating students with 1) Nutrition/ag education via classroom lesson 2)Fiber pot, soil pellets and seeds 3) MyPlate laminate placemat with “Let’s Get Growing” branding.

Beneficiaries

The wine and floral initiative benefitted over 200 florists specifically within the Texas State Florists network as well as over 400 wineries in Texas who’s product could be sold in their shops. The Let’s Get Growing campaign benefited 400 growers and producers of Texas vegetables across the state of Texas by promoting the health benefits of eating vegetables. The GO TEXAN citrus, watermelon and grapefruit adds directly benefited 26 GO TEXAN member producers, however indirectly supported the industry in Texas as a whole through demos getting consumers to taste the produce.

Lessons Learned

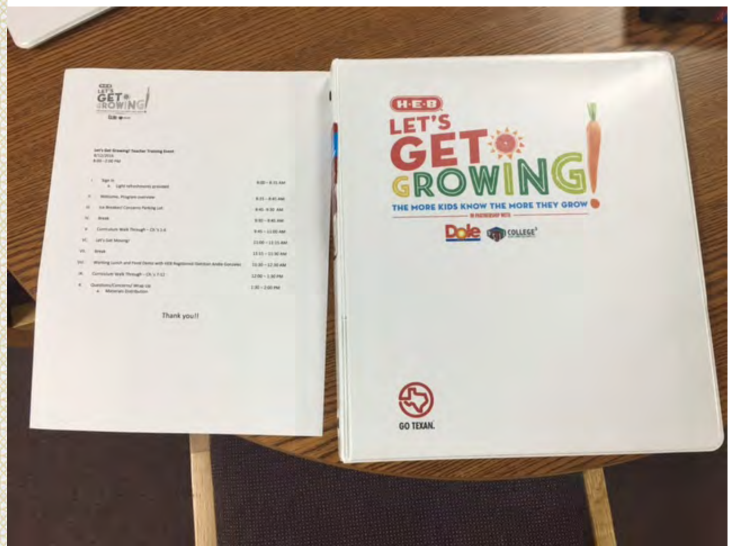
"Let's Get Growing" – during initial pilot phase, retail partner worked with their own Registered Dieticians to pare down the educational portion of the program into a more manageable one-day activation. Staffing and scheduling of the retail educational events continues to be a struggle. Each year TDA staff need to re-evaluate how to improve these. TDA staff have tried working directly with retailers, directly with producers and commodity organizations. No matter which direction, staffing and scheduling continue to be difficult. Staff has learned that it needs to be an all-inclusive project in which all three methods are done at the same time. Not only does this help with conducting the events, it also helps in collecting the data for reporting.

Additional Information

Wine & Floral licensing information

Celebrate Romance Wine & Floral Poster

Guest with the Best Wine & Floral Poster   Let's Get Growing Teacher Resource



Let's Get Growing Booklet

Grapefruit,Citrus and Watermelon demos and corresponding Social Media Campaigns