Title of Project: Evaluation of Cultivars and Trellis Systems for Advanced Season and Low Pesticide Input Table Grape Production under High Tunnels for the Southeast U.S.

Final Report

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Research Proposal

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Objectives

The objective of this project was to investigate three table grape cultivars and two trellis systems for high tunnel (HT) table grape production and to continue to develop recommendations for advanced season, low pesticide input table grape production in the southeast U.S.

- Objective: To investigate the performance of three table grape cultivars for HT production using two different trellis systems. In year 1, vine establishment year, we evaluated ease of vine training and establishment for each cultivar and trellis system. In Year 2, we evaluated yield, vine performance, and photosynthetic gas exchange [photosynthetically active radiation (PAR), photosynthetic rate (A), transpiration (E), and stomatal conductance (g_s)].

Justification

Background: The sustainability of grape production can be improved by advancing and extending the harvest season to capture high-value markets and by reducing pesticide inputs to improve environmental and economic sustainability. High tunnels have the potential to achieve both goals. Despite the high potential for production and profitability of table grapes in Arkansas and the surrounding area, a sustainable and profitable production system has not yet been developed.

High tunnels offer several advantages for sustainable production of table grapes including: 1) reduction of pesticide inputs while advancing the production season for newly planted grape vines; 2) expanding and increasing harvest and market season, product quality, and crop value of

table grapes; 3) protecting flowers and fruits from frosts, hail, and damaging rain or sunburn resulting in reduced yields as experienced in field production; 4) exclusion of rain (wet foliage) allows for more sustainable management of diseases and pesticide use; and 5) extending the usefulness of pest management tactics including preventative tactics, applied pesticides or released beneficials.

With 34 pesticide residues found by the USDA Pesticide Data Program, grapes have the dubious distinction of being one of the "dirty dozen" due to these pesticide residues and are generally considered a high input crop. High tunnels provide the opportunity for higher production with lower inputs by altering the growing and production season of the crops outside normal pest life-cycles, altering the microenvironment, increasing the longevity of pest management applications (chemicals or beneficial insects) and by excluding some insect pests and disease agents.

In addition, because the grapes are protected from rainfall, and watered by drip irrigation, leaf and fruit wetness is reduced and, powdery mildew and bunch rots can be reduced, decreasing the number of sprays needed for disease control. Keeping the grapes dry reduces the spray frequency required for disease control. The cover of a HT also protects ripening grapes from birds and insect pests and mechanical damage due to hail or high velocity winds.

This project investigated different trellis systems and cultivars using HT technology to advance the production season and reduce pesticide and disease control inputs while strengthening the niche market for locally produced high quality table grapes. This project has potential to impact local markets in several of the member SRSFC states with climates similar to Arkansas such as Tennessee and North Carolina.

Methods:

The first year of this project was vine establishment phase of the project. In year 1, Dormant, one-year old vines were planted on June 2, 2014 in three rows under a Quonset-style Haygrove Supper Solo^{TM} HT (30' x 200'). Two modified double high cordon (MDHC) were established, one on the east side and one on the west side of the tunnel. The Geneva double curtain (GDC) trellis was positioned in the middle of the tunnel. The design was a randomized complete block with six blocks per training system. Vines were planted 8' apart and row centers were 10' apart. Three cultivars, 'Faith' and 'Gratitude', two newly UA released seedless table grape cultivars, and 'Jupiter,' an earlier release developed through the University of Arkansas breeding program, were evaluated. Plant material was bought from Double A Vineyards in New York. For each cultivar and trellis system, we investigated ease of training and vine establishment, yield, berry quality, as well as canopy management and light interception as PAR using an AccuPAR-Linear PAR ceptometer [PAR, photosynthetic rate (A), stomatal conductance (g_s), and water use efficiency (WUE)] once per month once a day between 11:00 and 14:00 hrs. In addition, cultivar establishment performance was evaluated by measuring trunk cross-sectional area in winter (TCSA) and pruning weights for the first year of the planting. We also monitored and evaluate ease and frequency of pesticide application for pest and disease management.

Results:
The objective of this study during its second year was to evaluate plant development, fruit production and fruit quality of three University of Arkansas table grape cultivars trained on two different trellis systems. Sustainable cultural practices were implemented during the trial as related to nutrient and pest management.

Vine measurements indicated significant differences in dormant pruning weight and cordon length reached at the end of the 2014 growing season, but no significant differences in trunk diameter. The cultivar Faith had the most amount of pruning wood taken out, but the shortest cordon length (Table 1).

Table 1. Vine parameters for three table grape cultivars grown in high tunnels.

Cultivar	Trunk diameter (mm)	Pruning weight (g)	Cordon length (cm)
Faith	12.65[z]	165.56a[y]	199.85c
Gratitude	10.92	105.00b	266.96a
Jupiter	10.65	98.89b	235.11b

[z]Not significant at $P \leq 0.05$
[y]Different letters within columns indicate significant differences at $P \leq 0.05$ (Tukey's test).

Vines of Faith and Jupiter had fruit in 2015. Many of Gratitude vines had winter damage and total yield was reduced for this cultivar. Although there were not significant differences for training system for all variables measured or cultivar differences for yield, average yield/vine was substantial (Faith -10.98 kg, Gratitude (9.94), and Jupiter – 9.63 kg) (Table 2) for one year old vines. The number of fruit clusters per vine was significantly different per cultivar. Fruit quality was excellent and very little damage due to diseases or insects was detected. Pesticide application was greatly reduced. High tunnel grapes in 2015 were sprayed as follows:

April 5- Dormant spray- Lime sulfur solution
May 29- Captan & Mancozeb
June 12- Entrust
Aug 28- After harvest- Agri-Mek

In contrast the grapes under ambient conditions in Fayetteville and Clarksville received on average 8 to 10 fungicide and 5 to 7 insecticide sprays during the growing season.

Table 2. Grape yield data for three table grape cultivars grown in high tunnels.

Cultivar	Yield/ plant (kg)	Cluster (no.)/ plant	Cluster weight (g)	Berry weight (g)	[0]brix
Faith	10.98*	37.5a[z]	310.8[z]	3.36*	19.1*
Gratitude	9.94	28.23b	375.4	3.32	18.6
Jupiter	9.63	29.1b	340.9	3.55	18.8

[z]Not significant within column at $P \leq 0.05$ (Tukey's test).
[zy]Different letters s indicate significant differences at $P \leq 0.05$ (Tukey's test).

As expected, there were significant differences in PAR for the vines planted outside the tunnel for

the three dates it was measured (23 June, 17 July, and 8 Aug.). Within the tunnel trellis systems had a significant effect on in PAR and A (Table 3). PAR and A were generally lowest in GDC (Center) and MDHC (West) having the highest PAR and A. E and g_s were not significantly different.

Table 3. Photosynthetic gas exchange for three table grape cultivars grown under three trellis systems in a high tunnel and outside measured at three dates.

Treatment	PAR[z]	A[y]	E[x]	g_s[W]
	23 June			
MDHC (East)	719.58c[V]	10.63c [u]	5.60[v]	899.75[v]
GDC (Center)	808.75b	14.29a	4.56	489.50
MDHC (West)	827.75b	14.18ab	5.24	928.83
GDC(Outside)	1187.92a	11.32bc	5.17	503.25
	17 July			
MDHC (East)	961.92c	11.07a	5.23	318.50
GDC (Center)	921.08d	9.03b	3.47	135.42
MDHC (West)	1020.33b	12.61a	5.15	297.50
GDC(Outside)	1653.17a	9.78b	4.81	193.50
	8 August			
MDHC (East)	963.08c	10.57b	3.97	241.42
GDC (Center)	823.42d	10.06b	2.98	151.92
MDHC (West)	1185.75b	15.69a	4.45	302.42
GDC(Outside)	1775.08a	11.03b	4.02	142.58

[z]PAR- hotosynthetically active radiation
[Y] A- Assimilation
[x] E- Transpiration
[W] g_s- Stomatal conductance
vNot significant at $P \leq 0.05$
[u]Different letters within columns indicate significant differences at $P \leq 0.05$ (Tukey's test).

Fig. 1. View of table grape planting in high tunnel shortly after planting (June 2014). Trellis systems: Geneva Double Curtain (GDC) trellis system. The outside rows were trained to vertical trellises resembling a "Double High Cordon" modified to match the curvature of the tunnel structure.

Fig. 2. Table grapes in high tunnel at the end of summer 2014.

Fig. 3. Table grape vines in high tunnel in July 2015.

Fig. 4. Table grape clusters on the vine in high tunnel, July 2015.

Fig. 5. A harvested cluster of table grape cultivar 'Faith' grown in high tunnel in July 2015.

Conclusions

Vine growth and development was very rapid. By 7/28/14 some of the vines had reached the top support wires. By 8/25/14 all experimental plants reached full height -7' for MDHT and 5.5' for GDC (Fig. 1 and 2). Vine growth was very vigorous (Fig. 3) requiring summer pruning Yield and fruit quality were exceptional for one-year old plants (Fig. 4 and 5). Very few insect or disease problems were noticed. However, in August, some vines exhibited malformation of leaves and shoots toward the cane tips. Leaf samples were collected and taken to the University of Arkansas Fruit Entomology Lab and examined. It was determined the malformation was caused by an infestation of Broad Mites (*Polyphagotarsonemus latus)*. The foliage was treated with an application of AgriMek™ miticide. After treatment, newly formed leaves and shoots, showed no

further mite damage. Preliminary results from this project indicate that the use of high tunnels for growing table grape is a feasible alternative in geographic areas where there are climatic limitations to production.

Impact Statement: There has been a high degree of interest among grape growers in the area. 10 area grape growers have stopped to see what is being done. One grower is currently planning on constructing a tunnel for wine grape production.

Citation(s) for any publications arising from the project

Garcia, M.E., Johnson, D.T., Dickey, D.A. Frey, S.D. 2014. Increasing Economic and Environmental Sustainability of Table Grapes Using High Tunnel Advanced Production. Invited talk. XXIX International Horticultural Congress: IHC 201, Brisbane, Australia.

Literature Cited:

Bavougian, C.M., P.E. Read, and E. Walter-Shea. 2012. Training System Effects on Sunlight Penetration, Canopy Structure, Yield, and Fruit Characteristics of 'Frontenac' Grapevine (*Vitis* spp.). International Journal of Fruit Science, 12:402-409.

Boriss, H., H. Brunke, and M. Kreith. 2013. Grapes profile. Agricultural Marketing Resource Center. Iowa State University, Ames, IA. 1 March 2015. http://www.agmrc.org/commodities__products/fruits/grapes-profile/.

Botelho, R.V., A.P. Pavanello, E.J.P. Pires, M.M. Terra, M.M.L. Müller. 2011. Organic production of red wine grapes under plastic cover subtropical region of Brazil. Ciênc. agrotec. 35(6):1186-1195.

Carey, E.E., L. Jett, W.J. Lamont, T.T. Nennich, M.D. Orzolek, and K.A. Williams. 2009. Horticultural crop production in high tunnels in the United States: a snapshot. HortTechnology. 19(1):37-43.

Carey, Richard. March, 2013. Beating Mother Nature at Her Own Game. Wines & Vines.

Carey, Richard. April, 2013. Commercial Establishment of High Tunnels. Wines & Vines.

Carey, Richard. June 2013. Quantity and Quality in a Tunnel. How the grapevine can produce both quantity and quality in a high tunnel.

Clark, J.R. and Moore, J.N. 2013. 'Faith', 'Gratitude', 'Hope', and 'Joy' Seedless Table Grapes. HortScience. 48(7):913-919. 2013.

Creasy, G.L. and L.L. Creasy. 2009. Grapes. CABI. Wallingford, UK

Demchak, K. 2009. Small fruit production in hightunnels. HortTech. 19:44-49.

Dhekney, S., J. Vardiman, and D. Smith. 2013. Evaluating table and wine grape cultivars in high tunnels for yield/quality improvement. University of Wyoming, Sheridan, WY.Garcia, M.E., Johnson, D.T., Dickey, D.A. Frey, S.D. 2014. Increasing Economic and Environmental Sustainability of Table Grapes Using High Tunnel Advanced Production. Invited talk. XXIX *International Horticultural Congress*: IHC 201, Brisbane, Australia.

EWG's Shoppers Guide to Pesticides in Produce 2013. http://www.ewg.org/foodnews/

Lehnert, Richard. January, 2011. Grape Grower Pioneers Hoops: Grapes Grown Under Unheated Plastic Hoophouses Will Be Distinctive, Producers Hope. Good Fruit Grower. http://www.goodfruit.com/Good-Fruit-Grower/January-15th-2011/Grape-grower-shypioneers-hoops/

Pottorff, L.P. and K.L. Panter. 2009. Integrated pest management and biological control in high tunnel production. 19:61-64