DIVISION OF AGRICULTURE
RESEARCH & EXTENSION
University of Arkansas System

NCCC212: Small Fruit and Viticulture Research

2020 Report from the University of Arkansas

Objective 1 - Develop improved small fruit germplasm through cooperative breeding and evaluation programs:

Blackberry and Raspberry (Clark, Worthington, Threlfall, Lee):

The 2020 season was very productive. We had a relatively mild winter at the Fruit Research Station, Clarksville, and no significant cold damage was observed this year. The average temperatures throughout the spring and summer were typical and ripening time was average overall. May was very rainy (7.26 in), but only 1.6 in of rain fell during peak blackberry season in June. The breeding crew and FRS staff were diligent about following COVID-19 safety guidelines and we were able to perform crossing and evaluations as usual this year with just a few modifications. Blackberry seed numbers for 2020 were excellent.

Two new floricane-fruiting cultivars with excellent flavor have been released in the past few years. 'Caddo', a high-yielding thornless, erect cultivar with medium-large fruit that are sweet and flavorful was released in 2018. 'Ponca', a high-yielding thornless, erect cultivar with medium-sized fruit with enhanced sweetness and good post-harvest handling was released in 2019.

One additional primocane-fruiting selection has been submitted for release approval by the AES, APF-268, and when approval is complete, it will be available for sale. The projected first offer date is December 1. The proposed name is Prime-Ark® Horizon, and if all goes well, this will be the name. This release is intended to be a complement to Prime-Ark® 45 as it is thorny. The floricane fruit potential is very high, among the highest of any blackberry genotype tested in the Arkansas program. Primocane crop is lower, as is the reality with all primocane-fruiting cultivars in Arkansas. During testing, the primocane crop ranged from 10 to 74% of the floricane crop among years. APF-268 is large, and average berry size of floricane berries was 7.8 g and primocane berries 7.3 g. The similarity in berry size from these two cane types is much closer than any primocane-fruiting cultivar, and suggests more stable berry size stability in summer heat. Postharvest storage potential is good for this new development, particularly for firmness and low leakage; reversion is similar to Prime-Ark® 45. Finally, this new development fruits longer in the fall, averaging 8 days longer than Prime-Ark® 45 and 19 days longer than Prime-Ark® Traveler.

There are a number of other primocane- and floricane-fruiting blackberry selections in advanced stages of testing. We are also continuing work on breeding blackberries with novel or 'dwarf' architecture for home gardeners. Dr. Worthington has assumed leadership of the novel breeding program and is collaborating with U. Arkansas System Division of Agriculture Controlled Environment Horticulture Specialist Ryan Dickson on testing these materials in new intensive production systems.

We have also expanded molecular breeding and research activities in blackberry. University of Arkansas researchers are collaborating with NCSU (Dr. Hamid Ashrafi and Dr. Gina Fernandez), USDA-ARS (Dr. Nahla Bassil), and United Kingdom researchers on the development of two diploid reference genomes. Our team has completed two years of phenotyping on a blackberry genome-wide association study (GWAS) funded by USDA-AFRI and we are looking forward to analyzing genotype data by the end of 2020. Graduate students have measured thorn density, internode length, fruit size and shape, sweetness, acidity, seed size, firmness, and red drupelet reversion in a panel of ~300 UA breeding selections and cultivars for this GWAS project. We are also working with breeders and scientists at Pairwise, NCSU, USDA-ARS, Cornell, and Plant Sciences, Inc. on a unique public-private partnership to identify and characterize the genetic diversity in a diverse *Rubus* collection.

Grapes and Muscadines (Clark, Worthington, Threlfall, Lee):

Table and wine grape evaluation and muscadine breeding continues at the Fruit Research Station, Clarksville. As with blackberries, no substantial cold damage was observed in grapes or muscadines this season. Many of the muscadine vines in our research vineyard were severely damaged by auxin herbicide drift during June 2020. We also observed much more powdery mildew on muscadine fruit than usual in 2020. Despite these challenges, we had a productive season with promising new selections identified and excellent muscadine seed numbers from 2020 crosses.

Two new white wine grapes with Muscat and Gewürztraminer flavors are currently being prepared for release. Both of these white wine grape cultivars have shown good adaptation and consistent productivity in Arkansas. Enological evaluations have shown that these cultivars produced high-quality wines from fruit grown in Arkansas. It is envisioned that these cultivars will be a nice complement to the 'Enchantment' and 'Opportunity' wine grapes released by our program in 2016 and that they can expand options for unique wine grape offerings for growers and wine-makers in Arkansas and the Mid-South region. We anticipate that these new cultivars, 'Indulgence' and 'Dazzle', will be officially released and offered for sale this winter. There are also several table grape selections in advanced testing, but no immediate releases on the horizon.

Dr. Worthington is currently leading muscadine grape breeding. Several advanced selections have been identified and submitted for virus testing at the NCPN site in Raleigh, NC. We anticipate making our first release(s) in winter 2021/2022! 2020 was our fourth year of crossing with pollen from seedless selections from the Jeff Bloodworth/Gardens Alive! breeding program. We made our first seedless selection this September from crosses made in 2017. We are optimistic that improved textures and seedlessness will broaden the appeal of muscadine grapes for a broader consumer base and generate a lot of excitement in the Southern US and beyond.

Other ongoing research on muscadines includes measuring firmness of berries analytically and by sensory, validation of a new candidate gene for bronze berry color, investigations into the inheritance of sex and leaf shape in collaboration with Patrick Conner (UGA), and estimation of genetic diversity of wild and cultivated muscadines across the native range

Impact:

The major impact of the small fruit breeding effort is in plantings of released blackberry cultivars. The primocane-fruiting cultivars have had significant production now for several years and are now providing for a much-extended blackberry marketing season for domestic production. The floricane-fruiting cultivars Ouachita, Natchez and Osage are the most popular and continue to provide for high quality berries. The new releases Caddo and Ponca are expanding production also, and Ponca looks to be a big step up in consistent sweetness in berries

Objective 2 - Develop practices for small fruit production tailored for climatic and market needs of growers.

Grapes:

High Tunnel Grape Production Systems: A Novel Sustainable Approach to Growing Grapes (Cooperators: D. T. Johnson, R. Threlfall UA; J. Lee, A. McWhirt, R. Rainey, UAEX; L. Freeman NCATT). SSARE R&E grant.

The purpose of this project was to investigate the efficiency and economic feasibility of using high tunnel technology as a tool for expanding table and wine grape production to areas where open field vineyard management requires high levels of inputs due to both biotic and abiotic challenges.

Objectives:

Objective 1. Evaluation of high tunnel grape cultural and pest management methods by investigating potential grape production management techniques
Objective 2. Determine marketable attributes through the evaluation of physiochemical, composition, and post-harvest attributes for high tunnel grapes
Objective 3. Develop economic budgets for high tunnel grape production
Objective 4. Generate production practices for high tunnel grape growers
Objective 5. Expand outreach efforts for high tunnel grape production

Impact:

Two MS students graduated in the spring of 2020

- Performance Evaluation of Four Arkansas Table Grape Cultivars Grown on Three Trellis Systems Under High Tunnels at Two Locations in Arkansas. Jose Hernandez
- Determining Cluster Thinning and Storage Effects on Fruit Quality and Marketability Attributes of Arkansas Table Grapes Grown Under High Tunnel Systems. Virginia Beasley

Grape food science activities (Threlfall)

- Physicochemical properties of wines and juices produced in from grapes grown in Arkansas (PhD Student Sarah Mayfield, defended 2020)
- Phylogenetic diversity of Arkansas vineyard and wine microbiota (PhD Student Natacha Cureau, defended 2020)
- Identifying unique attributes and postharvest practices for Arkansas muscadines (current MS student Cody Rawls)

Virtual Muscadine Workshop and Field Day hosted on September 18, 2020 (A. McWhirt and R. Threlfall, organizers and M. Worthington and A. Cato, speakers)

Strawberries:

Row covers and planting date for strawberry production 2018-2020 (A. McWhirt)

Objective for this trial was to compare the application of row covers at two timings in the fall to no row cover on both an on-time and late planting of Chandler. Ruby June and Fronteras were also used in the trial for single seasons. Trial was conducted at two locations in AR for the 2019 and 2020 harvest seasons.

- Plant size and yield observations support on-time planting date (before Oct. 5th in central AR) to maximize yield. Yield was on average 100g more per plant in on-time plantings relative to late plantings without row covers. Row covers may improve crown development and yield on late plantings relative to uncovered plants, but results did not indicate that row cover use on late plantings can result in yields equal to on-time planting dates. Row covers applied to on-time plantings did not impact yield.

Strawberry Variety Trial 2019-2020 (A. McWhirt)

Nine strawberry cultivars were evaluated at the University of Arkansas Vegetable Research Station (zone 7a) during the 2019-2020 season. Trial is being replicated in 2020-2021 with additional cultivars and advanced selections.

- Cold damage ratings after Nov 13th freeze (Temperatures dropped 40-50F overnight and was first major cold event of the fall). Moderate to severe damage observed in most cultivars. Reassessed cold damage during spring biomass sampling and observed lower levels of cold injury (indicating crown recovery from injury) in cultivars that previously had been rated as minor to moderate damage. Fronteras and Albion had severe cold damage ratings in the fall 2019 that persisted into the spring 2020. These two cultivars were also among the lowest yielding.
- Highest yielding cultivars: Camarosa, Rocco, Liz. Rocco and Liz had low cold damage ratings and low fall runner production at our site.

Strawberry IPM trials and pest management observations (Cato)

- Excessive rains led to statewide issues with anthracnose.
- Promax and Zap trial (Planted Fall 2020)
    - Assessing the effect of promax and zap rotations on soil pathogens and nematodes. We are also comparing these to some known standards.
- Assessing differences in diseases and pest abundance in many commonly grown cultivars and some new cultivars in the variety trial described above

Virtual Strawberry Field walk hosted April 20th, 2020 (McWhirt, Cato)

- https://www.youtube.com/watch?v=p_BFZaXdwIc&t=9s

Blackberries and Raspberries:

Rotating Cross Arm Trellis and Standard T-trellis Comparison. (A. McWhirt)

A comparison of varietal performance on both a rotating cross arm trellis and standard t-trellis is being conducted at the University of Arkansas Fruit Research Station in Clarksville, AR.

- 2019, 2020 first two full seasons of harvest data. Yield per plant is higher on the RCA vs standard for Ouachita and Osage cultivars. Yields per linear row foot and assessments of fruit quality are ongoing. Had higher incidence of white drupe in 2020, compared to 2019. Labor is being monitored between both systems and an economic report will be developed in 2021.
- MS Student Erika Henderson graduating Dec 2020, publications forthcoming

Preliminary evaluations of timing and rates of prohexadione calcium on blackberry (A. McWhirt, T. Kon (NCSU))

The trial evaluated high and low rates of prohexadione calcium applied starting a two different timings in early spring. Trial conducted at two locations in Arkansas, both on Ouachita.

- Impacts on primocane growth and yield on-going, preliminary observations indicate that material should not begin being applied until primocanes emerge.

Broad mite in blackberry and other pest management observations (Cato)

- Monitoring populations across the season in multiple locations across Arkansas. Broad mite was found state-wide in 2020, but not as serious as in 2021
- Project assessing the effect of post-harvest infestations on growth and yield of primocanes.
    - Infested and uninfested plots were established and will be monitored during the 2021 season.
- Very light year for Spotted Wing Drosophila.
- Large amount of cane lesions from Anthracnose on 2020 floricanes. This is likely due to record rainfall in 2019.
- Observations of yellow vein and other viruses are beginning to be much more common.

Evaluation of preemergent herbicides for newly planted blackberries (Bertucci, McWhirt, Cato. SRSFRC 2020 proposal).

Few preeemergent herbicides are registered for use on first year blackberry plantings. The majority of preemergent herbicides are restricted to plants that have been established for more than 1 year. New blackberry plantings, where plants are smallest and most vulnerable

to weed interference, have the fewest options for chemical weed control. Thus, this proposal is designed to assess tolerance of newly established blackberry plants to several preemergent herbicides.

Objectives of project:

1. To determine the effect of preemergent herbicide applications on establishment and growth of newly transplanted blackberry plants in AR and NC.
2. To generate data on weed control and crop response that can be utilized for regional recommendations and applications for supplemental labels for herbicides for blackberries grown in the southern region.

Herbicide treatments include simazine, pendimethalin, S-metolachlor, flumioxazin, and mesotrione. Preemergent herbicide applications will be made using a CO_2-powered backpack sprayer (8002 EVS flat fan nozzles), calibrated to deliver 20 gallons per acre covering a 40 inch swath on each side of the plot. All plants will be shielded during applications to ensure no herbicide reaches the foliage. Treatments will be applied within 72 hours after planting.

Impact
Results from this study will be used to guide recommendations for herbicide in new blackberry plantings, including the University of Arkansas Recommended Chemicals for Weed and Brush Control and the Southeast Regional Caneberries Integrated Management Guide. Data will also be used to solicit supplemental labels and 24(c) registrations for promising herbicides in the southern region.

Blackberry food science activities (Threlfall)

"Intelligent Soft Robotic Gripper for Fresh-Market Berry Harvesting" (University of Arkansas Chancellor's Innovation and Collaboration Fund grant)

- Robot gripper evaluated in 2019 and 2020

Consumer evaluation of six University of Arkansas blackberry cultivars. (Threlfall, Clark, Worthington)

- Consumers scored Ponca highest for overall impression and flavor
- Study results in press at Hort Science. See publication list

Identifying unique attributes and harvest practices that impact marketability of Arkansas fresh-market blackberries (MS student Andrea Myers)

Grower meetings and stakeholder outreach

AR Blackberry Growers Association, Winter Meeting Feb 8th, 2020. Little Rock, AR. Organized by A. McWhirt

US Blackberry Industry Strategic Planning Meeting. Funded by SCRI. Organized by M. Worthington

- Meeting held immediately following NARBA with discussion guided by results of a national stakeholder survey conducted during winter 2019/2020
- Industry and academic collaborators from all US blackberry production regions participated
- Survey results to be submitted for publication in HortScience. Manuscript in preparation
- Survey and planning meeting to guide development of full SCRI proposal for 2021/2022 cycle

Blueberry

Blueberry School Completed in late 2019. Trained 100+ agents and growers. Hosted by Bill Cline (NCSU) and Amanda McWhirt (UArk). Recording available online: www.uaex.edu/blueberryschool

Small Fruit Virology Activities

Ioannis Tzanetakis

- Validation of NGS technology for routine virus testing of G1 plants – even with NGS technology it is necessary to test plants for two seasons
- Field surveys to develop a list of 'canary viruses' affecting *Rubus* across the US was just completed - Results Are being analyzed
- New viruses of note: Two rhabdoviruses in strawberry (probably aphid-transmissible) and a carlavirus in blueberry - similar to blueberry scorch- looking at pathogenicity of the new viruses
- Improve diagnostics – major bottleneck the genetic diversity of berry viruses. There are many false negative- Example *Rubus* yellow net and tomato ringspot

Objective 3 - Explore the association between fruit constituents and human health impact

None

List publications arising from your collaborative research projects including journal articles, book chapters, review articles, theses, proceedings, and extension publications.

Brown, A., M. Worthington, A. Varanasi, L. Nelson, R.T. Threlfall, and L.R. Howard. 2020. Estimation of additive and dominance effects of a mutant glutathione S-transferase gene on anthocyanin content in muscadine grape (*Vitis rotundifolia*). Discovery, The Student Journal of Dale Bumpers College of Agricultural, Food and Life Sciences. 21:15-22.

Bushakra, J.M., L.A. Alice, K.A. Carter, M. Dossett, J.C. Lee, A. Liston, R. Meiers, C. Mulch, A.M. Nyberg, M. Peterson, K.J. Vining, M.L. Worthington, M.H. Yin, B.L. Sutherland, J.D. Zurn, J.R. Clark, C.E. Finn, N.V. Bassil, K.E. Hummer. 2020. Status of *Rubus* germplasm at the US National Clonal Germplasm Repository in Corvallis, Oregon. Acta Hort. 1277:121-128.

Clark, J.R., M. Worthington, and T. Ernst. 2019. 'Caddo' thornless blackberry. HortScience 54:1632–1636.

Delić, D., M. Radulović, M. Vakić, A. Sunulahpašić, D.E.V. Villamor, and I.E. Tzanetakis. 2020. Raspberry leaf blotch emaravirus in Bosnia and Herzegovina: population structure and systemic movement. Mol. Biol. Rpt. 47:4891–4896

Delić, D., M. Radulović, M. Vakić, A. Sunulahpašić, D.E.V. Villamor, and I.E. Tzanetakis. 2020. First report of black currant reversion virus and gooseberry vein banding associated virus in currants in Bosnia and Herzegovina. Plant Dis.104:2036

Felts, M., R.T. Threlfall, J. Clark, and M. Worthington. 2020. Effects of harvest time (7:00 AM and 12:00 PM) on postharvest quality of Arkansas fresh-market blackberries. Acta Hort. 1277:477-486.

Finn, C.E., M.E. Peterson, J.R. Clark, G.E. Fernandez, H.K. Hall, and M.L. Worthington. 2020. Merging blackberry germplasm pools and moving previously unutilized species into commercially viable selections. Acta Hort. 1277:47-54.

Foster, T.M., N.V. Bassil, M. Dossett, M.L. Worthington, and J. Graham. 2019. Genetic and genomic resources for *Rubus* breeding: a roadmap for the future. Hort. Res. 6:1-9.

Fuchs, M., C.V. Almeyda, M. Al Rwahnih, S.S. Atallah, E.J. Cieniewicz, K. Farrar, W.R. Foote, D.A. Golino, M.I. Gómez, S.J. Harper, M.K. Kelly, R.R. Martin, T. Martinson, F.M. Osman, K. Park, V. Scharlau, R. Smith, I.E. Tzanetakis, G. Vidalakis, and R. Welliver. 2020. Economic studies reinforce efforts to safeguard specialty crops in the United States. Plant Dis. *In Press.* https://doi.org/10.1094/PDIS-05-20-1061-FE

Lewter, J., M. Worthington, J.R. Clark, A.V. Varanasi, L. Nelson, C.L. Owens, P. Conner, G. Gunawan. 2019. High-density linkage maps and loci for berry color and flower sex in muscadine grape (*Vitis rotundifolia*). Theor. Appl. Genet. 132:1571–1585.

Molina-Bravo, R., M. Worthington, and G.E. Fernandez. 2019. Advances and challenges in raspberry and blackberry breeding. In: Lang, G.A. (ed.). Achieving sustainable cultivation of temperate zone tree fruits and berries. Volume 2. Burleigh Dodds Science Publishing, Cambridge, UK.

Spak. J., I. Koloniouk, and I.E. Tzanetakis. 2020. Graft-transmissible diseases of *Ribes* – pathogens, impact and control. Plant Dis. *In Press.* https://doi.org/10.1094/PDIS-04-20-0759-FE

Thekke-Veetil, T., T. Ho, J.D. Postman, and I.E. Tzanetakis. 2020. Comparative analysis of a new blackcurrant waikavirus with other members of the genus. Eur. J. Plant Pathol. 175:59-64.

Threlfall, R., J.R. Clark, A. Dunteman, and M. Worthington. 2020. Identifying marketable attributes of fresh-market blackberries through consumer sensory evaluations. HortScience. *In Press.*

Threlfall, R.T., A. Dunteman, J. Clark, and M. Worthington. 2020. Using an online survey to determine consumer perceptions of fresh-market blackberries. Acta Hort. 1277:469-476.

Worthington, M.L. and J.R. Clark. 2020. Development of blackberry cultivars with novel plant architecture. Acta Hort. 1277:159-164.

Worthington, M.L., R. Aryal, N.V. Bassil, D. Mead, G.E. Fernandez, J.R. Clark, F. Fernández-Fernández, C.E. Finn, K.E. Hummer, and H. Ashrafi. 2020. Development of new genomic resources and tools for molecular breeding in blackberry. Acta Hort. 1277:39-46.

Zurn, J.D., M. Driskill, S. Jung, D. Main, M.H. Yin, M.C. Clark, L. Cheng, H. Ashrafi, R. Aryal, J.R. Clark, M. Worthington, C.E. Finn, C. Peace, A. Iezzoni, and N. Bassil. 2020. A Rosaceae family-level approach to identify loci influencing soluble solids content in blackberry for DNA-informed breeding. Genes Genet. Genomes. 10:3729-3740.