Final Technical Report

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Grant 22*1557 *New Apple Varieties for Michigan Hard Cider Production*

Goals and Objectives

The hard cider industry in Michigan and throughout the United States has been growing rapidly, and now represents a significant portion of the craft beverage sector. The highest quality hard ciders are made from specialized varieties of apple called cider apples. These differ from common, culinary apples by containing very high levels of sugars, acids, and/or phenolics (tannins). Currently, apples high in sugar (e.g. 'Honeycrisp') are readily available, but apples with high acids and especially high tannins are in very short supply. Numerous growers have tried planting some of the traditional, famous cider apple varieties in Michigan, but most have not produced well under Michigan conditions, due to frost, low winter temperatures, premature fruit drop, and diseases such as fire blight. Michigan cider producers need reliable and quality sources of apples, and growers who want to initiate or expand cider apple operations need reliable information about which existing varieties will be most profitable. In addition, the Michigan industry badly needs new varieties with traits optimized for our climate, including late bloom that escapes spring frosts, cold hardiness, retention of ripened fruit, and disease resistance. Finally, as hard cider becomes firmly established in the U.S., consumers are demanding more diversity in taste and style. Red ciders are becoming very popular, and novel, red-juiced apple varieties present an attractive opportunity for Michigan growers and producers. This project directly addresses the MCBC FY22 Research Priority "New varieties for hops, fruit, barley, rye, or other agricultural inputs that are used in craft beverage production and are well-suited to be grown in Michigan".

We have launched a large variety trial of cider apples and have begun to collect production and fruit quality trait data from these varieties. This resource, the Great Lakes Cider Apple Collection (GLCAC), represents 88 apple varieties with a documented history of use in hard cider (Fig. 1). We have also identified two varieties of red-juiced apples that make excellent red ciders, and have initiated a small breeding project, called Michigan PureRed, to develop improved, red-juiced cider apples. The goals of this anticipated three-year project were to continue data collection from the cider variety trial, make existing data available for Michigan apple growers to assist in variety selection, continue development of red-juiced varieties, and initiate a small breeding program for new and improved cider apple varieties, through the following specific objectives:

1) To promote the Michigan hard cider industry and provide information to growers and hard cider makers through extension, outreach, and popular media highlighting initial results. The work is presented at the annual Great Lakes Fruit, Vegetable and Farm Market Expo (GLExpo) and disseminated to the industry through our MSU Extension team members. The existing MSU Cider Apple Trait Database (ciderapples.msu.edu) is further developed as a tool to provide growers with information about cider apple varieties, their production and juice qualities, and planting recommendations.

2) Continue to develop high-acid and high-tannin apples for cider use. We proposed to continue developing varieties that produce fruit with high levels of acids, and/or high levels of phenolics. Few such varieties exist, and ready availability of improved varieties could quickly expand the cider industry.

3) Continue to develop varieties with dark red juice for hard cider use. With MCBC support, we sought to continue our ongoing Michigan PureRed project to develop deeply red-juiced varieties with good production and high disease resistance. This project has already produced selections that appear superior to existing red-juiced varieties.

4) Continue to evaluate traditional hard cider varieties for production in Michigan. This step exploits the previously developed MSU GLCAC and collected data on yield, disease, production traits, fruit traits, and juice character (sugars, phenolics, color, and acid content).

Results, Conclusions and Outcomes

Results were presented to attendees at the 2022 GLExpo, including apple growers and hard cider producers. The work was also communicated to growers in Michigan through the efforts of a new MSU-extension agent, Emily Lavely (Tree Fruit Educator, West Central Michigan). The MSU Cider Apple Trait Database was to be used to provide current data to the public, and this is still pending an update to the MSU content management system. We also recruited two additional MSU-Extension agents to the project, Derek Plotkowski (Fruit Educator, Southeast Michigan) and Jackie Perkins (Tree Fruit Integrator, Entomology).

With regards to develop new high-acid and high-tannin apples for hard cider, five MSU accessions (Gala OP-47, Gala OP-53, Gala OP-55, Gala OP-80, Gala OP-117) have been propagated and should produce a good crop this year. All of these are progeny of open-pollinated 'Gala'. The selections will be analyzed for preharvest drop, fruit size, and juice characteristics, and fruit will be featured at the GLExpo apple variety showcase. In addition, open-pollinated progeny of nine traditional cider varieties were selected and moved to the USDA Pome Fruit Genomics and Breeding center in Kearneysville, West Virginia for further evaluation and breeding by team member Chris Gottschalk.

Currently, we have propagated 33 selections with dark red juice for cider use. These were developed in previous years of the project, and selected for high yield, large fruit and/or dark red juice. These are being evaluated by the same criteria used for the high-acid and high-tannin selections, with the addition of juice color. In this year of the project, we also cultivated seedlings of 12 previously made crosses. These were screened using molecular markers to identify up to 24 progeny (each) containing the MYB10-R6 allele conditioning red juice. Finally, we carried out new crosses between elite commercial varieties (Pink Lady, Rosalee, Golden Delicious, Buckeye Gala, and Empire and three elite red-juiced varieties (Otterson, Cranberry, and Robert's Crab) to

generate 15 additional new populations. These were likewise screened for MYB10-R6 and are being grown in the MSU-Clarksville Research Center (CRC) nursery. All are heterozygous for the MYB10-R6 allele and will be intercrossed in the future to generate homozygous plants that could bear fruit with commercial quality and intense juice color.

To evaluate existing hard cider varieties for Michigan production, in this year of the project, we focused on timing of spring bloom (57 varieties), resistance to fire blight (88), yield (52), preharvest drop (53), and juice sugar, acid, and phenolics (62). A total of 15 varieties were found to bloom early enough in spring to pose a risk of frost damage. There was no strong fireblight pressure in the orchard this year, so results from that evaluation are inconclusive. Nine varieties with exceptionally high yield were identified. Seven varieties were identified that dropped half or more of their crop before the fruit was mature; 11 additional varieties were identified with 5% or less preharvest drop. We also documented the 10 varieties that had the greatest juice content for sugar, acid, and/or phenolics (Table 1).

Time Span

Grant period, 1/27/2022-8/1/2023; project activities carried out 4/20/22-7/31/23.

Work Accomplished/ Methods

The following protocols were used in the varieties evaluations:

- **Bloom time** - bloom was recorded weekly spanning the period of natural bloom, from late April to mid-May
- **Disease including fruit defects** - foliage, whole plant and fruit afflictions were noted through observations every 2-3 weeks in the field. Damage was photographed for identification by plant pathology experts.
- **Subjective fruit maturity (SFM)** This was done during the period of natural ripening, from late July through the end of October. Softening, starch, sugar, acids, phenolics, flavor were assessed, on three fruit from separate trees.
- **% drop at SFM** - The total fruit number per tree both on tree and on the ground was estimated for each tree.
- **Yield** - was derived from averaged fruit weight and fruit number/tree.
- **Fruit weight -** was averaged from 5 fruit from each of 3 trees.
- **Juice yield** - was determined as extracted juice volume from 250 g fruit tissues.
- **Juice biochemistry -** including soluble solids, acid (TA, pH), and tannin content was determined using analytical techniques.
- **Storability** - was assessed from 6-12 fruit after 60 d cold storage.
- **Stem girth and crown spread** - was assessed at the end of the season.

Standard techniques were used for crossing and seedling/plant growth. Seeds were subjected to 8 weeks of stratification, then grown to a height of ~ 1-2 m in a controlled environment room. Plants were then moved to the MSU CRC nursery in late July. These will be propagated in the winter through grafting.

Communication Activities, Accomplishments and Impacts

Some results of the project were communicated to apple growers and cider producers at the 2022 Great Lakes Fruit, Vegetable and Farm Market Expo in Grand Rapids, December 2022. Technical data related to the evaluations are available through the project website, cideapples.msu.edu.

Budget Narrative

This project was conducted consistent with the budget proposed by the principle investigator and approved by the State of Michigan. No matching funds or additional sources of funding were sought nor contributed to the work described herein.

Figure 1. Red-juiced selections under trial at the MSU-CRC