

# Apple Cultivars for Production of Hard Cider in Michigan



## Preface

Michigan has long been a leader in production of both fresh market apples<sup>1</sup> and specialty apples, including many cultivars that are suited for the production of hard (alcoholic) cider. The rich history and established infrastructure positions the Michigan apple industry to capitalize on the recent groundswell of interest in hard cider. However, there is currently a need for knowledge about which apple varieties will produce good ciders and also be profitable to grow in Michigan. The goal of this article is to review existing information on cider apple cultivars including traits related to production, disease, and juice quality. Cultivar recommendations and trait information can be found in the tables at the end of this article.

## The state of cider

The rise in popularity of craft beverages in the last 20 years has fueled a cultural and industrial revolution within the beverage industry. The current demand for diverse and locally produced beverages has resulted in the reemergence of hard cider as an alternative to beer and/or wine. In 2015, the hard cider industry in the United States generated more than \$430 million in sales<sup>2</sup>, and now represents one of the fastest growing sectors within the craft beverage industry. This growth is reflected by the increase in hard cider drinkers, from 6.8 million in 2008 to 24.5 million in 2016 (Fig. 1)<sup>3</sup>. Michigan supports the second largest number of cider producers nationwide, behind New York<sup>4</sup>, and thus is in a prime position to dominate the national cider scene.

Currently, Michigan cider producers utilize culinary apples designated for processing or fresh sales from packing houses, or pay premium prices for cider-specific apples. However, cider apples are currently in short supply. As consumers become more knowledgeable about cider there will be an increased demand for ciders with more body, taste, and aroma. This trend should drive an increase in the production of cider apples, and growers looking to start or expand cider operations will need to consider growing specialty cultivars. Consequently, growers and producers will need information on which cultivars make good cider and will grow well in Michigan. This includes reliable

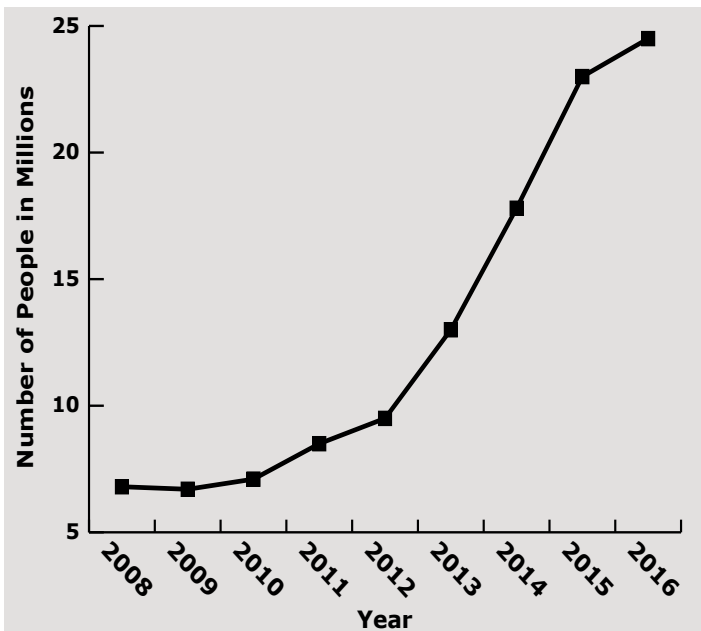


Figure 1. Increase in number of cider drinkers from 2008 through 2016.<sup>3</sup>



Figure 2. Cider apples harvested from the MSU Horticulture Teaching and Research Center (left, 'Golden Russet'; right, 'Yellow Bellflower').

data on production, disease and pest resistance, storage capacity, and compositional juice quality.

## What makes a good cider apple?

Traditional cider apples comprise a wide assortment of both domestic and hybrid apple varieties. They are typically classified according to their juice characteristics. One of the least complex classification

systems was developed by the Long Aston Research Station in the United Kingdom (U.K.)<sup>5</sup>. The U.K. system lists four categories: Sweets, Sharps, Bittersweets, and Bittersharps (Table 1). British cider makers typically blend juice from multiple classes to produce a balanced, consistent product.



Figure 3. A bin of the red-juiced cultivar ‘Otterson’, which has been used in a few commercial hard ciders.

Cultivars included in ‘Sweets’ can accumulate high levels of sugars and contribute sweetness to a cider, allowing for high final alcohol content. In addition, these cultivars have low acid levels. Most popular fresh market apples fall into this class, although there are many heritage cultivars including ‘Sweet Alford’ and ‘Sweet Coppin’ that are also considered Sweets. In contrast, ‘Sharps’ varieties provide acidity, typically in the form of malic acid. The high-acid ‘Granny Smith’ as

well as many heritage cultivars such as ‘Cox’s Orange Pippin’, are considered Sharps. Representatives of both ‘Sweets’ and ‘Sharps’ are usually readily available as produce otherwise destined for fresh market.

The two remaining classes, ‘Bittersweets’ and ‘Bittersharps’, include cultivars with high levels of tannins, measured as tannic acid. Tannic acid is a type of polyphenol, the group of compounds that lends body, astringency, and flavor complexity to fermented products. Tannins also provide for stability, one reason why red wines (with high levels of tannins) store much longer than white wines. Much like red wines, ciders made with fruit from these classes can have very distinct flavor and aroma profiles. Many of the apples that fall into these categories have no fresh market use. They have historically been referred to as “spitters”, due to the natural reaction of a person who ventures to take a bite. Bittersweets and Bittersharps are distinguished by acid levels. Bittersweets, such as ‘Somerset Redstreak’ and ‘Dabinett’, typically have low acid levels. Bittersharps, such as the famous cider apples ‘Kingston Black’ and ‘Broxwood Foxwhelp’, are high in acid.

It is important to note that, like wine grapes, the amount of sugar and acid in a particular variety can be strongly influenced by production approach. For example, even reliable ‘Sweets’ cultivars will fail to accumulate high sugar if extensively overcropped or harvested prematurely, and a normally high-acid apple such as ‘Granny Smith’ may significantly mellow if left to ripen too long. In addition, seasonal climate can have profound effects on sugar and acid levels at harvest. These considerations are especially important for varietal ciders (ie, those made from a single cultivar), and underscore the importance of blending to balance a juice with these deficits.

| Class        | Malic Acid Content (%) | Tannic Acid Content (%) | Example Cultivars                        |
|--------------|------------------------|-------------------------|--|
| Sweets       | < 0.45                 | < 0.2                   | Sweet Alford & Sweet Coppin              |
| Sharps       | > 0.45                 | < 0.2                   | Cox’s Orange Pippin & Bramley’s Seedling |
| Bittersweets | < 0.45                 | > 0.2                   | Somerset Redstreak & Dabinett            |
| Bittersharps | > 0.45                 | > 0.2                   | Kingston Black & Broxwood Foxwhelp       |

Table 1. U.K. cider apple system for classification by acid level (malic acid content) and tannins (tannic acid content).

### Existing documentation of cider apple variety traits

Probably the most exhaustive, organized source of scientifically generated trait information for apple varieties is found in a database sponsored by the U.S. National Plant Germplasm System (NPGS)<sup>6</sup>. This data has been generated over several years from trees maintained in a large planting near Geneva, New York, and has been compiled through efforts of the National Genetic Resources Program (NGRP). Among the ~1,100 cultivars listed in this database, there are at least 67 that have a documented history of use for hard cider. For these cultivars, we summarized five of the previously cataloged traits that we feel are particularly important for cider production, especially in Michigan: resistance to fire blight, harvest season, vigor, juice content, and sugar content (Brix) of the juice (Appendix 1). Although the traits were evaluated in upstate New York, this can be used as a guide to what might grow well in Michigan, given the similar climate between the fruit growing regions of the two states. Growers interested in obtaining scionwood for cultivars in this collection can make a request through the NPGS (<https://www.ars.usda.gov/northeast-area/geneva-ny/plant-genetic-resources-research/docs/apple-grape-and-cherry-catalogs/>).

The NPGS-NGRP apple germplasm collection and database have great potential for selecting optimal cider cultivars for Michigan, as well as identifying previously unrecognized cultivars for potential cider use. However, many additional traits crucial for profitable cider production have not yet been evaluated. These include biennial bearing and juice phenolics content. In addition, it is important to realize that even the most rigorous studies of individual traits are influenced by variation in yearly weather, disease and pest pressures, and other abiotic factors. Thus any variety sourced from the NPGS-NGRP might not behave as expected due to local environmental conditions.

Another excellent resource for Michigan growers is the publication, 'Hard Cider Varieties Suitable for Northern Michigan'. This describes a six-year study by MSU evaluating 35 traditional cider cultivars for production traits such as yield, vigor and harvest



Figure 4. The USDA-NPGS-NGRP apple germplasm collection located in Geneva, NY in August.



Figure 5. The USDA-NPGS-NGRP apple germplasm collection located in Geneva, NY in October.



Figure 6. A new variety that has a potential use for cider production being tested at MSU Clarksville Research Center.

season as well as fruit firmness, sugar content, flavor, and starch. Trees were grown at the MSU Northwest Research Station near Traverse City, MI on vigorous rootstocks and were subjected to evaluation after four to ten years of growth. Although the study was limited by the biennial bearing nature of most of the cultivars, this trial yielded numerous data that are important to prospective growers. For example, several cultivars failed to yield a significant crop, even after ten years! Many others produced fruit that was inherently poor quality and/or very susceptible to disease. A summary of the results of this study, including lists of cultivars that were found suitable or not suitable for Northern Michigan, are shown in Appendix 2 and 3.

Other existing information on cider apple cultivars include Orange Pippin (<http://www.orangepippin.com>), a web-based resource developed by apple enthusiasts and web designers in Michigan and Britain. Although it focuses on culinary apples and contains mostly anecdotal information, it includes some otherwise hard to find information on several cultivars often used for hard cider. Several existing texts on apples and/or cider making<sup>7-9</sup> contain descriptions of cultivars, often with anecdotal and brief information on their production traits. Other online resources<sup>10-12</sup> catalog traits of various apple cultivars, albeit without focus on cider.

Obviously, existing information on cider apple cultivars is limited by the few number of organized

research projects on cider apple traits. A cider-specific variety trial was initialized in 2016 at the Clarksville Research Center in Clarksville, MI. It is intended that this collection will eventually be a working cider apple production orchard and include 150 cider cultivars, maintained on three high-density systems. These will be assessed over the next ten years for production traits including vigor, yield, and biennial bearing, as well as disease resistance, fruit traits and juice chemistry.

Although many growers will probably rely on traditional, time-tested cider cultivars for cider making, the vast diversity of apple varieties offers the potential to create ciders with nearly unlimited styles and flavors. For example, a small assortment of domestic and hybrid varieties produce juice that can be pink to dark red in color<sup>13-14</sup>. These cultivars have not been grown for culinary use and can be classified as ‘Bittersweets’ and ‘Bittersharps’. Over the last few MSU has been conducting a variety trial of a few dozen of these red-juiced varieties, and a few selections have been tested for cider use with great initial results. ‘Otterson’ (origin unknown) is disease resistant, extremely productive and produces large fruit with high phenolic content and excellent storage capacity. ‘Cranberry’ (R.L. Wodarz) produces large quantities of egg-sized fruit with high acid content, high sugar levels and a strong berry flavor. Both are distinguished from most red-juiced varieties by the intensity of the juice color. ‘Otterson’ juice has already been incorporated into a commercial hard cider by Short’s Brewing Company (Bellaire, MI)<sup>15</sup>.

Finally, new apple cultivars are becoming continuously available, and many may be found suitable for use in cider. The Midwest Apple Improvement Association (MAIA) is a breeding/selection cooperative targeting the Midwestern states including Michigan. MAIA is continuously releasing new cultivars, and many are being analyzed for juice qualities by groups at Ohio State University and MSU<sup>16</sup>. In addition, MSU is now developing new red-juiced cultivars with the goal of even more intense juice color, increased size, higher phenolics, and better flavor. These cultivars, designated Michigan PureRed, are now being evaluated and should become available to growers over the next ten years.

## Useful links to academic resources

Michigan State University Apple Extension Site  
<http://msue.anr.msu.edu/topic/info/apples>

Cornell University Hard Cider Resource Website  
<https://hardcider.cals.cornell.edu/>

Washington State University Hard Cider Resource Website  
<http://cider.wsu.edu/>

'Hard Cider Varieties Suitable for Northern Michigan' Powerpoint  
[http://agbioresearch.msu.edu/uploads/files/Research\\_Center/NW\\_Mich\\_Hort/Training\\_Pruning\\_Varities/HardCiderVar2012Expo.pdf](http://agbioresearch.msu.edu/uploads/files/Research_Center/NW_Mich_Hort/Training_Pruning_Varities/HardCiderVar2012Expo.pdf)

2017 USDA Malus Collection Scion-wood Request form  
<https://www.ars.usda.gov/ARUserFiles/80600500/ClonalCatalogs/2017/MCatalog17.pdf>

## Funding Support



AgBioResearch  
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Figure 7. Freshly pressed juice from the cultivars 'Otterson' and 'Mutsu' in a 1:1 ratio.

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|                         | Plant ID                  | Cultivar/Variety Name      | Fire Blight Resistance | Avg. Brix | Comments |
|-------------------------|---------------------------|----------------------------|------------------------|-----------|----------|
| Very Early Harvest Date | PI 588995                 | Antonovka Kamenichka       | -                      | 13        | Vigorous |
|                         | PI 588846                 | Battleford                 | -                      | 14.5      | Vigorous |
|                         | PI 588843                 | Bessemianka Michurina      | -                      | 14.4      | Juicy    |
|                         | PI 589043                 | Bietigheimer               | +                      | 12.6      |          |
|                         | PI 588835                 | Burgundy                   | -                      | 11.2      | Vigorous |
|                         | PI 588857                 | Caravel                    | -                      | 11.9      |          |
|                         | PI 588803                 | Chestnut Crab              | -                      | 18.7      | Juicy    |
|                         | PI 588837                 | Gravenstein Washington Red | -                      | 13.8      | Vigorous |
|                         | PI 588939                 | Honeygold                  | -                      | 14.2      | Vigorous |
|                         | PI 588878                 | Lodi                       | -                      | 12.2      | Vigorous |
|                         | PI 589105                 | Maiden Blush               | -                      | 11.8      |          |
|                         | PI 589112                 | Melba                      | -                      | 11        |          |
|                         | PI 589099                 | Perrine Yellow Transparent | -                      | -         |          |
|                         | PI 589054                 | Red Astrachan              | -                      | 12.1      | Vigorous |
|                         | PI 588970                 | Shaw Ribston               | -                      | 13.3      | Vigorous |
|                         | PI 588819                 | Vista Bella                | -                      | 12.8      | Vigorous |
| PI 588779               | Wealthy Double Red PC-130 | -                          | 13                     |           |          |
| PI 588859               | Yellow Transparent        | -                          | 10.9                   |           |          |
| Early Harvest Date      | PI 588789                 | Antonovka Shafran          | -                      | 15        | Vigorous |
|                         | PI 588808                 | Bulmer's Norman            | -                      | 14.6      | Vigorous |
|                         | PI 588954                 | Fall Pippin                | -                      | 13.1      | Vigorous |
|                         | PI 588884                 | Lord Lambourne             | -                      | 14.5      | Vigorous |
|                         | PI 589063                 | Lord Seedling              | -                      | 13.7      |          |
|                         | PI 589124                 | McClintock Grimes          | -                      | 14.2      |          |
|                         | PI 588798                 | Rambo-Red Summer           | -                      | 11.5      | Vigorous |
|                         | PI 588840                 | Ribston                    | -                      | 14.6      | Vigorous |
|                         | PI 588871                 | Spartan                    | +                      | 13.4      | Vigorous |
|                         | PI 589081                 | Sweet Alford               | -                      | 18.9      |          |
|                         | PI 588788                 | Wealthy                    | -                      | 11.8      |          |

Appendix 1. Traits of cider apple cultivars found in the NPGS/NGRP. "+" or "-" indicates reported resistance to fireblight, respectively. All observations were made in Geneva, New York.



|                               | Plant ID     | Cultivar/Variety Name            | Fire Blight Resistance | Avg. Brix | Comments        |
|-------------------------------|--------------|----------------------------------|------------------------|-----------|-----------------|
| <b>Mid Harvest Date</b>       | PI 589018    | Cimitiere                        | -                      | 10.9      |                 |
|                               | PI 588848    | Cortland                         | -                      | 14.8      |                 |
|                               | PI 588853    | Cox's Orange Pippin              | -                      | 13        | Vigorous, juicy |
|                               | PI 589073    | Dabinett                         | +                      | 15.1      |                 |
|                               | PI 589012    | Fall Russet                      | +                      | 16.2      |                 |
|                               | PI 589040    | Gloria Mundi                     | -                      | 10.7      | Vigorous        |
|                               | PI 589126    | Golden Nugget                    | -                      | 15.2      | Juicy           |
|                               | PI 588791    | Grimes Golden                    | -                      | 15.1      | Vigorous        |
|                               | PI 588941    | Jonagold                         | -                      | 14.6      | Vigorous        |
|                               | PI 589026    | Laxton's Superb                  | -                      | 18.6      | Vigorous, juicy |
|                               | PI 588956    | Milton                           | +                      | 11.8      |                 |
|                               | PI 588981    | Mollie's Delicious               | -                      | 13.5      | Vigorous        |
|                               | PI 588772    | Monroe                           | -                      | 12.4      | Vigorous        |
|                               | PI 589077    | Mother                           | -                      | 14.5      | Vigorous        |
|                               | PI 589039    | Paragon                          | +                      | 14.3      | Juicy           |
| PI 588805                     | Tolman Sweet | -                                | 15                     | Vigorous  |                 |
| PI 588799                     | Winesap      | +                                | 13.3                   | Vigorous  |                 |
| <b>Late Harvest Date</b>      | PI 589046    | Annie Elizabeth                  | -                      | 13.1      |                 |
|                               | PI 588951    | Belle Sans Pepin                 | -                      | 15        |                 |
|                               | PI 588806    | Chisel Jersey                    | -                      | 12.2      |                 |
|                               | PI 588785    | Esopus Spitzenburg               | -                      | 14.9      |                 |
|                               | PI 589072    | Ingram                           | -                      | 12.7      | Vigorous, juicy |
|                               | PI 588943    | Liberty                          | +                      | 14        | Vigorous        |
|                               | PI 589042    | Middleton Fameuse                | -                      | 12.3      |                 |
|                               | PI 588971    | Roxbury Russet                   | -                      | 16.3      | Vigorous        |
|                               | PI 589125    | Sergeant Russet Golden Delicious | -                      | 15.6      |                 |
|                               | PI 588793    | Snow                             | -                      | 13.6      |                 |
|                               | PI 589025    | Splendor (Stark)                 | -                      | 12.4      |                 |
|                               | PI 588975    | Stayman                          | -                      | 13.9      | Vigorous        |
|                               | PI 589038    | Turley                           | -                      | 12.5      | Vigorous        |
| <b>Very Late Harvest Date</b> | PI 589117    | Arkansas Black                   | -                      | 13.3      |                 |
|                               | PI 588953    | Ben Davis                        | -                      | 11.2      |                 |
|                               | PI 589100    | Red Spitzenburg                  | -                      | 17        |                 |
|                               | PI 588778    | Virginia Gold                    | -                      | 14.1      | Vigorous        |
|                               | PI 588988    | Wagener                          | -                      | 12.6      | Vigorous        |
|                               | PI 588861    | Winter Banana                    | -                      | 13.7      | Vigorous        |
|                               | PI 588773    | Yellow Newtown Pippin            | -                      | 13.2      | Vigorous        |

Appendix 1. Traits of cider apple cultivars found in the NPGS/NGRP. "+" or "-" indicates reported resistance to fireblight, respectively. All observations were made in Geneva, New York.

| Variety/Cultivar    | Yield    | Growth Rate     | Harvest (GDD <sub>base42</sub> ) | Juice Yield (L/lbs.) | Avg. Brix |
|---------------------|----------|-----------------|----------------------------------|----------------------|-----------|
| Adam's Apple        | Moderate | Vigorous        | 3341                             | 0.17                 | 12.5      |
| Bedan               | Moderate | Vigorous        | 3162                             | 0.05                 | 13.2      |
| Binet Rouge         | Moderate | Low vigor       | 3326                             | 0.07                 | 14.2      |
| Brown Snout         | High     | Moderate vigor  | 3308                             | 0.11                 | 15.4      |
| Brown Thorn         | High     | Vigorous        | 3493                             | 0.12                 | 15.2      |
| Brown's Apple       | Moderate | Vigorous        | 3719                             | 0.15                 | 13.6      |
| Balmer's Norman     | Moderate | Vigorous        | 3020                             | 0.14                 | 13.6      |
| Burgandy            | Moderate | Vigorous        | 3000                             | 0.17                 | 12.2      |
| Claygate Pearmain   | Moderate | Low vigor       | 3311                             | 0.15                 | 15.9      |
| Creston             | High     | Moderate vigor  | 3255                             | 0.20                 | 13.9      |
| Ellis Bitter        | Moderate | Vigorous        | 2978                             | 0.09                 | 13.6      |
| Frequin Rouge       | Low      | Vigorous        | 3144                             | 0.16                 | 17.0      |
| Golden Pippin       | High     | Low vigor       | 3280                             | 0.17                 | 13.4      |
| Grenadier           | Moderate | Vigorous        | 2903                             | 0.16                 | 11.7      |
| King of Pippins     | Moderate | Moderate vigor  | 3347                             | 0.16                 | 14.5      |
| Macoun              | Moderate | Vigorous        | 3510                             | 0.21                 | 13.2      |
| Margil              | Moderate | Moderate vigor  | 3582                             | 0.09                 | 16.0      |
| Mettais             | Moderate | Highly vigorous | 3582                             | 0.09                 | 16.0      |
| Michelin            | High     | Moderate vigor  | 3296                             | 0.13                 | 14.9      |
| Nehou               | Moderate | Moderate vigor  | 3106                             | 0.14                 | 15.1      |
| Nickajack           | High     | Low vigor       | 3400                             | 0.20                 | 13.2      |
| Orleans Reinette    | Moderate | Moderate vigor  | 3398                             | 0.11                 | 17.1      |
| Pine Golden Pippin  | Moderate | Moderate vigor  | 3442                             | 0.10                 | 16.3      |
| Standbridge Cluster | Moderate | Highly vigorous | 3442                             | 0.10                 | 16.3      |
| Sweet Coppin        | High     | Highly vigorous | 3442                             | 0.11                 | 12.6      |
| Vilbrie             | High     | Moderate vigor  | 3373                             | 0.16                 | 14.0      |

Appendix 2. Cultivars found with good potential for Michigan.

| Cultivar/Variety Name | Reason             |
|-----------------------|--------------------|
| Adams Pearmain        | Low or no yield    |
| Champlain             | Low or no yield    |
| Court Royal           | Poor fruit quality |
| Cox Pippen            | Poor fruit quality |
| Dafflin               | Low or no yield    |
| Domains               | Low or no yield    |
| Fenouillet de Ribours | Low or no yield    |
| Fenouillet Gris       | Low or no yield    |
| Harry Master Jersey   | Low or no yield    |
| Kerry Pippen          | Poor tree health   |
| Kingston Black        | Poor fruit quality |
| Major                 | Poor fruit quality |
| Marin Ouyfray         | Low or no yield    |
| Muscadet de Dieppe    | Poor fruit quality |
| Old Non Pareil        | Poor fruit quality |
| Stoke Red             | Poor tree health   |

Appendix 3. Cultivars found to be not suitable for Michigan.