

MSU Extension Fruit Research Sites

Updated 10/01/2020

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Project Background

The Flathead and Bitterroot Valleys are the largest production regions in Montana for commercial tree fruits like apples, pears, plums, and cherries. Many other parts of the state are lacking in fruit production, leaving rural residents without easy access to fresh, affordable fruit.

In 2012, MSU Extension was awarded a grant to establish fruit tree research sites outside of the Flathead and Bitterroot Valleys. MSU Extension personnel Toby Day and Brent Sarchet were the project leads. Using the results of the study, project goals included providing recommendations for appropriate cultivars for each region, developing fruit care resources for growers, and providing fruit tree outreach and education. Fruit tree research sites were planted between 2013 and 2016.

The project was transferred to MSU-WARC in early 2019, following project leads' departure from MSU. In the spring of 2019, Chase Anderson of MSU-WARC worked to contact both Extension personnel and private landowners involved with these sites and coordinated visits to collect data regarding plots and trees.

Highlights

Before planting, one must [consider a multitude of variables](#), including site selection, design and management, severe weather, and pest and disease incidence. Individual research sites were managed differently ([Table 2](#)) and environmental conditions varied ([Table 1](#)). Many cultivars had multiple replacements over several years, [which](#) confounds comparisons among cultivars and sites. However, survival rates provide a commentary regarding cultivars' robustness to extremes in Montana's harsh climate. Tree survival rates averaged across sites and cultivars were 63% for apples, 45% for pears, and 46% for plums ([Tables 8, 9, and 10](#)).

As of spring 2019, the best-performing cultivars in terms of survival were 'Zestar!' apple and 'Mount Royal' and 'Toka' plum (see [Fruit Tree Cultivars](#), below). Although rootstock is an important consideration that could influence tree survival, this information was not available and so was not considered in [data analyses](#). As of spring 2019, we can summarize the following:

- **Apples:** 'Northern Lights' had a lower than average survival rate relative to 'Goodland,' 'Honeycrisp,' 'Frostbite,' 'Sweet 16,' and 'Zestar!.' 'Zestar!' had greater survival rates than average; two site managers noted this variety as a site favorite.
- **Pears:** There was no statistical difference in survival rates among core pear cultivars 'Golden Spice,' 'Luscious,' 'Parker,' 'Patten,' and 'Ure.' These pear cultivars were selected for the research trial due to their cold tolerance, but less is known about their fire blight resistance. Additionally, one site noted difficulties ripening the fruit, but it is unclear whether these pears exhibit typical "summer" vs "winter" ripening. We will explore these questions further as resources (and fruit production) allow.
- **Plums:** Survival rates were better for 'Mount Royal' and 'Toka' plum varieties, relative to 'Pipestone.' However, plums generally bloom earlier than apples and pears, which could make plums more prone to frost damage. We are planning to collect data on plum bloom timing relative to the other fruit species at two locations this spring (2020).
- **Sour cherries:** 'Evans Bali' sour cherry was planted at several sites, but not enough sites were represented to analyze survival rates. Note that MSU-WARC has research trials with these and other cold hardy small fruits.

A 2015 project summary is also available, with recommendations for [growing fruit trees in Montana](#). See also this updated list of [considerations and resources for growing apple trees](#).

Fruit Tree Cultivars

Each of the 10 sites has a core group of cultivars replicated at all the sites, with three replications of each cultivar at each site. Sites with additional space have additional cultivars, some of which are replicated at other sites. The core cultivars were selected based upon anecdotal information that they would perform in Montana, and that they could be procured from wholesale growers.

Cultivars planted at all sites:

Apple: 'Honeycrisp,' 'Sweet 16,' 'Northern Lights,' 'Goodland,' and 'Zestar!'

Pear: 'Parker,' 'Patten,' 'Golden Spice,' 'Ure,' and 'Luscious'

Plum: 'Mount Royal,' 'Pipestone,' and 'Toka'

Cultivar descriptions by Toby Day and Brent Sarchet

KEY:

Fire Blight Resistance Code – R.D. Koski and W.R. Jacobi, Colorado State University; University of Minnesota Extension, MSU Extension

* High Degree of Susceptibility

** Moderately Susceptible

*** Moderately Resistant

?? Unknown Susceptibility

Other Symbols:

◇ Best survival rates across the state

Apple

'Arkansas Black' – Old cultivar discovered in Arkansas in 1870; known for good storage. *

'Blondee' – Cultivar discovered in Ohio in 1998; early ripening. ??

'Carroll' – 'Moscow' pear x 'Melba' cross developed at the Experimental Farm in Morden, Manitoba in 1961. Excellent eating apple. Not as vigorous as other apple cultivars. ***

'Chestnut Crabapple' – University of Minnesota release in 1949. ***

'Cox's Orange Pippin' – Originates to England in 1825. **

'Frostbite' – A 'Malinda' seedling released from the University of Minnesota in 2008; grandparent of 'Honeycrisp' and parent of 'Keepsake' and 'Sweet 16.' ??

'Gale Gala' – A 'Gala' sport discovered by Wally Gale in his Malaga, WA orchard. **

'Ginger Gold' – A seedling discovered in the Harvey orchard near Lovingston, Virginia in 1980. *

'Goodland' – Developed from a 'Patten Greening' seedling at the Experimental Farm in Morden, Manitoba in 1931. Excellent eating apple, and excellent cold hardiness. Best performing apple cultivar in the research. **

'Good Mac' – 'Goodland' x 'McIntosh' cross released from the Experimental Farm in Morden, Manitoba; one of the best performing apple cultivars in the trial. ***

'Gravenstein' – Old cultivar originating from Denmark in the 1700's. Questionable cold hardiness east of the divide. **

'Honeycrisp' – 'Macoun' x 'Honeygold' release from the University of Minnesota in 1991. **

'Northern Lights' – 'Haralson' x 'McIntosh' cross made in 1938 at Geneva, New York and introduced from North Dakota State University in 1990. It has not performed in the research; we have had to replace them frequently from winter kill. ***

'Mutsu' – 'Golden Delicious' x 'Indo' cross developed from the Aomori Apple Experiment Station in Japan, 1937. **

'Prairie Magic' – 'Goodland' x 'Mantet' cross released by Mr. Wilfred Drysdale of Neepawa, Manitoba. Limited number of propagators. ??

'Ruby Mac' – 'McIntosh' sport. ***

'Smokehouse' – Old cultivar discovered in Pennsylvania in 1837. ***

'Stayman Winesap #20' – A cultivar of the original 'Stayman Winesap' discovered by Dr. J Stayman of Leavenworth, Kansas in 1886. Known for its long shelf life. **

'Sweet 16' – University of Minnesota release in 1977; good cold hardiness. ***

'Wealthy' – Old seedling cultivar discovered in 1869 in Minnesota; a popular choice in many of Montana's first orchards. It is still a dominate cultivar in heritage orchards located across the state where trees are 100 plus years old. *

'Zestar!' ◇ – 'State Fair' x 'Minnesota 1691' cross released from University of Minnesota in 1999. One of the best apple cultivars in the trial; great flavor; good cold hardiness. **

Pear

'Clapp's Favorite' – Discovered in Massachusetts in the 1800s. *

'Flemish Beauty' – A seedling discovered in Belgium in the early 1800's; very cold hardy with excellent fruit; few propagators of this cultivar. *

'Golden Spice' – A release from the University of Minnesota in 1949; best performing pear cultivars in our research; small fruit but makes a wonderful cider and is very cold hardy. ??

'John' – 'Aspa' x 'Siberian' pear cross released from the University of Saskatchewan in 1960; vigorous growth, very cold hardy, early blooms (late April in Helena area) are susceptible to frost damage. ??

'Luscious' – A South Dakota State University release; questionable cold hardiness east of the divide. **

'Parker' – A University of Minnesota release in 1934; questionable cold hardiness east of the divide. ??

'Patten' – Seedling discovered in Iowa; questionable cold hardiness east of the divide. ??

'Pioneer' – Developed by A.L. Young of Brooks, Alberta in 1936; good cold hardiness. ??

'Ure' – A release of the Morden, Manitoba Research Station in 1978. ??

Plum

'Mount Royal' ◇ – A European plum with dark blue fruit.

'Pipestone' – A University of Minnesota release in 1942.

'Toka' ◇ – A *Prunus americana* x *simonii* cross introduced in 1911 by Dr. Neils Hansen.

Sour Cherry

'Evans Bali' – Discovered by Leuan Evans in an old orchard near Edmonton, Alberta, Canada in 1920s.

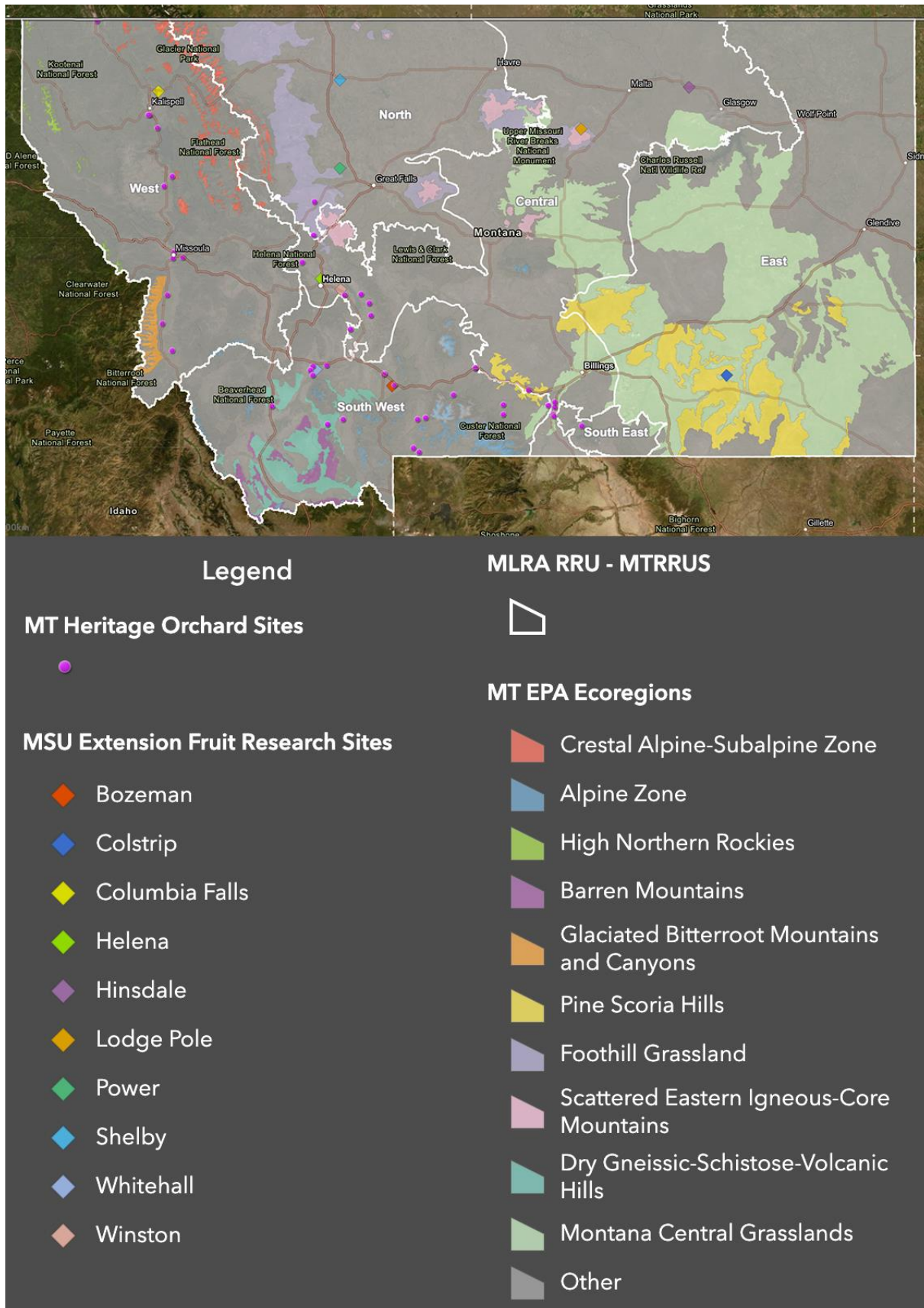
Research Site Access

Some MSU Extension Fruit Research Sites are on public land, while others are on private land. To visit an MSU Extension Fruit Research Site, please work with local personnel or extension, as listed by site, below. Plot maps, last updated in spring of 2019, are [shown below](#) and are also available as a [downloadable Excel document](#).

City / nearest city	County	Contact name and affiliation	Contact information
Bozeman	Gallatin	Mac Burgess, MSU-Plant Sciences and Plant Pathology Department	406-994-3510, mburgess@montana.edu
Colstrip	Rosebud	Melissa Ashley, MSU-Extension	406-346-7320, melissa.ashley@montana.edu
Columbia Falls	Flathead	Pat McGlynn, MSU-Extension or Shari Johnson, Columbia Falls Junior High	406-758-5553, pmcglynn@montana.edu 406-892-6530, s_johnson@cfmthschools.net
Helena	Lewis and Clark no responses from landowners in 2019	Mat Walter	406-447-8350, m.petersonwalter@montana.edu
Hinsdale	Valley	Shelley Mills, MSU-Extension	406-228-6241, smills@montana.edu
Lodge Pole	Blaine	Hillary Maxwell, MSU-Extension	406-353-2656, maxwell_hillary@yahoo.com
Power	Teton		406-466-2491, teton@montana.edu
Shelby	Toole	Kim Woodring, MSU-Extension	406-424-8350, kimberly.suta@montana.edu
Whitehall	Madison-Jefferson	Kaleena Miller, MSU-Extension	406-287-3282, kaleena.miller@montana.edu
Winston	Broadwater no responses from landowners in 2019	Allison Kosto, MSU-Extension	406-266-9242, allison.kosto@montana.edu

Research Site Locations

The map below illustrates over 70 [heritage fruit orchards](#) (with trees >75 years old) throughout the state along with the present MSU Extension research sites, overlaid on NRCS [Montana Rangeland Resource Units](#) and Montana EPA [Ecoregions](#). See the [interactive map](#) online.



Site photos

[Site photos from the spring of 2019](#), taken by Chase Anderson

The Future of the MSU Extension Fruit Research Sites

Funding specific to the MSU Extension Fruit Research sites, from the Montana Department of Agriculture - Montana Specialty Crop Block Grant, ended March 31, 2020. MSU-WARC will continue to coordinate research endeavors (e.g. insect trapping and bloom phenology) with sites and provide site support where possible and appropriate. For more information, please contact [Rachel Leisso](#).

Orchard Notes and Maps

Following are site maps and field notes by Chase Anderson for individual sites. Maps show planting date following the name of each tree. Replacement trees are indicated by 'replanted' after tree name as well as by highlighting cells orange. Trees that are crossed out died and will be removed.

Bozeman

Row 8	Row 7	North													
Golden Spice pear (rep 6) Planted May 2013 *		<p>Site visit notes, 4/24/2019</p> <ul style="list-style-type: none"> Trees look great and are producing fruit. This site has many unique cultivars that weren't part of the original study. Rows 1,6,7,8 contain the original planted trees for continued monitoring. Rows 1 and 6 are the best producers and include: 'Goodland' apple, 'Carroll' apple, Mount Royal' plum, 'Toka' plum, 'Pipestone' plum, 'Luscious' pear, 'Parker' pear, and 'Golden Spice' pear. <p>Bozeman Site Map</p> <p>Trees were initially planted in May 2013. No rootstock information is available for this site. Eighteen new apple trees were planted in spring 2020 (six 'Enterprise' apple on rootstock G11 rootstock, six 'Roxbury Russet' apple on Bud118 rootstock, and six 'Zestar!' on rootstock G11). Map updated 10/2020. Download an 11" x 17" printable map.</p>													
Sweet 16 apple (rep 1) *	Goodland apple (rep 6) Planted May 2013 *														
Sweet 16 apple (rep 2) *	Zestar apple (rep 1) Planted May 2013 *														
Sweet 16 apple (rep 1) *															
Zestar apple (rep 2) Planted May 2013 *	Zestar apple (rep 3) Planted May 2013														
	GoodMac apple (rep 1) Planted May 2013	Dead Carroll apple (rep 1) Planted May 2013	Dead Carroll apple (rep 2) Planted May 2013	Carroll apple (rep 3) Planted May 2013	Goodland apple (rep 1) Planted May 2013	Goodland apple (rep 2) Planted May 2013	Goodland apple (rep 3) Planted May 2013	Golden spice pear (rep 3) Planted May 2013 *	Golden Spice pear (rep 2) Planted May 2013 *	Golden Spice pear (rep 1) Planted May 2013 *	Goodland apple (rep 4) Planted May 2013 *			Ure pear (rep 1) (metal tag) *	Row 6
Zestar apple (rep x) Planted May 2020	Zestar apple (rep x) Planted May 2020	Dead Northern Lights apple (rep 2) Dead Planted May 2013 *					Montmorency Cherry Planted May 2013 *		Dead ? Golden Spice pear (rep 5) Planted May 2013 *		Golden Spice pear (rep 4) Planted May 2013 *			Pembina plum Planted May 2013 *	Row 5
Zestar apple (rep x) Planted May 2020	Zestar apple (rep x) Planted May 2020	Mount Royal plum (rep 4) Planted May 2013 *									Dead no tag/ unknwn apple	Dead no tag/ unknwn apple		Ure Pear (rep 2) Planted May 2013 *	Row 4
Zestar apple (rep x) Planted May 2020	Zestar apple (rep x) Planted May 2020			Whitney Crab Planted May 2013		McClellan Crab apple Planted May 2013		Kerr Crab apple Planted May 2013 *		Goodland apple (rep 5) Planted May 2013 *	Roxbury Russet apple (rep 3) Planted May 2020	Roxbury Russet apple (rep 2) Planted May 2020	Roxbury Russet apple (rep 1) Planted May 2020	Enterprise apple (rep 6) Planted May 2020	Row 3
Roxbury Russet apple (rep x) Planted May 2020		Idared apple Planted May 2013 *		Collet apple Planted May 2013	Breaky apple tag on tree	Carol apple tag on tree *			Enterprise apple (rep 5) Planted May 2020	Goodland/M2 apple Planted May 2013 *	Enterprise apple (rep 4) Planted May 2020	Enterprise apple (rep 3) Planted May 2020	Enterprise apple (rep 2) Planted May 2020	Enterprise apple (rep 1) Planted May 2020	Row 2
Roxbury Russet apple (rep x) Planted May 2020	Roxbury Russet apple (rep x) Planted May 2020	Mount Royal (rep 1) plum Planted May 2013 *	Mount Royal (rep 2) plum Planted May 2013 *	Mount Royal (rep 3) plum Planted May 2013 *	Toka plum (rep 1) Planted May 2013 *			Pipestone plum (rep 4) Planted May 2013 *	Pipestone plum (rep 1) Planted May 2013 *		Toka plum (rep 4) Planted May 2013 *	Luscious pear (rep 1) Planted May 2013 *	Luscious pear (rep 2) Planted May 2013 *	Luscious pear (rep 3) Planted May 2013 *	Row 1
* = Trees included in 2019 - 2021 Apple Phenology Bloom Study - Ongoing															
KEY:		Empty	Pear	Apple	Plum	Cherry	Dead - some questionable dead - on watch status	Girdled - all girdled trees are on 'watch' status							

Colstrip

Site visit notes 4/10/2019

- Trees have signs of fire blight, deer damage, and need to be pruned. A couple have fallen over, and most are dead or dying (trees with lines through the name appeared dead in the spring of 2019).
- 'Goodland' apples were still producing; they got a small basket of big red apples last year.

Colstrip Site Map

Trees were initially planted in April of 2013. No rootstock information is available. This map was last updated in April 2019. Orange cells indicate replants. Lines through names indicate trees were dead as of spring 2019.

N

'Ure' pear replanted April 2014 (rep 1)	'Ure' pear replanted April 2014 (rep 2)	'Ure' pear planted April 2014	'Golden Spice' pear planted April 2013	'Golden Spice' pear planted April 2013 (rep 1)	'Golden Spice' pear planted April 2013 (rep 2)	'Toka' plum planted April 2013	'Toka' plum planted April 2013	'Toka' plum planted April 2013	'Parker' pear planted April 2013	'Parker' pear planted April 2013	'Parker' pear planted April 2013 (rep 1)	'Mount Royal' plum planted April 2013 (rep 1)	'Mount Royal' plum planted April 2013 (rep 2)	'Patten' pear planted April 2013
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W

'Luscious' pear replanted April 2014 (rep 1)	'Luscious' pear planted April 2014	'Luscious' pear replanted April 2014 (rep 3)	'Sweet 16' apple planted April 2013 (rep 1)	'Sweet 16' apple planted April 2013 (rep 2)	'Sweet 16' apple planted April 2013	'Pipestone' plum replanted April 2014 (rep 1)	'Pipestone' plum replanted April 2014 (rep 2)	'Pipestone' plum replanted April 2014 (rep 3)	'Honeycrisp' apple planted April 2013	'Honeycrisp' apple planted April 2013	'Honeycrisp' apple planted April 2013	'Goodlan d' apple planted April 2013 (rep 1)	'Goodlan d' apple planted April 2013 (rep 2)	'Goodland' apple planted April 2013
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Columbia Falls

Site visit notes, 3/20/2019

- Well-maintained site; Shari (site manager/school counselor) has support from the school and access to students willing to learn and work.
- The main issue is the abundance of insects, codling moths, spider mites, and aphids. Trees are producing fruit, but most of the fruit is inedible due to insect fruit damage. Note: in 2020 we are working to implement an insect management program.
- No pesticides are used because the junior high students are often in the garden helping.
- Site favorites are the 'Arkansas Black' apple (which is very sweet), 'Goodland' apples, 'Zestar!' apples; all plums and pears are doing well.
- All the 'Pipestone' plums have an abundance of aphids.

Columbia Falls Site Map

Trees were initially planted in April of 2013. No rootstock information is available. This map was last updated in April 2019. Orange cells indicate replants.

		N					
	'Sweet 16' apple planted April 2013 (rep 1)	'Northern Lights' apple planted April 2013 (rep 2)	'Northern Lights' apple planted April 2013 (rep 3)	'Golden Spice' pear planted April 2013 (rep 1)	'Golden Spice' pear planted April 2013 (rep 2)	'Honeycrisp' apple planted April 2013 (rep 4)	'Sweet 16' apple planted June 2013 (rep 4)
	'Sweet 16' apple replanted May 2018 (rep 2)	'Northern Lights' apple planted April 2013 (rep 1)	'Mount Royal' plum planted April 2013 (rep 1)	'Ure' pear planted April 2013 (rep 3)	'Golden Spice' pear planted April 2013 (rep 3)	'Honeycrisp' apple planted April 2013 (rep 5)	'Sweet 16' apple planted June 2013 (rep 5)
W	'Sweet 16' apple replanted May 2017 (rep 3)	'Honeycrisp' apple planted April 2013 (rep 3)	'Mount Royal' plum replanted may 2014 (rep 2)	'Ure' pear planted April 2013 (rep 2)	'Parker' pear planted April 2013 (rep 1)	'Honeycrisp' apple planted April 2013 (rep 6)	'Sweet 16' apple planted June 2013 (rep 6)
	'Zestar' apple planted April 2013 (rep 1)	'Honeycrisp' apple planted April 2013 (rep 2)	'Mount Royal' plum replanted may 2014 (rep 3)	'Ure' pear planted April 2013 (rep 1)	'Parker' pear planted April 2013 (rep 2)	'Patten' pear planted April 2013 (rep 3)	'Arkansas Black' apple planted May 2013 (rep 1)
	'Zestar' apple planted April 2013 (rep 2)	'Honeycrisp' apple planted April 2013 (rep 1)	'Pipestone' plum replanted may 2014 (rep 1)	'Toka' pear planted April 2013 (rep 3)	'Parker' pear planted April 2013 (rep 3)	'Patten' pear planted April 2013 (rep 2)	'Honeycrisp' apple planted April 2013 (rep 7)
	'Zestar' apple planted April 2013 (rep 3)	'Goodland' apple planted April 2013 (rep 3)	'Pipestone' plum replanted may 2014 (rep 2)	'Toka' pear planted April 2013 (rep 2)	'Luscious' pear replanted April 2016 (rep 1)	'Patten' pear planted April 2013 (rep 1)	'Frostbite' apple planted May 2015 (rep 1)
	'Goodland' apple planted April 2013 (rep 1)	'Goodland' apple planted April 2013 (rep 2)	'Pipestone' plum replanted may 2014 (rep 3)	'Toka' pear planted April 2013 (rep 1)	'Luscious' pear planted April 2013 (rep 2)	'Luscious' pear planted April 2013 (rep 3)	'Goodland' apple planted April 2013 (rep 4)

Hinsdale

Site visit notes, 5/10/2019

- Landowner said that the trees have struggled since the first planting date. The trees were planted late in the season and most of the originals died and were replaced.
- Herbicide drift killed most trees on east facing rows.
- Wind, deer, and hailstorms keep trees from producing.
- Of the original plantings, the remaining trees are two 'Prairie Magic' apple, two 'Arkansas Black' apple, three 'Zestar!' apple, one 'Goodland' apple, three 'Toka' plums, and two 'Honeycrisp' apples.
- No fruit from any trees as of 2018.
- Lines through the name indicate the tree appears dead as of spring 2019.

Hinsdale Site Map

Trees were initially planted in May of 2013 and more in May 2014. No rootstock information is available. Map last updated April 2019.

W

'Cox's Orange-Pippin' apple	'Chestnut Crab' apple
'Cox's Orange-Pippin' apple	Empty
'Cox's Orange-Pippin' apple	'Cox's Orange-Pippin' apple
'Patten' pear	'Cox's Orange-Pippin' apple
'Patten' pear	'Northom Spy' apple
'Stayman Winesap-#20' apple	'Northom Spy' apple
'Stayman Winesap-#20' apple	'Stayman Winesap-#20' apple
'Arkansas Black' apple Planted June 2013 (rep 2)	'Stayman Winesap-#20' apple
'Arkansas Black' apple Planted June 2013 (rep 1)	'Stayman Winesap-#20' apple
'Arkansas Black' apple	'Arkansas Black' apple
Empty	'Arkansas Black' apple
'Prairie Magic' apple Planted June 2013 (rep 2)	'Prairie Magic' apple (rep 3)
'Prairie Magic' apple Planted June 2013 (rep 1)	'Prairie Magic' apple (rep 4)
Empty	'Chestnut Crab' apple
'Mount Royal' plum	'Mount Royal' plum
'Mount Royal' plum	'John' pear planted June 2013 (rep 1)
'John' pear	'John' pear (rep 2)
'Ure' pear	'Parker' pear
'Ure' pear	'Parker' pear
'Ure' pear	'Luscious' pear
'Luscious' pear	'Luscious' pear
'Ure' pear	Empty
'Chestnut Crab' apple	'Zestar' apple (rep 3)
'Zestar' apple Planted June 2013 (rep 1)	'Zestar' apple (rep 2)
'Goodland' apple Planted June 2013	Crabapple
'Chestnut Crab' apple	'Gravenstein' apple
'Gravenstein' apple	'Gravenstein' apple

N

Herbicide Damage	Herbicide Damage
'Chestnut' crabapple	'Chestnut' crabapple
Empty	Empty
'Arkansas Black' apple	'Arkansas Black' apple
'Northom Spy' apple	'Evans Bali' cherry
'Northom Spy' apple	'Evans Bali' cherry
'Northom Spy' apple	'Evans Bali' cherry
'Frostbite' apple Planted June 2013 (rep 3)	'Evans Bali' cherry
'Frostbite' apple Planted June 2013 (rep 2)	'Evans Bali' cherry
'Frostbite' apple Planted June 2013 (rep 1)	'Smokehouse' apple
'Smokehouse' apple	'Smokehouse' apple
'Smokehouse' apple	'Cox's Orange-Pippin' apple
'Smokehouse' apple	'Cox's Orange-Pippin' apple
'Cox's Orange-Pippin' apple	'Cox's Orange-Pippin' apple
'Cox's Orange-Pippin' apple	'Good Mac' apple
'Good Mac' apple	"Pipestone' plum' plum 'Toka' plum replanted May 2014
'Toka' plum Planted June 2013 (rep 1)	'Pipestone' plum
'Toka' plum replanted May 2014 (rep 2)	'Pipestone' plum
'Toka' plum replanted May 2014 (rep 3)	'Golden Spice' pear
'Parker' pear	'Golden Spice' pear
'Patten' pear	'Golden Spice' pear
'Patten' pear	'Chestnut' crabapple
Empty	Empty
'Patten' pear	'Honeycrisp' apple planted June 2013
'Honeycrisp' apple	'Honeycrisp' apple planted June 2013
'Manchurian' crabapple	'Sweet 16' apple
'Northom Lights' apple	'Northom Lights' apple
'Northom Lights' apple	'Manchurian' crabapple

'Pipestone' plum or 'Toka' plum?

Lodge Pole

Site visit notes, 5/8/2019

- MSU Extension personnel are great about keeping the community involved with the research.
- Well-maintained site that is continuing to grow (new fence and additional trees will be added this year).
- Orchard produced some fruit in 2018.
- Most trees look healthy. Two of the 'Spartan' apples, a 'Ginger Gold' apple, and a 'Mutsu' apple are dead.

Lodge Pole Site Map

The Wasay Wakpa orchard in Lodge Pole is located at 3527 Monument Peak Rd Lodge Pole, MT. Local contacts are Liz Werk (cell 406-390-3080) and Hilary Maxwell (cell 406-390-1085). Planting date is indicated after the name of each tree. Trees were initially planted in May 2015. Rootstock information is available after cultivar name. Replacement trees are indicated by 'replanted' after tree name as well as by highlighting cells orange. Map updated September 2020.

N						
Empty	DEAD fall 2020 'Wordarz' apple Planted May 2015	Wodarz' apple Planted May 2015 (rep 2)	Empty	Empty	Empty	'Norland' apple Planted May 2016 (rep 1)
'Spartan/m9' apple Planted May 2015 (rep 6)	'Spartan/m7' apple Planted May 2015 (rep 1)	'Ginger Gold/m7' apple Planted May 2015 (rep 3)	'Ginger Gold/m7' apple Planted May 2015 (rep 4)	Rootstock only fall 2020 'Ure' pear Planted May 2015 (rep 4)	'Ure' pear Planted May 2015 (rep 3)	'Norland' apple Planted May 2016 (rep 2)
Empty	'Spartan/m7' apple Planted May 2015 (rep 2)	DEAD fall 2020 'Mutsu/m7' apple Planted May 2015 (rep 1)	DEAD fall 2020 'Mutsu' apple Planted May 2015 (rep 2)	'Patten' pear Planted May 2015 (rep 4)	'Patten' pear Planted May 2015 (rep 3)	'Norland' apple Planted May 2016 (rep 3)
'Spartan/m7' apple Planted May 2015 (rep 4)	'Zestar' apple Planted May 2015 (rep 1)	'Patten' pear Planted May 2015 (rep 1)	DEAD fall 2020 'Patten' pear Planted May 2015 (rep 2)	Space fall 2020 (presumed DEAD)'Mutsu/m7' apple Planted May 2015 (rep 4)	Space fall 2020 (presumed DEAD)'Mutsu/m7' apple Planted May 2015 (rep 3)	'Red Wealthy' apple Planted May 2016 (rep 1)
'Sweet 16' apple Planted May 2015 (rep 4)	'Zestar' apple Planted May 2015 (rep 2)	'Ure+H11 apple Planted May 2015 (rep 1)	'Ure' pear Planted May 2015 (rep 2)	'Golden Spice' pear Planted May 2015 (rep 4)	'Golden Spice' pear Planted May 2015 (rep 3)	'Red Wealthy' apple Planted May 2016 (rep 2)
'Sweet 16' apple Planted May 2015 (rep 3)	'Parker' pear Planted May 2015 (rep 1)	'Honeycrisp/bud9' apple Planted May 2015 (rep 2)	'Honeycrisp/bud9' apple Planted May 2015 (rep 3)	'Ginger Gold/m7' apple Planted May 2015 (rep 4)	'Ginger Gold' apple Planted May 2015 (rep 7)	'Red Wealthy' apple Planted May 2016 (rep 3)
'Parker' pear Planted May 2015 (rep 4)	'Parker' pear Planted May 2015 (rep 2)	'Ginger Gold/111' apple Planted May 2015 (rep 2)	'Ginger Gold/m9' apple Planted May 2015 (rep 4)	'Honeycrisp/bud9' apple Planted May 2015 (rep 4)	'Honeycrisp/bud9' apple Planted May 2015 (rep 3)	'State Fair' apple Planted May 2016 (rep 1)
'Parker' pear Planted May 2015 (rep 3)	'Sweet 16' apple Planted May 2015 (rep 1)	'Frostbite' apple Planted May 2015 (rep 1)	'Frostbite' apple Planted May 2015 (rep 2)	'Summercrisp' apple Planted May 2015 (rep 4)	'Summercrisp' apple Planted May 2015 (rep 3)	'State Fair' apple Planted May 2016 (rep 2)
'Toka' plum Planted May 2015 (rep 3)	'Sweet 16' apple Planted May 2015 (rep 2)	'Honeycrisp/bud9' apple Planted May 2015 (rep 1)	'Honeycrisp/bud9' apple Planted May 2015 (rep 2)	'Ginger Gold/m9' apple Planted May 2015 (rep 7)	'Ginger Gold/m9' apple Planted May 2015 (rep 6)	DEAD fall 2020 'State Fair' apple Planted May 2016 (rep 3)
'Toka' plum Planted May 2015 (rep 2)	'Toka' plum Planted May 2015 (rep 1)	'Golden Spice' pear Planted May 2015 (rep 1)	'Golden Spice' pear Planted May 2015 (rep 2)	'Ginger Gold/111' apple Planted May 2015 (rep 8)	'Ginger Gold/111' apple Planted May 2015 (rep 5)	'Wodarz' apple Planted May 2016 (rep 3)
'Zestar' apple Planted May 2015 (rep 4)	'Spartan/m7' apple Planted May 2015 (rep 3)	'Ginger Gold/m9' apple Planted May 2015 (rep 1)	'Ginger Gold/m9' apple Planted May 2015 (rep 2)	'Frostbite' apple Planted May 2015 (rep 4)	'Frostbite' apple Planted May 2015 (rep 3)	'Chestnut Crab' apple Planted May 2016 (rep 1)
'Zestar' apple Planted May 2015 (rep 3)	'Spartan/m7' apple Planted May 2015 (rep 1)	'Goodland' apple Planted May 2015 (rep 1)	'Goodland' apple Planted May 2015 (rep 2)	'Honeycrisp' apple Planted May 2015 (rep 5)	'Honeycrisp' apple Planted May 2015 (rep 4)	'Chestnut Crab' apple Planted May 2016 (rep 2)
'Mount Royal' plum Planted May 2015 (rep 1)	Dead fall 2020 'Spartan/m9' apple Planted May 2015 (rep 2)	'Summercrisp' apple Planted May 2015 (rep 1)	'Summercrisp' apple Planted May 2015 (rep 2)	'Goodland' apple Planted May 2015 (rep 4)	'Goodland' apple Planted May 2015 (rep 3)	DEAD fall 2020 'Chestnut Crab' apple Planted May 2016 (rep 3)

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Power

Site visit notes, 5/22/2019

- Owners are enthusiastic about continuing site, but the orchard has only seven live trees remaining.
- The site has lots of tall grass, signs of fire blight, and deer damage.
- 'Goodland' apple and a 'Sweet 16' apple were budding out at the time of site visit.
- Trees have not produced any fruit thus far.
- Trees with a line through the name appeared dead at the time of the site visit.

Power Site Map

Trees were initially planted in May of 2013. No rootstock information is available. This map was last updated in April 2019. Orange cells indicate replants.

		N								
	'Golden-Russet' pear	'Goodland' apple	'Mutsu' apple planted May 2013	'Mutsu' apple	'Blondee' apple	'Goodland' apple Replanted April 2016 (rep 2)	'Blondee' apple	'Blondee' apple	'Frostbite' apple	'Redstar' peach
	'Chestnut Crab' apple Replanted April 2016 (rep 1)	'Zestar' apple	'Zestar' apple planted May 2013 (rep 2)	'Veteran' peach	'Mutsu' apple	'Mutsu' apple	'Blondee' apple	'Blondee' apple	'Spartan' apple planted May 2013 (rep 2)	'Rudymac' apple
W	'Chestnut Crab' apple Replanted April 2016 (rep 2)	'Patten' pear	Unknown	'Kaz' apple	'Golden Spice' pear planted May 2013 (rep 2)	'Sweet 16' apple Replanted April 2016 (rep 1)	'Golden Spice' pear			
	'Spartan' apple	'Sweet 16' apple	'Chestnut Crab' apple	'Spartan' apple	'Patten' pear	'Sweet 16' apple	'Pipestone' plum			
	'Toka' plum planted May 2014	'Spartan' apple	'Chestnut Crab' apple	'Rubymac' apple	'Chestnut Crab' apple					
	'Carrol' apple	'Toka' plum	'Patten' pear	'Spartan' apple	'Rubymac' apple					

Shelby

Site visit notes, 5/1/2019

- The orchard has had rough winters, but overall growth is good on most of the original cultivars, especially in rows 3 and 4.
- Herbicide spray drift from adjacent property; not very many of the original trees are left on rows 1 and 2.
- Some of the site issues include strong wind, deer getting through fence, and harsh winters.
- This site has lots of replants; lines through name indicate tree appeared dead at the time of site visit.
- Very little overall fruit on the original trees.

Shelby Site Map

Trees were initially planted in May 2015. No rootstock information is available. This map was last updated in April 2019. Orange cells indicate replants.

		N	
		Herbicide Damage	Herbicide Damage
	' Zester ' apple-replanted May 2018	' Zester ' apple replanted May 2018 (rep 3)	' Zester ' apple replanted May 2018 (rep 2)
	' Sweet 16 ' apple-replanted May 2018	' Honeycrisp ' apple planted May 2015 (rep 1)	' Toka ' plum planted May 2015 (rep 1)
W	' Sweet 16 ' apple-replanted May 2018	' Golden Spice ' apple replanted May 2018 (rep 1)	' Enterprise ' apple-replanted May 2018
	' Summer Crisp ' apple-planted May 2015	' Summer Crisp ' apple-May 2015	' Goodland ' apple replanted May 2018 (rep 1)
	' Summer Crisp ' apple planted May 2015 (rep 5)	' Blondee ' apple-replanted May 2018	' Sweet 16 ' apple-replanted May 2018
	' Toka ' plum planted May 2015 (rep 3)	' Toka ' plum planted May 2015 (rep 2)	' Golden Russet ' apple-replanted May 2018
	' Goodland ' apple (rep 3) planted May 2015	' Goodland ' apple-May 2015	' Zester ' apple-replanted May 2017
	' Frostbite ' apple planted May 2015 (rep 1)	' Honey Gold ' apple-replanted May 2018	' Kinder Crisp ' apple-replanted May 2018
	' Sweet 16 ' apple planted May 2015 (rep 5)	' Summer Crisp ' apple-replanted May 2018	' Kinder Crisp ' apple-replanted May 2018
	' Honeycrisp ' apple planted May 2015 (rep 2)	' Summer Crisp ' apple-replanted May 2018	' Snow Sweet ' apple-replanted May 2018
	' Mount Royal ' plum planted May 2015 (rep 1)	' Enterprise ' apple-replanted May 2018	' Blondee ' apple-replanted May 2018
	' Parker ' pear planted May 2015 (rep 2)	' Parker ' pear planted May 2015	' Kinder Crisp ' apple-replanted May 2018
	' Summer Crisp ' apple replanted May 2018	' Summer Crisp ' apple-replanted May 2018	' Honey Gold ' apple-planted May 2015
	' Honey Gold ' apple-replanted May 2018	' Honey Gold ' apple-replanted May 2018	' Golden Russet ' apple-replanted May 2018
	' Sweet 16 ' apple planted May 2015 (rep 4)	' Sweet 16 ' apple planted May 2015 (rep 3)	' Golden Russet ' apple 5-18

Whitehall

Site visit notes, 4/26/2019

- Very well cared for; most of the original trees have survived and are producing. The landowners sell produce at the local farmers market.
- Site issues include strong winds, hailstorms, pests exposing bark, birds eating cherries.
- The landowners are willing to continue and participate in any kind of research.
- This would be a great site for visits, presentations, and workshops.
- Landowner favorites, based on taste and size, include the apple varieties 'Zestar!' 'Goodland' and 'Prairie Magic'.
- All pear cultivars have had great growth, but landowners have yet to find a way to ripen them.
- Cultivars that didn't survive were 'Golden Spice' pear and 'Arkansas Black' apple. These cultivars were replaced with 'Frostbite' apple, 'Evans Bali' cherry, and a 'Chestnut Crab' apple.

Whitehall Site Map

Trees were initially planted in May of 2014. No rootstock information is available. This map was last updated in April 2019. Orange cells indicate replants.

		NW								
		'Frostbite' apple planted May 2014 (rep 2)	'Chestnut Crab' apple Replanted May 2017 (rep 2)	'Frostbite' apple Replanted May 2017 (rep 1)	'Chestnut Crab' apple planted May 2014 (rep 1)	'Evans Bali' cherry planted May 2014 (rep 2)	'Evans Bali' cherry planted May 2014 (rep 1)	'Sweet 16' apple planted May 2014 (rep 2)	'Sweet 16' apple planted May 2014 (rep 2)	'Sweet 16' apple planted May 2014 (rep 1)
S	W	'Frostbite' apple Replanted May 2017 (rep 3)	'Frostbite' apple Replanted May 2017 (rep 4)	'Evans Bali' cherry Replanted May 2016 (rep 3)	'Honeycrisp' apple planted May 2014 (rep 1)	'Honeycrisp' apple planted May 2014 (rep 2)	'Honeycrisp' apple planted May 2014 (rep 3)	'Zestar' apple planted May 2014 (rep 1)	'Zestar' apple planted May 2014 (rep 2)	'Zestar' apple planted May 2014 (rep 3)
		Empty	Empty	Empty	'Prairie Magic' apple planted May 2014 (rep 3)	'Prairie Magic' apple planted May 2014 (rep 2)	'Prairie Magic' apple planted May 2014 (rep 1)	Empty	'Goodland' apple planted May 2014 (rep 2)	'Goodland' apple planted May 2014 (rep 1)
		'Parker' pear planted May 2014 (rep 1)	'Parker' pear planted May 2014 (rep 2)	'Parker' pear planted May 2014 (rep 3)	'Patten' pear planted May 2014 (rep 1)	'Patten' pear planted May 2014 (rep 2)	'Patten' pear planted May 2014 (rep 3)	'Ure' pear planted May 2014 (rep 1)	'Ure' pear planted May 2014 (rep 2)	'Ure' pear planted May 2014 (rep 3)
		'Mount Royal' plum planted May 2014 (rep 3)	'Mount Royal' plum planted May 2014 (rep 2)	'Mount Royal' plum planted May 2014 (rep 1)	'Pipestone' plum planted May 2014 (rep 3)	'Pipestone' plum planted May 2014 (rep 2)	'Pipestone' plum planted May 2014 (rep 1)	'Toka' plum planted May 2014 (rep 3)	'Toka' plum planted May 2014 (rep 2)	'Toka' plum planted May 2014 (rep 1)

Data Tables

Due to differences in environmental conditions, differences in site management, and low numbers of fruit trees per cultivar per site, the reader is advised to consider each site separately, although general trends among cultivar survivability and productivity can be observed.

1. [Site Environmental Conditions](#)
2. [Site Management](#)
3. [Apple Cultivars](#)
4. [Pear Cultivars](#)
5. [Plum Cultivars](#)
6. [Predicted full bloom dates of early blooming apple cultivars at research sites, 2014-2019](#)
7. [Predicted frost damage to apple blossoms at full bloom stage for average blooming varieties at research sites, 2014-2019](#)
8. [Tree survival rates](#)

Table 1. Summary of Site Environmental Conditions

Data were obtained from [NOAA](#) from the weather station nearest the orchard site. Note that elevation and environmental conditions may vary somewhat from the orchard site. See [detailed data tables here](#).

SITE	Orchard Elevation (ft)	Nearest Weather Station Elevation (ft)	Average Total Annual Precip (in)	Annual Average High (F)	Average Annual Low (F)	Extreme High Temp (F)	Extreme Low Temp (F)
Bozeman	4,888	4,775	16.6	83	13	93	-10
Colstrip	3,024	3,218	19.4	86	12	98	-12
Columbia Falls	3,057	2,957	17.0	85	14	96	-10
Helena	3,730	-	-	-	-	-	-
Hinsdale	2,162	2,182	16.8	83	2	97	-27
Lodge Pole	3,432	4,032	23.0	80	6	92	-13
Power	3,776	3,983	12.3	82	11	94	-10
Shelby	3,406	3,297	13.4	84	7	97	-20
Whitehall	4,419	4,360	41.9*	88	14	97	-9
Winston	4,097	-	-	-	-	-	-

* Precipitation data may be unreliable from this weather station

Table 2. Site Management

Three trees of each cultivar were planted to each site, usually adjacent to one another in the same row. Sites were managed differently for irrigation, weed control, pruning, and pest control, due to varying resource availability according to private ownership, school/college, and community-driven sites. mgmt = management

SITE	Irrigation	Fertility mgmt	Weed mgmt	Pruning	Deer issues?	Fireblight presence	Pest notes	Other notes
Bozeman	underground sprinkler system, 2-inch, watered per night as needed	soil fertility monitored and fertilized as needed	6ft-wide mulch rows that are tilled and prepped each season. Weeds are sprayed and controlled through herbicides applications.	yes, each year for demonstration	fenced	no	high incidence of vole girdling in the winter of 2020	
Colstrip	handlines from river	none	mowed interrows; sod goes right up to trees	none	yes, not fenced	yes	no info	
Columbia Falls	automatic sprinkler irrigation from well; watered every evening	compost from school	hand pull weeds; sod is cleared around tree at least 1 ft radius from trunk.	yes	yes, until fenced in 2018	no	severe codling moth, abundance of aphids on 'Pipestone' plums	
Helena	no response from landowners	-	-	-	-	-	-	-
Hinsdale	flood irrigated as needed	none	field is mowed; sod goes right up to trees	none	yes	yes	no info	hail damage and strong winds reported at site; herbicide damage two rows
Lodge Pole	drip system on solar powered pump, 4 gallons to each tree every evening	unknown	sod goes right up to the trunk of the trees	pruning is up to date, but trees are smaller than at other sites	unknown	no	no info	

SITE	Irrigation	Fertility mgmt	Weed mgmt	Pruning	Deer issues?	Fireblight presence	Pest notes	Other notes
Power	drip irrigation from well	none	site was mowed but in 2019 the grass was high and goes right up to trees	none	yes	yes	no info	'Goodland' and 'Sweet 16' apples were still alive
Shelby	drip system from well, 2 x 2-gallon emitters per tree	none	black weed mat around tree; interrows mowed	yes, workshops are held by MSU extension	yes	no	no info	strong winds; herbicide damage one side
Whitehall	drip on well, 2-gallon emitters per tree	soil sampling and management per test results	6 ft wide mulch strips around trees; hand removal, no herbicides, grass mowed	yes, central leader	previously; now fenced	no	aphids	hail damage and strong winds at site, birds love the cherries
Winston	no response from landowners	-	-	-	-	-	-	-

Table 3. Apple Cultivars

In most cases, three replicates were planted for each cultivar

APPLE CULTIVAR	Bozeman	Colstrip	Columbia Falls	Helena	Hinsdale	Lodge Pole	Power	Shelby	Whitehall	Winston
'Arkansas Black'			x	x	x					
'Carroll'	x			x						x
'Chestnut Crab'				x			x		x	x
'Cox's Orange Pippin'		x			x					
'Frostbite'			x		x	x	x	x	x	
'Ginger Gold'				x	x	x		x		
'Goodland'	x	x	x	x	x	x	x	x	x	x
'Goodmac'	x	x		x	x					
'Gravenstein'					x					x
'Honeycrisp'	x	x	x	x	x	x	x	x	x	
'Mutsu'				x		x	x			
'Northern Lights'		x	x	x	x		x			
'Prairie Magic'				x	x				x	

APPLE CULTIVAR	Bozeman	Colstrip	Columbia Falls	Helena	Hinsdale	Lodge Pole	Power	Shelby	Whitehall	Winston
'Red Stayman Winesap'				X						
'Spartan'						X	X			
'Sweet 16'	X	X	X	X	X	X	X	X	X	X
'Zestar!'	X	X	X	X	X	X	X	X	X	X

Table 4. Pear Cultivars

In most cases, three replicates were planted per cultivar

PEAR CULTIVAR	Bozeman	Colstrip	Columbia Falls	Helena	Hinsdale	Lodge Pole	Power	Shelby	Whitehall	Winston
'Golden Spice'	X	X	X	X	X	X	X	X	X	X
'Luscious'	X	X	X	X	X		X	X		
'Parker'	X	X	X	X	X	X	X	X	X	
'Patten'	X	X	X	X	X	X	X	X	X	X
'Ure'	X	X	X	X	X	X	X	X	X	X

Table 5. Plum Cultivars

In most cases, three replicates were planted per cultivar

PLUM CULTIVAR	Bozeman	Colstrip	Columbia Falls	Helena	Hinsdale	Lodge Pole	Power	Shelby	Whitehall	Winston
'Mount Royal'	X	X	X	X	X	X	X	X	X	X
'Pipestone'	X	X	X	X	X		X	X	X	X
'Toka'	X	X	X	X	X	X	X	X	X	

Table 6-7. Potential for frost damage during bloom, 2014-2019

One of the project goals was to determine whether fruit trees could produce fruit at novel locations in Montana. We calculated the risk for frost during bloom —which could impair fruit set —for the research sites. See/download the full data here: [MSU Extension Fruit Research Sites potential for frost damage during bloom 2014-2019](#).

Table 6. Predicted full bloom dates of early blooming apple cultivars at research sites, 2014-2019. Red cells indicate years/dates where predicted full bloom was interrupted by a frost that would have damaged at least 10% of blossoms (28.9 F or lower). Full bloom stage = 50% or more of blossoms open. Heat units accumulated prior to predicted full bloom are based on single sine modelling connected with apple bloom records from Montana in 2018-2019.

SITE	2014	2015	2016	2017	2018	2019
Bozeman	5/24/2014	4/30/2015	5/5/2016	5/12/2017	5/22/2018	6/1/2019
Colstrip	4/22/2014	3/31/2015	4/2/2016	4/2/2017	5/1/2018	4/16/2019
Columbia Falls	5/22/2014	5/10/2015	5/3/2016	5/23/2017	5/16/2018	5/21/2019
Helena	5/14/2014	4/17/2015	4/22/2016	5/4/2017	5/14/2018	5/16/2019
Hinsdale	5/22/2014	5/2/2015	5/2/2016	5/6/2017	5/16/2018	5/22/2019
Lodge Pole	5/18/2014	4/20/2015	4/20/2016	5/2/2017	5/15/2018	5/15/2019
Power	5/24/2014	4/23/2015	5/2/2016	5/11/2017	5/20/2018	5/30/2019
Whitehall	5/18/2014	4/20/2015	5/3/2016	4/21/2017	5/16/2018	5/26/2019
Winston	5/17/2014	4/24/2015	5/2/2016	5/6/2017	5/16/2018	5/26/2019

Table 7. Predicted frost damage to apple blossoms at full bloom stage for average blooming varieties at research sites, 2014-2019. Red cells indicate years/dates where predicted full bloom was interrupted by a frost that would have damaged at least 10% of blossoms (28.9 F or lower). Full bloom stage = 50% or more of blossoms open. Heat units accumulated prior to predicted full bloom are based on single sine modeling connected with apple bloom records from Montana in 2018-2019.

SITE	2014	2015	2016	2017	2018	2019
Bozeman	6/2/2014	5/22/2015	5/26/2016	5/30/2017	5/30/2018	6/11/2019
Colstrip	5/4/2014	4/16/2015	4/14/2016	4/14/2017	5/7/2018	4/24/2019
Columbia Falls	6/2/2014	5/22/2015	5/15/2016	6/1/2017	5/25/2018	5/31/2019
Helena	5/24/2014	5/2/2015	5/7/2016	5/12/2017	5/24/2018	6/1/2019
Hinsdale	5/28/2014	5/19/2015	5/17/2016	5/16/2017	5/24/2018	6/1/2019
Lodge Pole	5/26/2014	5/5/2015	5/5/2016	5/11/2017	5/23/2018	5/30/2019
Power	6/3/2014	5/14/2015	5/18/2016	5/26/2017	5/28/2018	6/6/2019
Whitehall	5/28/2014	5/6/2015	5/19/2016	5/8/2017	5/27/2018	6/5/2019
Winston	5/26/2014	5/11/2015	5/13/2016	5/23/2017	5/26/2018	6/4/2019

Tables 8-10. Tree survival and growth evaluation, spring 2019

[The tables below are also available for download here.](#)

Table 8. Apple tree survival

APPLE CULTIVAR	Bozeman	Colstrip	Columbia Falls	Helena	Hinsdale	Lodge Pole	Power	Shelby	Whitehall	Winston	Percent survival over all sites
'Arkansas Black'			1/1	unknown	2/7						38%
'Carroll'	3/3			unknown						unknown	100% (one site)
'Chestnut Crab'				unknown			1/3		1/3	unknown	33% (limited number of sites)
'Cox's Orange Pippin'		0/2			0/10						0% (limited number of sites)
'Frostbite'			1/3		3/3	4/4	1/3	1/4	1/3		55%
'Ginger Gold'				unknown	4/4	4/4		0/3			73% (limited number of sites)
'Goodland'	3/3	2/3	4/4	unknown	1/3	4/4	1/3	2/3	2/3	unknown	73%
'Goodmac'	0/1	0/3		unknown	0/2						0% (limited number of sites)
'Gravenstein'					0/3					unknown	0% (limited number of sites)
'Honeycrisp'	2/3	0/3	6/6	unknown	0/3	4/4	0/3	2/3	3/3		61%
'Mutsu'				unknown		4/4	0/4				50% (limited number of sites)
'Northern Lights'		0/3	3/3	unknown	0/3		0/3				25%
'Prairie Magic'				unknown	0/4				3/3		43% (limited number of sites)
'Red Stayman Winesap'				unknown							

APPLE CULTIVAR	Bozeman	Colstrip	Columbia Falls	Helena	Hinsdale	Lodge Pole	Power	Shelby	Whitehall	Winston	Percent survival over all sites
'Spartan'						4/4	0/4				50% (limited number of sites)
'Sweet 16'	3/3	2/3	4/6	unknown	0/3	4/4	0/3	1/3	3/3	unknown	61%
'Zestar!'	3/3	2/3	3/3	unknown	3/3	4/4	1/3	1/3	3/3	unknown	80%
Total planted	16	20	26	unknown	48	32	29	19	21	unknown	
Total alive	14	6	22	unknown	13	32	4	7	16	unknown	
Percent survival per site	87.5%	30%	85%	unknown	27%	100%	14%	37%	76%	unknown	

Table 9. Pear tree survival

PEAR CULTIVAR	Bozeman	Colstrip	Columbia Falls	Helena	Hinsdale	Lodge Pole	Power	Shelby	Whitehall	Winston	Percent survival over all sites
'Golden Spice'	3/3	2/4	3/3	unknown	0/3	4/4	1/3	0/3	0/3	unknown	50%
'Luscious'	2/4	0/3	2/3	unknown	0/3		0/3	0/3			21%
'Parker'	2/3	1/3	3/3	unknown	0/3	4/4	1/3	2/3	3/3		64%
'Patten'	1/4	0/3	3/3	unknown	0/3	3/4	0/3	0/3	3/3	unknown	38%
'Ure'	2/3	0/3	3/3	unknown	0/3	4/4	0/3	0/3	3/3	unknown	48%
Total planted	17	16	15	unknown	15	16	15	15	12	unknown	
Total alive	10	3	14	unknown	0	15	2	2	9	unknown	
Percent survival per site	59%	18%	93%	unknown	0%	94%	13%	13%	75%	unknown	

Table 10. Plum tree survival

PLUM CULTIVAR	Bozeman	Colstrip	Columbia Falls	Helena	Hinsdale	Lodge Pole	Power	Shelby	Whitehall	Winston	Percent survival over all sites
'Mount Royal'	3/3	2/3	1/3	unknown	0/3	1/3	0/3	1/4	3/3	unknown	44%
'Pipestone'	2/3	0/3	0/3	unknown	1/3	unknown	0/3	0/3	3/3	unknown	29%
'Toka'	3/4	0/3	2/3	unknown	1/3	3/3	1/3	3/3	3/3	unknown	64%
Total planted	10	9	9	unknown	9	6	9	10	9	unknown	
Total alive	8	2	3	unknown	2	4	1	4	9	unknown	
Percent survival per site	80%	22%	33%	unknown	22%	67%	11%	40%	100%	unknown	

Data Analyses

Fruit tree cultivar survival was analyzed separately according to species (apple, pear, and plum), and included only cultivars present at most sites. Survival according to species was tabulated for in contingency tables (number alive vs number dead) and analyzed for 'goodness of fit' according to chi-square distribution, where the null hypothesis is that there is no difference between the observed (alive or dead) and expected (alive or dead) frequencies. Where the overall chi-square statistic was significant, post-hoc tests were performed on adjusted residuals (to account for variation in sample size) with Bonferroni's adjusted p-value for multiple testing comparisons.

- Apples: chi-square test statistic, 12.3; chi-square critical value, 11.1; degrees of freedom, 5; n, 139; p-value, 0.031
- Pears: chi-square test statistic, 8.8; chi-square critical value, 9.5; degrees of freedom, 4; n, 121; p-value, 0.065
- Plums: chi-square test statistic, 26.8; chi-square critical value, 5.9; degrees of freedom, 2; n, 71; p-value, 0.000001

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File downloaded from: http://agresearch.montana.edu/warc/research_current/MSU_Extension_Fruit_Research_Sites.html