MONTANA STATE UNIVERSITY
EXTENSION

EB0222

Growing Fruit Trees
in Montana

Hinsdale fruit tree cultivar research site in Valley County.

Growing Fruit Trees in Montana, EB0222

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Introduction and Background

The Bitterroot and Flathead Valley of Western Montana contain the majority of the fruit production in Montana. While production in these areas does not compare to production in New York, Washington or Michigan, there are many commercial orchards; the number of orchards, however is extremely reduced from the boom era of the late 1800s and early 1900s when growers in these regions of Montana shipped fruit all over the country.

Montana's Bitterroot Valley proved conducive to growing apples by early settlers enticed westward by the Homestead Act of 1862. According to the Montana Historical Society, the first commercial apple orchard was planted in the Bitterroot Valley in 1870. The Flathead Lake sweet cherry industry was established in 1895 taking advantage of the lake effect, which helps prevent killing frost in winter. Sweet cherries and peaches still grow successfully in this microclimate.

As the Homestead Act of 1862 was further expanded with the Homestead Act of 1909, settlers planted even more orchards. Many small orchards were planted near mining towns to supply fruit to the miners. Fruit was a luxury at the time. Homesteaders planted small orchards, mostly apple, many of which survive today. The pioneers were subsistence farmers, providing their own fruits, vegetables, grains, and livestock.

Today as we look at Montana's local food systems, a common void is fruit, both tree and small fruit, with the exception of some regions of Western Montana. Thirty of Montana's 56 counties have areas considered food deserts, low income areas where at least 500 people and/or one-third of residents must travel more than 10 miles to the nearest supermarket (or one mile in urban areas). In Montana, nearly 72,000 individuals live in areas considered food deserts and have limited access to a grocery store or supermarket, making access to fresh, affordable food a daily challenge. (Montana Foodbank Network, 2015).

Montana State University (MSU) Extension looked to encourage more residents to plant orchards by conducting research and developing appropriate resources. Fruit tree research had not been conducted in the state since the late 1970s, and that research was limited to the western region of the state. In fall of 2012, MSU Extension was awarded a Specialty Crop Block Grant through the Montana Department of Agriculture to establish fruit tree cultivar research sites across the state. By the spring of 2014, eight replicated sites had been established. This project received a Montana Department of Agriculture Growth Through Agriculture Grant in the spring of 2015 to establish two additional sites. Current research sites include: Helena, Winston, Whitehall, Columbia Falls, Power, Bozeman, Hinsdale, Colstrip, Shelby and Lodge Pole. At each site, apple, pear, plum and sour cherry cultivars are being evaluated. A Specialty Crop Block Grant from the Montana Department of Agriculture in 2014 was awarded to conduct research on heritage orchards across the state.

Redman orchard and fruit tree research site in Whitehall.

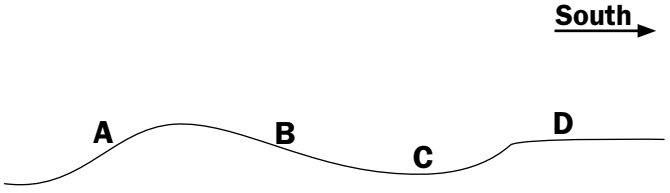
The Montana Heritage Orchard Program currently has 34 sites across the state. There are 100-plus-year-old orchards located in all parts of Montana. For more information on the program visit the web site, mtorchards.org.

This fruit tree production guide is developed through research conducted in the programs mentioned. As data is compiled, this publication will be updated and expanded. The purpose of this guide is to provide a future orchardist with enough information to begin an orchard. Additional questions can be addressed to local Extension agents and/or Horticulture Specialists. For information on apple diseases, please refer to the MSU Extension MontGuide (MT200812AG) *Important Apple Diseases in Montana and Recommended Varieties for Resistance*. It is online at http://store.msuextension.org/Products/Important-Apple-Diseases-in-Montana-and-Recommended-Varieties-for-Resistance__MT200812AG.aspx.

Site Selection

Site selection is the most important component of a successful orchard. Site selection is often overlooked by novice and experienced growers alike. Trying to correct problems on a poor site can result in high material and labor costs. The right combination of micro climate and soil type can be critical for future orchard success.

Characteristics of a good site include: well-drained deep soil, good southern exposure, an uphill 4-8 percent slope where cold air will not settle, and available dependable water – often through irrigation. Many heritage orchard sites are on southern and/or eastern hill slopes. Southern exposure is preferred, but eastern exposure can help combat the coldest part of the day, often just before sunrise. Getting early morning sunlight into an orchard can be beneficial for withstanding cold temperature extremes. The site also needs to be fenceable to keep deer, elk, and other browsing animals out of the orchard. The cost of fencing an orchard is significant, and often overlooked. Few sites in Montana will escape the threat of wildlife damage, so plan accordingly.



B, ideal location
D, potential location
A, C, not suitable locations

Can a marginal site be improved? Little can be done to the soil of an entire site without great expense or several years of soil building prior to planting. One of the biggest environmental factors that could eliminate potential orchard sites in Montana is wind. Orchards in the prairie provinces of Canada with windbreaks provide examples of wind and micro climate management for growing tree fruit. Windbreaks can be established many years prior to orchard establishment to reduce wind effects. Early planning is critical if a windbreak is necessary. A windbreak needs to be at least the height of the fruit trees to successfully affect the climate.

Choosing a Production System

There are many different orchard production systems, and few have been implemented or trialed in Montana. A system is a combination of planting, spacing, trellising and pruning techniques. The most common apple production systems include: Slender Pyramid, Vertical Axis, Slender Axis, Tall Spindle, Super Spindle, and the traditional system of low plant densities (100 – 200 trees/acre). The production systems' densities vary from 340 to 2,200 trees per acre (Robinson, et al.). Work done by Robinson, et al. at Cornell University has found that optimum planting densities are close to 1,000 trees/acre. This was determined from estimating the net present value for each system over 20 years. However, this does not mean that traditional planting systems cannot be profitable; much depends on individual markets and operation costs. Choosing which production system is best is contingent upon many factors including: location, amount of available land for the orchard, available labor (including skilled labor versus unskilled labor), and available markets.

Site Preparation

Proper site preparation cannot be overlooked. Plan in advance and have the site ready before trees arrive. A detailed site assessment is necessary prior to preparing the site for planting. When feasible, use a backhoe to dig several holes in different locations across the site to evaluate the soil profile. Proper soil drainage is important and cannot be fixed without great expense, so if soil has very poor drainage, consider a different site or select rootstock that can tolerate given soil properties at the site.

What is the current condition of the proposed orchard site? Is the site currently in crop production, fallow or

Stake or flag site ahead of planting to ensure row widths accomodate equipment and watering, and to monitor natural drainage patterns.

Measure the amount of space available during site preparation to ensure adequate space for the chosen production system.

pasture? What plant species are currently growing at the site? Will those plant species become a problem? The steps needed to ready a site for planting are highly dependent on characteristics of the site. As an example, if annual plant species are growing and the soil profile does not have drainage or compaction issues, the site may be prepared using a non-selective herbicide such as glyphosate applied in rows where the trees will be planted; tree holes can be dug after allowing a few days for herbicide (depending on label instructions) to take effect on the weeds. For an organic orchard, mulching around the trees after planting could be done instead of an herbicide application. In the above situation, tillage of the site prior to planting may not be necessary. However, if the site has perennial rhizomatous plant species and there is concern about soil compaction, herbicide application along with tillage may be necessary. Tree establishment will be delayed in compacted soil. Plant competition around the trees will also delay establishment and compete for water and nutrients. When using any herbicide, follow the label. Make sure it is labeled for orchard use. If you have questions about procedures for site preparation, contact your local county or reservation Extension agent.

Site preparation with discing/tilling rows.

General steps in site preparation:

1) Mark out the planting rows.
2) Till the planting rows and incorporate organic material at the site in the fall.
3) Collect a representative soil sample, see MSU Extension MontGuide (MT200705AG) *Home Garden Soil Testing and Fertilizer Guidelines* for more information on collecting a soil sample.
4) An aisleway or mid-row crop should be planted in fall before planting trees. A bunch grass species such as Sheep Fescue should be used. Rhizomatous grass species are generally not recommend because over time they will encroach on the trees.
5) Mark the tree spacing within the rows in the spring. Dig the holes with an auger, back hoe or use a tree planter. If using an auger, make sure the sides are not smooth, which should not be a problem if the soil is tilled prior to planting and the soil is not too wet.

Augered holes should be big enough to avoid root pruning.

If the holes have smooth sides, break them up with a shovel or pickaxe prior to planting. This will help prevent root girdling by allowing for proper outward root growth. The holes should be dug in the spring just before tree arrival, or if feasible, the same time the trees are being planted to avoid the soil drying out in the planting hole. The size of the roots will determine the hole size. Dig the holes big enough to avoid as much root pruning as possible. The bottom of the hole should be slightly compacted, so the trees do not sink after being watered. Trees will establish more quickly if soil is tilled prior to planting. Planting trees in compacted soil will delay establishment and compromise tree health.

Along with consistent, reliable irrigation, reducing plant competition around trees is another important management responsibility to ensure survival and health of the trees. Reducing plant competition in the planting row around the trees can be accomplished through the use of herbicides, tillage, mulch and a combination of all. When using herbicides, follow the label and ensure the product is labeled for vegetation management in orchards.

Tree Selection

An orchard can only be as good as the quality of its young trees (Crassweller et al.). Research various nurseries and growers and if possible, visit them to evaluate their stock. Ask neighbors and other orchardists about where they purchase stock, and their satisfaction with the quality. Ask about any guarantees the nursery/grower may offer. Know what to do if shipped stock does not meet specifications. Make sure the nursery/grower has the cultivars, rootstock, quality and size desired. Place orders early; ideally a couple years in advance. Many growers will custom graft and grow specific desired cultivars and rootstock, but this needs to be contracted at least three years in advance.

Generally, the smaller the tree the quicker it will establish. When selecting tree size, select smaller over larger when possible. We recommend planting trees with a 5/8" to 7/8" diameter. Smaller diameter trees (1/2" to 5/8") are recommended for high density production systems.

Ideally, trees should be planted as soon as they arrive, however Montana's spring weather does not always cooperate. Bareroot trees can be held for several weeks under the correct conditions before viability starts to decrease. Keep the roots moist and covered in damp wood mulch or heeled in the ground in a shady location. Cover the pile of trees with a tarp to keep the wood mulch moist. Daily watering may be necessary to keep the trees viable.

Smaller sized trees have an easier time establishing, and the recommended diameter, also referred to as caliper, is 5/8" to 7/8".

Cultivar Selection

Our research indicates that many cold-hardy cultivars developed by the University of Minnesota and Canadian breeding programs are suited for most sites east of the divide. Cultivars from Cornell University, Washington State University and others should be trialed on an experimental basis first, with the exception of Montana locations on the west side of the continental divide, many of which currently grow cultivars from Cornell University and Washington State University with good success.

Left: Bareroot trees are bunked in wood mulch to retain moisture. Right: Trees are held in mulch and then covered with a tarp to provide shade to help roots stay cool and moist.

The goal of the fruit tree cultivar research in Montana is to evaluate the performance of apple, pear and plum cultivars across the state, specifically not establishing research sites in two current fruit production regions of the state (Bitterroot and Flathead Valley) and focusing on areas with little to no current fruit production. 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. Apple cultivars planted at all sites: Honeycrisp, Sweet 16, Northern Lights, Goodland and Zestar. Pear cultivars planted at all sites: Parker, Patten, Golden Spice, Ure and Luscious. Plum cultivars planted at all sites: Mount Royal, Pipestone and Toka. Additional cultivars in trial at some of the sites include: (Apple) Goodmac, Carroll, Arkansas Black, Stayman Winesap #20, Ginger Gold, Mutsu, Frostbite, Spartan, Chestnut Crab, Blondee, Blue Pearmain, Kaz 93-12-02 and Prairie Magic; (Pear) Summer Crisp, John's, Pioneer and Clapp's Favorite. Evans Bali Cherry was planted at Hinsdale and Helena. Data in the following tables was collected at all 10 sites in the fall. The core cultivars were selected based upon anecdotal information that they would perform in Montana, and that they could be procured from wholesale growers.

Data collected includes: new terminal leader growth in inches, caliper/diameter in inches, blooming dates, and a **qualitative health score from 0 - dead, to 5 - lots of new growth**, healthy foliage with vigorous growth; information was also collected on insect pressure, physical damage (deer, voles, etc.) and the presence of disease. Only a few of the trees are starting to bear fruit, so yield and fruit size will be collected in 2016. As we continue to collect data, there will be clearer significance behind results of cultivar performance. This is by no means an exhaustive list of fruit tree cultivars that will work in your area. Research includes only three years of data and is ongoing.

The following table lists the best performing **apple** cultivars by site, based upon an average health score and terminal leader growth above 2 inches. This includes data for three years from Bozeman, Colstrip, Columbia Falls, Helena, Hinsdale, and Power. Two years of data have been collected at Whitehall and Broadwater, and only one year of data has been collected from Shelby and Lodge Pole. While it is clear there are some cultivars performing well, keep in mind this is based on limited data.

Best Apple Cultivars by Site *based on avg. health score and growth above 2 inches, ranked from high to low, left to right

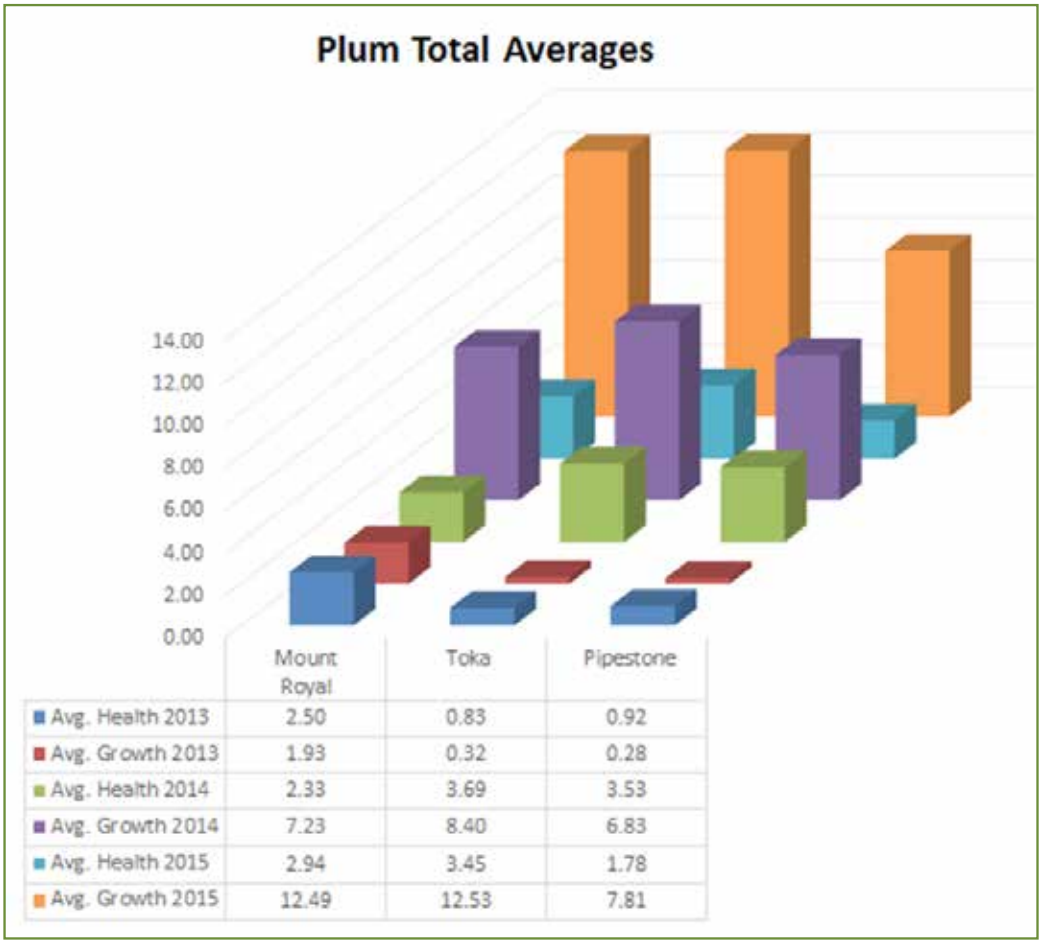
Bozeman	Goodland	Sweet 16	Northern Lights	Zestar	Carroll	Goodmac				
Colstrip	Goodland	Northern Lights	Zestar	Goodmac						
Columbia Falls	Goodland	Honeycrisp	Sweet 16	Zestar	Arkansas Black	Frostbite				
Helena	Goodland	Honeycrisp	Northern Lights	Zestar	Carroll	Goodmac	Arkansas Black	Prairie Magic	Ginger Gold/ Bud 9	Wealthy
Hinsdale	Winesap	Prairie Magic	Frostbite							
Power	Frostbite	Kaz 93-12-02	Blue Pearmain	Blondee/ EMLA7	Mutsu/ EMLA111	Spartan/ EMLA7				
Whitehall	Sweet 16	Chestnut Crab	Northern Spy	Honeycrisp	Zestar	Goodland	Prairie Magic			
Broadwater	Goodland	Sweet 16	Zestar	Carroll	Kerr Crab	Goodland	Chestnut Crab			
Shelby	Goodland/ M7	Honeycrisp	Honeycrisp/ Bud 118	Sweet 16	Zestar	Frostbite	Ginger Gold/M7	Summer Crisp		
Lodge Pole	Honeycrisp/ Bud 9	Sweet 16	Spartan/M7	Spartan/M9	Ginger Gold/ M7	Ginger Gold/ EMLA111	Ginger Gold/M9	Mutsu/ M7	Frostbite	

This table describes three years of average health and growth data for five recommended and sourced **apple** cultivars at 10 Montana research locations.

	Goodland	Honeycrisp	Sweet 16	Northern Lights	Zestar
Avg. Health 2013	3.31	3.81	3.15	2.14	3.36
Avg. Growth 2013	1.04	3.31	1.72	2.06	0.96
Avg. Health 2014	3.05	2.97	2.67	2.27	2.82
Avg. Growth 2014	6.86	5.35	3.49	7.78	5.74
Avg. Health 2015	3.47	2.74	2.98	2.44	3.56
Avg. Growth 2015	7.19	6.00	6.56	7.36	9.63

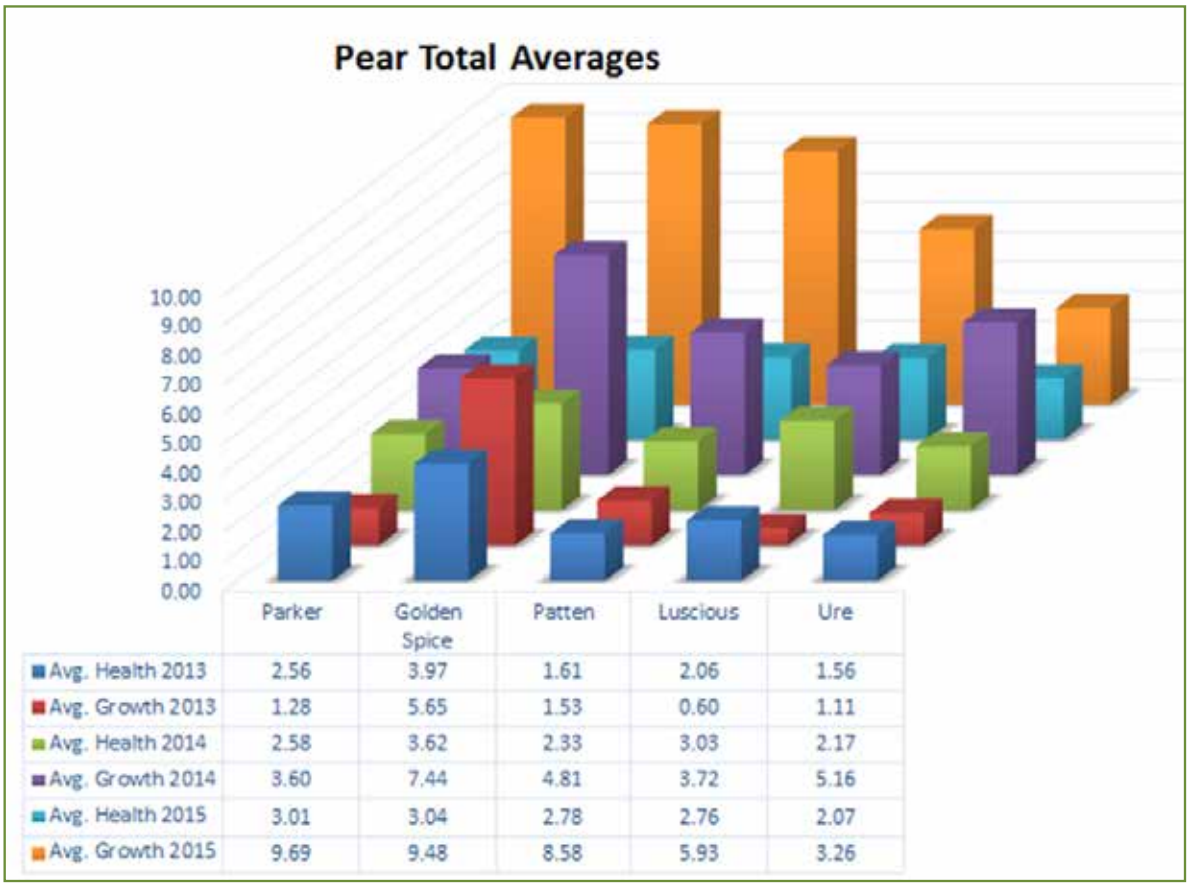
These photos provide an example of healthy tree growth and apple fruiting with the Goodland cultivar, one of the most successful in the study.

This table describes three years of average health and growth data for three recommended and sourced **plum** cultivars at 10 Montana research locations.



	Mount Royal	Toka	Pipestone
Avg. Health 2013	2.50	0.83	0.92
Avg. Growth 2013	1.93	0.32	0.28
Avg. Health 2014	2.33	3.69	3.53
Avg. Growth 2014	7.23	8.40	6.83
Avg. Health 2015	2.94	3.45	1.78
Avg. Growth 2015	12.49	12.53	7.81

This table describes three years of average health and growth data for five recommended and sourced **pear** cultivars at 10 Montana research locations.



	Parker	Golden Spice	Patten	Luscious	Ure
Avg. Health 2013	2.56	3.97	1.61	2.06	1.56
Avg. Growth 2013	1.28	5.65	1.53	0.60	1.11
Avg. Health 2014	2.58	3.62	2.33	3.03	2.17
Avg. Growth 2014	3.60	7.44	4.81	3.72	5.16
Avg. Health 2015	3.01	3.04	2.78	2.76	2.07
Avg. Growth 2015	9.69	9.48	8.58	5.93	3.26

The following table indicates the best performing **pear** cultivars by site based on an average health score (see p. 7) and terminal leader growth above 2 inches. Data averages to date show that Golden Spice and Parker pear cultivars are performing the best for most of the sites.

Best Pear Cultivars by Site *based on avg. health score and growth above 2 inches					
Bozeman	Parker	Golden Spice	Patten	Luscious	Ure
Colstrip	Parker	Golden Spice	Patten	Luscious	
Columbia Falls	Parker	Golden Spice	Patten		
Helena	Parker	John's	Pioneer		
Hinsdale	John's				
Power	Patten				
Whitehall	Golden Spice	Parker	Patten	Ure	
Broadwater	Golden Spice	Patten	Luscious		
Shelby	Parker	Golden Spice	Patten	Ure	Summer Crisp
Lodge Pole	Golden Spice	Patten			

The following table indicates the best performing **plum** cultivars by site based on an average health score (see p. 7) and terminal leader growth above 2 inches. Data averages to date show that Toka and Mount Royal plum cultivars are performing the best for most of the sites.

Best Plum Cultivars by Site *based on avg. health score and growth above 2 inches				
Bozeman	Mount Royal	Toka	Pipestone	
Colstrip	Toka			
Columbia Falls	Mount Royal	Toka		
Helena	Toka			
Hinsdale	Toka			
Power	Toka			
Whitehall	Mount Royal	Toka	Pipestone	
Broadwater	Mount Royal	Toka		
Shelby	Mount Royal	Toka		
Lodge Pole	No real success with Mount Royal, Toka or Pipestone			

Rootstock Selection

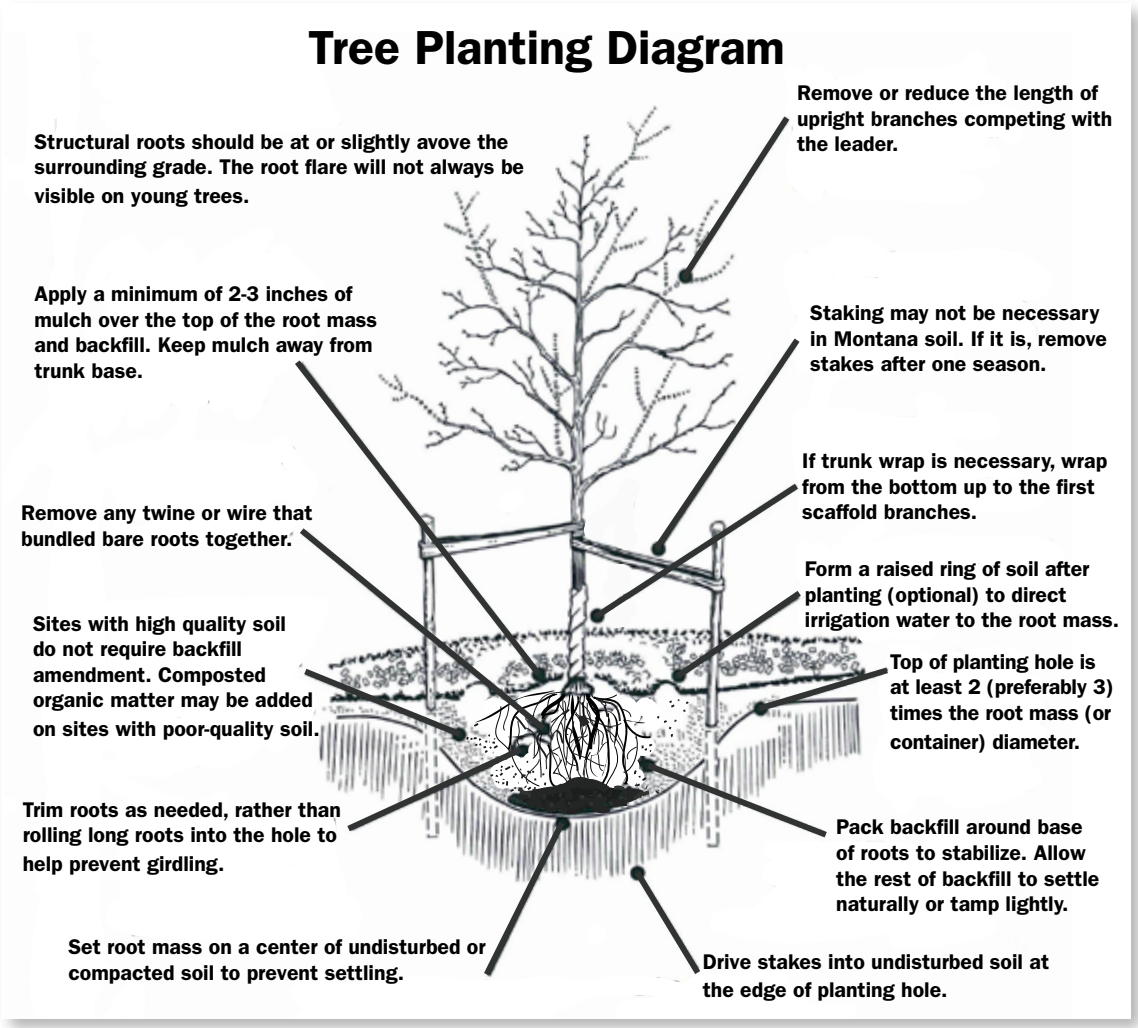
To date, no research has been conducted on performance of different rootstocks in Montana. A general recommendation is east of the divide, use a standard rootstock; west of the divide, many semi-dwarf and dwarf rootstocks should perform adequately. Standard rootstocks tend to be more cold hardy, and drought tolerant with better root anchorage than semi-dwarf and dwarf rootstock. Locations east of the divide are encouraged to experiment with semi-dwarf and dwarf rootstocks on a trial basis. Many Bud or Budagovsky (a Russian-developed rootstock) semi-dwarf and dwarf rootstocks should be hardy enough for most locations in central and eastern Montana.

Planting Fruit Trees

Care should be taken in planting fruit trees. Proper planting techniques will help ensure establishment of the root system and thus the overall health of the tree from year one and beyond. There are two ways to plant fruit trees, bare root and containerized. Bare root trees are preferred over containerized for orchards as the cost is much lower, the trees are younger and will establish quicker, and for the opportunity to root prune any broken, diseased or girdling roots. Containerized planting techniques are also an option (and included here), as not all cultivars can be purchased as bare root. However, as stated in the tree selection section (p. 6), it is best to contract with a grower three years in advance to ensure cultivar availability for an orchard.

General considerations
Avoid digging planting holes when soil is saturated and wet. Digging in wet soil will destroy the structure of the soil and may cause decreased water penetration, microbial activity, and air in the soil. It is better for proper root development to hold trees in mulch as long as necessary rather than to plant into a wet field.

The majority of fruit trees purchased today are grafted onto a rootstock. Extreme care should be taken to ensure that the graft union is 2-4 inches above the final soil grade. To ensure proper planting depth, it is equally important to only dig the planting hole to a depth no more than 2-4 inches below the graft union to the bottom of the root system. This may only be 8-10 inches deep. Check for proper depth by placing a shovel handle across the hole and temporarily inserting the tree that is to be planted.



If a planting hole is too deep, fill the bottom of the hole to the proper depth and compact soil. If soil in the bottom is left loose, the tree may sink after several waterings, causing the graft union to be at or below soil level. This may result in the graft union, the weakest point of the tree, to fail due to rot.

Another important aspect in digging the planting hole is making sure the hole is at least twice as wide as the root system, either the width of roots (bare root) or width of the pot (containerized). The planting hole should be dug like a large saucer. If holes are dug with an auger, creating smooth vertical edges, be sure to rough up edges or even dig away the top rim of the hole to resemble a saucer shape. This will allow the roots to spread out properly, rather than girdle. (Girdling is a restriction of movement of water, plant nutrients or stored food reserves within a tree. This physical disruption of the cambium layer can be caused by roots growing around the main trunk, staking that wears through bark, or voles that chew through bark.)

When backfilling the planting hole, it is not advised to incorporate soil amendments. The goal is for the fruit trees to establish into the native soil and for roots to expand beyond the area that was dug. Added amendments may cause the roots to remain in the hole and can cause the roots to girdle one another or even the trunk of the tree. If amendments are needed, it is better to prepare the entire planting area and not just the planting hole (see Fruit Tree Fertilization in the next section).

Bare Root
Bare root fruit trees are dug when dormant and are sold in spring. Bare root trees that are purchased will need to be held in a cool, moist and dark environment with the roots covered in wetted material (often wood chips, newspaper or shredded mulch) and remain dormant until the time of planting. If the trees start to leaf out before planting, the establishment rate of success will be greatly reduced.

When planting bare root stock examine and prune out roots that are crossing, broken, or have the potential to girdle the tree. Once the roots have been pruned, check the planting hole for depth. It may be advised, given the structure of the roots, that a small mound be placed on the center bottom of the planting hole for the roots to rest on. This will better ensure that the roots grow in the right direction, down and outward. Once the tree is placed, return the soil to the planting hole, while lighly compacting backfill soil with your hand or foot. When the tree is planted, it is imperative to get water to the tree as soon as possible. Roots that are longer exposed to dry conditions, either before planting or in dry soils, could have a greatly reduced rate of success.

Container Grown

Container grown fruit trees will have slightly different procedures for planting. The most important step is to see where the graft union is located in the container. Often soil or mulch is added to the top of containers, burying the graft union or at the very least, creating a false soil line. Be sure the graft union is 2-4 inches above the soil. Mulch or soil may have to be removed to find the proper planting hole depth. After the planting hole is dug, remove the tree from the container and observe the root system.

If the tree has been planted in the container for a long period of time, circling or girdling roots will need to be pruned. Severely pot-bound trees will need extensive root pruning. It is best to shave off the roots across the bottom and the sides with a saw in the amount of up to ¾-inch to remove any unwanted roots. If the root system is not pot-bound, rough up the sides of the root ball and place in the planting hole. Return the soil to the planting hole, while lightly compacting the soil with your hand or foot. Once planted, it is imperative to get water to the tree as soon as possible. Just as in bare root planting, the longer the roots are exposed to dry conditions either before planting or in dry soils, the rate of success is reduced.

Staking

Staking fruit trees is only advised in areas that are windy, have light soils that won't hold the tree when soil is saturated (this is rare in Montana soil). If it is decided a tree needs to be staked, be sure stakes are solid and placed just outside the planting hole. The tree should be tied loosely with a soft webbing material that is wide enough to not cut into tree bark.

Newly planted and staked trees with trunk guards.

Stakes should be removed once tree roots are established. If a tree is staked in the spring, staking should be removed in the fall. It is not advised to leave trees staked for more than one season as the staking will reduce tree trunk girth.

Trunk Protection

It is advised that tree trunks be wrapped the first year, and from fall to spring in following winters to keep bark from getting sunscald. Sunscald is caused when the sun warms cells in the trunk, causing the cells to metabolize and bring in water. In winter months the cells can freeze, rupturing the cell walls. When this occurs, the bark is compromised and will often crack or even slough off the tree.

Tree trunk protection comes in several forms. It is advised to have the trunk wrapped or use guards that reach the first branch of the tree. Carefully remove the wrap or guard once the threat of freezing temperatures has ceased, usually in May or early June. If voles or rabbits are present at a site, it may be beneficial to leave trunk guards on until trunk diameter is larger than the guard. Voles can girdle tree trunks if they are in need of a winter food source. An option for larger diameter trunks is to wrap the bottom of the trunk with 1/4-inch hardware cloth up the trunk a minimum of 12 inches. Be sure to remove the cloth at a later date so it does not girdle the tree. There also are protective sprays that can be used on the trunk to deter voles. They carry a heavy odor and will likely need to be reapplied several times over the winter.

A common practice for older trees (ones in which wrap no longer fits) is to paint the trunks with white latex paint. This helps deflect the winter sun and keeps trunks from getting further sunscald. It is imperative to only use latex paint, which is often mixed with 50 percent water to make a "white wash" that is then applied to the trunk.

Fruit Tree Irrigation

General

The success of fruit trees, especially in the first years of establishment, is dependent on trees getting the proper amount of water. Orchards can struggle due to over- or under-watering. Newly planted trees need frequent watering for proper establishment. Even established trees may need frequent watering, especially in spring. Watering frequency depends on soil texture (amount of sand, silt and clay). Sandy soils need more frequent watering than clay soils. Testing and knowing soil texture is important to determine monthly watering needs.

In the first year, apply at least 5-10 gallons of water to each tree per week. Without proper water amounts, roots will not anchor well and establishment of the orchard will suffer. After the tree is established, it will need about 10 gallons of water per diameter of the trunk per week. Commonly that is 1.5-2 inches of water per week around the dripline of trees. The water should reach about one foot deep into the soil profile. If an issue arises and it is believed to be water related, dig around the tree to see how deeply the water is penetrating and if there is enough water.

Drip irrigation watering frequency depends on water holding capacity of soil and environmental conditions at the orchard site.

Finally, although fruit trees need water, they do not like to be over-watered. Fruit trees that are over-watered or are standing in water for too long can develop root and collar rots. Be sure there is even water application and that soil is not continuously saturated.

Drip Irrigation

Drip irrigation is common on newly planted trees in an orchard, and is the preferred method. If using drip irrigation, be sure there is at least one emitter on each side of the tree (two total per tree) as the drip pipe runs down the row. Drip emitter size depends on how often the system runs each week and the water holding capacity of the soil.

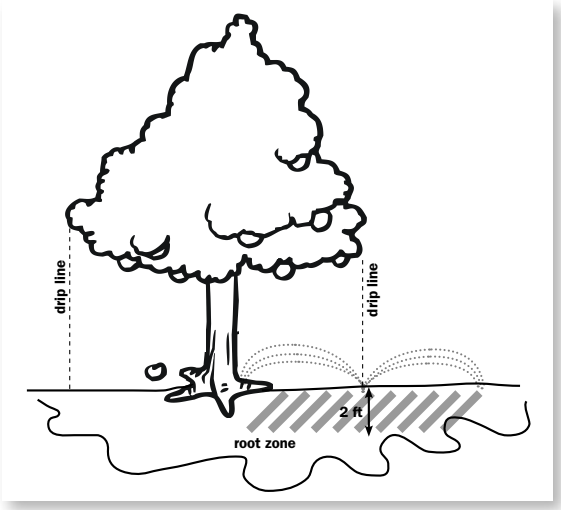
Most drip emitters used in orchards are 1-2 gallon per hour (gph) emitters. The drip system should be adjusted according to the soil type and the environmental conditions of the orchard. Once trees are established in year 1-3, it is advised to increase the distance/area the drip irrigation reaches, or add overhead irrigation.

Drip emitters coupled with "spaghetti tube" make water available out to the edges of the planting hole.

Overhead Irrigation

Once tree roots have expanded past the planting hole, usually around year three, trees will need supplemental overhead or flood irrigation to give enough water in a larger area. In other words, the water needs for the trees will increase beyond what drip irrigation provides.

This is where overhead or sprinkler irrigation becomes important. The area that needs water has expanded but the rule for watering the trees is relatively unchanged. The trees will need 5-10 gallons of water per trunk diameter per week. The general recommendation for watering trees is 1.5-2 inches of water per week. However, the water now needs to be dispersed beyond the trunk area. Sprinklers should be placed at the drip line with water spraying toward the trunk and past the dripline.



Use caution with overhead sprinklers: set a low trajectory so as not to spray the foliage.

Watering foliage can cause foliar infections, including fire blight. Using a sprinkler with a low trajectory is important. To measure the amount of water a sprinkler or irrigation head provides, test with a rain gauge so trees are not over- or under-watered. Trees should be watered only in the morning or daytime, as watering at night can promote disease.

Flood Irrigation

In many rural areas of Montana, orchard management may rely solely on flood irrigation. In other studies of heritage (100-plus year old) orchards, the orchards were and are still irrigated via flooding by irrigation ditches. Flood irrigation in the spring can be beneficial to orchards as long as trees do not sit in saturated soils for too long (more than three weeks). From that point, monthly quick flood irrigation may be needed. Overall quality of the trees and fruit may not be equal to areas where overhead irrigation supplies water evenly over a longer period of time. Soil water management in flood irrigation will be crucial so that the soil is not continually saturated or that it does not dry to a permanent wilting point for the trees.

Hardening-Off Trees for Winter

Once fruit has been picked, trees will need less water than in spring or during peak fruit growth. It may be beneficial to reduce watering in the fall to harden the trees for winter. While reduction in water may be warranted, stopping watering is ill-advised as the tree needs water to conduct photosynthesis as much as possible before leaf drop. Additional water during leaf drop to replenish the soil moisture for next spring is also encouraged.

Fruit Tree Fertilization

Tree Health

It is important to know soil and plant health to achieve the proper growth of an orchard. If an orchard is depleted of a particular nutrient, tree growth can suffer. Inversely, too much of a nutrient can cause a toxicity and reduce growth or even kill a tree. Soil testing ensures that proper nutrients are available to the fruit trees. Once trees are established, it is also common to have leaf tissue tested and compared to a soil test for nutrient deficiency, as the nutrients may not be available to the tree even if they are present in the soil.

Soil Testing

The soil in an orchard should be tested before planting and again every three years. Soil testing will show the soil's pH, relative organic matter, soluble salts and nutrient levels. Nutrients of importance to test for include nitrogen, phosphorous, potassium, boron, magnesium, manganese, zinc, sulfur and iron. There are many analytical labs that perform soil analysis. Be sure to find a laboratory that will give recommendations and one that understands the nutrient needs of fruit orchards. Soil sampling should be random throughout the orchard and to a depth of eight inches deep. If the orchard has differing soils throughout, it would be best to test each soil separately. Some soil testing laboratories are listed on the back of the MSU Extension MontGuide (MT200705AG) *Home Garden Soil Testing and Fertilizer Guidelines*, or contact your local county or reservation Extension agent. Find the guide online at http://store.msuextension.org/Products/Home-Garden-Soil-Testing-and-Fertilizer-Guidelines__MT200705AG.aspx.

Tissue analysis

Every year, a tissue analysis of trees in an orchard should be performed. This can be in conjunction with soil testing to reference whether there is soil nutrient deficiency or toxicity and compare that to the tissue analysis. It is common for micronutrient deficiencies to show up in leaf tissue analysis even though the soil report shows adequate amounts. When taking tissue for analysis be sure to take samples from the mid portion of current year growth. The table below shows the optimum and deficient levels of nutrients in apple leaf tissue analysis.

Nutrient	Optimum range	Deficient Levels
N (%)	2.0-2.6 1.8-2.4[1]	2.0
P (%)	0.16-0.30	0.11
K (%)	1.3-1.5	1.0
Ca (%)	1.1-1.6	0.5
Mg (%)	0.3-0.5	0.2
B (ppm)	25-50	25
Cu (ppm)	10-20	4*
Fe (ppm)	150-250	25
Mn (ppm)	50-80	20*
Zn (ppm)	20-40	15*

[1]Optimum range for soft varieties. *Deficiency levels are not well defined

http://apples.msu.edu/uploads/files/Applenutrition-EricHanson.pdf

In addition to fertility, orchardists must manage for pests and diseases. The most common pest will be codling moth (*Cydia pomonella*); the most common disease will be fire blight (*Erwinia amylovora*). For more information on apple diseases, see MSU Extension MontGuide (MT200812AG) *Important Apple Diseases in Montana and Recommended Varieties for Resistance*. For more information on pest management, see Utah State University Extension Fact Sheet (ENT-13-06), http://extension.usu.edu/files/publications/factsheet/codling-moths06.pdf.

Summary
The keys to a successful fruit tree orchard discussed in this publication include site evaluation and preparation, good rootstock, proper cultivar selection, proper irrigation, reducing plant competition, maximizing the potential of the soil, testing for nutrients, and using proper fertilization. Research is ongoing for what works best in areas across the state with differing soils and climates. It is best to talk with your local county or reservation Extension agent about the potential and limitations to growing fruit trees in your area.

References

Robinson, Hoying, Sazo, DeMarree, Dominguez, "*A Vision for Apple Orchard Systems of the Future*", V 21, N 3, Fall 2013.

Montana Foodbank Network http://mfbn.org

Crassweller, et al. 2014. Penn State Tree Fruit Production Guide 2014-2015.

Additional Resources

Oregon State University Extension Pest Management Guide (EM 8203-E), https://catalog.extension.oregonstate.edu/sites/catalog.extension.oregonstate.edu/files/project/pdf/em8203.pdf

Washington State University Crop Protection Guide for Tree Fruits in Washington (EB0419), http://www.tfrec.wsu.edu/pages/cpg/

Idaho State University Extension, *Growing Apples for Local Markets in Cold Climates*, http://www.cals.uidaho.edu/edcomm/pdf/BUL/BUL0820.pdf

North Dakota State University Carrington Research Extension Center, Northern Hardy Fruit Evaluation Project, https://www.ag.ndsu.edu/CarringtonREC/northern-hardy-fruit-evaluation-project

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