

**YELLOW JACKET FRUIT TREE AND VINEYARD  
RESEARCH & DEMONSTRATION PROJECT**

**Fruit Crop Management Guide**

BY

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Montezuma County Commissioners

Dolores County Commissioners

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## **Project Background**

The Fruit Tree and Vineyard Research and Demonstration Project was implemented in April, 1991. The recent completion of the Dolores Irrigation Project has resulted in a substantial number of new client requests for local research based information/data on fruit tree and vineyard cultivars, equipment usage and cultural practices. Presently, the Team is evaluating 29 different fruit tree cultivars including apples, peaches, cherries, pears, trellised apples, 8 trellised grape cultivars, 1 raspberry cultivar, 12 grass cultivars, 9 micro irrigation systems and 3 frost protection systems. We continue to investigate marketing opportunities (including NAFTA implications) as well as Home-Based Business opportunities as they relate to fruit and vineyard product utilization, i.e. fruit and bi-products.

Strong emphasis has been placed on demonstrating, evaluating and testing cultivars, irrigation equipment, orchard equipment and cultural practices that are cost effective, user friendly and available through local suppliers.

# ORCHARD DEVELOPMENT AND MANAGEMENT

Kenny Smith, MCHEA

## 1. Introduction

The planning and development of a fruit orchard involves a series of questions and management practices the grower must answer and accomplish before any trees are ordered or planted. Financial considerations should include a detailed cost and production budget for at least the first five years. Initial site selection will include such factors as availability of irrigation water, cold air drainage, soil type, and proximity to an improved transportation network. The grower will also need to consider the type of production system that will be established, either a conventional orchard setting or a high-density trellis system. Equipment requirements should be determined to insure field operations are conducted in a timely manner. This decision will factor into the overall budget projection mentioned previously. The following section will explain and detail management decisions and cultural practices required by fruit growers to establish and develop a fruit orchard.

## 2. Soil Preparation and Fertility

Ideally, soil preparation should be completed the fall prior to planting in the spring. This would include deep ripping and a disking operation. The ripping should be 18-24 inches deep to breakup any hard pan that may have developed from previous farming operations. In the event the land was previously in fruit production, fumigation will be a required step in the revitalization of this orchard. In addition, all dead trees should be removed from the site and burned. These materials provide a site for diseases and insects to over-winter and propagate.

Soil testing is a valuable tool which is used to help make fertilizer recommendations and give growers hints to problems that may arise in the area of nutrient management. Three keys to a good soil fertility program include taking representative samples, accurate laboratory analysis, and meaningful interpretations of results. The selection of the proper rate of fertilizer is influenced by knowledge of the nutrient requirement of the crop and the fertility level of the soil.

Observations of annual growth, size, color of leaves and fruit are helpful in determining fertilizer needs. In addition, leaf analysis indicates which elements are present in adequate, deficient, or excessive amounts. Growers should consider leaf analysis every 2-3 years to monitor their fertility program.

3. Fertilizer Application of fertilizer for the project at Yellow Jacket is completed in April with a dry blend of 20-8-10-10-10 ( N-P-K-Zn-S ). Rates of application are determined by tree trunk diameter in inches. Current Colorado State University recommendations of .10 lbs. of actual nitrogen for each inch of trunk diameter are used. In addition, a micronutrient spray of Zinc Sulfate is applied in early April. The rate of application for this liquid product is 15 lbs. Zinc per acre. After harvest when the leaves are still green, an additional 10 lbs. of Zinc per acre is applied.

## 4. Fertilizing Rates

The amount of nitrogen to apply late in the fall or early spring (preferably before bud break), depends upon the type of tree fruit and its productive status.

Trees should be fertilized to maintain the following annual terminal growth:

### Nonbearing Trees

Apple 24 to 36 inches  
Pear 12 to 26 inches  
Peach 16 to 24 inches

### Bearing Trees

Apple 12 to 14 inches  
Pear 6 to 12 inches  
Peach 10 to 15 inches

Much less than these recommended growth rates results in reduced fruiting wood and less crop. If just starting a fertilizer program 1/8-pound actual nitrogen should be soil applied to stone fruits for every one inch trunk diameter (measured one foot above ground level). In the case of some fruits (apples & pears), 1/10-pound actual nitrogen should be used for each inch of trunk diameter.

The actual amount of nitrogen differs between products and this must be taken into account when computing the amount of fertilizer needed. For example, a 5-inch diameter peach tree will need 5/8-pound of actual nitrogen (A.N.).

$$\begin{array}{l} \text{diameter x pounds actual N required} \\ (5 \times 1/8 = 5/8\text{-lb. (.625 lbs.) A.N. needed} \end{array}$$

If ammonium sulfate 20-0-0 (20%N) is used, 3-1/8 lb. of this fertilizer will be required to provide the N needed by this 5-inch peach tree.

Computations:

$$\frac{1\text{b. A.N. needed}}{\%N} = \frac{5/8 \text{ lb.}}{20\%} = \frac{.625}{.20} = 3.125 \text{ lbs.}$$

In the case of ammonium nitrate at 33% (33-0-0), a little over 1 and 7/8 pounds of ammonium nitrate is needed for that same 5-inch diameter peach tree.

Computations:

$$\frac{1\text{b. A.N. needed}}{\% N} = \frac{5/8 \text{ lb.}}{33\%} = \frac{.625}{.33} = 1.89 \text{ lbs.}$$

The following year, the amount of nitrogen to be applied is determined by the growth made the previous year. If more growth is needed, increase the nitrogen applied. If too much growth occurred, reduce the nitrogen application. This points out the need to keep accurate records on what and how much was applied.

Other nutrients need to be applied according to the results of a leaf analysis.<sup>1</sup>

**5. Integrated Pest Management**

Integrated pest management, or IPM, emphasizes preventative methods that provide economical, long-term solutions to pest problems while minimizing hazards to human health and the environment by coordinating pest management activities with production practices. The term pest refers to weeds, pathogens, destructive insects and mites, and harmful vertebrates.

Integrated pest management is based on an understanding of the factors that make an orchard / vineyard vulnerable to pest invasion or damage. The best management strategy not only controls pests but also anticipates and prevents problems. Integrated pest management can enhance your current control program; it provides an orderly and scientific-based system to diagnose, record, and evaluate pest problems as well as guidelines for selecting optimum pest control methods. Minimizing both pest-caused losses and environmental damage is the ultimate objective of IPM.

**Cite Reference**

1. Tri River Area, Colorado State University, CES21881.

A successful integrated pest management program has four key components:

- Pest identification
- Field monitoring
- Control action guidelines
- Effective methods for prevention and control

Accurately identifying pests and plant stress symptoms is essential for choosing effective management strategies.

Colorado State University Cooperative Extension offices have photographs which help growers recognize and identify common pests and damage symptoms.

Field monitoring provides information on a day-to-day or season-to-season basis, which can be used to help predict and evaluate potential pest problems. Because conditions may vary from year-to-year, orchard records should be kept for future reference. These records should include weather information, dates of insect activity which would include population levels of both beneficial and pest organisms.

Control action guidelines indicate when management actions, especially pesticide applications, are needed to avoid eventual losses from pests. Guidelines for insect pests are generally numerical thresholds indicating population levels that will cause economic damage. Current recommendations for Colorado crops can be found in "*Colorado Tree Fruits: Pest and Crop Management Guide, Bulletin XCM-41*".

The final element of an IPM program is the range of alternatives it offers growers to manage potential pests. These best management practices provide the grower with the opportunity to produce an optimum crop while utilizing as many tools and resources as possible. Options to be considered in this area include cultural practices, planting dates, fertilization, cultivars, irrigation, and pesticide management.

## 6. **Insect Program**

Although limited to relatively few insect pests in southwest Colorado, the severity of infestations can be extremely devastating in an orchard if left untreated. Pests of primary concern to growers in this area include the codling moth, pear psylla, and the peach twig borer.

The most serious pest and the major concern in apples and pears is the codling moth, *Cydia pomonella*, which causes most of the wormy fruit that is so familiar to everyone. The pinkish-white caterpillars that have brown heads and are about  $\frac{3}{4}$  inch long when fully grown eat the core of the fruit out. The winter is passed as mature larvae in tough silken cocoons underneath the bark of trees, in crotches, crevices, pruning scars, and debris on the ground or similar environments. Many larvae overwinter in packing sheds or places where apples have been stored. In the spring, the larvae transform within the cocoons into brownish pupae. Three or four weeks following pupation, grayish moths with a wingspan of approximately  $\frac{3}{4}$  inch emerge from the pupal cases. Near the tip of each front wing is a copper or bronze-colored rounded spot. The gray appearance of the rest of the body takes the form of undulating minute gray lines with interspersed chocolate-brown lines. Proper identification is critical when pheromone traps are used to monitor flights of adult male codling moths.

Moths that develop in the spring from overwintered larvae emerge over a period of 4-6 weeks. By blossom time pupation is generally complete. Moths typically emerge just at petal fall with the males appearing first. This emergence is associated with the accumulation of approximately 200 Degree Days from January 1<sup>st</sup>. Degree Days are a method for measuring insect development based on daily maximum-minimum temperatures. Egg deposition is usually heaviest about 4 weeks after the petals of the apple blooms have fallen. All eggs are deposited on leaves by the spring generations, but the following summer generations deposit eggs primarily on fruit. Eggs typically hatch in 8-10 days during warm weather, but may take 12 days or more in cool weather.

Many of the young larvae of this first generation enter the fruit by way of the calyx cup or blossom end and eat their way to the core. Larvae of later generations enter the fruit at almost any point and commonly produce a type of injury known as codling moth stings. Larvae complete development in Colorado on about 3 weeks. After emergence, they either migrate back to the twigs or trunk or drop to the ground to pupate. Twelve to fourteen days are required for the pupal stage at this time of year, and the second brood of moths appears about the first of July. A complete life cycle or generation for the codling moth requires 44-48 days, so the third brood begin appearing by the third week in August. The third generation should be monitored carefully in apples since harvest is generally in mid to late September.

Effective control of codling moth is optimized by carefully monitoring the orchard with the use of pheromone traps. Pheromones are chemicals produced by insects that regulate many types of behavior. The primary use of pheromones in orchard production has been in the area of pest detection and insect management. A lure containing the synthetic pheromone is generally placed in the bottom of a trap coated with a sticky material. These particular traps only attract the male codling moth.

As a general rule, conventional control measures that utilize chemicals should be implemented three to four weeks after the first male is observed in the pheromone trap.

An alternative method to chemical control involves the principal of mating disruption. The grower should follow a regular monitoring program throughout the growing season; this includes both pheromone traps and visual inspection of fruit for feeding damage. This principal applies the use of synthetic female sex pheromones impregnated on dispensers containing Isomate-C+ that are placed in the upper third of the canopy of the apple tree. Application rates for these dispensers range from 120 to 400 per acre. Heavier rates are placed in the trees on the perimeter. This technology will decrease the risk of codling moths becoming resistant to currently registered insecticides and allows natural enemies or beneficial insects to attack this devastating orchard pest. Mating disruption should be viewed as only one part of a successful integrated pest management program for codling moth. Additional cover sprays may be necessary to suppress high codling moth populations. Overall, codling moth damage was reduced to less than 1% at the Southwestern Colorado Research Center in 1997.

The pear slug, *Caliora cerasi*, is an important pest of pears and cherry trees. This insect can cause severe defoliation in a short period of time when scouting is not conducted on a regular basis. Pear slug populations build up rapidly in the early summer as cool temperatures and succulent foliage offer an ideal environment for development. The larvae feed mainly on the upper surface of leaves, causing a skeletonizing defoliation where main veins and the lower leaf surface are not eaten. The pear slug overwinters as a pupa in a small cocoon at the base of plants attacked the previous season. The adult emerges in late spring as a small, black, non-stinging wasp that is seldom observed. After mating, the female wasps insert eggs into leaves, and the slug-like larvae hatch within 7 to 14 days. The larvae are slimy and slug-like, olive green to black, and about ½ inch in length when fully grown. A second generation occurs in mid-August and September. Pear slugs are very susceptible to most insecticides used in fruit pest management programs.

The peach twig borer, *Anarsis lineatella*, causes most damage when larvae tunnel into fruit. Additional injury is also produced when caterpillars bore through the twigs of trees causing them to die back. This is an old European insect that was first found in this country in 1860. The twig borer overwinters as an immature larvae in hibernacula closely attached to the bark. The overwintered larvae emerge, tunnel out, and kill the young succulent shoots in the spring, causing the terminals to wilt and die (flagging). Pupation occurs in cracks, pruning scars, and rough places on the bark. In May, small gray moths with a wing expanse of up to ½ inch emerge from the pupal cases and deposit eggs on the twigs. Larvae of the summer hatch or second generation prefer fruit to twigs. The majority of fruit are attacked from the stem end, where the fruit touch or where the leaves are in contact with the fruit.

Research continues at the Colorado State University Orchard Mesa Research Center on the application of pheromone dispensers for mating disruption of peach twig borer. Several years of trials will be necessary for an accurate evaluation of this system.

## 7. Additional Cultural Practices

7A. **Planting** All fruit trees planted on the Demonstration Project have been bareroot. Growers should consider ordering quality trees from nurseries that have been certified as disease free. Based on our experiences, we highly recommend the fastest method of shipment to alleviate any unforeseen delays in shipment. Scheduling should be done to also avoid conflicts with weekends and holidays.

Upon arrival, trees should be planted as quickly as possible. Bareroot nursery stock is generally shipped in moist sawdust, which is an excellent packing material. Care should be taken to keep roots moist and out of sunlight to keep damage to a minimum. Holes should be dug 6-8 inches wider than the depth to allow for feeder roots to develop properly the first year. No additional soil amendments are necessary at this time. Planting depth should place the soil surface approximately 4-6 inches below the graft. The bud union knot should face a northerly direction to avoid winter damage. The only pruning necessary at this time would be to trim off any branches, which may have been damaged in shipment.

The trunks of the trees are painted with a 10% latex paint solution this first year in the fall. This practice has proven effective against radiant heating caused from large temperature fluctuations that area common in this region. This prevents bark damage due to a freezing / thawing effect. Trees should be treated in alternate years after this first application. A simple water based white latex paint is sufficient to accomplish this job.

7B. **Thinning Fruit** The ultimate objective for the grower is the production of a large quality fruit. Achievement of this goal involves implementing components from all areas of orchard management. Fruit thinning is a critical element in fulfilling this goal.

Growers can choose between two alternatives for the thinning of fruit. One option involves the application of chemical thinners to reduce fruit set. We have not used this method at Yellow Jacket, however, for large commercial orchards where labor is a limiting factor, this is a viable option. The second method of thinning involves physically removing excess fruit set by hand. This method requires extensive labor and may be cost prohibitive for some operations. We have used this method with a great deal of success in achieving the proper spacing of both apples and peaches. Thinning in southwest Colorado begins the first week of June. Subsequent thinning takes place over the next 10 days until optimum spacing has been achieved. Visual consideration is given to the final size of fruit in determining this spacing.

7C. **Weed Control** Due to the sensitivity of the fruit trees and grapes, selectivity of herbicides is severely limited. The primary method of weed control between plantings has been mowing. This has proven to be highly effective against most weed problems we have encountered on the project. Mechanical tillage practices such as disking are not recommended due to possible damage to feeder roots that are located in the upper 6-8 inches of the soil surface.

Control of broadleaf weeds and grasses under the fruit trees is critical in an orchard setting to minimize a moist environment which favors the development of insect and disease problems. In addition, the clean soil promotes a general heating of this area. In the event of low temperature conditions, this added heat will translocate upward through the canopy increasing overall air temperature. Weed control under these trees has been successfully achieved with the use of Roundup (glyphosate) herbicide used at the 2-3% rate. Full directions for use are included on the manufacturers label. Glyphosate is absorbed rapidly by tree leaves and bark, so all suckers should be removed before application and any contaminated branches should be removed immediately. Before using any pesticides, the grower should always READ THE LABEL.

7D. **Bird and Wildlife Problems** Wildlife damage is a major problem anyone interested in fruit production in southwest Colorado should consider in planning and design. The Colorado Division of Wildlife offers growers programs to deal with this serious problem. Growers on projects larger than one (1) acre in size may submit an application to receive fencing materials at no cost from the DOW. Growers are responsible for the installation and maintenance of these structures.

Damage to ripening fruit by birds is also of concern to Colorado fruit growers. We have utilized a flash tape to deter these pests. This colored aluminum tape works by reflecting sunlight. The bright red and silver coated sides alternate with the movement of air causing the tape to flash brilliantly. We have put the tape up in the orchard and vineyard just prior to the crop ripening so the birds do not become accustomed to its presence. Results achieved at the project indicate it to be highly effective. No visual bird damage has been observed since its application. Our staff removes the tape after frost and leaves have dropped to increase its effectiveness the following season.

7E. **Insect Control** Our main objective in this area has been to utilize mating disruption in the apples to control codling moth. However, when necessary, we have used Diazinon 50W at a rate of ½ pt. per 50 gal. of water. Additional components of the program include a 2% application of Dormant Oil spray in early April, prior to bud break.

7F. **Disease Control** Preventive control measures to avoid Powdery Mildew on the wine grapes include a sulfur and Bayleton application. Rates per acre to be included at a later time!

7G. **Equipment** Dan, you complete this section since I am inept in this technical arena!

## **References**

- Colorado Tree Fruits: Pest and Crop Management Guide, Bulletin XCM-41
- Pests of the West, Whitney Cranshaw, 1992
- Integrated Pest Management for Apples and Pears, University of California, 1991

## **TRELLISING - A NEW EMPHASIS FOR COLORADO APPLES**

Dan Fernandez, County Director  
Dolores County Extension Office.

The art of trellising apples is a relatively new concept to apple growers in the U.S., and is beginning to find its place in Colorado. Trellised apples are usually established in conjunction with high density tree plantings of 500 to 4,000 trees per acre - standard non-trellised plantings range from 150 to 200 trees per acre.

As with grape production, a trellis is used as a form of support for the apple tree. The main difference between the two is that an apple trellis is taller (10 feet vs 5 feet for grapes) and uses far less support wires (2 wires vs 4 to 7 for grapes). Tree support is a necessity because of the dwarfing rootstocks used in high density plantings. Dwarfing Rootstocks do not allow for good anchoring of the tree's root system. But the dwarfing characteristics do produce significantly smaller trees with less vigorous growth. This allows for a lower profile, narrowly spaced (both in the tree row and drive row) plantings.

High density trees maximize land use, but initial establishment costs for the trellis, irrigation system and nursery trees can be high - as much as \$8,000/acre depending on the number of trees purchased. But, from a production and income standpoint, 3 to 5 acres of high density apples have significant production potential with early income returns (3rd season) possible to the grower.

Tree management, using a trellis system, is intensive with the timing of cultural operations critical for good tree development and fruit production. Inputs such as water, fertilizer, herbicides and pesticides are maximized because of the tight spacings. Narrow drive rows require smaller equipment thus reducing capital expenditures, and the shorter, dense tree canopies makes for easier pruning and harvesting.

The Colorado State University Cooperative Extension Fruit Tree and Vineyard Project at the Southwest Colorado Research Center at Yellow Jacket is a cooperative effort that includes the NRCS offices in Dolores and Montezuma counties, the Extension offices and County Commissions in both counties, several CSU Fruit Tree Specialists from the Grand Junction area, and local growers. The project is currently evaluating 29 fruit tree varieties and 8 wine grape varieties for use in Southwest Colorado. 9 varieties are presently developing under a trellis system.

## APPLE VARIETY DESCRIPTIONS & EVALUATIONS

By: Dan Fernandez, Dolores County Director  
Colorado State University Cooperative Extension

**SCARLET GALA:** Beautiful color with bright red striping over an orange background. Mid-bloom, with moderate to large fruit size and heavy yield in SW Colorado. Recommend using central leader training to allow good light penetration. Moderate tree development. Matures early to mid September. Excellent potential for our area.

**NURED JONATHAN:** Dark red small fruit but heavy bearing in SW Colorado. Requires heavy thinning and is very cold hardy. Do not use on Mark rootstock. Poor tree development but this is due to Mark rootstock. Good pie apple. Matures mid to late September.

**SWISS GOURMET:** Beautiful color with a bright red over a rich yellow background. Mid-bloom, medium to large fruit that matures early to mid September. Excellent tree development on trellis system with a light to moderate crop in the third season. Susceptible to light hail. Excellent potential for this area.

**ROYAL EMPIRE:** Excellent dark red that colors early. Mid-bloom, medium to large fruit that is fairly resistant to light hail. Matures mid September. Long shelf life. Excellent tree development on trellis system with moderate production for third season.

**LIBERTY:** Good color with deep red over a slight yellow background. Mid-bloom, highly resistant to major apple diseases. Excellent tree development on trellis system, large fruit size with heavy production in third season. Highly susceptible to light hail. Matures a week to 10 days later than Scarlet Gala with late September to early October harvest.

**GOLDEN DELICIOUS:** Golden apple with an excellent light red blush that develops on sun side. Mid-bloom, early heavy bearer with small to medium fruit, needs early thinning, alternate bearing a possibility. Mid to late September harvest. Moderate tree development in third season.

**HONEY CRISP:** Excellent color with a scarlet red over a yellow background. Mid-bloom, keeps well in storage-high quality. Good tree development but poor production in third season. Tree also tends to grow upright and requires substantial limb training. Mid to late September harvest. Questionable for our area.

**RED FUJI:** Good color development with red stripe over a yellow-green background. Mid to late-bloom, late harvest mid October, very firm apple with excellent storage qualities that is very resistant to light hail. Excellent tree development on trellis system with medium to large fruit. Very heavy crop for third season. Big market potential.

**RED JONAGOLD:** Excellent red blush over a slight yellow background. Mid-bloom with late color development, small to medium fruit, susceptible to mildew but resistant to light hail. Good tree development with a light to moderate crop in fourth season. Mid to September harvest.

**LUSTRE ELSTAR:** Beautiful scarlet red blush over a yellow background, Mid-bloom, medium to large fruit. Good tree development and heavy crop in the fourth season with mid to late September harvest. Resistant to light hail. This appears to have excellent potential for our area.

**SUPER JON:** Mid-bloom, dark red small to medium fruit, resistant to light hail, good tree development with good crop in fourth season. Mid to late September harvest.

**MOR-SPUR McINTOSH:** Bright cherry red blush. Early, heavy producer. Smaller tree size is good for high density plantings. Upright growth that requires substantial limb training. Still Evaluating for SW Colorado.

**IMPROVED RED DELICIOUS:** Camble strain that is highly striped with strong red color. Mid-bloom. Upright tree growth that requires substantial limb training. Poor tree development so far but still evaluating for SW Colorado.

**ROYAL GALA:** Produces red stripes over an orange-red undercolor. medium sized fruit which may exhibit a wide variation of fruit coloration. 97 planting

**MYRA RED FUJI:** Medium to large apple which colors up substantially. The finish color is a pinkish red. Matures earlier than Red Fuji. 97 planting

**GRAVENSTEIN:** large, re-stripped, crisp and juicy. Excellent for cooking and pies. Hardy. 97 planting

**IDARED:** A solid, bright red apple. Tree bears young with a heavy annual yield. 97 planting

**LODI:** Yellow fruit large in size. good shipper. 97 planting

**RUBINSTAR JONAGOLD:** Intense red coloration that is uniform throughout the tree. Matures one week ahead of Jonagold and is less susceptible to sunburn. 97 planting

### APPLE ROOTSTOCKS

**EMLA 9:** Produces a tree that is 35-40% of a standard tree or semi dwarf, Does well in heavy soil and wet conditions, needs mechanical support throughout the life of the tree, large fruit.

**EMLA 26:** Produces a tree that is 40-50% of a standard tree, needs support though it roots well and is better anchored.

**EMLA 7:** Produces a tree that is 50-60% of a standard tree. Winter hardy, disease resistant, needs well drained soil.

**EMLA 111:** Produces a tree that is 70-75% of a standard tree. Winter hardy, adaptable to a wide range of soils, tolerant of drought, excellent for spur type cultivars.

**Mark:** Not advisable to use in SW Colorado due to bud-union incompatibility.

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#### Reference:

Snyder, Jack, Snyder, Jim, Snyder, Todd, Snyder, Dick, Snyder, Gary. Technologically Advanced. Traditionally Superior. C&O Nursery. Fall'97/Spring '98.

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**PEAR VARIETIES**

**Max Red Bartlett:** Still evaluating for SW Colorado.

**D'Anjou:** Firm, juicy with excellent flavor. Excellent storage capabilities. Still Evaluating for SW Colorado.

**Du Comice:** Excellent dessert pear with a rich, juicy flavor. Its flesh is tender, smooth and the fruit is large, color clear yellow. Still evaluating for SW Colorado.

**Bronze Beauty:** Fruit is medium to large with a russet that takes on a bronze color when ripe. Tree is vigorous and large, exhibiting a spreading habit. Still evaluating for SW Colorado.

**ROOTSTOCKS**

**Old Home x Farmingdale rootstock (O.H. x F.):** is hardy well-anchored and productive. Produces a semi-dwarf tree.

**Old Home x Farmingdale #97 rootstock (O.H. x F.#97):**

**Reference:**

Snyder, Jack, Snyder, Jim, Snyder, Todd, Snyder, Dick, Snyder, Gary. Technologically Advanced. Traditionally Superior. C&O Nursery Catalog. Fall'97/spring '98.

**FRUIT TREE & VINEYARD PROJECT**  
1997  
**PEACH VARIETY**  
**DESCRIPTIONS & EVALUATIONS**

**J.H. Hale:** Large fruit with excellent color that has good handling and shipping qualities. Yellow flesh with yellow ground color overlaid with red. Matures very late - late September. Suffers light winter damage every season. Heavy bearing and requires heavy thinning to avoid limb breakage. Use of proper pruning angles critical. Very susceptible to light hail. Requires cross-pollenization.

**Redskin:** Yellow flesh with a well colored red exterior blush. Less susceptible to fruit drop than Elberta and is a heavy producer with large fruit. Matures late- late September. Suffers moderate winter damage every season. Heavy bearing requires heavy thinning to avoid limb breakage. Use of proper pruning angles critical.

**Red Globe:** Firm yellow flesh with good flavor. Has a bright skin color and is excellent for canning and freezing. Good initial growth but still evaluating for SW Colorado.

**Flamin' Fury:** Large red fruit that has good flavor and shipping qualities. The trees are very winter hardy. Good initial growth still evaluating for SW Colorado.

**Notes:**

Only use ½ inch caliper or less nursery stock for new plantings.

The only rootstock currently being evaluated on all varieties is Certified Peach.

**Reference:**

Snyder, Jack, Snyder, Jim, Snyder, Todd, Snyder, Dick, Snyder, Gary. Technologically Advanced. Traditionally Superior. C&O Nursery Catalog. Fall'97/spring '98.

## IRRIGATION

By: Dan Fernandez, Dolores County Director  
Colorado State University Cooperative Extension

### **Dryland vs Irrigated**

Depending on your long term objectives, you can grow fruit trees and vineyards under both dryland and irrigated conditions in Southwest Colorado. Irrigated trees/vines allow for improved land utilization through higher planting densities, tree/vine growth is timely and rapid, the economic return on your investment is quicker, yields will be higher, and drought is usually not an issue. Dryland trees/vines rely on area weather conditions and generally must be watered during the establishment years (1 to 3) and also during periods of severe drought. Initial investment costs for dryland trees/vines is considerably less than irrigated. Rainfall in the Dolores and Montezuma counties area ranges from 10 inches to 16 inches per year.

### **Basic Irrigation System**

The Project uses a basic, limited frills, grower friendly, low volume irrigation system that emphasizes water conservation, limited maintenance, low cost and ease of operation. The water mainline delivery system is slightly oversized to accommodate expansion and higher watering rates for frost protection. The actual watering and water rates are controlled by an electronic irrigation controller that has the capacity to operate six irrigation valves (irrigation zones). The Project usually runs one valve at a time with scheduling determined by water emitter size and the stage of tree/vine development. In the tree row, black poly-lines are laid on the surface near the trees where the emitters/sprinklers are placed. These poly-lines have been functioning for over six years without any major maintenance problems. Some growers roll-up the poly-lines for Winter which may extend the life of the line, but this is labor intensive. Also, we do not recommend the placing of the poly-lines below ground because of the difficulties in replacing emitters and maintenance.

The irrigation valves are placed in plastic boxes below ground with only the box lid above ground. 30psi. pressure regulators are placed on the outflow side of each valve to insure a constant flow to the emitters/sprinklers.

Filtration consists of a locally purchased two inch filter with a 100 mesh filter screen. Filter cleaning may be accomplished through a .75in. back-flush valve, but this has proven to be ineffective. Removal of the filter screen and hand cleaning with water has been necessary. Generally, filter cleaning has been required after 50,000 gallons have passed through the filter. This requirement will vary greatly based on delivered water quality to your irrigation system.

System evaluations and water rates have been determined based on observations of, maintenance requirements, tree growth, yields, pan-evaporation readings and the use of soil probes.

### **Drip System**

The present drip system which the Project is using has been in operation for over six years. The 7 emitter types presently under evaluation have hourly drip rates ranging from .5 gallons two 2.0 gallons per hour. To date, the drip system and all emitter types have been virtually problem free with algae and clogging not a concern. This is due in part to the excellent water quality delivered by the Dolores Water Conservancy Irrigation Project. Periodic flushing (twice a season) of the poly-lines and main PVC lines has also prevented clogging problems.

A drip system allows for limited lateral movement of water away from the emitter - 2 to 3 feet of movement is all that can be expected. This may have an impact on the tree's development and yield during periods of severe drought. Increasing the number of emitters per tree (we are currently using 4 one gallon emitters/tree on our 6 year old trees) can improve the water distribution. Also, the attachment of micro-tubes to the emitters for increased water dispersal is an option.

The Project has found that weed control is considerably easier and cheaper with a drip system. A drip system allows for little air contact from emitter to the soil which is a highly efficient delivery system in terms of minimizing water loss due to evaporation. But the 1997 crop demonstrated a 10% lower difference in bushel weights when compared to the micro sprinklers.

Watering at the same rates as the micro sprinklers, the trend observed was better initial growth in the first two years using drippers because the water was concentrated around the root system. In years 3 to 5, this trend was equalized, and in year 6 the drippers were slightly outperformed by the micro sprinklers.

The Vineyard is irrigated using 1 gallon emitters that are placed on a support wire 1 foot off the ground. The reason for elevating the drippers is to facilitate weed control practices. As the current volume of water delivered to the vines is more than adequate, there are no plans to expand the number of emitters per vine in the Vineyard

## **Micro Sprinkler System**

The Project is presently using 5 micro sprinkler types that range in delivery rates of 7 to 20 gallons per hour. The wetting patterns of these sprinklers range from a radius of 2.5 ft. to 13.3 ft., with a standard operating pressure of 30psi. Because of the wide wetting patterns of most of the micro sprinklers, only one sprinkler per tree is currently being used.

To date, algae and clogging are not problems with micro sprinklers. But we have found that micro sprinklers require constant checking for leaks or breaks in the delivery tubes that are attached from the poly-lines to the sprinklers. If the micro emitters are not properly placed, or not at a 90 degree angle to the ground, your wetting pattern will be disrupted or distorted. Micro sprinklers increase weed problems and can cause problems to tree varieties that do not tolerate wet trunks or root crowns. Micro sprinklers that have moving parts have proven to be very erratic and unreliable in their water delivery efficiency due to jamming of the sprinkler head - these have all been removed from use in the Project.

Use of micro sprinklers during daylight hours can significantly increase your water losses due to evaporation. This is especially true if there are windy conditions. Generally, water rates are increased 25% over drip system rates to compensate for evaporation. With the summer winds in our area prevailing from the Southwest, all micro sprinklers should be placed on the Southwest side of the trees 3 to 6 feet from the trunk depending on the sprinkler's wetting radius.

For frost protection, micro sprinklers can be very effective because of the relatively high volume of water that they can distribute over the tree. This high volume of water is also a major benefit in large orchards where your system has many valves or zones and you need shorter run times per irrigation zone to accomplish an irrigation cycle. As stated in the drip system section, micro sprinkler system yield weights were 10% higher than drip yields. Close observations of tree growth and performance show that micro sprinklers and their larger wetted areas may be more beneficial to maturing trees (years 6 and beyond)

## **Pulsators**

Recent technology has developed a pulsator type of emitter/sprinkler that can be adapted to drip systems for crop cooling and frost protection purposes. The Project is currently using two types of Pulsators with flow rates of 1 and 3 gallons respectively; these are presently being used exclusively for frost protection on the grapes. The Pulsator will be discussed in greater detail in the frost protection section.

## **Irrigation Rates**

The following is a chart of the irrigation rates used by the project:

# YELLOW JACKET FRUIT TREE AND VINEYARD PROJECT

## GALLONS OF WATER PER TREE PER WEEK IRRIGATION SCHEDULE SUGGESTIONS

	FIELD TREES DRIP	TRELLIS TREES DRIP	FIELD TREES MICRO SPRINKLERS	GRAPES DRIP
year	gallons	gallons	gallons	gallons
1	25	25	30	12
2	50	50	50	12
3	60	60	70	14
4	70	*70	100	16
5	80	*80	120	16
6	100	*100	140	*18
7	120	*120	200	*18
8	*140	*120	*220	*20
9	*160	*120	*220	*20
10	*160	*120	*220	*20

\* Projected Crop Water Use

- Notes -
- ! Irrigation is usually performed 2 times a week
  - ! All irrigation rates are peak application rates
  - ! Early season irrigation rates are 50% lower
  - ! For Tree & Vines winter hardening, irrigation rates are reduced by 20% per week beginning in August 1st, with shut off by September 1st
  - ! The grapes are reduced at an accelerated rate with full cut off by mid August

# FRUIT TREE AND VINEYARD PROJECT IRRIGATION SCHEDULE

1997 SEASON

Value #	Type	Prog.	Days	Hours	Rate	% Timer	Amt Irr./Week
1	Maxi Jet	Drip	M-W-SAT	3.5	1-20 g/hr	100%	210 g
2	Mini Sprinkler	Drip	M-W-SAT	4.0	1-18 g/hr	100%	216 g
3	Ray Jet	Drip	M-W-SAT	7	1-7 g/hr	100%	147 g
4	Drip	Drip	M-W-SAT	10	4-1 g/hr	100%	120 g
5	Grapes - Drip	A	TU-TH-SUN	6	1-1 g/hr	100%	18 g
6	Drip & Drip Tape	A	TU-TH-SUN	7	1-2 g/hr	100%	42 g

## NOTES

Valves 1 to 4 are on the drip cycle with one start time. The drip cycle only has the capacity to run for 24 hours.

Valves 5 and 6 are on program A. This program needs multiple start times due to each cycle having a maximum run time of 90 minutes per cycle per valve. The present setting VARIES per valve with six start times presently programmed in at 15 minute intervals. This program will stack start times so exact start times will not be needed.

Be sure that run times do not conflict with start times - especially when using program A.

Valves 1 to 4 were reversed in order at the Controller in 1996 so that the high volume micro sprinklers would be operating during the night and be less subject to daytime winds and heat evaporation.

A graduated decrease in irrigation will start August 1 of every year. The usual reduction is 20% per week. The grapes are reduced at an accelerated rate with full cutoff by mid August.

Programs B & C and Valves 7 & 8 are not programmed and must be zeroed out or in the off mode. This must be checked during the spring start-up.

## FROST PROTECTION

Brian G. Leib<sup>1</sup>, Dan Fernandez<sup>2</sup>, and Adrian Fisher<sup>3</sup>

### Abstract

The project explores the feasibility of producing commercial quantities of fruit in the high and arid environment of Southwestern Colorado by using low-volume water delivery systems for irrigation and frost protection. The demonstration was installed during the spring of 1992 and consists of a one-acre plot with 40 trees each of apples, peach, and cherry cultivars. Half of the fruit trees have frost-protection capability since the micro-sprinklers used to irrigate the trees can be moved from the ground to above the tree canopy during the frost season. For comparison, the other half are only irrigated by means of micro-spray and drip irrigation left on ground. Since the young trees are not yet bearing fruit and there has not yet been a frost event during bloom, this paper will focus on the procedure employed to design from protection into the irrigation system.

### Objectives

The board range objective of this project is to investigate alternative crops suitable to southwestern Colorado. More specifically, the project will explore the feasibility of producing commercial quantities of fruit using low-volume, automated water delivery system for irrigation and frost protection.

The project has many facets, and this paper will only attempt to detail the design criteria, the micro-sprinkler selection, and the experimental layout for frost protection. A companion paper has been written for the American Society of Agricultural Engineer's (ASAE) 1993 Summer Meeting in Spokane, WA entitled "Micro-Irrigation Design of a Frost Protection Demonstration in Southwest Colorado." The ASAE paper focuses on the automated irrigation system and the tree response to four different types of low-volume emitters one year after planting.

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## Frost Protection Method

### Objectives

There are a variety of frost protection methods: wind machines, helicopters, under-tree sprinklers, over-tree sprinklers, various heater systems, bloom delay, and polymer coatings. Each method has its strong and weak points; yet, ice encasement via micro-sprinklers seemed most suitable for southwestern Colorado.

A primary factor in this decision was effectiveness. Ice encasement is the method that can provide the greatest level of frost protection (Keller & Bliesner, 1990). If enough water is applied, fruit buds have survived temperatures in the low twenties. A combination of wind machines and under-tree sprinklers may provide similar protection during radiant freezes (Snyder & Thompson, 1991).

Second, irrigation is required for maximum crop production in southwestern Colorado. The micro-irrigation system can double as a frost protection system without the added cost of specialized equipment such as wind machines and heaters (Evans, 1991).

Third, the operating cost for frost protection with overhead sprinklers is based primarily on the cost of water. In southwestern Colorado, pressurized water is inexpensive: Montezuma Valley Irrigation Company - \$2.50/acre-ft (with a gravity pressure pipeline), and Dolores Project - \$21.60/acre-ft. Wind machines and heaters will incur fuel and labor costs (Evans, 1991).

Finally, micro-sprinklers can be operated more efficiently than impact sprinklers because the open space between tree rows will not be irrigated by the tree targeted micro-sprinklers (Evans, 1991). Water will be conserved during both irrigation and frost protection. This can be especially important due to the high application rates required for frost protection.

These advantages are possible because the water used for irrigation has physical properties than can be manipulated to prevent fruit buds from freezing (Solomon, 1991). One means water releases heat is through a drop in temperature. A 10 degree temperature drop (i.e. 42 to 32 degree water in freezing conditions) will release 83 BTU/gallon of heat that was stored in the water. However, there is a much greater release of heat when water changes state from a 32 degree liquid to a 32 degree solid, known as ice. Freezing water will release 1200 BTU/gallon.

An example of how effective water can be in frost protection is illustrated by two different uses of one gallon of diesel fuel (Solomon, 1991). If the gallon of diesel is burned in a orchard heater, it will produce 140,000 BTU. That same gallon of diesel can pump 14, 040 gallons of water through an orchard irrigation system. Upon freezing, the 14,040 gallons of water will release 16,848,000 BTU. Therefore, frost protection with water has the potential to be 120 times more effective than direct heating of an orchard environment.

However, ice encasement has some of the greatest risks (von Bernuth, 1990). Ice loads can break tree limbs, especially those of stone fruits such as peaches. There is also the risk of evaporative cooling. When water evaporates, it absorbs 9000 BTU/gallon and some water will evaporate at any temperature not just at the boiling point. Evaporative cooling can damage fruit buds; if the system is not turned on early enough during the freeze event, if the application rate is not high enough, if the sprinkler system fails after ice encasement has begun, or if the system is turned off before all the ice has melted from the trees.

The decision to use micro-sprinkler for ice encasement maximizes effectiveness and minimizes cost. The high risks associated with this method can be alleviated through proper management. Choosing an irrigation method for frost protection is also practical for farmers who are already irrigating. Other areas with rain-fed agriculture and established orchards may opt for different methods.

### **Micro-Sprinkler Selection**

The selection of overhead micro-sprinklers for frost protection is based on the application rate needed to protect deciduous fruit buds and on the area targeted for protection. Once the application rate and the target area are determined, a micro-sprinkler with a matching pattern is sought.

From an equation presented by Keller & Bliesner (1990), a typical, radiant freeze event of 25 degrees F, 80% humidity, and 2.5 mph wind would require an application rate of 0.16 in/hr. Also, Evans (1991) stated that at least 0.15 in/hr is needed to protect against radiant freezes when micro-sprinklers are targeted to individual trees. The designated tree spacing (see Fruit Tree Demonstration below) is ten feet between trees in a row. When the trees grow to a 10' diameter, they will start to overlap. Therefore, 0.15 in/hr was designated as the minimum allowable application rate in a 10' diameter area.

There are numerous micro-sprinklers on the market today. Many will produce the necessary flow rate in the designated area but very few have been "can" tested to show the uniformity and application rate in the area. Plastro was one manufacturer located that could provide the desired technical support - another was Wade Rain Irrigation products.

The Tornado mini-sprinkler produces a flat pattern that matches the 5' tree radius (10' diameter), see Figure 1. At 20 psi, the Tornado emits 17 gph and provides a 0.2 in/hr application rate out of 5'. This should provide considerably more frost protection then designated by the 0.15 in/hr criteria.

The Rondo mid-sprinkler provides the desired coverage when the sprinklers overlap along the tree row, see Figure 2. At 35 psi, the green Rondo nozzle emits 22 gph and meets or exceeds the 0.15 in/hr criteria in a 10' foot strip down the tree row. This provides frost protection to an area larger then the targeted 10' diameter.

### **References**

Evans, R. G. (1991). Frost Protection Techniques For Trees in the Northwest. Paper presented at the Frost Protection Strategies for Trees and Grapevines Conference, Dec. 5th, Visalia, CA, 111-138.

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## Automated Crop Frost/Freeze Protection System

1. Automated Crop Frost/Freeze Protection System - based on the use of irrigation water for heat units/ice encasement.
2. Names, titles, departments of inventors
  - Steve Miles - Owner - Rainmaker Sprinkler Company - Cortez
  - Dan Fernandez - Director - CSU Cooperative Extension Dolores County
  - Janet Sennhenn - Director - CSU Cooperative Extension Montezuma County
  - Kenny Smith - Ag. Agent - CSU Cooperative Extension Montezuma County
3. Stage of Development
  - a. May 7, 1996 - CSU Extension District Meeting- CSU Extension Administration
  - b. Oct. 15, 1995 - Concept Discussion at Experiment Station - Fernandez, Miles, Sennhenn, Smith
  - c. May 19, 1996 - Diagrams - Miles
  - d. Oct. 20, 1995 - Dolores County Extension office - CSU Initiative Grant
  - e. May 2, 1996 - Southwest Colorado Research Center - Miles, Fernandez,
  - f. May 2, 1996 - Southwest Colorado Research Center - Miles, Fernandez, Installation and field test with ice.
  - g. May 26, 1996 - Southwest Colorado Research Center - Fernandez - Freeze Event-System performed as designed.
4. The Yellow Jacket Fruit Tree & Vineyard Project have photographs of the temperature controllers/thermostats, temperature sensor, transformer setup, and irrigation controller. We also have a complete set of diagrams of the system and its operation.
5. Disclosure has been limited to Rainmaker Irrigation Company, CSU personnel and the Dolores County Commissioners
6. List all known or contemplated use, publication, oral presentation of invention.

The Automated Frost Protection System has direct use with all types of tree crops, field nurseries and vegetable crops that rely on water/ice encasement for frost/freezing protection. This would include deciduous tree fruits, tropical tree fruits, grapes and vegetables. It would be especially useful in remote areas where it takes time for the grower to reach a field, or if there are several fields in different locations where immediate/direct supervision of the frost protection application is delayed. Best use is during unpredicted/mis-predicted frost/freezing events.

Local and area presentations are anticipated with possible inclusion in a proposed Four Corners Fruit Tree Production Guide
7. All financial support for this invention has come from the CSU Cooperative Extension Initiative Grant Program.
8. Irrigation supply companies, nursery supply companies, orchard (deciduous and tropical) production supply companies
9. Give concise technical description of invention, including:
  - a. **General Purpose**

Current use - Automated Crop Frost/Freeze protection system for deciduous tree fruits based on water/ice encasement.
  - b. **Previous Methods, materials, devices performing function of invention.**

There have been several computer-controller based systems that have performed similar functions.
  - c. **Disadvantages of prior art.**
    1. Expense - this system cost \$750.00 and was installed in one hour. Prior systems cost several thousand dollars and require extensive and complicated computer programming. Also, prior systems require a network of thermocouple wires for temperature sensing that takes several hours, if not days, to install and program. Programming our unit takes 30 seconds.

2. Prior systems also required continuous on-site management whereas this system has more management flexibility due to the ability to program-in specific start and shutdown temperatures for the irrigation system.

**d. Identification of component parts, steps, and explanation of mode of operation.**

**The basic component parts are four:**

1. Irrigation controller - This is a standard piece of equipment and is not part of the proposed patent. It is part of our overall frost/freeze protection system.
2. Thermostat controller
3. Transformers/switching network
4. In-field temperature sensor

**Operation**

**Step 1**

The thermostat controller has three settings:

1. The first is the mode selection - heating or cooling - we select the heating mode.
2. The second is the critical temperature for irrigation system shut. We have selected 38 degrees with optional temperatures ranging from 20 to 130 degrees.
3. The third is the temperature differential setting. This is set to operate the irrigation system start-and-stop cycles based on the preferred critical temperatures. We have set the differential temperature at 4 degrees with optional differentials ranging from 0 to 10 degrees.
4. The field sensor is located in the field 50 feet from our main area of frost/freeze protection.

**Example** - by setting the critical shutdown temperature at 38 degrees, and then setting the differential temperature at 4 degrees, the irrigation system will start when the temperature reaches 34 degrees and will not shut-off until the temperature rises to 38 degrees. This is essential in an ice-encasement frost/freeze protection system, as the continuous application of water is necessary until the ice is melted off of the crop/tree.

**Step 2.**

Transformer Controller/Switching Network

Once the critical low temperature is reached (in our case 34 degrees) a signal is sent to the transformer/switching network. This switching network is connected to the irrigation controller and has been wired/programmed to override any pre-programmed functions of the irrigation controller.

Receiving the activate command, the irrigation valves (we can wire up to 10 valves into the network) that have been selected for frost/freeze protection are turned-on. When the critical shut-off temperature is reached, (in our case, 38 degrees) the switching network turns-off the frost/freeze protection irrigation valves and frees the irrigation controller to resume with normal irrigation operations.

**10.** Lower cost, ease of programming (grower friendly), flexibility of programming, easy to install, simple design, resets automatically, can be used with any irrigation controller system, requires very limited direct management or monitoring.

# FRUIT TREE PRUNING

## The Art of Fruit Tree Pruning

By: Dan Fernandez, Dolores County Director  
Colorado State University Cooperative Extension

### Basics of Pruning

- a. It's personal, and must be customized to your location
- b. Promote tree development to your management scheme
- c. Production - early and consistent is the goal
- d. Tree support and strength are critical factors
- e. Reducing the effects of shading is essential

### When to Prune

- a. Pruning starts the first season the tree is planted - but only lightly - pruning intensifies as the tree ages
- b. Prune March or early April depending on how many trees there are to prune - the later the better
- c. Pruning must be completed before bud swell/bloom
- d. Summer corrective pruning is advisable
- e. Do not prune after August 1
- f. Do not prune early to mid winter

### Pruning Equipment

- a. Sterilize all equipment before and during use - especially if diseases are present
- b. Hand saws and pruners, loppers and air powered equipment are acceptable
- c. Use chain saws only as a last resort
- d. Keep all equipment sharp and clean
- e. Use only 3 point orchard ladders

### Pruning Cuts

- a. Pruning cuts should always be flush and smooth and never flat where water could accumulate
- b. Avoid limb tearing and bark peeling
- c. Bark damage that is jagged should be smoothed out
- d. Do not cut into the 'collar' of a limb
- e. NEVER use pruning paints or dressings

### Tree Shape, Size

- a. For apples, pears and cherries a central leader or modified central leader system works well - think of the shape of a christmas tree
- b. Peaches require an open center with 2 to 4 main scaffold limbs
- c. Tree size is determined by what you feel you can manage - a 10 to 12 foot tree is a lot of tree
- d. For all trees, limb angles should be between 45 and 60 degrees to promote good fruit development and limb strength

### How Much do I Prune

- a. It's personal depending on your management scheme and desired pruning system
- b. First - step back and look at the tree - then walk around the tree - start pruning slowly
- c. Remove dead, broken or diseased branches
- d. Remove congested or crossing branches and twigs
- e. Use heading cuts to promote side branching
- f. Remove all root suckers and water sprouts
- g. Heavy pruning can reduce fruit production, but enhance fruit size
- h. Old tree rejuvenation requires a lot of corrective pruning with subsequent reduction in production likely for 2 to 4 seasons

### General rules for pruning

- \* The first season is the tree establishment year with minimal pruning the objective - but whatever pruning is done should be with a specific training system in mind
- \* Remove broken or misplaced branches - those branches that remain should be lightly headed to force branching
- \* Prune to limb positioning - this will facilitate future pruning
- \* Follow your established pruning program consistently and every season

- \* Prune young trees (seasons 2 to 4) lightly concentrating on tree form
- \* Prune mature trees more heavily emphasizing form and production potential

### **Limb bending**

Bending nearly vertical or horizontal limbs to an aspect 45 to 60 degrees usually stimulates fruit production earlier in the life of the tree. The thicker and more upright or prone a limb is, the more benefit they will receive from bending. Early production stimulated by bending helps to keep a tree small and manageable.

**Open-center training.** To train trees to an open center, choose three or four shoots to form main scaffold branches the first season. Remove other shoots that might form competing limbs. Head them, removing a fourth to a third of their length, if they're long and unbranched. When you remove large limbs, first cut part way on the underside. Don't leave stubs but do not cut into the 'collar' of the limb.

**Central-leader training.** If a nursery tree has few or no branches at planting, head it just below the existing tree top. To train trees to a central leader, choose a vigorous shoot high on the tree after planting.

During spring or early summer, remove other shoots near the lead shoot - because of their upright aspect and vigor, these will compete with the lead shoot if not removed. Head this shoot by a third each dormant season, and tie down or remove competing shoots.

## APPLYING THE BASICS

### **Apple Trees**

**Fully dwarf tree rootstocks EMLA 26 & 9, M9, Bud 9, G65 & 30.** You must support these trees in some way, or they'll bend or lean to the ground under the weight of their fruit. You could support the central trunk against the side of your house or a fence with adjustable eye-bolts or turnbuckles and wires.

If you use individual posts, make sure they extend at least 6 feet above the ground, and drive or sink them at least 2 feet into the ground. Wooden tree stakes should be 2 inches or more in diameter.

You can grow dwarf apple trees on a post-and-wire trellis in a hedge row. Posts may extend from 6 to 10 feet above the ground. Treated posts are best, but sound, untreated 4 x 4 cedar posts may be satisfactory. Use galvanized wire, 12 gauge or heavier. The lowest wire, should be about 4 to 5 feet above the ground, with higher wires placed to 10 feet. (see section on trellising).

Anchor the end posts against another post driven several feet into undisturbed soil at an opposing angle. Tie the main trunk to these wires, using a loop big enough to allow the trunk to grow without being girdled.

Train fully-dwarf apple trees to a central leader. If you train them to a central leader, and support them from a post or trellis, they'll make highly productive 6 to 10-foot trees. If you don't train them in this manner, the weight of the fruit will bend them down so that they make bushlike trees only 4 or 5 feet tall.

In the spring following planting when shoots are 3 to 4 inches long, select the uppermost vigorous shoot and remove other shoots near it. Return in summer and remove any shoots that, because of their upright aspect and vigor, will compete with the lead shoot.

Head this shoot by a third in the dormant season, and tie down or remove competing shoots. Repeat the process in the following two seasons so that no side branches become vigorous enough to compete with the central leader.

Keep three to five branches 24 to 30 inches above ground to form a basic set of permanent branches. If they're upright, tie, spread or weight them down to 45 degree aspect. Using string attached to a ground stake, is a highly effective method for limb bending and positioning. Also varying lengths of wooden branch separators are excellent for this process.

**Semi-dwarf Trees EMLA 7, EMLA 111, G30.** You can train these trees to a central leader or develop them with three or four lead branches. Central leader is best for weak-growing varieties on poor soil. Train vigorous varieties with multiple leaders (when trained to central leaders, they may become too tall). In a windy site, use a sturdy stake for support in the first few years.

Head nursery trees the same as for central leaders, but develop three or four shoots instead of one. When they're 4 to 6 inches long, spread these shoots using wooden branch spreaders or light string.

In the following years, spread or tie out the lead limbs to an overall aspect about 45 to 60 degrees from vertical. As the tree begins to bear fruit, properly formed limb angles should reduce or eliminate the need for propping up limbs to prevent breakage.

**"Spur-type" trees** form many small spurs on young growth rather than the usual long shoots and leaf buds-this is how they got their name.

Each spur bears a flower cluster. The leaves are close together, the tree branches are less frequent, and the tree grows slowly. Because these trees are smaller than the standard strains of the same variety, and fruit at a young age, they make ideal home-orchard trees. If you grow them on vigorous rootstocks, spur-type trees may not require artificial support until they are in production.

Spur-type trees are available on both vigorous and dwarfing rootstocks. Because they branch sparsely, leave more branches in a spur-type than in a tree of standard growth habit. To train them to a central leader, space the lower set of limbs several inches apart vertically on the leader, and reduce their number to four or five.

**Standard trees (full size on seedling roots.)** Train them on non-dwarfing roots to the modified central leader system: Leave the central leader in place until fruiting begins, then gradually remove it.

It's desirable to have only four main scaffold limbs, equally spaced around the trunk and vertically spaced several inches apart. Develop the main scaffold limbs to an overall aspect 45 to 60 degrees horizontal. Make sure that all secondary branches also have an upward aspect.

The branches of a mature non-dwarf apple tree may spread over an area 40 feet in diameter and reach a height of 30 or 40 feet. Regular pruning, and tying down of upright limbs in the top, is required to maintain a height of 12 to 15 feet. Prune to make the lowest limbs the most vigorous and productive in the tree.

Shorten, thin out, and bend down the upper limbs to accomplish this. By removing risers that go straight up and hangers that grow straight down, you form the permanent limbs. Also, open a vertical space of about 3 feet above, so that light can penetrate.

If a tree hasn't been pruned for several years, it will have a dense thicket of upright shoots in the top and many weak, pendulant spur systems further down. Prune it back into shape gradually over several years, rather than trying to do the whole job in 1 year.

After you identify the main scaffold branches, prune out any excess large branches. Climb as high on your ladder in the tree's center as you intend to pick, and cut the main scaffold limbs down to a height that you can reach.

Remove limbs that overlap or hang down into other limbs. Thin out the upright shoots, leaving some of the smaller ones. Cut back weak pendulant limbs. Gradually invigorate the spur systems by cutting back some and removing others. For better sunlight distribution, the center of the tree should be fairly free of limbs.

### **Pear Trees**

At planting, pear trees should have minimal pruning. Selection of potential scaffold limbs is the main emphasis the first season. In the second season, head the trees at about 24 inches. If the top is branched, retain some branches as leaders. Train pear trees to three or four leaders. Do little or no pruning except to head and spread the leaders annually until the tree starts to bear.

Don't head side branches-heading would maintain their upright position. Spread, tie or weight all vigorous shoots except the lead shoots.

Regularly reduce tree height to one you can reach from your ladder. Shorten or remove upper limbs so they don't shade the lower limbs. Thin out the branches of the mature trees and do the heaviest pruning in the tops.

Remove the long shoots in the center and top, but leave some short shoots and most spurs. Remove horizontal branches in the tree top so that they won't produce suckers.

### **Sweet Cherry Trees**

At planting, sweet cherry trees should have minimal pruning. Selection of potential scaffold limbs is the main emphasis the first season. In the second season, head the trees at a height desired for scaffold branches. Cutting a foot or two above ground level will produce a shorter tree. Train sweet cherry trees to the open-center system with many scaffold branches. The vertical limbs of young sweet cherry trees often will grow 6 to 8 feet without branching.

If a young tree is growing very rapidly, cut off a foot or more of new growth after about 3 feet of growth has been made in the summer - this will cause branching.

To promote branching on trees not pruned in summer, head every shoot to about 2 feet in length in the early spring. After 5 to 6 years, stop heading and thin out crowded branches.

Bacterial canker, a common disease of cherry trees, frequently causes gumming and dead areas or "cankers" on limbs-or the death of the entire tree. If a gummy dead area encircles most of a limb, you must cut off the limb.

Mature trees require little pruning except as needed to reduce the tree height. Birds usually eat the top cherries. If you lower the trees too much, the birds may eat the cherries you want. If loss of fruit to birds is excessive, you may want to net or use flash tape in the lower limbs.

### **Sour Cherry Trees**

Since sour cherry wood is quite brittle, give special attention to developing wide-angled crotches in young trees. Either select wide-angled shoots to form limbs, or spread the shoots to widen the angles. Three main scaffold limbs are enough for a sour cherry tree.

In the first and second seasons, remove excess shoots so that all the new growth takes place on the permanent scaffold limbs. Regular pruning is needed in mature trees.

### **Peach Trees**

At planting, peach trees should have minimal pruning. Selection of potential scaffold limbs is the main emphasis the first season. With scaffold limb selection being the main consideration, cut off peach trees about 24 inches above the ground level the second season. Train trees to the open-center system. Develop two to four main scaffold limbs. Select the scaffolds that make the widest angles at the point of attachment with the trunk, and not all from one height. Peach limbs with poor crotches split more frequently than limbs of many other fruit trees.

Remove excess scaffold limbs in the third and fourth seasons if necessary. Head the scaffold limbs in the first and second dormant seasons to cause branching until there are 6 to 8 secondary scaffold branches and 12 to 16 tertiary branches.

Peach trees bear only on 1 year-old shoots. Enough pruning is required every year to stimulate new shoot growth for the following year's crop. Peach trees branch readily and have too many weak shoots unless they're pruned properly.

Thin out the shoots, leaving shoots of moderate vigor; remove weak or very strong shoots entirely.

Prune hardest in the tops and near the ends of major limbs. Cut the top limbs back to side shoots to stiffen them and reduce tree height. Peach trees crop more consistently and have larger fruit if they're pruned heavily. Commonly, up to 50% of all the previous season's growth is removed annually. Light summer corrective pruning is advisable to control unnecessary and unwanted growth.

### **Prune and Plum Trees**

Train them to the open-center system, with three or four main scaffold limbs. Prune very lightly for the first 5 years. Head only those limbs that will be permanent scaffolds.

Japanese varieties (such as Shiro, Redheart, and Burbank) have many long, thin shoots, so heading is far more important in them than it is in most European varieties.

Tieing or bending limbs stimulates early production. Remove the excess scaffold limbs and do little else.

In the mature trees, thin out the tops every few years and revive the dead limbs as they appear. Most plums and prunes have ample blooms every year; therefore, only enough pruning is required to control height and spread, to keep the trees fairly vigorous, and to prevent limb breakage.

### **Apricot Trees**

Apricot trees usually develop numerous branches in the nursery. Some of these may be selected for scaffold branches at planting time. Cut these branches back a few inches and remove other branches. Cut back long shoots 1 year after planting to induce branching. Train the tree similarly to peaches.

Pruning bearing apricot trees is mostly a process of thinning out the excess wood, and heading to shorten long shoots. After a side shoot has produced for 3 or 4 years, removed it and let a new shoot grow in its place.

## **PRUNING TO RESTORE AN OLD, NEGLECTED APPLE TREE**

Sometimes the grower is confronted with trees that have become unfruitful through neglect. Frequently the problem is one of old age. Apple trees can survive to great ages, but not necessarily in a worthwhile state. As a general rule, to which invariably there are exceptions, trees over 20 years of age are best taken out completely. This is especially true if you intend on growing the apples commercially.

Often the problem centers on disease, in both young and old trees. Some diseases, such as fire blight, scab and mildew, can be cured, and aphids, caterpillars, mites and other similar pests can be dealt with by chemical and biological controls. But diseases such as silver leaf, severe canker and collar-rot are for practical purposes often are incurable and trees thus affected are best removed and burned.

Trees left unpruned may produce a profusion of flowers but the fruit, if any, is likely to be small and affected by pests and diseases. The foregoing points must be stressed even in a pruning manual, because no amount of skilled pruning will restore a starved and pest-ridden tree to health and fruitfulness.

The first thing to put right is the level of nutrition. This is accomplished by the removal of competing weeds and other vegetation, and the prudent application of fertilizers.

The rootstock must also be considered. Sometimes soil has been heaped around the base of the tree and the union buried, resulting in scion rooting. If inspection indicates no sign of the union above ground level, and the tree is in a condition of unfruitful vigor, bark-ringing will be necessary.

More frequently the opposite state occurs, in which the trees are stunted and lacking in vigor.

### **The first year**

Initially any large branch that upsets the balance, and any obviously awkwardly placed or crossing branches, should be removed to leave the remaining framework branches as evenly spaced as possible. After cutting off each major branch, stand back and view the shape of the tree. This should ensure that important framework branches are not cut out in error.

This preliminary attack will usually dispose of a great deal of twiggy growth as well. The next step is to cut out all dead, diseased and damaged wood, including all basal suckers and the twiggy debris that often accumulates on the main trunk of a neglected tree.

The remaining work consists of carefully thinning out all the overcrowded twiggy growth so that an even branchlet system with a balance of young wood and older spur systems remains. If necessary, cut back overly long branches to vigorous laterals nearer the trunk to encourage a more compact habit.

First year of restoration pruning: 1) Central leader topped at 18 feet. 2) Main scaffold limbs topped at 16 feet. 3) Upper layers of horizontal and hanging wood removed. 4) Dead wood removed.

### **Second and subsequent years**

The season following severe pruning some vigorous shoots are likely to be produced, particularly if large branches have been removed. Sometimes these growths are suitably placed to fill a gap in the framework. If not, they should be cut out to prevent them spoiling the symmetry of the trees as they develop.

Once a neglected tree has been restored to health, normal pruning yearly is required to thin overcrowded shoots maintaining a balance of spurs and new wood.

### **The over vigorous tree**

It is important to consider the state of excess vigor, apart from the possibility of scion rooting, because paradoxically a tree may be neglected by being subjected to over-severe pruning. Such a butchered tree is out of balance and over-vegetative. The remedy is to thin out crossing, broken, diseased and overcrowded branches, but to leave branches that are healthy and well placed. The unpruned branches may well settle down to form flower buds and resume a fruitful career in two or three years. Branches should be removed cleanly, without snags, but at no time should wounds be painted over with pruning paints. Pruning paint/wound dressings trap moisture and do not let the tree heal naturally. Renovation of the kind indicated is best spread over more than one year to avoid further unbalances and tree shocks.

Late Winter or early Spring pruning stimulates growth, but summer pruning (July to August 1st) checks it and, assuming that the height of the tree makes the procedure sensible, the shortening of unwanted laterals is a great help.

### **The stunted tree**

The other extreme, the state of the stunted tree, is obviously best remedied in the first place by the measures involving staking and the removal of competition for water and nutrients mentioned earlier. Soil tests and leaf analysis should be conducted to evaluate the planting site and tree nutrient levels.

There is usually very little new wood to prune, but the thinning of spurs and the severe shortening of any original wood, coupled with the necessary cultural practices, should stimulate growth.

It is often desirable to reduce the quantity of fruit to small proportions, or to remove it all together, as it sets, for a year or two to relieve the tree of the strain of reproduction. Fruit from a really starved and neglected tree is not worth having anyway.

Once a balance has been restored between growth and flower bud formation it should be maintained by sensible pruning, coupled with correct management of the soil, nutrients and adequate control of pests and diseases.

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## WINE GRAPE PRODUCTION

### Introduction

As potential wine grape producer, you are encouraged to go and visit with as many growers in an area similar to your vineyard site. Every grower will have opinions on the best way to grow grapes. Take this information and consider your vineyard site and goals. Add in some common sense and patience, and you have taken a big step to starting your own vineyard.

You should also speak with different wineries in your area if you do not plan to process the grapes yourself. Ask what grape varieties they crush, how much tonnage is required, if there are vineyard practices they do not accept, what is the current market, and would they consider your grapes. No sense in growing a variety you can't sell.

Doing this leg work is time consuming but well worth it. Vineyard development from the time vines are planted before a vineyard is in full production, assuming there are no set backs due to weather conditions on frost events.

### Site Selection and Preparation

In higher elevations, shorter growing seasons and cooler climates, the grower must pay careful attention to the vineyard site.

The site should have gentle slope, preferably with southern exposure. Avoid valleys or "pockets" which hold the cold air or will not allow it to drain away from the vineyard. Imagine if water were to run through the vineyard, would it drain away? Would it pool in certain areas? Would it pool below the vineyard and back-up towards the vineyard? Cold air does the same thing. Since vines are cold tender, it is extremely important to pay attention to your site. If you have doubts about a site, take daily high/low temperatures for a year if possible.

Grapes will grow in a variety of soils. Ideal soils are deep, well drained and not overly fertile. It is advisable to have a soil test run. Dry soils should be ripped as deep as possible; 3 to 5 feet is recommended. This discourages shallow rooting. Vines planted in heavy soils that have not been ripped, will grow poorly and have a lower survival rate. Once ripped, disc and smooth the site in preparation for planting.

Soils high salts should be avoided as potential vineyard site. Unleached soils or areas that accumulate salts through seepage and evaporation will not support vine growth.

### Plant Selection

It is recommended a grower purchases virus free dormant number one rooted cuttings from a reputable nursery. Check the variety for cold or winter hardiness and number of days necessary for fruit maturation. It is also advisable to select a variety with a late spring bud break. Again, visit several wineries to determine the market for a particular variety.

Plan well in advance for the arrival of the vines. It can take up to two years to get the varieties you want.

Varieties being tested at the Yellow Jacket Orchard/Vineyard Demonstration Project include the following:

\* Foch: A French-American hybrid officially known as Kuhlmann 1882 is related to Leon Millot. Foch is winter hardy and matures early. The small red clusters do attract birds. Foch produces good red wines and is widely planted in the eastern United States. Even though this variety is said to be winter hardy, it suffered set backs when early spring temperatures have warmed and them dropped. With a healthy root system, it does come back and will mature fruit.

\* Seyval Blanc: This white wine variety can achieve high sugars and relatively high acids if cluster are thinned at bloom. The crop is reduced by this step, but poor maturation qualities are avoided. It is questionable this variety will mature at the Yellow Jacket site.

\* Gewurztraminer: A white wine variety, it is early ripening, with orange-skinned fruit. It appears to very winter hardy and can bear large crops. The variety can be harvested at desirable balance with careful monitoring of its maturity in September. The variety has shown promise to produce its distinctive aromatic qualities.

\* Merlot: In Colorado, Merlot appears to be equally as winter hardy as its traditional blending partner Cabernet Sauvignon. Merlot ripens fairly early and can achieve excellent sugar/acid balances. Since the wines mature quickly for red wines, the variety is becoming increasing popular with winemakers. In 1997, three vines in the Yellow Jacket vineyard developed crown gall. This is a result of ice damaging the vine or a nursery problem. Since it was late in the season when this developed, we are uncertain of the cause.

\* **Pinot Noir:** This variety, one of the red Burgundies, is generally considered to be the most winter hardy red variety. Unfortunately it has yet to demonstrate an ability to develop adequate color and character in Colorado. It should not be completely ruled out, however, at this time the variety is best suited to sparkling cuvee or blanc d'Noir wine styles. This variety has not matured fruit at the Yellow Jacket site.

\* **Chardonnay:** This grape makes the renowned white wines of Burgundy. It is one of the most winter hardy members of vitis vinifera and generally of the highest commercial value. Chardonnay reaches high sugars in Colorado with desirable high acidity. The big drawback to Chardonnay is its slightly earlier budbreak that can result in crop loss or crop reduction by frost as the variety has poor fruitfulness in secondary buds.

\* **White Riesling:** This major variety of Germany is very winter hardy. It matures fairly late, but reaches 20-22 Brix in the Grand Valley and usually retains 1.0 percent acid. This is a suitable balance for a wine that can be bottled with residual sugar. At the Yellow Jacket site, this variety probably will not mature fruit due to the short growing season. One vine was removed late in the 1997 season due to crown gall. Again, as with the Merlot, we are uncertain if it is a winter injury or nursery problem.

\* **Lemberger:** This loose-clustered dark pigmented variety shows promise for Colorado with very favorable sugar, acid and pH parameters. It is increasingly popular in Washington state and has moderately high winter hardiness under normal Colorado conditions. This variety has proven to be the most winter hardy of all the Yellow Jacket site varieties. It has also matured fruit in its third and fourth growing seasons.

As of 1997, there are other varieties being grown by individuals in Montezuma County. They include Cabernet Franc and Shiraz. These vines are in their first, second and third growing seasons. Consequently, not enough information has been gathered on their viability for Montezuma County. Dolores County has several individuals growing wine grapes but these are for home use at present.

### **Vineyard Layout and Trellis System**

Make a scale drawing of the layout of the vineyard. When possible run rows north to south for maximum sun exposure. Also consider the direction of prevailing winds. Row spacing should be at least as far apart as the trellis is high. This decreases shading from row to row. Consider the size of equipment to be used in the vineyard. Allow for enough turning space for equipment at the end of the rows.

The irrigation system should be included in this planning stage. Drip irrigation is used at the Yellow Jacket site. A drip system allows maximum control of water delivered directly to each vine.

The trellis system that is chosen for the vineyard should be capable of handling the spacing of the vines and how the vines will be trained. Think of the trellis as the support system which keeps the weight of the vine upright in order to maximize production, handle the management of the vines, and increase air flow through the canopy. It is advisable to have the trellis system in place before planting.

There are a number of training methods used; a single canopy, split canopy, or double curtains. Which is used is based on the variety's vigor and the equipment available to manage the vineyard. Vine spacing is based on the plant's vigor, soil capability and climate.

The Yellow Jacket site uses a seven wire vertical shoot position trellis system. It includes a single wire for the drip irrigation system; a single wire for the vine to trellis on; two double "catch" wires for the canopy; and a tip single wire. This wire is used for a frost protection system in the Yellow Jacket vineyard. Vine spacing is every 6 feet; rows are 12 feet apart. The training method used is spur pruning with cordon training. This is a relatively easy system to install, manage and maintain.

An elk/deer fence was also built to the planning and development of this vineyard for obvious reasons.

### **Planting**

When preparing to plant, keep in mind the goal is to develop a strong root system at the proper depth. Dormant rooted cuttings should be large enough to plant at a depth of 12 to 14 inches. This will leave two buds of the previous year's growth above ground. Planting at more shallow depths allows the vine to respond too quickly to temperature changes and will lead to winter kill or frost damage. Consistent rooting depth will help control drought stress and promote wine quality.

Protect the cuttings before and during planting from drying out and overheating. Spring planting, April-May, seems to be the best time to plant in Colorado. Broken or damaged roots should be pruned from the cutting before planting. Vines should be deep watered as soon as they are planted.

## **Training-Pruning**

**First Year-** Root development is essential.

One school of thought is to allow the vines to grow at will, tying canes up as they develop length. This was done at the Yellow Jacket site.

Another approach is to use grow tubes. These tubes encourage the plant to establish one cane with a vertical growth pattern. Tubes create an artificial environment which has benefits and disadvantages. Observed benefits are the accelerated development of the plant and "natural" pruning. Observed disadvantages are the added expense, added labor, access to the vines is difficult, and vines can suffer sun burn and shock when tubes are removed.

## **Second Year-Training**

Vines should be pruned to the first two live buds. This was not done to all vines at the Yellow Jacket site. Vines which were pruned to the first two live buds showed more vigorous growth through-out the growing season. Vines not pruned to the first two live buds developed weaker trunks, were less vigorous, and ended up being pruned back the following season.

As the vine grows, vertical growth is encouraged by tying it to some sort of guide post which reaches the first trellising wire. Lateral growth below the drip line should be removed. When the vine is 3-4 inches above the first trellis wire, select two canes to lay and tie to the trellising wire. When the cane has reached the desired length, cut the ends to encourage vertical growth along the trellised cane.

## **Third Year-Getting Down to Business**

Ninety (90) percent of the previous season's growth is removed each winter. Even though the one-year-old shoots produce next year's crop, the vine can not successfully support this crop level which makes the removal of the shoots essential. Pruning should do the following:

1. Space the shoots so each will present its leaves to adequate light.
2. Space the shoots so air circulation will be encouraged. This will reduce humidity which lowers incidence of disease.
3. Space the shoots to allow an adequate penetration of sprays for pest and disease control.
4. Provide good replacement shoots for the next winter's pruning.
5. Select the length and position of the shoot on which the buds have the best potential for fruiting.
6. Achieve an appropriate bud number per plant to give maximum yield of grapes of optimum quality.

Number of buds depends on the yield ability of the variety. Generally speaking, 4-6 buds per foot for high yielding; 6-8 buds per foot for moderate to high yielding; 8-9 buds per foot for moderate yielding; 9-11 buds per foot for moderate to low yielding; and 11-12 buds per foot for low yielding.

## **Timing**

Winter pruning-Should be done after the plant is fully dormant. If pruning in the late spring, care should be taken to not stimulate the plant into growing prior to the last frost.

Summer pruning-Once the shoots pass the highest wire they are usually topped and if laterals become too dense, they can also be trimmed back. If the tops are trimmed just before the flowers are ready to be pollinated (capfall), fruit set can be improved. The frequency of summer pruning will depend on the vigor of the vines. The last summer pruning should take place at veraison (when the plant goes from cell division to cell enlargement, or approximately 8 brix).

## **Frost Protection**

Late spring frosts are always a concern. There are a few mechanical and cultural practices the grower can use to protect the vine in light frost events. At the Yellow Jacket site a combination of methods are used. Of course the site which allows for maximum cold air drainage, winter hardy varieties, late budding varieties, maintaining a low cover crop, delayed pruning, and overhead pulsator sprinkling system. One note on the pulsators. There must be adequate pressure in the irrigation line to achieve full water coverage of the vine in order for the ice encasement method to be effective. All of these factors combine will successfully protect the vines from a light frost. In a heavy frost, vines will die back; however, if there is a healthy deep root system the vine will recover.

Other mechanical methods of frost protection include heaters and wind machines. These are not used at this time in Montezuma County.

## **Nutrition**

Generally speaking, grape vines have fewer mineral deficiencies and a lower plant food demand than many other horticultural crops. To accurately test the nutrition levels of the vines, a tissue analysis should be done. A soil test alone will not tell the grower if there is a nutritional imbalance in the vine. Incorrect and/or improper application of nutrients can do more harm than good.

Common nutrients applied through foliar sprays include zinc, manganese and iron. Zinc deficiency may be corrected by applying a foliar spray two to three weeks before bloom. Manganese deficiency is best corrected with soil treatments. Iron foliar sprays benefits only the existing foliage. Applications have to be repeated every 10-20 days for chlorosis problems.

## **Irrigation**

As stated earlier, drip irrigation delivers equal amounts of water to each vine. As important as it is not to over water stress the vines, it is equally important not to over water. Soils that are too wet open the door for disease development. Vines with too much moisture will continue vegetative growth late in the season when the grower should be concerned with the development of sugar, acid and pH levels in the grape. Actively growing vines will not begin the hardening off process necessary to the vine's winter survival. The grower will need to monitor soil moisture levels throughout the season. At the Yellow Jacket vineyard, vines begin with 8 to 10 gallons of water a week. After 4 seasons the vines are currently using 18 gallons per week. When rains have been sufficient, the irrigation system has been turned off to allow the soils to dry. Irrigation levels will start to be decreased as early as July 1 with the system completely shut down by August 15. Again, decreasing irrigation amounts depend on rainfall and time of the growing season. In an extremely dry fall, a final watering will be given to the vines following harvest to build sub-surface soil moisture levels.

## **Diseases**

Most disease problems can be managed in the vineyard even though temperature and moisture are the main factors in disease development.

Note, as with the use of all chemicals, read carefully and follow mix and application rates on the package instructions.

Powdery mildew is one of the most preventable if a regular applications of sulfur alternated with Bayleton are started in the second season of the vineyard. Prevention is key. Once powdery mildew has established itself in the vineyard it can only be controlled as it will over-winter. Severe powdery mildew will affect the flavor and taste of the wine, and will weaken the vine making it more susceptible to winter injury.

Crown gall is a bacterial disease usually brought on when there is an injury to the vine such as a wound or winter injury. It was discovered in the Yellow Jacket vineyard in 1997, with the die back of infected vines. The site of the gall is identified with the gradual change in size of the cane until the cane had doubled in size. The tissue under the bark will have a cauliflower texture. The cane should be cut below the gall site and remove all diseased plant material from the vineyard. Pruning shears must be sterilized after cutting infected tissue. The best prevention for crown gall is the prevention of injury; especially winter injury.

Botrytis bunch rot has not been found at the Yellow Jacket site, and is not common in Colorado vineyards due to lower humidity levels. Control is the management practice of leaf removal around developing bunches to allow maximum air circulation. Another method for very tight clusters is to remove young berries to open up the cluster for more air movement.

There are multiple diseases which affect wine grapes. The grower should refer to the "compendium of Grape Diseases" edited by Roger C. Pearson and Austin C. Goheen and published by APS Press, for a more complete listing of diseases.

## **Pests**

In our area deer and elk are a concern to the vineyard manager. The Yellow Jacket site, as do other vineyards in the county, have worked with the Division of Wildlife to acquire deer/elk fencing materials. From October, 1995 through September, 1996, were very dry months. As the fruit ripened, deer hoof prints circled the orchard/vineyard at Yellow Jacket. Had they been able to get in, they would have caused considerable damage.

Birds are also unwelcome in a vineyard. Generally, once the grapes start to change color birds will fracture the skins. This invites disease to take hold in the fruit. When the fruit is close to harvest, the birds have stripped the fruit completely off the vine at the Yellow Jacket site. Bird netting is used as the main control of bird activity. Flash tape has also been successful in the control of birds because the Yellow Jacket site has constant and varying wind directions, and the vineyard has yet to develop full row canopies. Flash tape is time consuming to put up and take out of the vineyard. The best preventative measure to take for controlling bird activity, is to keep the potential for bird habitats in the vineyard and surrounding area to a minimum.

There are a number of insect and mites which can be a problem in the vineyard. The biggest problem the Yellow Jacket site has had is tomato worms. They easily picked off the vine and disposed of; squashed. So far insect and mites have not been a big enough problem to warrant a regular schedule spray program. Common pests to the vineyard include grape leafhopper, grape berry moth, grape can borer, grape mealbug, grape skeletonizer, sphinx moth, thrips, cutworms, cottony maple scale, leaf miners and mites. So far phylloxera has not occurred in Colorado vineyards.

### **Weeds**

Weed management is a must in the vineyard. Weeds take water and nutrients away from the vines. The best weed management step is to get control of the weeds on the vineyard site before it is planted. This is followed by regular mowing or disking of weeds before seed heads develop and the use of a hydraulic hoe. At the Yellow Jacket site Roundup and is the main reason it is not used as a weed control method in most vineyards. Drought tolerant grasses were planted between the rows for weed and erosion control. These grasses are kept mowed throughout the growing season.

### **Harvest**

The quality of any wine is developed in the vineyard through proper growing season management practices and harvest timing. The maturity of grapes are based on sugar content (measured in Brix), acid content and pH.

**Sugar content-**Veraison is the point when the grape sugar content begins to rise rapidly; depending on the variety and climate conditions this will begin to happen in July or August. At the Yellow Jacket site, sugar content increases with hotter day time temperatures and dry conditions. The wet and cooler than normal season in 1997, produced lower sugar content levels in comparison with 1996, when it was hot and dry.

Sugar content can be measured with a refractometer. White wine grapes are usually harvested between 18-24 percent sugar depending of the style of the wine. Red wine grapes are harvested between 21-25 percent sugar.

**Acid content-**Acid content in grapes increases early in the growing season until veraison, when it begins to decrease especially in hotter temperatures. The desired acid content again varies with the intent of the end product. High acids are considered above .9 percent.

**pH-**pH will increase after veraison. The optimum pH range is 3.0-3.4. If it is too high, the wine will be unstable.

**Sampling-**When sampling it is important to remember to take grapes which are representative of the different growing conditions within the vineyard or block. For a representative sample, grapes should be taken from different vines in different locations within the block, and clusters with different sun exposure. Any variation within the block should be represented in the sample. Once the sample is taken, grapes should be squeezed to approximately the same degree they will be pressed, as a lighter crush will produce higher sugar readings.

### **Conclusion**

By no means is the work being done at the Yellow Jacket site complete. Time and ability to devote to the vineyard project is limited due to other staff responsibilities which causes some frustrations. The staff, like any grower, is learning through trial and error, asking questions, reading and common sense. The intent of the project is to make the mistakes so the grower doesn't have to, demonstrate the viability of wine grape production in this area, and to assist the development of the industry.

### **References**

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# CSU Fruit Tree & Vineyard Research & Demonstration Project

**John Lestina, Resource Conservationist  
Natural Resources Conservation Service**

## **Introduction:**

The primary purpose for the grass variety tests in the fruit tree & vineyard project is erosion control. Severe erosion plagued the site since planting and it was obvious that solutions were needed, since planting and it was obvious that solutions were needed, since similar erosion problems would occur on other orchards or vineyards in the area.

Soils on the site are classified as Wittco, with textures ranging from silty clays to clay loams. Long term average annual precipitation is 16 inches, with about half received as snow.

## **Grasses Planted April 1993**

**Blue Grama, (Variety - Lovington):** a warm season, perennial, native sod farmer. this variety was developed for its outstanding seedling vigor, and forage production.

This grass was slow to establish, with the quickest results occurring where irrigation water provided additional moisture. A solid turf is now forming in spots, with bare areas still evident. After four years this species now appears adequate, it is marginally suited for orchard use because of its slow establishment.

Seeding Recommendations PLS 1.5 lb/ac

**Canby Blue grass, (Variety - Canbar):** a cool season, perennial, native bunch grass. this variety was developed from a collection of seed in the Blue Mountains of southeastern Washington. it has vigorous early spring growth and thrives on short season moisture. However, it will be crowded out by other species, where season long moisture is available.

This grass was also slow to establish and after four years is finally showing signs of becoming dominant. There have been a lot of weeds and other grasses invading the stand. This species not yet proved satisfactory for orchard purposes.

Seeding Recommendations PLS 1.5 lb/ac

**Arizona Fescue, (Variety - Redondo):** a cool season, perennial, native bunch grass. This variety was developed from a collection of seed in the Ponderosa pine zone in New Mexico. it has an extensive fibrous root system and is drought tolerant.

This grass established a full stand after the first growing season. The open nature of a bunch grass stand has allowed weeds to invade but these are easily controlled with mowing. this species appears adequate for orchard purposes.

Seeding Recommendations PLS 2.5 lb/ac

**Crested Wheat grass, (Variety - Ephraim):** a cool season, perennial, introduced, bunch grass. Crested wheat grass was introduced, bunch grass. Crested wheat grass was introduced to America from Eastern Europe and Asia. This variety was developed for its drought and salt to tolerance and also for its ability to produce rhizomes.

This grass established the first growing season, producing a full open turf stand. It has been essentially weed free. There has been no apparent rhizome formation. Ephraim is adequate for orchard purposes.

Seeding Recommendations PLS 3.0 lb/ac

**Thick spike Wheat grass, (Variety - Critana):** a cool season, perennial, native sod farmer. This variety was developed for its excellent seedling vigor and extreme drought tolerance.

This grass was established a full stand the first growing season. Though it is still an open stand many rhizomes are forming and the drill rows are filling in. The stand has been essentially weed free. Critana is adequate for orchard purposes.

Seeding Recommendations PLS 5.5 lb/ac

## **Grasses Planted Fall 1995**

**Thick spike/Crested Wheat grass, (Variety Critana, Ephraim):**

These varieties are described in the preceding section. As a mixture or individually these grasses are adequate for orchard purposes.

Seeding Recommendations PLS 5.5 lb/ac

**Crested Wheat grass, (Variety - ARS Turf):** a cool season, perennial, introduced bunch grass. This variety is from a collection made in Turkistan in the 1980's. It was developed for its drought tolerance, coloration and its rhizomatous tendencies. It established readily the first year, as an open stand. This variety is adequate for orchard purposes.

Seeding Recommendations PLS 5.5/3.0 lb/ac

**Intermediate Wheat grass, (Variety - Tegmar):** a cool season, perennial, introduced sod farmer. This variety was developed for its dwarf characteristics, winter hardiness, longevity and its improved resistance to Banks grass Mites. It established a full open stand the first year and continues to fill in. This grass is adequate for orchard purposes.

Seeding Recommendations PLS 10.0 lb/ac

**Crested Wheat grass, (Variety - Douglas):** a cool season, perennial, introduced bunch grass. This variety was developed for its superior seedling vigor over other crested wheat grass varieties, though it is less drought tolerant than those varieties. It produced an uneven, open stand the first year, but appears adequate for orchard purposes.

Seeding Recommendations PLS 3.0 lb/ac

**Crested Wheat grass/Birds foot Trefoil (Variety - Ephraim):** Birds foot Trefoil is a non-bloating legume that can be hard to establish. At the seedling stage it is a slow grower and a weak competitor. Ephraim is described in the preceding section. This mixture does not appear to be adequate for orchard purposes.

Seeding Recommendations PLS 3.0/2.0 lb/ac

**Crested Wheat grass, (Variety - Fairway):** a cool season, perennial, introduced bunch grass. This variety starts its growth about the same time as other crested wheat grass varieties but will cure earlier and produces less vegetative growth. This grass did not establish a full stand the first year and remains an open stand with some weed pressure. It is still being evaluated for orchard suitability.

Seeding Recommendations PLS 3.0 lb/ac

**Buffalo Grass, (Variety - Topgun):** a warm season, perennial native sod farmer. This variety was developed for its density, dark color, early greenup and late dormancy. It is an excellent turf grass but needs supplemental moisture in our area to establish, as evidenced by the success near the tree rows where water from the fruit tree irrigation helped it. This grass is not suited for orchard purposes.

Seeding Recommendations PLS 3.0 lb/ac

We would like to express our deep appreciation to former Research Associate, Dave Sanford in his determination on developing and establishing this grass study.