Washington State University, Tree Fruit Research and Extension Center

Orchard Management Forum

Most of this information orginally appeared on the TFREC Online bulletin board -- discontinued January 1997. Material was produced by TFREC and WSU Cooperative Extension staff.

Appreciation is due to all those who contributed to the board's success, especially Gary Grove, Tim Smith, Kathleen Williams and Guy Witney.

Current extension orchard management information is maintained on the WSU Cooperative Extension Fruit Team web site

Irrigation

- Evapotranspiration calculator
- Irrigation-how much water is my system applying?
- Irrigation-how much water does your soil hold?
- Irrigation-scheduling
- Shorter showers, please...domestic use

Soil management

- Soil versus Foliar Fertilizer Application
- Leaf Analysis Time
- Late Summer & Fall Fertilization (*WSU CoopExt*)
- N on young trees
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- Orchard fumigation
- Compost trials in orchards in 1995-96 (*WSU CoopExt*)
- Disease Management of Dwarfing Apple Rootstocks
- Soil pH, Fertilizers, and Lime (*WSU CoopExt*)

Other...

- Spring temperatures & fruit size
- Weed Better Spray in the Fall
- Washington Fruit Acreage Survey
- Managing Apple Trees on Mark Rootstock

WSU-TFREC horticulture home page

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Friday, October 20, 2000

WSU-TFREC Orchard Calculator

Estimating Water Use by Plants

The following describes use of a calculator for estimating water use by plants (potential evapotranspiration). Two different versions are available to handle different web browser incompatibilties. Please read through the description before attempting to interpret its use.

Go to Penman water use calculator now

- **JavaScript version**
- **Java Applet version**

The use of water by plants can be estimated by calculating what is known as potential evapotranspiration (pET). This is the possible loss of water through evaporation and transpiration. Transpiration is the movement of water through a plant from the soil into the roots, up the stem, and out through the leaves. Simple calculations of pET can be based on sun, wind, temperature, and humidity.

Because water use varies widely from plant to plant, estimates are usually first derived for a single situation, such as grass, which we use here, and then adapted for other plants. Eastern Washington tree fruit growers should consult *Tree Fruit Irrigation*, edited by K. Williams & T. Ley, for such information.

Furthermore, true water use varies depending upon many other factors. When calculated daily, the accuracy of estimates will change from day to day. However, these will usually average out over a week to ten days, and the sum over that period may be quite accurate.

Persons using pET to estimate water use and schedule irrigation also must adjust pET values based on their experience with their own specific conditions, especially including soil type.

Using the Penman calculator

The calculator is based on the Penman equation, a formula in wide use by agricultural scientists around the world (see for example, *An Introduction to Environmental Biophysics* by Gaylon S. Campbell).

The calculator estimates daily pET in inches of water. It requires average daily values of four measurements: sunlight, wind, temperature, and humidity. I stress **average** because we often think of typical daytime conditions as being average. Here average means over the 24 hour day.

Solar radiation (sunlight):

The required measurement for solar radiation is the amount of energy reaching the grass in the form of visible and near visible light. This is usually measured in watts/meter-sq and requires expensive sensing devices. If this information is available, it can be entered directly into the calculator. Only remember, this is the average daily solar radiation. Night time values of zero should be averaged with day time values.

However, the calculator will derive fairly close estimates from the time of year and the cloud cover. The value of daily solar radiation is dependent on day length, angle of the sun from the horizon throughout the day, and the amount of clouds the sunlight must penetrate. I set up the calculator using typical conditions during the irrigation season from Wenatchee, Washington (47°N latitude; semi-arid climate). The values may differ for other locations.

To estimate sunlight, select cloud cover and time of year. The calculator will place an entry into the solar radiation box.

Air temperature:

Remember this must be an average daily temperature. At least it should be an average of the maximum and minimum for the day.

Average relative humidity:

Enter the average daily relative humidity or have the calculator find the relative humidity from the dew point. To use dew point, enter the value, and click on "Use." A rough approximation of dew point is the minimum overnight temperature.

Average wind speed:

An average may be difficult to obtain. You may enter the value directly into the box, or choose one from the popup window. Values from the popup window are based on the widely used Beaufort scale. The effect of wind on pET reaches a maximum under moderately breezy conditions.

Once again, this is the **average** wind speed. We often think of the gustier winds as being average because they are most noticeable, but they are not average. Also this is a daily average, wind conditions vary through the day, with increased wind on warm clear afternoons and evenings.

Calculate pET

Select the "Calculate" button to evaluate the entered values. The pET from grass will be displayed in the bottom line.

Now use Penman water calculator

- JavaScript version
- Java Applet version

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Wenatchee WA, 29 May 1996
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around the nation and world

WSU-TFREC is the research and extension center of Washington State University dedicated to the tree fruit sciences. Located in the primary fruit producing region of the world, the center features a cooperative, multidisciplinary approach to tree fruit production.

News and notes

Western Orchard Pest & Disease Management Conference

Home page for the WOPDMC; proceedings from the 2003 meeting are now online along with those from 2001 & 2002.

Updated Statistics on Organic Tree Fruit Production and Other Crops

Two new reports provide up-to-date information on organic crop acreage. One report details all the certified and transitional acres in Washington State by crop. The other report provides the 2002 acreages for organic apples, pears and cherries in Washington State, including apple and pear varieties. These reports complement the more detailed analysis in "Current Trends in Organic Tree Fruit Production - 2001" that covers national and international trends as well. All reports are in PDF format. Produced by D. Granatstein, WSU Center for Sustaining Agriculture and Natural Resources.

Pest Management Practices Survey 2000 Results

A survey of grower practices in Washington apple, pear, and cherry orchards during the year 2000 and a comparison with earlier surveys made in 1989 and 1990.

Building a Stable IPM System for Western Orchards

Newsletter, FAQ, reports and other resources produced by this multi-state project led by WSU-TFREC entomologists.

Pear Entomology-new web pages

The pages for the Pear Entomology Lab are now available. Information is featured on most arthropod pests of pear and the damage they cause, including a detailed picture gallery. The Peshastin Creek Growers Areawide Organic Project newsletter also will be available here.

Crop Protection Guide

for Tree Fruits in Washington--PDF version of the 2002 (soon to be updated for 2003) guide. Portions of this guide are now available in database format for Palm, Microsoft Access, or Filemaker Pro users.

Strategic IPM Plan for the Western Apple Production Region

focuses on general concerns facing the apple industry with the implementation of the Food Quality Protection Act of 1996 (FQPA). Results of a workshop held in Yakima, Washington, November 20-21, 1999.

WSU-TFREC Announce

Subscribe to the TFREC-Announce mailing list and receive up-to-date news and notices from WSU-TFREC

Pesticide labels and MSDS sheets

Links to labels and MSDS sheets for many insecticides and fungicides are available on the WSU fruit team web site.

Statewide Research and Extension Staff for Tree Fruits and Grapes--PDF format

List of the tree fruit and grape researchers and extension agents statewide within the State of Washington. This is in PDF format (a reader is available from www.adobe.com.

Updated April 16, 2003

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Fruit Pathology

AgWeatherNet
People
Public Agricultural Weather System
Publications and Reports
Field Plant Pathology
American Phytopathological Society
WSU Links & Research Centers

Disease Information:
Pome Fruit
Small Fruit
Stone Fruit

Contact webmaster

Powdery Mildew of Peach

WSU-TFREC WSU-IAREC WSU-WWREC

Digital Media Center
PDA Applications
Digital Video
Disease Image Library

Graduate Studies at WSU

WSU-TFREC Orchard Management Forum

How much water is my system applying?

by Tim Smith, WSU Extension

Below is a quick method that you may use to determine how much water you are applying each time you irrigate. This proceedure takes about 1/2 hour, less when you get on a roll.

Many systems were designed when people believed apple trees rooted 5 or 6 feet deep, rather than the 2 to 3 feet that is much more common in this region. The false root depth assumption lead people to assume a much larger storage capacity for water under the tree. Application rates were commonly designed for 4 to six acre inches of water applied over a 24 hour set.

To keep trees well watered during the stressful part of the year, most systems should apply between one and three inches of water per set, the amount dependant on the soil qualities, the age and type of tree in the planting.

To follow the operation outlined below, you'll need a tape measure, a gallon milk jug, a watch, and a calculator (unless you want to do all the arithmatic longhand-possible, very organic, but time consuming)

Step 1. Determine the number of sprinkler heads per acre.

a. Measure the number of feet between heads down the row_____

b. Measure the distance between laterals (crossways)_____

(this is usually the row or every other row spacing, don't measure on the diamond, diagonally between heads)

c. Multiply these two footages to get the square feet per head_____

d. Divide the square ft. Per head into 43560. This gives you the number of heads per acre.

e. Write your answer here: (heads per acre)_____

Step 2. Determine the gallons of water applied per set.

(you're gonna get wet. Do this on a warm afternoon).

a. Catch water in your gallon milk jug until it is full. Time the number of seconds it takes to fill it. This will take from about 20 seconds to about three minutes, depending on the size of the nozzle. Do this timing at several nozzles around the block. There may be some variation. Fix the problem if the variation is more than 10 percent down the lateral. Pressure and nozzle problems are the most common reasons for variation.

b. Divide the average number of seconds it took to fill your gallon into 60. This will give you the number of gallons the heads are putting out per minute.

Write that number right here: (gal./minute/head)_____

c. Now multiply the number of heads per acre by the average gallons each head applies per minute to get the gallons applied per acre per minute.

Write that number right here: (gal./min./acre) _____

d. Multiply that number by 60 to determine the gallons applied per hour.

Write that number right here: (gal./hour/acre) _____

e. Now multiply the gallons per hour by the number of hours you actually irrigate:

Write that number here (gallons per set per acre)_____

Step 3. Estimate net gallons per acre:

Water lost to uneven application, evaporation, runoff etc. can't be counted towards your trees use. Losses can vary from about 10 to 50 percent, depending on the time of season and the system design. The wider the head spacing, the lower the efficiency. Over-tree systems can lose a great percentage of water to evaporation on windy days, especially in mid-day and mid-summer. A normal undertree system will be about 70-80 percent efficient.

So, take a stab at estimating your system efficiency. If you just don't know, figure 70 percent.

Convert percent into a decimal (70 percent is .70)

Multiply the gallons per acre per set by this efficiency decimal.

example: 54,880 x .7 = 38416

This equals the: (net gallons per acre per set) _____

4. Determine the net acre inches applied per set:

Divide the net gallons applied per acre per set by 27000. This will give you the net acre inches applied per acre per set.

Example: 38416 net gallons per set per acre divided by 27000= 1.42 acre inches.

This is the amount of usable water you have applied. There are many questions that you may turn to once you have this number. For instance:

Are you sure that your soil can hold this amount of water?

Do you know how to determine when this amount of water has been taken from the soil by your trees?

Knowing how much water you are applying is an important first step in water management. If you go through the above proceedure for each separate irrigation system on your place, you may then move into the next installments of this irrigation management series.

Estimating soil water holding capacity (relates to how much water you are applying)

and

How many days between sets?

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WSU-TFREC Orchard Management Forum

Irrigation scheduling

Determining the approximate number of days that should pass between sets

Tim Smith, WSU Extension

Before you can carry out this process you need to determine how much water your system applies per set, and how much water your soil can hold in the trees effective root zone. When you compare those two values, the lowest amount of the two is the amount that you can let the trees use between irrigation sets.

To determine the approximate number of days that may pass safely between sets:

Look up the average daily water use that relates to the time of season and weather conditions in the table of values below. Divide this number into the orchard blocks net applied water per set, or the soils usable moisture holding capacity, whichever is least. The resulting number is the number of days that can pass safely between sets.

Irrigation season	**...cooler**	**...average**	**...warmer**
early April	=.04 in/day	=.05 in/day	=.06 in/day
late April	=.08	=.09	=.10
early May	=.12	=.13	=.16
late May	=.17	=.20	=.25
early June	=.20	=.23	=.25
late June	=.25	=.29	=.32
July	=.27	=.32	=.38
early August	=.27	=.31	=.35
late August	=.21	=.24	=.30
early September	=.15	=.18	=.22
late September	=.08	=.10	=.15
October	=.05	=.07	=.09

Probe your orchard soil prior to each set. If your soil seems too moist prior to your estimated set timing, you may have underestimated the soils water holding capacity or the net amount of water your irrigation system applies. Add 10 percent to your estimated stored water (multiply by 1.1). If the soil seems too dry prior to the set, reduce your estimated stored water amount by 10 percent (multiply by .9). By making these adjustments up or down, you will soon have a good, practical value to work with in that block. This working value wont change through time, except in blocks of immature trees, where root depth and tree size is increasing.

Example

Your orchard soil has the ability to store 2.4 inches of usable water in the trees effective root zone. You have evaluated your irrigation system, and have found that it applies a net amount of 2.2 acre inches per irrigation set. It is early June, the weather is warmer and windier than normal, and you need to determine how many days your block can go between sets.

You look at the table across from "Early June"' and in the "Warmer" column and determine that the average daily water use under these conditions is .25 inches per day. You divide that number into your 2.2 inch net application per set (since that is less than the soils water holding capacity) and you determine that about 8.8 days can pass between sets under these conditions. So you begin your next irrigation set 9 days after you began the last one. (You probed the top three feet of your soil just before you started irrigating, and it looked pretty good: top foot fairly dry, second foot moderately moist, third foot plenty moist.)

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Effect of N rate on Young tree growth

report on trial by Tim Smith, WSU Extension

As there seems to be a question on the best rates and application methods for nitrogen fertilizer in the tighter plantings of modern high density systems, I placed a N rate and timing trial in a 2 acre young block of Fuji on M 26 in Okanogan County, Washington. This was a replant site, but had good weed control and water management ever since it was planted. The soil is a fine sandy loam, and leaching of N was not as likely as we might expect in very sandy soils. There was very little N present in the soil, and relatively low organic matter. The trees were planted on a modified tatura system as whips, 3 feet apart in the row with alternating trees trained to a side of the trellis. Fruit was removed in the second season to encourage tree growth.

For two years I have applied the N (by "belly grinder" spreader) carefully and evenly in a band about six or seven feet wide, down two widely separated rows for each treatment. Each treatment covers about a quarter acre. From each treated row, two sets of twenty trees were measured at planting and each year since, so 80 trees growth is averaged for each N rate and timing.

There are five different N rates, ranging from 100 to 400 pounds of nitrogen per acre. This rate per acre refers to the surface treated acre, that is the rate per surface area in the band treated. I didn't think it was important to apply (or count) the N out in the grass where the M 26 roots did not yet reach.

All of the rates were split into five parts and applied every 3rd week starting at bloom and ending in July. In other words, the 100 lb. rate was applied as 20 lbs/acre. per application, 5 times, three weeks between applications.

Two of the rate treatments, 100 and 200 lbs. N per acre were also applied in two, rather than five, applications. One half of the total product was applied at bloom, the other half six weeks later.

It was quite educational to look at the soil surface under the trees when I had finished with each application. Even the highest rate (80 pound per acre at one time) didn't look like a lot of fertilizer compared to our normal "handful". A handful works out to be about 1/10 lb. of actual N when using 34-0-0. I then calculated what N rate **per surface-treated acre** the tree saw from a standard smith-sized handful of ammonium nitrate scattered in a zone 2 feet out from the trunk, Whew. It worked out to 690 lbs. of N per acre! No crop can use that much N at one time. This much N at one application should set the tree up for salt stress, which leads to moisture stress until the salt level drops. This is an important concept when you are growing a small tree with a small root system. It's not the same effect when you place a handful of fertilizer over the large root system of a big tree.

If I had wanted to apply the equivalent of 100 lbs. N per acre (still quite a lot, as far as the trees' needs are concerned) in that zone of 2 feet out from the tree in all directions, I would have to cut the rate to **two and 3/4 level tablespoons of amonium nitrate!** (or six tablespoons of calcium nitrate.) Spread 2.75 tablespoons worth of 34-0-0, or 6 level tablespoons of calcium nitrate, in a 2 foot zone around a young tree and see what 100 lbs. N per acre looks like. You'll be surprised. This **total** amount of product applied over the first half of the season, split into at least two (on fine textured soils) or four (on sandy soils) applications will grow trees very well. So, one tablespoon of 34-0-0 per young tree, applied (for instance) three times, three weeks apart is plenty for the tree. Apply another tablespoon or two if this rate seems too little, but don't expect increasing rates to lead to increasing tree growth.

When trees get into their second and third seasons, their roots develop a somewhat wider spread, so can use the N applied farther from the trunk. If you want to apply the equivalent of 100 lbs. N per acre in an area **three** feet in all directions from the tree trunk, multiply all of the above numbers by 2.2. So, it will take 6 level tablespoons of 34-0-0 per tree or 13 tablespoons of calcium nitrate per tree to give you that per-acre rate. Remember to split this into two to four applications, don't apply it all at one time. Also, be sure that the product is spread relatively evenly under the tree in that 3 foot zone.

Plot results:

After two seasons (involving 10 two-acre hand applications of fertilizer and umpteen tree measurments) here is the grand rolling out of the results:

100 lbs. per acre split by 5	... 247 % growth
150 lbs x 5	... 253 % growth
200 lbs x 5	... 264 % growth
300 lbs x 5	... 273 % growth
400 lbs. x 5	... 264 % growth
100 lbs per acre split by 2	... 269 % growth
200 lbs. x 2	... 248 % growth

There is no visible or statistical difference between these treatments, either in the orchard or in the data. I apparently took care of all the young trees' N needs with the 100 lb. per acre rate, even when only applied twice during the early season. It appears that we don't need the high rates of N to get good tree growth. Other factors far out-rank the N rate when it comes to getting trees to grow in the first two seasons. N is important, but the keeping the N rate high is not. I will probably have to repeat this work at a number of sites before the data becomes valid to most folks. Stay tuned.

For those who would like to know, applying the fertilizer in a band, with the 7 foot wide weed control strip treated out of the 16 foot row width, I applied the following actual product rates per acre (using 34-0-0). Numbers indicate the total product per season, you can split that total into as many applications as you

wish:

for amonium nitrate:

100 lbs. N per acre, 34-0-0 = 100 / .34 = 295 pounds product per treated acre. 7 feet out of 16 feet = .44 of the area being treated. .44 X 295 lbs = a total of130 lbs of 34-0-0 applied per acre.

If you wish to apply this split into 3 parts, apply 43 lbs. of product per acre each application.

for calcium nitrate:

100 lbs. N per acre, 15.5-0-0 = 100 / .155 = 645 pound product per treated acre. 8 feet out of 20 = .40 of the area being treated. .40 X 645 lbs. = a total of 258 pounds of product per acre. Spit this poundage into as many parts as you feel will match your soil texture.

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Orchard Soil Fumigation

by Tim Smith- WSU Extension, Chelan/Douglas/Okanogan Counties e-mail smithtj@wsu.edu

Pathogenic soil organisms present in the soils of most mature orchards often reduce root growth of young fruit trees when the site is replanted. Poor root development leads to reduced vegetative growth and poor fruit yields throughout the life of the replanted orchard. This effect is especially common in North Central Washington. Replant disease is most common when apples or pears are planted after either apples or pears, or when cherries are planted after cherries. There are noticable growth differences when cherries are planted after apples or pears, and growers notice a benefit when the site is fumigated prior to planting the cherries.

Five year old Fuji apple on M26 root planted on unfumigated old orchard site. Trees have not yet borne a significant crop.

Five year old Fuji on M26 root, 100 feet away and adjoining the planting shown on the left. Fumigated with metam sodium. 1000 boxes/Acre. (50 tonnes /HA)

Certain soil fumigants have controlled the Specific Orchard Replant Disease when properly applied. The positive effect of controlling this disease can be measured the first season, and even 20 years after treatment. There are no soil treatments that will effectively control replant disease problems after planting. Non-chemical control options include a five or more year rotation out of orchard (removing most of the tree roots the first year), or the replacement of soil in the planting hole with good quality soil from a non-orchard source. To be effective, the soil replacement should fill a planting hole 7 feet across

and 2 1/2 feet deep. Soil replacement is not at all practical in such large scale. Using less soil in a smaller planting hole helps the first season or two, but is not a long-term cure. Despite research efforts, and a great body of theoretical control recommendations, no practice or product other than long rotations or fumigation have been proven effective in orchard replant disease management.

Demonstration trials and thousands of acres of grower experience over the past decade have shown that soil fumigation does not always lead to excellent tree growth, but it usually does. There is a strong interaction between the quality of the soil, management of the young orchard, and preplant treatment relative to replanting success. See the table below for a general outline of this interaction. Unfumigated orchards are usually more difficult to manage when young, and take several extra years to break even, if they ever do. If you are not absolutely certain that replanted trees grow very well in your orchard, you may skip a $400-600/acre procedure and suffer a $40,000/acre reduction in gross returns over the next ten years (actual data).

OUTLOOK FOR TREE GROWTH ON REPLANTED SITE:

OVER-ALL MANAGEMENT: OF THE PLANTING:	GOOD SOIL QUALITY	MODERATE SOIL QUALITY	POOR SOIL QUALITY
GOOD MANAGEMENT	*EXCELLENT*	*GOOD*	*FAIR*
MODERATE CARE	*GOOD*	*FAIR*	*POOR*
POOR MANAGEMENT	*FAIR*	*POOR*	*DISASTEROUS*

While many soil fumigants, fungicides, fertilizers and soil amendments have been tested for effect on the orchard replant disease, only three have shown long-term growth and yield benefits in Washington orchard trials: methyl bromide, metam sodium (or metam potassium), and fumigants containing relatively high amounts of chloropicrin. The other treatments may help early tree growth, but the effect of replant disease can be seen during the second or third leaf, resulting in slightly larger, but sick, trees.

Some fumigants must be custom applied, others may be applied by a certified private applicator. If you are unfamiliar with the product, pay special attention to use and safety information. Used improperly, fumigants can be quite hazardous to the applicator and the crop, and will not effectively control orchard replant disease. Some application options described on fumigant product labels have not resulted in replant disease control, so closely follow the lable methods that have proven successful in Washington orchards.

Follow soil temperature and preparation guidelines on the product label. Since we are usually trying to fumigate in the late Fall after harvest, or in the early Spring before planting, we may not have optimum soil conditions when we get ready to fumigate (especially in the Spring). Fumigants are more effective if the soil is not at the bare minimum of conditions at the time of application. In general, colder, wetter, and

finer textured soils retain fumigants longer. The soil is usually in best condition for fumigation in October and early to mid-November, and in April or later in the Spring. In the Fall, treatment should be completed well ahead of the time that soil temperatures drop below the minimum recommended on the label.

To reduce the potential for fumigant damage to the newly planted trees roots, dig planting holes or disturb the planting area soil a few days prior to planting. Working the soil a few days prior to planting is especially important when you are planting by machine following a Spring fumigant application. Fumigants tend to remain longer in un-ripped, compacted soils.

It is far better to plant later than usual in the Spring than to risk tree damage by planting while fumigant residues remain in the soil. Skipping fumigation because it sets back the planting date is a poor choice. A May planted tree planted in fumigated soil will usually out-perform a March planted tree suffering from even a mild case of replant disease. Long-term productivity should be the main concern, not date of planting.

Fumigants are safe and effective when properly used, but special training is highly recommended for first time users. Use of other pesticides or fumigants does not qualify as adequate user experience, as each fumigant has unique properties. Before using any fumigant, carefully read and follow safe handling and protective equipment information on the label. Special respirator canisters and vapor-proof eye protection may be required.

Product choices:

Chloropicrin mixtures:

Chloropicrin (tear gas) was the first soil fumigant found to effectively control replant disease. Its use is relatively new in orchards only because properly designed custom application equiptment was not available in most areas until the past few seasons. This product moves not much more than nine to twelve inches from the point of injection, so it must be custom applied with specially designed equipment. A large volume of the trees' future root zone must be treated to assure long-term benefits. Therefore, the application equipment must apply the product in a manner that assures that the future tree row is treated in a band at least seven or eight feet wide and two to three feet deep.

The chloropicrin is usually mixed at high rates with either methyl bromide (at lower rates than used for straight methyl bromide fumigation) or 1,3-dichloropropine. The 1,3-D + chloropicrin mixture is often sold under the trade name of "Telone C-17" or "Telone C-35". These mixtures have performed very well in North Central Washington trials and orchards. "Telone", a 1-3 Dichloropropene product without chloropicrin is not recommended for orchard replant disease control. The lower rate of methyl bromide or the 1,3-D in the chloropicrin mixture will aid in nematode and soil insect control. These pests would not be adequately controlled if you used only chloropicrin.

Follow the critically important soil condition, soil preparation and application timing guidelines described in the methyl bromide section.

Metam Sodium or Metam Potassium:

Originally sold as "Vapam", this product is now also available under several other trade names, including: Soil Prep, Nemasol, Metam Sodium and Busan. The potassium form is known as "K-Pam". Metam is a water soluble liquid that is moved by irrigation water into the zone of the soil that you wish to treat. After the fumigant/water mixture stops moving downward in the soil, the metam converts into a more toxic fumigant gas (methy-isothiocyanate). This gas moves only a few inches from the zone treated with the water mixture. Since the most active ingredient moves only a short distance, it is critical that the metam/water mix evenly penetrate the future tree root zone 2.5 to 3 feet, but no more. Broadcasting the product with sprinkler irrigation or treating a band at least 7-8 feet wide along the future tree row has resulted in long-term tree growth and yield improvement. 75 gallons of product per treated surface acre is the most effective rate, lower rates have resulted in reduced tree growth and lower fruit production. In trials, higher rates have not usually increased growth and production. (Older trial reports will mention 100 Gal./Acre as the most effective rate, but this was with products containing lower percentage actrive ingredient.)

Prior to application, soil should be 45 to 75 degrees F, and relatively moist (over 85% of field capacity). Pre-irrigate the field if the soil is even moderately dry. Use approximately 1/2 to 1 inch of sprinkler irrigation water to drive the fumigant to the desired depth. Without immediate incorporation with water, the product will evaporate rapidly, creating a drift and applicator hazard. Over-application of water during application will over-dilute the product in the soil and greatly reduce the fumigant effect. Your goal during application should be to drive the product in no less than two feet, but no more than three. Sandy, wet soils require the lesser rate of water, finer textured, plowed or ripped, and drier soils require the higher amount. Measure the irrigation system application rate to determine the hours of irrigation that will apply the proper amount of water. Most systems should be run 2 to 5 hours during the application process.

It is not always practical to work the orchard soil prior to treatment. If the soil is prepared for planting after treatment, do not mix untreated soil into the fumigated area.

Please Note:

Metam sodium products have a number of application methods on their labels. *The only practical and effective treatment methods for orchard replant disease involve driving the product into the soil with sprinkler irrigation water.* Shanking or rototilling the product into the soil or filling planting holes with large volumes of water mixed with a per-site rate of the fumigant has not been effective on sites with moderate to severe replanting disorder. (There are some newly designed shank applicators being tried in the Columbia Basin that MAY be effective, but have not been fully tested relative to treatment of orchard

replant disorder). If you do not have sprinkler irrigation, I do NOT reccommend this product.

Filling 7 foot wide, shallow, level basins constructed at each planting site with 35 to 45 gallons of water mixed with 8-12 ounces of metam is effective, if properly done. This application method is far too labor intensive to be economical on a large scale, but may be useful for limited tests. Since this application method is so labor intensive, it is rarely done propery! Follow directions on a 24(c) special local needs label for banding the fumigant during sprinkler application.

Fall treatment will allow you to plant the treated site in late Winter or early Spring. If Fall weather or lack of irrigation water post-harvest delays treatment until Spring, label instructions require 21 to 30 days to pass between treatment and planting. The site and soil can be prepared for planting starting 10-14 days after treatment. Digging planting holes or disturbing the soil a few days prior to planting speeds the release of fumigant residues that may remain. Non-toxic, but unpleasant sulfurous odors may remain in the soil for several weeks after treatment.

Methyl Bromide:

This product is being phased out and is becoming quite expensive. It is not your best choice as a fumigant for these reasons. It is quite effective, but the other choices are equal in effect in long-term trial results.

Methyl bromide is stored as a liquid under pressure, but it turns to a gas when released under the soil surface if the soil temperature is over 45 degrees F. It moves through the soil as a gas, in the air spaces between soil particles. It is most effective when applied to relatively dry (50% of field capacity), warm (50-60 F) and well plowed or ripped soil. Since it may remain in the soil for six to eight weeks under cool, wet conditions, Fall treatment is highly recommended. Spring treatment is possible, but should be professionally monitored to determine that the product is at safe levels prior to planting. Keep application 20 or more feet from established plantings, especially if soil is warm, sandy and dry.

For widely spaced trees, such as cherries or most pears planted at less than 120 trees per acre, spot treatment of each individual future tree site may be more economical than broadcast application. Inject 1/2 to 1 pound methyl bromide by special probe about 18 inches below the soil surface at each future trees' planting site. Use a wood stake or a shovelful of soil to plug the injection hole as soon as the probe is removed. DO NOT use your foot to press the hole closed. This is dangerous and has caused serious injury to the foot of the applicator. Injection of the product is complicated by cold temperatures and in compacted or wet soils.

For closer plantings, methyl bromide is most often commercially applied at 400 to 600 pounds per acre. The higher rates are necessary when soil conditions are less than optimum. Contact the custom applicator well ahead of treatment, and carefully follow their directions on soil preparation. They will usually request a cleared, ripped, and smooth orchard surface prior to application. The better the soil is worked,

the more complete the treatment will be, and the faster the product will leave the soil. Working the soil will also give you a once in 20 year opportunity to properly lime and fertilize, and to break up compacted layers. If your site is excessively rocky, and impossible to rip properly, see the metam sodium section above, that product may be a more practical choice.

Late Summer & Early Fall Nitrogen Fertilization of Orchards

by ***Tim Smith, WSU Extension, Chelan/Douglas & Okanogan Counties***

Applying nitrogen fertilizer to Apples, Pears or Cherries between August 20 and Mid-September has certain advantages, and may benefit some of our orchards. Local on-farm research on pears and apples has helped clarify some of the more common questions and concerns about non-traditional N timing, but much remains to be learned and experienced.

While this timing appears to be generally beneficial, the response of the tree depends on the its present N level. Below are outlined some of the positive, negative, or response-neutral aspects you should consider before trying this "new" N timing:

Benefits: The tree is very active this time of season, and will recover a high percentage of the applied N, much more than it would from late Fall or Spring applications. Whatever rate you have been happy with when applied in the late Fall or Spring- reduce to 3/4 of that amount when applying in late August or very early September. This is the main benefit you can expect in pears, cherries, and most of our apples, as they are generally kept at a moderate to very adequate N level. However, you may be trying to increase fruit color or quality in Red or Golden Delicious by keeping the tree at a low or marginal N level. If so, this timing will provide slightly enhanced N levels during flowering, bud set, and early season leaf development, when the tree needs it the most. This timing of N, applied during the "off year" of production, increased flowering and fruit set two years later in the next "off year". (As this is an "off year" in most blocks, you should expect a potential of increased flowering in 1999 if you start this practice this season. Next seasons buds are set, or not, already.) On these low N trees, the flower cluster weight and leaf size was also increased, without effect on the fruit quality.

Disadvantages: It is difficult to get into orchards at this time of season. You can not apply the fertilizer by spreader. Even if you could drive through the block, the fertilizer prills will damage low-hanging fruit. This is not a problem in some fruits, such as cherries or early harvested pear and apple varieties. If you wish to apply fertilizer to later harvested varieties, you may need to apply it with your irrigation

water (fertigate) or hand apply. In widely spaced trees, hand application gives you a chance to adjust the rate to the individual tree. Look at the tree growth and fruit color and put on more or less than your standard rate according to what you see. Fertigation is quick and efficient, but treats all your trees (and grass) the same. Hand application took 2-3 hours per acre on a 12 x 20 planting, using a low-efficiency, broken-down extension agent.

What this practice will not do: It will not make your trees less winter hardy if application takes place after the trees have stopped growing and set terminal buds. We have had two "test winters" (-24 F in 1990 and -20 F in 1996) during our trials of this N timing, without increased tree damage. On pears, cherries, or most apples, it will not degrade fruit quality. We have not tested this N timing on late apples, such as Fuji and Braeburn, so do not recommend it yet. When these varieties mature, and we start reducing their N level to enhance color, a September N application may be beneficial.

If you apply N this Summer, remember that it is stored in the tree, and there may be no need for further applications next Spring.

WSU-TFREC Orchard Management Forum

Orchard irrigation-how much water does your soil hold?

by Tim Smith, WSU Extension

Soil holds a great amount of water, but your orchard must work increasingly harder to pick up the water as the soil becomes drier. In the spring and fall, trees use a relatively low amount of water per day, so they have little difficulty keeping up with their water needs, even when the soil is moderately dry. As the weather becomes warmer and dryer, it is better for the trees and fruit if the roots have easy access to soil water.

If you replace the orchard soil water when about half of the total has been used by the trees, the trees will come under minimum stress and the soil oxygen will be replaced periodically. The key question is: How do you know when about half of the soil water is going to be used?

First, a few basic concepts:

When the soil if completely wetted, then drained by the pull of gravity, the soil is considered at "field capacity". If your orchard pulled all of the water it could out of the soil, then died, the soil would be at "permanent wilting point". There would still be water in the soil at this point, but it would look dusty dry. The amount of water the trees could pull out of the soil between field capacity and permanent wilting point is the soils moisture holding capacity. This is often measured in inches of water per foot of depth.

The first 50 percent of that water used by the trees is the amount you should count on. I like to call this amount the "Usable Water".

The amount of "usable water" held in your trees root zone when your soil is at field capacity depends on the depth of the soil and root zone, the texture of the soil, its percentage of rock and gravel, textural layers, and compaction. Because of these factors, determining the "usable water" holding capacity of your soil is complicated and difficult to do acurately.

It may not be practical to spend much time getting the soil moisture holding capacity too finely defined, as it varies across most orchards. It is important to make your best estimation of the amount of usable water in the irrigation block, then "tweak" this estimate by observation of soil moisture prior to calculated irrigation time.

To come up with the preliminary estimate, you should estimate tree rooting depth, the soil texture, and

the percentage of the soil volume made up of rocks.

I assume two feet of root depth in young or dwarf rootstock orchards, and about 3 feet of root depth in older, vigorous rooted orchards. You might stretch it to 3.5 or even 4 feet in very high quality soil and old trees. I rarely do this depth, because we don't have much very-high-quality soil in Northcentral Washington. Root studies have determined that 2/3 of the root volume of large, old trees is in the top two feet of soil. About 80 percent of the roots are in the top three feet. Why count those few deep roots as equal to those in the top layers?

Good estmates of soil texture can be made by looking at area soil surveys (widely available on various bookshelves) or by sending soil from the first, second, and third foot of soil to local soils labs for a textural analysis.

Below are the common soil textures and the amount of "usable water" held in two or three feet of root zone in those soils.

soil texture:	**-- 2 ft. root zone**	**-- 3 ft. root zone**
coarse sand	= .92 inch	= 1.25 inch
sand	= 1.25	= 1.74
fine sand	= 1.37	= 1.95
loamy sand	= 1.41	= 2.03
loamy fine sand	= 1.47	= 2.08
sandy loam	= 1.54	= 2.20
fine sandy loam	= 1.87	= 2.65
very fine s. loam	= 2.00	= 2.82
loam	= 2.20	= 3.15
silt loam	= 2.41	= 3.40
sandy clay loam	= 2.20	= 3.11
silty clay loam	= 2.03	= 2.91
clay loam	= 2.03	= 2.95
sitly clay, clay	= 1.87	= 2.81

Note: the amount of usable water is reduced in very fine textured soils because the tree has difficulty competing with clay particals for water. there is a greater amount of water remaining in the soil at perminant wilting point.

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WSU-TFREC Orchard Management Forum

Soil versus Foliar Fertilizer Application

Guy Witney, WSU Extension, 400 Washington, Wenatchee

There has been a great proliferation of foliar fertilizers on the agricultural chemical market in recent years. Many of these have been useful in correcting nutrient deficiencies in leaves and fruit, but this does not mean that all foliar fertilizers are beneficial.

Remember that plants were not designed to take up nutrients through the leaves and fruit. Only a few nutrients, such as potassium, easily enter the above ground parts of the plant. Most are restricted from entering leaf and fruit surfaces by waxes, oils, hairs and highly charged surfaces. This is why, to be effective, calcium sprays on pears and apples have to be repeated several times a season, with only a small fraction of the applied material entering fruit tissue.

When is foliar fertilization best?

In the case of calcium, transport from roots to fruit is limited, so foliar applications are the best method we know of to get more calcium into fruit tissue to reduce post harvest disorders. The expense of the calcium sprays is more than justified by the potential post harvest losses.

If soil pH limits nutrient availability, and ground applied fertilizers are not taken up, foliar fertilizers may be a valid option. In this case, a soil sample should be taken to determine pH, and a leaf tissue sample taken to determine the need for additional foliar fertilization. In some cases poor root health from compaction, replant disease, crown rot, mouse damage, waterlogging or other problem may warrant foliar feeding of trees. However, the fertilizer in the required amount cannot be phytotoxic as a foliar spray, and foliar uptake must have been demonstrated with the product under consideration.

Zinc uptake deserves special attention. In our soils zinc is largely immobile and it is difficult to supply roots with adequate amounts of available Zn. As a result of limited soil availability, zinc is applied as a foliar spray. Research has shown that only a small amount of Zn can be taken up by leaves, however foliar applications are still more successful than soil applied Zn.

Soil application

If soil pH is not limiting nutrient availability, root health and growth are not restricted, and transport of the nutrient in the tree is not restricted, soil applications of fertilizers are much more efficient than foliar sprays. Consider spending money on soil and leaf analysis to determine nutrient deficiencies or uptake

problems, rather than embarking on a shotgun foliar approach.

--Guy Witney

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WSU-TFREC Orchard Management Forum

Leaf Analysis Time

Guy Witney, WSU Extension, 400 Washington, Wenatchee

"since leaves are the important synthesis centers of plants, tests of leaves more nearly reflect the nutritional status of the plant than do tests made on the soil."--Westwood, Temperate-zone Pomology.

With all the excitement of harvest it is easy to overlook taking annual leaf samples for tissue analysis. Late summer leaf analysis is an essential routine procedure in modern orchards, providing information on the nutritional status of trees relative to a set of general nutritional ranges. If combined with soil samples taken every three to five years, annual leaf analysis can be an excellent management tool.

Why use leaf analysis?

Leaf analysis, if used routinely, provides a historical reflection of fertilizer management as it relates to yield and fruit quality. Leaf tissue analysis can be used to estimate fertilizer needs for next season, thus avoiding deficiency or toxicity problems. It is also a useful tool to diagnose nutrition problems effecting post harvest quality.

When and how do you take the sample?

Sample mid-July through August once active growth stops. Leaves should be sampled from current season, mid-terminal, upright (but not vertical) branches after terminal bud formation. Generally, leaves are picked at shoulder height from the fruiting framework of the trees. Around 50 leaves should be selected randomly from no more than five acres of the same variety, strain, rootstock, training method, soil type and irrigation block.

Limitations of leaf tissue analysis

As stated above, leaf analysis provides growers with data on the nutritional status of their trees relative to a set of general guidelines provided in range tables. Sometimes the 'optimum' or 'critical' levels of a nutrient in a range table are not the best for a particular orchard. For example a Golden Delicious orchard with a severe bitter pit problem may need less nitrogen in the tissue, even if the leaf analysis indicates a level of 2.0% N which is in the upper end of the 'optimum' range for this variety.

Nutrient range tables for new varieties and training techniques are limited. This does not mean that growers should not collect leaf samples from these blocks - the opposite applies. The more data the tissue analysis labs can collect and analyze from new varieties, training techniques and locations, the faster the development of our knowledge on the best fertilizer regimes required for these varieties. Contact your

local analytical laboratory before collecting leaves so that the samples meet their requirements.

--Guy Witney

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New Fumigant Trial

Tim Smith, WSU Extension

Second year results of new & old fumigant trial

With the loss of methyl bromide as a soil fumigant coming soon (the year 2000?), it is important that we continue to find effective products and practices for the treatment of replant disease.

Until somebody comes up with something better, fumigation is the best treatment for this problem, and continues to greatly improve the growth of trees in replanted blocks. Most growers who fumigate are very satisfied with the tree growth in subsequent seasons. As with any new practice or material widely used, there have been a very few important problems in fumigated blocks. The most common problem remains the too soon planting of trees into fumigated soil. If we fumigate relatively warm soils in the fall, then plant after the soil has warmed reasonably in the spring, we are very unlikely to see trees damaged. If we rush to plant on cold wet spring appliations, as we did in 1995, some orchards are certain to see fumigation damage.

Since fumigation has been demonstrated as very effective in treatment of replant disease, a few alternative products have been proposed. Some of the products have potential.

In spring 1994, Doyle Fleming set up a fumigant product trial in a block that had been in apples for about 15 years. Various rows were treated with:

1. Metam sodium (the product we have used for some seasons- vapam, soil prep, nemasol, busan),

2. A similar product from Buckman Labs called metam potassium- reported effective at a lower rate than used with metam sodium,

3. Telone c-17- a product that has been used for many years for row-crop fumigation, especially in potato fields (don't confuse this product with telone 2, it's not the same stuff), and,

4. Municipal compost.....Because the trial bordered a block that is being managed organically. Rumor has it that compost alone will overcome the effect of many soil-borne diseases, perhaps it could help in the treatment of orchard replant disease. Perhaps.....Perhaps not.....

After the trees (Carousel on M-26) were planted, I measured the trunk caliper of 50 to 60 trees within each treatment. Cross section trunk growth is a good way of measuring vegetative growth of young trees. In the second season, I measured trunk growth. From the 3rd season on, I will measure fruit production only.

Summary of 1995, second leaf results:

The compost treatment, being organic, was weeded by hand 2 or 3 times this season, but the weeds still seem to have the upper hand this fall. Compost was mixed into the soil pre plant, and was piled around the base of trees early in the first growing season. The M26 roots grew into the compost, probably allowing the trees to grow much better than if they had no top dressing. (there are no replant disease pathogens in the compost to slow root growth). Dispite this, the trees in the compost row continue to grow poorly. I suspect this row will have continued problems, even if nursed along very carefully.

There is some slight variation in growth from row to row across the trial, but the general appearance of the remainder of the trial is very good. The soil on this block is very rocky and fairly steep, so the conditions for fumigant application were only fair. Dispite this, the trees in the fumigated rows are growing very well. I expected the telone c-17 would be the most affected by the rocky conditions, as the product must be injected by shanks drawn by a tractor, and large rocks cause the shanks to pop out of the soil. Dispite these application problems, tree growth in the telone c-17 treated rows was excellent.

Results, expressed as percent growth of cross section on the tree trunk (percent growth is the current trunk cross section area, divided by the starting trunk cross section area):

Telone c-17	... 503 a
Metam potassium	... 422 b
Metam sodium	... 453 b
Compost	... 223 c

Statistics indicate that there was no significant difference between the two metam products. There was a significant difference between the telone c-17 treatment and all the others, and the two metam treaments and either the compost or the telone c-17.

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COMPOST TRIALS IN ORCHARDS IN 1995-96

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As most of you may have noticed, compost is a hot new topic in agriculture. There are a number of cities, stockyards and chicken ranchers touting their products to the tree fruit industry, as well as any other high value per acre crop. Below I have reported the most up-to-date results of a number of in-orchard compost trials we have placed in North Central Washington. But first:

Composts- what are they?

These commercially sold "eco-waste-bio-poop-soil amendment" products come from a number of waste reduction programs in cities and farms around the region. You have a range of products available. They are generally produced from organic waste materials, such as livestock manure, sewage solids, wood chips, straw livestock bedding, tree leaves, and lawn clippings. Due to the variability in the original substances going into the compost mix, and the complexity of the composting process, each batch is slightly to wildly different from previous batches. Producers sometimes try to follow set mixtures, but product variability is almost certain. Important variables include nutrient content and moisture content. As you sometimes buy these products by weight, be well aware of how much water you are purchasing.

Nutrient content is often quite low, often only 1-2 percent by weight. Since nutrient content is low, and organic carbon (undecomposed plant matter) is often quite high, most composts should be considered soil amendments, not fertilizers. They have potential for improving some aspects of soil quality when used at high rates over the short term, but do not work well as traditional plant nutrient sources. Nutrient release will occur slowly as the compost is further broken down by soil organisms, often over a two or three year period. Slow nutrient release is often thought to be an advantage with some crops, but must be approached with care in fruit orchards. If you wish to use composts as a nutrient source, they must be incorporated into the soil, and relatively high rates must be applied yearly. Waiting for a crop response will try the patience of most growers. Composts may maintain an orchard that is presently in good nutrient balance, but may not be suitable for correcting deficiencies.

Dried poultry waste has more actual plant nutrient content per unit of weight than most other composted products. However, the major nutrients are generally in the 4-7 percent range, and the product is often far from being "finished" compost.

While the sellers of various composts will sing praises of their source vs. other composts, I doubt that we need to argue the biological merits of compost from one city or farm vs. another. There are some potentially important differences. Pay close attention to the salts content, the percent of the weight made up of water, and the physical characteristics that may affect the ease of application.

You should run a salt test on each new batch to be sure it isn't too salty. A salt index of 4 or less doesn't seem to hurt trees when used moderately. Higher rates of compost increase the salt hazard of even moderately salty products.

As with all composts, there is a variable amount of water in this product. Often you will pay for 50-60 percent water by weight, even when the product seems fairly dry. Do a moisture test, and pay by the adjusted dry ton. (Simple moisture test: weigh out 10 pounds of delivered product. Spread it on the kitchen table to air dry. No, wait a minute- maybe that would complicate things around the house. Spread the product on paper in a dry, well ventilated shed. Weigh the dried product. Divide the end weight by the starting weight, then multiply by 100. This gives you a rough percentage dry weight. To do this properly, you would have to dry the product in the oven, but I doubt you could get away with that, either.)

Some producers claim their product protects crops from soil pathogens. Evidence of disease control is usually based on greenhouse pot tests, using high rates of compost on plants other than fruit trees. The disease control often involves pathogens that are not specific to common orchard problems. We should stay skeptical on these disease control claims until we see better work done on the subject.

Some of the non-greenhouse plant tests were done using very high rates of compost. For instance, one source tested their product by mixing in a 6 inch deep layer mixed into a garden soil. Agriculturally speaking, this is about the equivalent of 100-120 tons of compost per acre, which would cost, for some products, from $4000 to $7500 / acre, plus application costs. Obviously, the use of low-input composts at high rates would be a better economic choice on home gardens than farmland. Most of peoples' positive compost experience comes from home garden use, which is great, but the observed garden benefits are not directly transferable to farms. Most farmers that use organic wastes from livestock apply 10 to 20 tons per acre, amounts that do give crop response, but far more product than we can economically use with commercial compost.

If you are a fruit grower, you should ask compost advocates and sellers about orchard results, developed through tests, not testimonials. Benefits are difficult to measure, therefore, proper tests are not often carried out. Tests that give valid results are difficult to set up, time consuming, and expensive. Because of this expense, they are rarely done properly. Tree growth differences of less than 25 percent are difficult to "eyeball" because young tree growth is quite variable. If you can "see" growth differences, the growth has probably been increased by 40-50%, an effect which is rare with any product, other than soil fumigants.

Opinion, for what it's worth: There are no regulations encouraging the compost seller to use only information developed through careful, well designed tests. While most composters are honest, and strongly believe that they are selling a good, useful product, some appear to be selling you a product full of "hopes and feelings". Compost use is a "good" behavior, beneficial to the soil, the environment, and people who need to dispose of organic waste products. You will have difficulty proving their claims wrong (or right.) The evidence of compost benefit is often one or two duplicated magazine articles

describing tests run by unheard-of people at obscure research centers that claim major benefits to annual plants. You can be sure that this article will not be hand-out material. Keep an open, but slightly skeptical, mind. Low rates of compost can cost $100 to $200 an acre. The investment you make on any product should return a profit, either economical or environmental.

MAJOR PRODUCTS:

"BIOSOLIDS": Biosolids are the slightly-processed or semi-processed solids that settle out of city sewage. These products have been spread (one time per field) on Eastern Washington wheat land during the fallow season for several years, often with very good subsequent wheat growth and production. All concerned, farmer and producers, are very pleased with the results. There is enough wheat land in Eastern Washington to take care of the disposal of this beneficial product for hundreds of years. As with most "composts" these have quite a highly variable water content, depending on the source. Biosolids can vary in qualities and physical characteristics as it is delivered. Some has been dried, ground and screened to improve its handling characteristics. As this biosolid industry has evolved, some local biosolids managers have better refined their product, which greatly improves its appearance, somewhat "de-smells" it, and greatly reduces potential heavy metal content. However, the "point source" that the original organic matter came from is objectionable to many of the more sensitive public, if they bother to think about it.

As of this moment in American history, public attitudes about the use of even "composted" human waste on fresh fruit or vegetable production lands should prevent anyone in the fruit industry from using it. This stuff is too close to the source, if you know what I mean. Some packinghouses specifically forbid the use of sewage biosolids in the production of fruit, not because of real safety issues, but because of the image problem. We don't want to get into the position of having to have signs above the fruit section at the local store, assuring the public that human waste is not hazardous, and these apples are just fine if washed carefully. (Just be sure to wash your hands before handling other food items). Really,..... trust us on this one. There are plenty of other places that we can put biosolids to beneficial use, we don't need them on orchards.

MUNICIPAL COMPOST is a mixture of leaves, chipped tree limbs, yard waste, and (sometimes, but rarely) "biosolids" from various cities, composted into an earthy, well mixed organic amendment that any home gardener would be happy to use on their garden. This product has become available because many cities decided to recycle yard and park waste, rather than throw the stuff into the dump at great cost. Of course, these cities would like to turn this waste into gold, so are selling it to anyone willing to buy. There is some small amount of nutrient in the compost, but most of the value is in the organic matter, which can act as a nutrient buffer and improve the soil structure for a year or two after application.

COMPOSTED CHICKEN LITTER is also called DPW- for "Dried Poultry Waste." It is the stuff used to cover the floors of the vast chicken coops of Western Washington and Oregon. It is composed of lots of wood chips and chicken "droppings", (and a few decomposed chickens) aged and scratched around under the biddies feet for a few months or so, until the chickens can't stand it anymore, then piled and

turned until it is well composted. This stuff is hot. There is quite a bit of nitrogen, phosphorus and zinc in the product (the ammonia in some batches almost brings tears to your eyes) . While you can safely use lots of unsalty municipal compost in the orchard, you must be careful with DPW rates. Too much at once can burn the trees.

We get some pretty impressive grower testimonials about the positive effects of chicken litter. I hear that it improves the growth of trees struggling to survive on shallow, poor soil zones, especially in the strange soils near Chelan and Manson. This positive effect has been limited to a few very specific situations, and has not been duplicated under more normal orchard soil conditions. In general, DPW treatments tend to show the most benefits on the worst soils. If your orchard has some bald spots where trees grow poorly, it's worth a look. Just go easy on the rate per tree. A 5 gallon bucketful per tree all at one time can burn the tree.

In Summary, I really have high hopes that we will be able to measure benefits from the use of composts on fruit trees. It would just be so peachy if we could use a waste product to get better tree growth on some difficult replant sites. Soil fumigation has proven very vital and effective, but we still can't get the kind of consistent tree growth seen on "virgin" sites. I hope that fumigation and compost combined will do the trick. I also hope I don't end up spending years trying to make these products work, and failing.

ORCHARD COMPOST TRIALS:

After some interesting trial results in 1994, I increased efforts in 1995 and 1996. I placed either municipal compost or chicken litter on apples or pears in four different replant sites Spring, 1995, with follow-up applications in 1996. In 1996, Co-worker Guy Witney, (an experienced compost spreader), and I set up a large compost trial in newly planted apples to demonstrate the effect of surface application of different rates of various products. These trials alternated the treatments randomly in the orchard and involved up to 110 treated vs. untreated trees each, so we gave the products a good chance to work (or not). We are measuring vegetative growth of the tree for the first two or three years after planting, and will not give up until the end of the 3rd or 4th year. So far, we haven't got much to write home about.

LEAF ANALYSIS SUMMARY:

In August 1996, leaf analysis for N, P, K, S, B, Fe, Ca, Mg, and Zn did not show us any differences in nutrient content between the various treatments in these trials. Maybe next year.

NOTE: *Calculating the increase in the cross sectional area of the trunk is a very accurate way to measure a tree's vegetative growth. The "Percent Growth" mentioned below is calculated by determining the tree's present cross sectional area, then dividing that by the cross sectional area of the tree measured at the time it was planted, then deducting 100. A 100% growth indicates that the tree trunk has twice the cross section that it had when it was planted.*

TRIAL RESULTS :

Municipal compost (Kent and Seattle, Washington) on apple:

Treatment:	First Season Trunk Growth (%)	Leader Growth (inches)	2nd Year Fruit/Tree
No Compost	136	17.3	10.7
4 Tons/Acre	135	15.1	8.4
8 Tons/Acre	134	16.7	10.2

There was no statistical difference between any of these treatments. Pay no attention to the very minor numerical differences, there was no treatment effect. With the normal variation we see in tree growth, it was odd to see all the tree growth and fruit yields average out this close.

CHICKEN LITTER COMPOST ON APPLE:

Mixed into the planting hole soil Spring 1995, then to soil surface in Spring, 1996:

Treatment:	1st Season Growth (%)	2nd Season Growth (%)
No DPW Applied	79	280
1.5 Lbs/Tree/Year	91	283
3.0 Lbs/Tree/Year	76	260

There was no statistical difference between any of these treatments. Pay no attention to the minor numerical differences, they doesn't mean anything. Maybe next year.

CHICKEN LITTER COMPOST ON APPLE:

Applied to the surface after planting in Spring 1995, then again in Spring, 1996:

Treatment:	1st Season Growth (%)	2nd Season Growth (%)	Fruit/Tree
No DPW	98	269	15.5
1.5 Lbs/Tree/Year	135	338	9.2

3.0 Lbs/Tree/Year	125	376	9.7

My breath quickened when I saw the tree growth results, but then I realized that there was quite a difference in the average fruit load per tree in the second season. The compost treated trees had about 9 fruit / tree, the uncomposted ones had about 15, which was a heavy load for 2 year old trees. This probably held back the uncomposted trees growth. So, pay no attention to the numbers, the plot wasn't positive enough to prove anything either way. Maybe next year.

CHICKEN LITTER COMPOST ON PEAR:

Mixed into the planting hole, Spring 1995 , soil surface applied Spring, 1996:

Treatment:	1st Season Growth (%)	2nd Season Growth (%)
No DPW	190	587
3.0 Lbs/Tree Each Year	187	567

Of course, there was no statistical or significant numerical difference. Maybe next year?

1996 ORONDO SOIL AMENDMENT TRIAL:

Rate per acre, banded 6 feet wide on row soon after planting- lightly incorporated, 1996:

Treatment:	1st Season Growth (%)
None	81.8
WSU Bovine @ 2.5 Tons/Acre	79.7
Pacific Compost Mix @ 2 Tons/Acre	77.3
Wood Ash @ 900 Lbs/Acre	74.4
Composted Chicken Litter (DPW) @ 1 Ton/Acre	73.0
Municipal Compost @ 5 Tons/Acre	72.7
Municipal Compost @ 2.5 Tons/Acre	72.7
WSU Bovine Compost @ 5 Tons/Acre	71.5
Chicken Litter Comost (DPW) @ 2 Tons/Acre	66.9

Humic Acids (Leonardite) 1000 Lbs/Acre	63.2

There were some minor numerical differences between treatments, but we should probably wait until the end of the second seasons' growth before making any suggestions that these treatments did anything at all. Especially since the untreated trees grew slightly better than those we treated. I'm looking forward to re-treating this plot Next Spring and measuring the 320 trees in the trial again in Fall 1997.

Some Thoughts About Soil pH, Fertilizers and Lime

Tim Smith, WSU extension, Wenatchee & north
(My apologies to any soil scientist in the audience.)

When you apply fertilizers that have ammonium as a portion of the product, or some portion that will turn into ammonium, you are adding acidity to the soil. It doesn't matter what kind or type of fertilizer, just that it has ammonium (or ammonia) in it.

Ammonium is made up of nitrogen and hydrogen, three particles of hydrogen for each particle of nitrogen. (NH3-). Shortly after the ammonium reaches the soil, it binds to soil or organic matter. Through time, it is converted to nitrate by soil bacteria. the warmer the soil, the faster the conversion. It is the nitrate form of N that is most mobile in the soil, and most likely to leach into groundwater.

During the conversion to nitrate, the nitrogen element loses the three hydrogen and adds two oxygen. The oxygen comes from the air in the soil. The three hydrogen particles are free to float about the water in the soil and to react with substances in the soil. Free hydrogen is real active, and is the "acid" in anything. (Incidentally, acids taste tart, but I don't recommend that you go around tasting soil to see if it's tart or sweet.) The H+ can react with lime in the soil, forming water and carbon dioxide and be neutralized, it can tie up on soil particles, react with all sorts of chemicals or organisms in the soil, or it can just drift around in the soil water, waiting to react with (and mess up) all sorts of things. Plants have difficulty getting the chemical nutrients they need, in the proper amounts, when soil has too many hydrogen ions in the solution.

Some soils have a great ability to cope with these added H+ particles, they have large amounts of natural "lime" to convert the h+ into water, they have lots of organic matter and clay to bind the H+, taking it (temporarily) out of the soil solution. Other soils quickly lose the ability to "buffer" the H+ in the soil, and allow the H+ to build up in the soil water. Once a soil has become acid, it has lost it's ability to deactivate H+ particles, and is likely to become even more acid rapidly if H+ is added to the soil.

When a lab does a pH test of the soil, they are measuring the balance of hydrogen particles to "bases" in the soil solution. If there are more H+ particles than bases (-OH, which taste sweet....), the soil is acid.

The pH number indicates a ratio of acid to base particles in the soil. The lower the number below 7 (neutral), the more acid the soil. Each pH number is in a multiple of 10. So a soil with a pH of 5 has 10 times as many free-floating H+ particles in the soil solution as a soil with a pH OF 6. Soil with a pH of 4 has 100 times the "acidity" of a soil with a pH of 6.

Most "native", uncropped soils in the desert areas of Eastern Washington have pH levels of about 7.5 to 8.5, Indicating that they are somewhat alkaline (sweet) to strongly alkaline. At this point, the pH test does not show you how quickly the pH will drop with the addition of ammonium fertilizers. The soil may have small or massive amounts of native lime, and both situations are common.

If there are massive amounts of lime and other bases in the soil, you have what people often call "alkaline", or "caleche" soil, which is difficult to manage. It is difficult or impossible to get all the lime out of this soil, and you will have to live with high pH, along with the drainage problems, iron deficiency, and compaction that are often present. If you have one of these soils, you should use the most acidifying forms of nitrogen fertilizer (such as ammonium sulfate), as you will never have an acidity problem.

Recently, growers have found that applying a narrow band of highly acidic product to the soil in the weed-strip zone under the tree has acidified a portion of the soil in the root zone of trees growing in high pH soils, leading to greener trees.

If your soil is normal, it will already have become acid since it was broken out of the sagebrush. Since acidity is a chemical reaction, it occurs at the point where the ammonium nitrogen was applied through the years. If the fertilizer was banded and concentrated under the tree, that is where the pH will be lowered. The pH is often much higher under the grass between the trees. Since the H+ particles react to the soil near where the fertilizer was placed, the surface soil is most effected. The pH is often higher in the second and third foot than in the surface foot in the zone beneath trees, unless you have been treating the soil acidity over the past several years.

So, it is a complicated question when you are asked, "what is the pH of your orchard soil?" The pH where? I have seen soil in the same orchard that ranged from 4.2 in the top foot directly under the tree to 7.2 in the second foot in the middle of the drive row. Under these circumstances, the trees roots contact many different pH's, which is likely to balance the trees needs a bit, compared to having the entire root zone in an unfavorable pH. However, since some substances, such as manganese and aluminum, are released in toxic levels from soils as they drop into pH's below about 5.5, it is best to treat your soil with lime to start the long process of bringing the soil acidity down and the pH up.

As I mentioned earlier, lime reacts with the H+ in the soil solution to form water and carbon dioxide. A ton of lime will convert a lot of H+. Each ton of lime added can neutralize the H+ particles added by 1110 pounds of ammonium nitrate or urea. So, depending on how much fertilizer you have applied each season, each ton can compensate for about 4 to 10 years of fertilization with those products.

Most growers have built up quite a large "lime debt" through the years, and may need to apply several tons to bring all their soil back to 6-7 pH. You can't put the required lime on all at once. Lime works best when it is mixed with the soil so it can come in contact with a large volume of the soil water. Since lime is not very soluble, it moves into the soil very slowly when applied to the soil surface. When you apply lime in the orchard, you are probably treating only the surface 4-8" for the first few years, so there is no hurry to get the total "lime debt" applied. We generally recommend that you apply two tons the first season of treatment, let a few seasons pass, then apply two tons more. You should then wait a few more years before re-testing and

possibly re-applying more lime.

The best time to take care of liming is "between" orchards, as the block is replanted. Lime should be applied while you can still identify the old rows, so the application can be concentrated along the row, where the pH is lowest and the lime needs are highest. Ripping and discing the soil prior to planting will greatly speed the correction of pH in the block.

Do NOT over-lime! Lime adjusts soil chemistry, it is not a fertilizer. A little too much can raise pH to undesirable levels, causing serious management problems. Make certain you know how much lime is needed, then apply it over a number of seasons until your soil is back in balance.

More on Soil Chemistry

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Visitors April 1999- July 2001: 9024

WSU-TFREC Orchard Management Forum

Spring temperatures & fruit size

Degree days after bloom (fruit cell division rate?)

Tim Smith -- WSU Extension, North Central Washington

There are a number of ways to measure the amount of heat the fruit has been exposed to during the cell division stage after bloom. One relatively crude, but somewhat effective, way is to total the daily degree days over the base of 40 F for the first 40 days after bloom. From this number, you can compare the potential for cell division across seasons. In general, warmer post bloom periods lead to larger fruit size, all other things being equal, (which they rarely are. Pruining, thinning and fruit load also make a major difference in fruit size, but these things often even out for any given season over the entire industry).

The table below was calculated using the following formula:

daily high temperature - 40 = daily degree days.

The daily amount was totaled for the 40 days following each years full bloom date at the WSU Tree Fruit Extension and Research Center, in Wenatchee.

average of all years, with April 28 as full bloom date, and the 30 year daily average temps

Average: 1405

```
1997-----1326   --normal
1996-----1119   --cold
1995-----1428   --normal
1994-----1392   --normal
1993-----1577   --hot
1992-----1388   --normal
1991-----1218   --cool
1990-----1180   --cold
1989-----1384   --normal
1988-----1240   --cool
1987-----1502   --warm
1986-----1408   --normal
1985-----1399   --normal
```

```
1984-----1105   --cold
1983-----1422   --normal
1982-----1408   --normal
1981-----1243   --cool
1980-----1272   --cool
```

coldest springs: 1984, 1996, and 1990

Fruit was generally smaller than usual in 1984, and blossom return was not as good as usual the next season.

warmest springs: 1993 and 1987

So, you think 1996 had a cool spring?? You're right. Perhaps we will see somewhat smaller average fruit size????? What happened in 1990 and 1991?

--Tim Smith

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Wenatchee WA, 22 August 1996
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WSU-TFREC Orchard Management Forum

Weed Better Spray in the Fall

Tim Smith -- WSU Extension, North Central Washington

Note: this page is available for archived purposes only. Please contact the author at smithtj@wsu.edu for updated information.

I've never met anybody that applied their weed control in the Fall and wasn't happy that they had done so the next Spring. It is always easier to put off something that can be done later. However, if you decide to try to control weeds next April or May, you are moving an operation from a flexible period in the Fall to a very busy time in the Spring. You can very quickly finish the season by applying your contact + residual mix, then get on to the three major reasons why we tend to avoid work post-harvest: 1. Deer, 2. Elk, and 3. upland game birds.

Why control weeds?

They just grow right back. It's a good thing we don't think the same way when it comes to pruning the trees. Managing the growth of plants under the trees is a yearly effort, but necessary. Why? Without much explanation, let's list some reasons:

Water management: weeds use water, lots of it. Keeping your weed strip fairly clear of weeds saves 50,000 to 100,000 gallons of water per acre per year. Water that goes through the trees, producing quality fruit, not weeds. Weeds also tangle sprinkler heads, stopping them from turning. Most importantly, they block the sprinkler pattern, causing uneven, therefore, inefficient irrigation.

Mouse management: Thinking about controlling mice in the Fall is something like thinking about the status of your boats drain plug after you have reached the middle of the lake. It's a useful thought, but maybe a bit late for best effect. Mice love weedy orchards. They can live and raise families all summer, and mouse control efforts may not be adequate under these extreme conditions. We must keep mouse cover to a minimum all season if we are to get the best effect in mouse control on bad mice seasons.

Haul out the sprayer and get it ready

O.K., so let's say you are now convinced that weed control is a good idea this Fall. If your sprayer is ready when you have the proper spray conditions, you can spray about 2 orchard acres per hour (2 MPH,

20 foot rows). You don't make much progress when you're tinkering with the sprayer until 10 or noon, then the wind comes up.

Uneven application is the most likely cause of poor weed control. Spend some time getting the boom set up right. Most people use flat fan nozzles, which is the best idea for residual products. You must have even application to assure tree safety. Most people use 8002 or 8004 nozzles in the fall, for 50 or 100 gallons per acre. I recommend the lower gallonage, as you will get better effect with lower rates of contact or systemic herbicides.

Take all the nozzles apart, clean them, with special attention to the strainers. Are all the strainers the same design? The same mesh (50 or 100)? Clean and flush the tank and line prior to reassembly.

Adjust the boom height until you have about 1/3 if each nozzle pattern overlapping the neighboring spray pattern on either side.

Use a tall, skinny container to catch the spray from each nozzle for one minute. At about 35--40 psi, the 8002 should put out about 25.6 ounces (.2 gallon) per minute, the 8004 about 51.2 ounces. If they are below this amount, take them apart and reclean them. If the 8002 is 2 or 3 ounces over the proper amount, or the 8004 is 3 or 4 ounces over, replace it. It is wasting more product per acre than it is worth, plus the spray pattern will be uneven. You can not eyeball a pattern that is only 10--20 percent uneven, trust your measurements and throw that worn nozzle into the trash.

When applying the product, keep systemic products off of young tree trunks and low hanging branches. Remember, if you wet the weed, then the weed slaps against sensitive parts of your tree, damage is possible. Stop spraying if the wind is over about 5--7 MPH. We have many calm days in the Fall (not so the Spring), so there is no need to push the conditions. If weed growth is heavy, use higher spray gallonage, and drive a bit slower. Dropping from 2.5 to 2 MPH will only cost you about 2 or 3 minutes per orchard acre.

Once the job is done you can pursue the Fall recreational activity of your choice with a conscience as clean as your orchard will look next May.

--Tim Smith

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WSU-TFREC Orchard Management Forum

1993 Washington Fruit Acreage Survey

The 1993 Washington Fruit Acreage Survey has been completed and the preliminary report has been distributed to the media. The report is available from Washington Agricultural Statistics Service, P.O. Box 609, Olympia, Wa 98507.

Following are highlights concerning apple acreage:

Apples, the largest fruit crop, totalled 172,000 acres compared with 161,000 acres in 1986. This represents an increase of approximately 7%. The inventory of total apple trees on January 1, 1993 was 45.0 million; this is an increase of 47% from the 1986 inventory.

'Delicious' accounts for 70% of the bearing apple acreage (147,000 acres total). In the 1986 survey, 75% of the total apple acreage was 'Delicious'. 'Delicious' comprises 62% of the bearing trees; newer varieties ('Fuji', 'Braeburn' and 'Gala') are replacing 'Delicious' in many new plantings.

The average tree density for 'Delicious' is 210 trees per acre compared with the average for other varieties at 353 trees per acre.

The stripe strains account for two-thirds of the 'Delicious' acreage and 43% of the total apple acreage. 'Redchief' is the dominant stripe strain with 26,900 acres. 'Oregon Spur', Top Red, Starking, Ace and Hi-Early (listed in order) are also major stripe strains.

Acreage for other varieties as of January 1, 1993 is:

Golden Del. 23,300

Fuji 11,000

Granny Smith 8,500

Gala 5,900

Rome Beauty 3,800

Braeburn 3,300

Jonagold 1,700

Winesap 1,100

misc. 3,300

The fruit tree survey also has some preliminary figures for the number of topworked acres. The dominant variety for topworking is 'Fuji'.

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