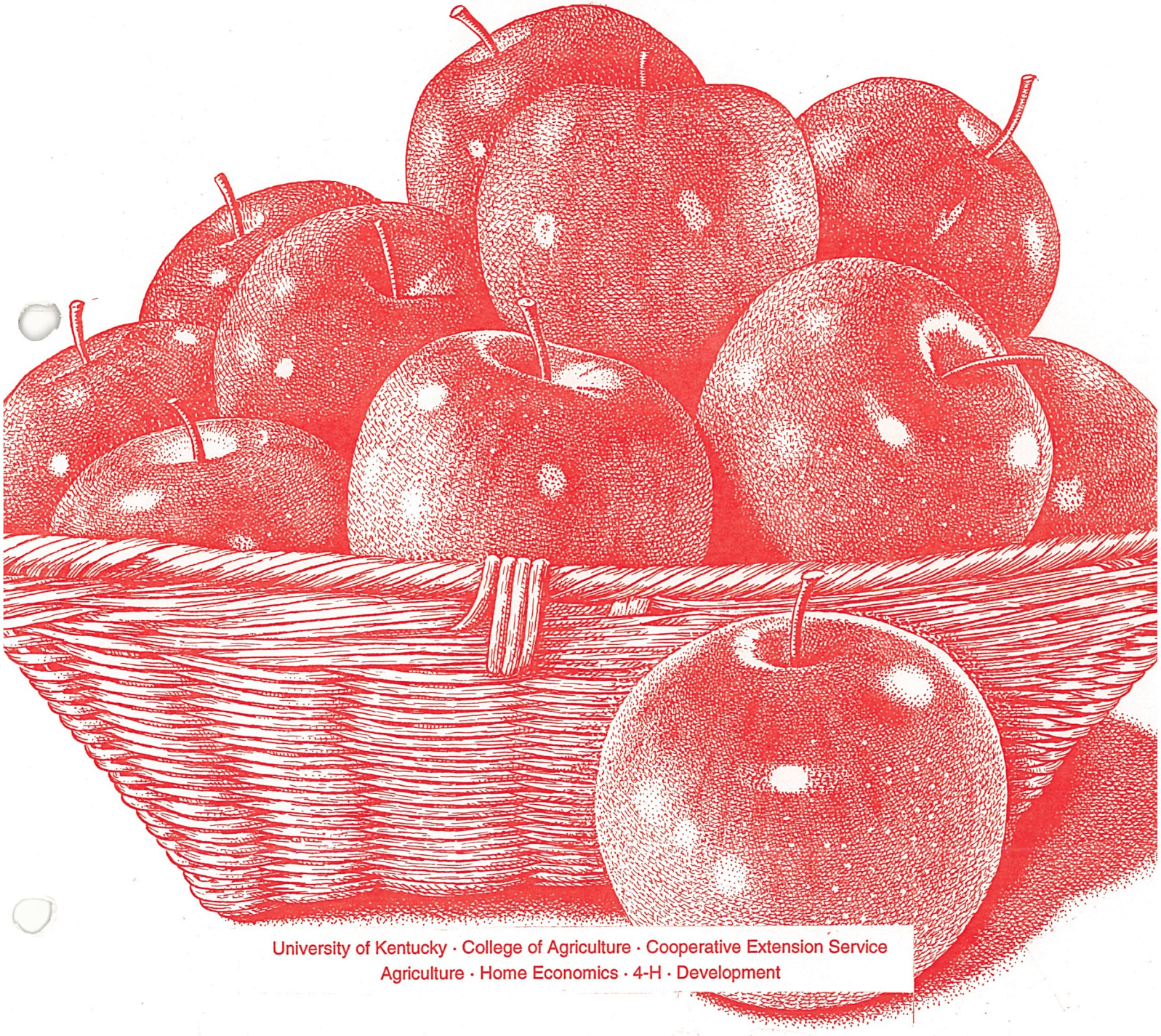
Kentucky Apple Crop Management

Scout Manual



University of Kentucky · College of Agriculture · Cooperative Extension Service
Agriculture · Home Economics · 4-H · Development

APPLE IPM PEST HISTORY

Please provide some information regarding apple cultivars and past insect/disease incidence that will help when designing specific IPM approaches to your orchards. Most growers will want to designate only part of their orchard for IPM practices. standard program.

Name _____ Address _____

Phone No. _____ _____

1. List the apple cultivars that the IPM block will contain and the block size.

2. List the apple cultivars that the standard spray schedule block will contain and the block size.

3. Please circle the number corresponding to how you perceive your orchard would fare from these insects/mites in most years if you did not spray.

	Severe	Moderate	Light	None
Codling Moth	3	2	1	0
San Jose Scale	3	2	1	0
Apple Maggot	3	2	1	0
Plum Curculio	3	2	1	0
Leafrollers	3	2	1	0
Green Fruitworms	3	2	1	0
Mites	3	2	1	0
Japanese Beetles	3	2	1	0
Aphids	3	2	1	0
Woolly Apple Aphids	3	2	1	0
Leafminers	3	2	1	0

4. Please circle the number corresponding to how you perceive your orchard would fare from these diseases in most years if you did not spray.

	Severe	Moderate	Light	None
Apple Scab	3	2	1	0
Cedar Apple Rust	3	2	1	0
Powdery Mildew	3	2	1	0
Frogeye Leaf Spot/Blackrot	3	2	1	0
Sooty Blotch/Fly Speck	3	2	1	0
Other Fruit Rots	3	2	1	0
Fire Blight	3	2	1	0

5. Which of these insects/diseases do you find most difficult to control?

6. Describe any other insect/disease problems or symptoms you have experienced in the past in your orchard.

7. Did you participate in the 1993 apple IPM program?

8. What type of sprayer do you use and what is your GPA at 2 MPH?

Other comments:

Thank You

Please return this form to:

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Lexington, KY 40546

Return by FEBRUARY 16, 1994.

Kentucky Apple Management Program Scout Manual

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INTRODUCTION

Agriculture is the world's most important industry because of rapidly expanding populations which demand increased amounts of food and fiber. Crop protection problems associated with this increased production have become more complex. A simplistic approach to pest control leads to serious environmental complications and economic losses. A truly successful pest management program must take a multi-disciplinary approach in order to supply the farmer with reliable pest control information. An approach to crop production based on economic, ecological, technical and social considerations is needed to assist the farmer to achieve the production and quality levels needed to satisfy increasing world demand.

Current economic conditions mandate that we provide farmers with the information needed to manage pests while maximizing profits. Integrated Pest Management is used to maximimze profits as well as striving to increase worker and food safety and reduce environmental impact through the reduction of pesticide usage. As an agent, supervisor, scout, or apple producer in Kentucky's IPM program, you are an important member of a team responsible for providing these types of information. Your enthusiasm, professionalism and ability will allow all of us to obtain the information the farmer needs to make important management decisions. Your sound judgment and dedicated effort will directly affect the success of this program.

Over the years, the Kentucky Apple IPM program has changed considerably from a scout-oriented monitoring program to one in which the producer monitors his/her own orchard. We welcome your participation and look forward to working with you in the coming growing season.

PRODUCER-SCOUT RELATIONSHIP

In an Integrated Management Program, where the orchard is scouted by someone other than the grower, it is imperative that the scout enjoy a good relationship with the producer-cooperator. The farmer must have confidence that the scout is doing his or her job. In some cases hundreds or even thousands of dollars may rest upon the scout's report. The scout's report will weigh heavily on whether or not control measures for certain insects, diseases or weeds are employed.

The following points will assist scouts in developing a harmonious relationship between IPM scouts, cooperators and supervisory personnel. These points were developed during conversations between cooperators, the Pest Management Supervisor and a County Agent.

1. Let the grower know that you feel this job is important.
2. Be courteous and friendly.
3. Present a good appearance.
   a. Dress appropriately for the job--short or long sleeve shirt, long pants, cap and shoes. No athletic shirt, cut off pants or sandals.
   b. Be and look busy.
4. Go about your work in a businesslike manner.
5. Keep a neat legible record.
6. Do not be a "know it all". Be tactful.
7. Answer the grower's questions to the best of your knowledge.
   Do not be afraid to say "I do not know".
8. NEVER make a recommendation for control measures.

9. Do not discuss other grower's problems or control measures.
10. Do not block drives or lanes with your vehicle.
11. Keep all gates closed or open as the cooperator has left them. Do not ride down fences.
12. Do not trample or otherwise damage crop.
13. Let cooperator know the type vehicle or vehicles you will be using and approximate time that you will be on farm.
14. Place report in location agreed upon with cooperator.
15. Let the cooperator know where you can be reached by phone.
16. Use tact in dealing with cooperator's dog.
17. ALWAYS follow recommended sanitation practices in regard to disease, insects and weeds. Clean shoes are a must. Washable boots are preferred.
18. Remarks regarding the pest management program, fellow scouts, cooperators and supervisory personnel should be positive. If you cannot say anything good about the program and/or people involved, do not say anything.
19. Always keep in mind that the cooperator is paying for having his acreage scouted. He expects you to do a good job.
20. Do not spend excessive time talking with the cooperator or others.
21. If asked to have lunch with the cooperator, do so, but make it clear that your time is limited.
22. Carry your own water supply so that you don't have to ask for water.
23. Keep vehicle on solid ground.
24. Be on time to begin work.

25. Do not get involved with jobs on cooperator's farm unless there is some emergency. STAY OFF MACHINERY.
26. You are not to scout crops not in program. Make sure you scout the right field.
27. You are not to take anyone with you while scouting unless instructed to do so by supervisory personnel.
28. You are not to be on farm after dark.
29. Do not go in farm buildings unless invited or caught in rain.
30. Do not scout when you are miring to shoe tops unless advised to do so by supervisor.

When in doubt about proper procedures, consult with supervisory personnel.

*Prepared by Marvin Davidson, Todd County Extension Agent for Agriculture, Elkton, Kentucky.

MONITORING ORCHARD PESTS

I. INTRODUCTION

Each orchard visit will require the scout to perform four functions. The scout must:

1) obtain the desired information:
2) legibly record the information;
3) properly disseminate the information; and
4) perform some maintenance functions on equipment.

Although obtaining good information is very important, that information will be of absolutely no use if the recording and dissemination portions of the procedures are not adequately followed!

II. GENERAL PROCEDURES

A) TREE EXAMINATION

1) Enter Orchard - look for obvious problems as you move through the orchard. Record in "comments section". (See Appendix 2.)

2) Select a tree - Select a minimum of 5 trees per block. If block is larger than 25 acres, select a minimum of one tree for each five acres. Select trees so that they are representative of the different cultivars in the block. Do not select trees just for scouting convenience.

3) Select a limb - On each tree 5 limbs will be examined. Select limbs as follows: equal distance around the tree, 3 at chest level, 1 at head level, and 1 below your belt.

4) Limb Exam - Examine, on each limb, 20 leaves and 20 bud clusters, blooms or fruit whichever is present.

5) Repeat for each of the five limbs. You will note that this means you will have examined 100 leaves and 100 bud clusters, blooms or fruit for each tree. Any variation from this procedure will be noted in the scouting reference table, and in the text.

B) EQUIPMENT LIST

The following tools are used one or more times during the season by the Apple IPM growers or scouts. Some equipment such as the hygrothermograph and leaf wetness meter may be substituted with automated weather monitoring equipment.

Scout Manual
Record Forms
Pencil not pen!
Clipboard
Hand lens
Knife
Meter/yardstick
Soil Test Kit
Marking Tape
Pheromone & traps
Black "electricians tape"
Plastic bags
Glass vials
Alcohol
Beat Cloth and Mallet
Tissue Analysis Kit
Fruit ring or Caliper 2-4"
Soil Probe

Hygrothermograph
Leaf wetness meter
Extra charts and ink
Fruit tester (pressure)
Refractometer

C) INSECT TRAPS

The basic principle of pest management is that you do not take action against a pest unless you are certain the pest is present and will be a threat to your crop. Insect traps are a good method of determining if an insect is present and can also give an estimate of their concentration and distribution.

Food, light, color or chemicals can be used to attract insects to a trap. However, if you are interested in only one species of insect, such as only the European Corn Borer or only Armyworms, a pheromone would be the best choice to attract the insect. A pheromone is a secretion from an unfertilized female insect that attracts only male insects of the same species. The male insects are attracted by the odor of the pheromone. The traps consist of a plastic top and bottom that are held together by a wire hanger. The tops of the traps can be reused and the disposable bottoms are coated with a sticky gel to hold the insects once they land in the trap. The trap can hang from a tree or be mounted to a fence post. (See Figure 1.)

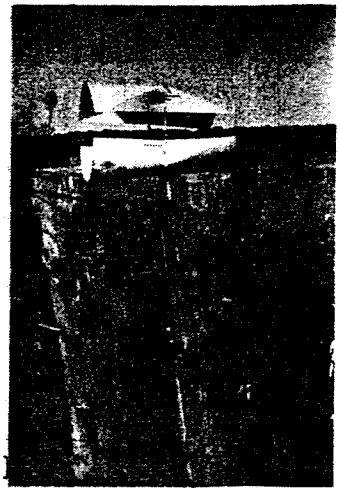


Figure 1

Wire, cone shaped traps can be used to capture live insects. A pheromone is attached to the bottom of the cone to attract the insect. Once the insect enters the trap from the bottom of the cone, it is trapped since it will not fly down. Insects will fly up into the cone and into a smaller, removable top. The top can then be removed to collect the insects for identification or counting. (See Figure 2.)

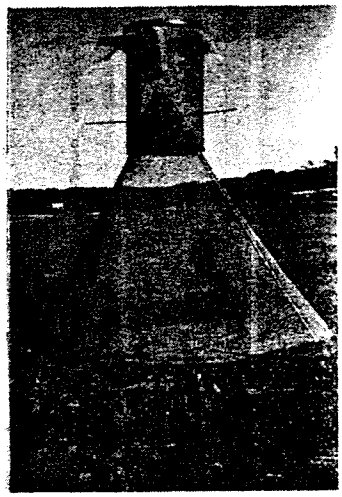


Figure 2

We are interested in catching many insects when they are in the moth stage of their life cycle because this is when they will be laying eggs and males will be attracted by the odor of the pheromone. The moths lay eggs which develop into worms that feed on crops. To complete their life cycle the worms change to moths that in turn lay more eggs thus producing more worms. By knowing that the moth stage of a pest is present the farmer can be on the look out for damaging worms that are sure to follow. The presence of the first moth can also be used as a starting point for calculating the number of day degrees before the emergence of the worms. This information can help the farmer determine the best time to spray for insect control. Some of the insects which follow this

pattern of development are the Codling Moth and San Jose Scale. Initial catches of either of these in their respective traps determines the timing and\or need of insecticide treatments against these pests.

D) TRAP EXAMINATION

Examine pheromone traps on each visit. Count and record the number of captured insects in each trap. Remove the captured insects during each visit and wipe them on a rag. Replace the trap bottom each month. Replace the complete trap if discolored or drooping. DO NOT LOSE THE BAIT!!! Pheromone trap baits should be REPLACED once each month. (See Appendix 2 and 3.)

E) INSECT TRAPPING GUIDELINES

- Store replacement lures in freezer or refrigerator when not in use. Lures can be stored from one season to the next in the freezer. Write the date the lures were placed in the freezer on each package.
- Change gloves or wash when handling pheromones for different species of insects to prevent cross-contamination. Minute traces on one pheromone contaminating another will render the second completely ineffective.
- Hang codling moth and San Jose scale traps in orchard by April 1 or before.
- Hang traps in the southeast quadrate of the tree, six feet off the ground. Avoid hanging traps in outside rows.
- Hang San Jose scale traps in a tree known to have an active San Jose scale infestation. Attach the trap hanger to a scaffold limb that has scale.
- Be sure to place the correct pheromone lure into the correct trap.
- Use 1 trap of each type per each 10 acres. But use a minimum of two traps of each type in representative locations.
- Monitor traps at least twice a week. But during the early spring traps will need to be monitored daily to set biofix dates.
- Record trap catches on IPM scouting log. It helps to keep a running graph of the information.
- Remove moths collected in trap during each visit, wipe them on a cloth, and dispose of them away from field.
- Change pheromone lures every 4 weeks. DO NOT dispose of used pheromone lures in the orchard. These will compete with traps and lower trap catch numbers. It is useful to establish a pattern when changing lures, such as the first of every month.
- Sticky trap liners should be changed regularly to maintain trap effectiveness.
- If you cannot identify a particular insect in a trap, send it to your county CES office or to UK Lexington for identification.

F) INSECT DEVELOPMENT & DEGREE DAYS

Temperature plays a major role in determining the rate at which insects develop. Each insect has a temperature range at which it is the most comfortable. Below that temperature they will not develop and, likewise, above it development will slow drastically or stop . Each insect also has an optimum temperature at which it will develop at its fastest rate.

By using this relationship you can make predictions on the rate of development of insects. By being able to predict when an insect will appear, you can estimate when your crop is most likely to be damaged. This method of estimating time is called the *degree day* method. The *degree day* method can be used to predict when insects will reach a particular stage of their life cyle if you know three things: the threshold temperature, the average daily temperature, and a thermal constant.

Each insect has a *threshold* temperature. Below this temperature no development of the insect occurs.

A degree day is the number of degrees, above the threshold temperature over a 24 - hour period. For example if the *threshold* temperature of an insect is 65°F and the average temperature for the day is 80°F, then 15 degree days would have accumulated on this day. (80 - 65 = 15)

The accumulation of degree days can be used to predict when insects will hatch, pupate and emerge as adults. However, for degree days to be used to make these predictions researchers must have determined the number of degree days necessary for the event to occur. That is called the *thermal constant*. The *thermal constant* just like the *threshold* temperature will be different for different insects.

The easiest way to calculate degree days for a date is to subtract the threshold temperature from the average daily temperature. The average daily temperature can be determined by simply averaging the high temperature and low temperature for the date (maximum temp + minimum temp/2). For example, if the high temperature for the day was 90°F and the low was 50°F, then the average temperature for the day would be 70°F (90 + 50 / 2 = 70). If the threshold temperature for an insect were 60°F, the degree days accumulated on this day would be 10 (70 - 60 = 10).

Temperature extremes add variables to this simple method of calculating degree days. To overcome these and more accurately predict when insects will be present follow these rules:

1.) If the maximum temperature for a 24 hour period is not greater than the threshold temperature, no degree days are accumulated. For example,

maximum day time temperature= 55°F

threshold temperature= 65°F

2.) If the high temperature for the day is greater than the threshold temperature but the low temperature for the day is less than the threshold temperature, then when calculating the average temperature for the day the threshold temperature is used as the low temperature for that day. For example:

maximum day time temperature= 70°F

low day time temperature=55°F

threshold temperature=65°F

The threshold temperature of 65°F

would be used as the low day time temperature when calculating the average daily temperature.

3.) If the high temperature for the day is greater than the optimum temperature, the temperature at which the insect will develop at the fastest rate, then you use the optimum temperature as the high temperature for the day when calculating the average temperature for the day.
For example:

maximum day time temperature= 98°F

optimum temperature=95°F

The optimum temperature of 95°F would be used as the high temperature for the day when calculating the average temperature for that day.

By using accumulated degree days a farmer can estimate when a pest should appear in his crop, scout for the pest and then determine if treatment is needed.

Reference

Pedigo, Larry P. Entomology - Pest Management. 1989. MacMillan Publishing Company, New York, New York.

Degree Day Accumulations for San Jose Scale and Codling Moth

With apple IPM, degree day models are used primarily for two insects, San Jose scale and codling moth. Degree day accumulations are used to predict when certain biological events, such as egg laying, egg hatch, or scale crawler movement, they also indicate optimum periods for Insecticide applications. For both of these pests, degree days are accumulated after certain events, termed "BIOFIXES". These occur in the early spring.

Two tables are provided to help calculate degree days for the codling moth and San Jose scale (Appendix 15). To use the table, the daily degree day value is found at the intersection of the appropriate maximum daily temperature column and minimum daily temperature row on the respective table. Minimum and maximum temperatures should be recorded from a Min/Max thermometer about the same time each day, preferably in the late afternoon. It is important to use the correct table for accuracy.

G) WEATHER MONITORING

Time of year

Daily weather observations of temperature and precipitation should be taken during the growing season (March 15th to October 1st). In addition, from the start of green tip (near April 1st) until the end of 2nd cover (near June 30th) daily leaf wetness observations are also needed.

Stations should be set up about 1 week before March 15th in order to check out equipment and to take care of any problems.

Time of Day

Weather observations should be taken once a day at approximately 7:00pm. It is very important to take the observation, reset the thermometer, and empty the rain gauge at the same time each day.

Observer

To ensure accurate and continuous weather observations, one person should be designated as the weather observer. The observer should be given the authority and responsibility of taking and recording the weather observations and maintaining the station. Also, at least one other person (i.e. a member of the family or neighbor) should be trained to take and record observations in the event of the observer's absence.

Observation Form

The observer should enter his or her daily weather observation on the supplied Apple IPM Scouting Log. The log is designed to contain one week's weather and management data. The first section of the form is for recording all weather data, certain insect and orchard development stages. The second half is to record all spray applications for the week, with the third part containing any management activities (i.e. pruning, mowing, etc.). The remainder of the form is for scouting information.

Weather Observations

Max/Min and Current Air Temperatures

The maximum air temperature is defined as the highest temperature that has occurred in a 24-hour period. The minimum air temperature is the lowest temperature that has occurred in a 24-hour period. Current air temperature is the temperature at the time of observation

The maximum, minimum, and current air temperatures are obtained from a "U-type" Max/min thermometer. All three temperatures are representative of the past 24 hours and are indicated on the thermometer since it was last read and reset. At the time of observation, all three temperatures should be recorded and the thermometer reset. The current temperature should be read off the minimum side of the thermometer.

The thermometer should only be reset at the stated observation time. Both Max/min temperatures are to be recorded on the date the thermometer is read even though the maximum or minimum temperature may have occurred on the preceding day.

Total Precipitation

Precipitation is the amount of water deposited upon the earth surface in both liquid (rain, drizzle) and solid (snow, ice pellets, hail, freezing rain) forms. Measurement is determined by the vertical depth of liquid or solid deposit accumulated over a flat surface. Since scouting begins in early spring in Kentucky, the grower might want to pour a small amount of alcohol or other liquid which does not freeze into the bottom of the rain gauge to keep the collected precipitation from freezing and busting the gauge. If this is done, be sure to subtract the amount of antifreeze from the total amount of liquid in the gauge to get an accurate measurement of precipitation. The rain gauge should be emptied only at the time of observation although additional readings may be taken at any time.

Periods of Leaf Wetness

Leaf wetness periods are the time intervals when the leaves or branches of a

tree are wet with water. Rain, fog, or even dew can cause leaf wetness. For apples, a leaf wetness period is defined as a time interval of at least one hour when the leaves or branches of an apple tree are wet with moisture.

The presence of leaf wetness can be determined by direct observations of leaves and branches of an apple or comparative vegetation. The tree should be in the general proximity of the station. Depending on weather conditions, direct observations of leaf wetness may or may not be necessary. If rain, snow or fog has occurred in the past 24 hours, then observations of wetness should be taken and recorded, along with supplemental temperatures. Leaf wetness observations include the beginning and ending times of precipitation periods. On the Scouting Log, there is a row for this information. simply circle the time of the observed leaf wetness period in either the am or pm column. If the wetness begins or ends upon a half of an hour, start or end the circle halfway through the corresponding number. If it starts upon the hour, circle the entire number.

Record Management

It is very important that all weather observations and management operations be recorded for the success and implementation of IPM in your orchard. Be sure to keep up with the daily weather observations at the correct time.

Maximum/Min Thermometer

1. Before resetting each day, make sure all bubbles are out of the thermometer mercury. If there are breaks in the mercury, grasp the top of the instrument and shake it downward until it is normal.

2. Always read the minimum side of the thermometer to obtain the current temperature.

3. Read and record the maximum, minimum, and current temperatures at approximately 7:00pm every evening once scouting begins.

4. It is very important that the thermometer does not come into contact with direct weather elements, i.e. direct sunlight, rain, etc.

5. The thermometer needs to be mounted very securely onto the 4"x4", as any vibration of the instrument will cause an inaccurate reading and separation of the mercury.

Rain Gauge

1. The rain gauge may be placed either on top of the temperature shelter, nailed up above 4"x4", or placed on a separate wooden post about 1-3.3 feet above the ground. This should be about 20 feet from the temperature shelter.

2. If the gauge is affixed atop the temperature shelter, make sure the mouth of the gauge is high enough up to avoid collecting extra precipitation that splashes or runs off the top of the shelter.

3. If there is a chance of freezing weather, place a small amount of anti-freezing liquid, such as alcohol, in the bottom of the gauge to keep the precipitation from freezing,

expanding, and busting the gauge.

4. Be sure, when recording a measurement with alcohol, to subtract the amount of anti-freezing liquid from the total amount of collected liquid for an accurate reading.

5. The rain gauge needs to be read, recorded, and emptied at approximately 7:00pm daily.

6. Both instruments should be checked daily for breakage and inconsistent measurements. Such signs may suggest that separations are present in the thermometer or leaks in the rain gauge.

Thermometer Shelter

1. Facing the front of the shelter, both left and right sides and the top dimensions of the shelter are all equal, 1"x7"x12". Several small holes are to be cut out of the sides for proper ventilation in the shelter.

2. You may opt to slant the top to prevent the accumulation of water on the top of the shelter, but it may be level as well.

3. The back wall of the shelter is a 1/2"x12"x12" piece of plywood.

4. Insert the 4"x4" deep enough into the ground (1-2 feet) to be very sturdy.

5. Mount the thermometer very securely onto the 4"x4"; any vibration of the instrument will lower the magnets and produce an inaccurate reading.

6. The thermometer is to be placed in the shelter approximately 5 feet above the ground.

7. The shelter should be on the side of a gently sloping terrain with a southerly exposure (not a ridge or depression).

8. The shelter should be at an elevation which is representative of the grower's farm.

9. Place the shelter at least 100 ft from non-vegetated surfaces (dirt roads, extensive concrete or paved areas, etc.); also it should be far from any obstructions such as buildings, trees, etc. (any nearby obstructions should be at least twice the distance from the outside edge of the site as the obstruction is tall).

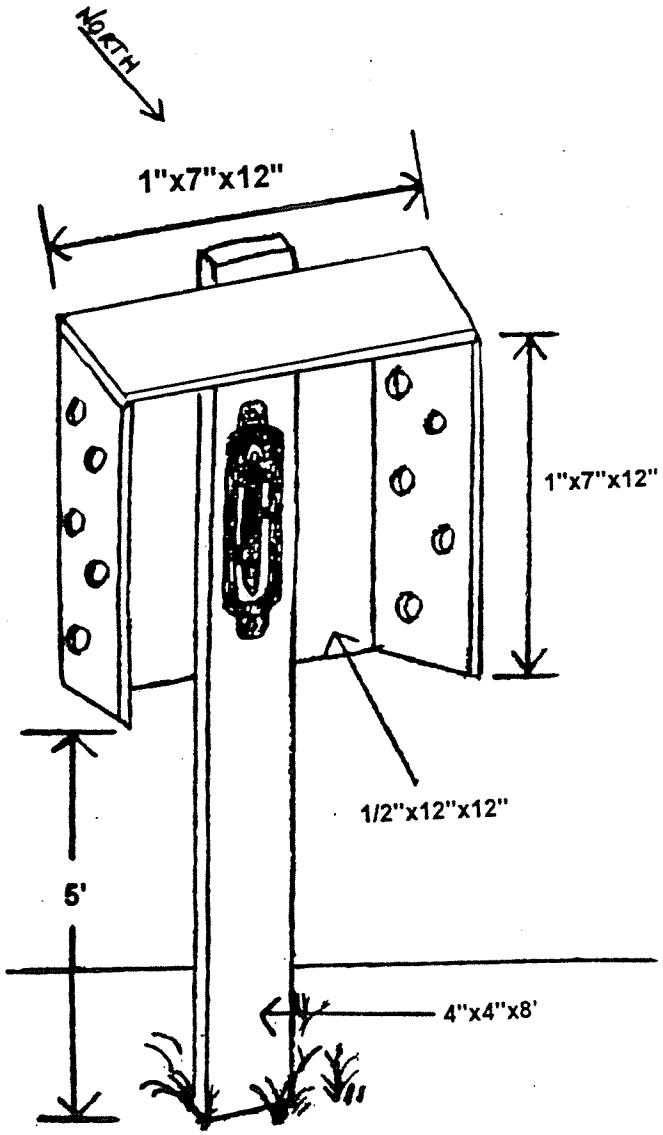


TABLE 1
SCOUTING REFERENCE TABLE - INSECTS

Pest	Where to look	When to look	What to record	Comments
RAA	Fruit clusters/bud terminals	Until mid-season	No. of infested terminals / 100 terminals or fruit clusters	Stop counting at 5 infested terminals / tree
WAA, GAA	Fruit clusters/bud terminals	Until mid-season	No. of infested terminals / 100 terminals or fruit clusters	Stop counting at 50 infested terminals / tree
CM	Pheromone traps (1 trap for each 10 acres, with a minimum of 2 traps)	Starting early April	No. of moths captured / trap	Mark this number with a "PT". Use date of 5th moth captured as biofix for Degree Day model.
	Fruit	Fruit set through maturity	No. of fruit with entry holes / 100 fruit	Entry holes mostly at caylx end
PC	Fruit	Fruit set through maturity	No. of fruit with "moon" shaped scars / 100 fruit.	Record any adult curculio seen while scouting. Use precautionary sprays at pink and petal fall.
WALH	Underside of leaves	All Season	No. of nymphs and adults / 100 leaves	Stop counting at 300 / tree.
FTLR, OBLR, RBLR	Pheromone traps	Fruit set through maturity	No. of moths captured / trap	Mark this number with a "PT"
	Fruit clusters and leaves	All season	No. of larvae / 100 fruit clusters or leaves	Distinguish between fruit and leaf samples on scouting form.
ERM, TSSM	Undersides of leaves	All season	Number of leaves with mites per 20, 40, 60, 80 or 100 leaf sample	Additional samples may be necessary, see page 24, 25, and Appendix 14.
SJS	Pheromone traps	April and May	Date of 1st male scale capture	Use this date for biofix with SJS degree day model.
	Twigs and limbs	Beginning mid-May	Incidence of crawlers	Record date crawlers are first seen
STLM	Leaves	All season	No. of mines / 100 leaves	
GFW	Fruit	Fruit set through maturity	No. of larvae / 100 fruit	

CM-Codling Moth
SJS-San Jose Scale
RAA-Rosy Apple Aphid
WALH-White Apple Leafhopper
GAA-Green Apple Aphid
RBLR-Red Banded Leafroller
ERM-European Red Mite
OBLR-Oblique Banded Leafroller
TSSM-2-Spot Spider Mite
WAA-Wooly Apple Aphid
GFW-Green Fruitworm
STLM-Spotted Tentiform Leafminer
FTLR-Fruit-Tree Leafroller
PC-Plum Curculio

TABLE 2 SCOUTING REFERENCE TABLE - DISEASES

(See descriptions pp 31-39, and color pictures in this manual for more details.)

Pest	Where to look	When to look	What to record	Comments
Scab	Flower bud leaves	Starting 10-14 days post bud break	No. leaves with spots	May be noticed first on underside of leaf. Cortland, Empire, Jersey Mac, Jonagold, McIntosh, Mutsu, Rome, and Staymen are very susceptible to scab.
	Leaves	Beginning at emergence	No. leaves with spots	
	Fruit	Fruit set through maturity	No. scabby fruit	
Fire blight	Blossom/spurs	Bloom period to first cover	No. blighted blossoms/spurs	Especially during warm, humid, rainy periods. Fuji, Gala, Granny Smith, Indared, Jonathan, Mutsu, Paulared, Rome, & York are extremely susceptible.
	Twigs suckers	During active shoot growth	No. blighted twigs	
Powdery mildew	Leaves/terminal shoots	During active shoot growth	No. mildewed terminals	Cortland, Granny Smith, Idared, Jonathan, Mutsu, and Rome are highly susceptible
Rust	Cedar branches	Starting at apple pink bud	Emergence of orange fungal telia from cedar galls	Note presence of cedar galls before and during bloom; this signals probable apple infection periods. TYPE 1 common on Sir Prize, Prima, Lodi, Jonathan, Rome, Wealthy, & York Imperial. TYPE 2 common on Cortland, McIntosh, Red Delicious, Golden Delicious, Staymen, and Winesap. See page 44 for description of Type 1 and Type 2 fruit spots.
	Leaves	Starting 30 days post bloom	No. leaves with rust lesions	
	Fruit (especially blossom end)	Fruit set to maturity	No. of fruit with rust colored spots (Type 1) & dark sunken blossom end spots (Type 2)	
Frogeye leaf spot	Leaves	Beginning at petal fall	No. Leaves with spots	Also note presence of dead twigs & branches, branch cankers, fruit mummies, leaf yellowing and drop.
Collar rot	Orchard	All season	No. weak or collapsing trees. Look for brown stain under bark at tree base.	Most severe on clonal rootstocks MM.104, MM.106, & M.26. M.7 & M.2 have some field resistance.
Canker	Twig and limbs	All season	Record occurance of cankers	Especially on weakened or poorly growing trees.
Black rot	Fruit	As fruit ripen	No. of affected fruit	More common on old trees. Note presence of mummified fruit in trees.
Bitter Rot, White Rot	Fruit	When fruit are half grown through maturity	No. of affected fruit	Look also for other rots which occasionally appear on fruits.
Sooty blotch Flyspeck	Fruit	As fruit reach maturity	No. of affected fruit	Note disease as light (less than 5% of surface blemished), moderate (5-20%) or severe (20% or more).

TABLE 3
SCOUTING REFERENCE TABLE - HORTICULTURE

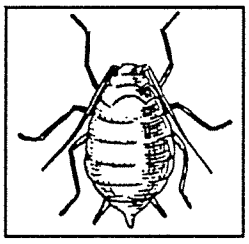
Situation	Where to look	When to look	What to record
Bloom date	Terminals	Spring	Date of first bloom (10% blooms open) and full bloom (70% blooms open).
Weed control	Under trees	Weekly	Record the density [W-0 (no weeds) - W-5 (full of weeds)], height (in inches), and major weed species in the treated area.
Fruit load	Four 3-foot terminals per tree	From bloom weekly for five weeks	No. of buds, blooms & fruit in a 3 foot section. The 3-foot terminal is measured from the bottom of the previous season's terminal growth down the limb. It does not include any side branches. Divide total of 4-3 foot terminals by 12 and record the no./ft.
Fruit quality	Randomly select 2 fruit per sample tree.	Weekly starting 3 weeks before harvest	Record cultivar, skin color (striped or solid) seed color, soluble solids, fruit pressure, anticipated harvest date. Taste, dark brown seeds, skin color, pressure test in the 16-19 lb. range, Starch-Iodine Test and days from bloom to picking are used to determine optimum time of harvest.
Pack out	Grading line	While grading	See sampling and grading line section

III. Insect Pests

A. Apple Aphids

Generally four species of aphids - the **green apple aphid, rosy apple aphid, apple-grain aphid and woolly apple aphid** -attack apples in Kentucky. Three of these aphids, the green apple aphid, rosy apple aphid and the apple-grain aphid are very similar in appearance. The woolly apple aphid is different enough from these three to be discussed separately.

Apple aphids are small pear to tear-drop shaped insects. Color varies from purple to rosy to light green. Generally a pair of projections (cornicles) will be present on the fifth or sixth segment. Mouthparts are piercing-sucking. Generally these aphids will be in colonies.



The life cycle of these aphids begin with the egg, which is the overwintering stage. Overwintering eggs will generally be found on twigs, around buds or in crevices in the bark. Eggs will generally begin hatching in early spring about green tip stage. The first generation of nymphs are all wingless females, called stem mothers. These females give birth to live young, and a generation is completed about every fourteen days. In early summer some winged young will be produced, these will fly to new host plants and start new colonies. During late summer and early fall, both male and female forms will be produced, mate and lay overwintering eggs. When first laid, these eggs are green but soon turn shiny black as they mature.

Damage is primarily on new foliage and fruit by feeding on the juices using their piercing-sucking mouthparts. The rosy apple aphid injects a toxin with its saliva that causes the leaf to curl and fruit to be malformed. For this reason, rosy apple aphids are the most serious aphids attacking apples.

The **woolly apple aphid (WAA)** differs from other apple aphids in appearance, life cycle and the type of damage inflicted. A colony of WAA's will appear as a cottony mass generally clustered in wounds of the trunk and branches of the tree. The aphids themselves will be purplish in color.

The life cycle of WAA is very complex. The winter may be passed in two forms, the egg or immature nymph. Nymphs will hibernate underground on roots of apple. Wherever apples and elms are close together, overwintering eggs will be deposited in cracks or protected places on the elm. During spring, eggs will hatch into wingless nymphs which feed on elm buds and leaves. In early June, a winged form is produced which migrates to apple and other hosts. These individuals will feed on wounds in the branches and trunk, and many work their way down to the roots, and trunk below ground surface. It is the feeding on the roots that produces the greatest damage. Rootstocks vary in susceptibility to WAA, use M111 or M106 if WAA is a serious problem.

During the summer, repeated WAA generations of wingless individuals will be produced. In the fall, winged individuals are produced which fly back to elm and lay overwintering eggs, while some wingless

forms will remain on the apple on both above and below ground parts throughout the winter.

SCOUT: Symptoms of aphid damage include curled and crinkled leaves, especially on new growth.

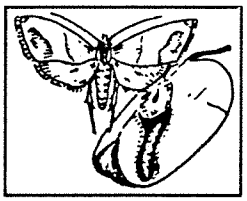
RECORD: The total number of aphid infestations per 100 leaf terminals, fruit clusters or pruning scars (WAA) by species.

ACTION THRESHOLD: Rosy Apple Aphid - 5 infested leaf terminals or fruit clusters /100 leaf terminals or fruit clusters; Apple-Grain & Green Apple Aphid - 50 infested leaf terminals or fruit clusters /100 leaf terminals or fruit clusters; Woolly Apple Aphid - 50 colonies/100 pruning scars.

B. Codling Moth (CM)

The codling moth (CM) is an apple pest introduced from Europe by settlers. It occurs in all known apple growing regions of the United States and is considered to be one of the worst insect problems.

The adult moth is about 3/8 in and blends in well with the bark. The adult moth's forewings are gray-brown crossed with lines of light gray and deep gold or bronze wing tips. The larva is white, often tinged with pink, and has a brown head. The length is generally about 1/2 in. when fully developed.



The fully developed larva is the overwintering stage. They survive in silken cocoons in protected places underneath loose bark on the trunk. Pupation occurs in the spring with moth emergence beginning about the same time as bloom. These moths of the first generation are present throughout April and early May (see Table 4). They lay their eggs just after sundown each night. Eggs are laid singly usually on leaves near developing fruit, or on the fruit. In the spring, it may take 1-1/2 to 3 weeks for eggs to develop. Young larvae bore into fruit generally through the calyx end, feed for about 3 weeks, then exit, spin cocoons and pupate. Brown frass is often noticed near the calyx of the damaged fruits or other openings in the apple skin. About two weeks later the second generation of adults emerge, and the cycle begins again. Three generations per season normally occur in Kentucky.

Control of codling moth in commercial orchards relies on three tools; regular examination of the trees and fruit, pheromone trapping, and the use of weather monitoring and degree day models. Orchards should be scouted on a weekly basis for insects and mites beginning at the half-inch green stage in the early spring until harvest. Closer to harvest every other scouting trip may be omitted such that visits are no more than two weeks apart.

SCOUT: Two types of damage are caused by CM larvae. The first type is the tunneling in the fruit. This damage completely destroys the fruit's usefulness. Second, the larva may start to tunnel but not enter at that spot. This causes spotting of the fruit, and if it occurs on very small fruit may result in "catfacing". Examine 100 fruit for evidence of codling moth larvae. Pheromone traps should be hung by April 1.

RECORD: The number of codling moths captured in the pheromone trap each

week. Mark this entry on your scout form with a "PT". Also, record the number of fruit with entry holes per 100 fruit.

ACTION THRESHOLD: The biofix for the codling moth is the starting date of the first sustained flight of male moths captured in pheromone traps. Generally, this is when the fifth moth has been captured in the trap. A few moths often emerge very early in the spring ahead of the rest. Using the fifth moth as the biofix better represents when the majority of the codling moths begin to emerge. This usually occurs just after petal fall. Codling moth traps need to be examined daily in order to know exactly when the biofix occurs. After the biofix has occurred, degree days are calculated on a daily basis and a running total is kept. The codling moth has a 50°F threshold temperature. These degree day accumulations are compared with the target values in the following table.

DD targets and actions to be taken

250 Egg hatch begins. An insecticide application is recommended. If codling moth populations are abundant (See Appendix 7), a second application may be necessary 7 to 10 days later.

1000 About when 1st generation moth begin to fly. Use their emergence as the next biofix.

1300 About when 2nd generation egg hatch begins. An insecticide application is recommended. If codling moth populations are abundant, a second application may be necessary 7 to 10 days later.

C. Plum Curculio (PC)

The plum curculio is a native pest of North America that is widely distributed in fruit growing regions east of the Rocky Mountains. This insect is an important pest of stone fruits such as peach, plum and cherry, as well as apple, pear, quince, and related species. In apples, the larvae (worms) will COMPLETE development only in FRUIT DROPS.

The adult is a typical snout beetle, 1/4 inch long, dark brown in color with patches of white or gray. There are four prominent humps on the wing covers. The snout is 1/4 the length of the body, with mouth parts located at the end. Plum curculio overwinter in the adult stage in ground litter or soil usually outside the orchard. Adults migrate into the orchards each spring to feed on the early foliage. Often border rows near woods are the first to show injury.

The adult curculio becomes active in the early spring where it flies to trees and feeds on buds, flowers and newly set fruit. This insect causes cat-facing while feeding and egg-laying over a five to six week period. The female adult cuts a hole in the fruit with her mouthparts and hollows out a small cavity then turns and deposits an egg in the cavity. She then cuts a crescent-shaped silt which extends beneath the egg so as to leave the egg in a flap of flesh. Injury will appear as a 1/8 inch crescent-shaped cut on the fruit. This prevents the egg from being crushed by the rapidly developing fruit. After about five days, the larvae will hatch burrow into the fruit. The larva is a leg-less grayish white grub with a brown head. Its length will be about 1/3 inch when full grown.

When the larvae are fully developed, they will leave the fruit through clean-out holes. No frass or webbing will be evident. Frass is usually found around the calyx end on codling moth damaged fruit.

Major curculio damage is a result of larva developing within the fruit, causing apples to be decreased in size. However, the feeding scars left by the female on the fruit skins in the early spring results in lower quality fruit. If this damage was inflicted on young fruit "catfacing" may result. Fruit infested with plum curculio larva usually drop from the tree prematurely.

Newly emerging adults in the summer will feed on apples for a short period of time. These round feeding sites that penetrate the fruits about 1/4 inch often lead to localized rots on the fruits.

SCOUT: These insects are active primarily at night and serious damage may appear in orchards that have been scouted rigorously even though the adults were not detected. Currently there are no methods to accurately predict when plum curculio damage will occur. Examine the 100 fruit for the adults and fruit scars.

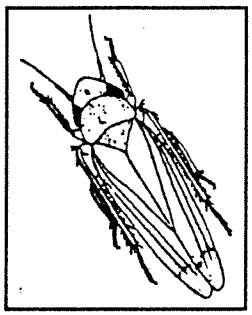
RECORD: The number of fruit with feeding or oviposition scars per 100 fruit.

ACTION THRESHOLD: Damaging infestations of plum curculio cannot be predicted accurately. Control of the adults is accomplished by insecticide applications timed at the pink and petal-fall stages for apples. Serious plum curculio damage is usually restricted to orchards that do not use both these insecticide applications. Use preventive sprays at the pink and petal-fall stages to reduce damage.

D. Apple Leafhoppers

Several species of leafhoppers will attack apples. The **White apple leafhopper, Rose leafhopper, apple leafhopper, Potato leafhopper and Oblique-Striped apple leafhopper** are the more common ones.

The several leafhopper adults will have various color patterns, however, generally they are small insects, long and slender, with a convex shaped back. Generally with bright blue, white and crimson color patterns. Juveniles are generally light green, wingless and "scurry" around by sideways and backward movements.



Damage is caused by nymphs and adults removing chlorophyll and sap from leaves. Whitish spots or stippling on upper leaf surface are evidence of feeding.

All of these leafhoppers have similar life cycles consisting of egg, several nymphal stages (juveniles) and the adult. However, the stage which overwinters is different. The white apple, rose and apple leafhoppers overwinter in the egg stage.

The Oblique-striped apple leafhopper overwinters in the adult stage. The Potato leafhopper overwinters only in the south and infests orchards of the northcentral and northeastern areas by annual migration.

The white apple leafhopper eggs begin hatching at pink and continue hatching until petalfall. Nymphs and adults feed on the undersides of leaves. White apple leafhoppers are resistant to Guthion and Imidan.

SCOUT: Select 100 leaves per tree. Examine the undersides of leaves near midrib and other major veins for nymphs. When high numbers are encountered, stop counting at 300 leafhoppers.

RECORD: The total number of leafhopper adults and nymphs present per 100 leaves.

ACTION THRESHOLD: An average of three adults and nymphs/leaf (300 leafhoppers per 100 leaves).

E. Leafrollers

There are several different species of Lepidoptera commonly known as leafrollers. The most common of these insects are the **Fruit-Tree leafroller, Oblique-Banded leafroller, Omnivorous leafroller and the Red-Banded leafroller.**

The **Fruit-Tree leafroller (FTLR)** is a native pest occurring in the northern half of the United States. The adult is a brown moth slightly larger than the codling moth. Thin light markings will appear in various patterns across the front wings. The larva is a slender worm, pale green in color. The head is black and a black spot will appear just behind the head. The larva may reach 3/4 in. in length.

The insect overwinters in the egg stage. Hatching will occur about the time buds begin to open. Larvae feed on buds, blooms, leaves and fruits. In June full grown larva transform into pupae, inside folded or rolled up leaves. Moths appear in about two weeks, lay their eggs, and die. Only one generation occurs each year.

The **Oblique-banded leafroller (OBLR)** is somewhat less important than the Fruit-tree leafroller. Adults are brown with three dark bands on the front wings. Wingspread is about one inch. Larva are small and green with black heads.

Overwintering occurs as partially grown larva inside tightly woven cases, on the host trees. During spring, larva emerge and continue feeding until late May. Pupation occurs and adults will emerge in June. One or two generations may occur. Damage is done by young larva mining the leaves, with larger larva feeding inside rolled up leaves.

The **Red-banded leafroller (RBLR)** is generally a problem north of the Ohio and east of the Mississippi Rivers. However, they are at times a problem in Kentucky. Adults are brown, about the size of the codling moth, and have broad reddish bands on each forewing. Larva are green, slender and will reach a length of about 2/3 in.


Red-banded Leafroller

Winter is passed in the pupal stage. This pupa will generally be found in a silken cocoon, in detritus at the base of host trees. Moths emerge in the early spring, and lay their eggs in clusters on the bark of host trees (See Table 4). The first generation larva will emerge and begin feeding at about petal-fall. Up to four generations may occur each season.

SCOUT: Leafroller populations can be sampled by both tree examination and pheromone trap. Therefore, you may have two entries for each species on the scout form, one for the number of live larvae found and a second for the number of adults captured in pheromone traps. Mark your entry on the scout form for trap catch with

a "PT". Pheromone trap catches will indicate when to monitor carefully for the larvae. If pheromone traps will be used, they should be placed in the orchard by March 1 to provide 2 to 4 week lead time before moth activity.

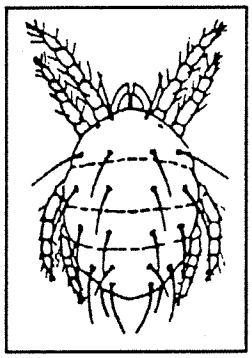
RECORD: The number of larvae/100 leaves or fruit clusters. Record the number of moths in each trap (mark this entry with "PT").

ACTION THRESHOLD: An average of 4 larvae per 100 leaves or fruit clusters.

F. European Red Mite (ERM)

The European Red Mite (ERM) was introduced into the United States, from Europe, sometime before 1911. Since that time, ERM has become one of the most common and important pests of fruit grown in the northern United States. ERM is reported on elm, apple, pear, peach, plum and prune, as well as other deciduous trees.

ERM is usually rusty in color, with newly emerging females being bright velvety red, changing with time to dark red-brown. There are often noticable white spots at the base of six to eight hairs on its back. Males are dull green to yellowish brown. Females are more globular shaped; males are narrower with a more pointed abdomen. Eggs are of two forms. Overwintering eggs are red-orange and are globular, somnewhat flattened (onion shaped) with a slender stalk on top. Eggs produced during the growing season are spherical without the stalk..



Overwintering occurs in the egg stage laid in roughened bark around the bases of buds and spurs on small branches. Egg hatch in the spring is closely correlated with bud development and begins close to the tight cluster stage where upon mite larvae crawl onto the unfolding leaves and begin feeding. The first mite stage (instar) has 6 legs and succeeding instars have 8 legs. Development from egg to adult may take from 1 to 3 weeks, and is very temperature dependent. There may be 6-8 overlapping generations per season. Summer eggs are laid on the undersides of leaves, unlike winter eggs that are laid on twigs and branches.

All active stages of the European red mite injure the foliage by feeding with piercing mouthparts and removing cell contents, including chlorophyll. Moderate to high numbers of mites can cause the leaves to initially turn pale and with continued feeding the leaves turn bronze. Heavy mite feeding early in the season can reduce tree growth, yield, and also effect fruit bud formation for the following year. If intense infestations are present, defoliation and undersized, poorly colored fruits may result.

Overwintering mite eggs should be controlled through the use of a delayed-dormant oil treatment, just before the buds begin to swell. Control of European red mite eggs with oil improves the closer to hatching. The oil coats the egg shell and suffocates the developing embryo by blocking respiration. Management of mites during the growing season is based on scouting and the use of miticides or summer oil treatments as needed. Often when heavy summer infestations exist, a second miticide treatment may be required 10 to 14 days

later. While effective control can be obtained with summer horticultural oil treatments, caution is advised as these may be incompatible with some other pesticides (particularly sulfur containing products), are potentially phytotoxic at higher temperatures (usually above 90°F and high humidity), and may affect fruit finish on some varieties.

SCOUT: For ERM's by examining the undersides of leaves with a hand lens. Look first near the midrib for very small purple or red mites. Collect 4 leaves from each of 5 trees, examine them for the presence or absence of mites (do not count the number of mites per leaf). Plot the number of leaves with either TSSM or ERM mites on the chart in Appendix 14. Take additional leaf samples if indicated by the charts.

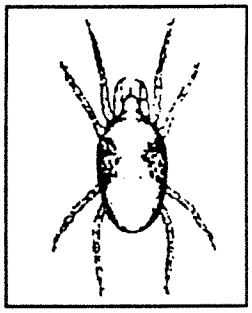
RECORD: The number of leaves with mites per sample.

ACTION THRESHOLD: The action threshold for mites will vary according to the time of year. From April until June 15, use Chart 1 in Appendix 14. From June 15 until July 15 use Chart 2, and after July 15 use chart 3. These charts will recommend 1 of 4 alternatives: stop sampling and treat for mites; continue sampling (take another 20 leaf sample); do not treat and resample in about a week; or do not treat and resample in about two weeks.

G. Twospotted Spider Mite (TSSM)

The twospotted spider mite (TSSM) is a pest of many crops worldwide. TSSM populations in apples are favored by hot dry weather and when predators have been destroyed by pesticides.

TSSM is light to dark green with two distinctive black spots on the abdomen. Eggs are spherical and clear when first laid. After hatching, the larva has three pairs of legs, but later stages will have four pairs. Male TSSM are smaller with a more pointed abdomen than the females.



TSSM overwinter as full grown females under the bark or in leaf litter. In the spring and early summer, mites will feed on weeds and grasses, in mid-summer they move into trees. Development from egg to adult may take no more than three weeks. There may be five to nine generations per season depending on the weather.

Damage due to TSSM is by sap removal and is similar to that of ERM. Superior oil is not effective in controlling TSSM.

SCOUT: For TSSM's by examining the undersides of leaves with a hand lens. Look first near the midrib for very small straw-colored or green mites. Collect 4 leaves from each of 5 trees, examine them for the presence or absence of mites (do not count the number of mites per leaf). Plot the number of leaves with either TSSM or ERM mites on the chart in Appendix 14. Take additional leaf samples if indicated by the charts.

RECORD: The number of leaves with mites per sample.

ACTION THRESHOLD: The action threshold for mites will vary according to the time of year. From April until June 15, use Chart 1 in Appendix 14. From June 15 until July 15 use Chart 2, and after July 15 use chart 3. These charts will recommend 1 of 4 alternatives: stop sampling and treat for mites; continue sampling (take another 20 leaf sample); do not treat and resample in about a week; or do not treat and resample in about two weeks.

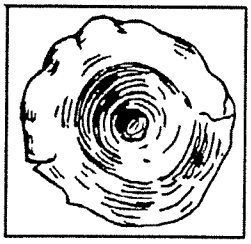
H. San Jose Scale (SJS)

The San Jose Scale (SJS) is an extremely important indirect pest of apples, pears, peaches, and plums. Additionally, under very high population pressure, SJS will also show up on the fruit.

There are two main problems with control of this insect: 1) the insect is very small and so goes unnoticed until large populations have built up; and 2) the insect spends much of its life cycle under a protective cover or scale. Therefore, TIMING of insecticide applications becomes of paramount importance.

San Jose scale overwinter as nymphs on the bark of trees. They resume feeding in the spring when sap begins to flow in the tree.

The adults are very small and the female does not fly. In the spring, tiny "gnat-like" adult males will emerge about mid-May and seek out winbgless females. Mating occurs and then about one month later, live young (called crawlers) are born. These tiny yellow insects move around on bark and foliage until they locate a suitable site to settle down permanently. Once located, the crawler sticks its mouthparts into the tree and secretes a waxy shell over its body. From this point on, scales will not move. Males will remain in one location until maturity at which time, they will seek out females and begin the cycle again.



San Jose scale inject a toxin into the tree which causes a "red halo" around feeding sites on apples, leaves, and young wood. Infested leaves usually drop from the tree and limbs may lose vigor and die. Fruit will have an undesirable finish because of the red, spotted appearance, small depressions and the presence of scale.

SCOUT: Scale should be monitored by 2 methods (1) adult traps will be monitored for about two months in early spring. (2) San Jose scale infestations will be monitored for appearance of the crawler stage. Assemble traps according to instructions (Appendix 3). Be sure the lure is secure. Mark traps with the date and hang trap in a scale infested tree by April 1. At least twice a week, remove the trap from the tree and examine the surface with a hand lens for adult scale. Once adult scale have been captured, begin degree day accumulation. Crawlers can be easily detected by wrapping a small amount of black electrical tape with the sticky side out around an infested limb. Pay particular attention to the edge of the tape. Crawlers can also be detected using a hand lens and a straight pin to probe or "flip" over mature scales and look for tiny but bright yellow crawlers. Report the date crawlers are first seen.

The presence of reddish blemishes on fruit at harvest indicates potentially damaging numbers on the trees. If such damage is noted, inspect trees for scale, especially one year-old wood. During

pruning operations, look for purplish-red halos on young bark that are indications of scale infestation. Often this very small insect goes unnoticed until large populations have developed.

ACTION THRESHOLD: The biofix for the San Jose scale is the capture of males in pheromone traps. Male flight usually occurs after petal fall. After the biofix has occurred, degree days are calculated on a daily basis and a running total kept. The San Jose scale has a 51°F lower threshold temperature and a 91°F upper threshold. Degree day accumulations are compared with the target values in the following table.

<u>DD targets and actions to be taken</u>

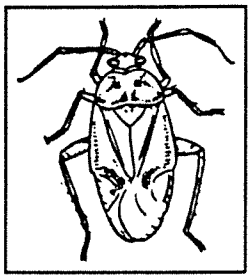
300	Place a piece of black tape, with sticky side out on an infested scaffold limb. Begin examining tape at least twice weekly for minute scale crawlers.
380-400	Crawler emergence should begin.
600-700	Crawler movement is at a maximum. This is the optimal time for an insecticide application.

This technique if used properly will have a great impact on San Jose scale. However, it is best used in conjunction with a well applied dormant or delayed-dormant oil and a good pruning and training program. Usually, dormant oil applications are more effective against scale than delayed-dormant applications.

I. Tarnished Plant Bug (TPB)

The Tarnished plant bug (TPB) is distributed throughout the U.S. and Canada. It feeds on fruits, grasses, and broadleafed weeds. While primarily a seed feeder, it attacks fruit buds and the fruit in early spring before preferred crops are available.

Adult TPB are mottled brown insects with wings folded over its abdomen. Adults are difficult to find in apples and will fly when disturbed. Nymphs are small and greenish and resemble the adult without wings. Eggs are flask shaped and laid in the plant tissue such that only the narrow end protrudes.



Adult TPB overwinters under bark, in leaf litter, and other such protected places. Early in the spring, TPB feed on developing fruit buds, and later on, developing fruit. Their feeding with piercing-sucking mouthparts early in the spring results in catfaced fruit at harvest.

SCOUT: Pay particular attention to plant bugs at pink. Hold a beat cloth under a scaffold and strike the scaffold sharply once or twice with the mallet. Sample five scaffold limbs per tree. Examine 100 fruit clusters for tarnished plant bugs.

RECORD: Number of nymphs and adults per 100 fruit clusters. If sampling with a beat cloth, record the numbers of nymphs and adults per tree and mark this entry on the scout form with a "BC".

ACTION THRESHOLD: Five nymphs or adults per 100 fruit clusters.

In the early 60's, Japanese beetles spread into Kentucky from surroundding states. Japanese beetles will feed on the leaves of more than 300 species of plants, including apple foliage and damaged fruit. Kentucky provides a favorable climate, abundant pasture areas for grub development, and few natural enemies of the beetles. Orchard trees that may be severely attacked include apple, cherry, black cherry, peach, and plum.

The adult beetles feed on leaves of a wide variety of trees and shrubs. Adults feed on the upper surface of foliage, chewing out tissue between the veins, leaving a lace-like skeleton of the leaf. They usually feed in groups, starting at the top of a plant and working downward. The beetles are most active on warm, sunny days, and prefer plants that are in direct sunlight. A single beetle does not eat much; it is group feeding by many beetles that results in severe damage. Trees that have been severely injured appear to have been scorched by fire.

Adult Japanese beetles are 3/8-inch long metallic green beetles with copper-brown wing covers. A row of white tufts of hair project from under the wing covers on each side of the body.

Japanese beetles over winter underground in the grub stage, and pupate near the soil surface in the spring. Grubs spend 10 months in the soil where they feed on roots of grasses and can be serious pests. Adults emerge from the ground and begin feeding on various plants in June. Activity is most intense over a 4 to 6 week period beginning in late June. By mid-July, numbers of beetles gradually diminish. Individual beetles live about 30 to 45 days. There is a single generation per year.

SCOUT: Look for the presence of Japanese beetles in the orchard. Try to estimate the number of beetles per tree.

RECORD: Note the presence of live Japanese beetles on the scouting form. If present, note the approximate number of beetles per tree.

ACTION THRESHOLD: There are few threshold guidelines relative to when apples need to be treated for Japanese beetles. Carbaryl is the most effective insecticide used in managing Japanese beetles. **However, because carbaryl can greatly increase problems with European red mites, other insecticides are recommended to manage low to moderate Japanese beetle populations in apples.** Repeated insecticde applications may be necessary at 7-10 day intervals to prevent reinfestation during the adult flight period, or after heavy rains. Use of a spreader/sticker in the spray mix can increase the duration of effectiveness.

Table 4. Apple Insect Calendar for Kentucky.

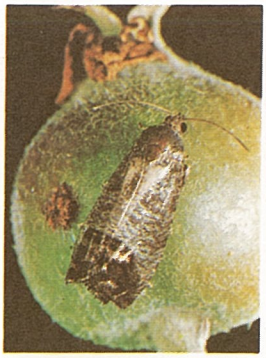
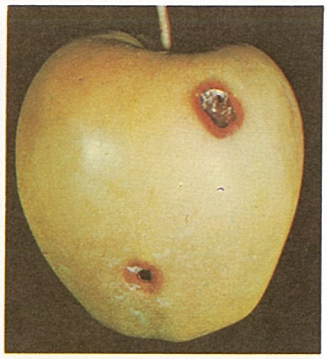
	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.
Codling Moth		----*	*****	--	******	--	
Oriental Fruit Moth		--**	*----------	---***	*******	****	**--
Red banded Leafroller	---***	***----		--	****---	-	
European Red Mite				-----	******	******--	---
Tentiform Leafminer				-	------*	******	
White Apple Leafhopper			--*	******-		---**	**

* = period when economic populations are most likely to occur

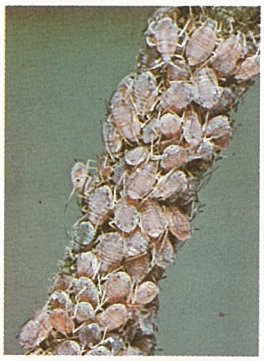
- = pest present

COMMON FRUIT INSECTS

For safe and effective use of insecticides, always identify the problem correctly.

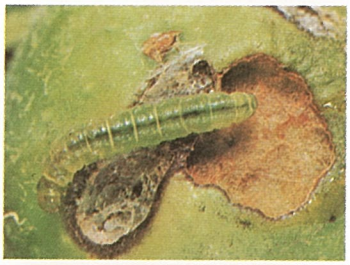
1. Codling moth adult and new larval entry, and damaged or "wormy" apple



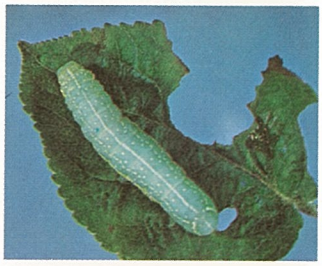

5. Rosy apple aphid, and deformed fruit shown with normal apples for comparison


8. Plum curculio adult and egg-laying slit on cherry, and curculio larva in plum

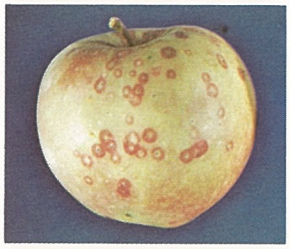

2. Apple maggot in apple, and blotching and streaking of maggot-infested fruit



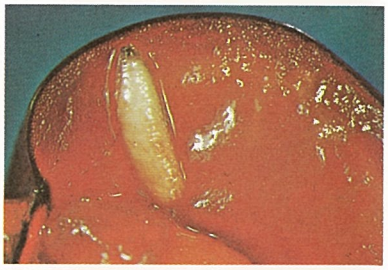
3. Red-banded leaf roller and damage



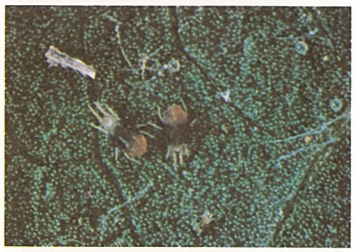
4. Green fruitworm



6. San Jose scale on apple



7. Cherry fruit fly maggot



9. Two-spotted spider mite and eggs (enlarged). Not an insect.

10. Grape berry moth larva and damage


11. Oriental fruit moth. Twig damage and larva in peach.

12. Peach tree borer and pupa

Prepared by Extension Entomologists of the North Central States in cooperation with the Federal Extension Service, U.S. Department of Agriculture

IV. Horticultural Measurements

The trees used for pheromone traps will be the trees used to monitor horticultural factors. The traps should be numbered and placed in cultivars representative of the planting. Record the cultivar containing each trap.

A. Records To Be Kept

<u>One time</u> - Record the bloom dates, i.e. first bloom (10% blooms open), and full bloom (70% blooms open).

<u>Weekly</u> - if weed control other than mowing is used, record the method, date of treatment and rate. The density, 0-5 (1 = sparse, 5 = full coverage of weed) height (inches) and major weed species in the treated area. Weeds under the tree canopy compete with the tree for water and nutrients and increase disease problems because of higher humidity.

<u>Weekly</u> - From bloom until 5 weeks after bloom, measure, mark and tag a 3 foot terminal on 4 separate limbs per tree. The 3 foot terminal is measured from the bottom of the previous season's terminal growth down the limb. It does not include any side branches. Count the total number of buds, blooms and/or fruit for each tree, divide by 12 to determine the number of fruit per foot of terminal growth. Before counting, look at each pedicle to see if it is light brown. A light tap on the blossom or fruit will help determine if the fruit structure is alive since dead and dying fruit structures will abscise.

Most commercial cultivars crop annually with adequately sized fruit when fruit spacing averages 6"-8" apart on the fruit bearing terminals.

<u>Weekly</u> - Starting 3 weeks before the anticipated harvest, select at random 2 fruit per sample tree, record the cultivar, then determine the following indices of maturity: skin color (striped or solid), seed color, soluble solids and fruit pressure. Taste, dark brown seeds, skin color, pressure test in the 16-19 lb. range, Starch-Iodine Test and days from bloom to picking are used to determine optimum time of harvest. The following table show's the anticipated days from bloom to harvest for a number of cultivars:

<u>CULTIVARS</u>	<u>DAYS FROM BLOOM TO HARVEST</u>
Yellow Transparent	70-100
Lodi	75- 95
Mollies Delicious	119-124
McIntosh	125-130
Cortland	125-140
Gala	135-145
Golden Delicious, Jonathan	140-145
Empire	140-145
Grimes Golden, Red Delicious	140-150
Mutsu	145-170
York Imperial	155-175
Rome, Winesap	160-165
Staymen	160-175
Granny Smith, Fuji, Braeburn	180-210

B. Leaf Analysis

Leaf analysis (foliar analysis) is a more reliable indicator of a tree's nutritional status than soil analysis. Foliar analysis kits are obtained from your County Extension Office. County Extension Offices can request the kits from Dr. Bill Thom, Department of Agronomy, Ag. Sci. Bldg. N., University of Kentucky, Lexington, KY 40546.

Follow the procedure for taking leaf samples outlined below. Correct sampling techniques are essential for reliable results.

Take a soil sample from the same general area that each leaf sample is taken. Sample the upper 6 to 8 inches of soil under the tree's drip line. See AGR-16 (Appendix 11) for information regarding soil sampling. Problem blocks should be sampled annually until corrected. Normal blocks are sampled every 3-5 years.

Plant analysis has 2 main applications: (1) to confirm a suspected nutrient deficiency indicated by visual symptoms, and (2) to monitor the plant nutrient element status to determine whether each tested nutrient is sufficient for optimum yield.

Ideally, monitoring the nutrient status of an orchard with a regular foliar analysis program helps maintain high quality production while minimizing nutrient deficiency problems. Regular sampling lets the grower detect upward or downward trends in a nutrient's concentration that could lead to a deficiency or imbalance.

WHEN TO SAMPLE: The concentration of any nutrient varies during the growing season. As the leaves become more mature, a period of relatively stable nutrient composition occurs. This is the time to collect leaf samples because differences in analytical values reflect differences in the nutrient status of the tree and not differences due to time. **The optimum time for collecting leaf samples in Kentucky is the last two weeks in July.**

When a suspected nutrient deficiency or excess exists, take samples as soon as visual symptoms appear. Take samples both from trees where the suspected nutrient problem exists and from "normal" trees of the same variety, but keep the samples separate. The closer the "affected" and "normal" trees are to each other in the orchard, the better the comparisons will be. **Do Not Include Dead Or Severely Affected Leaves In The Sample.**

HOW TO SAMPLE: To increase the reliability of leaf analysis results, take leaves from different trees but from the same areas on the trees. Pull leaves from all sides of the trees in a band 4 to 6 feet above ground.

Collect leaves from the middle of the current season's shoot growth or if there is little or no shoot growth, collect spur leaves. Do not include the oldest or youngest leaves on a shoot. For one sample, collect 4 to 8 leaves per tree from 25 trees of the same cultivar and apparent condition.

Avoid selecting dusty or soil-covered leaves if possible. Under normal conditions rainfall is frequent enough to keep leaves fairly clean. If necessary, brush or wipe with a damp cloth to remove dust. If leaves are covered with spray materials, wash quickly in a mild detergent solution and rinse quickly in water. Don't let samples remain in the wash or rinse water very long.

Air-dry the samples in a paper bag before mailing. Once the sample has dried, it should be mailed directly to the University of Georgia in the self-addressed kit obtained from your County Extension Office. Samples will be analyzed only if appropriate

checks for the analysis costs are included. Your check should be made payable to the University of Georgia. The charge for this service is $25 per sample and includes spectrographic analysis for several elements plus total nitrogen. Analysis results will be returned to the University of Kentucky Horticulture Department for interpretation and recommendation.

Appendix 13 contains recommendations for soil and foliar applications of nutrients when a deficiency is present.

C. Fruit Maturity Analysis

1.) PRESSURE TESTING FRUIT

Pressure testing is one means to determine fruit maturity. A suitable sample will consist of 10 fruit selected at random from a number of trees within a block and from various locations within the trees. Two measurements should be taken on each fruit one on the blush side and the other on the opposite side, at the midpoint of each side, after removing a 1/2-3/4" diameter disc of peel. (See Appendix 5.)

Use a 7/16 (large) plunger. Hold the fruit firmly in the left hand, while holding the fruit pressure-tester between the thumb and forefinger in the palm of the right hand. Set the indicator hand to zero and then, place the plunger against the fruit and press with increasing strength until the plunger tip penetrates into the pulp up to the notch.

Slow penetration of the plunger is essential. Sharp movements and sudden pressure application may impair your measurements. In order to avoid mistakes and to assure slow penetration of the plunger. Hold the apple firmly and keep your arm rigid. You may want to hold the apple on a table for this.

2.) THE STARCH-IODINE MATURITY TEST

The starch-iodine test is used to determine apple maturity and harvest dates. As an apple fruit matures and ripens it converts its stored reserves of starch to sugars. If a freshly cut fruit is stained with an iodine solution the distribution and amount of starch becomes readily apparent. Sugars do not show up in the starch-iodine test. By monitoring the reduction in the distribution and amount of starch a determination of when apples are at the correct stage of maturity for harvesting can be made.

The pattern of starch accumulation and loss varies between seasons and apple cultivars. Consequently starch-iodine staining patterns for a number of the most common apple cultivars have been included. Note that the pattern of starch loss begins in the core area and proceeds toward the peel.

It is normally necessary to monitor starch loss using this test on a weekly basis beginning three weeks prior to normal harvest. Fruit for testing should be freshly harvested as described under the section on pressure testing fruit and be at room temperature. You can use the same fruits that were used for pressure testing if they have not been refrigerated.

Make the 1.0% potassium iodide, 0.1% iodine solution by dissolving 1 level teaspoon of potassium iodide crystals (10 grams) in 1/8 cup of clean water in a 1-quart container. Swirl the liquid in the container to dissolve the crystals. Next add **1/4 teaspoon of iodine (2.5 grams)**, and swirl the liquid until the iodine dissolves. Then dilute the solution with clean water to make one quart.

Since this solution is sensitive to light **it should be stored in a dark brown bottle**

or the jar should be kept covered with aluminum foil. Make a fresh solution up at the beginning of each season. These chemicals may be available at your local drug store, however you may need a prescription to purchase them. Contact your County Extension agent if you have problems obtaining these chemicals. Use 10 to 20 freshly harvested apples that are at room temperature for the test. Pour iodine solution at room temperature into the bottom of a shallow glass pan to a depth of 1/4 inch. Cut each apple in half across its equator. Soak the cut surface of the stem end of the apple in the iodine solution for about one minute. The stem makes a good handle. Next, remove the apple halves and place them cut surface up to drain. Within five minutes the starch on the cut surfaces will have turned a dark blue-black color.

Score each fruit by comparing it with the appropriate starch- iodine staining pattern chart and calculate the average score for each lot of apples.

Apples will exhibit starch-iodine staining scores ranging from 1 to 9 over the several week long harvest season. The appropriate score for harvesting depends on when the apples will be marketed and the use for which they are intended. Fruit intended for the fresh market or for processing are usually harvested when more starch has disappeared than fruit for long term storage.

In general, an average test score of 1, 2, or 3 indicates that the fruit are too immature for harvesting. These fruit will not develop good eating quality and are more prone to scald and other disorders in storage. Fruit with an average rating of 4 are suitable for long term storage of up to three months. An average rating of 5 or 6 indicates that fruit are ready for fresh market. While ratings of 7, 8, or 9 indicate that fruit are over mature and may have poor eating quality or may not store well.

When these tests are used with other maturity tests a reasonably good indication of fruit maturity can be obtained. (S e e Appendix 10, Starch-Iodine Test Guides.)

WARNING: Iodine is very poisonous. The iodine solution should be properly labeled and kept away from children and pets. Apples used in the test should not be eaten or used in composting. In case of ingestion of either iodine, or iodine treated apples, induce vomiting and quickly consult a physician.

The Starch-Iodine staining technique was adapted for use in Kentucky from publications originally produced by the North Carolina Agricultural Extension Service, The University of Massachusetts Cooperative Extension Service and The Ontario Ministry of Agriculture and Food.

North Carolina Authors:
Mikal E. Saltveit, Jr., Assistant Professor
Susan A. Hale, Research Technician

Massachusetts Authors:
Duane W. Greene, Professor
Wesley R. Autio, Assistant Professor
James T. Williams, Ph.D.

Ontario Author:
C.L. Chu, Ph.D.

3.) SOLUBLE SOLIDS TESTING

The soluble solids level in the fruit refers primarily to the fruit sugar level. The equipment needed includes a refractometer, paper towels or toilet paper and a squeeze bottle of water. Clean the prism and cover

it with water then, look through the instrument, and adjust the refractometer to read 0 for the water if necessary. Clean and dry the prism and squeeze a few drops of apple juice on the prism from the bottom portion of an apple not used in the starch-iodine test. Read and record the soluble solids (SS). Note the correction for the present temperature. Rinse and dry the prism between each reading. Usually, the instrument will only need calibration once a day. It should be checked with water at the start of each site, record one SS per apple pressure tested.

Ripe Delicious apples usually have soluble solids of greater than 10%.

4.) SEED COLOR

Seed color is recorded from the apples that are sampled above. Record seed color as white, light brown, dark brown or black. Seeds from mature fruit will be dark brown to black.

C. Sampling the Apples from the Grading Line

See Appendix 7.

1. Randomly collect 200 fruit from the harvested apples and record their total weight.

2. Run the 200 fruit through the grading line and record:

1) the spacing (inches) of the eliminator
2) the number of eliminated fruit and their weight
3) grade the remaining fruit as to culls or marketable noting on the form the major problem seen on each one
4) count and weigh the total marketable fruit. Record this on the chart
5) count and record the culls as follows:

total # culls
culls rots
culls scab
culls scale
culls other insect
culls bitter pit
culls other

Note when a cull has more than one defect, record only under the major defect. (See Appendix 7.)

V. Specific Diseases

A. Apple Scab (SCAB)

Apple scab is the most consistently serious disease of apples in Kentucky. This disease has the potential to cause serious economic losses every year, and should, therefore, be monitored closely.

SYMPTOMS: Scab infections are most prominent on the leaves and the fruit. On the leaves, early infections appear velvety, olive-green and become puckered with time. Severely diseased leaves may become distorted or turn yellow and fall from the tree. Spots initially appear on the underside of leaves, so be sure to look there; later, spots also appear on the upper leaf surface, where they are somewhat easier to detect. (See Apple Disease I picture sheet, plate #8.)

Fruit spots resemble leaf spots when young, but eventually become brown or black, develop a corky ("scabby") appearance, and frequently become cracked. Infections may be more prevalent near the blossom end.

DISEASE CYCLE: The scab fungus overwinters in diseased leaf litter on the ground. In spring, the fungus produces windblown spores, which can blow to susceptible apple tissue and cause an initial (primary) infection, given the proper temperature and moisture conditions. If primary infection occurs, new spores are produced; this is the velvety growth on leaf and fruit spots. These new spores can then be splashed by raindrops to nearby tissues and cause repeating (secondary) infections the rest of the season when the weather is conducive. The cycle is completed when diseased leaves eventually fall to the ground.

As can be seen from the accompanying Mill's table (page 42), infection and incubation periods are predictable, being based upon average temperatures and the number of hours that leaf surfaces remain wet. A knowledge of recent weather, consequently, will indicate when new scab infections might be observed. Also, note that secondary infections cannot develop unless primary infections occur first, during the early part of the season.

SCOUTING: Lesions (spots) can first appear about 10-14 days after bud break. Early infections are most likely to be noticed on the flower bud leaves (sepals). Recall also that the undersurface of leaves may become spotted before the top surface. Examine 20 leaves on each of 5 limbs per tree and record the number of leaves showing any scab lesions. After fruit has set, but in addition to leaf observations, also examine 20 fruit on each tree showing any scab lesions.

B. Fire Blight (FIRE)

Although not a serious problem every year, fire blight is a disease which can "explode" with devastating consequences under the proper conditions. Consequently, fire blight should be monitored closely.

SYMPTOMS: Infection first occurs around bloom. Infected blossoms appear water-soaked and turn brown or black. The infections may then spread through the blossom-bearing stem (pedicel), turning it

MILLS' TABLE

Approximate number of hours of wetting required for primary apple scab infection at different air temperatures and the length of time required for secondary spore development.

Ave Temp °F	Degree of Infection (hrs)[a] Light	Moderate	Heavy	Days Incubation[b]
78.	.13	17	26	
77.	.11	14	21	
76.	9.5	12	19	
63-75.	9	12	18	9
62.	9	12	19	10
61.	9	13	20	10
60.	9.5	13	20	11
59.	.10	13	21	12
58.	.10	14	21	12
57.	.10	14	22	13
56.	.11	15	22	13
55.	.11	16	24	14
54.	.11.5	16	24	14
53.	.12	17	25	15
52.	.12	18	26	15
51.	.13	18	27	16
50.	.14	19	29	16
49.	.14.5	20	30	17
48.	.15	20	30	17
47.	.17	23	35	
46.	.19	25	38	
45.	.20	27	41	
44.	.22	30	45	
43.	.25	34	51	
42.	.30	40	60	

[a] The infection period is considered to start at the beginning of rain.
[b] Approx. no days required for secondary spore development after primary infection.
[c] Data are incomplete at low temperatures.
* From W. D. Mills, Cornell University.

Disease prediction instruments such as the Envirocaster, when placed in the orchard, use Mills Table to compute the disease prediction. Such instruments offer the grower and IPM scout a precise means of managing apple scab diseases. The advance of new fungicides capable of "eradicating" already progressing infections up to 4 days after a wetting event makes apple scab management using predictive instruments a practical activity.

black, and into the spur or main branch to form a canker. As young shoots begin to develop, they may also become infected. This "twig blight" phase of the disease begins at the succulent growing tip and moves downward. Infected twigs turn dark brown and become hook-shaped, like the top of a cane. The leaves on infected twigs or spurs then turn brown and die and appear as though they have been scorched by a fire, but remain attached. (See Apple Disease II picture sheet, plate #7.)

If the fire blight bacteria spread into the main branches, they may cause a canker to develop. Such cankers often appear outlined by cracks in the bark at their margins. Fruit may occasionally become infected; these generally turn brown to black at the site of infections, and exude droplets of milky or amber ooze. In fact, the presence of ooze on the surface of any diseased tissue, especially during humid weather, is a good diagnostic sign for fire blight.

DISEASE CYCLE: The fire blight bacteria, which overwinter in the margins of limb and trunk cankers formed the previous season, begin to multiply rapidly as temperatures warm in the spring to about 60^0 F or higher. As the bacterial population increases, oozing sticky droplets will be formed on the surfaces of cankers. The bacteria from these droplets are then spread to open blossoms by insects, where they may cause infections and continue to multiply and ooze. Further spread to additional blossoms or twigs is accomplished by insects and splashing or windblown rain.

SCOUTING: Be especially alert for the blossom blight and spur blight phase of this disease when the weather is warm ($65\text{-}80^0$ F), humid, and rainy during the bloom period; similarly, be especially alert for the twig blight phase if these conditions prevail while active shoot growth is occurring. **All apple varieties are at least partially susceptible to fire blight; however, the following varieties are highly susceptible and should be watched closely: Beacon, Fuji, Gala, Idared, Jonathan, Lodi, Paulared, Rome, Tydemans Red, Wealthy, Yellow Transparent and York.**

During the bloom period, examine 20 blossom clusters on each of 5 limbs per tree and record the number of fire blight strikes. After the bloom period, similarly note the number of strikes per 100 spurs and 100 terminal shoots on each tree examined. Continue monitoring until the terminal shoot buds have set.

When scouting for fire blight, be sure to check for the presence of blighted suckers arising from the rootstock. Report any blighted suckers to the grower or your supervisor immediately, as these can quickly lead to the death of the tree.

A computer program called MARYBLYT is an aid to determining when fire blight infections will take place, when to spray for control, and when symptoms of infection should appear. While scouting an orchard, growers using MARYBLYT will need to record daily maximum and minimum temperatures, rainfall, hail or frost, and stage of tree growth and development. Growers with home computers can learn to use the MARYBLYT program, or in some cases have access to a computer in the local county extension office. Knowing when apples are at greatest risk can benefit control programs. For further details on using MARYBLYT, see Appendix16.

C. Powdery Mildew (MLDW)

SYMPTOMS: The most obvious sign of powdery mildew is the presence of a whitish, powdery or felt-like growth on the leaves, first along the margins and lower surfaces, and eventually over the entire leaf surface. Infected leaves are distorted, becoming narrow, cupped towards the middle, and brittle.

Fruit on heavily infected trees may become severely russeted.

DISEASE CYCLE: The powdery mildew fungus survives the winter within buds which became diseased the previous summer. When these buds open in the spring, the fungus resumes growth in the newly expanding leaves and produces the white, powdery spores which give the disease its name. These spores are then blown by the wind to emerging tissue and produces secondary infections until tree growth stops or temperatures become limiting. (See Apple Disease II picture sheet, plate #4.)

Disease development, although rapid between 60-80^0 F, is slow both between 40-50^0 F, and at temperatures above 90^0 F. High relative humidities favor disease development; however, rain and dew are not required for spore movement or for infection to take place.

SCOUTING: Powdery mildew is most likely to be a problem on highly susceptible varieties, including Jonathan, Rome, Cortland, Baldwin, and Idared. Disease pressure is also likely to be higher in seasons following a mild winter where fungal survival is greatest.

Record the number of terminal shoots showing powdery mildew infections out of 100 observed on each tree (20 per limb x 5 limbs). Begin monitoring at shoot emergence, and continue until terminal growth has ceased.

D. Rust Diseases (RUST)

Three different rust diseases can occur on apple. However, it is not necessary to distinguish the subtle differences between these rusts for the purposes of scouting, since the disease cycles and control programs are similar for each.

SYMPTOMS: Small pale yellow spots appear on the upper surface of infected leaves shortly after bloom. These spots gradually enlarge up to 1/4" in diameter, depending upon the apple variety and the number of spots per leaf, and become bright yellow-orange in color. By early or mid-summer, yellow spots will also be present on the lower leaf surface; from these come small, orange-yellow tubular fruiting bodies which eventually project downwards. As the tubes mature, they split towards the base into narrow strips and curl back on themselves to form cup-like structures. Within these structures a mass of light brown spores can normally be seen with a hand lens (10x). Heavily infected leaves may fall off the tree. (See Apple Disease I picture sheet, plate #10.)

Fruit spots usually appear near the blossom end, and may be of two types: 1) spots that are similar in color to the leaf spots, but larger (up to 3/4" in diameter), which may be outlined by a dark green border; 2) spots that are dark green and sunken. Fruits with type 2 infection usually become puckered at the blossom end while the fruit is still an inch or less in diameter.

DISEASE CYCLE: Spores produced in the cup-like structures on the lower surface

of infected apple leaves become wind-dispersed, and infect nearby cedar or juniper trees during the summer and fall. The rust fungus then grows and survives two succeeding winters in galls which are formed on infected cedars. When apple buds are in the pink to early bloom stage, the fungus produces spores upon the cedar galls, and these spores are blown to apple tissue, where they infect and complete the disease cycle two years after it began. The infection period for apple usually ends about 30 days after bloom. Unlike apple scab or fire blight there is no apple-to-apple (secondary cycle) spread of disease.

SCOUTING: Apple varieties vary greatly in their susceptibility to rust. Be especially alert for leaf infections and Type 1 fruit infections on Prima, Sir Prize, Lodi, Jonathan, Rome, Wealthy, and York Imperial. Be especially alert, also, for Type 2 fruit infections on Cortland, Golden Delicious, McIntosh, Red Delicious, Stayman, and Winesap.

For each tree record the number of infected leaves per 100 observed (20 per limb x 5 limbs). Also, examine 100 fruit per tree and record the number with at least one rust spot. Make separate notations for Type 1 and Type 2 fruit infections, where possible.

If you can see cedar trees near the orchard, look for the presence of the orange cedar galls from pink bud to 30 days after bloom. Note your findings on the comments section of the scouting form.

E. Frogeye Leaf Spot (FROG)

The fungus which causes frogeye leaf spot also causes a canker disease on limbs and twigs, and "black rot" on the fruit later in the season. These diseases are more likely to be a problem on old trees than on young trees.

SYMPTOMS: Small purple specks typically appear 1-3 weeks after petal fall. These specks then enlarge to 1/8" - 1/4" in diameter and become brown with a purple margin. Older spots become irregularly shaped or lobed, retain their purple margin, and appear brown with a light colored center. Small black dots may appear in the light centers of older spots on the upper leaf surface. Heavily infected leaves may turn yellow and fall off, especially on the variety Jonathan. (See Apple Disease I picture sheet, plate #4.)

DISEASE CYCLE: The fungus overwinters in dead bark and mummified fruit. Spores are primarily dispersed in splashing rain; this commonly results in the development of cone-shaped zones of infected leaves beneath the source of spores (e.g., fruit mummies hanging in the tree, or dead twigs and branches). Although spores may be released during rainy periods throughout the season, leaf infections occur primarily around the time of petal fall. Warm temperatures (minimum 60^0 F, optimum 75-80^0 F) and adequate moisture are necessary for infection to occur.

SCOUTING: Examine 100 leaves from each tree scouted (20 leaves per 5 limbs) and record the number showing at least 1 spot. On your scouting form, note the presence of fruit mummies and dead wood above zones of infection. Black rot cankers often form in branches that were infected with fire blight the previous season. From records or from the grower, note whether or not fire blight was serious the previous season. Note leaf yellowing and leaf drop if it occurs.

F. Collar Rot (CROT)

Collar rot caused by various species of Phytophthora is impossible to positively diagnose without laboratory culturing. However, the scout can perform a necessary function by identifying trees which may be infected, and delivering appropriate samples to his or her supervisor for forwarding to the lab, if requested to do so.

SYMPTOMS: The symptoms of collar rot are often similar to those caused by any agent which interferes with part or all of the tree's root or trunk system (rodents, soil compaction, mechanical injury, canker diseases, fire blight, etc.). Affected trees may exhibit poor terminal growth; have small, chlorotic leaves; and/or wilt and eventually die. Trees collapsing as a result of collar rot will be largely or completely girdled by a zone of dead inner bark just beneath the soil line. Bark discoloration sometimes extends above the soil line as well. Collar rot is most common on MM.104 and MM.106 clonal rootstocks, although all rootstocks are at least partially susceptible. (See Apple Disease II picture sheet, plate #5.)

DISEASE CYCLE: The collar rot fungus persists for long periods in diseased host tissue or as resting spores in the soil. When the soil becomes saturated with water, the fungus produces small swimming spores (zoospores), which are chemically attracted to plant roots. Spores may also be carried by water as it drains down a slope and through the soil profile. Upon contacting a root or the trunk, the spores may germinate and infect. Both of these processes depend upon the susceptibility of the rootstock, and how long the soil remains excessively wet. Spore production and infection is most common in the spring and the fall.

SCOUTING: Observe and note the location of any weakly-growing or collapsing trees. Note these trees especially if they appear to be growing in a low-lying or poorly-drained area. Gently dig the dirt away from a portion of the crown (trunk/root area) and check to see if the inner bark is still alive. If so, it will appear green and the wood just inside the bark will be firm and white with no discoloration being evident.

If a sample is requested, dig a shallow hole within the drip line of the tree, and put some moist soil and segments of roots into a plastic bag. If the crown or lower trunk appears infected, remove a few pieces of inner bark from near the margin of the infected region, and place them in a plastic bag with moist soil. It is important to **KEEP SAMPLES COOL** and do not place bags in direct sunlight before they are delivered.

G. Fungal Twig and Limb Cankers (CANK)

In addition to fire blight (caused by a bacterium), twig and limb cankers are caused by several different fungi. It will not be necessary to determine the actual cause of cankers other than fire blight; however, it is important to note the occurrence of cankered limbs when they are observed.

SYMPTOMS: Generally, cankers will appear as small to large sunken areas on twigs, limbs and/or tree trunks. Depending upon the cause of the cankers, the sunken areas may exude a liquid or develop sporulating structures which in turn exude a gelatinous material laden with fungal spores.

This is especially true during humid, rainy weather. Cankers may become cracked or appear to blister in a way which is not characteristic of "normal" apple bark. Many times cankers will be associated with lenticels or tree wounds, especially those resulting from improper pruning techniques. Additionally, healthy wood bordering cankered tissue will often be swollen with callous tissue as the tree attempts to "heal" cankered wood. (See Apple Disease I picture sheet, plate #11 and Apple Disease II picture sheet, plate #1.)

DISEASE CYCLE: Canker-causing fungi normally overwinter in diseased or dead wood on the tree, and produce and disseminate spores during rainy periods in the growing season. New infection sites then become sources of additional spore production. Weakened or poorly-growing trees are especially susceptible to fungal canker diseases.

SCOUTING: A quantitative assessment of these diseases is not required; rather, be on the lookout for twig and limb cankers as you scout for leaf and fruit diseases, and record their occurrence in the comments section of your scout form.

SUMMER FRUIT ROTS

Several different rots can occur on apple fruits, especially as they approach maturity. The following are the most common and important "summer rots" which occur in Kentucky.

H. Black Rot (BROT)

SYMPTOMS: Infections are usually not apparent until fruit begin to ripen. The disease may first be noticed as a brown to black spot at the blossom end of the fruit, or around a worm hole or some other wound. Usually, only ONE spot appears per fruit. This is a characteristic which helps distinguish black rot from some other fruit rots.

As the infected area enlarges, a series of brown or black concentric rings sometimes develops, producing an alternating "bulls-eye" or target-shaped pattern. Small black dots will frequently be seen within older rotted areas. The infected tissue remains firm as the rotted area expands throughout the entire fruit. At this point the whole fruit typically turns black. Such fruit will eventually shrivel and harden into mummies which remain attached to the tree and become a source of spores for future infection. (See Apple Disease I picture sheet, plate #4.)

DISEASE CYCLE: Same as "Frogeye Leaf Spot", discussed previously.

SCOUTING: For each tree observed record the number of fruits with black rot per 100 examined (20 fruit per 5 limbs). Note the presence of mummified fruit in the tree in the comments section of the form. This disease is more likely to occur in old and in poorly pruned trees that have poor air and light penetration than in young trees.

I. Bitter Rot (BITR)

SYMPTOMS: One to several small brown circular spots may first appear anytime after fruit are half grown. These spots expand rapidly in warm weather, becoming dark brown or black and somewhat sunken in the center (saucer-shaped). After the spot has enlarged to about 3/4" in diameter, a number of

orchard.

Exclusion. Use only disease free nursery stock when planting a new block of trees.

The apple grower needs to be aware that some disease-causing microbes can be kept out of the orchard, or can be kept from spreading to a tree or block from one nearby. Soil contaminated with the collar rot fungus should not be moved about, and pruning tools contaminated with fire blight bacteria should be disinfested before using in the next tree, especially during summer.

Eradication. Remove and destroy nearby cedar trees to break the cycle of cedar rusts on apple.

Chemical Control

Although chemical control strategies may vary for each disease, they are generally classified as being protective, or reactive (where the control measure employed is in reaction to the development of a problem), or a combination of the two.

Protective strategies are based primarily upon prior disease histories and the likelihood that a disease will show up year after year. Protective strategies are also used for diseases such as fire blight because of its erratic, yet potentially devastating nature. With the more predictable diseases such as apple scab, rust, and the "summer diseases", as well as fire blight, control measures are generally in place prior to known periods of infection. The primary role of scouting in these instances is to provide insight into where a control program can be adjusted to provide for more effective disease control in subsequent seasons.

Scouting also allows reactive control strategies to be implemented into protective programs. That is, scouting may detect lapses in the effectiveness of the protective program due to one reason or another. These lapses may indicate ways to correct a problem before it gets out of hand. This is especially true of diseases such as apple scab and fire blight where the development of secondary inoculum, if left unchecked, can soon result in poor disease control.

When properly implemented, a protective spray program will effectively control most of the apple diseases encountered on a yearly basis. However, many of the chemicals used in a protective program require that they be present on the plant surfaces prior to the arrival of the disease organism. Unfortunately, this is not always possible because of the unpredictability of the weather in Kentucky. Many times it is simply impossible to apply spray materials prior to periods of infection. Fortunately, the development of a new breed of fungicides, and a modified method of application have provided us with means to circumvent this logistics problem.

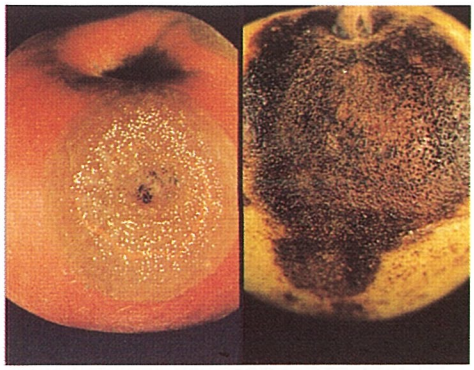
Chemicals are now available which show substantial "kick back" action against certain diseases. These chemicals have the ability to stop disease activity after infection has taken place. This is very desirable in situations where plant tissue is left unprotected during periods of infection, because of rapid growth and/or lengthened spray intervals. Sometimes they are included early in the season to assure the grower of eradicating infections that might have escaped protectant fungicides. Consequently, these chemicals add a certain degree of flexibility to a spray schedule and ease the demands of a strictly protective spray schedule. In most cases, growers having orchards with a history of diseases are best served with a strict protective spray schedule.

In orchards where apple scab has been kept under control, growers can reduce early season fungicide use. Scab infections, determined using Mill's Table as explained earlier, can be controlled using "eradicating" or "kick back" fungicides. Scab fungicide use can also be reduced by using a four spray schedule at tight-cluster, pink, petal-fall, and first cover. An eradicating fungicide such as myclobutanil (Nova), used in the four-spray schedule, will also control cedar rust and powdery mildew. Beginning at first cover, traditional calendar sprays are then used.

Although the above discussion is very general in nature, it should assist in the development of control strategies based upon individual needs. It is also meant to tie together the role of scouting in the development and implementation of an effective spray schedule. For more specific information concerning diseases and control recommendations, please consult the current Commercial Tree Fruit Spray Guide (ID-92) or the Midwest Tree Fruit Handbook (ID93) which was developed in cooperation with the University of Kentucky College of Agriculture and the Kentucky Cooperative Extension Service.

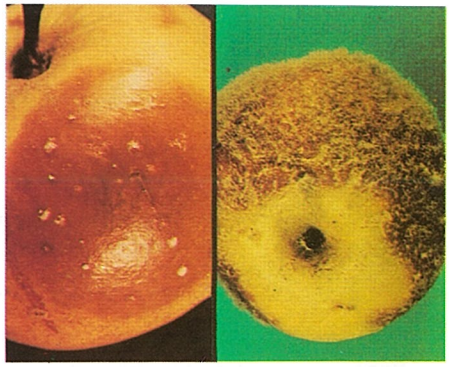
More detailed information about symptoms, causal organisms, disease cycle and epidemiology, and control can be found in the Compendium of Apple and Pear Diseases. This book is available from The American Phytopathological Society, 3340 Pilot Knob Road, St. Paul, MN 55121.

APPLE DISEASES I

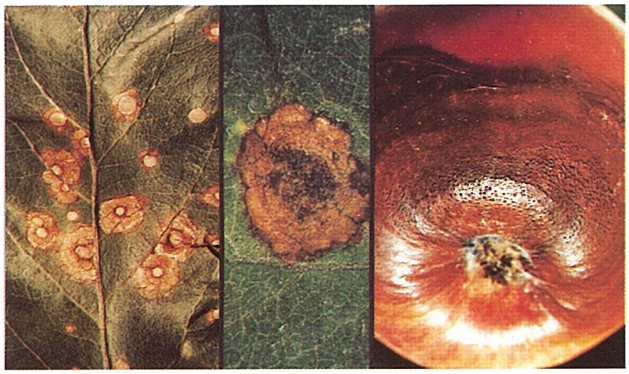


1. Northwestern anthracnose or bull's-eye rot

2. Bitter rot

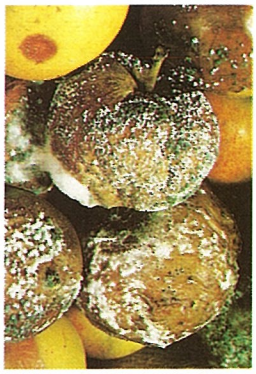


3. Botrytis rot

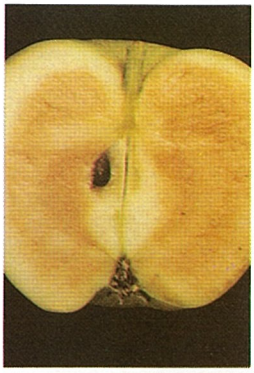


4. Black rot or frogeye leaf spot

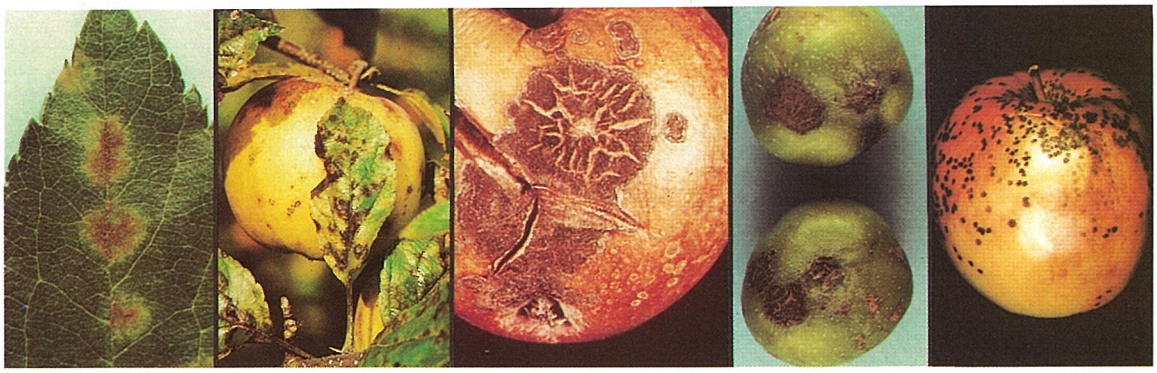
5. Sooty blotch and flyspeck



6. Soft rot or blue mold rot

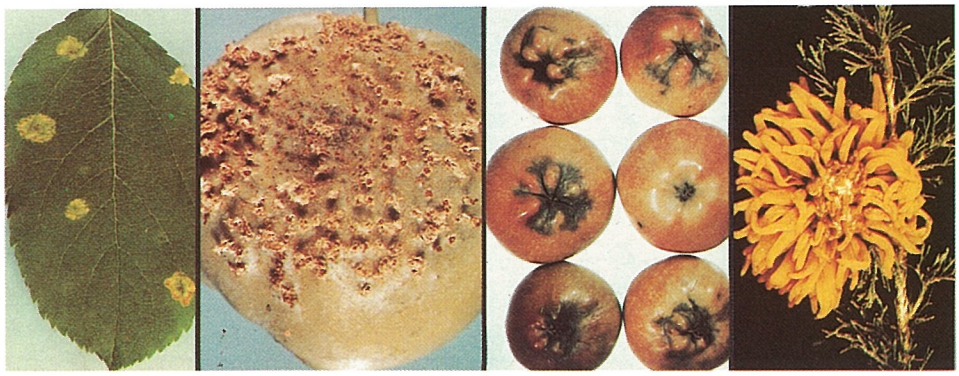


7. Internal breakdown



8. Apple scab

9. Soft scald



10. Cedar-apple rust

Quince rust

11. Nectria canker

UNIVERSITY OF ILLINOIS COLLEGE OF AGRICULTURE
COOPERATIVE EXTENSION SERVICE
and VOCATIONAL AGRICULTURE SERVICE

FRUIT DISEASE NO. 1
JULY 1982
URBANA, ILLINOIS

APPLE DISEASES I

1. **Northwestern anthracnose or bull's-eye rot,** caused by the fungus *Neofabraea malicorticis*, is a rot primarily of stored fruit and a branch canker disease found mostly in northern areas (chiefly the Pacific Northwest) with a heavy autumn rainfall. The centers of the concave fruit lesions are light brown with a dark brown margin. Later, two or more concentric rings, alternating tan and brown, give a bull's-eye appearance to the rot. Enlarging, elliptical, dark sunken cankers with concentric rings, form in the younger branches. The causal fungus, which can only invade injured tissue, overseasons in cankered limbs and fruit.

2. **Bitter rot** is a fairly firm rot that starts as a small, circular, light brown spot which enlarges rapidly, darkens, and eventually turns almost black. Characteristic of this rot is the saucer-shaped depression in the center and later the concentric rings of tan fungus fruiting structures that form inside the spot. The bitter rot fungus, *Glomerella cingulata*, attacks a wide range of woody plants during warm moist weather in the southern two-thirds of the United States. The source of most infections are mummified fruit and broken limbs.

3. **Botrytis rot** is fairly common on injured mature fruit. The causal fungus, *Botrytis cinerea*, attacks a wide range of plants in cool damp weather. Characteristic of this disease is (1) a small, quarter- to half-inch, somewhat sunken, shallow dry rot at the blossom end of the fruit, (2) a moldy core rot, and (3) a tan-to-medium brown rot covered by a dense, tan-to-gray mold that forms under damp conditions. The fungus overseasons in plant debris.

4. **Black rot or frogeye leaf spot** is caused by the fungus *Physalospora obtusa*, which infects the leaves, fruits and wood. Small purple specks on the leaves enlarge to form round to angular spots with a dark margin and brown or yellowish-brown centers (called frogeyes). Twig, limb and trunk cankers are slightly sunken and reddish brown. Some cankers enlarge each year until they cover several feet. The canker margins are lobed. Diseased fruit develop a brown-to-black rot containing alternating light and dark bands. Such fruit often shrivel into black "mummies" that hang in a tree overwinter. The black rot fungus overwinters in mummified fruit and dead wood.

5. **Sooty blotch and flyspeck** normally occur together on the same fruit. Sooty blotch is caused by the fungus *Gloeodes pomigena*; flyspeck by the fungus *Microthyriella rubi*. Sooty blotch gives a superficial smudgy appearance to affected fruit due to large numbers of minute, black fungus structures (pycnidia) connected by thread-like hyphae. Flyspeck consists of shiny, black dots in groups of 10 to 50 that resemble true flyspecks. Both fungi are superficial and can be removed by vigorous rubbings. They overwinter on the twigs of many woody plants.

6. **Soft rot or blue mold rot** is the most common storage rot. This soft to watery, tan-to-brown or gray rot is most prevalent in fruit with a bruised or broken skin handled roughly at harvest time and later. When humidity is high, gray-to-bright blue cushion-like structures form on the surface of the rot. The primary cause of soft rot is the fungus *Penicillium expansum*.

7. **Internal breakdown** characterizes the gradual transition from the normal to the senescent fruit; the end of normal storage life. The fruit flesh becomes off-white to yellow, then brown and mealy. In advanced stages, the skin is also discolored and the flesh slowly softens. Large apples, late picking, delayed cooling, and high storage temperatures are primary factors that lead to early breakdown. It commonly follows water core and freezing and may be associated with a very low calcium and/or phosphorus status in the tree.

8. **Apple scab** occurs wherever apples and crabapples are grown. Scab infects primarily the leaves and fruit. Velvety, green-to-brown spots, that blacken with age, appear on the leaf. Infection causes the leaves to drop early greatly weakening the tree. Fruit infections resemble leaf infections when young; later becoming brownish-black and corky. Early fruit infections give the fruits a scabby, knotty, misshapen appearance. Such fruit commonly crack and drop early. Small, rough, black, circular, lesions may develop on stored fruit. The scab fungus, *Venturia inaequalis*, overwinters in dead leaves on the ground.

9. **Soft scald** is a physiological or noninfectious disease that attacks fruit picked when immature and stored under unfavorable conditions. The degrees of scald are classified as common scald, soft scald, and soggy breakdown. Common scald first appears as a diffuse browning of the skin, which is most pronounced on light colored varieties. Usually a sharp line exists between affected and normal fruit tissue. Soft scald is characterized by irregular, burn-like brown areas with definitely outlined edges. The flesh beneath these areas is often soft and discolored to a slight depth. In advanced stages, a deep brown flesh rot develops that may extend to three-fourths of the fruit. Sometimes the brown areas in the flesh remain small and firm; at other times large, soft and watery (soggy breakdown). Apple varieties differ markedly in the scald symptoms they express.

10. **Cedar-apple rust,** caused by the fungus *Gymnosporangium juniperi-virginianiae*, commonly occurs on leaves and fruit, and occasionally the twigs. Leaf infections appear as pale yellow spots on the **upper** surface which enlarge, turn orange and exude an orange exudate in the center. Later, black fruiting bodies (pycnia) appear within the spot. On the **underleaf** surface, a number of orange-yellow, tube-like structures (aecia) form in each spot. When severe, leaves may turn yellow and drop early, Fruit lesions appear usually near the calyx end. They resemble leaf lesions, but are much larger. Aecia sometimes appear on the fruit. The rust fungus overseasons on red cedars and other *Juniperus* species where brown to reddish brown galls are formed that produce gelatinuous masses of yellow to bright orange spore-horns during spring rains.

Two other rust fungi attack apples: hawthorn rust (*Gymnosporangium globosum*) and quince rust (*G. clavipes*). Hawthorn rust may infect apple foliage and fruit, producing symptoms similar to those of cedar-apple rust. Quince rust infects apple fruit but not the leaves. Fruit lesions are somewhat similar to those of cedar-apple rust except that they are usually larger, dark green, and commonly produce deep, crater-like depressions. Both the hawthron and quince rust fungi overseason on *Juniperus* species. The quince rust fungus produces somewhat swollen, spindle-shaped swellings on juniper twigs, branches, and trunks that are covered with orange gelatinuous masses during and following spring rains.

11. **Nectria canker**, caused by the fungus *Nectria galligena*, attacks a wide range of woody plants especially in northern areas with a maritime climate. Slowly enlarging, sunken or flattened areas of bark, usually centered around the base of a dead side shoot or wound, form on the twigs and branches. The girdling cankers slowly enlarge, becoming conspicuous and somewhat targetlike with the bark later sloughing off to expose concentric rings of callus. Small, bright red fungus fruiting bodies (perithecia), that later blacken, are clustered on the bark or wood at the margin of older cankers in autumn. When twigs and branches are encircled, the parts beyond the canker wilt and die.

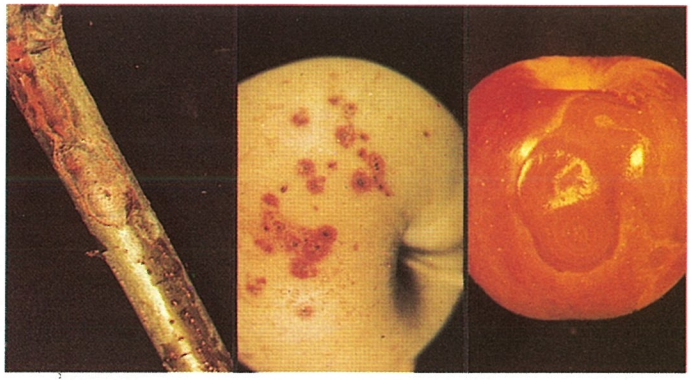
Nectria twig blight, caused by a closely related fungus (*N. cinnabarina*), is cosmopolitan on hundreds of woody plants. It mostly occurs on dead wood but may be weakly parasitic. It produces small, sunken cankers that girdle and kill infected twigs. In mid to late summer, bright-pink or coral-red globular structures (sporodochia) form in the dead bark. Later, the pustules turn chocolate-brown. Both *Nectria* fungi overwinter in dead wood.

For chemical and cultural control suggestions consult the Extension Plant Pathologist at your land-grant university, or your county extension office.

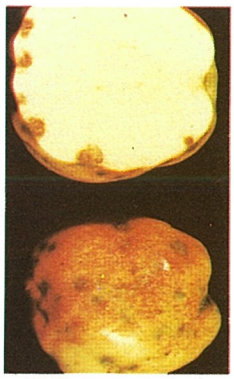
Photo credits: K. T. Leath (1, 2, 3, 5R, 6L), University of Wisconsin (4, 6R, 8, 14), University of Illinois (5L, 9), USDA and Clemson University (7, 10), British Ministry of Agriculture (11), and M. C. Shurtleff (12, 13).

APPLE DISEASES II

1. Papery bark canker

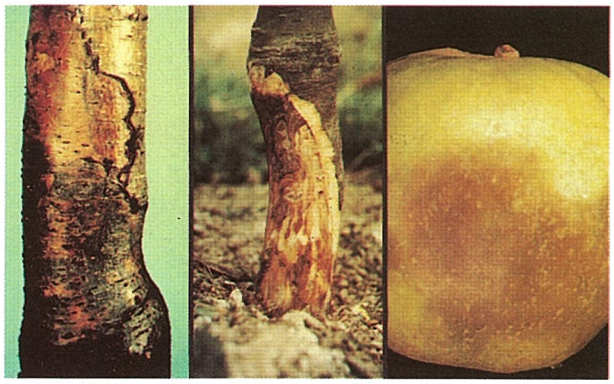


2. Botryosphaeria (Bot) rot

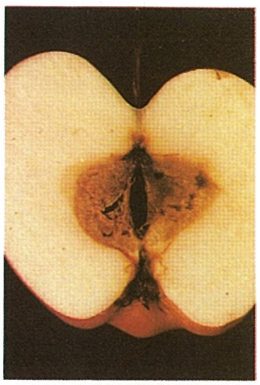


3. Bitter pit or Jonathan spot

4. Powdery mildew



5. Phytophthora collar rot



6. Water core

7. Fire blight

8. Brown rot

9. Apple mosaic

10. Trunk twisting and flattening

11. Russet-ring

12. Leaf pucker

13. 2,4-D injury

14. Brown heart or core

UNIVERSITY OF ILLINOIS COLLEGE OF AGRICULTURE
COOPERATIVE EXTENSION SERVICE
and VOCATIONAL AGRICULTURE SERVICE

FRUIT DISEASE NO. 2
JULY 1982
URBANA, ILLINOIS

APPLE DISEASES II

1. **Papery bark canker**, commonly called **silver leaf**, is caused by the fungus *Stereum purpureum*. The fungus infects a wide variety of woody plants, including pome and stone fruits, in the northern states, being most prevalent following severe winters. The first symptom is usually the appearance of dull lead to silvery leaves on infected branches. Death of infected branches or the entire tree may occur within a year or two after the appearance of the silvered leaves. The fungus enters through wounds and produces a dark brown decay first of the heartwood, later killing the sapwood. The outer bark becomes "papery," splits, and sloughs off. Stunting of growth is often apparent before the tree dies. The characteristic, small (½ to about an inch in diameter), round, leathery, flattened to somewhat shelf-shaped sporophores of the causal fungus can often be found on limbs and trunks of dead trees. The upper surface of the fruiting body is velvety and buff or grayish in color; the spore-bearing under surface is purplish.

2. **Botryosphaeria (Bot) rot**, caused by the fungus *Botryosphaeria dothidea (B. ribis)*, infects a wide range of woody plants. Young twig, limb, and trunk cankers appear as blisters filled with liquid. The liquid spreads over the wood surface when the blisters rupture. Enlarging, sunken, dark colored cankers are soon evident. Dark, spore-producing structures (stromata) form on the canker surface. The following spring the canker may cork off and become inactive or may continue to grow. Mechanical injury or environmental stress (freeze injury, drought) predispose wood to infection. Fruit infections start as small, reddish-brown spots surrounding a lenticel. The fungus advances through the fruit forming a soft rot. The skin color fades to a light brown and then a deeper brown. Completely rotted fruits may often have syrupy beads of exudate on their surface. Fruit rot commonly starts to develop in storage. The fungus overwinters on living and dead limbs.

3. **Bitter pit or Jonathan spot** is a noninfectious disease that is most common in years when the fruit crop is light. Slightly sunken, circular, dark green spots with some internal browning form on the skin of the fruit. Later the spots may become deep red or light green; finally gray or black. As the fruit matures, the pits become more sunken with a definite brown corkiness of the flesh that may extend ¼ inch into the fruit. Bitter pit seems to be related to a fluctuating soil moisture supply associated with calcium nutrition, and is increased by abundant rainfall shortly before harvest. The disease is most severe on fruit picked immaturely; it increases in storage.

4. **Powdery mildew**, caused by the fungus, *Podosphaeria leucotricha*, overwinters mostly in terminal buds. A whitish, powdery to felt-like growth covers infected buds, blossoms, leaves, twigs, and fruit. The leaves are often stunted, narrower than normal, folded lengthwise, and become stiff and brittle with age. Twig growth is stunted and may have a witches'-broom appearance. Infected fruit commonly have a fine network of russeting, may be severely russeted, and sometimes are dwarfed. This disease is most common on certain cultivars in southern apple-growing areas.

5. **Phytophthora collar rot**, caused by the soil-borne fungus *Phytophthora cactorum*, infects a wide range of plants. Disease incidence has increased as dwarfing rootstocks (especially Malling-Merton or MM) have replaced seedling rootstocks. The fungus attacks the lower 30 inches of apple trunks, usually between the soil line and the crown roots. Infected bark becomes brown, somewhat depressed, and is often slimy when wet. A brown to reddish-brown discoloration of the wood and a gummy exudate under the dead bark is typical. The enlarging, definitely outlined cankers, girdle the lower trunk and/or roots and often result in death of the entire tree. A general lack of vigor, poor shoot growth, and formation of sparse leaves in summer, or reddish leaves in early autumn, is commonly the first indication of the disease. The *Phytophthora* fungus attacks the fruit of susceptible apple cultivars producing a firm, brownish rot. The disease is more common in heavy, poorly drained soils.

6. **Water core** is a noninfectious disease that occurs both in the orchard and in storage. The fruit must be cut open to observe the symptoms which arise in the core as a clear, "glassy" translucence that soon spreads to the surrounding flesh. Water core is most common in large mature fruits from sun-exposed portions of the tree. Fruits with low calcium or high potassium and magnesium are most susceptible to water core.

7. **Fire blight** is an extremely destructive disease caused by the bacterium *Erwinia amylovora*. Infected blossoms become water-soaked in appearance and soon wilt, turning brown to dark brown. Infected shoots wilt from the tip, often forming a "shepherd's-crook," and soon turn dark brown (as if scorched by fire). The disease may progress into the shoot from its base, blighting the lower tissues and girdling the parts beyond. In young trees, the bacteria may girdle the trunk and kill the tree. The bark of invaded branches and scaffold limbs is darker than normal with the wood beneath turning brown. Later the margins become sunken and often cracked, forming a definite canker. During wet, humid weather, blighted tissues exude a milky, sticky ooze that soon turns brown.

8. **Brown rot** is caused by two closely related species of fungi, *Monilinia fructicola* and *M. laxa*. The disease is usually a minor problem in the United States, but is much more important in Great Britain and continental Europe. In the U.S., the fungi infect apple fruits injured by insects, hail, birds, or other means. Mature apples develop soft, light brown spots that enlarge rapidly in warm weather. Entire fruits may be destroyed within a day or two. Ash-gray tufts of mold develop on the surface of rotted fruits in damp weather. These fungi are much more destructive to stone fruit trees where the blossoms, twigs and fruit are infected.

9. **Apple mosaic** is the most familiar viral disease of apple. The leaves on some twigs develop white-to-light yellow flecks, spots and blotches and bands along the veins. Occasionally, mosaic may appear as light and dark green areas in the leaves. Severely infected leaves turn brown and drop early. Tree vigor and yield may be reduced. The virus is transmitted by budding, grafting and by root grafts between adjacent trees.

10. **Trunk twisting and flattening**, believed by some to be caused by a virus, results in twisting and flattening of the trunk. Infected trees are generally weak and vigor declines by the sixth year.

11. **Russet-ring** is a viral disease that is fairly common in certain years. Affected Golden Delicious fruits develop narrow, irregularly closed rings to a solid circle of russet up to 1 to 2 inches in diameter. Yellow Newton apples develop elaborate networks of ring russeting, usually covering much of the fruit surface. Extensive, superficial, purple-to-brown blotches, without russeting, form on Stayman and Jubilee fruits. Some cultivars are symptomless carriers (see also Leaf pucker below).

12. **Leaf pucker** may be part of a virus complex with russet-ring and fruit blotch. Foliage symptoms appear on the first-formed leaves in early spring. Leaves on the fruit spurs appear dwarfed and puckered and sometimes show yellowish-green flecking. Symptoms are masked on leaves formed during hot weather. Fruit symptoms vary depending on the variety, tree, and orchard and are described under Russet-ring. The severity of leaf pucker and fruit russeting varies from season to season, depending largely on temperature. In cool summers severe russeting occurs; when summers are warm, no fruit symptoms occur and only the first-formed leaves develop puckering and flecking.

13. **2,4-D injury** appears as a curling, twisting, and distortion of the leaves. Often there is a fern-leaf effect instead of normal foliage. Fortunately, unless the dose (from spray drift, other air-borne particles and sprayer contamination) is too large, the plants gradually return to normal.

14. **Brown heart or core** is a noninfectious disease that develops in storages that are excessively cold (below 36° F.). The core is dark brown. Symptoms are not evident until the fruit are cut in half.

For chemical control suggestions, a listing of resistant varieties, and other control measures, consult the Extension Plant Pathologist at your land-grant university, or your county extension office.

Photo credits: University of Wisconsin (1L), British Ministry of Agriculture (1R, 5C, 6, 12, 13), University of Illinois (2, 3, 7L, 8L, 10, 11), BASF (4, 8R, 9), University of Missouri (5L), unknown (5R, 7R, 14), USDA and Clemson University (7 far L), S. V. Beer (7 far R).

APPENDICIES

APPENDIX 1

1994 - APPLE IPM SCOUTING LOG

Name: _____ Week of _____ thru _____

I. DAILY RECORDS

Date								
Time								
Min. Temperature								
Max. Temperature								
Rainfall Total								
Trap (Codling Moth)								
Trap (San Jose Scale)								
Development Stage*								

* **D**=dormant, **GT**=green tip, **TC**=tight cluster, **PK**=pink, **B**=bloom, **PF**=petal fall, **PB**=post bloom

II. WEEKLY SPRAY RECORD

Product (include herbicides)	**Date**	**Rate**	**IPM and / or STD Block**	**Comments**

III. WEEKLY MANAGEMENT RECORD

Activity (Mowing, Fertilization, Thinning, Pruning,...)	**IPM and / or STD Block**	**Comments**

IV. SCOUTING REPORT

Pest	IPM Trees						Standard Trees					
	1	2	3	4	5	Avg	1	2	3	4	5	Avg
Bud Count/Foot												
Weed Pressure	**Height**						**% Ground Cover**					

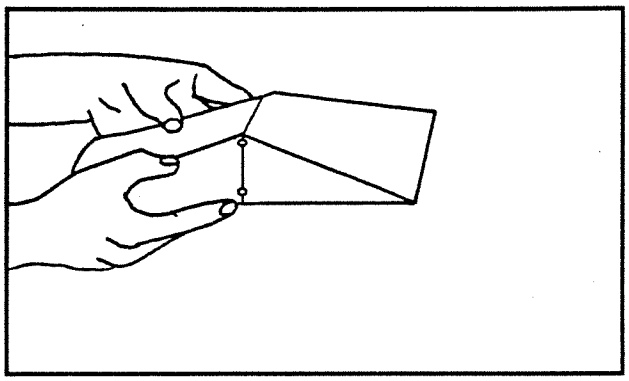
Scouting Comments (grower)

Notes and Action
(UK Specialists)

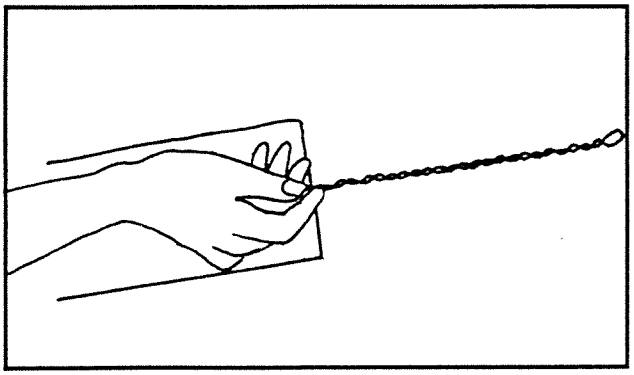
zoëcon®
Zoecon Corporation
Pherocon Supply Service
975 California Avenue
Palo Alto, Calif. 94304
415/857-1130

APPENDIX 2 Instructions for Assembling Pherocon™ 1C Traps

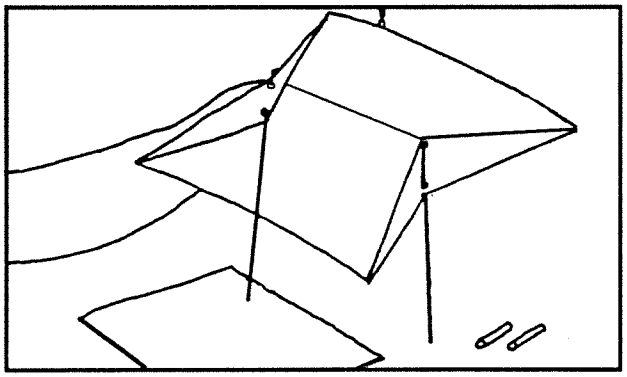
1. Remove one folded trap top, one folded trap bottom, (with sticky inside surface) two spacers and one wire hanger from shipping container.



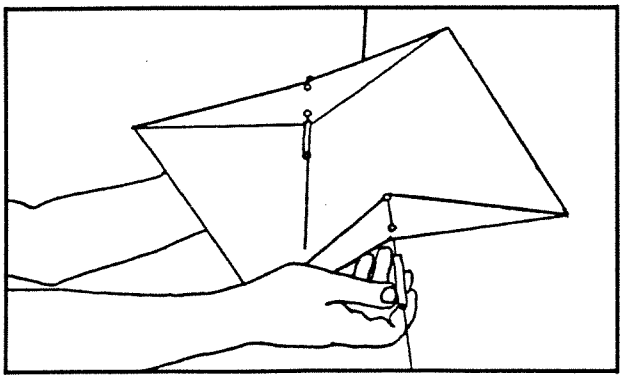
2. Open top section and push down on side panels to position shown. Be sure to fold only along score marks provided.



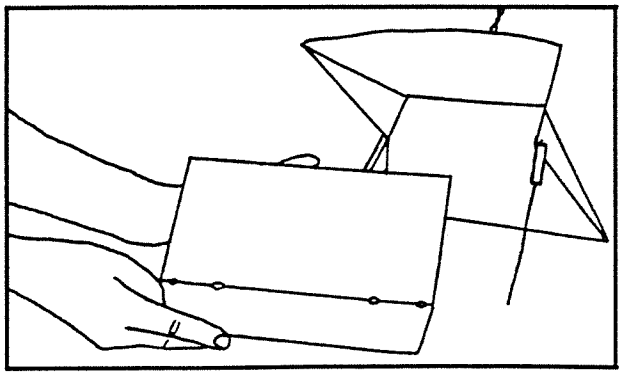
3. Straighten wire hanger to shape shown.



4. Insert ends of wire hanger into holes provided in side panels of top section. Weave wire ends through top holes from the outside and through bottom holes from the inside. With wire ends inserted in holes, push wire hanger down as far as it will go.

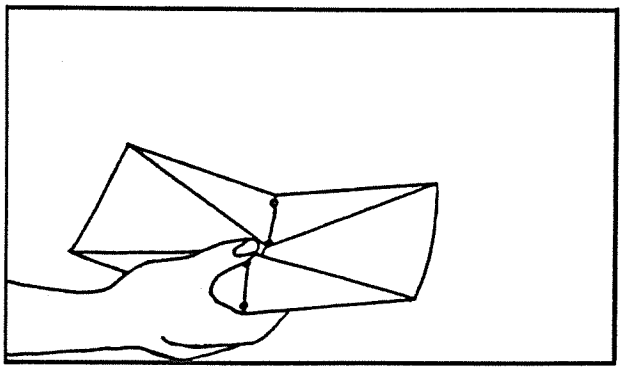


5. Slide one spacer on each of the wire ends. Push them up all the way up to the bottom hole so that the ends of the spacers are caught and held between the wires and the side panels.

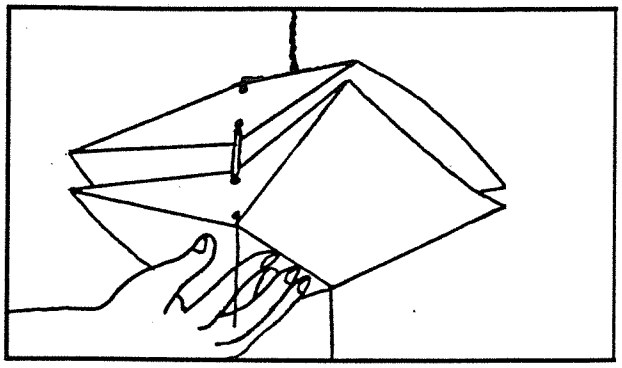


6. Open folded bottom section as shown to expose sticky surface.

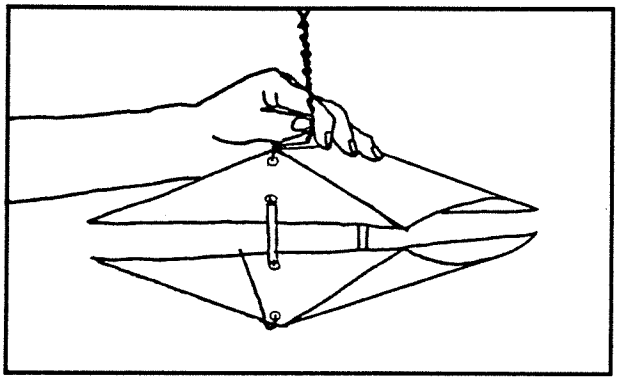
over



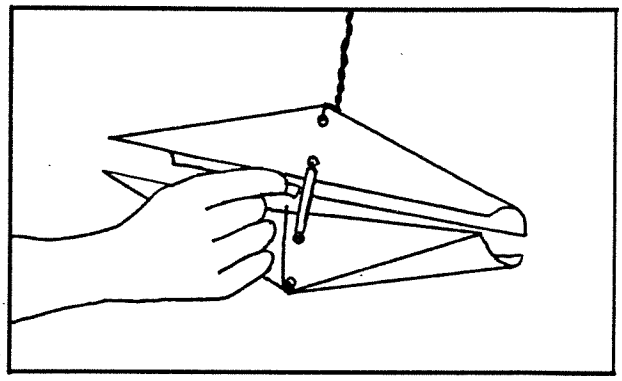
7. Push up on side panels to position shown. Be sure to fold only along score marks provided.



8. Insert ends of wire hanger into holes provided in both side panels of bottom section. Weave wire ends through top holes from the outside and through bottom holes from the inside.



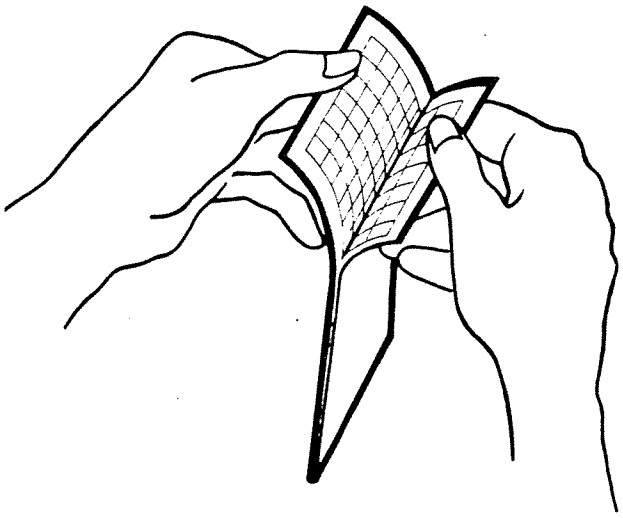
9. Push bottom section all the way up to the top hole so that the ends of the spacers are in line with the top holes of the bottom section between the wires and the side panels. Then bend projecting wire ends outward and upward as shown.



10. Place Pherocon Cap directly on sticky surface by dropping it through the side opening and into the center of the trap. To hang trap in tree, wrap braided portion of wire securely around limb. Place trap in orchard according to location and density recommendations.

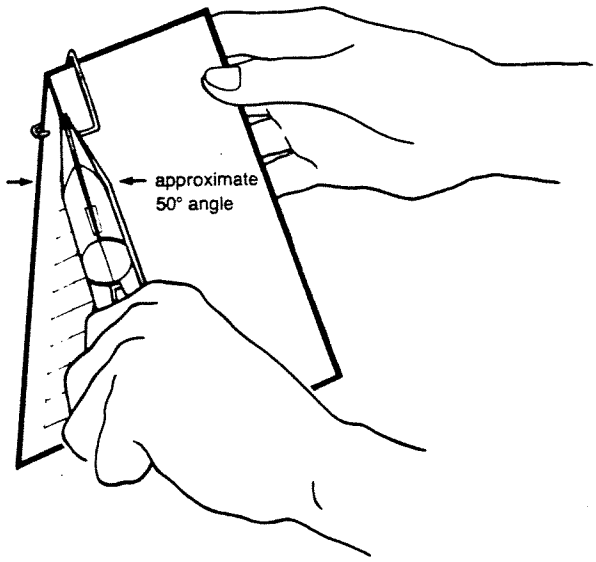
Note: To facilitate replacement of caps and the removal of insects, bottom section may be lowered on one side by straightening the wire end on that side. Be sure to return bottom section, spacer and wire end to their original positions.

Pherocon® Tent™ Trap Assembly Instructions



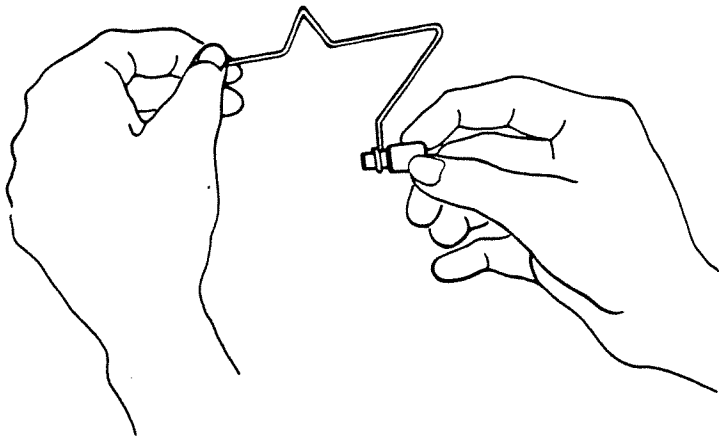
1

Unfold sticky card until it forms a tent.



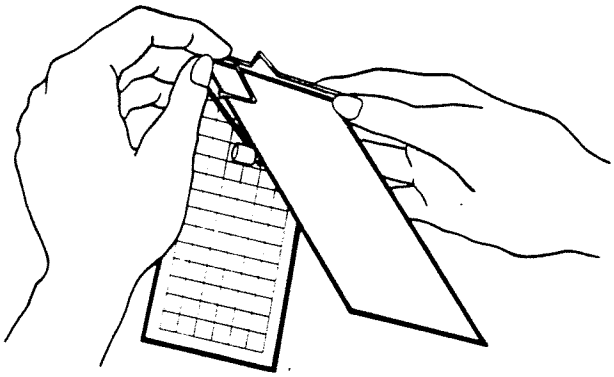
2

Slip the small wire (spacer) over the folded edge of the card so that the hook at each end of the wire grabs the edge of the card. Use needlenose pliers to pinch both hooks closed. Adjust angle of tent opening to approximately 50°.



3

Place the rubber attractant cap in the loop at the bottom of the larger wire. The cap is now at right angles to the wire. Twist the bottom loop so that the cap is parallel to the rest of the wire.



4

Slip the "shoulders" of the main wire over the fold of the card. Use the pliers to pinch the wire ends.

zoecon®

Zoecon Corporation
Agricultural Chemical Division
975 California Avenue, Palo Alto, Calif. 94304

APPENDIX 4

INSECT SAMPLE ABUNDANCE CLASSES AND ACTION THRESHOLDS, 1994.

Pest	Type of Sample	Few	Common	Abundant	Extreme
Codling moth	Per trap per week	1-4	5*	6-20	21+
Green fruitworm	Per 100 fruit clusters	1-9	10*	11-20	21+
Early season leafrollers (April & May)	Per trap per week	1-5	6-10	11-30	31+
	Per 100 fruit clusters	1-9	10*	11-20	21+
Oriental fruit moth	Per trap per week	1-9	10	11-20	21+
	Per 100 fruit clusters	1-3	4*-10	11-20	21+
Plum curculio**	Per 100 fruit clusters	0.1-0.9	1*	2-5	6+
Leafrollers	Per 100 leaves	1-3	4-6	7-10	11+
Rosy apple aphid	Per 100 fruit clusters	1-4	5*	6-10	11+
San Jose scale	Per trap per week	1*-100	100-1000	1001-3000	3000+
	Per tape (crawlers)	0.1-0.9	1*	2-10	11+
Tarnished plant bug	Per 100 fruit clusters	1-4	5*	6-10	11+
Aphids	Infested terminals / 100 leaf terminals	1-49	50*	51-70	71+
Woolly aphids	Infestations / 100 prunning scars	1-49	50*	51-70	71+
European red mites and Twospotted spider mites	Per leaf (until Apr 1 or less than 300 DD)***	1-2	2.5*	3-10	11+
	Per leaf (until June 1 or less than 1200 DD)***	1-4	5*	6-20	21+
	Per leaf (after June 1 or more than 1200 DD)***	1-7	7.5*	8-30	31+
Spotted tentiform leafminer	Per leaf (until 900 DD)***	0.1-0.9	1*	2-3	4+
	Per leaf (until 1700 DD)***	1	2*	3-4	5+
	Per leaf (until 2200 DD)***	1-2	3*	4-6	7+
	Per trap per week (until 300 DD)***	1-999	1000*	1001-2000	2000+
White apple leafhopper	Per leaf	1-2	3*	4-6	7+

* = Action Threshold

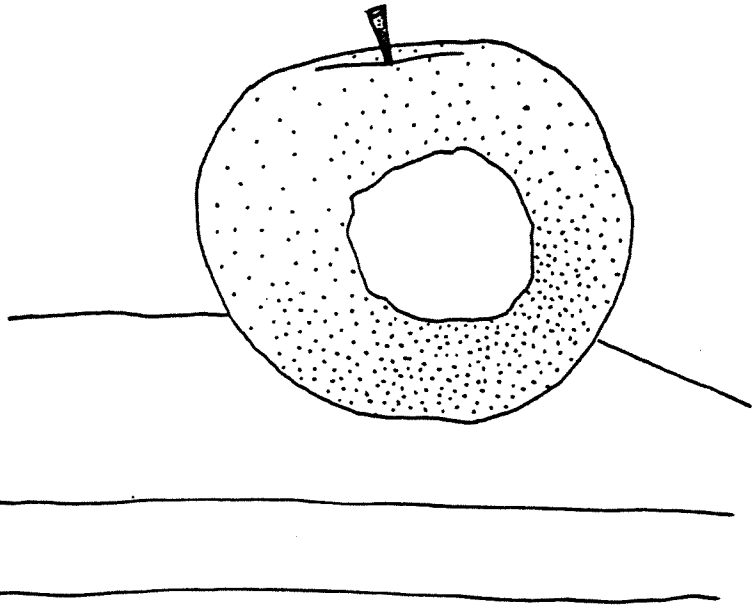
** Use precautionary sprays for plum curculio control at pink and petal fall stages of development.

*** Degree day measurements are more accurate than fixed calendar dates.

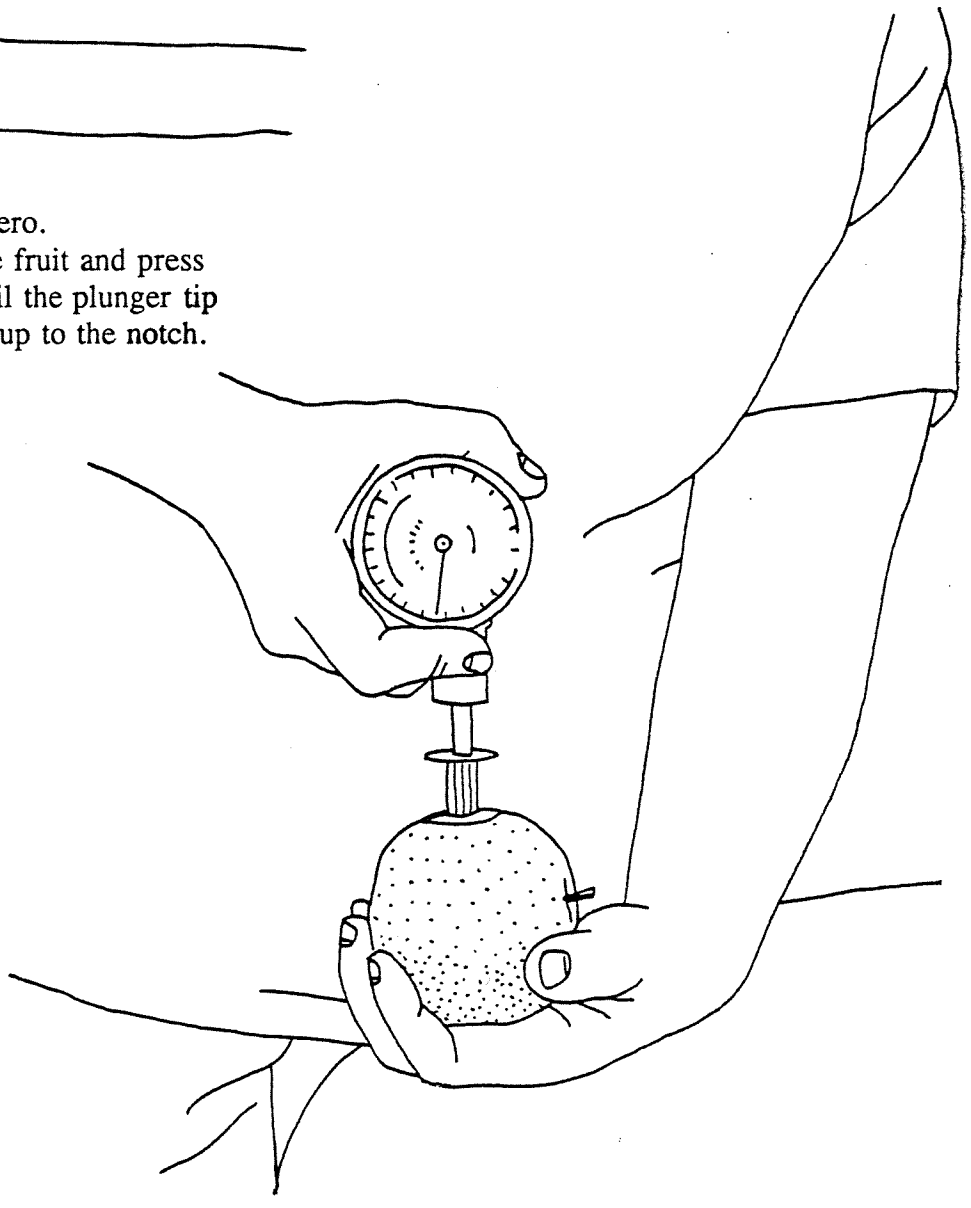
APPENDIX 5

Pressure Testing Fruit

1.) Remove 1/2 to 3/4 inch diameter of peel.



2.) Set the indicator button to zero.
Place the plunger against the fruit and press with increasing pressure until the plunger tip has penetrated into the pulp up to the notch.



APPENDIX 6

Vendors of Pressure Testers and Refractometers

Pressure Testers

McCormick Fruit Tech
6111-A Englewood Ave.
Yamika, WA 98908

Michigan Orchard Supply
07078 - 73½ St.
South Haven, MI 49090

Spectrum Technologies
12010 S. Aero Dr.
Plainfield, IL 60544
800/248-8873

Refractometers

McCormick Fruit Tech
6111-A Englewood Ave.
Yakima, WA 98908
509/966-3999

Michigan Orchard Supply
07078 - 73½ St.
South Haven, MI 49090
800/634-6426

Necessary Trading Co.
P.O. Box 305
New Castle, VA 24127
800/447-5354

Orchard Equipment &
Supply Co.
P.O. Box 540
Conway, MA 01341
800/634-5557

General Class Defects

DEFECT[1]		MEASURE	CODE	PART	UNIT	RATING										
						10	9	8	7	6	5	4	3	2	1	0
Size		Diameter	0	Surface	box	<72	72	80	88	100	113	125	138	150	>150	cider
Form		Maximum: Minimum length	1	Surface	ratio	1	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	>2.0
Color[2]		Area[3] of striped or partially red shade	2	Surface	%	100	99-75	74-66	65-50	49-40	39-33	32-25	24-15	14-10	9-1	0
		Area of compensating shade	3	Surface	%	100	99-90	89-80	79-66	65-50	49-40	39-30	29-20	19-10	9-1	0
Ripeness		Firmness	4	Internal	lb	8-8.4	8.5-8.9	9-9.9	10-10.9	11-11.9	12-12.9	13-13.9	14-14.9	15-17.4	17.5-20	<8>20
Immaturity		Taste	5	Internal	ns[4]	10	9	8	7	6	5	4	3	2	1	0
Invisible water core		Volume[5]	6	Internal	%	0	1-5	6-10	11-15	16-20	21-25	26-40	41-55	56-70	71-85	86-100
Internal breakdown		Volume	7	Internal	%	0	1-5	6-10	11-15	16-20	21-25	26-40	41-55	56-70	71-85	86-100
Internal browning		Volume	8	Internal	%	0	1-5	6-10	11-15	16-20	21-25	26-40	41-55	56-70	71-85	86-100
Core browning		Volume	9	Internal	%	0	1-5	6-10	11-15	16-20	21-25	26-40	41-55	56-70	71-85	86-100
Freezing (browning)		Volume	10	Internal	%	0	1-5	6-10	11-15	16-20	21-25	26-40	41-55	56-70	71-85	86-100
Moldy core		Volume	11	Internal	%	0	1-5	6-10	11-15	16-20	21-25	26-40	41-55	56-70	71-85	86-100
Scald	Broken skin (unhealed)	Area	12	Surface	%	0	1-5	6-10	11-15	16-20	21-25	26-35	36-50	51-65	66-80	81-100
Soft scald	Broken skin (unhealed)	Area	13	Surface	%	0	1-5	6-10	11-15	16-20	21-25	26-35	36-50	51-65	66-80	81-100
Cracks	Broken skin (unhealed)	Area	14	Surface	%	0	1-5	6-10	11-15	16-20	21-25	26-35	36-50	51-65	66-80	81-100
Cuts	Broken skin (unhealed)	Area	15	Surface	%	0	1-5	6-10	11-15	16-20	21-25	26-35	36-50	51-65	66-80	81-100
Hail	Broken skin (unhealed)	Area	16	Surface	%	0	1-5	6-10	11-15	16-20	21-25	26-35	36-50	51-65	66-80	81-100
Punctures	Broken skin (unhealed)	Area	17	Surface	%	0	1-5	6-10	11-15	16-20	21-25	26-35	36-50	51-65	66-80	81-100
Bruising	Broken skin (unhealed)	Area	18	Surface	%	0	1-5	6-10	11-15	16-20	21-25	26-35	36-50	51-65	66-80	81-100

LEGEND: US Extra Fancy | US Fancy | US Extra Fancy or US Fancy | US No.1 | Utility | Utility or Cull | Cull

Modified Russo/Rajotte Apple Grading Scheme

Physiological Defects

DEFECT	MEASURE	CODE	PART	UNIT	RATING										
					10	9	8	7	6	5	4	3	2	1	0
Cleaness (material)	Area of toxic spray residue	19	Surface	%	0	1-5	6-10	11-15	16-20	21-25	26-35	36-50	51-65	66-80	81-100
	Area of non-toxic spray residue	20		%	0	1-5	6-10	11-15	16-20	21-25	26-35	36-50	51-65	66-80	81-100
	Area of dirt residue	21		%	0	1-5	6-10	11-15	16-20	21-25	26-35	36-50	51-65	66-80	81-100
Freezing	Area	22		%	0	1-5	6-10	11-15	16-20	21-25	26-35	36-50	51-65	66-80	81-100
Visible water core/sun scald	Diameter of affected area	23		mm	0	<1.3	1.3-2.5	2.6-3.8	3.9-5	5.1-6.3	6.4-8.9	9-12.7	12.8-19	19.1-25	>25
Russeting (no pronounced color contrast)	Diameter[6] of rough texture	24		mm	0	<1.3	1.3-2.5	2.6-3.8	3.9-5	5.1-6.3	6.4-8.9	9-12.7	12.8-19	19.1-25	>25
	Diameter of slightly rough texture	25		mm	0	<1.3	1.3-2.5	2.6-3.8	3.9-5	5.1-6.3	6.4-8.9	9-12.7	12.8-19	19.1-25	>25
	Area of solid smooth pattern	26		%	0	1-5	6-10	11-15	16-20	21-25	26-35	36-50	51-65	66-80	81-100
	Area of net-like smooth pattern	27		%	0	1-5	6-10	11-15	16-20	21-25	26-35	36-50	51-65	66-80	81-100
Russeting (Pronounced color contrast)	Diameter of rough texture	28		mm	0	<1.3	1.3-2.5	2.6-3.8	3.9-5	5.1-6.3	6.4-8.9	9-12.7	12.8-19	19.1-25	>25
	Diameter of slightly rough texture	29		mm	0	<1.3	1.3-2.5	2.6-3.8	3.9-5	5.1-6.3	6.4-8.9	9-12.7	12.8-19	19.1-25	>25
	Area of solid smooth pattern	30		%	0	1-3	4-8	9-15	16-20	21-25	26-35	36-50	51-65	66-80	81-100
	Area of net-like smooth pattern	31		%	0	1-3	4-8	9-15	16-20	21-25	26-35	36-50	51-65	66-80	81-100
York skin cracks	Absolute diameter of individual cracks	32		mm	0	<0.1	0.1-0.2	0.3-1.5	1.6-2.5	2.6-3.1	3.2-3.8	3.9-6.3	6.4-12.7	12.8-25	>25
Skin checking	Absolute depth of individual crack	33		mm	0	<0.1	0.1-0.2	0.3-1.5	1.6-2.5	2.6-3.1	3.2-3.8	3.9-6.3	6.4-12.7	12.8-25	>25
Heat cracking (well-healed broken skin)	Absolute aggregate diameter of cracks	34		mm	0	<1.3	1.3-2.5	2.6-3.8	3.9-5	5.1-6.3	6.4-8.9	9-12.7	12.8-19	19.1-25	>25
	Relative aggregate diameter of cracks	35		%	0	1-2	3-5	6-8	9-10	11-12	13-15	16-25	26-50	51-75	76-100
York skin cracks	Absolute diameter of individual cracks	36		mm	0	<0.1	0.1-0.2	0.3-1.5	1.6-2.5	2.6-3.1	3.2-3.8	3.9-6.3	6.4-12.7	12.8-25	>25
Skin checking	Absolute depth of individual crack	37		mm	0	<0.1	0.1-0.2	0.3-1.5	1.6-2.5	2.6-3.1	3.2-3.8	3.9-6.3	6.4-12.7	12.8-25	>25
Heat cracking (unbroken skin)	Absolute aggregate diameter of cracks	38		mm	0	<1.3	1.3-2.5	2.6-3.8	3.9-5	5.1-6.3	6.4-8.9	9-12.7	12.8-19	19.1-25	>25
	Relative aggregate diameter of cracks	39		%	0	1-2	3-5	6-8	9-10	11-12	13-15	16-25	26-50	51-75	76-100

Modified Russo/Rajotte Apple Grading Scheme

Physiological Defects continued

DEFECT	MEASURE	CODE	PART	UNIT	RATING										
					10	9	8	7	6	5	4	3	2	1	0
Hail (well-healed broken skin)	Absolute diameter of individual mark	40	Surface	mm	0	<0.1	0.1-0.2	0.3-1.5	1.6-2.5	2.6-3.1	3.2-3.8	3.9-6.3	6.4-12.7	12.8-25	>25
	Absolute depth of individual mark	41		mm	0	<0.1	0.1-0.2	0.3-1.5	1.6-2.5	2.6-3.1	3.2-3.8	3.9-6.3	6.4-12.7	12.8-25	>25
	Absolute aggregate diameter of marks	42		mm	0	<1.3	1.3-2.5	2.6-3.8	3.9-5	5.1-6.3	6.4-8.9	9-12.7	12.8-19	19.1-25	>25
	Area of marks	43		%	0	1-2	3-5	6-8	9-10	11-12	13-15	16-25	26-50	51-75	76-100
Hail (unbroken skin)	Absolute diameter of individual mark	44		mm	0	<0.1	0.1-0.2	0.3-1.5	1.6-2.5	2.6-3.1	3.2-3.8	3.9-6.3	6.4-12.7	12.8-25	>25
	Absolute depth of individual mark	45		mm	0	<0.1	0.1-0.2	0.3-1.5	1.6-2.5	2.6-3.1	3.2-3.8	3.9-6.	6.4-12.7	12.8-25	>25
	Absolute aggregate diameter of marks	46		mm	0	<1.3	1.3-2.5	2.6-3.8	3.9-5	5.1-6.3	6.4-8.9	9-12.7	12.8-19	19.1-25	>25
	Area of marks	47		%	0	1-2	3-5	6-8	9-10	11-12	13-15	16-25	26-50	51-75	76-100
Broken skin Old cuts Abrasions Stem pulls (well-healed broken skin)	Absolute diameter of individual mark	48		mm	0	<0.1	0.1-0.2	0.3-1.5	1.6-2.5	2.6-3.1	3.2-3.8	3.9-6.3	6.4-12.7	12.8-25	>25
	Absolute depth of individual mark	49		mm	0	<0.1	0.1-0.2	0.3-1.5	1.6-2.5	2.6-3.1	3.2-3.8	3.9-6.3	6.4-12.7	12.8-25	>25
	Absolute aggregate diameter of marks	50		mm	0	<1.3	1.3-2.5	2.6-3.8	3.9-5	5.1-6.3	6.4-8.9	9-12.7	12.8-19	19.1-25	>25
	Area of marks	51		%	0	1-2	3-5	6-8	9-10	11-12	13-15	16-25	26-50	51-75	76-100
Abrasions Dents (unbroken skin)	Absolute diameter of individual mark	52		mm	0	<0.1	0.1-0.2	0.3-1.5	1.6-2.5	2.6-3.1	3.2-3.8	3.9-6.3	6.4-12.7	12.8-25	>25
	Absolute depth of individual mark	53		mm	0	<0.1	0.1-0.2	0.3-1.5	1.6-2.5	2.6-3.1	3.2-3.8	3.9-6.3	6.4-12.7	12.8-25	>25
	Absolute aggregate diameter of marks	54		mm	0	<1.3	1.3-2.5	2.6-3.8	3.9-5	5.1-6.3	6.4-8.9	9-12.7	12.8-19	19.1-25	>25
	Area of marks	55		%	0	1-2	3-5	6-8	9-10	11-12	13-15	16-25	26-50	51-75	76-100
Stem/calyx cracks (well-healed)	Absolute aggregate length of cracks	56		mm	0	<1.3	1.3-2.5	2.6-3.8	3.9-5	5.1-6.3	6.4-8.9	9-12.7	12.8-19	19.1-25	>25
Bitter pit Lenticel spot	Area of pits	57		%	0	1-2	3-5	6-10	11-15	16-20	21-30	31-40	41-50	51-75	76-100
Jonathan spot	Area of spots	58		%	0	1-2	3-5	6-10	11-15	16-20	21-30	31-40	41-50	51-75	76-100

Modified Russo/Rajotte Apple Grading Scheme

Physiological Defects continued

DEFECT	MEASURE	CODE	PART	UNIT	RATING										
					10	9	8	7	6	5	4	3	2	1	0
Cork (York) spot Fruit spot (well-healed broken skin)	Absolute diameter of individual spot	59	Surface	mm	0	<0.1	0.1-0.2	0.3-1.5	1.6-2.5	2.6-3.1	3.2-3.8	3.9-6.4	6.4-12.7	12.8-25	>25
	Absolute depth of individual spot	60		mm	0	<0.1	0.1-0.2	0.3-1.5	1.6-2.5	2.6-3.1	3.2-3.8	3.9-6.4	6.4-12.7	12.8-25	>25
	Absolute aggregate diameter of spots	61		mm	0	<1.3	1.3-2.5	2.6-3.8	3.9-5	5.1-6.3	6.4-8.9	9-12.7	12.8-19	19.1-25	>25
	Relative aggregate area of spots	62		%	0	1-2	3-5	6-8	9-10	11-12	13-15	16-25	26-50	51-75	76-100
Cork (York) spot Fruit spot (unbroken skin)	Absolute diameter of individual spot	63		mm	0	<0.1	0.1-0.2	0.3-1.5	1.6-2.5	2.6-3.1	3.2-3.8	3.9-6.4	6.4-12.7	12.8-25	>25
	Absolute depth of individual spot	64		mm	0	<0.1	0.1-0.2	0.3-1.5	1.6-2.5	2.6-3.1	3.2-3.8	3.9-6.4	6.4-12.7	12.8-25	>25
	Absolute aggregate diameter of spots	65		mm	0	<1.3	1.3-2.5	2.6-3.8	3.9-5	5.1-6.3	6.4-8.9	9-12.7	12.8-19	19.1-25	>25
	Relative aggregate area of spots	66		%	0	1-2	3-5	6-8	9-10	11-12	13-15	16-25	26-50	51-75	76-100
Bruising (well-healed broken skin)	Absolute diameter of individual mark	67		mm	0	<0.1	0.1-0.2	0.3-1.5	1.6-2.5	2.6-3.1	3.2-3.8	3.9-6.3	6.4-12.7	12.8-25	>25
	Absolute depth of individual mark	68		mm	0	<0.1	0.1-0.2	0.3-1.5	1.6-2.5	2.6-3.1	3.2-3.8	3.9-6.3	6.4-12.7	12.8-25	>25
	Absolute aggregate diameter of marks	69		mm	0	<1.3	1.3-2.5	2.6-3.8	3.9-5	5.1-6.3	6.4-8.9	9-12.7	12.8-19	19.1-25	>25
	Area of marks	70		%	0	1-2	3-5	6-8	9-10	11-12	13-15	16-25	26-50	51-75	76-100
Bruising (unbroken skin)	Absolute diameter of individual mark	71		mm	0	1-8	9-10	11-12	13-14	15-16	17-18	19-20	21-22	23-29	>29
	Absolute depth of individual mark	72		mm	0	0.5-1	1.5-2	2.5-3	3.5-4	4.5-5	5.5-6	6.5-7	7.5-8	8.5-10	>10
	Absolute aggregate diameter of marks	73		mm	0	1-5	6-7	8-9	10-11	12-13	14-15	16-17	18-19	20-29	>29
	Area of marks	74		%	0	1-2	3-5	6-8	9-10	11-12	13-15	16-25	26-50	51-75	76-100
Limb rubs	Abs. aggr. diameter of dark brown rubs	75		mm	0	<1.3	1.3-2.5	2.6-3.8	3.9-5	5.1-6.3	6.4-8.9	9-12.7	12.8-19	19.1-25	>25
	Area of light brown rubs	76		%	0	1-3	4-8	9-15	16-20	21-25	26-35	36-50	51-65	66-80	81-100
Chemical injury (storage dips)	Diameter of heavily concentrated spots	77		mm	0	<1.3	1.3-2.5	2.6-3.8	3.9-5	5.1-6.3	6.4-8.9	9-12.7	12.8-19	19.1-25	>25
	Area of thinly scattered spots	78		%	0	1-5	6-10	11-15	16-25	26-33	34-40	41-50	51-66	67-75	76-100
Storage injury (Ammonia, CO_2, low O_2)	Aggregate diameter	79		mm	0	<1.3	1.3-2.5	2.6-3.8	3.9-5	5.1-6.3	6.4-8.9	9-12.7	12.8-19	19.1-25	>25
	Area	80		%	0	1-3	4-8	9-15	16-20	21-25	26-35	36-50	51-65	66-80	81-100

Modified Russo/Rajotte Apple Grading Scheme

Insect Defects

DEFECT	MEASURE	CODE	PART	UNIT	RATING										
					10	9	8	7	6	5	4	3	2	1	0
CM (tunneling)	Volume	81	Internal	%	0	1-5	6-10	11-15	16-20	21-25	26-40	41-55	56-70	71-85	86-100
CM (stings)	Absolute aggregate diameter of stings	82		mm	0	<1.6	1.6-3	3.1-4.7	4.8-6.3	6.4-9.5	9.6-12.7	12.8-15.9	16-19	19.1-25	>25
CM (unhealed/ decayed)	Number of stings	83		no.	0	1	2	3	4	5	6-10	11-15	16-20	21-30	>30
TABM scars	Absolute aggregate diameter of scars	84		mm	0	<1.6	1.6-3	3.1-4.7	4.8-6.3	6.4-9.5	9.6-12.7	12.8-15.9	16-19	19.1-25	>25
	Absolute depth of individual mark	85		mm	0	<0.1	0.1-0.2	0.3-1.5	1.6-2.5	2.6-3.1	3.2-3.8	3.9-6.3	6.4-12.7	12.8-25	>25
TABM (unhealed/ decayed)	Number of scars	86		no.	0	1	2	3	4	5	6-10	11-15	16-20	21-30	>30
RBLR scars	Absolute aggregate diameter of scars	87		mm	0	<1.6	1.6-3	3.1-4.7	4.8-6.3	6.4-9.5	9.6-12.7	12.8-15.9	16-19	19.1-25	>25
	Absolute depth of individual mark	88		mm	0	<0.1	0.1-0.2	0.3-1.5	1.6-2.5	2.6-3.1	3.2-3.8	3.9-6.3	6.4-12.7	12.8-25	>25
RBLR (unhealed/ decayed)	Number of scars	89		no.	0	1	2	3	4	5	6-10	11-15	16-20	21-30	>30
GFW scars	Diameter of indentation	90	Surface	mm	0	<1.3	1.3-2.5	2.6-3.8	3.9-5	5.1-6.3	6.4-8.9	9-12.7	12.8-19	19.1-25	>25
	Diameter of slightly rough texture	91		mm	0	<1.3	1.3-2.5	2.6-3.8	3.9-5	5.1-6.3	6.4-8.9	9-12.7	12.8-19	19.1-25	>25
	Absolute depth of individual mark	92		mm	0	<0.1	0.1-0.2	0.3-1.5	1.6-2.5	2.6-3.1	3.2-3.8	3.9-6.3	6.4-12.7	12.8-25	>25
GFW (unhealed/ decayed)	Number of scars	93		no.	0	1	2	3	4	5	6-10	11-15	16-20	21-30	>30
TPB scars	Absolute aggregate diameter of scars	94		mm	0	<1.6	1.6-3	3.1-4.7	4.8-6.3	6.4-9.5	9.6-12.7	12.8-15.9	16-19	19.1-25	>25
	Absolute depth of individual mark	95		mm	0	<0.1	0.1-0.2	0.3-1.5	1.6-2.5	2.6-3.1	3.2-3.8	3.9-6.3	6.4-12.7	12.8-25	>25
PC scars	Absolute aggregate diameter of scars	96		mm	0	<1.6	1.6-3	3.1-4.7	4.8-6.3	6.4-9.5	9.6-12.7	12.8-15.9	16-19	19.1-25	>25
Scale	Number of scales on green surface	97		no.	0	1	2	3	4	5	6-10	11-15	16-20	21-30	>30
	Number of scales on red surface	98		no.	0	1	2	3	4	5	6-10	11-15	16-20	21-30	>30
	Area of scales on any surface	99		%	0	1-2	3-5	6-8	9-10	11-12	13-15	16-25	26-50	51-75	76-100
Insect sooty mold or spotting	Diameter of heavily concentrated spots	100		mm	0	<1.3	1.3-2.5	2.6-3.8	3.9-5	5.1-6.3	6.4-8.9	9-12.7	12.8-19	19.1-25	>25
	Area of thinly scattered spots	101		%	0	1-5	6-10	11-15	16-25	26-33	34-40	41-50	51-66	67-75	76-100

Modified Russo/Rajotte Apple Grading Scheme

Disease Defects

DEFECT	MEASURE	CODE	PART	UNIT	RATING										
					10	9	8	7	6	5	4	3	2	1	0
Rusts	Absolute aggregate diameter of spots	102	Surface	mm	0	<1.6	1.6-3	3.1-4.7	4.8-6.3	6.4-9.5	9.6-12.7	12.8-15	16-19	19.1-25	>25
Apple Scab	Absolute aggregate diameter of spots	103		mm	0	<1.3	1.3-2.5	2.6-3.8	3.9-5	5.1-6.3	6.4-8.9	9-12.7	12.8-19	19.1-25	>25
Sooty blotch	Diameter of heavily concentrated spots	104		mm	0	<1.3	1.3-2.5	2.6-3.8	3.9-5	5.1-6.3	6.4-8.9	9-12.7	12.8-19	19.1-25	>25
Fly speck	Area of thinly scattered spots	105		%	0	1-5	6-10	11-15	16-25	26-33	34-40	41-50	51-66	67-75	76-100
Rots	Volume	106		%	0	1-5	6-10	11-15	16-20	21-25	26-40	41-55	56-70	71-85	86-100
Powdery mildew	Area of net-like smooth pattern	107		%	0	1-5	6-10	11-15	16-20	21-25	26-40	41-55	56-70	71-85	86-100
Brooks spot	Number of spots on green surface	108		no.	0	1	2	3	4	5	6-10	11-15	16-20	21-30	>30
	Number of spots on red surface	109		no.	0	1	2	3	4	5	6-10	11-15	16-20	21-30	>30
	Area of spots on any surface	110		%	0	1-2	3-5	6-8	9-10	11-12	13-15	16-25	26-50	51-75	76-100
Bird peck (decayed)	Number of pecks	111		no.	0	1	2	3	4	5	6-10	11-15	16-20	21-30	>30
Bird peck (healed)	Absolute aggregate diameter of pecks	112		mm	0	<1.6	1.6-3	3.1-4.7	4.8-6.3	6.4-9.5	9.6-12.7	12.8-15	16-19	19.1-25	>25
Other		113													

Modified Russo/Rajotte Apple Grading Scheme

1 Defect refers to any quality variable, other than size, having a range of values which delineate grade categories. (Based on Delicious grade standards. The chart should be modified for use with other cultivars.)

2 Color accounts for scarfskin-like disorders.

3 Area refers to *relative aggregate area* unless stated otherwise. Unit of measure is given as percentage (%) of total surface area of fruit.

4 Numerical Score: 0 = starchy; 5 = edible; 10 = mealy.

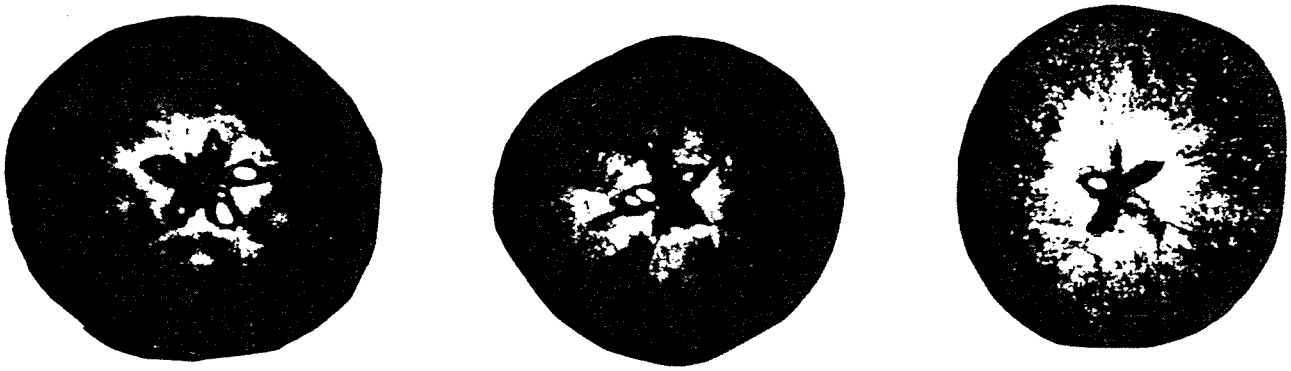
5 Volume refers to *relative aggregate volume* unless stated otherwise. Unit of measure is given as percentage (%) of total volume of fruit.

6 Diameter refers to *absolute aggregate diameter* unless stated otherwise. Unit of measure is given as diameter (mm) across the affected areas.

Red Delicious

STARCH-IODINE TEST GUIDES

IMMATURE



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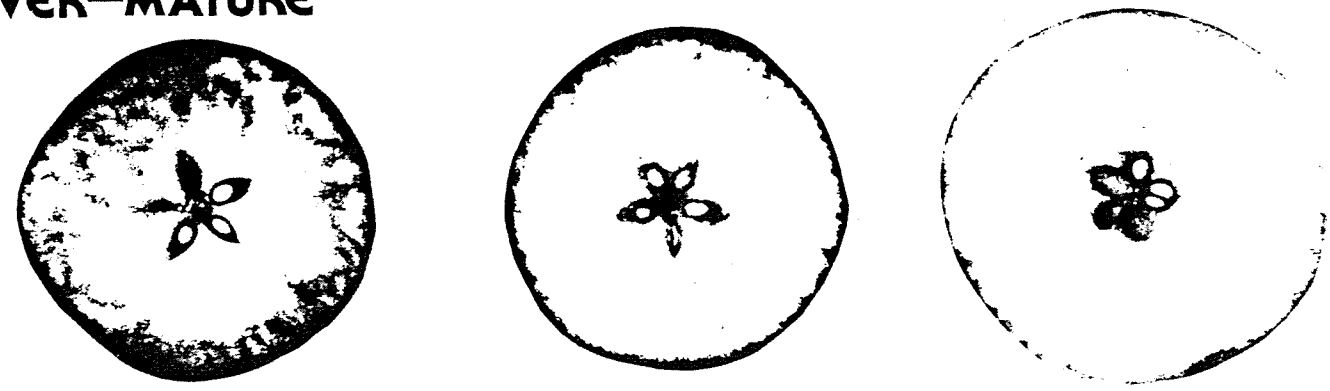
MATURE

4 5 6

OVER–MATURE



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Law Rome

IMMATURE

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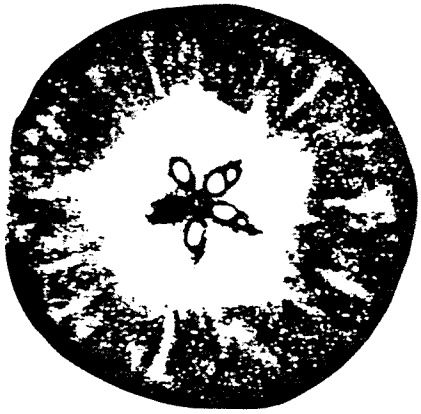
MATURE



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OVER—MATURE

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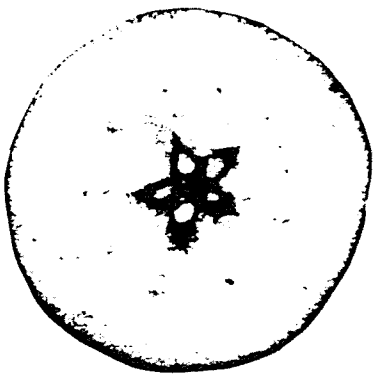

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Golden Delicious

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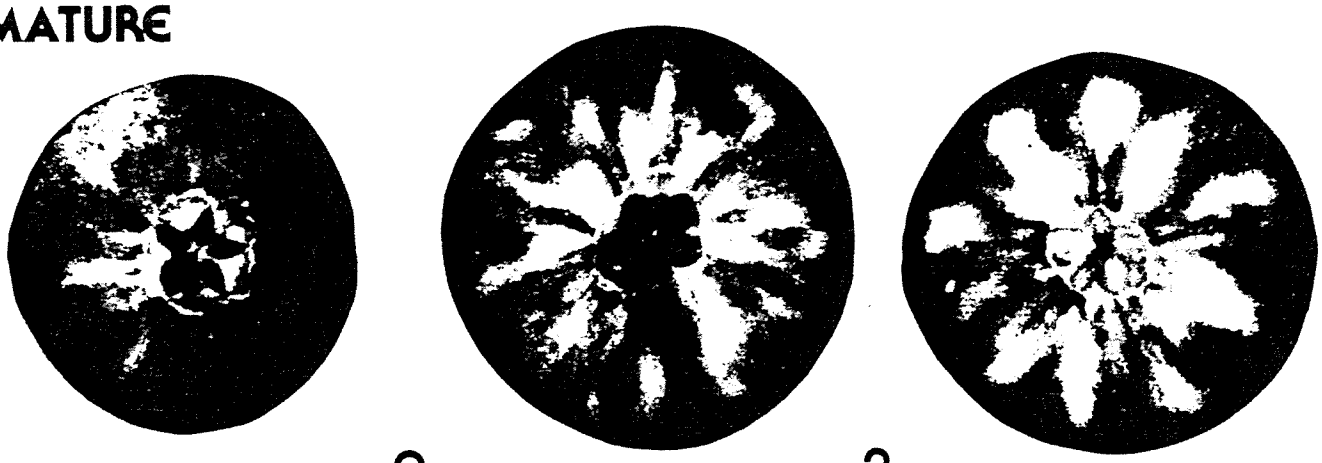

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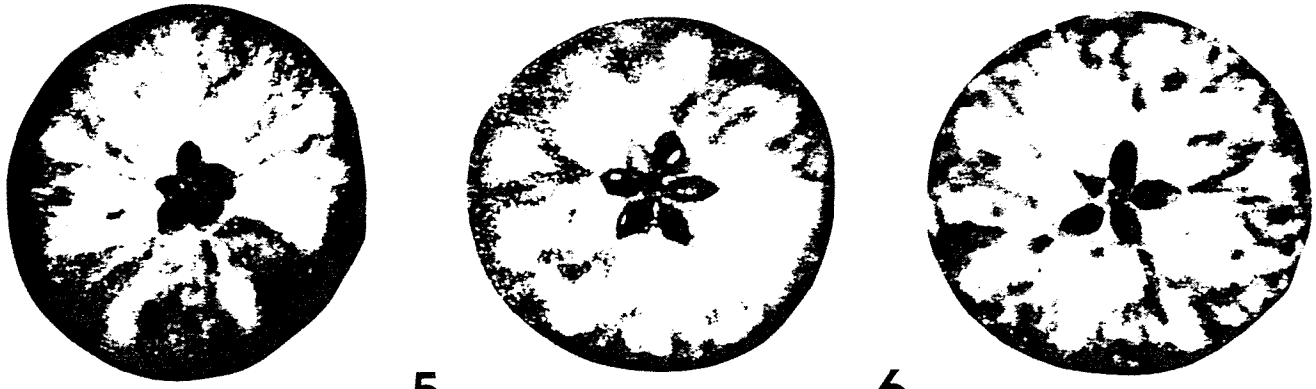

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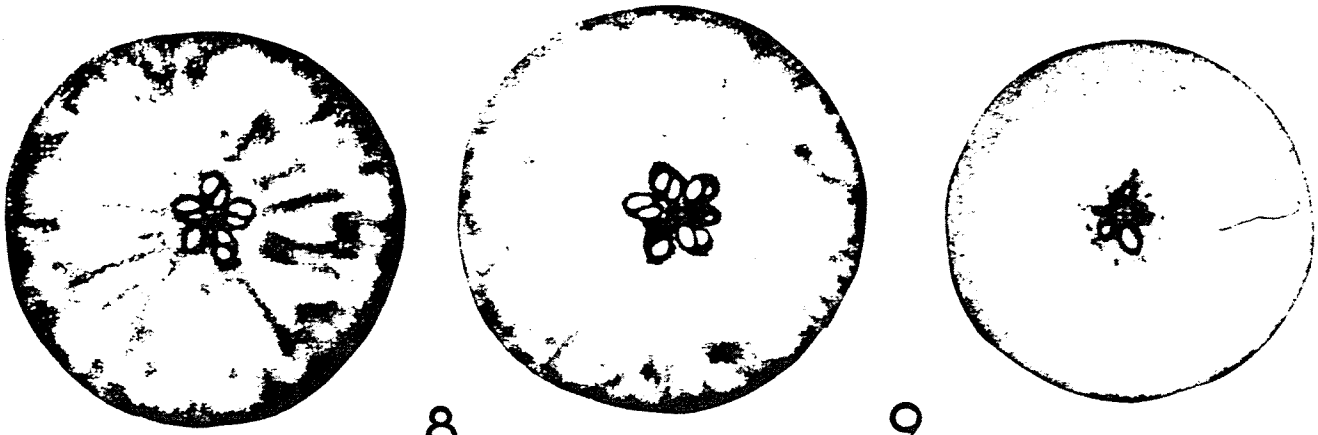
OVER—MATURE



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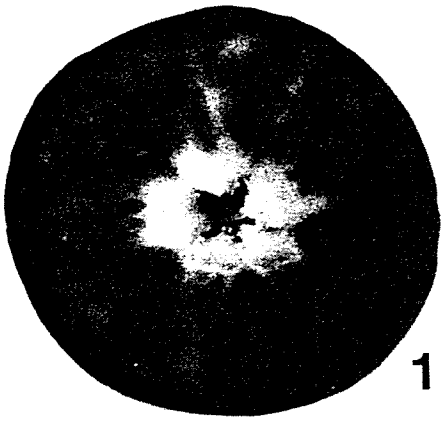
University of Massachusetts Cooperative Extension
Fruit Program

Mutsu Starch Chart

Duane W. Greene and Wesley R. Autio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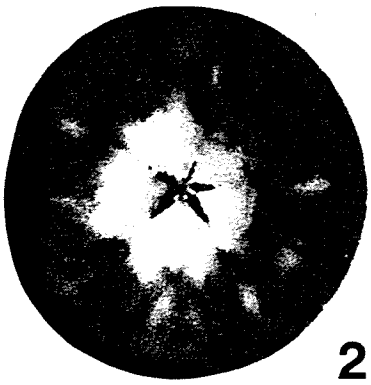
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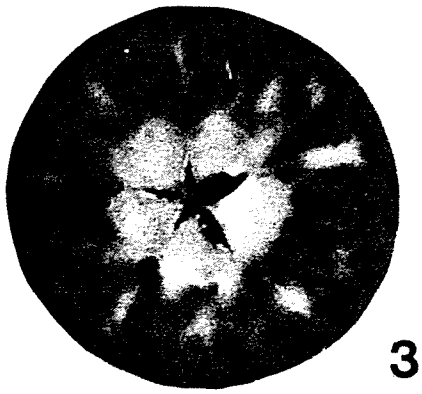
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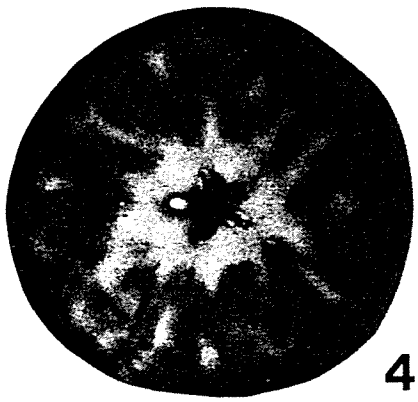
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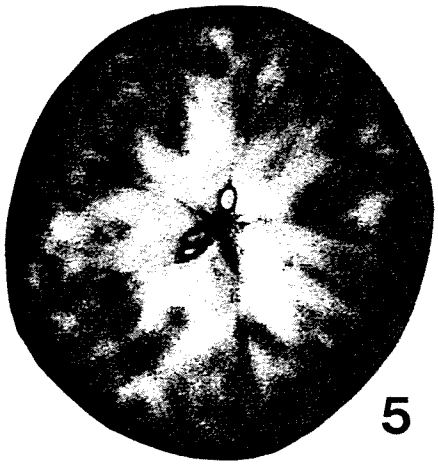
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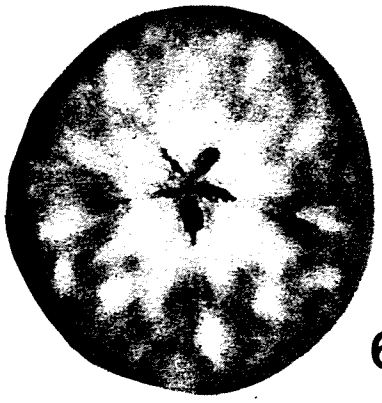
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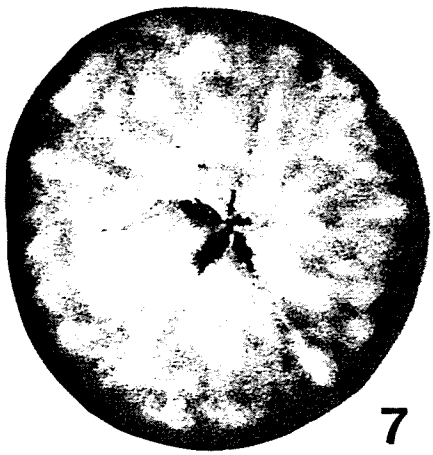
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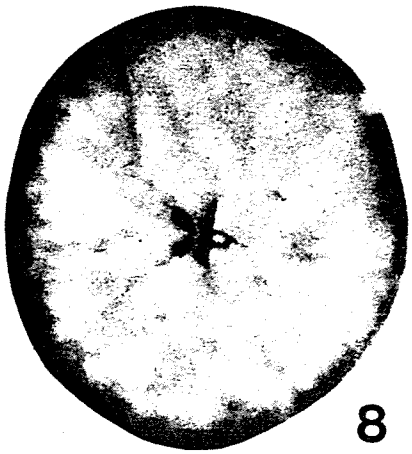
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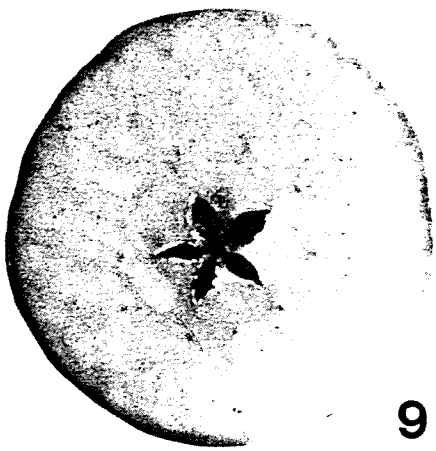
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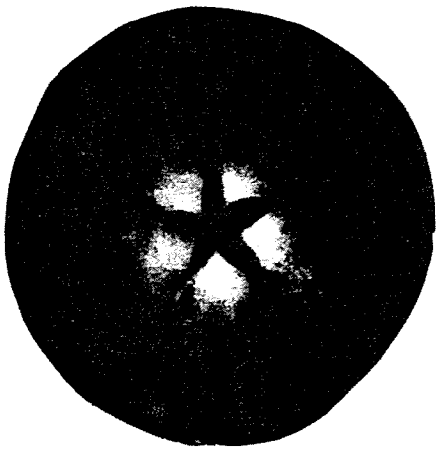
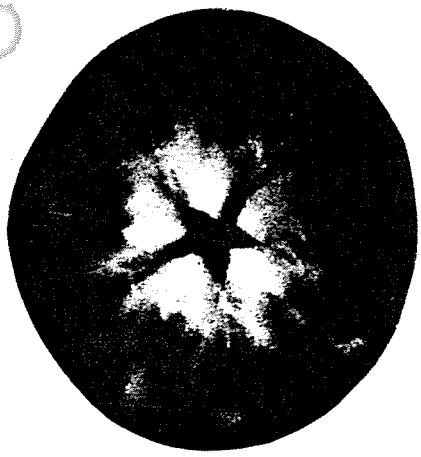
University of Massachusetts Cooperative Extension

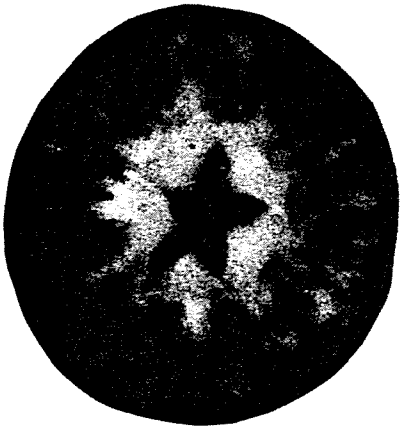
Fruit Program

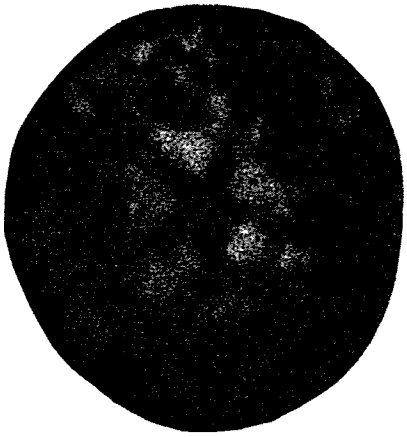
Cortland Starch Chart

James T. Williams and Wesley R. Autio



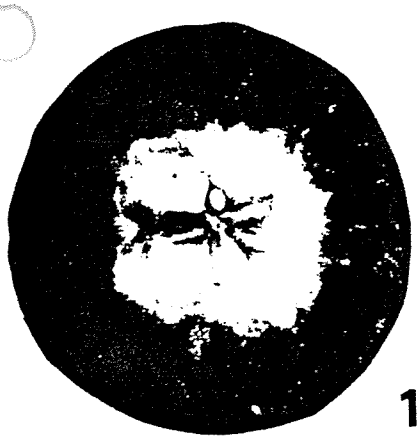






STARCH TEST GUIDE

FOR HARVESTING McINTOSH APPLES



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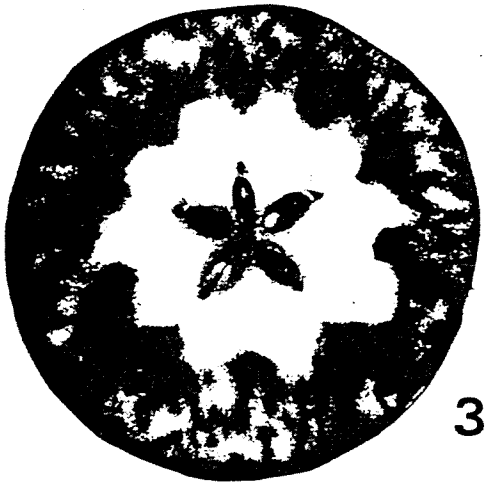

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IMMATURE

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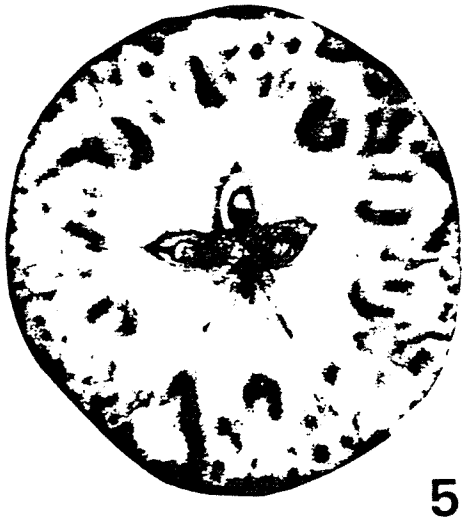

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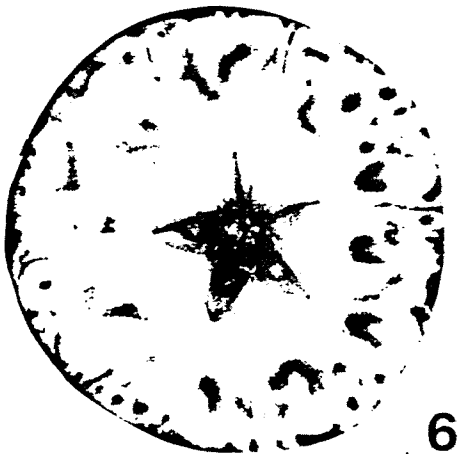

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MATURE

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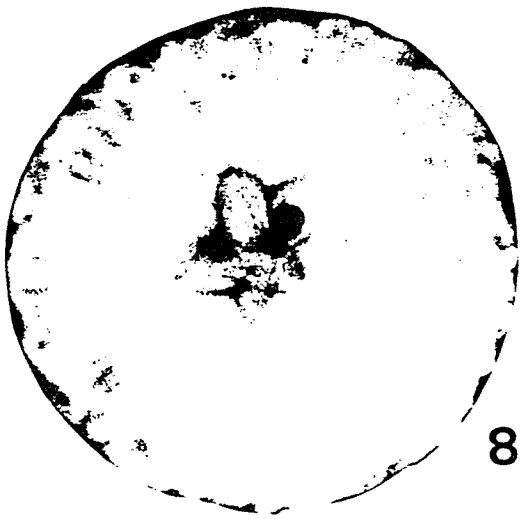

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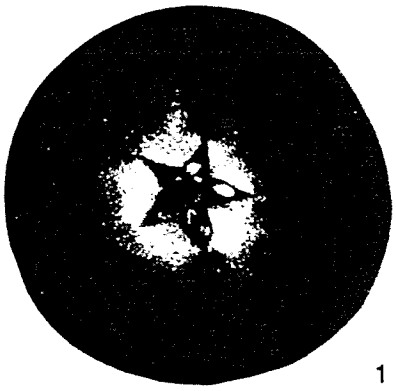
OVER-MATURE

Empire & Gala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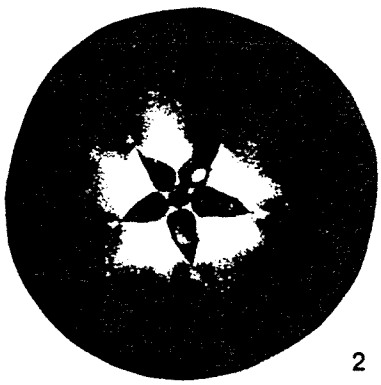
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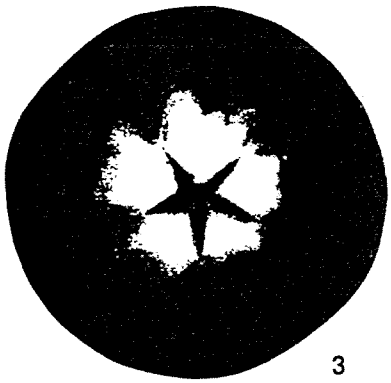
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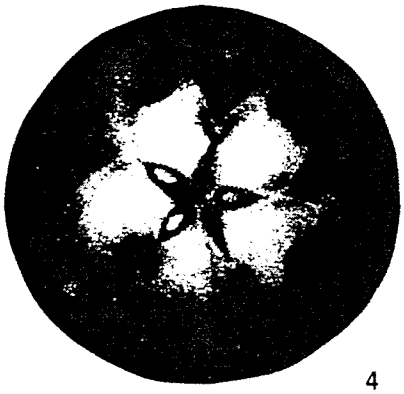
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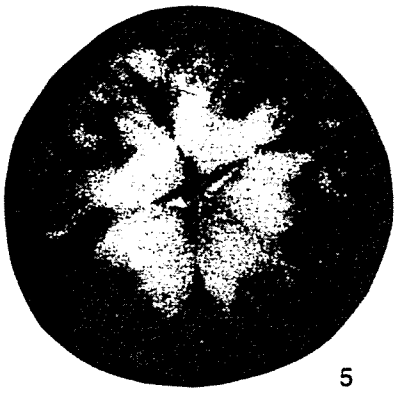
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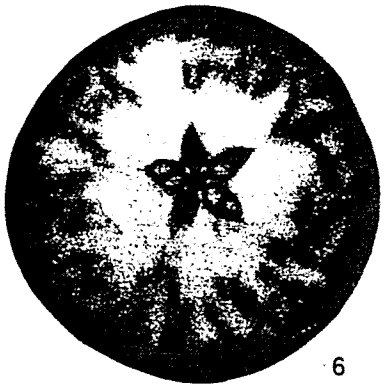
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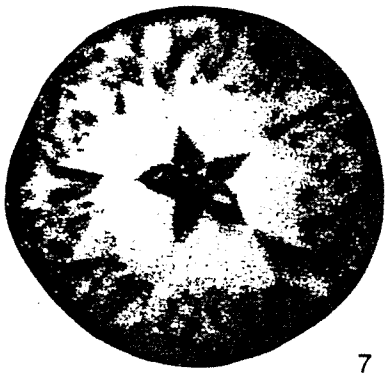
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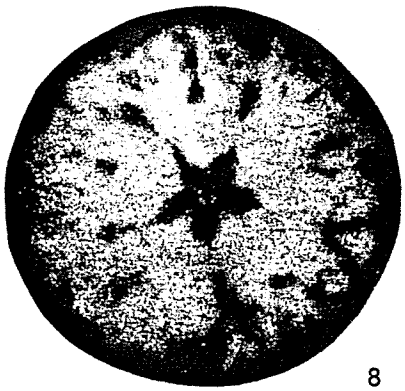
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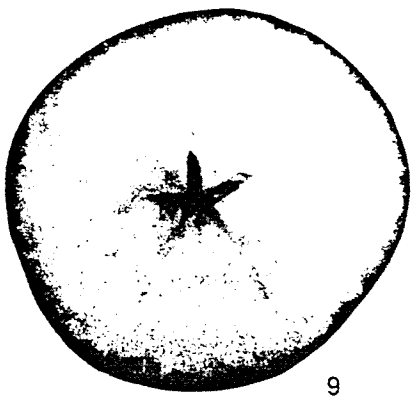
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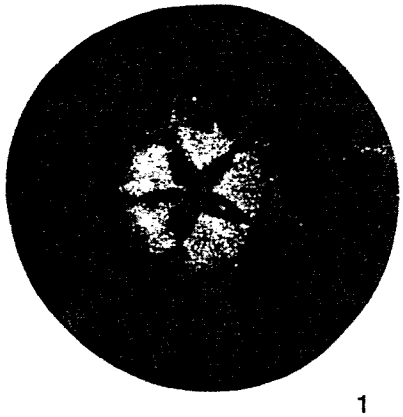

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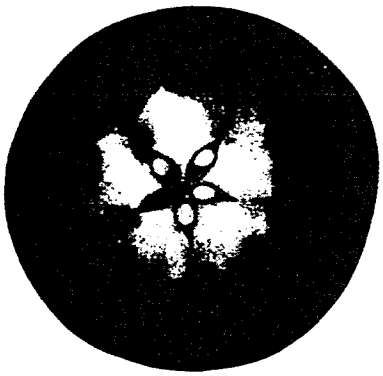

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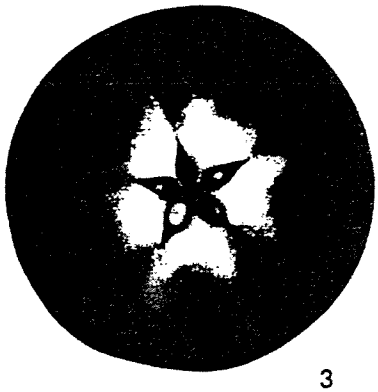

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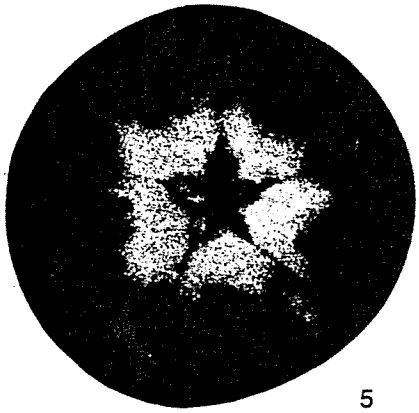

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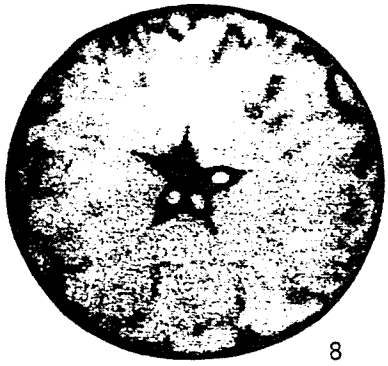

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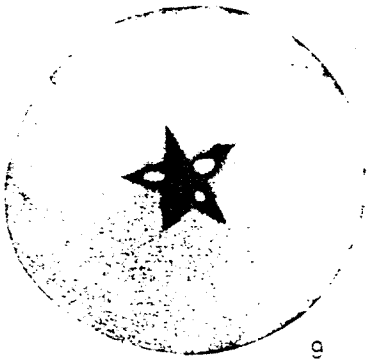

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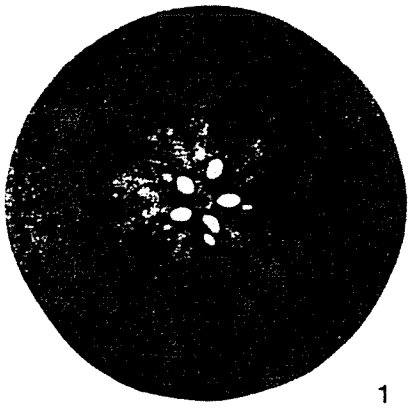

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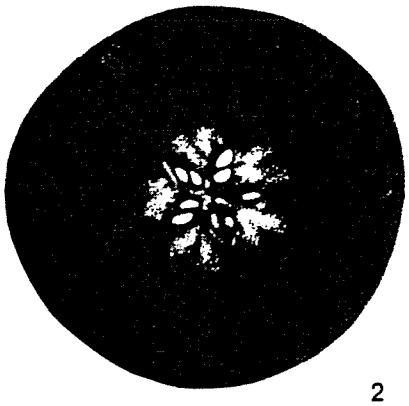

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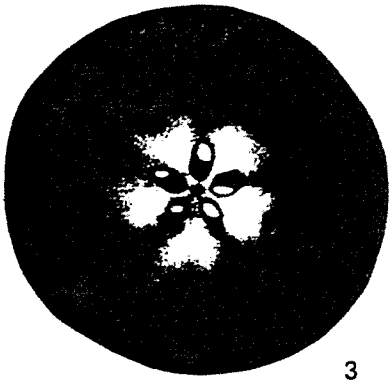

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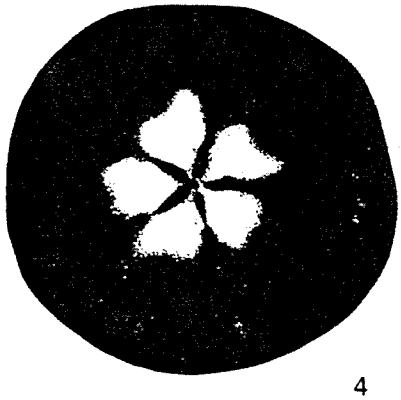

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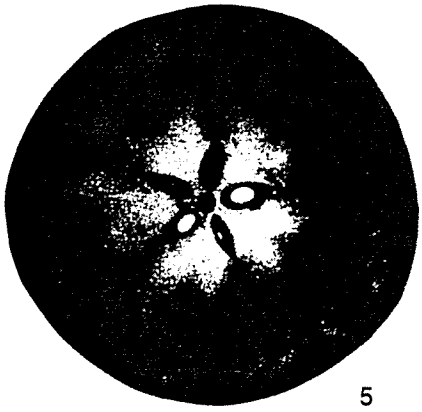

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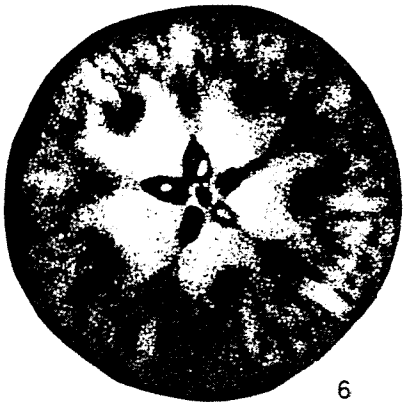

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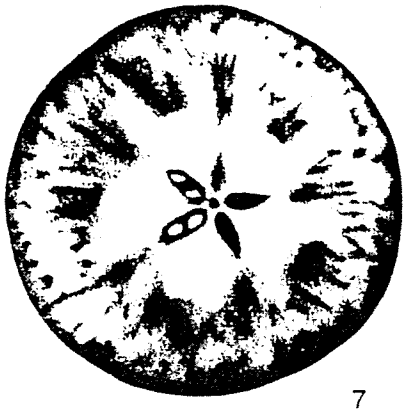

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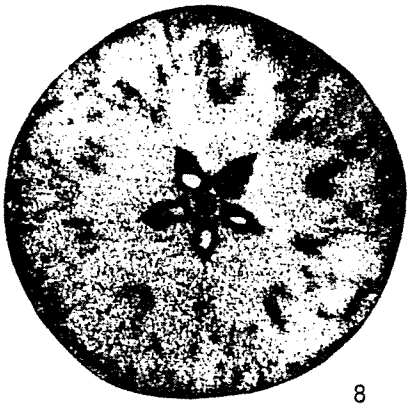

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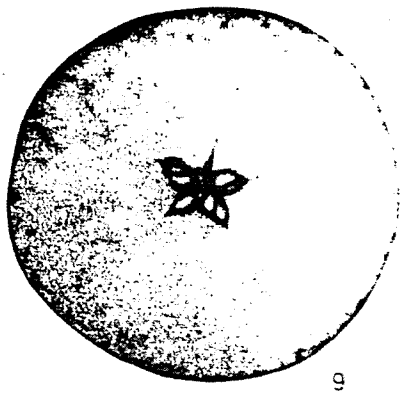
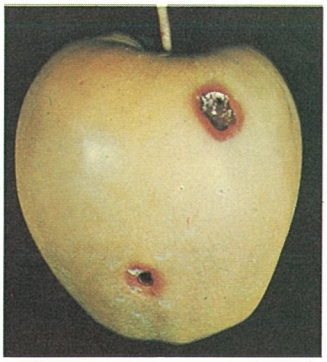


9

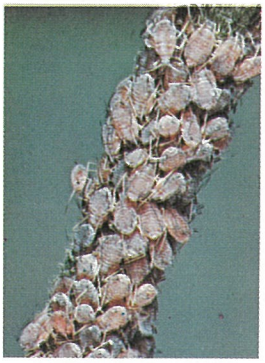
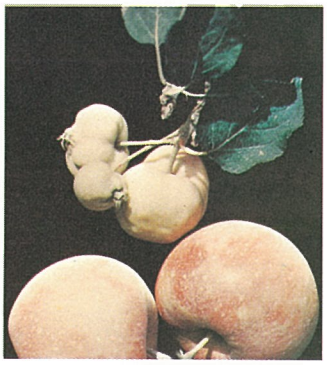
COMMON FRUIT INSECTS

For safe and effective use of insecticides, always identify the problem correctly.

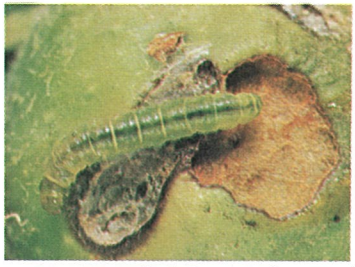



1. Codling moth adult and new larval entry, and damaged or "wormy" apple

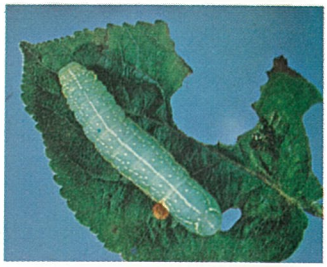

2. Apple maggot in apple, and blotching and streaking of maggot-infested fruit

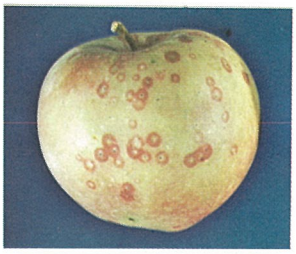
5. Rosy apple aphid, and deformed fruit shown with normal apples for comparison



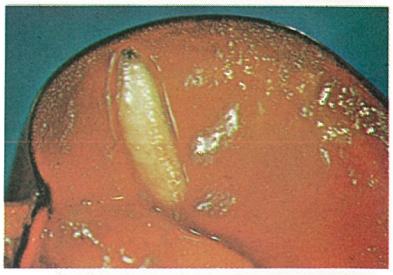
3. Red-banded leaf roller and damage



4. Green fruitworm



6. San Jose scale on apple



7. Cherry fruit fly maggot


8. Plum curculio adult and egg-laying slit on cherry, and curculio larva in plum

9. Two-spotted spider mite and eggs (enlarged). Not an insect.

10. Grape berry moth larva and damage


11. Oriental fruit moth. Twig damage and larva in peach.

12. Peach tree borer and pupa

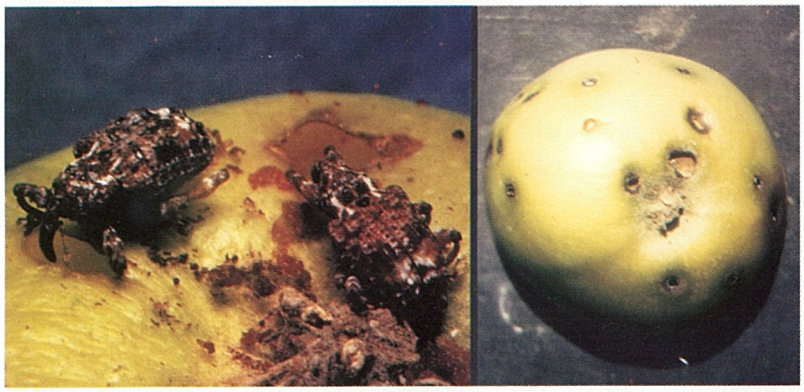
Prepared by Extension Entomologists of the North Central States in cooperation with the Federal Extension Service, U.S. Department of Agriculture

FRUIT PESTS I

1. Aphid

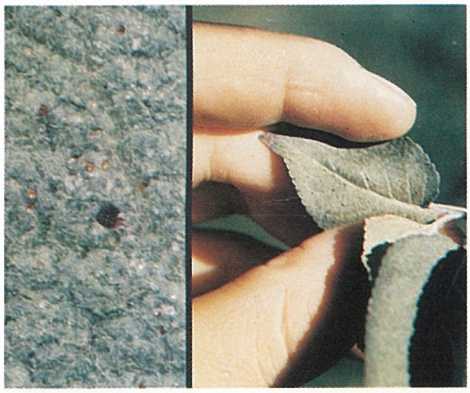
2. Codling Moth

3. Apple Maggot



4. Plum Curculio

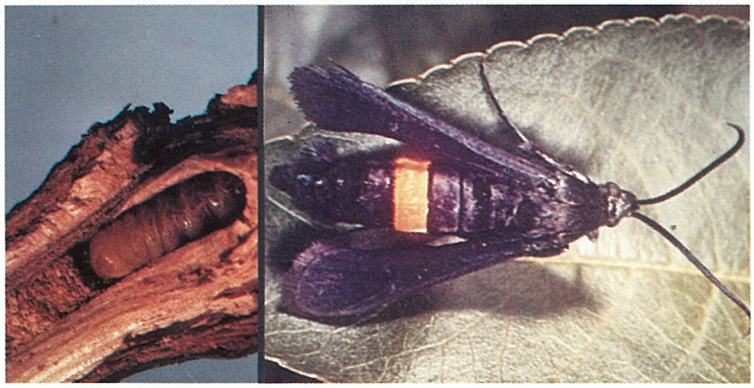
5. Leafroller



6. European Red Mite

7. Two-spotted Spider Mite

8. San Jose Scale



9. Peach Tree Borer

10. Picnic Beetle

UNIVERSITY OF ILLINOIS COLLEGE OF AGRICULTURE
COOPERATIVE EXTENSION SERVICE
and VOCATIONAL AGRICULTURE SERVICE

X698.46
July 1988
URBANA, ILLINOIS

FRUIT PESTS I

1. **Aphids** feed on plant sap and are most common on the tips of growing shoots and on young leaves. Large numbers of aphids may cause wilting and leaf curling, and produce large amounts of honeydew (concentrated plant sap). The pinhead-sized, pear-shaped insects may be green or any other color. Lady beetles, tiny parasitic wasps, and other insect predators usually reduce the number of aphids before insecticide spraying is needed. **Rosy Apple Aphid** causes small and misshapen fruit on apples.

2. **Codling Moth** caterpillars are the famous "worms" in the apple. Mature caterpillars overwinter in bark crevices and in other protected areas. The resulting adult moths lay eggs on the leaves and developing fruit. These eggs hatch into caterpillars that enter the core of the apple to feed, producing excrement that exudes from the blossom end. Mature caterpillars then exit through the apple flesh to pupate in a protected area. There are two generations per year.

3. **Apple Maggots** overwinter as pupae in the soil, emerging as flies during the summer. Adult flies (about ¼ inch long) are most numerous from late July through August, laying their eggs on the developing apples. The eggs hatch into larvae that burrow through the apples, producing brown trails for which they are called "railroad worms." Mature larvae exit the fruit and drop to the ground to pupate.

4. **Plum Curculio** feeds on nectarine, plum, cherry, peach, apricot, apple, pear, and quince. The 3/16-inch-long adult beetles overwinter under fallen leaves and other debris, emerging in the spring to feed on flower pollen and leaves of the host tree. Egg laying begins once the fruit starts to form. The female beetle chews a hole in the fruit, lays an egg in the hole, and then chews a crescent around the egg, which results in a characteristic crescent-shaped wound. The egg hatches into a larva, which eats out a cavity in the fruit of apple and pear and feeds near the pit in stone fruits. Mature larvae leave the fruit and drop to the ground to pupate, emerging as adults in midsummer.

5. **Leafroller** caterpillars typically feed on leaves that are tied together with silk webbing. They will also feed between a leaf and fruit and between two fruits. When fruit feeding occurs, the caterpillars burrow into the fruit, causing damage. Red-banded, oblique-banded, and fruittree leafrollers feed on apple and other fruit trees. Adults are brownish, ¼-inch-long moths.

6. **European Red Mite** feeds on apple, pear, plum, and other fruit trees. These mites feed throughout the summer on the leaves, sucking the sap out of them. Heavy infestations result in reduced tree growth, fruit set, and fruit size, and cause the leaves to turn bronze or brown. They have several generations per year before overwintering as red eggs.

7. **Two-spotted Spider Mites** feed on the leaf sap of most tree and small fruits, causing leaves to turn bronze or brown in color. Adult mites are very small and barely visible to the naked eye. Other life stages are smaller. They are not insects, but have 8 legs and are closely related to spiders. There are many generations per year. These mites overwinter as adult females under loose bark and under debris on the ground.

8. **San Jose Scale** feeds on apple, pear, plum, and other tree and small fruits. Partly grown nymphs overwinter on the tree, maturing in the spring. In June, the adult females give birth to living young, which feed on the sap of the leaves, bark, or fruit. Two or more generations are produced per year. The presence of scale on the fruit reduces its quality, and large populations on the tree may weaken or kill it.

9. **Peach Tree Borer** attacks peach, cherry, apricot, nectarine, and plum. The larvae feed as borers beneath the bark at the base of the tree. These borers overwinter as larvae, completing development to mature larvae that are 1½ inches long. After pupation, the adult moths emerge during the summer to mate and lay eggs. Adult moths are particularly attracted to trees with fresh wounds due to mechanical injury. Larvae hatching from the eggs bore into the bark at the base of the tree.

10. **Picnic Beetles** feed as adults on most ripe and rotting fruits and vegetables, but attack and damage strawberry fruits well before ripening. These ¼-inch-long adult beetles are more common near wooded areas where the larvae feed on decaying plant material. Picking berries as soon as they are ripe and removing any damaged or rotten berries are the most effective ways to avoid damage.

Prepared by Philip L. Nixon, Ph.D., Extension Entomologist, Cooperative Extension Service, University of Illinois. Assisted by Ken McPheeters, Ph.D., Horticulture Specialist, Vocational Agriculture Service, University of Illinois.

Vendors of Beneficial Organisms in North America

D.W. Johnson, Extension Entomologist, University of Kentucky

The author would like to thank Mr. Larry G. Bezark and the California Biological Control Services Program for graciously providing information included in this publication.

Inclusion in this publication does not imply any endorsement nor does exclusion imply any criticism of suppliers or their products. Microbial, or single-celled, organisms (CGP, CPB, BP, GHP, MCP, MB, NPV) are considered pesticides under current government regulations. Before using these biologicals, consult your county Extension agent for information concerning legal use.

Introduction

Current attitudes in the United States concerning food safety and environmental quality have raised the general public's interest in alternative (non-synthetic pesticide) pest controls. Although unknown to most people, research and implementation of biological control projects has a long history in the United States. The year 1989 marked the 100th anniversary of the importation and release of the Vedalia beetle into the citrus groves of California. This "lady beetle" predator single-handedly reduced a major pest (Cottony Cushion Scale) to sub-economic levels.

Kentucky also has successfully utilized biological control. Importation and release of parasites and management of a fungal disease have greatly reduced the first generation of alfalfa weevil. Currently, research exploring the use of insect viral pathogens to control tobacco budworm is underway.

Although the use of one living organism (beneficial) to control another (pest) works, it can be quite complicated. Simple purchase of a beneficial organism may not be the answer to your pest problem. However, if you are willing to experiment and learn, you may find that use of the various forms of biological control provides good pest control.

Conditions for Success

Biological control (biocontrol) is very different from the use of insecticides for controlling insect pests. While biocontrol does work, is less harsh on the environment and is safer for people to handle, it also is much more complicated to implement. Unlike chemical insecticides, biocontrol organisms, called beneficials, are alive. They have behaviors which must be understood and are subject to the same adverse environmental factors as are the pest insects.

For best success, ensure that there is some prey for your beneficial organisms to feed on. (Pest insects are the food source of beneficials.)If beneficial organisms are released into an area with no prey, they will either leave in search of prey or die of starvation. Second, use as little insecticide as possible. Beneficials will be killed just as easily as pests by these materials. Additionally, because pest insects are prey (food) for beneficials, killing the pests removes the beneficials' food source. Therefore, beneficials are hit twice as hard as pests by any insecticidal application. As you become more adept at using beneficials, you will find that there are some "insecticides" that may be employed with no, or slight, harm to your beneficial insects.

Predatory Mites

PM Predatory Mites — various species
PMC — *Amblyseius californicus*
PMU — *Amblyseius cucumeris (for thrips)*
PMI — *Amblyseius iroquois (for thrips)*
PMO — *Metaseiulus occidentalis*
PML — *Phytoseiulus longipes*
PMM — *Amblyseins mckenziei (= barker)*
PMP — *Phytoseiulus persimilis*
PMA — *Pyemotes tritici (for ants)*

Fly Parasites

FP Fly Parasites — various species
FPR — *Carcinops sp.*
FPM — *Muscidifurax raptor*
FPL — *Muscidifurax raptorellus*
FPZ — *Muscidifurax zaraptor*
FPN — *Nasonia vitripennis*
FPP — *Pachycrepoideus vindemiae*
FPC — *Spalangia cameroni*
FPS — *Spalangia endius*
FPA — *Spalangia nigroaenea*
FPG — *Sphegigaster sp.*

Parasitic Nematodes

PN Parasitic Nematodes — various species
PNB — *Neoaplectana bibionis*
PNG — *Neoaplectana glaseri*
PNH — *Heterorhabditis heliothidis*
PNC — *Steinernema feltiae (= Neoaplectana carpocapsae)*

Other Organisms

CGP — *Agrobacterium radiobacter* — Crown Gall Preventive
AE — *Anagrus epos* — Leafhopper Parasite
AC — *Anisopteromalus calandrae* — Stored Product Weevil Parasite
APA — *Aphidoletes aphidimyza* — Aphid Predator
RSM — *Aphytis melinus* — Red Scale Parasite
BP — *Bacillus popilliae* — Milky Spore
MB — *Bacillus thuringiensis israeliensis* — Mosquito Bacterium
CPB — *Bacillus thuringiensis var. San Diego* — Colorado Potato Beetle
BH — *Bracon hebetor* — Stored Product Moth Larva Parasite
CN — *Chilocorus nigritus* — Scale Predator
GL — *Chrysoperia carnea or C. rufilabrus* — Green Lacewings
RSB — *Comperiella bifasciata* — Red Scale Parasite
GMC — *Cotesia melanoscela* — Gypsy Moth Parasite
MD — *Cryptolaemus montrouzieri* — Mealybug Destroyer
DB — *Dacnusa sibirica* — Leafminer Parasite
DP — *Delphastus sp.* — Whitefly Egg Predator
DI — *Diglyphus isaea* — Leafminer Parasite
CPP — *Edovum puttleri* — Colorado Potato Beetle Parasite
GWP — *Encarsia formosa* — Greenhouse Whitefly Parasite
MF — *Gambusia affinis* — Mosquito Fish
AM — *Aphidus matricariae* — *Aphid parasite*
MBP — *Orius tristicolor* — *Thrips predator*
GMI — *Glyptapanteles indiensis* — *Gypsy moth parasite*
GMG — *Glyptapanteles flavicoxis* — Gypsy Moth Parasite
NOW — *Goniozus legneri* — Navel Orangeworm Parasite
CL — *Hippodamia convergens* — Convergent Ladybird Beetle
CMD — *Leptomastix dactylopii* — Citrus Mealybug Parasite
LT — *Lysiphlebus testaceipes* — Greenbug Parasite
BSP — *Metaphycus helvolus* — Black Scale Parasite
GMM — *Meteorus pulchricornis* — Gypsy Moth Parasite
PBP — *Microchelonus blackburni* — Pink Bollworm Parasite
PM — *Podisus maculiventris* — Mexican Bean Beetle Predator
MCP — Mormon Cricket Pathogen
GHP — *Nosema locustae* — Grasshopper Pathogen
NPV — Nuclear Polyhedrosis Virus
BBP — *Pediobius foveolatus* — Bean Beetle Parasite
NOP — *Pentalitomastix sp.* — Navel Orangeworm Parasite
DS — *Rumina decollata* — Decollate Snail
PMT — *Tenodera aridifolia sinensis* — Praying Mantid
EW — *Trichogramma sp. (minutum, platneri, pretiosum)* — Egg Wasps
XF — *Xylocoris flavipes* — Stored Product General Predator

The caterpillar larval bacterium *Bacillus thuringiensis* is available through many retail and wholesale concerns under various brand names.

Predatory Mites	Fly Parasites	Parasitic Nematodes	Other Organisms	Supplier	Mail Order	Phone Order	Retail	Whole-sale	Notes
			CGP	Ag Bio Chem Inc. 3 Fleetwood Court Orinda, CA 94563 (415)254-0789	x	x		x	Free brochure
PMM,PMO PMP,PMU	FP		APA, BSP CMD, GWP MD, RSM MMU, DP, CL	Applied Bionomics 11074 W. Saanich Rd. Sidney, B.C. Canada, V8L 3X9 (604)656-2132	x	x	x	x	Free catalog Need permit for US import
			DS,MD RSM	Associates Insectary P.O. Box 969 Santa Paula, CA 93060 (805)933-1301	x	x			
PMC,PML PMO,PMP	FP,FPM FPN,FPS FPZ		EW,GHP GL	Beneficial Insectary 245 Oak Run Road Oak Run, CA 96069 (916)472-3715	x	x	x	x	Postage paid
	FP		EW,GL	Beneficial Insects Ltd. P.O. Box 154 Banta, CA 95304 (209)835-6158	x		x		Lacewings April-July

Predatory Mites	Fly Parasites	Parasitic Nematodes	Other Organisms	Supplier	Mail Order	Phone Order	Retail	Whole-sale	Notes
PMM,PMP			APA,GWP	Better Yield Insects P.O. Box 3451 Tecumseh Station Windsor, Ontario Canada, N8N 3C4 (519)735-0002	x	x	x	x	Need permit for US import
PMC,PMP	FPG,FPG FPS,FPZ		AE	Bio Ag Services 4218 W. Muscat Fresno, CA 93706 (209)268-2835		x	x	x	Free brochure Consulting
			DS	Bio-Con Systems P.O. Box 30186 San Bernardino, CA 92413 (619)242-3800	x	x	x	x	Free brochure
PMA	FPM,FPS		AC,BH,EW GL,XF	Biofac P.O. Box 87 Mathis, TX 78368 (512)547-3259	x	x	x	x	Brochures available
			EW,CL	Bio Insect Control 710 S. Columbia Plainview, TX 79072 (806)293-5861	x	x	x	x	
		PN,PNC		BioLogic P.O. Box 177 18056 Springtown Rd. Willow Hill, PA 17271-0177 (717)349-2789	x	x	x	x	Free brochure send SASE Free con-sultation
		PNC		Biosys 1057 E. Meadow Circle Palo Alto, CA 94303 (415)856-9500	x			x	Free brochure

Predatory Mites	Fly Parasites	Parasitic Nematodes	Other Organisms	Supplier	Mail Order	Phone Order	Retail	Whole-sale	Notes
PMC, PML PMO, PMP				Biotactics Inc. 22412 Pico Street Grand Terrace, CA 92324 (714)783-2148	x	x	x		Information PMO is OP resistant strain
	FP		EW, GL NOW, NOP	Bo-Biotrol, Inc. 54 S. Bear Creek Drive Merced, CA 95340 (209)722-4985	x	x	x	x	Free literature and price list
		PN, PNB PNC, PNG		B.R. Supply Company P.O. Box 845 Exeter, CA 93221	x			x	
			BP	Burgess Seed & Plant Co. Department 91 905 Four Seasons Road Bloomington, IL 61701 (309)663-9551	x	x	x		Free catalog
		PN	CL, EW GL, PMT	Burpee Seed Company 300 Park Avenue Warminster, PA 18974 (215)674-4900	x				Free catalog
			BP	Fairfax Biological Laboratories, Inc. Clinton Corners, NY 12514 (914)266-3705	x	x	x	x	Free brochure

Predatory Mites	Fly Parasites	Parasitic Nematodes	Other Organisms	Supplier	Mail Order	Phone Order	Retail	Whole-sale	Notes
			BP,GHP,MB	Farmers Seed & Nursery Department 71 1706 Morrissey Drive Bloomington, IL 61704 (309)663-9551	x	x	x		Free catalog
	FP		CL,EW,GHP GL,PMT	Henry Field Seed & Nursery Co. 415 N. Burnett St. Shenandoah, IA 51602 (605)665-4491	x	x	x		Free catalog
PM	FP		BSP,CL,DS EW,GL,GWP MD,PMT,RSM	Foothill Ag Research, Inc. 510 W. Chase Drive Corona, CA 91720 (714)371-0120	x	x	x	x	Free literature
			CL	Fountain's Sierra Bug Co. P. O. Box 114 Rough & Ready, CA 95975 (916)273-0513	x	x	x	x	Free brochure
PMM,PMP PMU			APA,DB DI,GWP	Gerhart, Inc. 6346 Avon Belden Road North Ridgeville, OH 44039 (216)327-8056	x	x		x	Free Catalog Consulting
	FP		CL,EW GHP,GL PMT	Gurney Seed & Nursery Corp. 2nd and Capitol Yankton, SD 57078 (605)665-4451	x	x	x		Free catalog
PMC. PML PMM. PMO PMP, PMU	FPM,FPP EPR,FPS	PN, PNH, PNC	ABA, BSP CL, CGP, DS EW, GHP, GL GWP, MB, MD PMT, RSB, RSM, CPB, DB	Harmony Farm Supply P.O. Box 460 Graton, CA 95444 (707)823-9125	x	x	x	x	$2 Charge for catalog (Refundable with order)

Predatory Mites	Fly Parasites	Parasitic Nematodes	Other Organisms	Supplier	Mail Order	Phone Order	Retail	Whole-sale	Notes
PMM, PMP, PMC, PMU, PML		PNH, PNC	APA, CL GL, GWP, MD, DP, GHP, EW	Hydro-Gardens, Inc. P. O. Box 9707 Colorado Springs, CO 80932 (303)893-3618	x	x	x	x	No charge for catalog
PMP, PMU PMC, PMO PML, PMM	FPC, FPM FPN	PNC	CGP, GWP APA, MB GL, MD, DP DI, EW	IPM Laboratories, Inc. Main Street Locke, NY 13092-0099 (315)497-3129	x	x	x	x	Free catalog Consulting
PMA	EPA, FPC FPG, FPL FPM, FPS FPZ		CL, EW GL	Kunafin Trichogramma Insectaries Route 1, P.O. Box 39 Quemado, TX 78877 (512)773-0149	x	x	x	x	Free information
			CL, PMT	Lakeland Nurseries Sales Inc. 340 Poplar Street Hanover, PA 17331 (717)637-5555	x	x	x		Free catalog
PMO				Mead's Resistant Predatory Mites, 9093 Troxel Road Chico, CA 95928 (916)895-8125		x	x	x	Free information Sulfur & OP resistant strain

Predatory Mites	Fly Parasites	Parasitic Nematodes	Other Organisms	Supplier	Mail Order	Phone Order	Retail	Whole-sale	Notes
	FPS,FPZ		BP,CL EW,GHP GL,GWP MCP,MD PMT	Mellinger's Nursery 2310 W. South Range Road North Lima, OH 44452 (216)549-9861 (800)321-7444 (orders/catalog)	x	x	x		Free catalog
			BP	Miller Nurseries 5060 West Lake Road Canandaigua, NY 14424 (716)396-2647	x		x		Free catalog
			DS	Chuck Musgrove 2707 Monroe St. Riverside CA 92504 (714)785-1680		x		x	Will ship UPS Wholesale only
			GMC, GMG GMM, GMI	National Gypsy Moth Management Group RD 1, Box 715 Landisburg, PA 17040 (717)789-3434	x		x	x	Free brochure IPM services
			PMT	Nationwide Seed & Supply 4801 Fengenbush Lane Louisville, KY 40228 (502) 499-0115	x				Postage paid
PMC, PML PMP	PN	PNH, PNC	BP,CL CPB,EW GHP,GL GWP,MB PM,PMT	Gardens Alive! Hwy 48, P.O. Box 149 Sunman, IN 47041 (812)623-3800	x	x	x		Free catalog
PMC,PMO PMP,PMU	FPN,FPS FPZ		BSP,CL DB,DI EW,GL MB,MF PBP,PMT	Natural Pest Controls 8864 Little Creek Drive Orangevale, CA 95662 (916)726-0855	x		x	x	Free brochure

Predatory Mites	Fly Parasites	Parasitic Nematodes	Other Organisms	Supplier	Mail Order	Phone Order	Retail	Whole-sale	Notes
PMC,PML PMP	FP	PN	APA,CL,EW, GL,MD,PMT	Nature's Control P.O. Box 35 Medford, OR 97501 (503)899-8318	x	x	x	x	Free brochure
PMC,PMO PMP	FP	PNC	BBP,BP,CL, CPP,EW,GHP, GL,GWP,MB, MD,NPV	Necessary Trading Co. P.O. Box 603 New Castle, VA 24127 (703)864-5103	x	x	x	x	Catalog $2 refundable with order
PMP	FP	PNC	CL, PMT GL, EW DS, GWP	Organic Control, Inc. 5132 Venice Blvd. Los Angeles, CA 90019 (213)937-7444	x	x	x	x	Free catalog Postpaid
PM,PMI PMU	FP	PNC	APA,BSP,CL CMD,EW,GL, GWP,MB,MD, PMT,RSM	Organic Pest Mgmt. Consultant P.O. Box 55267 Seattle, WA 98155 (206)367-0707	x			x	Charge for catalog
			BP	Richard Owen Nursery Department 36 2300 East Lincoln St. Bloomington, IL 61701 (309)663-9551	x	x	x		Free catalog
PMC,PML PMO,PMP			DS	Pacific Tree Farms 4301 Lynwood Drive Chula Vista, CA 92010 (619)422-2400	x	x	x	x	Charge for catalog

Predatory Mites	Fly Parasites	Parasitic Nematodes	Other Organisms	Supplier	Mail Order	Phone Order	Retail	Whole-sale	Notes
PMP,PMU			DB,DI,GWP	Plant Sciences, Inc. 514 Calabasas Road Watsonville, CA 95076 (408)728-7771		x	x	x	Catalog IPM information
PM	FP	PN	CMD,DP,GWP MG,RSM	Praxis P.O. Box 134 Allegan, MI 49010 (616)673-4672	x	x		x	Consulting Free brochure
PMP Canada only	FP	PN Canada only	CL,EW,GL, PMT APA,GWP Canada only	Richters P.O. Box 26 Goodwood, Ontario Canada, LOC LAO (416) 640-6677					Canada orders only in June
PMC,PMO PMP	FP		BSP,CL CMD,DS EW,GWP,MD	Rincon-Vitova Insectaries, Inc. P.O. Box 95 Oak View, CA 93022 (805)643-5407	x	x	x	x	Free brochure
PM	FP		BSP,CL,DS EW,GL,GWP RSM	Sespe Creek Insectary 1400 Grand Avenue Fillmore, CA 93015 (805)524-3565	x	x	x	x	Free literature

Predatory Mites	Fly Parasites	Parasitic Nematodes	Other Organisms	Supplier	Mail Order	Phone Order	Retail	Whole-sale	Notes
	FPG,FPM FPS			Spalding Laboratories 760 Printz Road Arroyo Grande, CA 93420 (805)489-5946	x	x	x	x	Free brochure
PM			APA,GWP MD	Troy Hygro Systems 4096 CTH ES East Troy, WI 53120 (414)642-5928		x	x		Free brochure and price list
PMC,PMO PMP	FPM,FPS		CL,EW,GL, GWP,PMT	Unique Insect Control 5504 Sperry Drive Citrus Heights, CA 95621 (916)961-7945	x	x	x	x	Free literature
			CL,PMT	West Coast Ladybug Sales P.O. Box 903 Gridley, CA 95948 (916)534-0840	x	x	x	x	Free literature
PMO				Whittier Enterprises P.O. Box 3958 Chico, CA 95927 (916)895-8170	x	x	x	x	Carbaryl sulphur, of resistant strain

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Vendors of Microbial and Botanical Insecticides and Insect Monitoring Devices

D.W. Johnson, Extension Entomologist, University of Kentucky

Inclusion in this publication does not imply any endorsement nor does exclusion imply any criticism of suppliers or their products. Microbial (single celled) organisms are considered pesticides under current government regulations. Before using these biologicals, consult your Extension agent for information concerning legal use.

Introduction

Current attitudes in the U.S. concerning food safety and environmental quality have raised the general public's interest in alternative (non-synthetic pesticide) pest controls. Although the use of "natural" or "organic" insecticides appear as logical alternatives, their use is not quite as clear cut as one might expect. First, there is considerable difference of opinion about the definitions of what products are natural and/or organic. (Although Kentucky now has a law which defines organic for purposes of commerce.)What is called natural by one person may not be considered so by another. Additionally, some products generally considered to be natural or organic are more toxic to mammals than some synthetic insecticides. For example, nicotine has an LD 50 (rat oral) of 50 to 60 mg/kg (milligram of toxin per kilogram of body weight). For example, 1 mg/kg would be roughly equal to 0.00004 ounces of toxin per 2.2 pounds of body weight, or 0.0132 ounces of toxin per 150 pound person. These figures for the common synthetic pesticide Sevin® is LD 50 (rat oral) of 246 to 283 mg/kg. (Lower LD 50 figures are more toxic.) The moral: answers that appear to be too simple and too good, probably are.

Botanical Insecticides and Insecticidal Soaps

Botanical insecticides and insecticidal soaps are promising alternatives for use in insect management. However, like conventional synthetic insecticides, botanicals and insecticidal soaps have advantages and disadvantages and should be judged accordingly. Each compound must be evaluated in terms of toxicity, effectiveness, environmental impacts and costs. Even though botanicals and insecticidal soaps are naturally derived and are relatively safe if used properly, they are poisons and should be handled with the same caution as synthetic insecticides.

What are botanical insecticides and insecticidal soaps? Botanicals are naturally occurring insecticidal compounds derived from plants. They are processed into various forms which include:

- preparations of crude plant material;
- plant extracts or resins; and
- pure chemicals isolated from plants.

Advantages

- Rapid degradation — less persistence in environment and reduced risks to non-target organisms. May be applied shortly before harvest without leaving excessive residues.
- Rapid action — act very quickly to stop feeding by pest insects. They may not cause death for hours or days, but they often cause immediate paralysis or cessation of feeding.
- Low mammalian toxicity — most botanicals and insecticidal soaps have low to moderate mammalian toxicity.
- Selectivity — in the field, their rapid degradation and action as stomach poisons make them more selective in some instances for plant-feeding pest insects and less harmful to beneficial insects.
- Low toxicity to plants — most botanicals are not phytotoxic (toxic to plants). Insecticidal soaps and nicotine sulfate, however, may be toxic to some ornamentals.

Disadvantages

- Rapid degradation — this characteristic, although desirable in some respects, creates a need for more precise timing or more frequent applications.
- Toxicity — all toxins used in pest control pose some hazard to the user and to the environment.
- Cost and availability — botanicals tend to be more expensive than synthetics, and some are not as widely available.
- Lack of test data — data on effectiveness and long-term (chronic) toxicity are unavailable for some botanicals, and tolerances for some have not been established.

Botanical insecticides include the following:

- Pyrethrum and Pyrethrins — Pyrethrum is the powdered dried flower head of the pyrethrum daisy, *Chrysanthemum cinerariefolium.* Most of the world's pyrethrum crop is grown in Kenya. The word "pyrethrum" is the name for the crude flower dust itself, and the term "pyrethrins" refers to the six related insecticidal compounds that occur naturally in the crude material.

Note: *Pyrethroids are not botanical insecticides. They are synthetic compounds that are based on the chemical structure, etc. of natural pyrethrins.*

- Rotenone — Rotenone occurs in the roots of *Lonchocarpus* species in South America, *Derris*

species in Asia, and several other related tropical legumes. It is also used in fish management programs.

- Sabadilla — Sabadilla is derived from the ripe seeds of *Schoenocaulon officinale,* a tropical lily plant which grows in Central and South America.
- Ryania — Ryania comes from the woody stems of *Ryania speciosa,* a South American shrub.
- Nicotine — Nicotine is a simple alkaloid derived from tobacco, *Nicotiana tabacum,* and other *Nicotiana* species. Insecticidal formulations generally contain nicotine in the form of 40 percent nicotine sulfate and are currently imported in small quantities from India.
- Citrus Oil Extracts: Limonene and Linalool — Crude citrus oils and refined compounds are extracted from orange and other citrus fruit peels.
- Other Essential Plant Oils: Repellents and Insecticides — The most common essential oils are the oils of cedar, lavender, eucalyptus, pennyroyal and citronella.
- Neem — Neem products are derived from the neem tree, *Azadirachta indica,* that grows in arid tropical and subtropical regions on several continents. The active ingredient is both a feeding deterrent and a growth regulator.
- Insecticidal Soaps — Insecticidal soaps generally are not considered to be botanical insecticides, although the oils from which they are produced may be of plant origin. In general terms, insecticidal soaps are made from the salts of fatty acids. Oleic acid, present in olive oil and other vegetable oils, is especially effective.

Caution: Homemade soap spray "recipes" can be dangerous and harmful, calling for cleaning agents, fuel oils, polishes, solvents, and other materials that are toxic to plants and many animals (including humans).

Microbial Insecticides

Microbial insecticides are products containing microorganisms (or their byproducts) which result in insect diseases. Like botanical insecticides, they are of natural origin and have similar advantages and disadvantages. However, unlike botanicals, microbials have no effect on mammals. In fact, any given microbial will kill only a very limited group of insects.

Microbial insecticides include:

- *Bacillus thuringiensis* (B.t.) — This is probably the most common microbial "active ingredient." This organism is incorporated into several products, most of which are used to control caterpillar pests. Recently specific strains of B.t. have been selected for the ability to control mosquitos, black flies and other organisms.
- *Bacillus popilliae* or *B. lentimorbus* — These microbes are used to control the larval stage (white grub) of Japanese beetle. They, too, are formulated into several different products.
- *Nosema locustae* — This microscopic protozoan is used in several products to control grasshoppers.

Because of the very selective nature of microbial insecticides, users must know what pest they are after and read the label of the selected product to ensure a proper selection.

In addition to using commercial products, it often is possible to collect diseased insects in the field. By grinding and spreading this "disease," you may be able to produce your own "insecticide."

Abbreviations Used in This Publication

Insect Diseases
BTH — *Bacillus thuringiensis*
BP — *Bacillus popilliae*
BL — *Bacillus lentimorbus*
NL — *Nosema locustae*

"Natural" Insecticides
SP — Soaps
OL — Oils
SB — Sabadilla
RT — Rotenone
PY — Pyrethrum
NS — Nicotine Sulfate
RY — Ryania

Traps
PT — Pheremone Traps
FT — Food Traps
RS — Red Spheres (apple mimic)
YST — Yellow Sticky Traps

Collecting Equipment
SU — Sticky Stuff for replenishing sticky traps
SN — Sweep Nets
MA — Magnifying Device
WMD — Weather Monitoring Device
SD — Saving Device (live trap)

The caterpillar larval bacterium *Bacillus thuringiensis* is available through many retail and wholesale concerns under various brand names.

Note: Many vendors listed in this publication also are listed in: Johnson, D.W. 1989. *Vendors of Beneficial Organisms in North America.* ENT 53. University of Kentucky College of Agriculture Cooperative Extension Service.

These two publications in conjunction with the appropriate publication listing synthetic insecticides for your crop will give you the widest possible range of insect control tactics.

Insect Disease	Natural Insects.	Traps	Collecting Equipment	Supplier	Mail Order	Phone Order	Retail	Whole-sale	Notes
		PT		AgriSense 4230 West Swift, Suite 106 Fresno, CA 93722 (209)276-7037	x	x			
	SP,RY,RT	YST	WMD	Alternative Garden Supply, Inc. 108 Barrington Rd. Streamwood, IL 60107 (312)289-4545	x	x	x	x	Free catalog
		PT,YST	SU,MD	Applied Bionomics P.O. Box 2637 Sidney, B.C. Canada, V8L 4C1 (604)656-2123	x	x	x	x	Free catalog Need permit for US import
BTH,NL				Beneficial Insectary 245 Oak Run Road Oak Run, CA 96069 (916)472-3715	x	x	x	x	Postage paid
BP	SP,OL,RT	PT		Burpee Seed Company 300 Park Avenue Warminster, Pa 18974 (215)674-4900	x				Free catalog
BP,BL				Fairfax Biological Laboratories, Inc. Clinton Corners, NY 12514 (914)266-3705	x	x	x	x	Free brochure
		PT,YST		Foothill Ag Research, Inc. 510 W. Chase Drive Corona, CA 91720 (714)371-0120	x	x	x	x	Free literature

Insect Disease	Natural Insects.	Traps	Collecting Equipment	Supplier	Mail Order	Phone Order	Retail	Whole-sale	Notes
BTH,BP	SP,SB,RT RY,PY,NS OL	PT	SU	Gardens Alive National Gardening Res. Cen. Hwy 48 - P.O. Box 149 Sunman, IN 47041 (812)623-3800	x	x	x		If member, receive all literature
		PT,FT	SU,SN,MA	Great Lakes IPM 10220 Church Road NE Vestaburg, MI 48891 (517)268-5693	x	x		x	
BTH,NL	PY,RT RY,SB,SP	PT	SU,MA, WMD	Harmony Farm Supply P. O. Box 451 Graton, CA 95444 (707)823-9125	x	x	x	x	Charge for catalog
NL		YST	MA,SU,WMD	Hydro-Gardens, Inc. P.O. Box 9707 Colorado Springs, CO 80932 (303)893-3618	x	x	x	x	Charge for catalog
		YST		IPM Laboratories, Inc. Main Street Locke, NY 13092-0099 (315)497-3129	x	x	x	x	Free catalog Consulting
		PT,YST		Koppert System c/o Gerharts P.O. Box 146 North Ridgeville, OH 44039	x	x	x	x	
		PT,YST		Kunafin Trichogramma Insectaries Route 1, P.O. Box 39 Quemado, TX 78877 (512)773-0149	x	x	x	x	Free information

Insect Disease	Natural Insect.	Traps	Collecting Equipment	Supplier	Mail Order	Phone Order	Retail	Whole-sale	Notes
BT		PT		National Gypsy Moth Management Group RD 1, Box 715 Landisburg, PA 17040 (717)789-3434	x		x	x	Free brochure IPM Services
	SP	YST	MA	Nature's Control P.O. Box 35 Medford, OR 97501 (503)899-8318	x	x	x	x	Free brochure
BTH	SB,RT RY,SP PY	PT,RS YST	SU	Necessary Trading Co. P.O. Box 603 New Castle, VA 24127 (703)864-5103	x	x	x	x	Catalog $2 refundable with order
BTH,NL	RT,PY,NS RY,SB,SP	PT,YST RS	WMD,SU,SD, SN,MA	Peaceful Valley Farm Supply 11173 Peaceful Valley Rd. Nevada City, CA 95959 (916) 265-3276	x	x	x		Charge for catalog
		PT,YST		Phero Tech Inc. 1140 Clark Drive Vancouver, B.C. Canada, V5L 3K3 (604)255-7381	x	x	x		Permit needed for US import
		PT		Rincon-Vitova Insectaries, Inc. P.O. Box 95 Oak View, CA 93022 (805)643-5407	x	x	x	x	Free brochure
BP,NL,BTH	SP,PY	PT		Ringer Corporation 9959 Valley View Rd. Minneapolis, Minn. 55304 (612)941-4180	x	x	x	x	

Insect Disease	Natural Insect.	Traps	Collecting Equip.	Supplier	Mail Order	Phone Order	Retail	Whole-Sale	Notes
		PT		Trece, Inc. P.O. Box 5267 Salinas, CA 93915 (408)758-0205	x	x		x	
BTH,NL				West Coast Ladybug Sales P.O. Box 903 Gridley, CA 95948 (916)534-0840	x	x	x	x	Free literature

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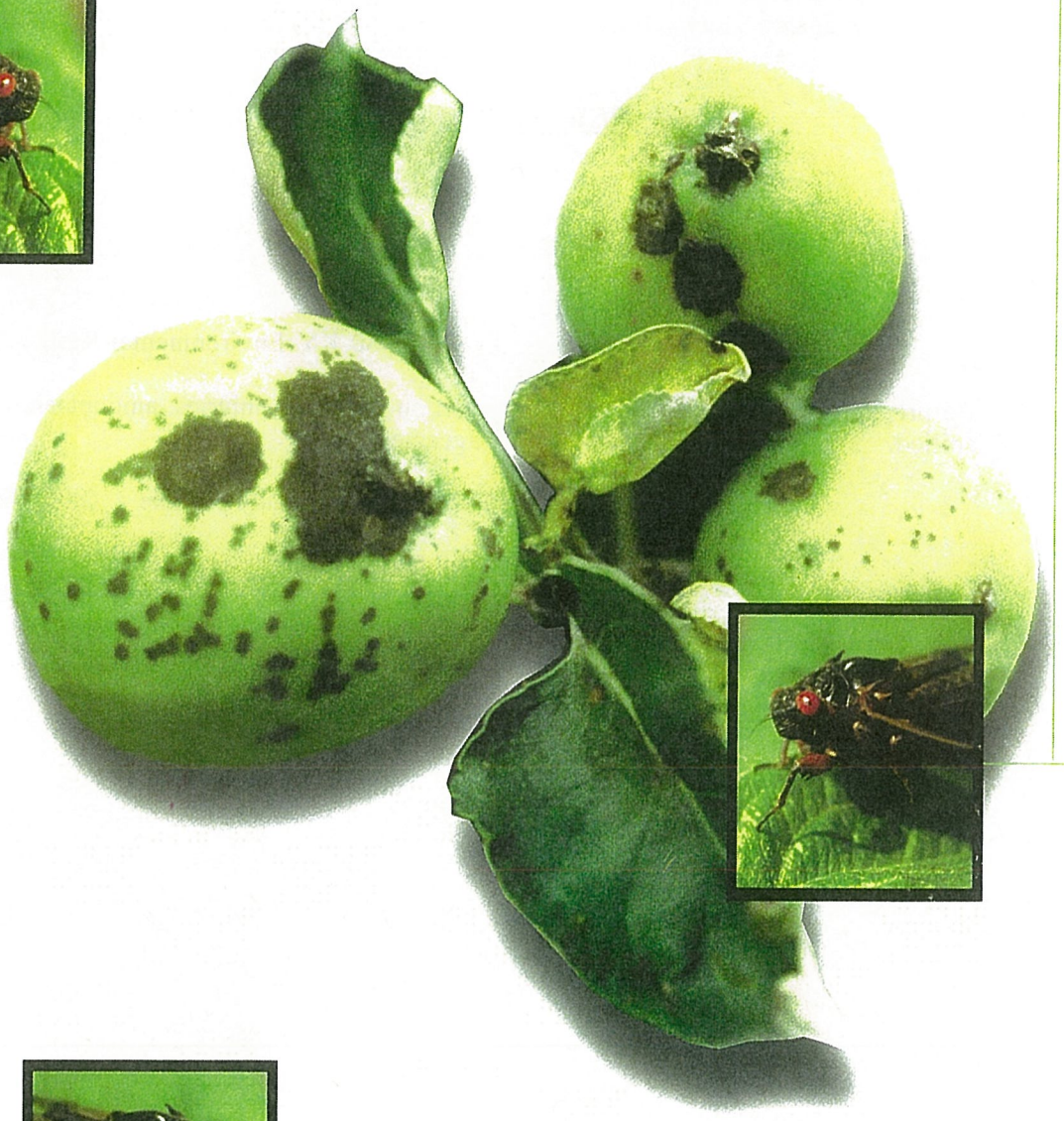
Commercial Tree Fruit Spray Guide



1998

Kentucky

University of Kentucky College of Agriculture
Cooperative Extension Service
Agriculture - Home Economics - 4-H - Development

1998 Kentucky Commercial Tree Fruit Spray Guide

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PESTICIDE EMERGENCY TELEPHONE NUMBERS

First Call - 911

Be prepared to provide specific information on location, injuries, amount and type of any materials spilled. You may be instructed to other agencies.

Second Call - (800) 928-2380 KY Environmental Response

Be prepared to provide specific information on location, injuries, amount and type of any materials spilled. You may be instructed to other agencies.

CHEMTREC (24 Hour) Pesticide Emergency Hotline - (800) 424-9300

EXPOSURE

If you have a person who has been exposed to a particular pesticide, provide your physician or emergency room with the following number for treatment information:

KENTUCKY REGIONAL POISON CONTROL CENTER
State 1-800-722-5725
Metro Louisville 589-8222

Note: The National Pesticide Telecommunication Network (800) 858-7378 has been listed in our recommendation books as a 24-hour number. Now called the National Pesticide Clearinghouse, it operates only during business hours and provides only general information. Emergency treatment information should come from the KENTUCKY REGIONAL POISON CONTROL CENTER.

FRUIT SPRAY NEWSLETTER

A Cooperative Extension newsletter, "Fruit Facts", is issued monthly to all Kentucky growers at no cost. This service supplies timely information on disease and insect activity throughout the state, as well as cultural information. To obtain this service, send your name, address and present fruit interests to: Kentucky Fruit Facts, P. O. Box 469, Princeton, KY 42445

Contents

Midwest Tree Fruit Handbook

The "Midwest Tree Fruit Handbook" is a companion publication to this spray guide that contains further information on pesticide safety, sprayer calibration, tree fruit disease and insect pests, pesticide characteristics, growth regulators and spray adjuvants and other related topics. Copies of this publication are available from your state extension service.

Foreword

Commercial fruit production has become a highly skilled technological profession. Concerns for residues, operator risks and the environment dictate that all fruit growers exercise extreme caution in the use of all pesticides and indeed all chemicals. The EPA has designated a number of fruit pesticides as "**restricted-use**". Record-keeping and worker protection requirements have changed dramatically since 1994. Consult the Pesticide Applicator Training program or local extension office for further information. Growers who wish to use these restricted-use materials must be certified as **private applicators**. Certification requires that applicators understand the following: labels and labeling, safety factors, potential environmental concerns, identification of common pests encountered, a knowledge of pesticides and their usage, proper equipment use, application techniques, and applicable State and Federal regulations. Training programs are offered to help you become certified. Contact your local Extension Office for information.

These pest management recommendations have been formulated for your guidance by providing up-to-date information on pesticides and their applicability to your problem. It is suggested that you use this information to set up your own spray program. You should include space in that program for records, such as materials used, date of application, stage of growth, and weather. In case of questions, nothing beats a good set of records. (Required for restricted use pesticides!)

Handling Pesticides

1. Know the pesticide toxicity and act accordingly.
2. When mixing pesticides do not breathe the dust, powder or vapor. Always mix outdoors.
3. Use an adequate respirator and protective clothing, especially when mixing pesticides. The necessary protective equipment is listed on the pesticide label. Suitable respirators should be available from your pesticide dealer.
4. Do not smoke, eat or drink when handling or applying pesticides.
5. Stay out of drift from spray or dust.
6. Rinse out liquid containers with water at least three times and pour into spray tank as it is being filled. Punch holes in metal and plastic containers and crush. Dispose of these and all other pesticide containers in accordance with the pesticide label directions as allowed by state and local authorities. Do not re-use pesticide containers.
7. Have a "Buddy" around when using toxic organo-phosphates or carbamates, just in case.
8. For maximum safety, get a blood test for cholinesterase level for each worker before the spraying season and periodically during the season. This will allow you to monitor the cholinesterase level in those people using insecticides and can help prevent overexposure.
9. Consult a doctor immediately if unusual symptoms develop while spraying: such as blurred vision, nausea, headaches, chest pains, weakness, diarrhea, or cramps.
10. Wash hands thoroughly before eating or smoking.
11. Bathe and change clothes daily.
12. Always store pesticides in their original container, never in an unmarked container.
13. Always store pesticides under lock and key. Keep children away.
14. Follow all label instructions carefully.
15. Always use an anti-syphon device when filling spray tank from a domestic water source.

Management Tips for Safety

THE LABEL IS THE LAW- - READ AND FOLLOW ITS INSTRUCTIONS.

1. Maintain accurate spray records. Show application rates, pesticides used, total gallonage, stage of development and weather data.
2. Be prepared to show your records to the EPA or state lead agency inspectors if necessary.
3. Do not contaminate forage crops or pastures.
4. Prevent excess drift.
5. Do not allow animals to graze orchards.
6. Maintain equipment in top condition.
7. Protect children, pets, livestock and your environment from pesticides in any form.
8. Inform all workers of re-entry restrictions and other safety information.
9. Comply with the Right-To-Know law. Have complete product labels readily available for workers to see. Have the Material Safety Data Sheet (MSDS) for each product you use available for workers to see and for rescue or fire personnel to use in case of emergency.
10. Provide pesticide safety training for pesticide handlers as well as other workers to comply with Worker Protection Standards (WPS).
11. Regularly inspect and maintain pesticide personal protective equipment.

Dilute Spraying

The object of spraying is to distribute a fungicide, insecticide, miticide, or growth regulator uniformly over all parts of the tree. Pesticide recommendations are based on the amount of dilute spray needed to wet trees thoroughly. In a standard apple or pear orchard with trees approximately 20 ft tall, 22 ft wide, and set on rows 35 ft apart, 400 gal water/acre has been established as a standard dilute spray for fungicide and insecticide application and recommendations are made per 100 gal or per acre based on this standard. Dilute is considered 1X concentration. For cherry, peach and plum, 300 gal water/acre is the standard dilute spray volume for full sized trees.

Low Volume Spraying

Low volume or concentrate spraying is the principle of increasing the mixing rate of the pesticide in water by 2X, 3X, 4X, 5X, or more and applying correspondingly reduced gallons of water per acre to achieve the equivalent rate of pesticide being applied as with a dilute application. At concentrations of 5X or higher, one can reduce the mixing rate by 20 to 25% and achieve the same control. This is because the sprays are no longer being applied to run-off. For additional information on low volume spraying refer to the Midwest Tree Fruit Handbook.

Tree Row Volume Spraying

In today's modern orchards which are based on smaller trees, research has shown that 400 gal water/per acre in a dilute application is not necessary to achieve complete coverage, nor is it necessary to base low volume spraying on the dilute gal water/acre standards. Tree row volume (TRV) is an objective method for estimating the gallons/acre (GPA) of dilute (1X) spray solution needed to effectively spray an orchard, and provides a basis for determining GPA for a low volume application. For information on calculating TRV gal/acre refer to the Midwest Tree Fruit Handbook.

Spray Tank pH

Several pesticides break down rapidly in alkaline water. In a matter of hours (or in extreme instances only minutes), 50 percent or more of the active ingredient may be hydrolyzed to yield a less active compound. Captan, Carzol, Cygon, Imidan, Kelthane, malathion, and Omite are examples of compounds that are especially vulnerable to alkaline hydrolysis. To ensure the maximum effectiveness of pesticide applications, check the pH of spray mixes in the spray tank and add buffering agents if necessary to adjust the pH to neutral (7). Buffercide, Buffer-X, Unifilm B, and LI 700 Acidiphactant are examples of such buffering agents.

Legal Responsibilities for Pesticide Use

Pesticides suggested for use in this publication are registered by the Environmental Protection Agency, Pesticides Regulation Division and are cleared for use as indicated on the individual labels. **The legal limitations in the use of these pesticides should be strictly observed to prevent excessive residues in or on harvested fruit.** Each grower is held responsible for the residues on fruit from his orchard and should follow labels carefully and observe cut off dates and rates of application. Some of the pesticides listed may be on the EPA restricted use list.

DISCLAIMER CLAUSE

Reference to products in this publication is not intended to be an endorsement to the exclusion of others which may be similar. Any person using products listed in this publication assumes full responsibility for their use in accordance with current directions of the manufacturer.

APPLE

About 400 gallons of dilute spray per acre is required to adequately cover an acre of mature standard well-pruned apple trees in full leaf and 20 to 22 feet high in rows spaced 35 feet apart.

Pest/Problem		Material	Rate/ 100 gal	Rate/ Acre	Comments
DORMANT TO SILVER TIP					
(Apply before growth starts in spring and when temperatures are above 45°F.)					
Fire blight		Bordeaux mixture	8-8-100, plus oil (see comments)		If fire blight was severe last year, a Bordeaux or fixed copper spray at silver tip is suggested. Use a dilute Bordeaux spray of 8 pounds copper sulfate, 8 pounds spray lime, and 1 gallon miscible superior oil per 100 gallons of water. To mix, dissolve the copper sulfate in one-half tank of water. Once completely dissolved, add the spray lime with constant agitation as the tank fills. Add the oil last but before completely filling the tank. The mixture must be agitated continuously. Do not apply after 1/4 - inch green leaf stage or when drying conditions are slow, as severe injury can occur. Bordeaux mixture and its residue have many compatibility problems with other pesticides. Fixed coppers (Kocide101, C-O-C-S) can be mixed with oil; however, **never combine copper sulfate alone with dormant oil.**
	OR	Copper hydroxide (Kocide 101)	2-4 lb	8-16 lb	
	OR	Copper oxychloride (C-O-C-S)	2-4 lb	8-16 lb	
Crown rot		Ridomil 2E			Refer to crown rot section at end of apple spray schedule for use recommendations.
	OR	Aliette 80WP			
GREEN TIP					
Primary Scab		*Benlate 50 WP or	2-3 oz	8-12 oz	* **Fungicide Resistance Management:** Benlate and Topsin-M should be used in combination with another fungicide at 1/2 the labelled rate to prevent buildup of resistant strains of the apple scab fungus. Similarily, Nova, Rubigan and Procure are at risk for the development of resistance; thus growers should consider using these fungicides (at the full labeled rate) in combination with other, non-related fungicides. **Note:** Captan has a 4 day reentry limitation.
		*Topsin-M 70 WSB	4-6 oz	1-1.5 lb	
		plus			
		Captan 50 WP or	1 lb	4 lb	
		Mancozeb 80 WP or	12 oz	3 lb	
		Polyram 80 WP	12 oz	3 lb	
	OR	Captan 50 WP	1.5 lb	6 lb	
	OR	Syllit 65 WP	0.25 - 0.5 lb	1 - 2 lb	
	OR	Thiram 65 WP	2 lb	8 lb	
	OR	Ziram 76 DF	2 lb	6-8 lb	
	OR	Mancozeb 80 WP	1.5 lb	6 lb	
	OR	Polyram 80 WP	1.5 lb	6 lb	
	OR	*Nova 40 WP	1.25-2 oz	5-8 oz	
	OR	*Rubigan EC	3 fl oz	8-12 fl oz	
	OR	*Procure 50 WS	3-4 oz	12-16 oz	

EBDC Products (maneb, mancozeb or metiram)

EBDC products have two rate recommendations depending upon how you choose to use the fungicides. Label recommendations for mancozeb are identical for apples and pears. The following information is taken from the label:

Pre-Bloom Use - begin applications at 1/4 to 1/2 inch green tip and continue on a 7 to 10 day schedule through bloom. DO NOT 1. apply more than 6 lb mancozeb per acre per application; 2. apply more than 24 lb per acre per year; 3. apply after bloom.

Extended Application Schedule Or Use In Tank Mixtures - begin applications at 1/4 to 1/2 inch green tip and continue applications on a 7 to 10 day schedule through the second cover spray. DO NOT - 1. apply more than 3 lbs per acre per application; 2. apply within 77 days of harvest; 3. apply more than 21 lbs of mancozeb or Polyram per acre per year.

DO NOT Combine or Integrate the Two Treatment Schedules.

Green tip continued on next page

APPLE

Pest/Problem		Material	Rate/ 100 gal	Rate/ Acre	Comments
GREEN TIP (Continued)					
San Jose scale, European red mite eggs		Superior oil 70 Sec. Viscosity	2 gal		Apply now or at half-inch green when temperature is above 45°F; never during freezing weather. Check label for fungicide/oil compatibility. Oil is most effective when sprayed dilute under calm conditions to assure thorough coverage of all woody tissue. *Note:* although several organophosphate insecticides (usually Lorsban or Supracide) are registered for use with oil to aid in the control of scale insects, aphids, and European red mite, research has shown that the use of oil alone resulted in greater than 98% control of scale insects when adequate coverage was obtained. An organophosphate insecticide or a miticide does improve aphid or European red mite control.
European red mite eggs		Apollo SC	1-2 fl oz	4-8 fl oz	Apply once between delayed dormant and tight cluster (Apollo) or pink (Savey). Apollo and Savey kill eggs and newly hatched mite larvae.
	OR	Savey 50 WP		3 oz	
Spotted tentiform leafminer					Put pheromone traps in place now to monitor adult leafminer activity.
HALF-INCH GREEN					
Primary scab		Same as for green tip			Same as for green tip
San Jose scale, European red mite eggs		Same as for green tip			Oil application delayed until this time may give even better control of scale than when applied earlier.
Rosy apple aphid (if present)		Dimethoate 4EC	0.5-1 pt	2-4 pt	Lorsban will also control San Jose scale. The Lorsban 4EC formulation may be used only during the dormant or delayed dormant period.
	OR	Dimethoate 25 WP	1 - 2 lb	4 - 8 lb	
	OR	Dimethoate 2.67 EC	0.75-1.5 pt	3 - 6 pt	
	OR	Lorsban 4 EC	0.5 - 1 pt	2 - 4 pt	
	OR	Lorsban 50 WP	8 - 12 oz	2 - 3 lb	
	OR	Thiodan 50 WP	1 - 1.5 lb	4 - 6 lb	
	OR	Thiodan 3 EC	0.67 - 1 qt	2.67 - 4 qt	
	OR	Diazinon 50 WP	1 lb	4 lb	
Spotted tentiform leafminer (if present)		Thiodan 50 WP	1 lb	4 lb	Control may be improved by spraying in evening when moths are active. Ambush and Pounce: do not make more than three applications per season nor apply after petal fall. Use of pyrethroids is likely to cause mite outbreaks because pyrethroids kill mite predators and persist a long time.
	OR	Thiodan 3 EC	0.67 qt	2.67 qt	
	OR	Ambush 25 WP		6.4-25.6 oz	
	OR	Ambush 2 EC		6.4-25.6 fl oz	
	OR	Asana XL 0.66 EC	2 - 5.8 fl oz	4.8-14.5 fl oz	
	OR	Pounce 25 WP		6.4- 12.8 oz	
	OR	Pounce 3.2 EC		4-8 fl oz	
	OR	Vydate L 2L	1 - 2 pt	2 - 4 pt	

Pest/Problem		Material	Rate/ 100 gal	Rate/ Acre	Comments
TIGHT CLUSTER (When buds in the cluster are short stemmed and closely packed.)					
Primary scab		Same as for green tip			Same as for green tip. A critical time for control.
Scab and Powdery mildew		Bayleton 50 DF*plus*	0.5-2 oz	2-8 oz	If powdery mildew has been a chronic problem start mildew sprays at green tip.
		Captan 50 WP or	1.5 lb	6 lb	
		Mancozeb 80 WP or	12 oz	3 lb	
		Polyram 80 WP or	12 oz	3 lb	Growers using an Extended Protectant program should use an SI fungicide (Nova, Rubigan, or Procure) in combination (tank-mixed) with a protectant fungicide such as Captan, Mancozeb, Polyram or Ziram through the period from at least tight cluster through second cover. Using a 10 day spray interval this should result in no more than 4 applications during this period.
		Ziram 76 DF	2 lb	6-8 lb	
	OR	Benlate 50 WP or	2-3 oz	8-12 oz	
		Topsin-M 70 WSB	4-6 oz	1-1.5 lb	
		plus			
		Captan 50 WP or	1 lb	4 lb	
		Mancozeb 80 WP or	12 oz	3 lb	
		Polyram 80 WP or	12 oz	3 lb	
		Ziram 76 DF	2 lb	6-8 lb	
	OR	Nova 40 WP	1.25-2 oz	5-8 oz	
	OR	Procure 50WS	2-4 oz	8-16 oz	
	OR	Rubigan EC	3 fl oz	8-12 fl oz	
	OR	Sulfur 95 WP plus scab fungicide	2-3 lb	8-12 lb	Applications of sulfur at temperatures above 85°F may result in fruit injury. Sulfur is available in dry flowable (DF) and flowable (F) formulations as well as wettable powder (WP) and dusts (D).
European red mite		Apollo SC	1-2 fl oz	4-8 fl oz	Last chance to use Apollo if not applied earlier. Limit one application per year.
	OR	Savey 50 WP		3 oz	
PINK					
Primary scab		Same as for green tip			A critical time for control
Scab and Powdery mildew		Same as for tight cluster			A critical time for control
Scab, Powdery mildew and Rust		Bayleton 50 DF*plus*	0.5-2 oz	2-8 oz	Rust diseases need to be controlled with sprays at regular intervals from pink through the second cover spray. Nova, Bayleton, Rubigan, Procure, Mancozeb, Polyram, and Ziram will control rust; Benlate, Topsin-M and Captan will not. See green tip comments regarding primary scab fungicides.
		Captan 50 WP or	1.5 lb	6 lb	
		Mancozeb 80 WP or	12 oz	3 lb	
		Polyram 80 WP or	12 oz	3 lb	
		Ziram 76 DF	2 lb	6-8 lb	
	OR	Nova 40 WP	1.25-2 oz	5-8 oz	
	OR	Rubigan EC	3 fl oz	8-12 fl oz	
	OR	Procure 50WS	2-4 oz	8-16 oz	
Aphids		Same as for rosy apple aphid at half-inch green			The Lorsban 4EC formulation may be used only during the dormant or delayed dormant period.
Spotted tentiform leafminer		Same as for half-inch green			
	OR	Carzol SP	4-8 oz	1-4 lb	
Tarnished plant bug		Thiodan, Ambush, Asana, or Pounce as listed for tentiform leafminer			Use of pyrethroids (Ambush, Asana, Pounce) is likely to cause mite outbreaks because they kill mite predators and persist a long time.
	OR	Carzol 92% SP	0.5 lb	2 lb	

Pink continued on next page

APPLE

Pest/Problem		Material	Rate/ 100 gal	Rate/ Acre	Comments
PINK (Continued)					
European red mite		Savey 50 WP		3 oz	A miticide may be needed if oil, Savey or Apollo was not applied earlier. This is the latest stage at which Savey may be used. This is the only time that Morestan may be used until post-harvest. Do not use Morestan within 10-14 days of oil spray.
		Morestan 25 W	0.5-1lb	2-4 lb	
		Refer to mite section at end of apple spray schedule (p.12).			
San Jose scale					Put pheromone traps in place now to monitor adult scale activity; crawlers are expected 4-6 weeks after adult emergence. Place traps in trees where scale infestations were observed last year.
Nutrient level		Solubor (boron)	1 lb	2 lb	Add Solubor to pesticide spray; check compatibility before adding. Urea can also be added to pesticide sprays when needed.
		AND/OR			
		Feed grade Urea (nitrogen)	3 lb	12 lb	
BLOOM					
Primary scab		Same as for green tip			
Scab and Powdery mildew		Same as for tight cluster			
Scab, Powdery mildew and Rust		Same as for pink			
Fire blight		Streptomycin 17 W	0.5 lb	2 lb	Start fire blight control at first sign of blossoms; repeat sprays at 4- to 5-day intervals through bloom and petal fall on susceptible varieties. If warm, wet weather occurs during bloom it is critical that sprays be applied on a tight schedule using the maximum strength of 100 ppm (o.5lb per 100 gal). Growers can improve timing and confidence in using streptomycin with the assistance from a computer program (MARYBLYT).
	OR	Streptomycin 17 W	0.25 lb	1 lb	
		plus			
		Regulaid	1 pt	1 pt	
Insects or Mites		SAVE THE BEES! Do not use insecticides or miticides.			
Codling moth (monitoring)		Pheromone traps		1 per 10 acres. Minimum of2	Put out pheromone traps now to monitor adult codling moth activity. Apply insecticide 250 degree days (base 50°F) after catch of 3-5 moths per trap, with a second application 300 degree days later.
Codling moth (control)		Isomate-C Plus		400 dispenses	See section on mating disruption (p.11).
Red Delicious shape		Promalin		1 pt	Apply in early bloom when most of the king flowers are open and before petals fall from the king flowers. Promalin can cause fruit thinning if time of application guidelines are not followed.

PETAL FALL

Pest/Problem		Material	Rate/ 100 gal	Rate/ Acre	Comments
Scab		Same as for green tip			
Scab and Powdery mildew		Same as for tight cluster			
Scab, Powdery mildew and Rust		Same as for pink			
Fire blight		Same as for bloom			Continue sprays on susceptible varieties until all petals have fallen.
Plum Curculio, Red-banded leafroller, codling moth		Guthion 50WP	0.5 - 0.75 lb	2 - 3 lb	Peak hatch of redbanded leafroller usually coincides with petal-fall. Control at this time helps prevent late-season problems. If plum curculio has been severe, increase Guthion 50W to 0.75 lb. or Imidan 70W to 1.0 lb per 100 gal. Use of pyrethroids (Ambush, Pounce, Asana) is likely to cause mite outbreaks because they kill mite predators and persist a long time. Do not apply Ambush or Pounce after petal-fall. Although Asana is registered for application at intervals throughout the growing season, we do not recommend use after first cover, except for special problem pests.
	OR	Guthion 3F	0.5 pt	2 pt	
	OR	Imidan 70 WP	0.75 - 1 lb	2.13-5.33 lb	
	OR	Lorsban 50 WP	8-12 oz	2-3 lb	
	OR	Ambush 25 WP		6.4-25.6 oz	
	OR	Ambush 2 EC		6.4-25.6 fl oz	
	OR	Asana XL	2 - 5.8 fl oz	4.8-14.5 fl oz	
	OR	Pounce 25 WP		6.4-12.8 oz	
	OR	Pounce 3.2 EC		4-8 fl oz	
Spotted tentiform leafminer		Provado 1.6 F	2 fl oz	8 fl oz	Treat if mines average 2 or more per leaf and larvae are still in the initial sap feeding stage on the underside of the leaves. Use Provado as soon as pollination is complete. Use Agri-Mek at petal fall or first cover. Use Provado at 8 fl oz/A only for large standard trees; 6fl oz/A is adequate for smaller trees. Apply Agri-Mek with horticultural oil or a penetrating surfactant. Vydate is not listed because it may cause fruit thinning if used within 30 days of bloom. Ambush and Pounce should not be used after petal-fall. Control of spotted tentiform leafminer with Lannate, Ambush, Asana, Pounce, or Carzol may disrupt mite control later in the season.
	OR	Agri-Mek 0.15 EC	2.5-5 fl oz	10-20 fl oz	
	OR	Lannate LV (2.4SL)	0.75 pt	3 pt	
	OR	Lannate 90 SP	0.25 lb	1 lb	
	OR	Ambush 25 WP		6.4-25.6 oz	
	OR	Ambush 2 EC		6.4-25.6 fl oz	
	OR	Asana XL 0.66 EC	2 - 5.8 fl oz	4.8-14.5 fl oz	
	OR	Pounce 25 WP		6.4-12.8 oz	
	OR	Pounce 3.2 EC		4- 8 fl oz	
	OR	Carzol SP	4-8 oz	1-4 lb	

Petal fall continued on next page

Pest/Problem		Material	Rate/ 100 gal	Rate/ Acre	Comments
PETAL FALL (Continued)					
White apple leafhopper		Lannate, Ambush, Pounce, or Asana as at petal fall for leafminer			White apple leafhopper nymphs begin hatching at tight cluster and begin feeding on the underside of apple leaves. The presence of leafhopper nymphs, their cast skins, and the white feeding marks (stippling) on leaves will indicate any need for control. Early season management may be needed at petal-fall. The nymphs present at this time become adults in early June and lay eggs on leaves. Nymphs from these eggs begin the next generation. Lannate, Ambush, Pounce, Asana, and Carzol are highly toxic to predatory mites.
	OR	Provado 1.6 F	1-2 fl oz	4-8 fl oz	
	OR	Thiodan 50 WP	1 lb	4 lb	
	OR	Thiodan 3 EC	0.67 qt	2.67 qt	
	OR	Carzol 92 SP	2 - 4 oz	0.5 - 1 lb	
	OR	Dimethoate 4EC	0.5 - 1 pt	2 - 4 pt	
	OR	Dimethoate 25 WP	1 - 2 lb	4 - 8 lb	
	OR	Dimethoate 2.67 EC	0.75-1.5 pt	3 - 6 pt	
European red mite		Refer to mite section at end of apple spray schedule (p. 12).			An opportunity to control the overwintering generation if prebloom treatment not used or ineffective.
Aphids		Dimethoate,Lorsban 5OW Thiodan,or Diazinon as at half-inch green	2 fl oz	8 fl oz	Treat green apple aphid when numerous but before excessive terminal leaf curling and honeydew deposits are observed. Do not use the Lorsban 4EC formulation at this stage; it may be used only during the dormant or delayed dormant period.
	OR	Provado 1.6 F			
For thinning summer varieties		Refer to section on thinning (p. 33)			
Nutrient level		Solubor (boron)	1 lb	2 lb	May be added to insecticide/fungicide spray solutions but check for compatibility, order of mixing, etc.
		and/or			
		Feed grade urea	3 lb	12 lb	
FIRST AND SECOND COVER (Seven to 10 days after petal-fall and 7 to 10 days later)					
Scab and Fruit rots		Captan 50 WP	1.5 lb	6 lb	Benlate 50% WP and Topsin-M 70% WSB may cause scarf skin on Rome apples if applied within a 4 week period following petal fall. Sprays beyond second cover for mildew control should be based on previous field history and orchard scouting.
	OR	Thiram 65 WP	1.5 lb	6 lb	
	OR	Ziram 76 DF	2 lb	6-8 lb	
	OR	Benlate 50 WP or	2-3 oz	8-12 oz	
		Topsin-M 70 WSB	4-6 oz	1-1.5 lb	
		plus			
		Captan 50 WP or	1 lb	4 lb	
		Mancozeb 80 WP or	12 oz	3 lb	
		Polyram 80 WP or	12 oz	3 lb	
		Ziram 76 DF	2 lb	6-8 lb	

Note on Mancozeb and Polyram

Mancozeb and Polyram cannot be used past bloom at the 6 lb per acre rate. The 3 lb per acre rate may not be sufficient under heavy scab pressure. If sterol inhibiting (SI) fungicides (Nova, Rubigan or Procure) are used in an extended protectant program for primary scab control (tight cluster to second cover), the last spray containing the SI fungicide is a "transition spray" where you are moving from the use of the SI fungicide to strictly protectant fungicides for control of summer diseases and secondary scab. This "transition spray" should contain the full label rate of a protectant fungicide in combination with the SI fungicide. If growers choose to use mancozeb or Polyram, no more than 3 lbs per acre can be used at this time. This rate may be too low, especially under heavy disease pressure. In situations such as this, growers should consider the use of Captan which can be applied at higher rates in the "transition spray". Do not apply mancozeb or Polyram within 77 days of harvest.

First and second cover continued on next page

Pest/Problem		Material	Rate/ 100 gal	Rate/ Acre	Comments
FIRST AND SECOND COVER (Continued) (Seven to 10 days after petal-fall and 7 to 10 days later)					
Scab, Rust, Powdery mildew, and Fruit rots		Bayleton 50 WP *plus*	0.5 - 2 oz	2-8 oz	See Note on Mancozeb, page 6.
		Captan 50 WP or	1.5 lb	6 lb	
		Mancozeb 80 WP or	12 oz	3 lb	Use of Ziram in cover sprays has been reported to be beneficial in reducing the incidence of necrotic leaf blotch on Golden Delicious apple leaves.
		Polyram 80 WP or	12 oz	3 lb	
		Ziram 76 DF	2 lb	6-8 lb	
	OR	Nova 40 WP *plus*	1.25 - 2 oz	5-8 oz	
		Captan 50 WP or	1.5 lb	6 lb	
		Mancozeb 80 WP or	12 oz	3 lb	
		Polyram 80 WP or	12 oz	3 lb	
		Ziram 76 DF	2 lb	6-8 lb	
	OR	Rubigan EC *plus*	3 fl oz	8-12 fl oz	
		Captan 50 WP or	1.5 lb	6 lb	
		Mancozeb 80 WP or	12 oz	3 lb	
		Polyram 80 WP or	12 oz	3 lb	
		Ziram 76 DF	2 lb	6-8 lb	
	OR	Procure 50 WS *plus*	3-4 oz	12-16 oz	
		Captan 50 WP or	1.5 lb	6 lb	
		Mancozeb 80 WP or	12 oz	3 lb	
		Polyram 80 WP or	12 oz	3 lb	
		Ziram 76 DF	2 lb	6-8 lb	
Blister spot on 'Mutsu' ('Crispin')		Streptomycin 17 W	0.5 lb	2 lb	First application no later than two weeks following petal fall and followed weekly by two additional sprays. Do not concentrate Regulaid. Use 1 pt per 100 gal or 1 pt per acre.
	OR	Streptomycin 17 W *plus* Regulaid	0.25 lb 1 pt	1 lb 1 pt	
Codling moth, Plum curculio, Red-banded leafroller		Lorsban, Guthion, or Imidan as listed for petal-fall			First and second covers are key times for first generation codling moth control. See mating disruption comments under special problems (p. 11).
	OR	Penncap-M	1.5 pt	6 pt	
Mites		See mite section at end of apple schedule (p.12).			
San Jose scale crawler		Diazinon 50 WP	1 lb	4 lb	San Jose scale "crawlers" may be present at this time in blocks of trees that had red spots on fruit and concentration of scales in the calyx end of fruit at harvest last year.
	OR	Lorsban 50 WP	0.75 lb	3 lb	
	OR	Penncap-M	1 pt	4 pt	
Aphids		Same as for petal fall			Lorsban applied for codling moth control will also suppress aphid populations. Lorsban 4EC is not labeled for use after the delayed dormant stage.
Excess crop		Refer to section on thinning (p. 33).			
Cork spot, Bitter pit and Jonathan spot		Calcium chloride	2 lb	8 lb	Start calcum chloride sprays in the first or second cover. Do not re-apply calcium chloride anytime during the growing season if rain has not washed off residue from previous calcium spray. Do not exceed 4 pounds per acre for low-volume spray.

APPLE

THIRD COVER

(Ten days after second cover)

Pest/Problem		Material	Rate/ 100 gal	Rate/ Acre	Comments
Scab, Fruit rots		Captan 50 WP	1.5 lb	6 lb	Frequent summer rains may result in severe sooty blotch and fly speck. Benlate and Topsin-M are the fungicides of choice for prevention of sooty blotch and flyspeck; however, excessive use of Benlate and/or Topsin-M may result in a buildup of resistant strains of the apple scab fungus and/or increased mite injury due to the adverse effect of these fungicides on predator mites.
Sooty blotch and Flyspeck	OR	Thiram 65 WP	1.5 lb	6 lb	
	OR	Ziram 76 DF	2 lb	6-8 lb	
	OR	Benlate 50 WP or	2-3 oz	8-12 oz	
		Topsin-M 70 WSB	4-6 oz	1-1.5 lb	
		Plus			
		Captan 50 WP or	1 lb	4 lb	
		Ziram 76 DF	2 lb	6-8 lb	
Codling moth, Red-banded leafroller		Same as for first and second cover.			
White apple leafhopper		Same as for petalfall (except do not use Ambush or Pounce)			Delay use of Sevin until at least 30 days after full bloom to avoid fruit thinning.
	OR	Sevin 50 WP	1 lb	4 lb	
	OR	Sevin 80S	0.67 lb	2.67 lb	
	OR	Sevin 4F	0.5 qt	2 qt	
	OR	Sevin XLR(4EC)	0.5 qt	2 qt	
Apple maggot (where a problem)		Guthion 50WP	0.5 - 0.75 lb	2 - 3 lb	Apple maggot flies generally begin emerging from the soil about mid-June. Monitor for the first appearance of flies each year by a detailed examination of fruit and leaves in the center of trees, the use of yellow sticky board traps baited with an attractant, or by hanging red or green spheres coated with a sticky substance in trees, or a combination of all three methods. Continue applications until late September, or as long as flies are present.
	OR	Guthion 3F	0.5 pt	2 pt	
	OR	Imidan 70WP	0.75 - 1 lb	2.1 - 5.3 lb	
	OR	Penncap-M	1.5 pt	6 pt	
	OR	Diazinon 50WP	1 lb	4 lb	
	OR	Sevin 50 WP	2 lb	8 lb	
	OR	Sevin 80S	1.25 lb	5 lb	
	OR	Sevin 4F	0.75-1 qt	3 - 4 qt	
	OR	Sevin XLR(4EC)	0.75-1 qt	3 - 4 qt	
Aphids		Same as for petal fall			Lorsban applied for codling moth control will also suppress aphid populations.
Mites		Refer to mite section at end of apple schedule (p. 12).			
San Jose scale crawlers (if present)		Same as for first cover			
Cork spot, Bitter pit and Jonathan spot		Same as for first cover			

Pest/Problem		Material	Rate/ 100 gal	Rate/ Acre	Comments
SUMMER COVER SPRAYS (Apply at intervals of 10 to 14 days)					
Scab, Fruit rots, Sooty blotch and Flyspeck		Same as for third cover			See comments under third cover regarding late season use of Benlate and Topsin-M. Check days-to-harvest and reentry restrictions of various materials before making the final application.
Codling moth		Same as for first and second cover.			
Apple maggot		Same as for third cover			
Mites		Refer to mite section at end of apple spray schedule (p. 12).			
Leafhoppers		Provado, Thiodan, Carzol, Lannate, Dimethoate, or Sevin as at petalfall stage.			
Spotted tentiform leafminer		Provado, Carzol, Asana, or Lannate as at petalfall			Treatment is recommended if there are an average of more than two mines per leaf from petal-fall to mid-summer, and more than three mines per leaf for the late-summer third generation. Vydate may cause fruit thinning if used within 30 days of bloom.
	OR	Vydate 2L	1 - 2 pt	2 - 4 pt	
Redbanded and Obliquebanded leafrollers		Same as for first and second cover			*Bacillus thuringiensis* (BT) sprays will kill only caterpillar larvae that ingest residues. Reapply at 4- to 5-day intervals; thorough coverage is essential.
	OR	*Bacillus thuringiensis* (Dipel, Biobit, Condor, and others)			
Japanese beetle		Imidan 70WP	0.75 - 1 lb	2.13 - 5.3 lb	
	OR	Sevin 80S	1.25 lb	5 lb	
	OR	Sevin 4F	0.75 - 1 qt	3 - 4 qt	
	OR	Penncap M	1-2 pt	4-8 pt	
Aphids		Same as for petalfall			
Bitter pit and Jonathan spot		Same as for first cover			During August and September, the rate for calcium chloride may be increased to 3 lb/100 gal or 12 lb/acre.

SPECIAL PROBLEMS/PESTS OF APPLE

Apple Scab Control

Programs for apple scab control are based primarily on the proper timing of fungicide applications. There are four general approaches.

1. Protectant-Only Program - The apple spray schedule outlined herein is developed as a protective spray progam. Protectant sprays are applied before infection takes place and serve as a chemical barrier between the susceptible plant tissue and the germinating spore. To insure adequate coverage of the expanding foliage, and to replace fungicides lost by weathering, these protectant fungicides must be re-applied on a regular schedule. Generally, this requires spraying on a 5-7 day schedule during the early part of the growing season and 7-10 day intervals later in the season.

2. Curative-Only Program - Curative sprays are those applied after an infection period has occurred, i.e. after periods favorable for infection by the fungus. These infection periods are dependent on air temperature and the number of hours of leaf wetness. Table 1 lists the degree of infection one may expect given the number of hours the leaves remained wet at a certain temperature. For example, if the leaves remained wet for 12 hours at an average temperature of 62 degrees F, a moderate degree of infection should be expected. Fungicides with curative capabilities stop further development of the scab fungus and thereby prevent development of scab lesions and secondary conidia. The ability of a fungicide to stop infections that have already started has been variously referred to as "curative activity", "after-infection activity", "burn-out ability", "kick-back ability", etc. The sooner a curative spray is applied the better chance it has of being effective. Fungicides with curative activity should be used at their full recommended rate, because at lower rates their ability to stop infections is reduced or lost. The number of hours a compound remains effective after the beginning of an infection period is as follows:

Fungicide	Rate/acre	Curative activity (hr)[1]
Benlate 50% WP	3 oz	18 to 24 hr
Captan 50% WP	8 lb	18 to 24 hr
Nova	8 oz	96 hr
Rubigan 1 EC	12 fl oz	96 hr
Sulfur 95% WP	20 lb	None

[1]Use beginning of rain as the start of infection. Based on average temperature of 50 to 60°F. At average temperatures lower than 50°F, use higher after-infection time figures.

Table 1. Approximate Number of Hours of Wetting Required for Primary Apple Scab Infection at Different Air Temperatures[1]

	Degree of Infection		
Average Temperature (°)	Light (hr)[2]	Moderate (hr)	Heavy (hr)
78	13	16	26
77	11	14	21
76	9 1/2	12	19
63 to75	9	12	18
62	9	12	19
61	9	13	20
60	9 1/2	13	20
59	10	13	21
58	10	14	21
57	10	14	22
56	11	15	22
55	11	16	24
54	11 1/2	16	24
53	12	17	25
52	12	18	26
51	13	18	27
50	14	19	29
49	14 1/2	20	30
48	15	20	30
47	17	23	35
46	19	25	38
45	20	27	41
44	22	30	45
43	25	34	51
42	30	40	60

[1]From W.D. Mills, Cornell University

[2]The infection period is considered to start at the beginning of the rain.

In the past, curative sprays have generally been used only for emergency situations when a rain has occurred without a protectant fungicide being in place. However, with the development of new fungicides with more powerful curative capabilities, along with the introduction of new equipment to monitor the activity of scab, it is becoming increasingly possible to use "curative-only" programs for scab control.

3. Protectant/Curative Program - Most growers use this combination program which takes advantage of both the protectant and curative properties of fungicides. Most commonly used scab fungicides are active as protectants and as curatives. When applied at the curative rate,

SPECIAL PROBLEMS/PESTS OF APPLE (Continued)

they control infections that may have occurred a few hours or days previous and also protect exposed tissues for several days after the time of application. These compounds are usually applied on a 5- to 10-day interval during the early season. After petal fall the interval can be lengthened to 7-14 days, depending on the weather. Due to the excellent curative ability, but poor protectant ability, of some of the newer fungicides, it is becoming increasingly popular to tank-mix fungicides to take advantage of the superior curative/protectant abilities of each. Such tank mixes are applied on a 7-10 day interval.

4. New York IPM Program (Scheduled Curative-Only Program)

In New York, a scheduled four-spray curative program has been used successfully by several growers. This program delays the first fungicide application and coincides disease control with insect control sprays. It consists of Nova or Rubigan applied at: 1. Tight Cluster (with oil); 2. Pink (with insecticide); 3. Petal Fall (with insecticide); and 4. First Cover (with insecticide). Captan or mancozeb is tank mixed with Rubigan in sprays 2 through 4, and with Nova in spray 4. Some growers also tank mix Captan or mancozeb with Nova in sprays 2 and 3. In clean orchards, (little or no scab last year), this program has worked well in New York. In some parts of the Midwest, this program has worked well using Nova as the only fungicide for the first three sprays and with captan or mancozeb combined with Nova in the fourth. The program is not recommended in orchards with high levels of scab inoculum from the previous year.

Collar Rot (Crown Rot) of Apple

RIDOMIL 2E (metalaxyl) is labeled for use on bearing apple trees. The label reads as follows: Use of Ridomil 2E will aid in the control of crown rot caused by *Phytophthora cactorum* when used in conjunction with good cultural practices and rootstocks that are most tolerant to the disease. Applications should be made before symptoms appear, especially in areas of the orchard favorable for disease development. Ridomil 2E will not revitalize trees showing moderate to severe crown rot symptoms. Mix 1 quart of Ridomil 2E with 100 gal. of water. Apply the amount of diluted mixture indicated in the table below around the trunk of each tree. Applications should be made in early spring before growth starts and in the fall after harvest but before the ground freezes up. On new plantings, delay the first application until two weeks after planting. (To determine trunk diameter, measure the trunk 12 inches above the soil line.)

NOTE: Ridomil Gold EC and Ridomil Gold WSP are new formulations of Ridomil (metalaxyl) that will eventualy replace the Ridomil 2E formulation. If you cannot obtain Ridomil 2E, use the Ridomil Gold EC or WSP formulation. See the label for application rates.

Trunk Diameter	Quarts of Diluted Mixture/Tree
< 1 inch	1 quart
1-3 inches	2 quarts
3-5 inches	3 quarts
> 5 inches	4 quarts

Notes: (1) Do not dip roots of trees in or spray bare roots with solutions containing Ridomil 2E. (2) Do not graze or feed cover crops in treated orchards, or illegal residues may occur.

ALIETTE 80WDG (Fosetyl-Al) is registered as a foliar spray for control of collar and root rot on apples and pears. Under moderate disease pressure apply Aliette 3 or 4 times at 5.0 lbs/100 gallons on a 60 day spray interval or 6-8 applications at 2.5 lbs/100 gallons on a 30 day schedule. Make the first application in the spring after sufficient foliage is present to absorb chemical. Do not apply more than 5.0 lbs of Aliette per acre per application. Do not exceed 20 lbs of Aliette per acre per season. Nursery tree resets and new plantings should be treated after leaf emergence. Read the label!

Restrictions On Foliar Applications Of EBDC Products

Users should carefully read, understand, and follow all use restrictions prior to using EBDC products.

a) Where EBDC Products Used Allow the Same Maximum Poundage of Active Ingredient Per Acre Per Season

If more than one product containing an EBDC active ingredient (maneb, mancozeb or metiram) is used on a crop during the same growing season and the EBDC products used allow the same maximum poundage of active ingredient per acre per season, then the total poundage of all such EBDC products used must not exceed any one of the specified individual EBDC product maximum seasonal poundage of active ingredient allowed per acre.

b) Where EBDC Products Used Allow Different Maximum Poundage of Active Ingredient Per Acre Per Season

If more than one product containing an EBDC active ingredient is used on a crop during the same growing season and the EBDC products used allow different maximum poundage of active ingredient per acre per season, then the total poundage of all such EBDC products used must not exceed the lowest specified individual EBDC product maximum seasonal poundage of active ingredient allowed per acre.

Mating Disruption for Codling Moth Control

Isomate C-Plus and CheckMate CM are registered for the control of codling moth. They dispense the sex attractant of the codling moth and are designed to prevent male moths from locating females for matng. This strategy, termed mating disruption, is most likely to succeed in blocks of at least 5 acres and where initial populations of codling moth are low. If mating disruption is used for codling moth control in smaller blocks or where

SPECIAL PROBLEMS/PESTS OF APPLE (Continued)

infestations are greater, border sprays or at least one or two cover sprays will also be necessary. Controlling codling moth by mating disruption will not control other insect pests that are controlled by cover sprays (plum curculio and apple maggots, for example). Isomate C-Plus has performed better than CheckMate CM in most studies.

Apple Borers

Flat-headed and round-headed apple borers attack trunks, often in association with mechanical or other injury or generally weakened trees. Lindane 20% EC is labelled for preventive control of the borers at the rate of 1 Tbsp./gal. finished spray. Apply spray to the trunk and large limbs in spring to prevent egg laying and reinfestation. Do not apply to fruit or foliage. Apply to trunk crotch to ground. Soak bark to run-off. Do not apply within 60 days of harvest.

Miticides for Apple

The following miticides are for use on apples. Refer to product label for registered uses, amount of use, harvest restrictions and remarks for use on other crops.

Brand Name	Rate Per 100 Gal.	Rate Per Acre	Days to Harvest
"Superior oil"	2 gal	----	(Before pink)
Agrimek 0.15 EC[a]	2.5 fl oz	10 fl oz	28
Apollo SC	1-2 fl oz	4-8 fl oz	(by tight cluster)
Carzol 92% SP	4-8 oz	1-4 lb	7
Dicofol 1.6 EC	1.5 qt	4-10 qt	14
Kelthane 35W*	1-1.33 lb	4.8 lb	7
Kelthane 50W*	0.75-1.5 lb	3-6 lb	7
Morestan 25W	0.5-1 lb	2-4 lb	+
M-Pede[bc]	1-2%	1.2 gal	++
Pyramite 60W[d]	2.2 oz	4.4-6.6 oz	25
Saf-T-Side[b]	1/2%	---	++
Savey 50 WP		3 oz	(by pink)
SunSpray[b]	1-2%	1-2 gal	++
Vendex 50W	4-8 oz	1.3 lb	14
Vendex 4L	4-8 fl oz	1-3 pt	14
Vydate L[e]	1-2 pt	2-4 pt	14

+ Apply Morestan before bloom or post-harvest.
++ Apply before waxy bloom forms on fruit

[a] Apply within 2 weeks after petal fall.

[b] Do not use with captan, Sevin, or other sulfur containing products. Do not apply when temperatures exceed 90°F.

[c] Not very effective alone. Enhances effectiveness of other miticides.

[d] Allow at least 30 days between sequential appliations.

[e] Vydate may cause fruit thinning if used within 30 days of bloom.

* Not permitted for use in Wisconsin.

Pyrethroid Insecticides

Use of pyrethroid insecticides (Ambush, Asana, or Pounce) is likely to cause mite outbreaks. These materials are highly toxic to mite predators and have a long residual activity.

Notes on "Soaps" and "Horticultural Oils"

SunSpray UFO (UFO = "ultrafine" oil), Saf-T-Side and M-Pede (a potassium salt of fatty acids, previously called an insecticidal soap) are relatively new insecticides that may be used in certified organic production systems. Summer oils and M-Pede are effective against only the insects that are present and contacted by sprays at the time of application. These sprays provide no residual control. Many questions about the efficacy of these insecticides remain unanswered, and their use should be considered experimental. Nonetheless, they appear to be useful in certain situations.

A summer oil alone at a concentration of 1 to 2 percent by volume provides some control of mites and aphids (rosy apple aphid, apple grain aphid, green apple aphid, and spirea aphid). Limited observations suggest that aphid control is likely to be greatest if oil is applied when clusters are at the 1/4 inch green stage. M-Pede alone reduces mite, aphid, pear psylla, and white apple leafhopper populations, but control may not be satisfactory or long-lasting unless multiple sprays are applied. Unlike oils, M-Pede is not ovicidal. If applied alone, a summer oil is likely to be more effective for aphid and (especially) mite control than M-Pede. Data from Michigan indicate that adding M-Pede at 2 percent by volume to full-rate sprays of Omite, Vendex, Kelthane, and presumably other miticides greatly enhances the control they provide.

Phytotoxicity, leaf drop and fruit blemishes, should be a major concern in decisions on the use of a summer oil or soap. To prevent damage to foliage or fruits, never use a summer oil with Captan, Sevin, or other sulfur-containing pesticides. Allow at least 14 days between applications of sulfur-containing compounds and the use of a summer oil. Do not apply oils if temperatures exceed 90°F or if drying conditions are poor. Because of concerns about fruit russeting, some authorities suggest that insecticidal soaps should be used only in nonbearing orchards. Russeting problems appear to be linked to quality problems in soap formulations produced before 1992. To minimize any risk of fruit damage in bearing orchards, use only M-Pede, not older soap products. Oils and soaps must be mixed at the proper dilution (1 to 2 percent); concentrated sprays will be less effective and more phytotoxic. Deposits of large droplets or the coalescing of droplets on fruit or foliage also increases the likelihood of leaf damage and fruit blemishes.

PEAR

About 400 gallons of dilute spray per acre is required to adequately cover an acre of mature pear trees in full leaf and 16 to 18 feet high in rows 30 feet apart.

Pest/Problem		Material	Rate/ 100 gal	Rate/ Acre	Comments
LATE DORMANT (Before buds break into green-tip in the spring)					
Scale insects, European red mite eggs		Superior oil (70-second viscosity)	2 gal		Apply when temperatures are above 45°F - never during freezing weather. Do not apply within 2 weeks of sulfur spray, within 7 days of a captan spray, or later than delayed dormant.
European red mite eggs		Apollo SC	1-2 fl oz	4-8 fl oz	Limit one Apollo or Savey application per year.
	OR	Savey 50 WP		3-6 oz	
Pear pyslla		Ambush 25% WP		12.8- 25.6 oz	Ambush and Pounce may be combined with 2-8 gallons of oil per acre for dormant through delayed dormant periods only; see label for amounts of finished spray per acre for either air or ground application. Apply this rate of Asana only during dormant to prebloom (white bud) stage only.
	OR	Ambush 2 EC		12.8- 25.6 oz	
	OR	Pounce 25% WP		12.8- 25.6 oz	
	OR	Pounce 3.2 EC		8-16 fl oz	
	OR	Asana XL 0.66 EC	7.3-12.8 fl oz	9.6-19.2 fl oz	
PREBLOOM When blossom buds are separated in the cluster before bloom					
Pear scab		Benlate 50% WP	4-6 oz	1-1.5 lb	**See Note on Mancozeb**, page 1 of apple schedule, for directions on use of mancozeb. Rubigan will also control powdery mildew. Refer to Rubigan label for further information on recommended rates of use.
	OR	Ferbam 76 WP	1.5 lb	6 lb	
	OR	Rubigan EC	3-4 fl oz	8-12 fl oz	
	OR	Mancozeb 80% WP	0.75-1.5 lb	3-6 lb	
	OR	Ziram 76 DF	2 lb	6-8 lb	
	OR	Procure 50 WS	2-4 oz	8-16 oz	
Pear Pyslla		Same as late dormant			Same as for late dormant
BLOOM					
Pear scab		Same as for prebloom			Mancozeb may not applied above the 3 lb per acre rate past bloom. Do not apply within 77 days of harvest.
Fire blight		Streptomycin 17 W	0.5 lb	2 lb	Start fire blight control at first sign of blossoms; repeat sprays at 4- to 5-day intervals through bloom and petal fall. If warm, wet weather occurs during bloom it is critical that sprays be applied on a tight schedule using the maximum strength of 100 ppm (0.5 lb per 100 gal).
	OR	Streptomycin 17 W	0.25lb	1 lb	
		plus Regulaid	1 pt	1 pt	
Insects		SAVE THE BEES! Do not use insecticides.			

PEAR

Pest/Problem		Material	Rate/ 100 gal	Rate/ Acre	Comments
PETAL FALL					
Pear scab		Same as prebloom			
Fire blight		Same as for bloom			Continue sprays for fire blight until the last petals have fallen.
Plum curculio,		Guthion 50% WP	0.5 - 0.75 lb	2 - 3 lb	
Codling moth,	OR	Guthion 3F	0.5 pt	2 pt	
Tarnished plant bug, Stink bugs	OR	Imidan 70% WP	0.75-1 lb	2.13-7.13 lb	
Pear psylla		Ambush as at late dormant			Apply Mitac now and again in 10 days at first cover. Apply only when daily maximum temperatures exceed 50°F. Use 8-10 oz/A of Pyramite to control moderate to heavy infestations.
	OR	Asana XL 0.66 EC	2.0-5.8 fl oz	4.8-14.5 fl oz	
	OR	Mitac 50% WP	6 - 12 oz	1.5-3 lb	
	OR	Mitac 1.5 EC	1 - 2 pt	2 - 4 qt	
	OR	Provado 1.6F	5 fl oz	20 fl oz	
	OR	Pyramite 60 WP	3.3 oz	6.6-13.2 oz	
Pear rust mite		Thiodan 50% WP	1 lb	4-5 lb	Rust mite also controlled by Mitac or Pyramite.
	OR	Thiodan 3 EC	0.67 qt	2.67 - 3.33 qt	
FIRST AND SECOND COVER (Apply 10 to 14 days after petal fall and again 10 to 14 days later.)					
Pear scab		Same as for prebloom			
Plum curculio, Codling moth,		Guthion or Imidan as at petal fall			Ambush or Asana used for psylla also controls codling moth and plum curculio.
Plant bugs, Stink bugs	OR	Penncap-M	0.5-2 pt	2-8 pt	
Pear psylla		Agri-Mek 0.15 EC	2.5-5 fl oz	10-20 fl oz	Psylla control required for first cover only; not required for second cover. Best results are found when psylla are in adult or young nymphal stage. Agri-Mek at 10 oz rate gives 3-4 weeks of control; at 20 oz rate gives season long control.
	OR	Mitac or Asana or Pyramite as at petal fall			
SUMMER COVERS (Apply 10 to 14 days intervals observing harvest restrictions and limitations.)					
Pear scab and Sooty blotch plus Flyspeck		Same as for prebloom			Rubigan and Procure will not control sooty blotch and flyspeck and should not be used past second cover. See note on mancozeb on page 1 of apple schedule.
Codling moth		Guthion 50% WP	0.5 - 0.75 lb	2-3 lb	
	OR	Imidan 70% WP	0.75-1 lb	2.13-7.13 lb	
	OR	Sevin 50% WP	2 lb	8 lb	
	OR	Sevin 80S	0.67 lb	2.67 lb	
	OR	Sevin 4F	0.5 qt	2 qt	
	OR	Sevin XLR(4EC)	0.5 qt	2 qt	
	OR	Penncap-M	0.5-2 pt	2-8 pt	
Pear psylla (if a problem)		Same as at petal fall			

CHERRY

About 300 gallons of dilute spray per acre is required to adequately cover an acre of mature cherry trees in full leaf and 14 to 16 feet high in rows 30 feet apart.

Pest/Problem		Material	Rate/ 100 gal	Rate/ Acre	Comments
DORMANT (before buds break in the spring)					
European red mite eggs		Superior oil (70-sec. viscosity)	2 gal		Apply when temperatures are above 45°F -- never during freezing weather.
	OR	Apollo SC	0.5-2 fl oz	2-8 fl oz	Limit one Apollo application per year, not within 21 days of harvest!
EARLY BLOOM					
Brown rot (Blossom blight)		Benlate 50% WP or	5-10 oz	1-2 lb	Benlate, Topsin-M and sterol inhibiting fungicides (Nova, Indar, Elite, and Orbit) should always be alternated or combined with another fungicide such as captan so as to minimize the development of resistance.
		Topsin-M 70 WSB	8 oz	1.5 lb	
		plus			
		Captan 50% WP	1.3 lb	4 lb	
	OR	*Bravo 720F	1-1.4 pt	3 - 4 pt	
	OR	Captan 50% WP	1.3 lb	4 lb	
	OR	Ronilan 50% WP	5 - 10.5 oz	1-2 lb	Do not apply more than 3 bloom (pink through petal-fall) treatments of Ronilan. Refer to Ronilan label for other restrictions and limitations.
	OR	Rovral 50% WP	5 - 10.5 oz	1-2 lb	
	OR	Wettable sulfur 95%	6 lb	18 lb	Many formulations of sulfur exist, check labels for rates.
	OR	Nova 40% WP	1.25-2 oz	2.5-6 oz	Nova is registered for control of brown rot blossom blight, leaf spot, and powdery mildew on cherries. Do not apply more than 3.25 pounds of Nova 40% WP per acre per season and do not apply within 7 days of harvest. Note: Captan has a 4 day reentry limitation. *Bravo 720 is also available as Bravo 720 Weather Stik and Bravo Ultrex for use on cherries
	OR	**Indar 75 WSP		2 oz	**Apply Indar and Orbit in a minimum of 50 gallons of water per acre.
	OR	Elite 45 DF	2 oz	8 oz	
	OR	Orbit 41.8% L		4 fl oz	
FULL BLOOM					
Brown rot (Blossom blight)		Same as for early bloom.			Same as for early bloom
Insects or mites		SAVE THE BEES! Do not apply insecticides during bloom.			

CHERRY

Pest/Problem		Material	Rate/ 100 gal	Rate/ Acre	Comments
PETAL FALL					
Brown rot (Blossom blight)		Same as early bloom.			Same as for early bloom. Do not apply Bravo after shuck split.
Leaf spot		Syllit 65% WP	0.25 - 0.5 lb	1 - 2 lb	Except for Ronilan and sulfur, all materials listed for brown rot under early bloom may be used for both brown rot and leaf spot. Do not apply Bravo after shuck split and before harvest. Do not apply more than 36 fl oz of Rubigan per acre before harvest.
	OR	Rubigan EC	2 - 3 fl oz	6 - 12 fl oz	
	OR	Indar 75 WSP		2 oz	
	OR	Elite 45 DF	2 oz	8 oz	
Powdery mildew		Wettable sulfur 95%	6 lb	18 lb	
	OR	Nova 40% WP	1.25-2 oz	2.5-6 oz	
	OR	Rubigan EC	2 - 3 fl oz	6 - 12 fl oz	
	OR	Elite 45 DF	2 oz	8 oz	
Plum curculio		Guthion 50% WP	0.5 lb	1.5 lb	Do not use Imidan on sweeet cherries.
	OR	Guthion 3F	0.67 pt	2 pt	
	OR	Imidan 70% WP	0.75 lb	2.13-2.5 lb	
	OR	Penncap-M	1-2 pt	3 - 6 pt	
	OR	Ambush 25% WP	1.6 - 3.2 oz	4.8-9.6 oz	
	OR	Ambush 2 EC	1.6 - 3.2 fl oz	4.8-9.6 fl oz	
	OR	Pounce 25% WP	1.6 - 3.2 oz	4.8-9.6 oz	
	OR	Pounce 3.2 EC	1 - 2 fl oz	3-6 fl oz	
	OR	Asana XL 0.66 EC	2-5.8 fl oz	4.8-14.5 fl oz	
SHUCK-FALL (Apply when shucks have split and are falling from expanding fruit.)					
Brown rot and Leaf spot		Benlate 50% WP or	4 - 8 oz	0.75 - 1.5 lb	Do not apply Bravo after shuck split.
		Topsin-M 70 WSB	8 oz	1.5 lb	
		plus			
		Captan 50% WP	1.3 lb	4 lb	
	OR	Captan 50% WP	1.3 lb	4 lb	
	OR	Nova 40% WP	1.25-2 oz	2.5-6 oz	
	OR	Rovral 50% WP	5 - 10.5 oz	1-2 lb	
	OR	Indar 75 WSP		2 oz	
	OR	Elite 45 DF	2 oz	8 oz	
Powdery mildew		Same as petal fall			
Leaf spot		Same as petal fall			
Plum curculio		Same as petal fall			
FIRST COVER SPRAY (ten days after shuck-fall)					
Brown rot and Leaf spot		Same as shuck-fall			
Powdery mildew		Same as petal fall			
Leaf spot		Same as petal fall			
Plum curculio		Guthion 50% WP	0.5 lb	1.5 lb	Note: Lorsban may be used on tart cherries only; it is phytotoxic on sweet cherries.
Cherry fruit fly	OR	Imidan 70% WP	0.75 lb	2.1-2.5 lb	
	OR	Penncap-M	1-2 pt	3-6 pt	
	OR	Lorsban 50% WP	1 lb	3 lb	

Pest/Problem		Material	Rate/ 100 gal	Rate/ Acre	Comments
SECOND COVER SPRAY (Ten days after first cover)					
Brown rot and Leaf spot		Same as shuck-fall			
Powdery mildew		Same as petal fall			
Leaf spot		Same as petal fall			
Plum curculio Cherry fruit fly		Same as first cover			
ADDITIONAL COVER SPRAYS (Ten days after second cover, then every 10 to 14 days)					
Brown rot and Leaf spot		Same as shuck-fall			
Powdery mildew		Same as petal fall			
Leaf spot		Same as petal fall			
Cherry fruit fly		Guthion, Imidan, or Penncap-M, same as first cover.			Note: Lorsban may be used on tart cherries only; it is phytotoxic on sweet cherries.
	OR	Diazinon 50% WP	1 lb	3 lb	
	OR	Sevin 50% WP	2 lb	6 lb	
	OR	Sevin 80S	1.25 lb	3.75 lb	
	OR	Sevin 4F	1 qt	3 qt	
	OR	Sevin XLR(4EC)	1 qt	3 qt	
	OR	Lorsban 50% WP	1 lb	3 lb	
Borer control					Refer to section on borers of peach trees (p. 22)
PRE-HARVEST SPRAYS (Apply according to label directions beginning 3-4 weeks before harvest)					
Brown rot		Benlate 50% WP or	4 - 8 oz	0.75 - 1.5 lb	Pre-harvest use restrictions and limitations are variable according to product; refer to label for details.
		Topsin-M 70 WSB	8 oz	1.5 lb	
	plus	Captan 50% WP	1.3 lb	4 lb	
	OR	Captan 50% WP	1.3 lb	4 lb	
	OR	Ronilan 50% WP	5 - 10.5 oz	1 - 2 lb	
	OR	Rovral 50% WP	5 - 10.5 oz	1 - 2 lb	
	OR	Indar 75 WSP		2 oz	
	OR	Elite 45 DF	2 oz	8 oz	
	OR	Orbit 41.8% L		4 fl oz	
POST-HARVEST SPRAYS					
Leaf spot		Bravo 720 F	1-1.4 pt	3 - 4 pt	Make one application of Bravo to foliage within 7 days after fruit is removed; in orchards with a history of high leaf spot incidence, make a second application 10-14 days later.
	OR	Syllit 65% WP	0.25 - 0.5 lb	1 - 2 lb	
	OR	Nova 40% WP	1.25-2 oz	2.5-6 oz	
	OR	Rubigan EC	3 fl oz	6 fl oz	
	OR	Elite 45 DF	2 oz	8 oz	
Leaf spot and powdery mildew		Nova 40% WP	1.25-2 oz	2.5-6 oz	
	OR	Rubigan EC	2 - 3 fl oz	6 - 12 fl oz	
	OR	Indar 75 WSP		2 oz	
	OR	Elite 45 DF	2 oz	8 oz	
Cherry fruit fly		Same as late covers			

PEACH

About 300 gallons of dilute spray per acre is required to adequately cover an acre of mature peach trees in full leaf and 10 to 12 feet high in rows apaced 25 feet apart.

Pest/Problem		Material	Rate/ 100 gal	Rate/ Acre	Comments
DORMANT					
(Apply after leaves drop in the fall or before buds swell in spring.)					
Peach leaf curl		*Bravo 720 F	1-1.4 pt	3 - 4 pt	Apply any time after leaf drop but **before** buds begin to swell in the spring. Thorough coverage is essential. Fixed copper compounds applied at leaf fall may improve bacterial spot control by reducing the inoculum that overwinters in leaf scars. *Bravo is also available as Bravo 720 Weather Stik and Bravo Ultrex for use on peaches.
	OR	Carbamate 76WDG	1.5 lb	4.5 lb	
	OR	Ziram 76 DF	1.25-2 lb	3.75-6 lb	
	OR	Copper hydroxide (Kocide)	4 lb	8 - 16 lb	
	OR	Copper oxychloride (C-O-C-S)	4 lb	8 - 16 lb	
	OR	Bordeaux mixture	6-6-100		
Mites		Superior oil (70-Sec. viscosity)	2 gal		
	OR	Apollo SC	0.5-2 fl oz	2-8 fl oz	Limit one Apollo application per year, not within 21 days of harvest!
PINK					
Brown rot (Blossom blight)		Benlate 50% WP or	4 - 8 oz	0.75 - 1.5 lb	Benlate, Topsin-M and sterol inhibiting fungicides (Nova, Indar, Elite, and Orbit) should always be alternated or combined with another fungicide such as captan so as to minimize the development of resistance. Do not apply more than 3 bloom (pink thru petal-fall) treatments of Ronilan. Refer to Ronilan label for other restrictions and limitations. Many formulations of sulfur are available, check label for rates. * Apply Indar and Orbit in a minimum of 50 gallons of water per acre. **Note:** Captan has a 4 day reentry limitation.
		Topsin-M 70 WSB	8 oz	1.5 lb	
		plus			
		Captan 50% WP	1.3 lb	4 lb	
	OR	Bravo 720 F	1-1.4 pt	3.1 - 4.1 pt	
	OR	Captan 50% WP	2.6 lb	8 lb	
	OR	Ronilan 50% WP	5 - 10.5 oz	1 - 2 lb	
	OR	Rovral 50% WP	5 - 10.5 oz	1 - 2 lb	
	OR	Wettable sulfur 95%	6 lb	18 lb	
	OR	Nova 40% WP	1.25-2 oz	2.5-6 oz	
	OR	Orbit 41.8 % L	1.3 fl oz	4 fl oz	
	OR	Indar 75 WSP*		2 oz	
	OR	Elite 45 DF	2 oz	8 oz	
	OR	Ziram 76 DF	1.5-2 lb	4.5-8 lb	
Tarnished plant bug and Stink bugs		Ambush 2 EC		6.4-25.6 fl oz	As pink begins to show, examine trees for tarnished plant bug. If present, apply insecticides. Make application before any blooms open. Use of pyrethroids (Ambush, Asana, Pounce) can cause mite outbreaks because they kill mite predators and persist a long time.
	OR	Ambush 25% WP		6.4 - 25.6 oz	
	OR	Asana XL 0.66 EC		4.8-14.5 fl oz	
	OR	Pounce 3.2 EC	2 - 5.8 oz	4-16 fl oz	
	OR	Pounce 25% WP		6.4 - 25.6 oz	
	OR	Guthion 50% WP		1.75 - 2.25 lb	
	OR	Guthion 2S, 2L	0.5 - 0.625 lb	3.5 - 4.5 pt	
	OR	Sevin 50% WP	2 lb	6 lb	
	OR	Sevin 80S	1.25 lb	3.75 lb	
	OR	Sevin 4F	1 qt	3 qt	
	OR	Sevin XLR(4EC)	1 qt	3 qt	
	OR	Thiodan 50% WP	1 lb	3 lb	
	OR	Thiodan 3 EC	0.67 qt	2.67-3.33 qt	

Pest/Problem		Material	Rate/ 100 gal	Rate/ Acre	Comments
FULL BLOOM					
Brown rot (Blossom blight)		Same as for pink.			
Insects or mites		SAVE THE BEES! Do not apply insecticides during bloom.			
Oriental fruit moth		Refer to petal fall			Pheromone traps to monitor Oriental fruit moth should be in place **now** to determine need for sprays at petal fall.
PETAL FALL					
Brown rot		Same as for pink			
Plum curculio, Catfacing insects (Tarnished plant bug, Stink bugs), Oriental fruit moth	OR	Ambush, Asana, Pounce or Guthion as at pink Imidan 70% WP	0.75 - 1 lb	2.13 - 4.25	Catfacing is worst where weed control is poorest. Keep weeds mowed regularly. See comments at pink relative to the use of Asana, Ambush and Pounce. Lannate will also control Oriental fruit moth and catfacing insects, but not plum curculio.
Peach tree borers		See comments (page 22).			Begin to consider the need for **borer** control at this time. If borers have been a problem, consider the use of pheromone traps to monitor moth flights to determine timing of borer sprays.
SHUCK-SPLIT					
Brown rot and Scab		Benlate 50% WP or Topsin-M 70 WSB PLUS	4 - 8 oz 8 oz	0.75 - 1.5 lb 1.5 lb	Do not apply Bravo 720 after shuck-split. If powdery mildew has become a chronic problem, Benlate, Topsin-M, Nova or sulfur should be included in your spray schedule.
		Captan 50% WP	1.3 lb	4 lb	
	OR	Bravo 720 F	1-1.4 pt	3.1 - 4.1 pt	
	OR	Captan 50% WP	2.6 lb	8 lb	
	OR	Wettable sulfur 95%	6 lb	18 lb	
	OR	Ziram 76 DF	1.5-2 lb	4.5-8 lb	
Powdery mildew		Nova 40% WP	1.25-2 oz	2.5 -6 oz	
	OR	Elite 45 DF	2 oz	8 oz	
Bacterial spot		Mycoshield 17 WP			See bacterial spot section at end of peach schedule
Plum curculio, Catfacing insects (Tarnished plant bug, Stink bugs)		Guthion, Asana, Pounce, or Ambush	Same as for petal-fall	Same as for petal-fall	
	OR	Imidan 70% WP	0.75 - 1 lb	2.1 - 4.25 lb	
	OR	Penncap M	2 pt	6 pt	
	OR	Sevin 50% WP	2 lb	4 - 8 lb	

Shuck-split continued on next page

PEACH

Pest/Problem		Material	Rate/ 100 gal	Rate/ Acre	Comments
SHUCK-SPLIT (Continued)					
Oriental fruit moth		Same as for petal fall			When tip leaves flag and turn brown, it's too late to apply an insecticide for that generation.
European red mite		Vendex 50% WP	4 - 8 oz	1 - 2 lb	Apollo is most effective on eggs and newly hatched nymphs. Limit one Apollo application per year.
	OR	Vendex 4L	4 - 8 fl oz	1 - 2 pt	
	OR	Apollo SC		4 - 8 oz	
FIRST COVER - 7 to 10 days after shuck-split					
Brown rot and Scab		Benlate 50% WP or	4 - 8 oz	0.75 - 1.5 lb	Do not apply Bravo 720 after shuck-split.
		Topsin-M 70 WSB	8 oz	1.5 lb	
		plus			
		Captan 50% WP	1.3 lb	4 lb	
	OR	Captan 50% WP	2.6 lb	8 lb	
	OR	Wettable sulfur95%	6 lb	18 lb	
	OR	Ziram 76 DF	1.5-2 lb	4.5-8 lb	
Powdery mildew		Nova 40% WP	1.25-2 oz	2.5-6 oz	Nova can be applied on a 10 - 14 day interval for powdery mildew control until terminal growth stops.
	OR	Elite 45 DF	2 oz	8 oz	
Plum curculio, Catfacing insects		Same as for shuck-split			
Oriental fruit moth		Same as for petal fall			
European red mite		Same as for shuck-split			
SECOND COVER (Ten days after first cover)					
Brown rot and Scab		Same as for first cover			
Powdery mildew		Same as for first cover			
Plum curculio, Oriental fruit moth, catfacing insects		Same as for shuck-split			
Mites (if present and a problem)		Same as for shuck-split			
Lesser peachtree borer		Refer to section on borers at end of peach schedule (p. 22).			Pheromone traps for lesser peachtree borer should be in place by peach petal-fall. Traps will indicate when borer moth flight begins and peaks. This will aid in better timing of borer sprays.

Pest/Problem		Material	Rate/ 100 gal	Rate/ Acre	Comments
THIRD, FOURTH, AND ADDITIONAL COVERS (Apply at 10 to 14 day intervals)					
Brown rot and Scab		Same as for first cover			Scab requires control until fruit is within 40 days of harvest.
Powdery mildew		Same as for first cover			
Oriental fruit moth		Same as for shuck-split			
Mites		Same as shuck-split			
PRE-HARVEST (Apply according to label directions beginning 3-4 weeks before harvest.)					
Brown rot		Benlate 50% WP or	4 - 8 oz	0.75 - 1.5 lb	Pre-harvest use restrictions and limitations are variable according to product; refer to label for details.
		Topsin-M 70 WSB	8 oz	1.5 lb	
		plus			
		Captan 50% WP	1.3 lb	4 lb	
	OR	Captan 50% WP	2.6 lb	8 lb	
	OR	Ziram 76 DF	1.5-2 lb	4.5-8 lb	
	OR	Ronilan 50% WP	5 - 10.5 oz	1-2 lb	
	OR	Rovral 50% WP	5 - 10.5 oz	1-2 lb	
	OR	Wettable sulfur95%	6 lb	18 lb	
	OR	Orbit 41.8%L		4 fl oz	
	OR	Indar 75 WSP		2 oz	
	OR	Elite 45 DF	2 oz	8 oz	
Oriental fruit moth, Japanese beetle, Green June beetle		Sevin 50%WP	2 lb	6 lb	Sevin is suggested here since it can be used one day before harvest. Oriental fruit moth pheromone traps will indicate if moths are flying at this time.
	OR	Sevin 80S	1.25 lb	3.75 lb	
	OR	Sevin 4F	1 qt	3 qt	
	OR	Sevin XLR(4EC)	1 qt	3 qt	

Special Problems/Pests of Peach

Phytophthora root, crown, and collar rots

Peach rootstocks are highly susceptible to Phytophthora root, crown, and collar rots. The main defense against these diseases should be providing good soil drainage through proper site selection and tiling. However, Ridomil 2E will provide additional protection in wet years, on marginal sites, or in wetter sections of the orchard. Applications (6 fl oz per 1000 sq ft) should be made just before growth starts in the spring and at 2-3 month intervals thereafter if soil conditions are very wet. Apply to the soil beneath the tree canopy in sufficient water to assure good coverage (material is moved into the soil by subsequent rain or irrigation). Ridomil 2E is also registered for use on cherries (sweet and sour), nectarines, plums and prunes.

Ridomil Gold EC and Ridomil Gold WSP are new formulations of Ridomil (metalaxyl) that will eventually replace the Ridomil 2E formulations. If you cannot obtain Ridomil 2E, use the Ridomil Gold EC or WSP formulations. See label for application rates.

Special Problems/Pests of Peach (continued)

Borers of Peach, Cherry, and Plum Trees

The peachtree borer, lesser peachtree borer, and shothole borer often infest peach trees, also, apricot, cherry and plum trees. The peachtree borer is primarily a pest of young trees, the lesser peachtree borer of older trees, and the shothole borer in trees of low vigor with dead and/or diseased limbs. Moths of the borers lay their eggs on the bark while the shothole beetles lay their eggs in the inner bark. Some of the regularly applied cover sprays aid in controlling borers; however, specific trunk and scaffold branch sprays are often required. Pheromone traps are now available to monitor moth emergence and peak of moth flights. Where borers have been a problem, make a spray 7 to 14 days after moth emergence begins (spray mid May to early June) and again 6 to 8 weeks later. Where damage has been light, make 1 spray at peak flight (spray after harvest).

Borer		Material	Rate/ 100 gal	Rate/A dilute	Comments
Lesser peachtree borer		Lorsban 50 WP		2 - 3 lb	NOTE: Lesser peachtree borer pheromone traps should be in place by peach petal-fall. They will indicate moth emergence and aid in proper timing of spray applications. Lorsban 50WP is labelled for borer control on sour cherry but not on sweet cherry, peach, or nectarine.
	OR	Lorsban 4 EC	1.5-3 qt		
	OR	Thiodan 3EC	1 qt		
	OR	Thiodan 50 WP	1.5 lb		
	OR	Asana XL 0.66 EC	2 - 5.8 fl oz	4.8-14.5 fl oz	
	OR	Ambush 2 EC		6.4-25.6 fl oz	
	OR	Ambush 25%WP		6.4 -25.6 oz	
	OR	Pounce 25% WP		6.4 -25.6 oz	
	OR	Pounce 3.2 EC		4-16 fl oz	
	OR	Penncap-M	1.5-2 pt	4.5-6 pt	
Peachtree borer		Lorsban 50 WP		2 - 3 lb	For Lorsban 4EC on peach or nectarine do not make more than 1 application per season, nor within 14 days of harvest; on cherry, make 2 pre-harvest (at least 6 days before harvest) and one post-harvest application. Lorsban 50WP is labelled for borer control on sour cherry but not on sweet cherry, peach, or nectarine. For Thiodan, do not make more than 2 applications during fruiting period, nor within 21 days of harvest of peach, nectarine, or cherry.
	OR	Lorsban 4 EC	3 qt		
	OR	Asana XL 0.66 EC	2 - 5.8 fl oz		
	OR	Thiodan 50% WP	1.5 lb		
	OR	Thiodan 3EC	1 qt		
Shothole borer		Insecticide sprays are not effective			Maintain tree health and vigor, prune dead and dying limbs and remove dead trees to prevent beetle problems.

Bacterial Spot of Peach

Bacterial spot of peach can be a serious problem on certain varieties in localized areas in certain years. The disease is favored by stormy, rainy weather during June and July. It has caused the most damage in areas where the soil is sandy and where the sand is blown by strong winds. Control programs using foliar sprays of zinc sulfate plus lime, or fall applications of copper with and without lime have been tried in the past. None of these programs offered reliable control and, in some cases, have caused foliar and twig damage. An antibiotic, oxytetracycline (Myco-Shield Agricultural Terramycin 17 percent SP), has given good control when properly applied. For best results, oxytetracycline must be used at the 12 ounces per 100 gallons of dilute spray. Use dilute or 2X; higher concentrates are not effective and may be phytotoxic. Once a week spraying of the entire tree is essential. If only one side of the tree is sprayed (alternate middle row), make certain the other side of tree is sprayed within three to four days. Begin sprays at shuck-split and continue at 7-day intervals until 3 weeks before harvest. Planting cultivars that are resistant to bacterial spot is the best control. Captan plus Syllit are also labeled for control of bacterial spot; seeSyllit label for further information (dodine, formerly known as Cyprex, is currently marketed as Syllit). Copper sprays applied for peach leaf curl at leaf drop may also aid in control of bacterial spot.

PLUM

About 300 gallons of dilute spray per acre is required to adequately cover an acre of mature trees in full leaf and 12 to 14 feet high in rows spaced 25 feet apart.

Pest/Problem		Material	Rate/ 100 gal	Rate/ Acre	Comments
DORMANT (Before buds break in the spring)					
Black knot		See comments			Prune out all black knots during the dormant period, making cuts 6 to 8 inches below any knots. Remove these prunings from the orchard and burn.
European red mite and Scale insects		Superior oil (70-sec. viscosity)	2 gal		Apply when temperatures are above 45°F -- never during freezing weather.
PRE-BLOOM					
Brown rot (Blossom blight) and Black knot		Benlate 50% WP or	4 - 8 oz	0.75 - 1.5 lb	Benlate or Topsin-M should always be combined with another fungicide such as captan so as to minimize the development of resistance. **Note:** Captan has a 4 day reentry limitation.
		Topsin-M 70 WSB	8 oz	1.5 lb	
		plus			
		Captan 50% WP	1.3 lb	4 lb	
Brown rot (Blossom blight)		Benlate 50% WP or	4 - 8 oz	0.75 - 1.5 lb	Many formulations of sulfur are available, check label, for rates.
		Topsin-M 70 WSB	4 - 5.3 oz	0.75 - 1 lb	
		plus			
		Captan 50% WP	1.3 lb	4 lb	
	OR	Bravo 720F	1-1.4 pt	3.1 - 4.1 pt	
	OR	Captan 50% WP	2.6 lb	8 lb	
	OR	Rovral 50% WP	5 - 10.5 oz	1-2 lb	
	OR	Wettable sulfur 95%	6 lb	18 lb	
	OR	Orbit 41.8%L		4 fl oz	
FULL BLOOM					
Brown rot (Blossom blight) and Black knot		Same as for pre-bloom			Same as for pre-bloom
Brown rot (Blossom blight)		Same as for pre-bloom			Same as for pre-bloom
Insects or mites		SAVE THE BEES! Do not apply insecticides during bloom.			

PLUM

Pest/Problem		Material	Rate/ 100 gal	Rate/ Acre	Comments
PETAL FALL					
Brown rot (Blossom blight) and Black knot		Same as for pre-bloom			Same as for pre-bloom
Brown rot (Blossom blight)		Same as for pre-bloom			Same as for pre-bloom. Do not apply Bravo after petal fall.
Plum curculio		Guthion 50% WP	0.5-0.625 lb	1.75-2.5 lb	Failure to control curculio may result in an increase in brown rot.
	OR	Guthion 2 L, 2S	1-1.5 pt	3.5-4.5 pt	
	OR	Imidan 70% WP	0.75 - 1 lb	2.13 - 4.25 lb	
	OR	Penncap-M	1.5 pt	6 pt	
	OR	Asana XL	2-5.8 fl oz	4.8-14.5 fl oz	
SHUCK-SPLIT					
Brown rot and Black knot		Same as for pre-bloom			Same as for pre-bloom
Brown rot		Benlate 50% WP or	4 - 8 oz	0.75 - 1.5 lb	
		Topsin-M 70 WSB	8 oz	1.5 lb	
		plus			
		Captan 50% WP	1.3 lb	4 lb	
	OR	Captan 50% WP	2.6 lb	8 lb	
	OR	Wettable sulfur 95%	6 lb	18 lb	
Plum curculio		Same as for petal fall			
Mites (if present)		Vendex 50% WP	4-8 oz	1 - 2 lb	
	OR	Vendex 4L	4-8 oz	1- 2 pt	
FIRST COVER SPRAY (Seven to 10 days after shuck-split)					
Brown rot and Black knot		Same as for pre-bloom			
Brown rot		Same as shuck-split			
Plum curculio		Same as for petal fall			
Peachtree borers		Refer to section on peachtree borers (p. 22).			

Pest/Problem		Material	Rate/ 100 gal	Rate/ Acre	Comments
SECOND AND ADDITIONAL COVER SPRAYS (Apply 2 weeks after first cover spray and repeat at 10 to 14 days as needed.)					
Brown rot		Same as shuck-split			
Plum curculio		Same as for petal fall			
PRE-HARVEST SPRAYS (Apply according to label directions beginning 3-4 weeks before harvest.)					
Brown rot		Benlate 50% WP or	4 - 8 oz	0.75 - 1.5 lb	Pre-harvest use restrictions and limitations are variable according to product; refer to label for details.
		Topsin-M 70 WSB	8 oz	1.5 lb	
		plus			
		Captan 50% WP	1.3 lb	4 lb	
	OR	Captan 50% WP	2.6 lb	8 lb	
	OR	Rovral 50% WP	5 - 10.5 oz	1 - 2 lb	
	OR	Orbit 41.8%L	1.3 fl oz	4 fl oz	

PREHARVEST INTERVALS AND RESTRICTED ENTRY INTERVALS FOR COMMON FUNGICIDES

Trade Names	Common Names	Preharvest Interval -- Days					REI*** (Hours)
		Apple	Pear	Peach	Cherry	Plum	
Aliette	foestyl-AL	14*	14*	--	--	--	12
Agri-strep	streptomycin	50	30	--	--	--	12
Bayleton	triadimefon	0	0	--	--	--	12
Benlate	benomyl	14	14	3	3	3	24
Bravo	chlorothalonil	--	--	*	*	*	48
Captan**	captan	14	--	0	0	0	see note
Carbamate	ferbam	7	7	21	0	--	24
Dithane M-45	mancozeb	77*	77*	--	--	--	24
Elite	tebuconazole	--	--	0	0	--	12
Indar	fenbuconazole	--	--	0	0	--	12
Manzate 200	mancozeb	77*	77*	--	--	--	24
Mycoshield	oxytetracycline	--	60	21	--	--	*
Nova	myclobutanil	14	--	7*	7*	--	24
Orbit	propiconazole	--	--	0*	0*	0*	24
Penncozeb	mancozeb	77*	77*	--	--	--	24
Polyram	metiram	77*	--	--	--	--	24
Procure	triflumizole	14	14	--	--	--	24
Ridomil	metalaxyl	*	--	0	0	0	12
Ronilan	vinclozolin	--	--	14	14	--	12
Rovral	iprodione	--	--	0*	0*	0*	12
Rubigan	fenarimol	30	30	--	0	--	12
Sulfur	sulfur	0	0	0	0	0	24
Syllit, Cyprex	dodine	7	--	15*	0	--	48
Thiram	thiram	0	--	7	--	--	24
Topsin-M	thiophanate-methyl	0	--	1	1	1	12
Ziram	ziram	14	14	14	14	--	48

-- Not registered or recommended.

* Limited number of applications allowed or other restrictions apply - REFER TO LABEL DIRECTIONS.

** Captan has a 4 day reentry limitation on all food crops except strawberry. Strawberry has a 24 hr reentry for Captan.

*** All fungicides have a Restricted-Entry Interval (REI). The restricted-entry interval is the time immediately after a pesticide application when entry into the treated area is limited. Check labels for REI; restrictions in REI may prohibit the use of certain pesticides during harvest.

PREHARVEST INTERVALS AND RESTRICTED ENTRY INTERVALS FOR COMMON INSECTICIDES AND MITICIDES

Trade Names	Common Names	Preharvest Interval -- Days					REI (Hours)
		Apple	Pear	Peach	Cherry	Plum	
Agri-Mek	abamectin	28	28	--	--	--	12
Ambush	permethrin	*	14*	7*	3*	--	24
Apollo	clofentezine	*	21	21	21	--	12
Asana	esfenvalerate	21*	28*	14*	14*	14*	12
Carzol	formetanate hydrochloride	7*	7*	21*	--	7*	48
Cygon[1]	dimethoate[1]	28	28	--	--	--	48
Diazinon	diazinon	14	14*	20	10*	10	24
Dipel[2]	*Bacillus thuringiensis*[2]	0	0	0	0	0	4-12
Guthion[3]	azinphosmethyl[3]	7*	7*	21*	15-21*	15*	48*
Imidan	phosmet	7	7	14	7	7	24
+Kelthane	dicofol	7-14	7	--	--	--	12
Lannate	methomyl	14	7	4	--	--	*
Lorsban	chlorpyrifos	28*	*	14*	14	*	24
Malathion	malathion	3	1	7	3	3	12
Marlate	methoxychlor	7	7	21	7	7	12
Metasystox-R	oxydemetonmethyl	*	30	*	*	*	48*
Mitac	amitraz	--	7*	--	--	--	24
Morestan	oxythioquinox	*	*	*	*	*	24
M-Pede	potassium salts of fatty acids	0	0	0	0	0	12
Penncap-M	methyl parathion (encapsulated)	14-21	14-21	21-28	14	21-28	48
Pounce	permethrin	*	14*	7*	3*	--	24
Provado	imidacloprid	7*	7	--	--	--	12
Pyramite	pyridaben	25	7	--	--	--	12
Savey	hexythiazox	*	28	--	--	--	12
Sevin	carbaryl	3	3	3	3	3	12
Saf-T-Side	horticultural oil	0	0	0	0	0	12
SunSpray		0	0	0	0	0	12
Superior oil		*	*	*	*	*	12
Supracide	methidathion	*	*	*	*	*	*
Thiodan[4]	endosulfan[4]	21-30*	7*	21-30	21*	7*	24
Vendex	fenbutatin-oxide	14*	14*	14*	14*	14*	48
Vydate	oxamyl	14	14	--	--	--	48

-- Not registered or recommended.

\+ Not permitted in Wisconsin.

* Specific preharvest intervals or restricted entry intervals vary for different formulations, application rates, crops, or geographical locations. See product labels for details.

1 Products that contain dimethoate include Cygon, Dimate, and Dimethoate.

2 Products that contain *Bacillus thuringiensis* strains active against caterpillars include Agree, Biobit, Cutlass, Dipel, and Javelin.

3 Products that contain azinphosmethyl include Azinphosmethyl, Guthion, and Sniper.

4 Products that contain endosulfan include Endosulfan, Phaser, and Thiodan.

Insecticide use restrictions on amount applied per year, number of applications, and/or timing of applications.

	Apple	Pear	Peach	Cherry	Plum	Nectarine	Apricot
Ambush 25 WP	12 lb/A; not after petalfall	179 oz/A	192 oz/A	6 appl.*	–	–	–
Ambush 2 EC	12 pt/A; not after petalfall	179 oz/A	192 oz/A	6 appl.*	–	–	–
Apollo SC	1 appl., by tight cluster	1 appl.	1 appl.	1 appl.	–	1 appl.	1 appl.
Asana XL	101 oz/A	111 oz/A	72 oz/A	72 oz/A	72 oz/A	72 oz/A	72 oz/A
Carzol 92 SP	4 lb/A	4 lb/A	2.5 lb/A	–	3 lb/A	4 lb/A	–
Guthion 50 WP	12 lb/A	12 lb/A	9 lb/A	6 lb/A	6.7 lb/A	6.7 lb/A	–
Guthion 3F	8 pt/A	8 pt/A	–	4 appl.	–	–	–
Guthion 2S, 2L	–	–	18 pt/A	–	13.5 pt/A	13.5 pt/A	–
Imidan 70 WP	30 lb/A	–	17 lb/A	–	–	–	–
Kelthane 35 WP+	2 appl.	2 appl.	–	–	–	–	–
Lannate 90SP	5 appl.	2 appl.	6 appl.	–	–	–	–
Lannate 2.4 SL	–	1 appl.	–	–	–	–	–
Lorsban 4 EC	1 appl.	1 appl.	1 appl.	3 appl.	1 appl.	1 appl.	–
Lorsban 50 WP	8 appl.	–	–	8 appl.	–	–	–
Metasystox-R	non-bearing	1 appl.	non-bearing	non-bearing	non-bearing	non-bearing	non-bearing
Mitac 50 WP	–	6 lb/A	–	–	–	–	–
Mitac 1.5 EC	–	2 gal/A	–	–	–	–	–
Morestan 25 WP	pre-bloom and post harvest	pre-bloom and post harvest	non-bearing	non-bearing	non-bearing	non-bearing	post-harvest +non-bearing
Penncap-M	5 appl.	5 appl.	4 appl.	6 appl.	4 appl.	4 appl.	–
Pounce 25 WP	2.4 lb/A; not after petalfall	8 lb/A	192 oz/A	6 appl.*	–	–	–
Pounce 3.2 EC	3 appl.; not after petalfall	5 appl.*	120 oz/A	6 appl.*	–	–	–
Provado 1.6 F	40 fl oz/A	40 fl oz/A	–	–	–	–	–
Pyramite	26.4 oz	26.4 oz	–	–	–	–	–
Savey	1 appl.	1 appl.	–	–	–	–	–
Superior Oil	delayed dormant before bloom	delayed dormant before bloom	delayed dormant before bloom	delayed dormant before bloom	delayed dormant before bloom	delayed dormant before bloom	delayed dormant before bloom
Supracide 2E							
Thiodan 50 WP	6 lb/A*	6 lb/A or 2 appl.	2 appl.	6 lb/A or 2 appl.	6 lb/A or 2 appl.	2 appl.	2 appl.
Thiodan 3 EC	4 qt/A*	4 qt/A or 2 appl.	2 appl.	4 qt/A or 2 appl.	4 qt/A or 2 appl.	2 appl.	2 appl.
Vendex 50 WP	4 appl.*	4 appl.*	2 appl.	2 appl.	2 appl.	2 appl.	–
Vendex 4 L	4 appl.*	4 appl.*	2 appl.	2 appl.	2 appl.	2 appl.	–
Vydate 2 L	8 pt./A	–	–	–	–	–	–

*see label for additional detail
+Not permitted inWisconsin

Mouse Control

Mice (more properly known as voles) can cause serious damage to fruit plantings. Frequently damage occurs but it is not noticed until trees become weak, die or are removed. Damage can be anticipated each year particularly from late summer to early spring. Apple trees are most susceptible, but hungry mice will attack other fruit trees. Apple trees on dwarfing root stocks are particularly palatable to mice.

Many plantings are being made in a hedgerow pattern; this does not permit cultivation between trees. Such plantings favor mouse migration. Mulches and vigorous sods also favor mouse migrations as well as high populations. *No single material or technique is sufficiently effective for complete control of mice.* It is therefore suggested that both the materials and the methods of control be varied during the season.

GENERAL ORCHARD MANAGEMENT PRACTICES

A number of general orchard management practices can be employed to reduce the hazard of injury and improve the effectiveness of control programs. Tree guards can be constructed from "hardware cloth" or similar materials with no larger than 1/4 inch mesh. These guards should enclose the tree and extend from several inches below the soil surface to several inches above maximum snow line (about 18 inches). Pea-sized gravel or cinders when placed around the trees, 4-6 inches wide and deep, also tend to discourage meadow mice from attacking the crown of the tree but do not discourage other mouse species. To proliferate, voles must have abundant amounts of cover. Thus, maintaining a clean area, 1 to 2 feet wide, around the base of the trunk of the tree, discourages surface feeding and will regulate vole populations in the long term. Chemical weed control in early spring reduces significantly the amount of labor involved in keeping the area around the tree clean.

The orchard cover or sod should be mowed short in late August and again after harvest. This reduces runway cover and aids baiting procedures. Cleaning out drainage ditches and fence rows as well as either picking up or crushing all dropped fruit discourages large mouse populations.

ORCHARD MOUSE CONTROL PROGRAM

Essential Knowledge

1. *Determine species of mice* (with snap traps). Three species may be found: Meadow Mouse (*Microtus pennsylvanicus*), Prairie Mouse *(Microtus ochrogaster),* Pine Mouse *(Pitymys pinetorum).* Materials for control may be the same, but control methods differ.

   Quick field identification may be made for both juveniles and adults based on the length of the tail.

   Pine Mouse: tail length about same length as the length of the hind foot.

   Meadow and Prairie Mouse: tail length about twice the length of the hind foot.
2. *Determine infestations* (with snap traps). There is a definite advantage in knowing when and where mice are most abundant. This makes control easier.

Control

Control of mice in orchards can be accomplished using either zinc phosphide or chlorophacinone baits. Both baits will provide good control if used according to label directions.

Zinc phosphide is considered an acute bait causing death of mice within 24 hours. It is available as either a weather-resistant pellet bait or mixed with prepared grains such as oats and corn. It is usually well accepted by mice. Zinc phosphide is not effective if applied more than two times.

Chlorophacinone (e.g.,RoZol ™) is an anticoagulant bait also available in some states (check your state regulations) as a weather-resistant pellet style bait. This bait is highly accepted by rodents, but death does not occur for several days. For effective control, a second application of chlorophacinone is needed within 20 to 40 days.

In general, all baits can be attractive to other wildlife including some birds and to domestic pets as well. Care must be taken that bait is applied correctly in runs, bait stations (see below), or broadcast. Pick up all spilled materials to avoid contact by nontarget animals

Effectiveness of baits against meadow and pine voles.

Chlorophacinone is more effective against pine vole than meadow vole, while zinc phosphide is more effective against meadow vole than pine vole. Consistent use of one of these chemicals will result in a shift of the vole population from one species to the other; therefore alternate baiting using zinc phosphide in the first application followed by chlorophacinone in the second application will likely reduce the population of both species.

Read and follow all label directions and precautions.

1. Machine baiting: Expose bait in artificial trail (Trail Builder)
2. Trail baiting: Expose bait in natural active runways only.

3. Broadcast baiting: (NOT RECOMMENDED FOR PINE MOUSE CONTROL). Broadcast bait by hand, cyclone type seeder, or tractor drawn equipment at recommended rates. When using zinc phosphide baits, the 2% concentration is recommended.
   OBSERVE SAFETY PRECAUTIONS. *Zinc phosphide is a restricted use material.*

Percentage Comparison of Control Methods

Method	*Meadow or Prairie Mice*	*Pine Mice*
Machine	90-95%	80-85%
Trail	80-85%	70-75%
Broadcast	78%	Not recommended

Timing

Apply on a sunny day in late fall when the mice are active. Mice begin to build up in early August, but baiting should be delayed as late as possible in the fall. The most effective period for application is just before snow cover develops and after the grass cover is down from frost and the fruit rotted. Spot treatment during the winter and into early spring is recommended. Treat marginal lands to prevent re-invasion.

Pre-harvest Baiting Is Not Recommended.

Application of poisoned bait before harvest to prevent orchard mouse damage to fruit in cold storage is <u>not</u> a sound practice for the following reasons:

1. The recommended methods of orchard mouse control do not always result in 100 percent control of the species in the orchard. Therefore, some mice survive the pre-harvest control and may enter into the boxes of fruit on the ground and still be carried into the cold storage.
2. The pre-harvest poison application will reduce the population of mice in the orchard; competition among the survivors will be greatly reduced, and food and cover will be more than ample. The survivors, under these favorable conditions, will breed and the number of young per litter may be as high as eight. In a very short time, the population will recover to its original level. A large number of young mice will be present during the recovery period. These mice, having a short home range, would not be exposed to poisoned baits applied during the normal control season.
3. The recommended control season is just prior to freezing conditions. This is the best time to control the mice in an orchard and prevent their damage during the winter months, the season when population recovery is very slow. Any control program that might lessen the effect of the recommended control program is defeating the purpose for which it was developed.
   Check your control program with snap traps. Lack of visible damage does not indicate the effectiveness of your program.

Control in Storage

1. Before Harvest
   a. Poison rats and mice in storage one month before picking; keep storage area baited, and free of debris.
   b. Clean up all outside debris, especially near loading door, one week before picking.
   c. Rodent-proof storage, seal all holes and cracks. Mice can enter a hole the size of a dime.
2. During Harvest
   a. Move filled boxes into storage quickly, any left overnight may have mice in them.
   b. AS YOU LOAD fruit into storage, bait storage with either bait. Place teaspoonful amounts in bait stations on floor along alleys, between rows of boxes, and under pallets. Do not place open baits on floors or any areas where contamination might occur. Commercial bait stations are available from agricultural supply companies. Always prevent contact with fruit.

Bait Stations in Orchard

Bait stations can be prepared in several ways and eliminate or reduce the opportunity for non-target animals to contact the bait. Squares of heavy roofing shingles or other weather-resistant materials placed out of traffic areas between trees can serve as bait stations to provide protection for the bait and hiding places for the rodents. Some growers have constructed bait stations that require less refilling by building inverted T-shaped stations from PVC tubing and fittings that will provide bait storage and a protected feeding area. Place bait stations in the field 2 to 3 weeks before adding the bait.

Suggestions for Growth Regulators

Ethephon on Apples

Ethephon, which is available as a 21.3% formulation of 2-chloroethylphosphonic acid (ETHREL or CEPHA) may be beneficial on apples to (a) promote early color development and maturity (b) loosen fruit for easier harvesting by hand or machine (c) increase fruit bud formation and early bearing on young trees.

(A) To Advance Maturity and Red Coloring

To obtain increased red coloration and early maturity apply 14 to 21 days prior to anticipated harvest at a concentration of 150 to 300 ppm (1/2 to 1 pt. per 100 gals. water). For concentrate sprays use 2 1/2 pints per acre in 50 to 100 gallons of water. Use lower dosage ranges for late maturing varieties. Red color development should be apparent in about 7 days. Ethephon is most effective under weather conditions which favor good color development.

Do NOT apply ethephon during hot weather or if hot weather is forecast during the next 14 days. Apply ethephon when air temperatures are between 60°F and 90°F. Most red apple varieties do not develop red color during hot weather either with or without ethephon. Ethephon does speed-up ripening. Do not use on Golden Delicious.

Add a fruit drop inhibitor to control the tendency to increase pre-harvest drop of the fruit. NAA (napthaleneacetic acid) may be added to the same spray as the ethephon. NAA is effective for 7 to 10 days, and a second application might be necessary if harvest is delayed.

Precautions

No spreader-sticker is necessary. Ethephon will not overcome poor management practices. Trees of moderate vigor that are well-pruned and thoroughly sprayed respond most favorably with well-colored fruit of uniform maturity. For dense trees, harvest outer fruit first and then apply ethephon. Harvest at proper maturity. Do not delay harvest to obtain additional red coloration. Treat only the acreage that can be harvested and marketed on a timely basis. Fruit treated with ethephon should be marketed promptly and may have reduced shelf life.

(B) For Early Bearing on Young Trees

To increase fruit bud development on young, non-bearing trees apply a foliar spray of ethephon 1 to 2 weeks after full bloom period using a dosage of 1000 ppm (3 1/3 pts. per 100 gallons of water). For spur-type trees the rate should be reduced to 500 ppm (1 2/3 pts. per 100 gallons of water). *Caution* : Do not use this treatment on trees that have started to bear fruit because the application may defruit the trees completely.

Stop-Drop Sprays

If used properly, stop-drop sprays can significantly reduce pre-harvest apple drop. Use knowledge of orchard conditions when applying stop-drop sprays and keep notes on the response in your orchard.

Naphthaleneacetic Acid or NAA (Fruitone N) should be applied before the beginning of fruit drop, 7 to 14 days before harvest, at the rate of 5 ppm for summer varieties and 10 ppm for late varieties. It should normally prevent fruit drop for 7 to 10 days. A second application of NAA should be made within 7 to 10 days of the first application, if fruits are not harvested. Do not use more than 2 NAA applications. Do not apply within 2 days of harvest. NAA works best as a dilute spray.

Concentration and timing of stop-drop application

Variety	Application Time before picking	NAA concentration
Delicious	7-10 days	10-15 ppm
Jonathan	7-10 days	10 ppm
Golden Delicious	7 days	10 ppm
Rome Beauty	7 days	10 ppm
Winesap	7 days	15 ppm

Using NAA too early or in greater than recommended concentrations may accelerate fruit maturity and decrease storage life. Apply stop-drop sprays at concentrations no higher than 3X. Stop-drop sprays may be applied with pesticides. Do not use stop-drop sprays on trees in a low state of vigor; healthy leaves are essential for these sprays to be effective.

"**Retain**" is a new stop drop spray formulation from Abbott Laboratories for use on apple. Check product information label for information on concentration and timing of application.

Sprout and Sucker Control on Apple and Pear

Tre-Hold Sprout Inhibitor A112 can be used to inhibit sprouting when applied to pruning cuts on scaffold limbs and trunk bases, and to rootstock suckers on bearing and non-bearing trees.

To make 1 gal of spray mixture, add 10 fl oz of Tre-Hold to 1 gal of water. For sunscald protection, 1 to 4 pt of interior white latex paint may be substituted for an equal volume of water. One gallon of dilute spray will treat 50 to 100 trees

TreHold RTU Sprout Inhibitor, a ready to use formulation (1.15% Ethyl, 1-NAA) is also available to control sprouts and sucker growth on apples and pears. Follow manufacturer's label for use instructions..

Pro-Gibb on Cherries

The active ingredient in Pro-Gibb is a natural plant hormone, gibberellin A_3, and it can be used to maintain and extend high fruiting capacity of bearing tart cherry trees and reduce occurrence of "blind" nodes by stimulating lateral vegetative buds to develop a more productive balance of lateral shoots and spurs. Apply 4 to 8 fluid ounces of Pro-Gibb 4% in 100 gallons finished spray from 14 to 28 days after bloom in 50 to 150 gallons per acre. Do not spray within one month of harvest.

To reduce flowering and fruiting in young tart and sweet cherry trees and to minimize competitive effect of early fruiting on tree development, apply 20 to 40 ounces of Pro-Gibb 4% in 100 gallons of water, 2 to 4 weeks after bloom. Under conditions of low vigor, two applications are recommended allowing at least a 7-day interval between sprays. Since Pro-Gibb acts on differentiation of flower buds for the following growing year, responses will not begin to be visible until the year after application. Do not spray trees the year of planting.

Pro-Vide on Apples

Russeting

Applications of Pro-Vide, which is a mixture of gibberellins A_4 and A_7, has been successful in reducing, but not eliminating, russet on 'Golden Delicious'. Pro-Vide should be applied as 3-4 applications beginning at petal fall and continuing at 7-to 10- day intervals. The rate is 10-13 ounces applied in 100 gallons of solution per acre. Do not use surfactants with Pro-Vide because of the potential of some surfactants to cause russeting. No more than 40 ounces of Pro-Vide should be applied per season.

Stayman Cracking

Pro-Vide applications should start 2-3 weeks before cracking begins, normally by mid-June to mid-July. Apply 3 to 4 consecutive sprays at 12- to 16- day intervals at an application rate of 16 to 32 ounces of Pro-Vide per acre per application. Because cracking is influenced by weather changes and can occur over an extended period, multiple applications have given the best response.

Promalin on Apples

Promalin contains 1.8% 6BA N-(phenylmethyl)-1 H-purine-6-amine and 1.8% gibberellins A_4 and A_7. A single application to 'Delicious' during the period from full bloom to early petal fall of the king bloom elongates the fruit and encourages development of more prominent calyx lobes. The rate of application is 1 pint per acre in 50 to 200 gallons of spray mixture. Some thinning may occur from the use of Promalin, particularly if applied late. Do not apply Promalin when air temperatures are lower than 40°F or greater then 90°F.

Chemical Thinning of Apples

Chemical sprays to reduce the fruit set on apples and thus promote larger fruit size at harvest and increase return bloom have become standard practice in most commercial orchards. Proper usage by the grower is vital to the success of chemical thinning applications.

NAA (naphthalene acetic acid), NAD (naphthalene acetamide), Sevin (1-naphthyl-N-methylcarbamate) and Accel (benzyl-adenine) are the suggested chemical thinners. Apply NAA to fall and winter varieties when the king fruit is 11-13 mm in diameter. For fruit larger than 13 mm, Sevin is more effective than NAA. Sevin is useful because of its ability to give uniform results from petal fall to 21 days after petal fall.

NAD is most effective when applied at late bloom to petal fall. NAD is a milder chemical than NAA, and is less likely to overthin.

The combination of NAA plus Sevin should be applied on fall and winter varieties when king fruit are 11 to 13 mm in diameter, and on summer varieties (Wealthy and Earliblaze) at petal fall.

Use of NAA on early summer varieties may result in excessive foliage injury, fruit cracking and premature ripening.

In the warmer parts of the midwest, NAA at concentrations that successfully thin frequently cause pygmy apples on spur-type Red Delicious. These small seedless apples persist through harvest and are a nuisance. Sevin is preferred for thinning spur-type Red Delicious. In some experiments, Sevin has over-thinned Rome and Gallia Beauty and should not be used on these varieties.

RECOMMENDED CHEMICAL THINNERS FOR APPLE

Cultivars	NAD[1,2,3] (PPM)	NAA[1,3] (PPM)	NAA[1] + W.A[4] (PPM)	Sevin XLR Plus[1,5,6] (qts/100 gal)	Accel[7] (PPM)	Combinations[1,2,3,6] (PPM + qts/100 gal)
Summer Varieties	35-50	—	—	—	—	NAA 5-10+Sevin 1/2-1
Earliblaze	—	—	—	—	—	NAA 10+Sevin 1/2-1
Paulared	—	5-10	3-5	1/2-1	—	—
Gala	—	5-10	3-5	1/2-1	—	—
Jonamac	—	5-10	3-5	1/2-1	—	—
McIntosh	35-50	7 1/2-12	3-5	1/4-1/2	50	—
Jonathon	35-50	7 1/2-12	3-5	1/4-1/2	50	—
Spartan	—	10-15	5-7 1/2	1/2-1	—	—
Cortland	35-50	7 1/2-12	3-5	1/4-1/2	—	—
Grimes Golden	35-50	5-10	5-7 1/2	—	—	NAD 25-50+Sevin 1/2-1
Red Delicious/non-spur	—	5-10	3-5	1/2-1	—	—
Red Delicious/spur	—	10-15	5-7 1/2	1/2-1	—	—
Empire	—	10-15	5-7 1/2	1/2-1	50	—
Golden Delicious	—	10-20	5-10	1/2-1	—	NAA 5-10+Sevin 1/2-1
Blushing Golden	—	—	—	1/4-1/2	—	—
Firmgold	—	—	—	1/4-1/2	—	
Idared	—	—	—	1/2-1	—	—
Winesap	35-50	7 1/2-10	3-5	1/2-1	—	—
Staymen & Turley	35-50	7 1/2-10	3-5	1/2-1	—	—
Rome & Gallia	50-60	15-20	7 1/2-10	—	—	—
Fuji[7]	—	5-10	3-5	—	—	Accel 50 + Sevin 1

1 Lower concentrations suggested when conditions are favorable for thinning.

2 Applications of NAD (Amid-Thin) should be made from late bloom to petal fall.

3 Applications of NAA or Sevin or the combination should be made of fall and winter varieties when king fruits are 11-13 mm in diameter. On summer varieties, Wealthy and Earliblaze the combination should be applied at petal fall.

4 WA=Wetting Agent: Tween 20, Regulaid or Amway Wetting Agent at 3/4 to 1 pint per 100 gallons.

5 The addition of NAA at 2 1/2 to 4 ppm to Sevin stimulates the initiation of fruit buds for return bloom. This low NAA rate should not thin fruit or cause pygmy apples on Red Delicious.

6 The Sevin XLR Plus formulation is most commonly used for thinning and is the only formulation labeled for early use (petal fall to 6mm diameter). Consult the label if other Sevin formulations are used.

7 Experience with adequate rates of Accel across many varieties is limited.

Variability of results and excessive foliage injury often experienced with NAA may be avoided by using this material at 1/3 to 1/2 of the rates recommended on the label in combination with 3/4 pint of "Tween 20" per 100 gallons. The addition of the "Tween 20" increases the rate of foliar absorption and decreases the effects of seasonal factors such as temperature, relative humidity and wind on the drying rate and amount of material entering the leaf. The elimination of foliage wilting and tree "shock" results in better fruit size at harvest than the same amount of fruit thinning obtained by the full dosage of NAA alone. Wetting agents other than "Tween 20" that have been used successfully in tests in Illinois and Indiana include Regulaid and Amway Wetting Agent, or Ortho X 77.

Accel is a newly labeled post-bloom period (10 mm fruit size) chemical thinner for apples. Accel has worked well with small fruited varieties and has shown a benefit of increase in fruit size. Accel has not been a successful thinner for Red Delicious. Refer to the product label for additional information.

Important Reminders About Chemical Thinning

NAA generally gives best results under fast drying conditions, and when the temperature is between 70 and 75 degrees F. Amid-Thin gives the best results under slow drying conditions and is often applied in the evening.

Thorough spraying and uniform coverage are necessary for satisfactory results. However, if you want to reduce the degree of thinning or are afraid of over-thinning, reduce the concentration but not the gallonage applied per tree.

Lower limbs are easier to thin than upper ones. Reduce the spray application on the lower limbs by shutting off one or more nozzles; some spray applied to the tree tops will fall on lower limbs.

Concentrate sprays of chemical thinners have been satisfactory. Care should be exercised that calibration is correct so that the right amount of material is applied to all parts of the tree and row. Be careful to avoid double applications to row ends, etc. Miscalculation of the sprayer manifold is magnified in concentrate application. Concentrating more than 4X has resulted in variable results and should be avoided.

Applying chemical thinning sprays after frost or freezing temperatures is risky. Foliage exposed to such conditions absorbs chemicals much more readily, and over-thinning may result. If you must spray under such conditions, reduce the concentration 25 to 30 percent.

Chemical thinners are generally more effective under the following conditions: (1) low vigor trees, (2) light pruning, (3) heavy bloom, (4) poor pollination, (5) high humidity before spraying, (6) slow drying of spray, (7) poor air drainage and (8) cloudy, cool weather preceding or following the bloom period.

You should keep records of the conditions prevailing when you make applications and should leave several trees unsprayed to evaluate critically the results of thinning applications. This way you will be able to work out the concentrations best suited for your orchard conditions.

NAA formulations Not all NAA formulations have the same amount of active ingredient. Since calculating ppm can be difficult, the table below describes each of several materials and the amount of formulation per 100 gallons of water required to make a 10 ppm solution (Table developed by R. Marini, VPI)

Trade Name	Chemical	Formulation	Acid equivalent (% of active ingredient)	Amount of formulation per 100 gallons to make 10 ppm.
Amid-Thin W	1 Napthaleneacetamide	WP	8.4	1.6 oz
Fruitone N	1-Napthaleneacetic acid, sodium salt (3.5%)	WP	3.1	4.0 oz
Kling-Tite 256	1-Napthaleneacetate, potassium salt (8.3%)	liquid	8.6	1.9 fluid oz
K-salt Fruit Fix 800	1-Napthaleneacetic acid, potassium salt (24.2%)	liquid	20.2	0.63 fluid oz
K-salt Fruit Fix 200	1-Napthaleneacetic acid, potassium salt (6.25%)	liquid	5.18	2.47 fluid oz

Chemical Weed Control

Controlling weeds in fruit plantings is increasingly important, particularly as the number of trees per acre is increased and most particularly in hedge row situations. Herbicides can provide good weed control with little labor and frequently at a low cost. When herbicides are used properly, plant or tree growth will be improved, and control of insects and diseases, as well as mice, is facilitated.

Proper Application

To be effective, herbicides must be selected properly for the job they are to do; they must be applied at the proper time, at the proper rate, and with the proper equipment. The degree of weed control depends largely on the skill of the operator.

Herbicides can injure fruit plants if used improperly. Therefore, sprayer adjustment and calibration should be as good as possible to assure uniform applications. Use flat fan type nozzles at low pressures (20 to 40 pounds) on a fixed boom-type applicator. This type of sprayer is calibrated easily and when designed properly will deposit herbicide uniformly under the trees. Do not attempt to apply residual herbicides around fruit plants with hand guns on a weed sprayer. Handguns are useful only for spot treatment with materials like Gramoxone or Roundup.

Calibrate the sprayer carefully, and apply material according to the suggested rates. Note that in many instances, rates should be lower on sandy soil with low organic matter and higher on heavier textured soil and those high in organic matter. With some materials, no rate changes are suggested.

Tank Mixes

Certain herbicides can be tank mixed with other herbicides to increase the spectrum of weed species controlled and to increase the effectiveness of herbicide materials. Consult herbicide labels for specific information on tank mixes.

Use Restrictions

Herbicide use is controlled by federal regulations which prescribe the crops upon which the herbicides can be used and the timing and rates for which these materials are registered. Be sure to use only registered materials at the rates recommended. The product label is the final authority. Follow it carefully.

Herbicide labels are often complicated and it is difficult to distill use directions into a short paragraph. Always refer to the specific label for detailed directions, precautions, restrictions, and tank mixes.

Good Rules to Remember

1. Use a fixed spray boom, uniform speed, flat fan nozzles and low pressure for even application without drift.
2. Follow restrictions on herbicides on young trees. Allow trees to become well established and the soil well settled before applying.
3. Where applicable, follow rate suggestions based upon soil type.
4. Use herbicide sprayers for herbicides only.
5. Clean sprayers thoroughly when changing herbicides, especially when 2,4-D has been used.
6. Store herbicides as carefully as you would any other pesticide.
7. Dispose of excess spray material carefully; avoid damage to shrubbery, lawns, etc.
8. Do not graze treated areas.
9. READ THE LABEL - - UNDERSTAND IT THOROUGHLY- - FOLLOW DIRECTIONS.

Herbicide Resistance Management

Avoid use of the same product or chemically related products for several consecutive years to avoid a buildup of herbicide resistant weed biotypes. Rotate herbicides and include non-chemical controls where possible to reduce dependence on herbicides to which weeds might develop resistance.

Crop	Weeds Controlled	Materials & Rate Per Treated Acre
Apples, Pears, Cherries, Peaches, Plums, Prunes, (Bearing and Nonbearing)	Annual and perennial grass and broadleaf weeds	CASORON or NOROSAC granular (4%) at 100 - 150 lb. per acre. For control of perennial weeds use 150 lbs. per acre. Soil surface application - apply from November 15 to February 15. Incorporated treatment - Apply in late fall or early spring before May 1 and incorporate immediately. Regrowth usually occurs in late summer. Avoid over-dosage on young trees. Do not apply until 4 weeks after transplanting. Do not apply within one month of harvest on stone fruits. Note Casoron is no longer labeled for peaches, plums or prunes.
	Annual grass and small-seed broadleaf weeds	SURFLAN A. S. (4lb/gal) at 2-6 quarts/acre or SURFLAN granular (0.85 lb ai/lb product) at 2.4 to 7.1 lb per acre. Apply under trees in spring prior to weed emergence; use low rate for short term control and high rate for long term control. Allow soil to settle around young plants prior to treatment. A single 1/2 to 1 inch rainfall or irrigation is required to activate Surflan. A shallow cultivation (1-2 inches) will destroy existing weeds and place Surflan in the zone of weed seed germination. Tank mix with Roundup or Gramoxone Extra to control established weeds.
	Annual grass and small-seed broadleaf weeds	DEVRINOL 50-DF at 8 lb per acre or DEVRINOL 10-G at 40 lb per acre. Apply under trees in late fall to spring on weed free soil or supplement with a postemergence herbicide. Do not apply to frozen ground. If no rainfall occurs within 24 hours after treatment, cultivate or irrigate to incorporate. Do not allow spray to contact fruit or foliage. Approved tank mix: Gramoxone Extra.
	Annual grass and some broadleaf weeds	SOLICAM DF (80%) at 2 1/2 lb. on light colored soils, 5 lb. on heavy or dark colored soils in at least 20 gal. water per acre. Apply to soil surface from fall to early spring before weeds emerge. Rainfall or irrigation within 4 weeks of application is necessary for product activation. Multiple applications may be used, but do not exceed rate and soil texture restrictions (see label). Peaches must be established at least 6 months. Pears, plums and prunes must be established at least 12 months. Cherries must be established at least 18 months. Do not use on coarse textured soils such as sand, loamy sand or gravelly sand. Loss of pigment (whitening) of leaf veins may occur in cherries grown in coarse textured soils when Solicam is applied within 3 months after bud break. Avoid spray contact with fruit or foliage. Tank mix with Roundup or Gramoxone Extra to control established weeds.
Apples, Pears, Sour Cherries	Annual weeds	PRINCEP 4L at 2 to 4 qt per acre, or PRINCEP Caliber 90 at 2.2 to 4.4 lb per acre. Use lower rate on sandy or light colored soils, higher rate on heavy or dark colored soils in a minimum of 20 gal. of water per acre. Apply under trees in spring. Apply alone to weed-free area or in labeled tank mix with a burndown or postemergence product. Avoid contact with fruit, foliage or stems. Make only one application per year. Trees must be established at least 1 year.

WEED CONTROL IN TREE FRUIT CROPS (Continued)

Crop	Weeds Controlled	Materials & Rate Per Treated Acre
Peaches, Plums, Sweet Cherries	Annual weeds	PRINCEP 4L at 1.6 to 4 qt per acre, or PRINCEP Caliber 90 at 1.75 to 4.4 lb per acre. Use lower rate on sandy or light colored soils, higher rate on heavy or dark colored soils in a minimum of 20 gal. of water per acre. Apply under trees in late fall to early spring prior to weed emergence. Apply alone to weed-free area or in labeled tank mix with a burndown or postemergence product. Trees must be established at least 1 year. **Not labeled in any state west of the Mississippi River.**
Apples, Pears, Cherries, Peaches, Plums, Prunes, (Bearing and Nonbearing)	Annual and perennial grasses and certain broadleafs.	KERB (50%) at 2 lb. on sandy or light colored soils to 8 lb. on heavy or dark colored soils in 40 to 50 gal. water per acre. Apply in the fall after fruit is harvested, but prior to leaf drop and soil freeze-up. Make only one application per year. Trees must be established 6 months. ***Restricted Use Material.***
Apples, Pears, Cherries, Peaches, Plums, Prunes, (Bearing and Nonbearing)	Most annual weeds and top kill of perennial weeds	GRAMOXONE EXTRA (2.5 lb./gal) at 2 to 3 pt. in 10-20 gal of water for weeds less than 6 inches in height, 20-30 if greater than 6 inches. Apply as directed spray when weeds are growing rapidly and before they reach maturity. Repeat applications will be necessary to give sustained control. Use low pressure to produce a coarse spray. Always add nonionic surfactant (1-2 pt per 100 gal as directed on label) or crop oil concentrate (1 gal per 100 gal). *Caution: Do not allow spray to contact leaves, fruit or green stems.* ***Restricted Use Material.***
	Annual broadleaf weeds, especially winter annuals	GOAL 1.6 E at 2.5 to 10 pints per acre postemergence (weeds up to 4 inches high), and 6 to 10 pints per acre preemergence. Do not apply more than 10 pt. per acre per year. Goal must be applied during dormancy and before bud swell. Use directed spray to avoid plant contact.
Apples, Pears, Peaches Cherries, Plums, Prunes, (Bearing and Nonbearing)	Annual and some perennial grass and broadleaf weeds	GLYPHOSATE (Roundup Ultra) - See note at end of table and refer to product label for specific state restrictions on use.
Apples and Pears	Most annual grass and broadleaf weeds	KARMEX DF (80% a.i.) at 4 lb per acre. *Apples and pears must be established at least 1 year.* On pears, do not treat varieties grafted on full -dwarf rootstocks. When applied in combination with SINBAR, the use rate is 1 to 2 lb per acre, depending on soil texture. Make one application only per year as a directed spray, avoiding contact with foliage and fruit.
Peaches	Most annual grass and broadleaf weeds	KARMEX DF at 2 to 5 lb per acre. On sandy or light colored soils use lower rates and on heavy or dark colored soils use higher rates in a minimum of 25 - 40 gal. of water per acre. Apply in spring before weeds emerge. Do not apply within 3 months of harvest. *Peaches must be established at least 3 years.* When applied in combination with SINBAR, the use rate is 1 to 2 lb per acre, depending on soil texture. Make one application only per year as a directed spray, avoiding contact with foliage and fruit.

Crop	Weeds Controlled	Materials & Rate Per Treated Acre
Apples and Peaches (Bearing)	Most annual weeds and grasses	SINBAR (80%) at 2 lb. on light-colored soils, 4 lb. on heavy or dark colored soils in at least 20 gal. water per acre. Make a single band or broadcast application as a directed spray. Do not contact foliage or fruit with spray or mist. Apply either in the spring before weeds emerge or during early stages of seedling regrowth or after harvest in the fall. *Trees must be established 3 years or more.* Do not replant areas to crops within 2 years of last application. Do not use on soils with less than 1% organic matter.
Stone Fruits	Annual and some perennial broadleaf weeds	HI-DEP (2,4-D) at 3 pt/A. Apply in 20-50 gals. water. Apply as directed spray when weeds are in pre-bud to early bud stage. Do not allow spray to contact leaves, fruit or limbs of tree. Use coarse spray and low pressure to avoid drift.
Apples and Pears, Bearing and Nonbearing, All others, Non-bearing only	Most annual and perennial grasses (postemergence only)	POAST 1.5 E at 1.5 - 2.5 pt. plus crop oil concentrate at 1 qt in 25 gal. water per acre. Apply as a directed spray at lower rates to actively growing annual grasses up to 12 in, or at higher rates to perennial grasses early in the growth cycle. *Do not apply to trees that will be harvested within one year after application except apples and pears. On apples and pears do not apply within 14 days of harvest.* For apples and pears the maximum rate per application is 2.5 pt. and the maximum rate per season is 7.5 pt. per acre. Do not tank mix with other herbicides.
Bearing Stone Fruits	Most annual and perennial grasses	FUSILADE DX at 6 to 12 oz per acre plus crop oil or non-ionic surfactant in 25 gals. water per acre. Apply as a directed spray when grass is actively growing and before tillering or seed head formation. Avoid contact with tree foliage. Do not apply within 14 days of harvest. The maximum rate per season is 72 fl Oz. Do not tank mix with other herbicides.
Apples, Pears, non-bearing	Most annual and perennial grasses	FUSILADE DX at 16-24 oz plus crop oil or non-ionic surfactant in 25 gal. water per acre. Apply as a directed spray when grass is actively growing and before tillering or seed head formation. Do not apply within one year of harvest. Do not tank mix with other herbicides.
Apples, Pears, Cherries, Peaches, Plums and Prunes (Non-bearing)	Annual grass and small-seeded broadleaf weeds	PROWL 3.3 EC at 2.4 qt. preemergence for short term weed control to 4.8 qt. for long term weed control in a minimum of 20 gal. of water per acre. Apply as directed spray to weed free soil. Do not allow spray to contact leaves, shoots or buds. If no rainfall occurs within 21 days of treatment, irrigate to incorporate. Do not apply in new plantings until soil around trunk has settled. Not effective on muck soils.
Apples, Pears, Cherries, Peaches, Plums, and Prunes (Non-bearing)	Most annual and perennial weeds and grasses	TOUCHDOWN (6E) at up to 5 1/3 pt. in 10 to 30 gal of water per acre per year. See label for details regarding specific rates on weed species. May also be used for spot treatment or as a wiper application. An approved surfactant or wetting agent containing at least 75% active ingredient at 2 qt. per 100 gal. is required to improve coverage of weed foliage. Apply postemergence as a directed spray when weeds are actively growing. Do not allow spray, mist or drift to contact any part of the plant as serious injury may result. Can be applied during site preparation and up to one year prior to harvest. Does not provide residual control; can be mixed with labeled preemergence herbicides for residual control.

Crop	Weeds Controlled	Materials & Rate Per Treated Acre
Apples	Most annual and some perennial grass and broadleaf weeds	RELY (1 lb per gal) from 3 qt per acre (weeds less than 6 in) to 6 qt per acre (weeds greater than 8 in as per label) as a broadcast application in a minimum of 20 gal water. For spot application mix 1.5 to 4 fl oz per gal of water. Best results when applied postemergence to young, actively growing weeds; does not provide residual control. Do not allow spray to contact foliage or green or uncallused bark on young trees. Do not apply within 14 days of harvest. Do not use on trees within one year of transplanting. May be mixed with suitable residual herbicides.

GLYPHOSATE (ROUNDUP ULTRA)

Glyphosate is available in many products sold under other trade names; check product label to make sure the product is labeled for fruit trees. Products vary in formulation concentration and surfactant requirements. Check product label for specific instructions.

Weeds Controlled

Most annual and perennial grass and broadleaf weeds.

Materials and Rate per Treated Acre

ROUNDUP ULTRA Apply when weeds are in bud stage but still actively growing. Application too early is not as effective in killing perennial weeds. To most effectively control perennial weeds such as bindweed, apply in the fall so that the herbicide is translocated down into the root system. Caution: do not allow spray to contact any part of the tree since severe damage may result. Labelled non-ionic surfactants may be used, check product label for recommended rates. Pre-harvest interval for apples and pears is 14 days, and for stone fruit it is 17 days.

Crop	Application Method
Apples, Pears, Cherries	Any application method
Peaches, Plums (in Kansas and Kentucky)	Any application method
Peaches, Plums (all other states)	Wiper application only
Peaches (Arkansas and Tennessee)	Wiper or boom (shielded)

Application Method	Rates
Boom	1-5 qt/A depending of weed species to be controlled. Perennial weeds generally require higher rates. See label for details.
Hand held	1-2% solution
Wiper or wick	33% solution

Suggested recordkeeping form for restricted-use pesticides. Farm name and address: _____

Date & stage of growth	Crop	Chemical applied (Trade name, formulation and EPA registration number)	Rate per Acre	Total Applied	Location & Size of Block	Target Pest(s)	Name of Applicator & Certification number	Wind, Weather, Notes

Adapted from Michigan State University CES Publication E-154, 1993, used by permission

Suggested recordkeeping form for restricted-use pesticides. Farm name and address: _____

Date & stage of growth	Crop	Chemical applied (Trade name, formulation and EPA registration number)	Rate per Acre	Total Applied	Location & Size of Block	Target Pest(s)	Name of Applicator & Certification number	Wind, Weather, Notes

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Date & stage of growth	Crop	Chemical applied (Trade name, formulation and EPA registration number)	Rate per Acre	Total Applied	Location & Size of Block	Target Pest(s)	Name of Applicator & Certification number	Wind, Weather, Notes

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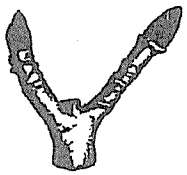
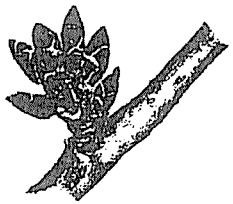
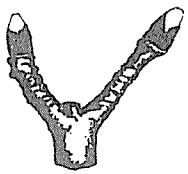
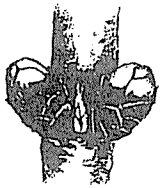
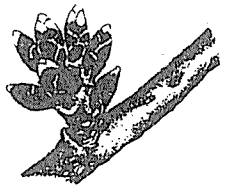
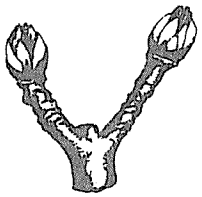
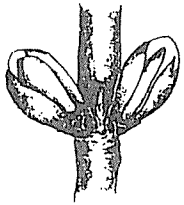
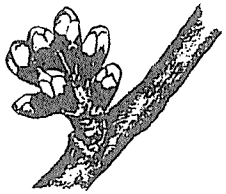
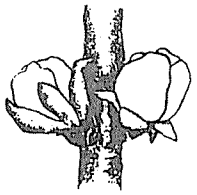
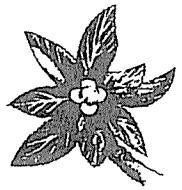
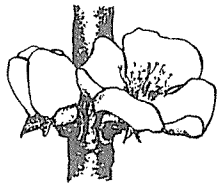
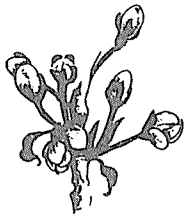
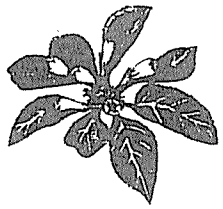
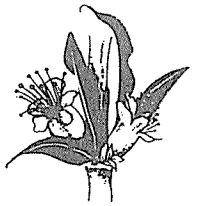
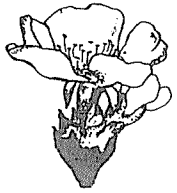
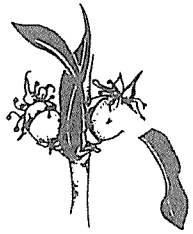
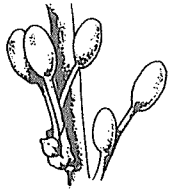
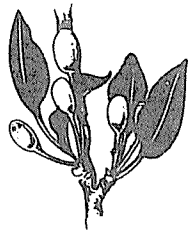
Floral Development Stages for Fruit Crops and Critical Temperatures for Flower Bud Kill

Stage	Apple	Pear	Peach	Tart Cherry	Plum and Prune
	°F 10% Kill — °F 90% Kill	°F 10% Kill — °F 90% Kill	°F 10% Kill — °F 90% Kill	°F 10% Kill — °F 90% Kill	°F 10% Kill — °F 90% Kill
1	 Dormant	 Dormant	 Dormant	 Dormant	 Dormant
2	 15° Silver Tip 2°	 15° Swollen bud 1°	 18° Swollen bud 2°	 17° Bud burst 5°	 14° Swollen bud 1°
3	 18° Green tip 10°	 20° Bud burst 7°	 23° Half-inch green 5°	 25° Green tip 14°	 18° Bud burst 3°
4	 23° Half-inch green 15°	 26° Green cluster 15°	 25° Pink 18°	 26° Tight cluster 17°	 26° Green cluster 16°

5	27° Tight cluster 21° 	26° White bud 22° 	27° Bloom 24° 	27° Swollen bud 24° 	26° White bud 21° 
6	28° Pink 25° 	28° Bloom 23° 	28° Petal fall 25° 	28° Bloom 25° 	27° Bloom 23° 
7	28° Bloom 25° 	28° Petal fall 24° 	28° Fruit set—shucks on 25° 	28° Petal fall 25° 	28° Petal fall 23° 
8	28° Petal fall 25° 	28° Fruit set 24° 	Fruit set—shucks off 	28° Fruit set 25° 	Fruit set 
9	28° Fruit set 25° 				

Compatibility Chart *

(Primarily for apples; may be incomplete for other crops.)

1 Materials compatible

2 Decomposes on standing; residual action reduced

Q Questionable, compatibility not clear

W Wettable or soluble powder only

■ Not compatible

Streptomycin is most favorable applied as a separate application, although it is compatible with Ferbam or Captan when necessary for scab control. Urea formulated for foliar application is compatible with the commonly used pesticides. However, it is not compatible with fixed copper or Bordeaux.

Compatibilities of some materials may depend upon solvents and emulsifers used by the manufacturer. Emulsifiable concentrate formulations are more likely to cause compatibility problems than wettable powders. **If wettable powders are mixed with emulsifiable concentrates, incompatibilities may result.**

Do not allow spray mixtures to sit overnight.

* Taken from Michigan State University "*Fruit Spraying Calendar*," Extension Bulletin E-154.

Ambush, Asana, Pounce																																		
Bayleton, Rubigan, Nova	1																																	
Benomyl, Topsin M	1	1																																
Bordeaux	Q	1	■																															
Bravo	1	1	1	1																														
Captan	W	1	1	■	1																													
Carzol	1	1	1	■	1	1																												
Copper (fixed)	■	1	■	1	Q	■	Q																											
Diazinon	W	1	1	■	Q	1	1	Q																										
Dikar	W	1	1	Q	1	1	Q	■	1																									
Dimethoate	1	1	1	1	1	1	Q	1	1	1																								
Dinocap (Karathane)	W	1	1	Q	1	1	1	Q	1	1	1																							
Dodine (Syllit, Cyprex)	1	1	1	■	Q	1	1	■	1	1	1	1																						
Carbamate, Thiram, Maneb, Polyram	1	1	1	■	W	1	1	■	1	1	1	1	1																					
Funginex	Q	Q	1	■	1	1	Q	■	1	Q	1	1	1	Q																				
Guthion	1	1	1	Q	Q	1	1	Q	1	1	1	1	W	1	1																			
Imidan	1	1	1	Q	1	1	1	Q	Q	1	1	1	1	1	1	1																		
Lannate	1	1	1	■	1	1	Q	1	1	1	1	1	1	1	1	1	1																	
Lime	■	1	■	1	1	■	■	1	2	Q	1	Q	■	■	Q	2	■	Q																
Lorsban	1	1	1	■	1	1	1		1	1	1	1	1	1	1	1	1	1	1															
Malathion	1	1	1	■	1	W	Q	1	1	Q	1	W	1	W	1	1	1	Q	■	1														
Methoxychlor	1	1	1	1		1	1	1	1	1	1	1	1	1	Q	1	Q	1	Q	1	1													
Mitac	1	1	1	Q	Q	1	Q	Q	Q	1	Q	Q	■	■	Q	1	1	1	Q	Q	Q	Q												
Oil (Superior)	1	1	1	■	1	■	1	1	1	■	■	■	1	1	Q	W	1	Q	1	1	1	1	Q											
Omite	1	1	1	Q	1	1	Q	1	■	1	1	Q	1	1	1	W	1	1	■	■	■	1	Q	■										
Penncap-M	1	1	1	■	1	1	1	1	1	1	1	1	W	1	Q	1	1	1	■	1	1	Q	Q	1	1									
Phosphamidon	1	1	1	■	1	1	1	1	1	1	1	1	1	1	1	1	1	Q	■	1	1	1	Q	1	1	Q								
Rovral, Ronilan	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	Q	1	1	Q	1	1	1	1							
Sevin	1	1	1	■	1	1	1	1	1	1	1	1	1	1	1	1	1	1	■	1	1	1	Q	Q	1	1	1	1						
Sulfur (elemental)	1	1	1	1	1	1	1	1	1	1	1	1	■	1	Q		1	Q	1	1	1	1	Q	■	1	1	1	1	1					
Supracide	1	1	1	Q	1	1	1	Q	1	1	1	1	1	1	1	1	1		■	1	1	1	Q	1	1	1	1	1	1	■				
Thiodan	1	1	1	■	Q	W	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
Vendex	1	1	1	■		1	1	1	1	1	1	1	1	1	Q	1	1	1	Q	1	■	Q	Q	1	1	1	1	1	1	1	1	1		
Vydate	1	1	1	1	1	1	1	1	1	1	1	1	1	1	Q	1	1	1	■	1	1	1	Q	1	1	Q	1	Q	1	Q	1	1	1	
Ziram, Zineb	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	Q	1	1	W	Q	1	1	1	1	1	1	1	1	1	1	1

This chart is based on data believed reliable. No warranty is expressed or implied regarding the accuracy of this information. The chart does not imply registration nor recommendations on specific tree fruits. For details, consult the container label.

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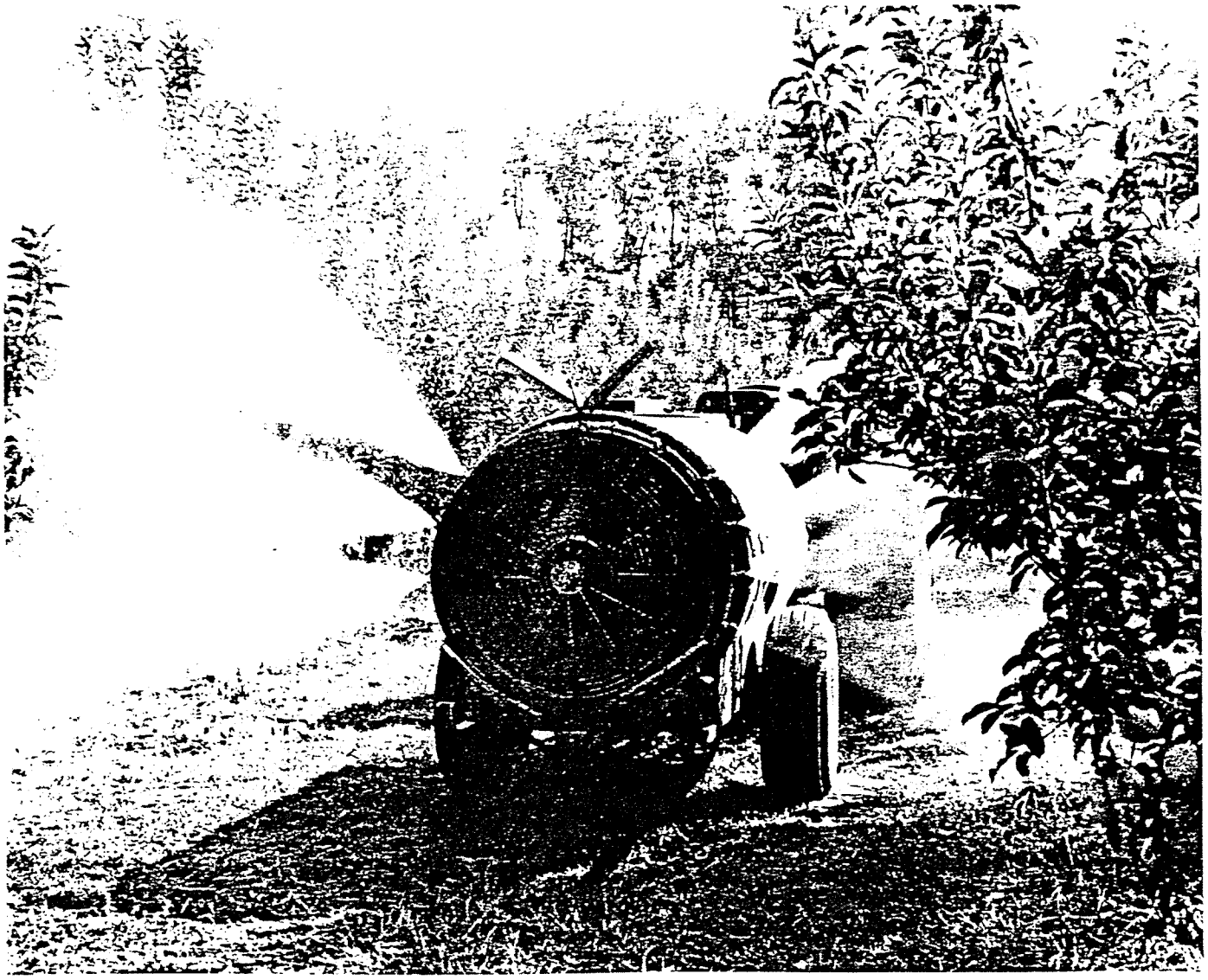
Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914 in cooperation with the United States Department of Agriculture. C. Oran Little, Director, of Cooperative Extension Service, University of Kentucky College of Agriculture, Lexington, and Kentucky State University, Frankfort. 12-98, 1.5

APPENDIX 12

Sprayers for Fruit Crops

Selecting & Calibrating



Cooperative Extension Service
Kansas State University, Manhattan

Control of insects and diseases is one of the main expenses in a commercial fruit enterprise. To keep costs under control, a grower should select the proper sprayer to fill the needs of the operation, and learn how to use that equipment to obtain the maximum control from the chemicals applied.

The basic objective of any spray operation is to provide a means of depositing the correct amount of the pesticide in the correct location to control a pest infestation and prevent plant and fruit damage.

Sprayer selection

Selecting the correct equipment for the intended application is crucial to success with today's pesticides. Fruit enterprises typically require applications of herbicides, insecticides, and fungicides throughout the growing season. Herbicides have different application requirements than those of insecticides and fungicides. It is difficult to find one sprayer with enough flexibility to meet the application requirements of each pesticide. *Two machines* are advisable since herbicides may not be completely removed from the spray tank and may cause injury when following with fungicides and insecticides.

It is possible for any brand sprayer to do a satisfactory job of application, provided that the spray equipment is properly matched to the tree or vine size, spacing, pruning, and local weather conditions. The spraying equipment selected must:

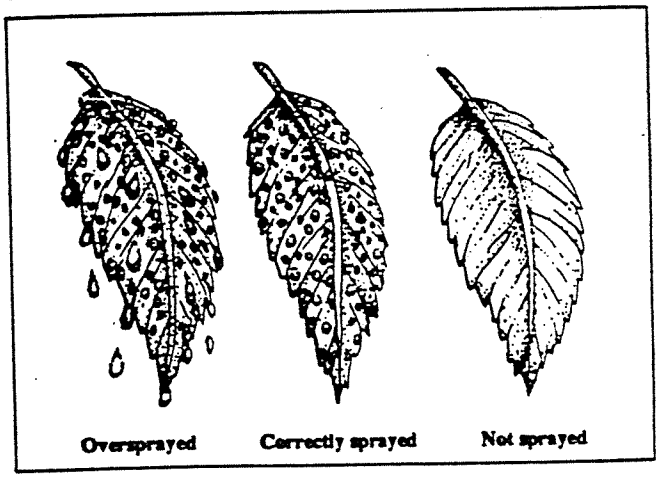
- Provide the coverage and gallonage requirements for the existing plantings during a projected growth period of 10 years.
- Have the versatility to spray both the largest and the smallest plants. Growers should keep in mind that large trees can be sprayed with small sprayers traveling slowly or during periods of very light winds (wind speeds less than 3 mph).
- Have the ability to maintain uniform deposition and coverage during the entire growing season. The spray coverage normally will decrease as the season progresses due to the changing shape of the plant and the increasing foliage density. The equipment must have adjustable pressure, booms, manifolds, air vanes, etc. to maintain uniform deposition.
- Have the size and output to meet the requirements of the grower's spray schedules. Timeliness will affect the selection of such variables as the tank, fan, pump and pressure capacities.
- Be able to combat the prevailing winds. In general, high velocity air blast sprayers (usually high horsepower) are able to combat winds better than low velocity sprayers. The combination of air velocity and air volume should be sufficient to cause air turbulence in the upper part of the tree.

There is no general purpose sprayer. Sprayers are composed of various parts including a tank, pump, agitation device, filter, distribution device (manifold, spray gun, or boom), and power source. However, the selection and configuration of each of the individual components of a machine determine the optimum operational situation for that machine. The sprayer that has the best possible combination of components for the application of soil-applied herbicides will do a less than acceptable job of applying fungicide and insecticide compounds. Each of these components should be considered when selecting the correct sprayer for each operation.

For the application of fungicides and insecticides, there are several categories of sprayers, according to the volume of liquid materials being applied.

- Ultra-low volume sprayers generally spray *undiluted* pesticide concentrate in the range of 1/2 gallon per acre or less.
- Concentrate sprayers involve the use of highly concentrated spray solutions involving *some dilution* of the pesticide formulation. For example, if a typical orchard application rate suggested on a label is 400 gallons per acre (a dilute rate), a 4x concentrate could be used to apply the same amount of active ingredient using a total carrier of only 100 gallons per acre. However, the total amount of active ingredient applied remains constant, regardless of the amount of carrier solution used for the application.
- High volume *(dilute)* applications usually are application rates of 100 to 400 gallons per acre.

Handgun operations often are used to apply materials to the point of liquid runoff of the foliage. The key to complete coverage is to apply spray solution to the entire surface of the leaves and fruit in sufficient quantities to cover the surface but not so heavy that the materials will combine into larger drops and run off the leaf.



There are several types of sprayers suitable for use in fruit or orchard operations. These include a broadcast sprayer, an air delivery sprayer and a band sprayer.

The broadcast sprayer is any type of sprayer designed to apply a uniform distribution of material across an area. It typically has a spray boom or a boomless broadjet.

A band sprayer is designed to apply materials uniformly in specific strips of an area while leaving the area between strips untreated. Band application sprayers are usually an adaptation of a broadcast sprayer modified with special equipment for the band application. Band applications can also be done with handgun or backpack sprayers.

An air delivery sprayer is designed to apply material uniformly to foliage in an orchard or vineyard. The air delivery system differs from a broadcast unit in that air is used to deliver the spray to the target. Air delivery sprayers typically produce sprays composed of small droplets that are more susceptible to evaporation and drift.

Droplet transport mechanisms

Common orchard or vineyard sprayers rely on hydraulic or air transport mechanisms for delivering the pesticide to the target. In the case of hydraulic transport, the liquid is released under pressure from a nozzle or metering orifice with sufficient energy and velocity to ensure its trajectory to the target and ultimate deposition. The liquid carrier must be discharged with a large enough droplet size to overcome evaporation and with enough velocity (energy) to carry it against the forces of gravity, wind, turbulence, friction, etc. to the desired location. Because this method relies on the energy imparted to the liquid stream for the atomization and transport of the spray, pump pressures of 300 pounds per square inch (psi) or more often are used.

The advantages of hydraulic transport include: the droplet size produced varies from large to small, the mechanical system is easy to use and calibrate, and the units have lower power requirements. A disadvantage of hydraulic transport is that the droplets reaching the final target may be too large to provide coverage at extreme distances. In the case of handgun operation, the nozzle orifice is varied from a small opening to produce fine spray for deposit at close range to a large opening to produce very large droplets for longer distances. The large droplets may not provide adequate coverage at the tops of large trees.

Air transport uses a low- to medium-pressure nozzle system to deliver an atomized spray into a high-speed air stream for delivery to the target. It uses the energy in the air stream to transport the spray to the target. The air stream can be used for transporting the spray to the target only with air velocities less than 150 mph. It can also be used to both atomize the spray by wind shear action and to transport the spray to the target with air velocities generally greater than 150 mph. Air is supplied by a fan unit which may have high power requirements.

The advantage of an air system is that it provides for a turbulent transport of the spray particles to the canopy and may provide better coverage in extremely dense applications due to physical movement of the foliage. Its disadvantages are that the droplets are affected by evaporation while being transported and are subject to wind shear within the air delivery stream, which results in very small droplets that are more susceptible to drift and off-target deposition.

There is no practical method of atomizing a liquid into a spray cloud composed of uniform droplet size. Spray clouds are composed of droplets ranging in size from large to tiny droplets. This range of droplet sizes can affect the performance of the material being applied. For example, to apply a pesticide that requires complete coverage, a spray cloud that deposited one droplet 1,000 microns in size per leaf would not be as effective as a spray cloud that deposited eight droplets 500 microns in size per leaf, even though the volume of a single 1,000-micron droplet is the same as the volume of eight 500-micron droplets.

Sprayer components

Sprayers are composed of several components. The choice and assembly sequence of these components will determine the versatility of the final machine. Several of these components should be considered in detail.

Tanks

Various types of materials are used for sprayer tanks: fiberglass, polyethylene or polypropolene, and stainless steel. Aluminum or black iron tanks are not suitable for sprayer tank construction because of corrosion due to chemical reactions with pesticides. The tank should be large enough to allow sufficient carrier volume, thereby avoiding frequent refilling. Tank sizes range from one to two gallons for spot treatment applications to 500 gallons found on high-volume units. The tank should have a fill opening large enough to allow for easy cleaning.

Pumps

Pump types available for use in fruit enterprises include the roller pump, centrifugal pump, diaphragm pump and piston pump. The roller pump will provide pressures up to 300 psi in volumes up to approximately 30 gallons per minute. This will provide enough pressure and volume for handgun operation

for vineyards or small fruit trees and can also be used for boom broadcast and band applications. A roller pump is susceptible to wear from abrasive solutions such as wettable powder formulations, causing increased wear and maintenance costs.

The centrifugal pump will provide maximum pressures of 40 to 45 psi (multiple stage pumps will provide higher pressures), with volumes as high as 150 to 200 gallons per minute (gpm) and will provide enough pressure for broadcast or band herbicide applications requiring low pressures but will not provide the high pressure required for handgun operations used in most insecticide or fungicide applications.

Diaphragm and piston pumps will provide the high pressures (400-500 psi) required for use with handguns but with low volume output. The diaphragm pump uses a flexible diaphragm that contacts the spray material and will provide good service when spraying abrasive solutions. A piston pump has more contact with the spray solution but will still provide good service with abrasive materials. Maintenance is easy with both pumps but initial cost is higher.

Diaphragm or piston pumps are found on most commercial air blast or air-assisted sprayers. Roller or centrifugal pumps are found on most broadcast boom-type sprayers.

A commercial fruit grower should have both a broadcast sprayer and an air blast sprayer. A centrifugal pump on the broadcast sprayer allows for high-volume, low-pressure applications for herbicides. An airblast or a high-pressure handgun sprayer allows for application of insecticide or fungicide sprays to the vineyard or orchard.

Agitation systems

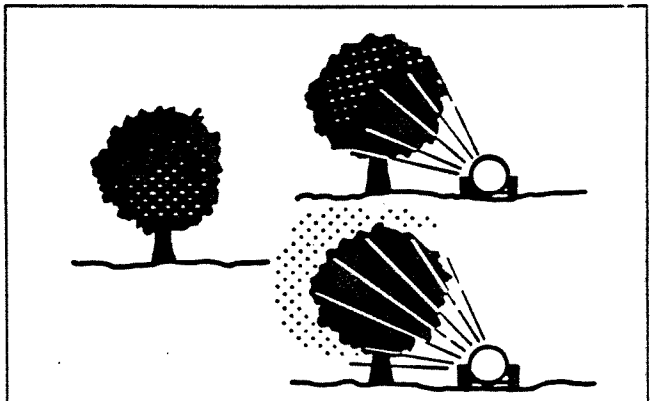
A sprayer must have an agitation system to ensure that applied solutions remain properly mixed. Three common methods of agitation are: sparging, hydraulic and mechanical agitation. A sparger agitation system emits air or liquid under pressure from holes in a tube along the inside bottom of the tank. The liquid or air being emitted causes continuous circulation of the solution in the tank.

The sparging system requires liquid flows of 6 gpm per 100 gallons of tank volume for adequate agitation. A hydraulic agitation system returns fluids from the pressure output of the pump to a hydraulic agitation nozzle. Hydraulic agitation systems using "flow increaser" agitation nozzles require a fluid flow of 3 gpm per 100 gallons of tank volume.

A mechanical agitation system is composed of a mechanically turned set of paddles on a bearing-mounted shaft that physically stirs the solution inside the spray tank. Any of these systems will provide adequate agitation for most spray solutions.

Air transport fan requirements

When air is used for both atomization and delivery, the sprayer should be capable of delivering a medium volume of air but at high velocities. To meet this requirement, the sprayer blower should have air velocities above 150 mph at the exit to apply spray particles to the foliage. Air vanes should be adjustable to ensure that the emitted air curtain has sufficient angle and turbulence to cause foliage movement across the width and height of the tree. As the unit advances along a tree row, one should observe visible movement of the foliage in the inner and upper-most portions of the tree.



Air from sprayer displaces air in tree.

Care must be taken to ensure that the sprayer fan has the capacity to deliver the spray to the tree. As a rule of thumb, the total air delivered to the tree should displace twice the tree volume measured in cubic feet per minute (cfm). For example, a tree that is 15 feet high and has a canopy diameter of 15 feet will have a volume of 2650 ft^3 (volume = $D/2^2 \times 3.14 \times H$ or $15/2^2 \times 3.14 \times 15 = 2650\ ft^3$). If a grower wanted to spray two-sided at 1 mph (88 ft/min/mph) and the tree rows were spaced 20 feet apart, air capacity can be determined by:

$$\text{required air capacity (cfm)} = \frac{\text{rate of travel} \times 2 \times \text{tree volume}}{\text{tree spacing}}$$

or

$$\text{cfm} = \frac{88\ \text{ft/min/mph} \times 2\ \text{sides} \times 2650\ \text{ft}^3/\text{mph}}{20\ \text{ft}}$$

$$\text{cfm} = 23{,}320$$

The table on page 7 is based on this formula and provides an excellent starting point for good spray coverage. This table gives the volume of air required for complete displacement at the indicated rates of travel.

Sprayer configuration

Air blast sprayers must be configured properly to ensure uniform deposition of the material in the target canopy.

The following procedure can be used as a guide to the proper configuration of air delivery sprayers:

Step 1. Determine sprayer ground speed in miles/hour (mph). Tractor speed can be determined by measuring the distance traveled in one minute. A travel rate of 88 feet per minute equals one mile per hour.

a. Stake off 88 feet (1/60 of a mile) in the field to be sprayed.
b. Select tractor gear and throttle setting to be used. Determine the setting by driving over the area to be sprayed without changing gear or throttle.
c. Using a stopwatch, determine the seconds required to drive 88 feet from a moving start.
d. Divide the number of seconds into 60 to obtain mph. Usually, 2.5 to 3.0 mph is suggested for orchard pesticide spray applications.

Step 2. Determine gallons of spray solution to be applied per tree. The table below is a record of the number of gallons of spray solution applied per tree of different ages at the Ohio Agricultural Experiment Station and can be used as a guide in achieving proper gallonage. These gallonages may then be adjusted, depending on concentration desired.

Spray Solution Required

Age of trees (years)	Average amount per application dilute spray (gallons)			
	Apples	Peaches	Sour cherries	Sweet cherries
2-3	.5	.7	.5	.5
5	1.5	3.0	2.5	1.5
10	6.0	5.5	6.0	6.0
12	8.0	6.0	8.0	8.0

For example, assume that the previous dilute gallonage applied to 15-year-old apple trees was 10 gallons and that you now want to apply a 5X concentrate. The new application rate per tree would be:

$$\frac{10 \text{ gallons}}{5X} = 2 \text{ gallons}$$

If the tree is to be sprayed from both sides, the gallons applied to the tree for each pass will be:

$$\frac{2 \text{ gallons/tree}}{2 \text{ passes/tree}} = 1 \text{ gallon/pass}$$

Step 3. Determine total discharge rate for sprayer (gallons/ minute). If the spray recommendation is given in gallons applied per acre, the discharge rate may be determined by:

$$\text{gpm} = \frac{(\text{mph})\,(\text{sw})\,(\text{gpa})}{990}$$

a. mph is travel speed: 2.5 to 3.0 mph (speeds above 3.0 mph reduce penetration and, therefore, coverage).
b. sw is swath width: distance in feet between rows if spraying every other row and half the distance between rows if spraying every row.
c. gpa is gallons per acre: 300 gallons/acre for high volume sprays of dilute mixtures spraying mature trees. Use 50 to 100 gallons/acre for low volume sprays of concentrated mixture (3X to 6X). Low volume concentrate sprays generally deliver the same amount of chemical per acre as in dilute sprays.
d. gpm is gallons per minute: the discharge rate needed for each side of the sprayer. This is the total output from all nozzles used on one side. Multiply by 2 for actual use with both sides.

Example: 3 mph, 20 foot swath width (20 foot row spacing, spraying every other row), 50 gallons/acre of low volume spray.

$$\frac{3 \times 20 \times 50}{990} = 3 \text{ gallons/minute/sprayer side}$$

If the spray recommendation is given in material applied per tree, the discharge rate may be determined by:

a. Knowing the number of trees passed per minute (rate of travel/tree spacing = trees/minute)
b. Knowing the desired gallonage to be applied per tree per pass.
c. Calculating the total discharge rate.

For one side this is:

number of trees passed per minute **x** gallons per tree per pass **=** total discharge rate

For two sides:

$$2 \times \frac{\text{number trees}}{\text{passed per minute}} \times \frac{\text{gallons per}}{\text{tree per pass}} = \frac{\text{total}}{\text{discharge rate}}$$

Example:

2 x 6 trees per minute x 1 gallon/tree/pass =
2 x 6 x 1 = 12 gpm

The total discharge rate is now known, and nozzle arrangement can be determined.

Step 4. Determine the effective air blast.
- a. Pull sprayer opposite a typical tree at the normal spraying distance.
- b. Turn on sprayer.
- c. Shut off all nozzles at the top and bottom of the discharge manifold that are not spraying into the tree target area.
- d. The effective air blast is marked by the nozzles still operating.

Step 5. Determine the operating pressure.
- a. Place a reliable pressure gauge on one of the nozzle fittings in the manifold.
- b. Turn sprayer on for one side spraying and note the operating pressure.
- c. Turn sprayer on for spraying both sides. The pressure should be the same as for one side, but there may be a slight difference. Large differences indicate a mechanical problem which should be corrected before proceeding.
- d. A range of 100 to 400 psi is to be expected.
- e. Select to desired operating pressure.

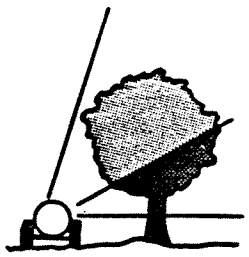
Step 6. Arrangement of nozzles on sprayers.
- a. The gpm total discharge rate is now known for setting nozzles on each side.
- b. Determine the proper number of gallons per minute for each manifold.

Example: It is desired to nozzle an air blast sprayer at 12 gallons per minute for two sides. The sprayer has two manifolds (one on each side) so the gallons per minute discharge for each manifold will be:

$$\frac{12 \text{ gpm}}{2 \text{ manifolds}} = 6 \text{ gpm/manifold}$$

- c. Determine the proper number of gallons per minute in each sector of the spray manifold. Normally the lower two or three nozzles in each manifold cover the skirt of the tree. This lower third of the tree area is served by 25 percent of the gallonage discharge rate. These nozzles should have a nozzle tip that gives a wider angle, more highly atomized spray. Higher atomization is possible here because the droplet path is shorter, therefore evaporation losses are negligible. Also the wide angle spray from this nozzle fills in the spray pattern next to the sprayer. A nozzle tip producing larger droplets and narrower spray pattern should be used in the balance of the manifold to reach the "hard to get" areas of the tree. About 75 percent of the gallonage discharge rate should be directed to the upper two-thirds of the tree area.

Example:



An average of 75 percent of discharge from manifold is discharged in the upper two-thirds, therefore .75 x 6.25 = 4.6 gpm per sector.

An average of 25 percent of discharge from manifold is discharged in the lower one-third, therefore .25 x 6.25 = 1.6 gpm per sector.

- d. Divide the gpm for each sector by the number of nozzles in the sector to determine the gallons per minute from each nozzle.

Example:

Upper sector: $\frac{4.5 \text{ gpm}}{4 \text{ nozzles}} = 1.12$ gpm/nozzle

Lower sector: $\frac{1.5 \text{ gpm}}{3 \text{ nozzles}} = .53$ gpm/nozzle

Be sure to install the correct size of nozzle tips in the appropriate sectors. (Refer to sprayer manual or nozzle catalog for correct selection.)

Step 7. Calibration. This is one of the most important steps in applying pesticides correctly. The following procedures are included as guides for correct calibration. Other procedures may be used but it is important that each operator becomes thoroughly familiar with and regularly uses calibration.
- a. Determine the time required to empty the spray tank with the nozzles selected. Fill the tank with water and turn the sprayer on (both sides) at operating pressure. Record the time required to empty the tank. Calculate total discharge (gpm) by:

$$\frac{\text{gallons/tank}}{\text{minutes to empty tank}} = \text{total gallons/minute (both sides)}$$

b. The calculated total gallons/minute in step 7a should equal the amount determined in step 3. If not, make the necessary minor changes in nozzle selection, pressure or speed. Then recheck the time required to empty the tank.

Step 8. Sprayer operation in the orchard. The sprayer should apply the selected rate at the operating pressure and ground speed that was determined earlier. Monitoring the sprayer operation throughout the season will ensure optimum performance.

a. Flag the tree where the sprayer tank empties for this calibration set-up. The flag will serve as a permanent check through the season.

b. If the tank empties before or after this point, one of the following has occurred:
- The sprayer speed has changed.
- The pressure has changed.
- The nozzles have become worn, plugged, or were changed.

Operation Techniques

Wind has a significant effect on spray patterns. For two-sided applications, the sprayer should be operated closer to the upwind trees to compensate for the crosswind within the pattern. However, fruit and foliage injury due to high pressure must be considered. Applications during high temperatures will result in lesser amounts of active ingredients being deposited on the leaf surfaces due to the increased evaporation rates. Wind will also increase evaporation rates and may cause more off-target movement.

The spray pressure used will affect the droplet size being emitted from the nozzle, with higher pressure generating smaller droplet sizes. On air delivery systems, lower pressures can result in large droplet sizes being emitted from the individual spray orifices, but shear or shatter forces due to the air stream may result in a smaller spray droplet spectrum in the delivery air stream.

Monitoring the Orchard Spray Pattern

Efficient use of pesticides is an economic necessity in fruit pest control programs. Overspraying is costly and may create an environmental hazard. Inadequate coverage results in poor pest control and wasted dollars for chemicals and their application.

Proper tree coverage is necessary throughout the pest control season. Poor coverage early in the season generally results in early problems, which can cause secondary infection for the remainder of the growing season.

Spray deposits can be checked by placing 3 x 5 inch cards or water-sensitive cards in sections of the tree canopy. For the 3 x 5 cards, a colored dye is added to the tank. The spray deposits on the cards indicate the spray pattern from the nozzles. The water-sensitive cards (available from Spraying Systems Co.) change color where the card receives moisture from the spray.

Procedure:

Step 1. Label the cards to indicate the sample position in the tree. The labels could include:
- Tree identification
- Elevation (low, medium, high, etc.)
- Lateral distance (close, middle, far, etc.)
- Row (sprayed, skip, etc.)

Step 2. Attach the cards (with paper staples, clothes pins, etc.) to the foliage or branches of at least three trees, including the equipment travel rows and each of two adjacent rows. The cards should be placed at three levels for trees 12 to 15 feet and higher so that one is located near the lower branch level, another about midway and one near the top. Cards should be at different depths into the tree so that at least three cards are near the outside of the tree close to the sprayer, three in the tree center, and three on the far side of the tree from the sprayer, with a minimum of nine cards in each medium-size tree. The three or more trees monitored can be consecutive or every second or third tree. It is important to monitor enough trees to have a good representation of the sprayer delivery.

Step 3. Add enough water to the sprayer tank to spray a minimum of ten trees (more would be better). Add 2 to 4 ounces of dye concentrate to each 25 gallons of water in the tank if using other than water-sensitive cards. The dye should be strong enough to produce a visible color contrast on the sprayed cards.

Step 4. At the calibrated spray application speed, begin spraying one or two trees ahead of the monitoring trees so the sprayer is in full operation as it passes the monitoring trees and deposits the dye on the cards. Where spray guns are used, follow the same procedures described above and apply the spray in the usual manner. Do not make a special effort to spray the cards. Remember, the objective is to monitor the spray coverage as it is usually applied, so the procedures must be objective.

Step 5. Remove the cards and lay them out in the same pattern as they were placed in the tree. The dye should cover at least 90 percent of each of the cards. It is particularly important that the cards in the upper part of the tree are well covered. Some pest problems

can become established in this area if it is not thoroughly protected. The larger nozzle sizes should be arranged so that 75 percent of the spray discharges into the top two-thirds of the tree.

If the coverage in the upper tree is inadequate, the nozzles should be adjusted, and the monitoring procedures repeated until the dye on the cards shows thorough spray coverage.

Required Air Volume

Travel Speed of Sprayer		Tree Dimensions (Diameter x Height in Feet) 10'D x 10'H	15'D x 15'H	20'D x 20'H	
		Tree Volume in Cubic Feet 785	2650	6280	Manifold
M.P.H.	F.P.M.	Tree Spacing (Ft.) 15'	20'	25'	(1) One Siding (2) Two Siding
.50	44	2300 4600	5800 11600	11000 22000	(1) (2)
.75	66	3450 6900	8700 17400	16500 33000	(1) (2)
1.0	88	4600 9200	11600 23320	22000 44000	(1) (2)
1.5	132	6900 13800	17400 34800	33000 66000	(1) (2)
2.0	176	9200 18400	23200 46400	44000 88000	(1) (2)
2.5	220	11500 23000	29000 58000	55000 110000	(1) (2)
3.0	264	13800 27600	34800 69600	66000 ---	(1) (2)
3.5	308	16100 32200	40600 81200	77000 ---	(1) (2)
4.0	352	18400 36800	46400 92800	88000 ---	(1) (2)

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MF-910 November 1988

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APPENDIX 13
SOIL AND FOLIAR APPLICATIONS OF NUTRIENTS TO FRUIT CROPS

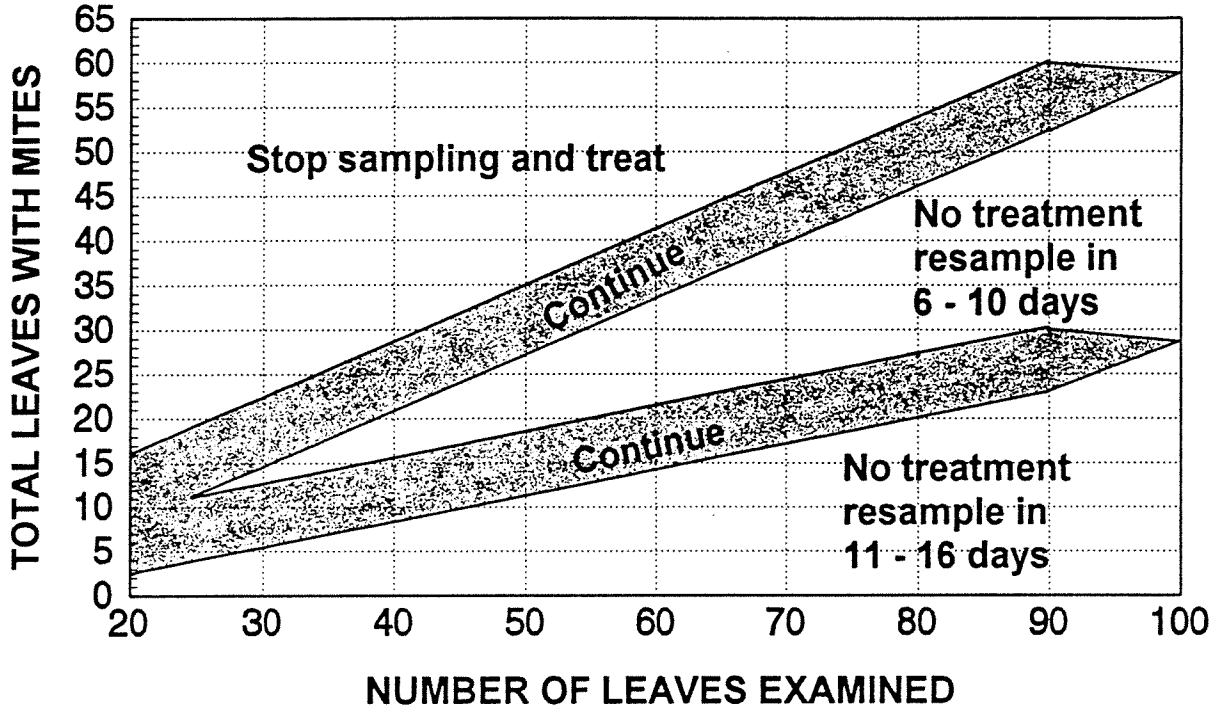
Nutrient	Material	Soil Application (lb/acre)	Foliar Application (lb/100 gal of water)	Foliar Application (amount/acre)
Boron	Borax ($Na_2B_4O_7 \cdot 10\ H_2O$)	10	-------	
	Solubor ($Na_2B_4O_7 \cdot 5\ H_2O$) and $Na_2B_{10}O_{16} \cdot 10\ H_2O$) 20.5%B	8	1 at full-bloom, petal-fall or first-cover	
Calcium	From liming materials, calcium nitrate and superphosphate when used as soil amendments or as fertilizers	based on soil pH	-------	
	Calcium chloride (77-80% $CaCl_2$ flakes) 27.8% Ca	-------	-------	1.8-6.2 lbs
	Calcium chloride (35% $CaCl_2$ liquid) 12.6% Ca	-------	2	0.35-1.24 gal
	Nutri-CAL 8% Ca	-------	-------	1-2 qts
	Nutri-Phos 12 11% Ca	-------	-------	3-10 qts
	Sorba-Spray Ca 8% Ca	-------	-------	1-4 qts
	Stopit Calcium 12% Ca	-------	-------	2-4 qts
Copper	Copper sulfate ($CuSO_4 \cdot 5\ H_2O$) 25.5% Ca	25 dormant season	2-5 dormant season	
	Fixed copper sulfate	------	See label, apply between green-tip and ¼-inch green	
Iron	Chelated iron 9-12% Fe	18-36	¾-1	
Magnesium	Dolomitic limestone 20-45% Mg	25-30 of Mg	-------	
	Magnesium sulfate (Epsom salts) ($MgSO_4 \cdot 7\ H_2O$) 9.8% Mg	150-200	5 at pink, petal fall and first cover	

Nitrogen	Ammonium nitrate (NH_4NO_3) 33% N Urea (CO $[NH_2]_2$) 42-45% N	based on tree age and growth	------- 3 before bloom 5 after bloom (Don't apply after first cover)	
Zinc	Zinc sulfate (Zn $SO_4 \cdot 7\ H_2O$) 22.7% Zn Chelated zinc 14% Zn Zinc containing fungicides will supply small amounts	10-40 15-40 -------	20 dormant season ¾-1 Fungicide rate	

MITE SAMPLING CHARTS

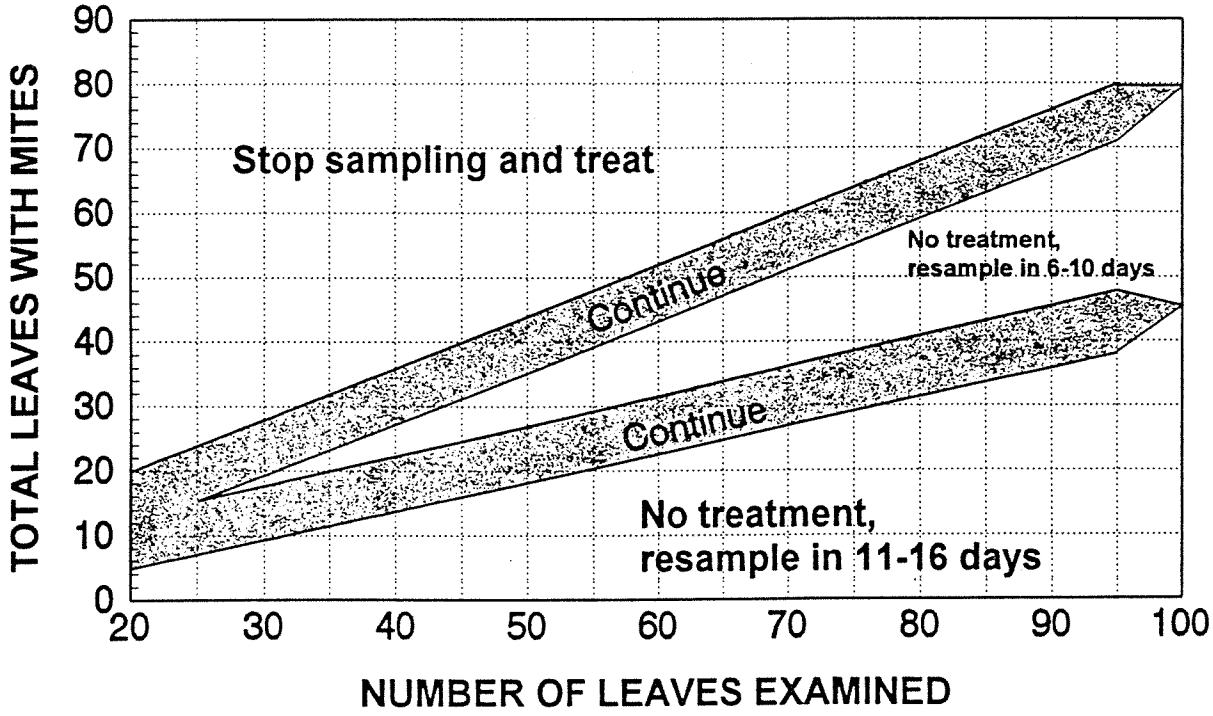
EARLY SEASON CHART

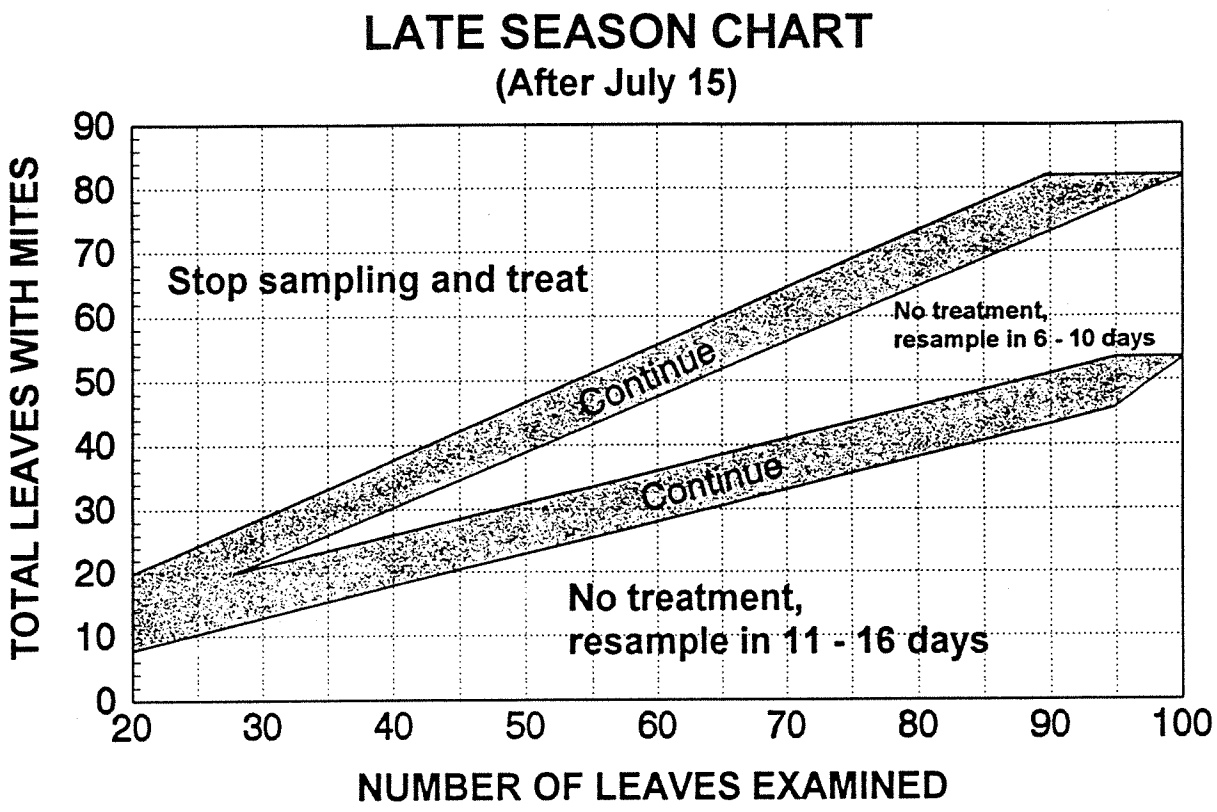
(April - June 15)



MID-SEASON CHART

(June 15 - July 15)





Early season chart based on a threshold of 2.5 mites per leaf

Mid-season chart based on a threshold of 5 mites per leaf

Late season chart based on a threhold of 7.5 mites per leaf

Source: Cornell's Cooperative Extension's "1993 Pest Management Recommendations for Commercial Tree-Fruit Production"

APPENDIX 15

CODLING MOTH DEGREE DAY VALUES

M / N	MAXIMUM TEMPERATURE (°F)																			
	52	54	56	58	60	62	64	66	68	70	72	74	76	78	80	82	84	86	88	90
22	0.2	0.6	1.1	1.6	2.2	2.9	3.6	4.3	5.0	5.7	6.5	7.3	8.1	8.9	9.7	10.6	11.4	12.2	12.9	13.4
24	0.2	0.6	1.1	1.7	2.3	3.0	3.7	4.4	5.1	5.9	6.7	7.5	8.3	9.1	9.9	10.8	11.6	12.4	13.1	13.7
26	0.2	0.6	1.2	1.7	2.4	3.1	3.8	4.5	5.3	6.0	6.8	7.6	8.5	9.3	10.1	11.0	11.9	12.7	13.3	13.9
28	0.2	0.7	1.2	1.8	2.5	3.1	3.9	4.6	5.4	6.2	7.0	7.8	8.7	9.5	10.4	11.2	12.1	12.9	13.6	14.2
30	0.3	0.7	1.3	1.9	2.5	3.3	4.0	4.8	5.6	6.4	7.2	8.0	8.9	9.7	10.6	11.5	12.4	13.2	13.9	14.5
32	0.3	0.7	1.3	1.9	2.6	2.4	4.1	4.9	5.7	6.6	7.4	8.3	9.1	10.0	10.9	11.8	12.7	13.5	14.2	14.8
34	0.3	0.8	1.4	2.0	2.7	3.5	4.3	5.1	5.9	6.8	7.6	8.5	9.4	10.3	11.2	12.1	13.0	13.8	14.5	15.1
36	0.3	0.8	1.4	2.1	2.9	3.7	4.5	5.3	6.1	7.0	7.9	8.8	9.7	10.6	11.5	12.4	13.3	14.2	14.9	15.5
38	0.3	0.9	1.5	2.2	3.0	3.8	4.7	5.5	6.4	7.3	8.1	9.1	10.0	10.9	11.8	12.7	13.7	14.6	15.2	15.8
40	0.4	0.9	1.6	2.4	3.2	4.0	4.9	5.7	6.6	7.5	8.5	9.4	10.3	11.2	12.2	13.1	14.1	15.0	15.7	16.3
42	0.4	1.0	1.8	2.5	3.4	4.2	5.1	6.0	6.9	7.9	8.8	9.7	10.7	11.6	12.6	13.6	14.5	15.4	16.1	16.7
44	0.4	1.1	1.9	2.8	3.6	4.5	5.4	6.4	7.3	8.3	9.2	10.2	11.1	12.1	13.1	14.0	15.0	15.9	16.6	17.2
46	0.5	1.3	2.1	3.0	3.9	4.9	5.8	6.8	7.7	8.7	9.7	10.7	11.6	12.6	13.6	14.6	15.6	16.5	17.2	17.8
48	0.6	1.5	2.4	3.4	4.4	5.3	6.3	7.3	8.3	9.3	10.2	11.2	12.2	13.2	14.2	15.2	16.2	17.1	17.8	18.4
50	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	17.9	18.6	19.2
52	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	18.9	19.6	20.2
54	*.*	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	19.9	20.6	21.2
56	*.*	*.*	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0	20.9	21.6	22.2
58	*.*	*.*	*.*	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0	21.0	21.9	22.6	23.1
60	*.*	*.*	*.*	*.*	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0	21.0	22.0	22.9	23.6	24.1
62	*.*	*.*	*.*	*.*	*.*	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0	21.0	22.0	23.0	23.9	24.6	25.1
64	*.*	*.*	*.*	*.*	*.*	*.*	14.0	15.0	16.0	17.0	18.0	19.0	20.0	21.0	22.0	23.0	24.0	24.9	25.5	26.0
66	*.*	*.*	*.*	*.*	*.*	*.*	*.*	16.0	17.0	18.0	19.0	20.0	21.0	22.0	23.0	24.0	25.0	25.9	26.5	27.0
68	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*	18.0	19.0	20.0	21.0	22.0	23.0	24.0	25.0	26.0	26.9	27.5	28.0
70	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*	20.0	21.0	22.0	23.0	24.0	25.0	26.0	27.0	27.9	28.5	28.9
72	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*	22.0	23.0	24.0	25.0	26.0	27.0	28.0	28.9	29.4	29.8
74	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*	24.0	25.0	26.0	27.0	28.0	29.0	29.9	30.4	30.8
76	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*	26.0	27.0	28.0	29.0	30.0	30.9	31.3	31.7

SAN JOSE SCALE DEGREE DAY VALUES

MIN	MAXIMUM TEMPERATURE (°F)																			
	53	55	57	56	61	63	65	67	69	71	73	75	77	79	81	83	85	87	89	91
21	0.2	0.6	1.1	1.6	2.2	2.8	3.5	4.2	4.9	5.6	6.4	7.1	7.9	8.7	9.5	10.4	11.2	12.0	12.9	13.7
23	0.2	0.6	1.1	1.6	2.2	2.9	3.6	4.3	5.0	5.7	6.5	7.3	8.1	8.9	9.7	10.6	11.4	12.3	13.1	13.9
25	0.2	0.6	1.1	1.7	2.3	3.0	3.7	4.4	5.1	5.9	6.7	7.5	8.3	9.1	9.9	10.8	11.6	12.5	13.4	14.2
27	0.2	0.6	1.2	1.7	2.4	3.1	3.8	4.5	5.3	6.0	6.8	7.6	8.5	9.3	10.1	11.0	11.9	12.7	13.6	14.5
29	0.2	0.7	1.2	1.8	2.5	3.1	3.9	4.6	5.4	6.2	7.0	7.8	8.7	9.5	10.4	11.2	12.1	13.0	13.9	14.7
31	0.3	0.7	1.3	1.9	2.5	3.3	4.0	4.8	5.6	6.4	7.2	8.0	8.9	9.7	10.6	11.5	12.4	13.3	14.2	15.0
33	0.3	0.7	1.3	1.9	2.6	2.4	4.1	4.9	5.7	6.6	7.4	8.3	9.1	10.0	10.9	11.8	12.7	13.6	14.5	15.3
35	0.3	0.8	1.4	2.0	2.7	3.5	4.3	5.1	5.9	6.8	7.6	8.5	9.4	10.3	11.2	12.1	13.0	13.9	14.8	15.7
37	0.3	0.8	1.4	2.1	2.9	3.7	4.5	5.3	6.1	7.0	7.9	8.8	9.7	10.6	11.5	12.4	13.3	14.2	15.2	16.1
39	0.3	0.9	1.5	2.2	3.0	3.8	4.7	5.5	6.4	7.3	8.1	9.1	10.0	10.9	11.8	12.7	13.7	14.6	15.6	16.4
41	0.4	0.9	1.6	2.4	3.2	4.0	4.9	5.7	6.6	7.5	8.5	9.4	10.3	11.2	12.2	13.1	14.1	15.0	16.0	16.9
43	0.4	1.0	1.8	2.5	3.4	4.2	5.1	6.0	6.9	7.9	8.8	9.7	10.7	11.6	12.6	13.6	14.5	15.5	16.4	17.3
45	0.4	1.1	1.9	2.8	3.6	4.5	5.4	6.4	7.3	8.3	9.2	10.2	11.1	12.1	13.1	14.0	15.0	16.0	17.0	17.9
47	0.5	1.3	2.1	3.0	3.9	4.9	5.8	6.8	7.7	8.7	9.7	10.7	11.6	12.6	13.6	14.6	15.6	16.5	17.5	18.5
49	0.6	1.5	2.4	3.4	4.4	5.3	6.3	7.3	8.3	9.3	10.2	11.2	12.2	13.2	14.2	15.2	16.2	17.2	18.2	19.1
51	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	19.9
53	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0	20.9
55	*.*	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0	21.0	21.9
57	*.*	*.*	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0	21.0	22.0	22.9
59	*.*	*.*	*.*	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0	21.0	22.0	23.0	23.9
61	*.*	*.*	*.*	*.*	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0	21.0	22.0	23.0	24.0	24.9
63	*.*	*.*	*.*	*.*	*.*	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0	21.0	22.0	23.0	24.0	25.0	25.9
65	*.*	*.*	*.*	*.*	*.*	*.*	14.0	15.0	16.0	17.0	18.0	19.0	20.0	21.0	22.0	23.0	24.0	25.0	26.0	26.9
67	*.*	*.*	*.*	*.*	*.*	*.*	*.*	16.0	17.0	18.0	19.0	20.0	21.0	22.0	23.0	24.0	25.0	26.0	27.0	27.9
69	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*	18.0	19.0	20.0	21.0	22.0	23.0	24.0	25.0	26.0	27.0	28.0	28.9
71	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*	20.0	21.0	22.0	23.0	24.0	25.0	26.0	27.0	28.0	29.0	28.9
73	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*	22.0	23.0	24.0	25.0	26.0	27.0	28.0	29.0	30.0	29.9
75	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*	24.0	25.0	26.0	27.0	28.0	29.0	30.0	31.0	30.9
77	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*	*.*	26.0	27.0	28.0	29.0	30.0	31.0	32.0	31.9

APPENDIX 16

USING THE MARYBLYT COMPUTER PROGRAM TO AID IN APPLE FIRE BLIGHT CONTROL

An approach to understanding and thereby attaining better control of fire blight is presented in a computer program called MARYBLYT developed by Paul Steiner at the University of Maryland and Gary Lightner of the USDA/AFRS, Kearnysville, WV. MARYBLYT can be run in a DOS compatible home or office computer. When using MARYBLYT in an IPM program, growers are required to record daily high and low temperatures, rainfall, hail, frost, and tree development stage to be entered into a computer program file for their orchard. The computer calculates when fire blight infections have occurred, when they are likely to occur, based on weather forecasts, and furthermore, predicts when visible symptoms would appear in the days following infection.

MARYBLYT predicts four distinct types of fire blight: blossom, canker, shoot and trauma blight. Disease development is monitored using current weather and phenological (seasonal tree development) information to operate three cumulative time-temperature "clocks". There is an "apple clock," a "disease clock" and a "pathogen clock" which keep track of tree, canker disease, and pathogen development to make predictions about fire blight disease.

Blossom blight involves direct infections of open flowers and killing of the spur. The source of inoculum is overwintering cankers in and around the orchard. Early symptoms often show ooze droplets or browning of blossom pedicels. The infection of a single flower in a cluster usually kills the entire spur. In later stages bacteria invade the supporting twig, causing a canker that girdles the twig, resulting in the loss of other nearby spurs.

Canker blight involves the renewal of infection activity at the margins of overwintering fire blight cankers. Some cankers may expand laterally to girdle limbs, causing their sudden death.

Shoot blight, or twig blight, is the most visible and damaging phase of fire blight. Primary shoot blight involves direct infections of vegetative shoot tips. The top 3 leaves of growing shoots are most susceptible. Inoculum for shoot blight comes from earlier blossom or canker blight infections. If these sources are nearby, early shoot blight can usually be forecast. Early shoot blight symptoms show a slight wilt of the shoot tip, sometimes with ooze droplets visible on the stem. This is soon followed by leaf and shoot browning and death which proceeds down the shoot. Infections of short shoots are more likely to lead to canker development on the supporting limb.

Trauma blight is the sudden, widespread occurrence of fire blight on many tissues following hail, severe wind or late frost damage when the populations of the bacteria on the foliage are high.

The MARYBLYT screen display shows risks of infection (low to high) and decisions on whether to spray for blossom blight are based on these risks. A "predictions" option uses forecasted weather information to determine risks for one or more days in advance. Growers could use the MARYBLYT risk warning to determine whether or not to spray. Research has shown that in years with low disease pressure, growers have saved one or more streptomycin sprays by following the MARYBLYT recommendations.

The MARYBLYT program also informs the grower when an infection has occurred. By continuing to enter weather data, the program also predicts or alerts the grower when certain symptoms such as blossom blight or shoot blight are going to occur. If infected spurs are removed immediately when symptoms just begin to appear, further spread of the disease can be stopped, and this reduces later infections of twigs and branches. Growers with labor available could use this feature of MARYBLYT for timely pruning.

Using the computer program.

Using MARYBLYT from your hard drive or a floppy disk, activate the file MB.EXE and continue past the title screen as directed. From this point, procedures and features will vary depending on the version of MARYBLYT used. A file menu and directory screen presents choices, the most important of which are to start a new file, to get an existing file (to add to or review), and to exit. Other choices might include an explanation of fire blight and MARYBLYT, and various file operations including deleting, adding, changing the name, and printing a list of files. The screen might look like this:

MARYBLYT, Version 2.1
[Copyright 1989, All Rights Reserved]

A. Fire Blight control and the MARYBLYT Program

B. Start a New File

C. Retrieve a File

D. Exit

At this stage it would be wise for the user to explore one or more of the demonstration files provided with the MARYBLYT program. They may be listed as a numbered file on this menu screen, or as a number in the list of files on the diskette or computer subdirectory. After some practice, the user can begin to create files relating to their own orchard or orchard blocks.

When a grower creates a new file, it will be given a short name and in some cases the variety, orchard name, and year. The program immediately calls for a beginning date, usually sometime in March near the end of the dormant season, the high and low temperatures for that date, and the rainfall or other weather events for that day. Once this data is entered, a file for the orchard or block in the orchard is begun and a new chart appears on the screen. (See below.)

This chart is divided; the left portion is data entered by the grower relating to date, tree growth stage, high and low temperature, rainfall, trauma events, sprays, and other notes. The user then follows directions from a lower section of this chart to add, modify, graph, view, and make predictions from data. The right portion of the screen presents the computer calculations of average temperature, epiphytic inoculum potential, risk factors and potential, blossom blight symptoms, canker blight symptoms, shoot blight symptoms, and trauma blight symptoms. The chart on the computer screen might appear as follows:

DATE	PH	HI	LO	WET	T	S	NOTE	AVG	EIP	BHWTR	BBS	CBS	SBS	TBS
3/31	D	46.0	40.0	0.00				43.0	0		0	0	0	0
4/ 1	GT	59.0	42.0	0.00				50.5	0		0	0	0	0
4/ 2	GT	67.0	38.0	0.50				52.5	0		0	0	0	0
4/ 3	GT	71.0	49.0	0.00				60.0	0		0	13	0	0
4/ 4	GT	75.0	58.0	0.00				66.5	0		0	42	0	0
4/ 5	TC	70.0	49.0	0.00				59.5	0		0	55	0	0
4/ 6	TC	76.0	42.0	0.00				59.0	0		0	65	0	0
4/ 7	TC	73.0	50.0	0.20				61.5	0		0	81	0	0
4/ 8	TC	75.0	48.0	0.35				61.5	0		0	CMI	0	0
4/ 9	PK	77.0	50.0	0.00				63.5	0		0	38	0	0
4/10	PK	81.0	48.0	0.00				64.5	0		0	45	0	0
4/11	B	78.0	49.0	0.00				63.5	39	+--+M	0	52	0	0
4/12	B	84.0	55.0	0.00		X		69.5	124	++-+H	0	64	0	0
4/13	B	70.0	60.0	0.55				65.0	139	++++I	0	72	0	0

A - ADD DATA M - MODIFY DATA G - GRAPH DATA
P - PRINT DATA H - HELP X - PREDICTIONS
V - VIEW DATA T - MODIFY THRESHOLDS E - EXIT

CHOICE =

It is important for the grower to begin taking records while the trees are still dormant. Temperatures leading up to bloom help determine growth of the fire blight bacteria in the old cankers and how many bacteria are available for infection. The most vulnerable stage for the apples is the bloom period. This is also the only time chemical control can be used to reduce infection. Growers could enter data weekly from dormant to tight cluster stages, but beginning with pink, data should be entered daily to track fire blight progress.

Notice that in this example, the (+) and (-) designations begin to appear at bloom. The heading BHWTR stands for bloom, heat (accumulated), wetness, temperature (for that day), and risk (+ = low, ++ = medium, +++ = high, and ++++ = infection). On April 11, in this example, the risk was medium because only two of the four criteria needed for infection were met: the trees were in bloom, and the temperature that day was suitable for infection. On April 12, accumulated heat had built up so that bacterial inoculum (EIP) crossed a threshold of 100, and the risk was high, but still no infection occurred because the rain or heavy dew needed to wash the surface bacteria into the base of the blooms did not occur. On that day, the X appearing in the left part of the chart told the grower to look at the weather forecast and if rain was predicted, to spray if needed. Notice that on April 13, the rain provided the fourth risk factor and infection occurred.

As data are added to the chart after bloom, growers will be alerted to the date of first appearance of fire blight symptoms in the blossoms and the shoots. Careful pruning of infected fruit clusters can reduce further spread of the disease. Additional details about MARYBLYT can be found in the help menu of the program.

COOPERATIVE EXTENSION SERVICE
UNIVERSITY OF KENTUCKY • COLLEGE OF AGRICULTURE

Taking Soil Test Samples

W.O. Thom, K.L. Wells, and Lloyd Murdock

When you take soil test samples keep in mind that a few ounces of soil are being tested to determine lime and fertilizer needs for what may be several million pounds of soil in the field. It is absolutely necessary to take care to assure that the soil sample you send to the laboratory accurately represents the area sampled.

Soil samples can be collected through much of the year, although fall (September to December) or spring (February to April) are the best times. Fall sampling will often result in a faster return of results and recommendations.

Tools You Need

A soil probe, auger, garden trowel, or a spade and knife are all the tools you need to take the individual cores that will make up the "field" sample (*Figure 1*). You will also need a clean, dry bucket (preferably plastic) to collect and mix the sample cores. Soil sample boxes or bags and information forms for submitting samples are available at all county Extension offices.

The most representative sample can be obtained from a large field by sampling in smaller units on the basis of soil type, cropping history, erosion, or past management practices. More accurate results are obtained when problem areas are sampled separately, especially when "trouble-shooting" in fields during the growing season. In such instances, take a sample both from the poor growing area and adjacent areas of good growth. Designate each sample area with a letter or numbers on a field or area map for record-keeping purposes (*Figure 2*). A sample should represent no more than 20 acres except when soils, past management, and cropping history are quite uniform.

Collect at least 10 soil cores for small areas and up to 30 cores for larger fields. Take the soil cores randomly throughout the area to be sampled and place in the bucket.

Tilled Areas — Take soil cores to the depth of the tillage operation (usually 6 to 8 inches).

Non-Tilled Areas — Take soil cores to a depth of 3 to 4 inches for pastures and no-tillage planting where fertilizer or lime remains on the soil surface or is incorporated only in the surface 1 to 2 inches.

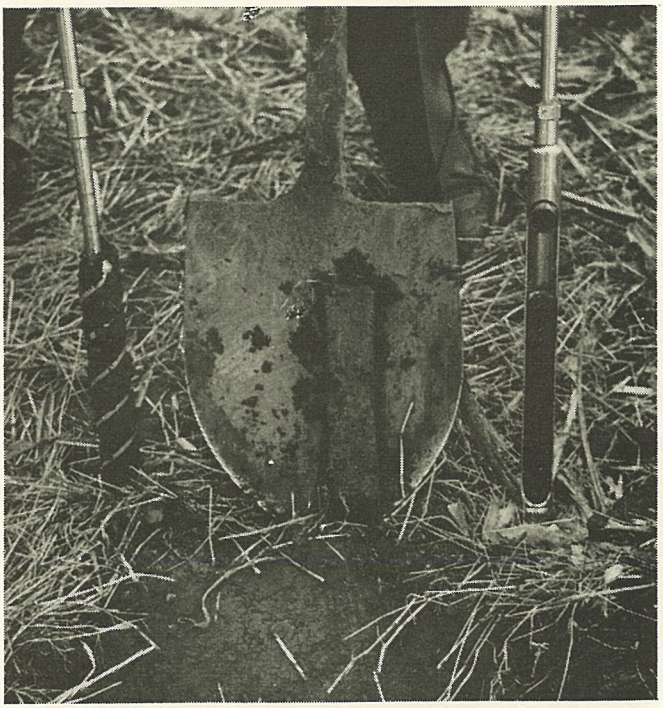


Figure 1. A soil probe, auger, or spade and knife should be used in sampling soils. The spade sample must be trimmed as shown.

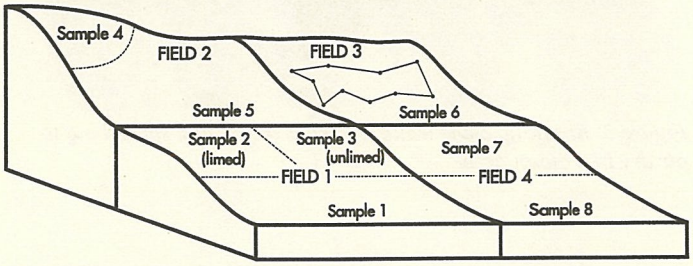


Figure 2. This shows how four fields might require the analyses of 1 to 3 composite samples for determining fertility needs. Each composite must contain 10 or more cores, as shown for sample 6 in field 3.

Lawns and Turfgrasses — Collect soil cores to a depth of 3 to 4 inches. Sample problem areas and areas with shrubs or flower beds separate from other turf or lawn areas.

Do not sample:

- *back furrows or dead furrows*
- *old fence rows*

- *near or in rows where banded fertilizer was applied*
- *areas used for manure or hay storage, and livestock feeding, or*
- *highly eroded areas.*

For lawn and garden samples avoid

- *compost areas*
- *under drop-line of trees, and*
- *close to yard driveways or streets.*

Sample Preparation

After all cores are collected and placed in the bucket, crush the soil material and mix the sample thoroughly (*Figure 3*). Allow the sample to **air dry** in an open space free from contamination. **Do not dry the sample in an oven or at an abnormally high temperature.**

When dry, fill the sample container with soil and fill out the information sheet completely (*Figure 4*). Separate information sheets are needed for:

- *agricultural soils*
- *home gardens, lawns and turfgrasses, and*
- *commercial horticultural crops.*

Completing all sections of the form will assure that the computerized printout of your recommendations takes into account all important factors needed for making the best possible recommendation.

Figure 3. Break up clods while sample is moist, and spread out to air dry in a clean area.

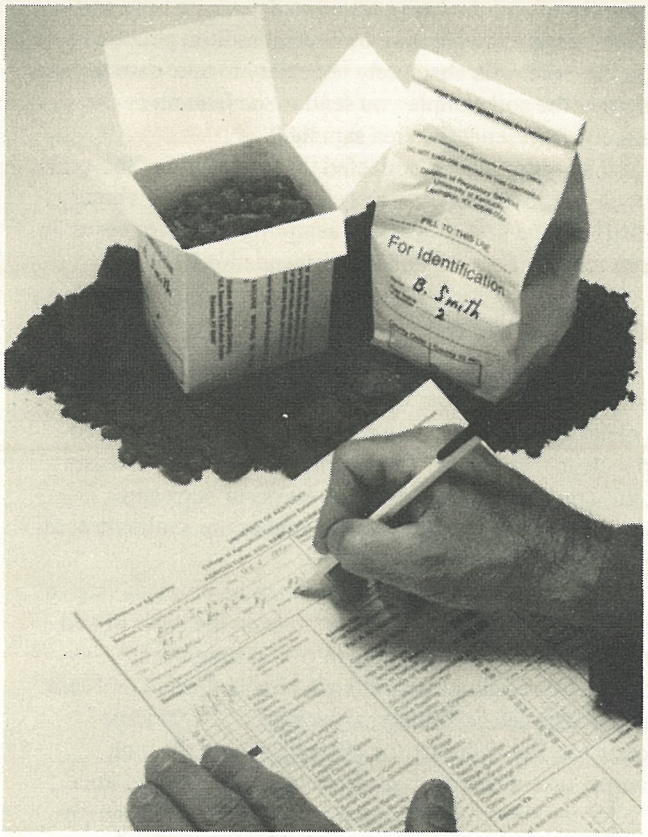


Figure 4. Thoroughly mix the air dried sample, fill the sample bag or box, mark with your sample designation, fill out the information sheet, and take the sample to your county Extension office.

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, C. Oran Little, Director of Cooperative Extension Service, University of Kentucky College of Agriculture, Lexington, and Kentucky State University, Frankfort.

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