Study Manual for Private Applicator Certification

Small Fruit Growers

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Preface

Any person who uses restricted-use pesticides must be licensed in order to be able to purchase such products. Licensing is not required if only general-use pesticides are used, with the exception of commercial applications.

Any person who sprays another's property in exchange for money must possess a commercial applicator's license. However, individuals that are licensed as a private applicator can spray another's property in exchange for services. (i.e.; he might trade a spray job in the spring for help with harvest in the fall)

A farmer wishing to use restricted-use pesticides would apply for a "private applicator's license." The private applicator may then buy and apply restricted-use pesticides on their own farm, property they rent or on the farms of others, provided that they do not get paid to do so.

It is not necessary for the licensed private applicator to actually perform all pesticide applications. An employee or family member can apply pesticides, however, the license holder is responsible for training the person who actually does the work, and must be available if needed.

Private applicators are required to maintain records with respect to each use of restricted-use pesticide and must file a report of their usage on or before January thirty-first each year for the previous year's applications.

This booklet was prepared as a study guide for those individuals seeking certification as private applicators in Connecticut. It contains brief descriptions of the major pests of each crop, their life cycles and the damage they cause to the host plants.

As a minimum requirement for certification, a private applicator must show that they possess a practical knowledge of laws pertaining to pesticide applications and the pest problems associated with their farming operation. This practical knowledge includes ability to recognize common pests and damage caused by them. Recognition is critical because it is the first step in control. The private applicator must be able to recognize the pest problem before they select among the available pesticides.

This booklet is not to be considered a complete source of information. Information on integrated pest management (IPM) and suggested spray schedules may be obtained from the Connecticut Cooperative Extension Service.

Strawberry Insects

Cutworms

Description
Cutworms are stout, soft-bodied caterpillars which grow to a length of 1 1/4 inches. They are dull gray, brown or black in color and curl up tightly when disturbed. The adults are dull gray or brownish-yellow moths.

Life Cycle
Most cutworms pass the winter in the larval stage hidden in soil, under trash, or in clumps of grass. They resume feeding in the spring and grow until early summer. The mature larvae pupate beneath the soil surface and later emerge as moths. The females then lay eggs for the next generation.

Damage
Cutworms cause severe damage by cutting off new plants at ground level and by chewing the foliage of older plants.

Management/Control
Begin treatment when damage is found.

Strawberry Leaf Roller *(Ancylis comptana fragariae)*

Description
The adult strawberry leaf roller is a light reddish-brown moth with brown and white markings and a wingspread of slightly more than 1/2 inch. Mature larvae are about 1/2 inch long and vary in color from yellowish green to greenish brown.

Life Cycle
This insect over winters both as a larva and a pupa. The adult moths appear in May and the females lay eggs on the underside of the leaves. The caterpillars roll and tie the strawberry leaves together, living and feeding inside. When fully grown the larvae pupate and in a short time the moths emerge. There are two generations each year in Connecticut.

Damage
The caterpillars fold, roll or tie the leaves into tubes, feeding from within. Plants are weakened, leaves turn brown and die. Fruits are withered and deformed; infested buds appear white or gray from a distance.

Management/Control
Begin treatment when damage is found.

Strawberry Weevil *(Anthonomus signatus)*

Description
The adult strawberry weevil is chestnut brown in color and about 1/10 inch long. The larvae is a creamy white, curved grub.

Life Cycle
Adults leave their hibernation quarters in early spring and move to strawberry fields. The females puncture the buds with their mouthparts, insert an egg, then crawl down and girdle the stem of the flower bud causing it to wilt. The grubs feed in the buds for about four weeks, and the adults emerge just before midsummer.

Damage
Adults sever stems of fruit buds, causing them to hang by part of the stem or fall to the ground. This prevents the formation of fruit. The adults also eat irregular holes in petals and other parts of the blossoms.

Management/Control
Begin treatment at the first sign of damage to flower buds.

Spittle Bug *(Philaenus spumarius)*

Description
Adult spittlebugs are drab brown, gray or black, with paler mottled markings; the head is broad and the body is somewhat flattened and is about 1/4 inch long. They look somewhat like short robust leafhoppers. Newly hatched nymphs are bright yellow.

Life Cycle
Spittle bugs deposit their eggs on plants. The nymphs suck plant juices and produce a "spittle" that is voided from the anus. Nymphs will surround themselves with the spittle as a means of protection.

Damage
The feeding by the nymphs can cause a crinkled, dark green appearance of the leaves and stunted growth of the berries.

Management/Control
Begin treatment before the foliage emerges in the spring to prevent egg-hatching.

Spider Mites

Description
The adult is a tiny greenish-yellow or reddish mite that is barely visible to the naked eye. Web formation on the underside of the leaves is a good indication of the presence of spider mites.

Life Cycle
Spider mites pass the winter on strawberry plants or on weeds in or around old strawberry fields. During favorable weather, they complete a generation in ten days to two weeks, making it possible for mite populations to increase rapidly.

Damage
The mites feed on the undersides of leaves and suck out plant juices. Injured foliage turns yellow and develops rusty brown blotches. Plants may become stunted and yield may be greatly reduced

Management/Control
Begin treatments as soon as mites are found. It is important to start treatment early before heavy infestations are well established. Two treatments should be made about one week apart.

Cyclamen Mite *(Steneotarsonemus pallidus)*

Description
The adult is a tiny whitish to caramel colored mite that is barely visible to the naked eye. Damage is characteristic and a good indicator of this insect's presence.

Life Cycle
Cyclamen mites live on young folded leaves in the center of the plant crowns. Activity is greatest in the spring and fall. Adult females over winter in crowns and at the bases of the petioles of leaves. Immature stages of development may be completed in less than two weeks, making rapid population increase possible.

Damage
Mites feed on young, expanding leaves in crowns of plants. They cause severe distortion, stunting, bronze discoloration, and sometimes kill the leaves. They also feed on the blossoms causing distortion of the fruit.

Management/Control
Treat when mites or injury are noticed. Damaging infestations may be prevented by planting only uninfested or treated plants.

Strawberry Diseases

Leaf Scorch *(Diplocarpon earliana)*

Description
Leaf scorch causes small, irregular dark-purple spots up to 1/4 inch in diameter on the upper side of the leaves that can grow together. Middle aged and older leaves are most susceptible. The centers of these spots become brownish. When the entire leaf is covered, it appears purplish to reddish to brown. Tiny dots appear in the spots. The leaves will eventually dry up, making the leaf look scorched. The spots caused by leaf scorch never have light centers as do those of leaf spot and they have a more irregular outline.

Life Cycle
The fungus that causes leaf scorch lives through the winter on infected plants. Warm weather (68 - 86 F) and an abundance of moisture favor their spread. Most of its spores are formed in mid-summer, as the leaves age and the weather is favorable. The fungus is usually brought into a field when new plants are set or may be carried in from nearby fields by birds or insects, by farm implements, or on the hands and clothing of field workers.

Prevention
Plant disease free plants where there is good air circulation and well drained soil. Plant narrow rows with well-spaced plants to keep the canopy dry. Irrigate in the morning so that leaves can dry quickly. Remove old plant tissue at the end of the season. Remove or plow under any clipping that remain if the field is mowed at the end of the season.

Management/Control
Begin treatment when blossom buds separate in early clusters.

Leaf Spot *(Mycosphaerella fragariae)*

Description
Leaf spot, which only infects strawberry, can be easily recognized by round purple spots that are 1/8 to 1/4 inch across on the upper side of the leaves. Middle-aged leaves are most susceptible. At first the whole spot is purple. Later, the center of the spot becomes tan or gray, then almost white on older leaves or a light brown on younger leaves; the border of the spot remains reddish-purple to rusty brown. Spots can also develop on fruit ("black seed disease"), stems, petioles, caps and runners in favorable years.

Life Cycle
The fungus that favors leaf spot lives through the winter on infected plants. Cool weather (68 - 77 F) and an abundance of moisture favor their spread. The fungus is usually brought into a field when new plants are set or may be carried in from nearby fields by birds or insects, by farm implements or on the hands and clothing of field workers.

Management/Control
Begin treatment when blossom buds begin to show, or earlier if the fungus is found on leaves.

Powdery Mildew *(Sphaerotheca macularis)*

Description
Powdery mildew occurs worldwide, wherever strawberries are grown. Leaves, flowers and fruit can be affected. Gray powdery growth on the bottom of leaves causes the leaves to curl upward. Purplish or reddish blotches are sometimes seen on the undersides of leaves. Flowers and ripe fruit may also be covered with the powdery masses as well. If green fruit is infected, it may fail to ripen, and will remain hard.

Life Cycle
The disease is favored by cool (58 to 68 F) dry weather. Severe foliar infection happens late in the season and usually does not result in lower yields. Infection of flowers and fruit can cause lower crop yield. Powdery mildew is significant on only a few highly susceptible varieties.

Management/Control
Pesticide applications may help to prevent high levels of disease and fruit infection for the following season.

Gray Mold *(Botrytis cinerea)*

Description
Gray mold is the most important disease on strawberry fruit. The disease primarily infects fruit but can also infect leaves, petioles, stems and flowers. At first, it shows as light brown spots on the fruit. Spots will usually begin at the cap end, but can also start at the point where an infected berry touches a healthy

berry. Affected areas become covered by a powdery gray fungal growth. Berries that are entirely rotted can retain their shape but become tough and dry. The greatest crop loss is caused by infections on the main fruit stems. Infections kill these stems and destroy the entire cluster of berries.

Life Cycle
The fungus can live on the dead leaves and litter under plants. During periods of rain or humid weather the fungus will infect any part of the plant including the green fruit.

Management/Control
Treatment should begin as soon as blossom buds are visible in the spring.

Red Stele *(Phytophthora fragariae)*

Description

The fungus Phytophthora fragariae causes red stele. Generally, the fungus thrives in poorly drained, cool, wet soils. The fungus is often introduced to an uninfected site through the planting of infected planting stock or contaminated planting equipment. The fungus is very persistent and can survive for many years once it has become established, even if strawberries are not grown during that time. The spores of the fungus reside in infected soil and are attracted to developing strawberry rootlets. Once infected, the roots begin to rot from the root tip upwards toward the crown, causing a characteristic reddening of the inner portion of the root. The symptom that positively identifies this disease is found in the center (or stele) of the root when it is cut and examined. In a plant with red stele, the center of the root is a distinctive brownish-red, which contrasts with the normal yellowish-white of the part around it. Poor growth, frequent wilting of plants, and new leaves that may appear bluish-green while older leaves turn yellow or red are other symptoms that should make you suspect red stele.

Diagnosis of red stele should be confirmed by examining the roots of plants that are just beginning to show signs of wilting. Samples should be collected during early spring and summer, up until the time of harvest. Samples taken after harvest are not reliable because infected roots may have already begun to decay. Plants should be dug rather than pulled from the ground. If red stele is present, the roots will appear unbranched and will be lacking feeder roots. Red stele infected roots will have a reddish-brown core, but the outer tissue will be white.

Management/Control

Because the development of red stele is favored by cool, wet soil, site selection and preparation are an important part of disease management. The site selected for planting should have good soil drainage or raised beds should be used. Resistant varieties should be planted in areas where soil drainage is not ideal. Plants should be purchased from a reputable nursery to reduce the chances of introducing infected plants. Additionally, soil and/or tissue analysis should be performed each year to determine optimum fertilizer applications.

There are fungicides available that should help to control red stele, especially when used in combination with good cultural practices. The fungicide may not be effective on susceptible varieties that are grown in wet soil. Use of the fungicides should be avoided on soils that have a moderate to high leaching potential.

Black Root Rot

Black root rot is caused by a complex interaction of fungi, nematodes and environmental factors. One or more fungi may be present in the field at the time of planting. When root lesion nematodes are present in the planting, the disease is often more severe. This indicates that the root feeding by the nematodes may predispose the roots to infection by the fungi. Therefore, black root rot is not usually introduced into a new planting through nursery stock or contaminated equipment. The disease most commonly occurs in low areas, on compacted soils or where organic matter is low.

Damage

Aboveground, symptoms usually become evident in the first fruiting year. Damage will be most noticeable in low or soil compacted areas of a field where drainage is poor. Plants will show a general lack of vigor with poor runner growth and small berries. Plants may collapse when water demand is high such as during spring growth, during or after fruiting, or during drought stress. Symptoms may resemble those caused by other root disorders; therefore, the roots also need to be examined.

Belowground, roots may be rotted at their tips or may appear mottled with black lesions along the white roots. In the early stages of black root rot the core of the root is white, rather than red which is indicative of red stele disease. In severely affected plants, the core and outer tissue will be black. Plants that appear to be declining should be sampled in April or May by digging, rather than pulling the

plant from the ground to examine the root tissue. In healthy plants, the interior of woody roots is a yellowish-white, and there is an abundance of fleshy white roots and lateral roots with white cores.

Control
Black root rot is favored by wet soils and soils that are low in organic matter. Therefore, proper site selection and preparation are both important management tools for this disease complex. Also, only healthy, white rooted plants that have been purchased from a reputable nursery should be used when planting.

Blueberry Insects

Blueberry Maggot *(Rhagoletis mendax)*

Description
The adult is a two-winged fly, slightly smaller than the common housefly. It is the most important and pervasive insect pest of blueberries in New England. The

female fly is about 3/16" long with a wingspan of about 1/3". The abdomen is pointed and black with four white cross-bands. The thorax is dark brown to black with a white dorsal spot and the wings are clear, marked with dark colored bands that appear as an M or W, depending upon the direction they are viewed from.

The peg shaped larvae or maggot is 3/8 inch long, milky white and very difficult to see in the flesh of the fruit.

Life Cycle
The winter is passed in the soil as a pupa just below the surface. Flies begin to emerge about July 1 and continue to emerge until early August. After emerging, the flies spend 1 to 2 weeks resting and feeding on dew, insect honeydew, and secretions on foliage. During this period, adult females become sexually mature and mate. When the berries begin to ripen, the female fly punctures the skin of the blueberry in order to deposit a single, white, elongate egg. Each female fly may lay up to 100 eggs in a period of 15-25 days. The larvae hatch in 7-10 days, feed and grow within the berries. The berry will begin to shrivel as the larvae feeds and grows. The larvae will become full grown after about two or three weeks and the berry is almost completely destroyed. When the bulk of the blueberries have ripened, the full-grown larvae begin leaving the berries to enter the soil where they pupate and remain over the winter.

Damage
The larvae attack the berries. Infested berries will shrivel and drop, reducing the crop yield.

Management/Control
Effective management is based upon accurately identifying the timing of emergence and the density of the pest in the planting. Traps are useful for monitoring both the emergence and the density of this pest. Yellow sticky rectangle traps baited with protein hydrolysate or ammonium acetate are preferred. The traps should be hung in the upper half of the canopy and about halfway from the center of the bush to the outer edge of the foliage. Fruit and foliage that is within 8 inches of the trap should be cleared away, and all traps positioned so that there is as much fruit and foliage surrounding them as possible. Trap density should be 2-4 traps per acre. Traps should be placed prior to the expected emergence of the flies, before any fruit ripening begins to occur. Traps should be checked once a week and an action threshold of one blueberry maggot fly per week is common and has been shown to be effective. Choices of pesticides change over time and growers should consult current recommendations for rates and timing of applications.

Cranberry Fruit worm *(Acrobasis vaccinii)*

Description

The front wings of the cranberry fruit worm moth are gray-brown with two very small dark dots near the front margin. There are also two white markings, one toward the base of the front wings and the other one around the middle of the front margin. The hind wings are also gray-brown. The moths are seldom seen because they are active only at night and stay hidden among crop plants or weeds during the day.
The cranberry fruit worm larva is mainly green with some brownish red coloration on its top surface and measures about 1/2 inch or more at maturity.

Life Cycle
Eggs are laid singly in the blossom end of the berries by the adult female moths while the berries are small and green. As they near hatch, the eggs develop an irregular orange streak. This is generally 3-5 days after being laid. Once larva emerge from the eggs, they immediately crawl onto the stem end of the berry. They will then burrow their way into the berry, close the entrance hole with silk, and begin to feed. They are found first within green fruit that will turn blue prematurely, alerting growers to the infestation. The larva will feed from early June through harvest. During that time, the larva will move from one berry to another, hollowing out several berries in a cluster. During this period the larva will molt roughly five times. When the larva reaches its last instars stage, it will drop to the ground and spin a cocoon of silk, leaf litter and soil. This is the dormant stage in which the larva over-winters. They will begin to pupate in the

spring and the adult moth will emerge within about five weeks. They will emerge over a long period between the end of May and end of July. The females will mate and lay eggs within a few days of emerging from their winter cocoon.

Damage
Larva will hollow out berries as they feed, filling them with brown frass, and webbing the fruit together with silk. Each larva will consume 3-6 berries. Their feeding reduces the crop and spoils marketability of the berries.

Management/Control
If damage has been noted in a planting, scouting for the cranberry fruit worm using pheromone traps the following year is recommended. The pheromone traps attract only male moths. The traps should be checked at least once per week. The scouting period lasts for a period of 5-8 weeks beginning in mid-May. Lures are effective for 2-3 weeks and should be replaced periodically. Insecticide applications should be timed for one week after a peak in trap catches is observed. A second application should be made 7-10 days later. Scouting should continue after the spray program has commenced to determine the effectiveness of the sprays and determine if additional applications are needed.

Another way to determine if additional applications are necessary is by examining berries for eggs. A hand lens will be needed for this purpose. If 1 or more eggs are found per 100 berries, a pesticide application 10-11 days after the previous application is recommended.

Blueberry Stem Borer *(Obera myops)*

Description
The adult is a pale yellow beetle that is about 1/2 inch in length. The larvae, or borer, is a small legless grub that is about 1/2 inch long when fully grown.

Life Cycle
The larvae pass the winter below ground. Adults emerge during July and deposit their eggs in the bark of the twigs. During the first summer the grubs bore downward hollowing out the stem and expelling the frass through a series of small holes in the bark. The following season the grubs continue down to the roots and in the fall they may cut some of the stems above the ground.

Damage
Dying tips in summer and breaking over of stems in the fall are evidence of infestations.

Management/Control
Cut off and burn infested twigs as soon as they are noticed.

Scale

Although there are many types of scale insects that can be problematic on blueberries, Putnam scale *(Diaspidiotus ancylus)* has been found to be the major cause of scale infestations in Connecticut. These scales usually occur in older plantings where irregular or improper pruning has allowed excessive old wood to remain on the bush. Stems and old canes are most likely to be infested, but scale colonization of new growth under heavy infestation and fruit infestations have been seen in some cases.

Description
The Putnam scale is an armored scale insect that over-winters as a fully developed adult that appear as gray waxy dots about 1/16 inch in diameter. The scale blends in with the color of the bark and are often invisible to the naked eye. A hand lens is needed to detect infestations on wood. Detection is easier on the leaves and fruit due to the contrast in color. On fruit, the scale appears to be surrounded by a circular red discoloration.

Life Cycle
An immobile yellow insect lies beneath the waxy scale covering. The female feeds, mates and produces live young, called crawlers, under the protection of the scale. The adult male is a tiny winged insect that emerges from the scale covering and will mate with the female. The adult male does not feed. Female scales lay a mass of eggs under their scale covering in the spring. The young scale crawlers will hatch from their eggs around mid-May. This stage is highly mobile and can migrate to leaves and fruit. The crawlers are mite-like in size, six-legged, yellow, with two antennae and flattened. As the crawlers mature, they stop moving and begin to feed. They will molt, shedding their legs and antennae to become flattened, yellow sacs attached to the bark. They will then begin to form the typical gray waxy scale covering over its body. The scales excrete honeydew while feeding which can drop onto the leaves and fruit. Black sooty mold may grow on the honeydew.

Damage
Putnam scale can cause excessive defoliation, decline and eventual death of blueberry plants. The fruit will also be dimpled at the site of the scale attachment, distorting the appearance of the fruit at harvest.

Management/Control
The best strategy for management of scale insects is an annual pruning of old wood. Dormant pruning of old, weak canes and scale encrusted wood helps to prevent the scales from increasing. The pruning should be followed by an application of Superior Oil between March 1 and first bloom. Thorough spray

coverage of all stems and branches is essential. The application should be made under high pressure to assure thorough coverage of the plant. Do not apply oil sprays when the temperature is at 32 degrees or below. Oil and lime sulfur, if used for the disease *Phomopsis,* should be put on as separate sprays and not combined because the sulfur is physically incompatible with superior oils.

Blueberry Diseases

Mummy Berry *(Monilinia vaccinii-corymbosi)*

Description
Mummy berry is usually present every year, but the severity varies tremendously from year to year. Newly emerging buds are blighted by the initial fungus, causing leaf and shoot blight, in the spring. Spores then infect healthy blossoms and young berries. Infected berries are tan or pink in color. As the berries approach maturity, they become mummified and drop to the ground where they over winter. The following spring a new cycle of disease is started from the over wintered mummies.

Life Cycle
Infection comes from spores discharged by funnel-shaped mummy cups produced in the spring on mummy berries on the ground. Infection is possible from the time buds swell until flowers drop and may be severe if weather is cool and rainy.

Management/Control
The most important strategy for of mummy berry is sanitation. Mummies should be raked up and discarded, if practical, or bury the mummies by cultivating between rows or adding two inches of mulch. An application of 50% urea prills in the spring will help to speed the degradation of the mummies via soil microorganisms. Generally, proper planting and regular pruning to allow for good air circulation around the plants can more effectively manage any diseases caused by fungi that affect the aboveground portion of the plant. If plants must be irrigated, it should be done in the early morning hours to allow for rapid drying of the leaves, flowers and berries.

Applications of a fungicide can be made to target against primary infection. The first application should be made at the green tip stage, followed by a second application 10 days later. Additional applications of fungicide can be made during bloom to control secondary infection.

Phomopsis twig blight *(Phomopsis vaccinii)*

The disease is present every year, but its prevalence increases when the plants have been stressed by cold or drought injury. It is favored by wet weather and temperatures of 70 - 80 degrees Fahrenheit. Small cankers may occur on stems or the fungus may kill entire branches, particularly when several lesions on the stem coalesce with each other. Infections in the crown may eventually kill the plant.

Management/Control
The spores enter the plant through wounds, including those from frost or winter injury. The disease can be managed by avoiding injury to the plants. Plants should be irrigated to avoid drought stress. Fungicide applications during the growing season may help to reduce infection, however, the most important fungicide application is a dormant lime-sulfur treatment. An application can be made in autumn after leaf drop, but a late winter or early spring application before buds break dormancy is more effective. This treatment should be avoided once the buds have started growth to avoid damaging the young plant tissue. Late season growth should be discouraged and early hardening off of the plants should be encouraged through the proper use of fertilizers.

Anthracnose *(Colletotrichum gloeosporioides)*

Anthracnose fungus primarily causes fruit rot but can also cause lesions on the stems and leaves. Infected berries have a distinctive area of salmon colored spores on the surface, easily identifying this fruit rot from others.

Management/Control
This disease is controlled primarily through the use of fungicides. Applications should begin at full bloom and continue at 7-10 day intervals. Good air circulation around the fruit clusters is suggested. Berries should be picked frequently (not when they are wet) to prevent spread from infected berries to uninfected berries during favorable weather conditions. Heavy nitrogen fertilization tends to induce a higher disease incidence.

Phytophthora root rot *(Phytophthora cinnamomi)*

Phytophthora root rot is nearly always associated with poorly drained low spots in a blueberry field. The plants will become stunted and off color, and production of berries will be significantly reduced as root systems are infected and reduced in quantity. The entire plant may be killed, sometimes within the course of a single growing season.

Management/Control
The disease can be avoided by proper site selection. Heavy clay soils and fields with low spots that puddle for extended periods should not be considered. Drainage should be improved in those troublesome areas of a field already in cultivation before replanting. Fungicide applications should be performed at planting if root rot has been a problem in the past or if the drainage of the field is not optimal. Fungicides can also be applied during the growing season to prevent new infections from occurring.

Blueberry Shoestring Disease

Blueberry Shoestring Disease is probably the most well-known and widespread virus disease of blueberry. It can cause a 25% loss of yield on infected bushes. Ripe berries are reddish rather than blue, causing an additional loss of quality.

The most common symptom of the disease is an elongated reddish streak along new and 1-year-old stems. The streaks are most often found on the side of the stems exposed to the sun. Leaves are often narrow and elongated with wavy edges. They may also be sickle shaped. Leaves may have red banding along veins and midribs, or red-purple oak leaf patterns. Flowers may be red streaked or pinkish to reddish petals. Berries will ripen prematurely, and are often reddish-purple rather than blue.

This disease is spread from infected plants to healthy plants by the blueberry aphid *(Illinoia pepperi)*. These aphids usually move from one plant to the next by crawling along touching branches. Therefore, the disease will spread down the row, affecting several plants in the row, while neighboring rows are disease free. It takes four years from the time the plant is infected until it begins to show symptoms.

Management/Control
There is no cure for the disease. Destroy wild plants near the production area. Remove and destroy any plants that become diseased. Wash any machinery that contacts plants to avoid carrying aphids from one plant to another. See current recommendations for aphid control measures.

Blueberry Stunt

Blueberry stunt is caused by a phytoplasma. Stunt is an important disease of blueberry throughout the United States and Eastern Canada.

Symptoms are most noticeable during mid-June and late September. Plants lack vigor and are stunted and excessively bushy, with shortened spaces between the

leaves and an abnormally high number of branches. Infected bushes can be less than half the size of healthy ones. Leaves are small and cupped downward. Leaves are yellow along the edges and between the veins, giving them a mottled appearance. Yellow areas of the leaves will turn brilliant red early in the fall, before the leaves of healthy plants. Few berries are produced, and these are small, hard and tasteless. The berries will ripen late, if at all, and will cling to the bush much longer than berries on healthy plants.

The disease spreads from infected plants to healthy plants by the sharp-nosed leafhopper *(Scaphytopius magdalensis)*, and two other closely related leafhoppers. These leafhoppers also feed on pin cherry, black cherry, chokecherry, dewberry, wild raspberry and blackberry.

Management/Control
Plant disease free plants. Remove and destroy diseased plants from the field as soon as possible. Apply insecticide to control leafhoppers before removing plants to avoid disturbing the insects, causing them to go to other healthy plants.

Raspberry/Cane Fruit Insects

Raspberry Cane Borer *(Oberea bimaculata)*

Description
The adult is a slender, black beetle that is about 1/2 inch long with a bright orange thorax that has two to three black spots. They are a long-horned beetle with characteristic long, black antennae. They require two years to complete their life cycle.

Life Cycle
The beetles appear in raspberry plantings in early June and may remain present until late August. During this time, the adults feed on the tender green epidermis of the cane tips, leaving brownish patches or feeding scars.

The adult female uses her mouthparts to puncture stems to form two rings of drilled holes about 1/2 inch apart in a girdling fashion about six inches from the cane tip or lateral shoot. After puncturing, the female will deposit an egg into the cane pith between these rings. Upon hatching, the larva, called a borer, burrows through the cane, reaching its base by fall and the crown by the next summer.

Damage
Wilting and blackening of the cane tips and laterals will be evident in early June once the female beetle has deposited her eggs. Infested canes will die or fall over before the fruit matures the following season.

Management/Control
In new growth, prune and destroy the infested portion of the stem or lateral a few inches below the wilted tip. Damaged canes and crowns or roots should be removed and burned during the dormant season. Pesticide applications to control the adults can be made at late prebloom, just before blossoms open. Also, eliminate any wild brambles near the field that may be harboring cane borer-type pests.

Flat-headed Cane Borers
Red-necked Cane Borers *(Agrilus ruficollis)*
Bronze cane borer *(Agrilus rubicola)*

The red-necked and bronze cane borers are collectively called flat-headed cane borers (referring to the larval stage), as both species have nearly identical life cycles and similar looking borers.

Description
The red-necked cane borer adult is about 1/4 inch long, with a reddish colored thorax that contrasts sharply with its black head and wing covers. The bronze cane borer beetle is similar in appearance except for its iridescent bronze or coppery color and is somewhat smaller.

Life Cycle
Adults are present from late May to early August. They feed along the edges of the leaves and are easily found on sunny days. Females deposit whitish, scale-like eggs along the bark of the new growth during May and June. Eggs are also inserted into young canes, usually within 10 inches of the base of the cane. They do not girdle the cane like the raspberry cane borer does, but later the tunneling of the borer causes a symmetrical swelling or gall to form. These canes may also weaken and break off.

After hatching, the young larva enters the bark at the axil of the leaf stem. The borer then constructs a long winding tunnel which spiral around the cane several times in the sapwood, then turns into the hardwood, and then deeper into the pith. By early August the galls begin to form where the bark has been girdled, although sometimes no gall results from the injury. Once the tunnel reaches the pith, it straightens into a path through the pith. The larvae is full grown by fall, remains in the tunnel during the winter and pupates in the spring during late April. Adults emerge in the summer beginning in late May. The swelling or galls usually have numerous slits and range in size from 1/2 to nearly 3 inches long on the cane.

Management/Control
Remove all canes that show swelling and destroy them. Also, eliminate any wild brambles nearby which act as hosts for these pests. Pesticide applications to control the adults can be made at late prebloom just before blossoms open.

Raspberry Crown Borer *(Pennisetia marginata)*

The raspberry crown borer is also known as the raspberry root borer. This insect should not be confused with the root damage caused by the larvae of three species of weevil that also damage strawberries, black vine weevil, strawberry root weevil and rough strawberry root weevil.

Description
The adult is a very striking moth, resembling a yellow jacket in color, with a wingspan of 1 to 1 1/4 inches and four or more bright yellow bands across the black abdomen.

Life Cycle
Adults appear in early August and are present through most of September. Female moths can be seen during the day resting near the outer edges of leaves.

Oval, reddish-brown eggs are individually laid on the undersides of leaves near the edge in late summer. After hatching, small white caterpillars move to the base of the canes. Here, they excavate a small blister like cavity under the bark near the base of the stem or find a protected place in the bark to over winter. The following spring, the larva enters the crown and also the roots, but it usually tunnels into a new cane and girdles it before returning to the crown and root tissue. The second winter is spent in the roots. By the second summer, the crown area can be extensively tunneled with galleries and damaged. The whole crown may be hollowed out.

Damage
The first indication of injury is withering, wilting and dying of the cane foliage, often with half-grown fruit still attached. Damaged canes will often break at the damaged area when pulled, revealing the larva inside. In New England, swelling of the crown has also been observed. In severe cases, the infested plant may die. The crown must be dug and opened to find the larva infesting it.

Management/Control
Dying and girdled canes that are showing signs of infestation should be removed and destroyed during the growing season. Wild brambles in the area should be eliminated. Pesticides applied as a heavy drench in the early spring to kill the

young larvae and repeated between mid-August and mid-September can also be effective.

Diseases of Raspberry/Cane Fruits

Verticillium Wilt *(Verticillium albo-atrum)*

Verticillium wilt infects raspberries and blackberries, blueberries, strawberry, squash, stone fruits, tomato and eggplant as well as many weed species. In brambles, it is most serious on black raspberries, but can also occur on red and purple raspberries.

Description
Symptoms are most noticeable in hot, dry weather, and plants may look better in cool, fall weather. Symptoms begin at the bottom of canes and work up. Leaves on new canes become pale green, then yellow in midsummer. Leaves may drop early. Fewer leaves are made on second year canes. Beginning at the bottom of the cane and progressing upwards, the leaves become yellow, wilt and fall off. Symptoms may only be on one side of the cane. If the canes are cut open, the water conducting vessels are usually reddish. Infected canes usually die within one to three years.

Infected raspberry canes may have a purple or blue streak that begins near the soil line and extends upward. On red raspberries, individual leaflets may fall, leaving the petiole attached to the plant. On blackberries, the canes wilt, and the leaves turn yellow, then brown and then die. The canes do not turn blue. If infected canes survive the winter, they may set fruit, but usually collapse as the fruit is ripening.

Management/Control
Use disease free planting stock. Do not plant raspberries after the host plants mentioned above for at least three to four years. Planting raspberries after at least two years of corn or wheat may help to reduce the amount of fungus in the soil. Keep weeds under control. See current recommendations for possible control measures using pesticides.

Phytophthora Root Rot *(Phytophtora fragariae)*

Phytophthora is primarily a disease of red and purple raspberries, but it can affect black raspberries and blackberries as well. It usually affects plants that are in wet or heavy soils. Infection can occur in patches in the planting that correspond to low, soggy areas. These patches can become larger over time as the amount of fungus in the soil increases. The symptoms are most noticeable in the spring.

Description
Both first and second year canes may be affected. Generally, fewer first year canes are produced than normal. First year canes may develop a dark, water soaked spot at the base and then may wilt rapidly and collapse. Symptoms may also develop more slowly, with yellowing, wilting, and dying of infected canes. Second year canes are weak and stunted with small off color leaves. They may produce weak side shoots. Leaves may turn yellow all over or turn brown around the edges or between the veins. Leaves or entire canes may wilt. The entire cane may die in warm weather.

To diagnose this disease, the roots of a dying, but not yet dead plant must be examined. If the bark is scraped from the main roots and crown, the layer underneath should be white on a healthy plant. This layer is red-brown and will become dark brown on infected plants. There is often a distinct line where the infected and healthy tissues meet.

Management/Control
Plant disease free nursery stock. Plant in well-drained sites, preferably where brambles have not been grown before. It is important to prevent puddling or flooding around the plant because the fungus spreads from plant to plant via swimming spores. It is best to prevent the disease by planting on an appropriate site. Planting on raised beds is suggested for areas that may be questionable. Discourage the movement of water from one field to another. See current recommendations for possible control measures using pesticides.

Anthracnose *(Gloeosporium venetum)*
Anthracnose is a common and destructive disease that can severely infect blackberries and black raspberries. On rare occasions red and purple raspberries can be infected with the fungus. Generally, young actively growing plant parts are more prone to infection; however, plants can become infected at any time during the season.

Description
The first symptom of the disease is usually reddish-purple round to oval spots on the first year canes in the late spring. The spots grow and become sunken, and the centers become tan to gray with purple edges. The spots may grow together, making large irregular patches, or completely encircling the canes. The canes may weaken and break or the bark may split. Canes that are infected in their first year may not survive the winter. If they do, they produce fewer leaves in the spring, and these leaves are weak and pale. The fruiting stems may also become infected and may die.

First year canes may also become infected later in the season. When this happens, shallow gray areas that may have tiny reddish dots in them may appear.

Fruit growing on diseased canes may develop brown, scabby areas, as the individual drupelets become sunken and light tan in color. The fruit has a bitter taste and is not marketable.

Management/Control
See Management/Control for Cane Blight

Cane Blight *Leptosphaeria coniothyrium)*
Cane blight is a potentially serious fungal disease on all of the cane fruits, but is most common on black raspberries. It also infects roses and other woody plants. It only infects canes that were damaged in their first year. The disease can cause winter injury, failure of the buds to open, and wilting and death of the canes.

Description
Symptoms do not appear until the late fall. Symptoms are not usually centered around a leaf joint, but around an injury. If the bark of the first year canes is scraped away from an injured area, a brown stripe can be seen. Usually, the first noticeable symptom is large brown to purple spots or streaks on the second year canes. On blackberry these spots or streaks are dark red to purple. These may appear on the length of the whole cane or on one side of it. The buds or fruiting spurs that are in the streaked area may wilt, be weakened, or die. If the spot completely encircles the cane, it may wilt or be killed and fall over easily.

Management/Control
Plant disease free nursery stock. Prune out diseased canes and old fruiting canes each year after harvest and destroy them. This must be done before new canes emerge in the spring. Any pruning, topping or tipping for cane blight prevention should be done when dry weather is predicted for at least three days to allow cuts to heal. It is also important to prevent damage to the canes by machinery or other means.

Good air circulation is important to keep the planting dry and helps to prevent infection. Air circulation can be improved by thinning canes. Use of certain trellising systems, such as the V-trellis, will also help to improve air circulation. Avoid excessive use of fertilizer, particularly nitrogen. Maintain narrow rows. Control weeds. See current recommendations for possible control using pesticides.

Grapes

Grape Berry Moth *(Endopiza viteana Clemens)*

Description

The adult grape berry moth is small and has an inconspicuous brownish appearance. The forewings are a gray blue at the base and become cream colored with brown patches toward the tips. The smaller smoky-brown hind wings are hidden underneath the forewings when the moth is at rest. The body color is brown. The moths will rest on the vines during most of the day. They will become active around mid to late afternoon and their rapid zigzag flight can be observed until after dusk.

Life Cycle

In early spring, white, oval, scale-like eggs are laid singly on buds, stems or newly formed berries. Later, most eggs are deposited directly on the grape berries. The eggs will hatch after 4 to 8 days, depending upon temperature.

Newly hatched larvae are a creamy white with a dark brown head and thoracic shield. As the larvae grows, the body becomes greenish, eventually turning purple. The head of the mature larva is light brown but the thoracic shield remains dark colored.

The first larvae in the spring feed on tender stems, blossom buds and newly set berries. They will often feed inside large protective webbings that can involve the entire cluster. When the berries become larger, the larvae will begin to burrow into them. Second generation larvae feed only on the berries. Larvae usually enter where berries touch each other or where the berry is joined to the stem. Larvae feed just below the skin but eventually the inside of the berry is attacked. A single larva can destroy up to seven berries. Some larvae may pupate in the fruit cluster where they have fed. Also, mature first generation larvae will move to a leaf where they cut out a circular flap to construct a pupation chamber. Most fully developed second generation larvae spin down to the ground where they construct over wintering pupal cells in fallen leaves. The pupa is either a light brown with a green shade on the abdomen or entirely dark green.

Damage

The damage by early first generation larvae can be quite serious since a single larvae can destroy a dozen or so potential berries by feeding on buds, flowers and newly set fruit. Late first generation and all second-generation larvae feed only on the berries. Often a reddish spot surround the point of larval entry. This discoloration can extend over half of the surface of an otherwise green berry. Injured berries may ripen pre-maturely, split open and shrivel. Webbing produced by the larvae prevents injured berries from dropping to the ground. Larval feeding directly reduces yield and contaminates the crop. Larval feeding also creates infection sites for rot organisms and invites attack by Drosophila flies. Infestations can vary greatly from year to year.

Management/Control

In light infestations, injured berries can be removed by hand. In the fall, leaves that contain pupal cells can be gathered and destroyed. Covering leaves that

contain cocoons with 2.5 cm of compacted soil will prevent emergence. This operation must be completed 15 days ahead of the bloom period. Post bloom insecticide applications may be necessary where the grape berry moth is an annual problem or if the problem is severe. Use of sex pheromone traps to monitor emergence and activity of male moths may be helpful to improve the timing and determine the need for control measures of this pest.

Grape Leafhopper *(Erythroneura comes)*

Description
As spring temperatures reach the mid 60s in May, the over wintering adults emerge from hibernation and begin feeding on various plants. They emerge with a reddish-orange coloring that changes to yellow when they begin feeding. In summer, the adult is pale yellow with three black spots and some zigzag lines of deeper yellow on the forewings. The markings will darken as the season continues, becoming salmon colored with red eyes just prior to hibernation. Migration to over wintering sites begins in the latter part of October and continues into December.

Life Cycle
In mid to late June eggs are laid singly just beneath the epidermis on the underside of the grape leaf producing a slight blister. They are tiny, colorless and slightly bean shaped.

The first nymphs will appear in late June, reaching the adult stage by late July. Second-generation nymphs and adults are found in late August.

There are five nymphal instars. A few days before hatching, a dark eye spot can be seen in the egg. Newly hatched nymphs are semi-transparent with conspicuous red eyes. The eye color of the second instars nymphs is less intense, and their thorax turns yellow and shows small lateral wing pads. The marking on the thorax become more prominent and the wing pads become larger with each successive molt.

Damage
Adults and immature leafhoppers feed on the underside of leaves by sucking out the liquid cell contents. The surrounding tissue turns pale white and eventually dies. Feeding injury first appears along the veins, later affecting the whole leaf. Initially, feeding is limited to the lower leaves.

Grapevines can tolerate populations of up to 15 leafhoppers per leaf with little or no economic damage. However, heavy leafhopper feeding can result in premature leaf drop, lowered sugar content, increased acid and poor fruit color. Ripening fruit is often stained by the excrement of the leafhoppers, affecting the appearance and supporting the growth of sooty molds. Severely infested vines

may not be able to produce sufficient wood the following season. Damage to the vine can be serious if infestations are allowed to persist unchecked for two or more years.

Management/Control
Cold and wet weather conditions in spring and fall are damaging to leafhopper populations, as are wet winters. Fall cultivation and clean up of adjacent weedy land will eliminate favorable over-wintering sites in and near a vineyard.

Application of a contact insecticide may be appropriate when there are high numbers of Grape Leafhopper. Complete spray coverage to the undersides of the leaves is necessary for good control. Coverage of the fruit clusters is of secondary importance.

Black Rot *(Guignardia bidwellii)*
Black rot of grapes is an important fungus disease of American origin. It can cause complete crop loss in warm, humid climates. Because of the climatic requirements the disease is especially important in the viticultural regions of the Midwestern and eastern United States. There is wide variation in disease susceptibility among native American cultivars.

Life Cycle
The black rot fungus over-winters in mummified fruit on the vine and on the ground. Spring rains trigger the release of airborne ascospores from the mummies and infection of green tissue results if temperature and length of leaf wetness are conducive. Brown circular lesions will develop on infected leaves and within a few days black spherical fruiting bodies form within the lesions. Petiole infection may cause the leaves to wilt. Shoot infection results in large black elliptical lesions. These lesions may contribute to breakage of shoots by wind. The fruit infection phase may cause substantial economic loss. Berries are susceptible to infection from bloom until they ripen. An infected berry first appears light brown, soon the entire berry turns dark brown and black fruiting bodies develop on its surface. Infected berries shrivel, turn hard and black and are called mummies.

Management/Control
Control of black rot is based on properly timed applications of fungicides. Most fungicides must be applied to the vine before rainfall triggers spore release and infection. Other measures that can help control black rot include selection of a site with good air drainage and orientation of the rows to maximize air drainage. Prune in a manner that will help to open the canopy so that air circulation and spray coverage are improved. Spring cultivation to bury the mummies helps to reduce the inoculums.

Phomopsis Cane, Leaf Spot and Fruit Rot *(Phomopsis viticola)*

Phomopsis cane, leaf spot and fruit rot is widely distributed in vineyards. It can weaken vines; reduce yields and lower fruit quality. Infected rachises and shoots develop black, elongated lesions that often split the green tissue. Numerous lesions give the surface a blackened scabby appearance. Leaf lesions are often numerous with brown or black brown coloration and become covered with black, pimple-like fruiting bodies. These infections do not usually become visible until late summer. When infections on shoots are numerous, they often run together and form dark blotches that crack. Cluster stems can blight and become brittle if infections are high. The clusters usually break and the fruit is lost. This fungus also causes fruit rot. Infected fruit will turn brown, shrivel and eventually drop. Cane infections can be observed in the winter.

Life Cycle

The fungus over-winters in bark and leaf petioles. Black fruiting bodies of the fungus over-winter in canes and rachises. During early spring rains, spore ooze from fruiting bodies and are rain splashed onto susceptible young tissue. Shoot and leaf lesions appear within 3-4 weeks after infection but do not form new spores until the following year. Rachises are susceptible from the time they first become visible until after pea sized fruit have formed. Fruit infections occur primarily from bloom through shatter, and then remain dormant until just before harvest. Thus, severe fruit rot can develop at harvest if the bloom period is very wet and fungicidal protection is not provided.

Management/Control

This fungus becomes a problem when it is allowed to build up on dead canes and in the vines. Diseased canes should be removed during pruning to reduce inoculums. The need for fungicidal protection programs on susceptible cultivars is dependent upon the level of inoculums within the vineyard and rain intensity. Because inoculums remains viable in canes for several years, hedged vineyards are particularly at risk of incurring economic losses, especially if rachis or fruit infection develop.

Cane blight and leaf spot can be controlled by a combination of sanitation and fungicide applications. At pruning, remove dead and diseased wood. Destroy pruning and debris by burning, burying or plowing them into the soil. Cane and leaf infections can be prevented by one or two fungicide applications. The period from bloom through fruit set is a critical time to protect against fruit infection under wet conditions. Fruit and cluster stem infections occur from bloom until the fruit are pea size. Regular fungicide applications are necessary to prevent disease.

Botrytis Bunch Rot *(Botrytis cinerea)*

Description
Botrytis infection of leaves begins as a dull, green spot, commonly surrounding a vein, rapidly becoming a brown lesion. The fungus may also cause a blossom blight or a shoot blight that can result in significant crop losses. Dead blossom parts in the cluster may be colonized by the fungus that can then move from berry to berry within the bunch prior to the beginning of ripening, and initiate development of an early season sour rot. However, the most common phase of this disease is the infection and rot of ripening berries. This will spread rapidly throughout the cluster. Berries of white cultivars will become brown and shriveled and those of purple cultivars develop a reddish color. Under proper weather conditions, the fungus produces a fluffy, gray-brown growth containing spores.

Life Cycle
Botrytis over-winters in debris on the vineyard floor and on the vine. The fungus produces small, dark, hard, resting structures called sclerotia. Sclerotia are resistant to adverse weather conditions and usually germinate in the spring. The fungus then produces conidia, which spread the disease. Sporulation may occur on debris left on the vine during the previous growing season, such as cluster stems remaining after mechanical harvest or mummified fruit. The fungus usually gains a foothold by colonizing dead tissue prior to infection of healthy tissue. Damaged or injured tissue is readily colonized by Botrytis. Ripe berries that split because of internal pressure or because of early season infection by powdery mildew are especially susceptible. Botrytis conidia are usually present in the vineyard throughout the growing season. Moisture in the form of fog or dew and temperatures of 59-77° F are ideal for conidia production and infection. Rainfall is not necessary for disease development.

Management/Control
Botrytis can be controlled by an integration of cultural practices, host factors, and applications of fungicides. Select open vineyard sites and orient rows to promote good air drainage. Prune in a manner that will help to open the canopy so that air circulation and spray coverage are improved. Consider application of growth regulators that will help to lengthen the rachis and separate the berries in tight clustered cultivars to reduce spread of the fungus from berry to berry. Appropriately timed applications of fungicide during the growing season can also provide good control.

Honey Bees and Pesticides

Pesticides are the single most serious problem to beekeeping in agricultural areas. Many crops must be protected from insect pests and diseases, but they must also be pollinated. The annual value of crops in the United States that require bee pollination exceeds one billion dollars.

Honeybees frequently are in danger of being killed when crops are treated with pesticides. Bees may be poisoned when they feed on nectar or pollen contaminated with certain pesticides. They may also be poisoned if they fly through a cloud of pesticide dust or spray, or walk on the treated parts of the plant. They may be overcome by the fuming action of certain pesticides, either in the field or in the hive if the material has drifted there. Farmers and beekeepers are dependent on each other and need to cooperate fully in protecting the bees from pesticide exposure.

Observance of precautions can significantly reduce bee losses from pesticide poisoning.

Precautions for Farmers

1. Use pesticides only when needed - Do not apply a pesticide unless its benefit will outweigh any injury that it might cause to pollinators. Consider the effect the pesticide will have on the pollination of crops in the area. An application of insecticide might increase the production of the crop, but by reducing the population of insect pollinators it could seriously reduce the production of crops in adjoining fields.

2. Select the right pesticide - All pesticides are not equally toxic to bees. Some pesticides will kill an entire colony; some will seriously weaken it; others are relatively safe. Of the pesticides that are effective against harmful insects, select one that is least toxic to bees. Do not use the more toxic pesticide on flowering plants that attract bees. (See accompanying list, "Relative Toxicity of Insecticides to Honey Bees")

3. Apply granules or sprays rather than dusts - Sprays do not drift as much as dusts and, consequently, are less likely to harm bees. Granules are usually harmless to bees.

4. Time pesticide application - Do not apply pesticides when bees are actively foraging. Treat plants before or after flowering, at night, or at a time of day when bees are not visiting them. Bees may cluster outside the entrance of the hive on hot nights. When this happens, pesticides drifting over the hives may kill the bees. Fumes of some pesticides can kill bees in the hive. Beekeepers should

consider the normal wind directions when placing hives near fields that may be treated.

5. Notify beekeepers - Notify beekeepers in your area several days before you apply a pesticide. This will give them an opportunity to protect their colonies. However, notification is not a release of responsibility for damage.

State law requires all beekeepers in Connecticut to register their hives. A list of registered beekeepers in your area may be obtained from the Office of the State Entomologist at the Connecticut Agricultural Experiment Station, Box 1106, New Haven, CT 06504 or www.caes.state.ct.us/Bee.

Relative Toxicity of Insecticides to Honeybees

Group I - Highly Toxic: Severe losses may be expected if the following materials are used when bees are present at treatment time or within a day thereafter:

- Acephate (Orthene)
- Carbaryl (Sevin)
- Ciodrin
- Diazinon
- Dichlorvos
- Dimethoate
- Imidicloprid
- Imidan
- Malathion
- Methyl Parathion
- Naled (Dibrom)

Group II - Moderately Toxic: These can be used around bees if dosage, timing, and method of application are correct, but should not be applied directly to exposed bees in the field or at the hives:

- Disulfoton (Disyston)
- Endosulfan (Thiodan)
- Fipronil
- Pyrethrins
- Synthetic pyrethroids

Group III - Relatively Non-Toxic: These can be used around bees with minimal injury:

- Allethrin
- Bacillus thuringensis
- Bordeau Mixture
- Captan
- Chlorobenside
- Copper sulfate (Monohydrated)
- Diquat
- Dodine
- Ferbam
- Folpet
- Kelthane
- Maneb
- Paraquat
- Rotenone
- Sulfur
- Thiram
- 2, 4-D

Herbicides

Herbicides are grouped on the basis of use into selective and non-selective and on the basis of mode of action into contact, translocated, and sterilant chemicals.

Selective and Non-selective Herbicides

Selective herbicides are those that kill certain weeds without seriously injuring the desirable plants among which they are growing. The reasons for selectivity in some combinations of weeds and desirable plants are known; in other situations they are unknown.

Non-selective herbicides kill vegetation with little discrimination. However, certain species of plants may be physiologically resistant to the chemical or may escape through a particular growth habit. Some escapees are perennials that have part of their root system below treated layers of soil; others are annuals and shallow rooted perennials that reinfest an area after the chemical has leached below the surface layer.

Contact, Translocated and Soil Sterilant Chemicals

Contact herbicides kill the tissues that are wetted with the spray. Whether the plant dies or recovers depends on whether it has a protected growing point. Perennials usually have underground buds that will regrow.

Translocated chemicals are absorbed by the roots and move through the vascular system to leaves, buds and root tips. When absorbed by the leaves and stems the chemical is commonly moved with the food materials that were manufactured in the leaves and stems. When absorbed by the roots, it moves in the water-conducting tissue. The growth regulator type of translocated herbicide is a synthetic compound that behaves like a plant hormone. It accumulates mostly in areas of rapidly dividing cells, upsetting the normal metabolism of the plant and causing death of the cells.

A soil sterilant herbicide makes soil incapable of supporting higher plant life, but it does not necessarily kill all life in the soil, such as fungi, bacteria or other micro-organisms. Its toxic effects may remain for only a short time or for years depending upon the product used.

Properties of Herbicides

The properties of herbicides and the mode of action of herbicides are factors of fundamental importance to be considered in how to use the chemical most

effectively. These properties determine how effective the chemical will be under varying conditions.

Adsorption

One of the most important interactions of the chemical with the environment is the tie up of the chemical by soil. This tie up or adsorption by various parts of the soil determines how much of the chemical will be available for action in the soil, how readily the chemical will leach, how fast the chemical will disappear from the soil.

Leaching

The movement of the herbicide in the soil is a factor that has to be considered in determining the maximum effectiveness of an herbicide. This movement is related to the adsorption of the chemical and also to the amount and intensity of water movement. Leaching is related to the type of soil. Leaching decreases as one goes from sand, to loam, to clay, to soil high in organic matter.

Decomposition and Metabolism

The soil contains animals and microorganisms that posses the ability to detoxify or bring about the decomposition of most organic herbicides. Such breakdown is possible through various biochemical mechanisms available to them. The more favorable the soil conditions are for the growth of soil organisms, the more quickly organic herbicides are decomposed.

Many herbicides are also broken down through a process of chemical degradation.

Volatility

Volatility refers to the vaporization of a compound. Plant damage can be caused by the volatization of certain herbicides. This is due to the vapors that are released by the herbicides. The volatization of a chemical may reduce the concentration of a chemical on the treated site, thereby making it less effective or almost non-effective. Some herbicides that are applied to the soil are sufficiently volatile that their effectiveness would be largely lost if not incorporated into the soil shortly after application. The higher the temperature the more likely a substance is to volatize.

Drift

Drift refers to the movement of spray droplets or vapor from one area to another. Drift is associated with the size of the spray droplets, wind speed and height of the sprayer above ground level. Drift problems can be avoided if certain precautions are followed.

1. Do not spray when there is a wind.
2. Use low pressure with a large nozzle to create a coarse spray droplet
3. Apply at slow speeds to reduce drift from turbulence.
4. Apply herbicide with spray nozzles as low to the ground as possible.

Safety in Using Herbicides

Any chemical is toxic to humans or other animals at a sufficiently high level of exposure. Concentrations of chemical and duration of exposure are important interacting factors. Some herbicides are fairly safe, but others are very toxic. All safety measures should be considered when using any herbicide.

Specific allowable herbicide residues are established by the U.S. Environmental Protection Agency for food, feed and livestock products. These residue tolerances are premised on the protection of human welfare. Registered herbicides and recommended application rates should be strictly observed to avoid the possibility of excessive residues.

Worker Protection Standard

Below is a *brief summary* of the Worker Protection Standard (WPS). The WPS is a federal regulation that is aimed at reducing the risk of pesticide exposures for employees of agricultural operations. Pesticide labels for all products that are used in agricultural production now refer to the WPS and, therefore, compliance with the entire regulation is required. Agricultural business owners and managers should familiarize themselves with these requirements by reading the "How To Comply Manual" or by going to EPA's website http://www.epa.gov/oppfead1/safety . You may also direct any questions that you may have to the State of Connecticut, DEP, Pesticide Management Program by calling 860/424-3369.

Under the Federal Insecticide Fungicide and Rodenticide Act (FIFRA) it is unlawful for any person to use a pesticide in a manner inconsistent with its labeling. When the WPS is referenced on a pesticide label, users must comply with all of its requirements or be subject to enforcement action, which may include monetary penalties.

Basic Principles of the Worker Protection Standard

EPA's Worker Protection Standard (WPS) is intended to reduce the risk of pesticide poisonings and injuries among persons who are employed at farms, forests, nurseries or greenhouses. The WPS contains requirements for pesticide safety training, notification of pesticide applications, use of personal protective equipment, restricted entry intervals following pesticide application, decontamination supplies, and emergency medical assistance.

The WPS identifies almost all agricultural employees as agricultural workers, early-entry workers or pesticide handlers depending upon the duties they perform. They are distinguished as follows;

Agricultural Workers are those who perform hand labor tasks related to the planting, cultivation and harvesting of plants on farms or in greenhouses, nurseries, or forests. Workers include anyone employed for any type of compensation (including self-employed) doing tasks, such as carrying nursery stock, repotting plants, or planting, weeding, hoeing or watering, related to the production of agricultural plants on an agricultural establishment.

Workers do NOT include employees such as office employees, truck drivers, mechanics, and any other workers not engaged in worker/handler activities.

Early-Entry Workers are workers that, under limited circumstances, may be asked to enter a pesticide treated area before the expiration of the restricted entry interval to perform limited tasks. Employers must provide special protections to early entry workers such as additional training and instructions, decontamination sites and label specific personal protective equipment.

Pesticide Handlers are those who mix, load, assist with or apply agricultural pesticides; clean, maintain or repair equipment that is used for pesticide applications; or perform other tasks that may bring them into direct contact with pesticides.

The WPS does not apply when pesticides are applied on an agricultural establishment in the following circumstances:

- For mosquito abatement, Mediterranean fruit fly eradication, or similar wide-area public pest control programs sponsored by governmental entities. The WPS does apply to cooperative programs in which the growers themselves make or arrange for pesticide applications.
- On livestock or other animals, or in or about animal premises.
- On plants grown for other than commercial or research purposes, such as home fruit and vegetable gardens, and home greenhouses.
- On plants that are in ornamental gardens, parks, and public or private lawns and grounds that are intended only for aesthetic purposes or climatic modification.
- By injection directly into agricultural plants. Direct injection does not include "hack and squirt," "frill and spray," chemigation, soil-incorporation, or soil-injection.
- In a manner not directly related to the production of agricultural plants, such as structural pest control, control of vegetation along rights-of-way and in other noncrop areas, and pasture and rangeland use.
- For control of vertebrate pests.
- As attractants or repellents in traps.
- On the harvested portions of agricultural plants or on harvested timber.
- For research uses of unregistered pesticides.

Summary of WPS Requirements

Protection During Applications

Pesticide handlers (applicators) are prohibited from applying a pesticide in a way that will expose workers or other persons. Workers are not allowed to enter areas where pesticides are being applied. In some circumstances, workers must remain outside of prescribed buffer zones that may be from 25 to 100 feet, depending upon where a pesticide is applied and the method of application, until the application has been completed.

Restricted-entry Intervals (REI)

Restricted-entry intervals are specified on all agricultural plant pesticide product labels. Usually REI's are 12, 24 or 72 hours, although some low toxicity products may have a zero hour REI. Workers are excluded from entering a pesticide treated area during the restricted entry interval.

Personal Protective Equipment
Personal protective equipment (PPE) that is specified on the pesticide label must be provided and maintained for handlers and early-entry workers. PPE must be inspected and cleaned prior to each use.

Notification of Workers
Workers must be notified about treated areas either orally, by posting of signs or both, as indicated on the pesticide label, in order to avoid inadvertent exposures. Workers that are on the premises at the start of the applications must be orally warned before the application takes place. Workers that are not on the premises at the start of the application must be orally warned at the beginning of their first work period if (1) the application is still taking place or (2) if the REI for the pesticide is still in effect.

Pesticide Safety Training
Specific training is required for all workers, early-entry workers and handlers and must be conducted in a language that they understand. Generally, certified private applicators, commercial supervisors or persons that have attended a state approved train the trainer session can train workers and handlers. Those that have been trained as "handlers" can also train workers. EPA has developed WPS training materials for workers and handlers that are available as booklets, flip charts and videotapes, some of which is available in languages other than English. The training must contain at least the concepts as described in the "How To Comply Manual - Criteria for Worker and Handler Training".

Central Posting

Agricultural employers must post specific information at a central location that is accessible to their employees. The information that is required to be posted is as follows:

- **Application list**, which must include the location and description of the area to be treated, the product name, EPA registration number, and active ingredients of the pesticide, the time and date the pesticide is scheduled to be applied and the REI.
- **Emergency information**, which must include the name, telephone number and address of the nearest emergency medical facility.
- A **pesticide safety poster**, which must be either the WPS safety poster developed by EPA or an equivalent poster as described in the "How To Comply Manual - Criteria for Pesticide Safety Poster"

Access to Labeling and Site-Specific Information
Handlers and workers must be informed of required pesticide label information. Central posting of recent pesticide applications is required.

Decontamination Supplies
Handlers and workers must have an ample supply of water, soap and towels for routine washing and emergency decontamination, and a change of clothes as specified in the regulation and the How to Comply Manual.

Emergency Assistance
Transportation must be made available to a medical care facility if there is a reason to believe that a worker or handler may have been poisoned or injured by a pesticide used on the agricultural establishment. Information must be provided to medical personnel about the pesticide to which the person may have been exposed.

Revisions of the Worker Protection Standard

The Environmental Protection Agency made several revisions to the WPS in April 1995. The revisions that are pertinent to Connecticut applicators are summarized below.

I. Training Requirements

As of January 1, 1996, employers must provide brief pesticide safety training to untrained agricultural workers before they enter pesticide treated areas. Employers must be able to verify compliance with this requirement. The brief pesticide safety training must consist of those components highlighted on the WPS safety poster and a statement to workers that complete Pesticide Safety Training will be provided before the end of the 6th day of entering a treated area. This differs from the original 1992 WPS, which allowed a 15-day grace period for complete WPS worker training until October 1997.

The basic pesticide safety information must include the following concepts:

- Pesticide may be on or in plants, soil, irrigation water, or drifting from nearby applications.
- Prevent pesticides from entering your body by:
  *Following directions and/or signs about keeping out of treated or restricted areas
  *Washing before eating, drinking, using chewing gum or tobacco, or using the toilet
  *Wearing work clothing that protects the body from pesticide residues
  *Washing/showering with soap and water, shampoo hair and put on clean clothes after work
  *Washing work clothes separately from other clothes before wearing them again
  *Washing immediately in the nearest clean water if pesticides are spilled or sprayed on the body and, as soon as possible, showering, shampooing, and changing into clean clothes.

- Further training will be provided before the 6th day that a worker enters any area on the agricultural establishment where within the last 30 days, a pesticide has been applied or a REI has been in effect.

To clarify: before working in an area treated with pesticides, an agricultural worker must receive basic pesticide training. Prior to day 6, he must receive complete worker training as described in the "How To Comply Manual." The complete training information is included in EPA's manual entitled, "Protect Yourself from Pesticides-A Guide for Agricultural Workers", or various EPA approved videotapes. Once a worker receives complete WPS training, he will not be required to be retrained for a period of 5 years.

Nothing in this exception changes the WPS training requirements for agricultural pesticide handlers.

II. Exception for Limited Contact Tasks/Early Entry Workers

Agricultural pesticide labels specify a restricted entry level (REI), usually ranging from 12 to 72 hours. The WPS had limited early entry worker activity in treated areas under an REI to 1 hour in a 24-hour period. EPA granted an exception to the WPS that would allow, under specified conditions, workers to enter pesticide treated areas during an REI to perform limited contact tasks that could not be foreseen and which, if delayed until the expiration of the REI, would cause significant economic loss. Some examples of limited contact tasks that qualify for the exception include: the operation and repair of weather monitoring and frost protection equipment; the repair of greenhouse heating, air conditioning and ventilation equipment; the repair of non-application field equipment; the maintenance and moving of beehives. Some examples of hand labor activities and other tasks which would not qualify for this exception include: harvesting; thinning; weeding; topping; planting; sucker removal; packing produce into containers in the field; operating, moving or repairing irrigation equipment; and performing the task of a crop advisor.

This exception increases the time workers will be able to remain in treated areas under an REI for early entry activities from 1 hour to 8 hours within a 24-hour period *providing the following conditions are met*:

1) The worker's contact with treated surfaces is minimal and is limited to the feet, lower legs, hands and forearms.

2) The pesticide product does not have a statement in the labeling requiring workers to be notified both orally and by posting;

3) Personal protective equipment for early entry is provided to the worker and must either conform with the label requirements or include at least coveralls, chemical resistant gloves, shoes plus socks, chemical resistant footwear, and

protective eyewear (if protective eyewear is required for handlers by the product labeling);

4) No hand labor such as hoeing, picking, pruning, etc. is performed;

5) The workers do not enter the treated area during the first 4 hours, and until applicable ventilation criteria have been met, and until any label specific inhalation exposure level has been reached;

6) Before early entry workers enter a treated area under an REI, the agricultural employer shall give them oral or written notification of the specifics of the exception to early entry as indicated on the pesticide label in a language the workers understand.

NOTE: Since this exception allows tasks to be performed during the REI, all persons engaged in the tasks under this exception must be trained as early entry workers as described in the How To Comply Manual or as a Handler prior to performing the tasks, in accordance with WPS.

III. Exception for Irrigation Tasks

EPA completed an exception to the WPS that allows early entry workers under specified conditions, to enter pesticide treated areas during a REI to perform irrigation tasks related to operating, moving or repairing irrigation or watering equipment. This exception extends the time that a trained early entry worker may remain in a pesticide treated area to perform irrigation tasks from one hour to 8 hours within a 24 hour period.

The terms of this exception further require that the need for the task could not have been foreseen and cannot be delayed until after the expiration of the REI. A task that cannot be delayed is one that, if not performed before the REI expires, would cause significant economic loss, and there are no alternative practices, which would prevent significant loss. (Discussions are currently underway with EPA to address watering needs in the greenhouse setting. At present, **this exception does not apply to routine watering needs in a greenhouse** since the need is not viewed as one that could not have been foreseen.)

In addition to the above criteria, the terms of the exception for irrigation activities requires compliance with items 1 through 6 listed above for the limited contact exception.

IV. Reduced Restricted Entry Intervals for Low Risk Pesticides

The WPS established an interim minimum REI of 12 hours for all end use pesticide products for agricultural uses. However, EPA had been asked to

consider reducing the minimum 12-hour REI for certain lower toxicity products. EPA determined that the reduction of the REI for specific low risk pesticides can be accomplished without jeopardizing worker safety and would also promote the use of less toxic products over those with greater risks and longer REI's. Therefore, EPA established a regulation to reduce the REI on 114 lower toxicity products to 4 hours or, in some cases, zero hours. EPA has instructed registrants to revise the labels of affected products to meet certain criteria. Pesticide users should examine labels closely for stickers or other indications of a reduced REI in accordance with this regulation.

The affected lower risk pesticides generally consist of microbial pesticides, biochemical pesticides and certain conventional agricultural pesticides.

V. Warning Signs

EPA amended the WPS to modify the warning sign size and language requirement. The amendment allows the substitution of the language commonly spoken and read by workers for the Spanish portion of the warning sign. The sign must be in the same format required by WPS and it must be visible and legible. Use of alternative languages is optional and the use of Spanish/English is always acceptable.

The amendment also allows the use of smaller signs provided that the minimum letter size and posting distance requirements are observed. In nurseries and greenhouses, smaller signs may be used at any time. A small sign may be used on a forest or farm if the treated area is too small to accommodate the standard sign.

SPANISH

For more information on the scope of the WPS, consult the How to Comply Manual or on the Internet at www.epa.gov/pesticides/safety.

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