2017 Cornell Integrated Hops Production Guide

Cornell University
Cooperative Extension

These guidelines are not a substitute for pesticide labeling. Always read and understand the product label before using any pesticide.

CHAPTER 7 – PESTICIDE INFORMATION *(continued)*

CHAPTER 8 – SPRAYER TECHNOLOGY *(continued)*

Chapter 1 – Introduction

This publication uses the term Integrated Pest Management (IPM). By definition, IPM is a pest management strategy that uses a combination of methods (such as scouting, thresholds, pest and weather forecasts, as well as biological and cultural controls) rather than relying solely on calendar-based applications of chemical pesticides. When developing a hopyard pest management strategy, growers must consider the following factors: pest biology (life cycle, infection requirements, etc.), varietal susceptibility, IPM strategies currently available, and the economics of implementing these strategies, in addition to the efficacy of available management options.

Since the resurgence of the hops industry in New York State is relatively recent, much of the pest and specific pest management information contained in this publication is based on research conducted in areas outside of New York, primarily the Pacific Northwest (see references section for complete listing of materials used in the production of this publication). While much of the pest information is transferable, it is important to keep in mind the distinct differences in growing-season conditions between the two regions (e.g., timing and probability of rainfall) and the effect that may have on IPM tactics such as thresholds and models for specific target pests. Every effort has been made to provide information that is applicable to hop growing in New York, but the best pest management plan will be based on knowledge developed in local hopyards. This publication has been developed to provide growers with research-based pest management information. It does not cover the entire spectrum of hop pests. Instead it concentrates on those pests which have been shown to be a problem in the Northeastern United States. With the limited number of pest control products available for hops in New York State, a conscientious use of additional IPM techniques such as selecting the proper site, keeping accurate pest history records, and preventing pest outbreaks through the use of sanitation, biological controls, variety selection and planting stock derived from certified, virus-tested sources is essential.

Chapter 3 – Hop Yard Nutrient Management

3.1 Introduction

To produce a healthy crop, soluble nutrients must be available from the soil in amounts that meet the minimum requirements for the whole plant. The challenge is balancing soil fertility to supply the required plant nutrients at the correct time and at sufficient levels to support healthy plant growth.

3.2 Soils and Fertility

Healthy soil is the basis for any successful farming operation. Regular additions of organic matter in the form of cover crops, compost, or manure create a soil that is biologically active; with good structure and capacity to hold nutrients and water (For more information on the use of Manure and Produce Safety see section 3.9). Decomposing plant materials will support a diverse pool of microbes, including those that break down organic matter into plant-available nutrients as well as others that compete with plant pathogens in the soil and on the root surface. The practice of crop rotation to promote a healthy soil should be done in the one or two years prior to hop yard establishment or is limited to row middles in a perennial crop such as hops. Growers must attend to the connection between soil, nutrients, pests, and weeds to succeed. An excellent resource for additional information on soils and soil health is *Building Soils for Better Crops*, 3rd edition, by Fred Magdoff and Harold Van Es, 2010, available from SARE, Sustainable Agriculture Research and Education, Building-Soils-for-Better-Crops-3rd-Edition (www.sare.org/Learning-Center/ Books/Building-Soils-for-Better-Crops-3rd-Edition). For more information, refer to the Cornell Soil Health website (soilhealth.cals.cornell.edu).

Fertility management is part of an overall soil management program that involves proper tillage practices, crop rotation, cover crops, water management (irrigation and drainage), liming, and weed management. Although it is important in obtaining maximum economic yields, fertilization alone will not overcome shortcomings in the areas mentioned above. Such problems should be corrected first so as to benefit fully from organic and inorganic fertilizer supplements and to sustain high yields and quality over the long term.

Regular soil testing and petiole testing will help monitor nutrient levels. It is recommended that regular petiole testing be incorporated into a fertility management program with soil testing to assist in determining the bines' nutrient status and to make sure that what is in the soil is making it into the bines in the proper amounts. It is recommended that soil and petiole tests be completed in each block/variety a minimum of every three years. Petiole testing is especially critical in getting the information needed to make management decision in problem areas of the hopyard and should be used on a more frequent basis if needed.

3.3 Soil Testing

Fertilizer requirements for best economic yield should approximate the difference between what hop plants take up from the soil for best growth and quality and what the soil can actually supply during the crop-growing period. The supply of essential nutrients in soil cannot be determined without conducting a soil test. Moreover, if pH is not in a desirable range, yields may be poor regardless of fertilizer added or already present in the soil.

Soils on which hops will be grown should be sampled at least once every three years. The pH of most hop soils can change with the removal of crop materials. Testing every year gives a more complete evaluation and is appropriate when significant changes have been made in the fertilizer program (e.g., applying less phosphorus or potassium when the previous year's test showed high levels). In general, when the Cornell-recommended rates of fertilizer are applied, low soil test values for phosphorus and potassium usually increase slowly and steadily in spite of crop removal. Medium soil test values tend to remain constant or increase slightly, whereas high values decrease gradually. The potassium level could decrease much more rapidly, however, if a light sandy soil with relatively low exchange capacity is coupled with a heavy potassium feeder such as hops. In such situations, yearly sampling is appropriate. The purpose of applying nutrients, however, is to benefit crop development, not to achieve a predetermined test result.

Growers interested in obtaining Cornell guidelines for crop management should submit samples to AgroOne (730 Warren Road, Ithaca NY, 14850; 1-800-344-2697) and request the Cornell Morgan test and Cornell guidelines. For New York samples submitted with the necessary field information, the soil test report will include results but for 2016 these will be forwarded for interpretation by Cornell's Hop Specialist. When submitting samples for hops, use the "F" form from the AgroOne website.

The soil test results provide soil pH, percent of organic matter, and level of phosphorus, potassium, magnesium, calcium, and zinc. Levels of aluminum, iron, and manganese are also listed to identify potential toxicities rather than deficiencies. Other nutrients can be tested for an additional fee. See the nitrogen, phosphorus, and potassium recommendations under each crop to design a fertility program for your farm.

Go to the Dairy One website (www.dairyone.com) to find out more about Agro-one soil testing services.

3.4 Soil pH

In general, hops grown on mineral soils will thrive at pH 6.0 to 6.8., the closer to 6.8 the better. Hops should not be grown on muck soils as they are prone to frost heaving.

Table 3.7.2. Estimated nutrient content of common animal manures

Type of Animal Manure	N	P_2O_5	K_2O	N1[a]	N2[b]	P_2O_5	K_2O
	Nutrient content lb/ton			*Available Nutrients lb/ton in first season*			
Dairy (with bedding)	9	4	10	6	2	3	9
Horse (with bedding)	14	4	14	6	3	3	13
Poultry (with litter)	56	45	34	45	46	36	31
Compost (from dairy manure)	12	12	26	3	2	10	23
Composted poultry manure	17	39	23	6	5	31	21
Pelleted poultry manure[c]	80	104	48	40	40	83	43
Swine (no bedding)	10	9	8	8	3	7	7
	Nutrient content lb/1000 gal			*Available Nutrients lb/1000 gal in first season*			
Swine finishing (liquid)	50	55	25	25*	20+	44	23
Dairy (liquid)	28	13	25	14*	11+	10	23

[a] N1 is the total N available for plant uptake when manure is incorporated within 12 Hours of application,
[b] N2 Is the total N available for plant uptake when manure is incorporated after 7 days.
[c] Pelletized Poultry manure compost. Available in New York From Kreher's.
*= injected
+ = incorporated
Adapted from *"Using Manure and Compost as Nutrient Sources for Fruit and Vegetable Crops"* by Carl Rosen and Peter Bierman and Penn State Agronomy

3.8 Manure

Most hop operations do not have a ready source of manure, but it can be used when available. Once applied to soil, manure is decomposed by microorganisms, forming humus. Manure provides both major and minor nutrients. When used regularly, it contributes organic matter and helps to alleviate structural deterioration, an important consideration in maintaining the productivity of heavily worked hop soils. One drawback of using manure is that certain weed seeds maintain their viability after passage through animals, so a potential exists for adding a new weed species to a field. This is especially true of horse manure. This threat is more likely with fresh than with composted manure. An excellent, thorough discussion of manure use in crop production is provided in the Cornell Field Crops and Soils Handbook.

Manure contains two forms of nitrogen, the unstable form in the urine and the stable form in the feces. The unstable form may account for 50 percent or more of the total nitrogen in manure. This nitrogen decomposes rapidly to ammonium, which in turn converts quickly to extremely volatile ammonia that can be lost from the system. For this reason, much of manure's unstable nitrogen may never be taken up by crops unless measures are taken to conserve it during the process of collection, storage, and application to the field. In general, about 35 percent of the stable nitrogen becomes available during the year of application, about 12 percent the second year, about five percent the third year, and about two percent the fourth year. Thus, repeated application to the same field results in an accumulation of a slow-release source of manure nitrogen.

Most potassium in manure is available for plant growth during the year applied; whereas, some of the phosphorus is in organic form and must decompose before it becomes available. Moreover, because phosphorus is not very mobile in the soil, broadcasting manure is not an efficient way of applying this element for crop establishment.

A micronutrient deficiency in a field with a history of manuring is rare because manure contains small quantities of these elements. If a deficiency is observed on a nonmanured field, a commercial fertilizer should be added immediately because of the slower availability of micronutrients in manure. If soil pH is acceptable, manuring may eventually solve the problem.

3.9 Manure and Produce Safety

The use of improperly aged or treated manure can increase microbial risks and contribute to foodborne illness. The possibility that fecal matter may come into contact with produce or that water might splash pathogens from the manure onto field produce are both important concerns. Pathogens such as *E. coli* O157:H7, *Salmonella*, and *Campylobacter* can be present in manure slurry for up to 3 months or more, depending on temperatures and soil conditions. Troubling for growers is that *Listeria monocytogenes* can survive in the soil for much longer than 3 months. *Yersinia enterocolitica* may survive, but not grow, in soil for almost a year.

It is important that all farms using manure follow good agricultural practices to reduce any microbial risk that may exist. These include:

Chapter 5 – Cover Crops

5.1 General

Cover crops are close-growing crops planted primarily for protecting and improving the soil. Integrating cover crops into hop production systems offers many benefits, but provides some challenges as well. Since hops are a perennial, cover crops are not used in the row. However, the following information can be useful for preparation in the year before the hops are planted or as an intercrop between the rows. For cover cropping to be successful, it is important to know the intended purposes, consider key management factors, and understand the characteristics of different cover crop species.

Cover crops offer a way to add organic matter to soils; improve soil tilth and remediate compaction; protect soil from wind and water erosion; add or recycle plant nutrients; increase the biological activity of soil; retain soil moisture; and in some cases, suppress weeds and may help control insects diseases and nematodes. No single cover crop can do all of these things. Matching the need and opportunity to the right cover crop requires information and planning.

5.2 Goals and Timing for Cover Crops

Cover crops play an important role in a hopyard, especially during the years prior to planting through improvement of soil organic matter, breaking up of compaction layers, erosion control and suppression or elimination of weeds. Goals should be established for choosing a cover crop; for example, the crop can add nitrogen, smother weeds, or increase equipment mobility. The cover crop might best achieve some of these goals if it is in place for an entire growing season prior to hopyard establishment.

Cover crops planted in late summer will suppress annual weed growth, improve soil texture, provide organic matter, and may increase soil nitrogen. The cover crop can be incorporated in late fall or in the spring before planting. Certain cover crops (marigold, sudangrass) will either suppress or resist nematode populations. These should be considered where fumigation is not an option. (See Tables 5.2.1 and 5.2.2.) In addition to producing large amounts of biomass that out-compete other plant species, some cover crops (annual rye, ryegrass) can inhibit weed growth through allelopathy, the chemical inhibition of one plant species by another. Rye provides allelopathic suppression of weeds when used as a cover crop, and when crop residues are retained as mulch. Rye residues retained on the soil surface release chemicals that inhibit germination and seedling growth of many grass and broadleaf weed species. Retention of residue on the soil surface can be accomplished by mowing after seed head formation.

Cover crops will perform best under good growing conditions, such as optimal temperatures, sufficient soil moisture, and adequate soil fertility. Practices, such as preparing an adequate seedbed; drilling seed or broadcasting and cultipacking; inoculating seed with the proper *Rhizobium* inoculant if using a legume; planting into sufficient soil moisture; correcting pH or soil fertility problems; and in some cases, controlling weeds with herbicides or mowing the cover crop in midseason, often further enhance cover crop performance. Access to appropriate equipment for incorporating the cover crop is also critical.

To be effective, cover crops should be treated as any other valuable crop on the farm, with their cultural requirements carefully considered including susceptibility, tolerance, or antagonism to root pathogens and other pests; life cycle; and mowing/incorporation methods. See Section 5.3 for more information on specific non-leguminous cover crops.

Use of cover crops in the row middles after hopyard establishment can have both beneficial and detrimental impacts so the choice of cover crop should be carefully considered. Care should be taken in the selection of a cover crop in established hopyards to minimize the competition for water and nutrients. In a four-year study in Western

Table 5.2.1. Non-leguminous cover crops: cultural requirements and crop benefits

Species	Planting Dates	Life Cycle	Cold hardi-ness zone	Tolerances[1]			pH Pref-erence	Soil Type Prefer-ence	Seeding Rate (lb/A)	Comments
				Heat	*Drought*	*Shade*				
Brassicas	April or late August to early September	Annual/ Biennial	6-8	4	6	NI	5.3-6.8	Loam to clay	5-12	• Good dual purpose cover & forage • Establishes quickly in cool weather • Biofumigant properties
Buckwheat	Late spring-summer	Summer annual	NFT	7-8	4	6	5.0-7.0	Most	35-134	• Rapid grower (warm season) • Good catch or smother crop • Good short-term soil improver for poor soils

Table continues on next page.

Chapter 7 – Pesticide Information

7.1 Pesticide Classification and Certification

The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) created two classifications of pesticides – general-use and restricted-use. **General-use pesticides** may be purchased and used by anyone. **Restricted-use pesticides can** only be purchased by a certified applicator. Restricted-use pesticides must also be used by a certified applicator or someone under their supervision.

The same federal law that classifies pesticides divided applicators into two groups: private and commercial. **Private applicators** use or supervise the use of pesticides to produce agricultural commodities or forest crops on land owned or rented by the private applicator or their employer. A farmer must be certified as a private applicator in order to purchase and use restricted-use pesticides on agricultural commodities. (No certification is needed if a farmer does not use restricted-use pesticides.)

A **commercial applicator** uses or supervises the use of pesticides for any purpose or on any property not covered by the private applicator classification. In New York, a commercial applicator must be certified to purchase or use any pesticide whether it is general- or restricted-use.

More information about pesticide certification and classification is available from your Cornell Cooperative Extension office (cce.cornell.edu/learnAbout/Pages/Local_Offices.aspx), regional NYSDEC pesticide specialist (www.dec.ny.gov/about/558.html), the Pesticide Applicator Training Manuals (store.cornell.edu/c-876-manuals.aspx), or the Pesticide Management Education Program (PMEP) at Cornell University (psep.cce.cornell.edu).

7.2 Use Pesticides Safely

Using pesticides imparts a great responsibility on the user to be a good steward of their health and that of others. Keep in mind that there is more to “pesticide use” than the application. Pesticide use includes mixing, loading, transporting, storing, or handling pesticides after the manufacturer’s seal is broken; cleaning pesticide application equipment; and preparation of a container for disposal. All of these activities require thoughtful planning and preparation. They are also regulated by state and federal laws and regulations intended to protect the user, the community, and the environment from any adverse effects pesticides may cause.

7.2.1 Plan Ahead

Many safety precautions should be taken *before* you actually begin using pesticides. Too many pesticide applicators are dangerously and needlessly exposed to pesticides while they are preparing to apply them. Most pesticide accidents can be prevented with informed and careful practices. **Always read the label on the pesticide container before you begin to use the pesticide.** Make sure you understand and can follow all directions and precautions on the label. Be prepared to handle an emergency exposure or spill. Know the first aid procedures for the pesticides you use.

7.2.2 Move Pesticides Safely

Carelessness in transporting pesticides can result in broken containers, spills, and contamination of people and the environment. Once pesticides are in your possession, you are responsible for safely transporting them. Accidents can occur even when transporting materials a short distance. You are responsible for a pesticide accident so take every effort to transport pesticides safely. Be prepared for an emergency.

7.2.3 Personal Protective Equipment and Engineering Controls

Personal protective equipment needs depend on the pesticide being handled. **Required personal protective equipment (PPE) are listed on pesticide labels.** These requirements are based on the pesticide’s toxicity, route(s) of exposure, and formulation. Label PPE requirements are the minimum that must be worn during the pesticide’s use. Pesticide users can always wear more protection than the label requires.

The choice of protective equipment depends on the activity, environment, and handler. The type and duration of the activity, where pesticides are being used, and exposure of the handler influences the equipment you should use. Mixing/loading procedures often require extra precautions. Studies show you are at a greater risk of accidental poisoning when handling pesticide concentrates. Pouring concentrated pesticide from one container to another is the most hazardous activity. More information on personal protective equipment can be found online at umes.edu/NC170/Default.aspx?id= 7184.

Engineering controls are devices that help prevent accidents and reduce a pesticide user’s exposure. One example is a closed mixing/loading system that reduces the risk of exposure when dispensing concentrated pesticides. More information on engineering controls can be found online at umes.edu/NC170/Default.aspx?id=7196.

7.2.4 Avoid Drift, Runoff, and Spills

Pesticides that move out of the target area can injure people, damage crops, and harm the environment. Choose weather conditions, pesticides, application equipment, pressure, droplet size, formulations, and adjuvants that

Chapter 8 – Sprayer Technology

8.1 Preparing the Airblast Sprayer for Work

8.1.1 Checking the Sprayer

Surveys have shown that many farmers are using inaccurate sprayers. Faulty sprayers contribute to increased drift levels and waste money through inefficiency and overuse of chemicals. For example, the cost of replacing a faulty pressure gauge that has been indicating at 15% below the actual pressure is recouped in around two hours' operation. Maintenance measures such as fitting a new set of nozzles at the beginning of each season also save money. Even when overdosing occurs by as little as 5%, the cost of a new set of nozzles would be recovered in less than a day's work. Sprayers must be checked over regularly to ensure that proper maintenance has been carried out and that no outstanding repairs need to be done. Before attempting any work on a machine, make sure that it is fully supported on stands and that all necessary protective clothing is on hand.

8.1.2 Fitting the Sprayer to the Tractor

The selected tractor must always be powerful enough to operate the sprayer efficiently under the working conditions that will be encountered. All its external services - hydraulic, electrical, and pneumatic - must be clean and in working order. Tractors fitting with cabs must have efficient air filtration systems. All protective guards must be in place. Trailed sprayers are often close-coupled to the tractor, so it is essential that the drawbar and the PTO shaft are correctly adjusted for turning. PTO shafts must be disengaged when making very tight turns.

CAUTION

- Take great care when adjusting a sprayer while the tractor engine is running.
- Always ensure that the fan is stationary before approaching the rear of the sprayer.
- Engage the handbrake when leaving tractor seat.

8.1.3 Checking the Operation of the Sprayer

Partially fill the tank with clean water and move the sprayer to uncropped waste ground. Remove the nozzles. Although you are not using any chemical at this point, get into the habit of wearing a coverall and gloves when working with the sprayer. Engage the PTO and gently turn the shaft, increasing speed slowly to operating revs. Test the on/off and pressure relief valves, and check the agitation system. Flush through the spray lines, and then switch off the tractor. Refit the nozzles and check the liquid system again for leaks.

It is a valuable exercise to assess the spray deposits at various points in the canopy and on upper and lower leaf surfaces of the bines to be sprayed. This is particularly important if the canopy foliage is dense. Water-sensitive papers or fluorescent tracers are available for this purpose. An increase in spray and air volume, or adjustment of the nozzles and their locations may be necessary in order to achieve the correct deposits.

8.1.4 Pre-season Maintenance

Use the following checklists before you begin spraying**:**

Hoses

- ✓ For splits and cracks.
- ✓ Connections to ensure they are water-tight.
- ✓ For hose chafe, particularly in routing clips.

Action:
Replace damaged hoses.

Filters

- ✓ For missing filter elements and seals.
- ✓ For leakage.
- ✓ For blocked or damaged filters.

Action:
Replace any damaged or blocked filters.

Tank

- ✓ For fractures and any other damage.
- ✓ That the tank sits firmly in its mount.
- ✓ That the securing straps are correctly adjusted.
- ✓ That the agitation is working.
- ✓ That the tank is clean.

Action:
See the supplier/manufacturer now about fractures and any other repairs.

Controls

- ✓ The control circuitry (electric or hydraulic) for correct operation.
- ✓ Valves for both internal and external leaks.

Action:
Replace leaky valves, which waste money and are potentially dangerous to operators and the environment.

Pump

- ✓ Lubrication levels.
- ✓ For leaks.
- ✓ That the air pressure in the pulsation chamber (if fitted) is at the recommended level.
- ✓ That the pump rotates freely without friction or noise. (Do so by rotating manually or starting at low speed, as corrosion may cause seizing up)

8.4.4 Boom Sprayer Calibration

-use clean water

Step 1. Check your tractor/sprayer speed

Formula: $\frac{\text{ft. traveled}}{\text{sec. traveled}} \times \frac{60}{88} = \text{MPH}$

Your tractor sprayer speed:

$$\text{MPH} = \frac{\text{ft. traveled}}{\text{sec. traveled}} \times \frac{60}{88} = \text{MPH}$$

Step 2. Record the inputs

	Your figures	Example
Nozzle type on your sprayer (all nozzles must be identical)	__________	110 04 flat fan
Recommended application volume (from manufacturer's label)	__________	20 GPA
Measured sprayer speed	__________	4 mph
Nozzle spacing	__________	20 inches

Step 3. Calculate the required nozzle output.

Formula: $\frac{\text{GPA X mph X nozzle spacing}}{\text{5940 (constant)}} = \text{GPM}$

Example: $\text{GPM} = \frac{20 \text{ X } 4 \text{ X } 20}{5940} = \frac{1600}{5940} = 0.27 \text{ GPM}$

Your figures: $\frac{\_\_\text{ X }\_\_\text{ X }\_\_}{5940} = \frac{\_\_\_\_}{5940} = \_\_\_\_\text{GPM}$

Step 4. Operate the sprayer

Set the correct pressure at the gauge using the pressure regulating valve.

Collect and measure the output of each nozzle for one minute. The output of each nozzle should be the approximately the same as calculated in Step 3 above.

Replace all nozzle tips that are more than 10% inaccurate.

8.5 Selecting Nozzles from the Nozzle Catalogue – Airblast Sprayers

We need to select hollow cone discs with a core or whirl plate.

Nozzle output is based upon gallons/acre required above.

$$\text{Gallons/minute} = \frac{\text{GPA X mph X row width in feet}}{495}$$

Where:
GPM = total sprayer output in gallons/minute

mph = travel speed in miles per hour

row width = width between rows of hops in feet

495 = a mathematical constant to correct units of measurement

Example 1

We wish to apply a 50 gallons/acre. We have an airblast sprayer with 5 nozzles each side and a comfortable forward speed for our ground conditions is 3.0 mph. **Rows are 12 feet apart.**

$$\text{Gallons/minute (GPM)} = \frac{\text{GPA X mph X row width in feet}}{495}$$

$$\text{Gallons/minute (GPM)} = \frac{50 \text{ X } 3.0 \text{ X } 12}{495} = \frac{1800}{495} = 3.64$$

$$\text{GPM} = \frac{3.64}{2} = 1.8 \text{ per side}$$

GPM per nozzle = 1.8 divided by 5 nozzles = 0.36

Using the hollow cone nozzle table in the Spraying Systems catalogues (Figure 8.5.1):

1. Read along the pressure row at the top of the table.
2. Read down the column for 150 psi until you read 0.34 GPM, look across to the left, you will see we can choose a D5 disc with a DC 23 whirl plate or core. Note we desire 0.36 GPM, so the same nozzles at 175 psi (midway between the 150 and 200 psi columns will give us our required amount.
3. Alternatively you may read down the column for 100 psi until you read 0.36 GPM, look across to the left and you will see we can choose a D3 disc with a DC45 whirl plate or core.

Example 2

We wish to apply a 100 gallons/acre. We have an airblast sprayer with 5 nozzles each side and a comfortable forward speed for our ground conditions is 3.0 mph. Rows are 12 feet apart.

$$\text{Gallons/minute (GPM)} = \frac{\text{GPA X mph X row width in feet}}{495}$$

8.11 Going Spraying!

Mixing Procedures

Safety and the Law

- Always remain alert; pesticides are potentially dangerous to the operator and the environment.
- Tractors and sprayers are dangerous machines and care should be taken when operating them.
- Always follow Federal and State laws concerning licensing of operators and handling, application and disposal of pesticides.

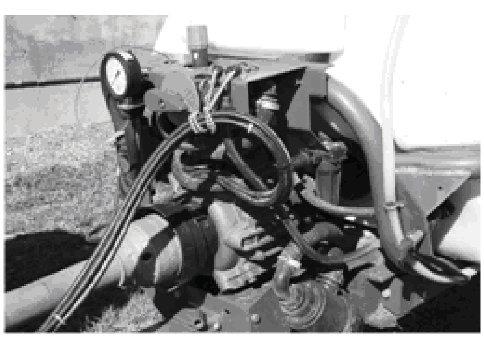
Always read the label for detailed application information and keep a record.


WORK REPORT
INSTRUCTIONS
DATE :
OPERATOR REPORT
NAME :
WEATHER

The seven P's of machinery management.

Proper prior planning prevents poor performance.

- Fill the tank on level ground per label instructions. If none are given, fill the tank half full with clean water.



- Prime the pump with water, if needed.

Table 9.7.3 Fusarium Canker management options.

Management Strategy	*Guideline*
Resistant varieties	There are no known resistant varieties
Cultural management	Fusarium canker is promoted by excessive moisture, high pH and high humidity around the crown of the plant. Choose a site with adequate drainage or install drainage prior to planting. Hilling up to the crowns will provide an area for rooting and reduce free moisture around the crown. Keep trickle irrigation to the side of the crown to avoid excessive moisture. Adjust th pH in acid soils to bring it back to the pH 6.0 to 6.8 range. Arching bines by tying them together approximately 6 foot above the crown will reduce sagging and provide more structural integrity, reducing the amount of wind damage to the bine. Care in cultivation, herbicide applications and timely management of insect feeding near the crown will help reduce entry sites for the fungus. Remove infected bines and plant material near the crown
Chemical treatment	No fungicides are labeled for use against Fusarium Canker

9.7.2 Virus and Viroid Diseases

The primary form of transmission of virus and viroid diseases in hops is through the propagation and planting of infected plants. The best way to keep these diseases out of a hopyard is to plant only clean plants produced from certified, virus-tested sources. Once established in a hopyard, all viruses and viroids can be transmitted mechanically during the implementation of standard cultural practices.

APPLE MOSAIC VIRUS (AMV) is considered to be the most important virus disease of hop around the world. Apple mosaic virus appears as chlorotic rings or arcs on the leaves that can become necrotic. These rings and arc often times will merge to create oak-leaf line patterns. Severity of symptoms has been shown to be dramatically affected by environmental conditions in the Pacific Northwest with symptoms typically most severe when a period of cool weather (temperatures below 80°F) is followed by higher temperatures. Hills infected by AMV can appear normal until the appropriate environmental conditions occur. Severe infection can cause cone and alpha acid yield to be reduced up to 50%. Apple mosaic virus is spread primarily through propagation of virus-infected plants so it is extremely important to purchase rhizomes, or plants, from certified, virus tested clean plants. Once established in a hopyard, AMV can be spread through mechanically and through root grafting. There are no known insect or mite vectors that transmit AMV. The rate of spread in a hopyard is dependent on hop variety, climatic conditions and farm management practices. The use of contact herbicides to control basal growth, rather than relying on mechanical means, my reduce movement of AMV to adjacent hills.

CARLAVIRUS COMPLEX: AMERICAN HOP LATENT VIRUS, HOP LATENT VIRUS AND HOP MOSAIC VIRUS are known to occur in mixed infections and all but the American hop latent virus (found primarily in North America) is found worldwide. Hop mosaic virus is the most likely to cause symptoms and crop loss through poor establishment in new plantings as well as reduced bine growth and failure of bines to attach to the string. Varieties most affected by Hop mosaic virus typically are those of the Golding type or those that have Golding parentage. In the Pacific Northwest, 15% reductions in yield have been linked to Hop mosaic virus with the most sensitive varieties showing up to 62% crop loss. Hop latent virus and American hop latent virus do not cause visually obvious symptoms on any commercial hop variety.

All three carlaviruses can be transmitted by the hop aphid, potato aphid and green peach aphid although this method is very inefficient. The primary means of transmission is through the propagation and distribution of virus-infected plants and rhizomes. As with Apple mosaic virus, spread within a hopyard is accomplished mechanically and through root grafting. Applications of insecticides against aphid populations do little to stop the introduction of these carlaviruses into a hopyard but can help to reduce their spread within the hopyard.

HOP STUNT VIROID (HSV) was confirmed in North American hops in 2004. The severity of symptoms caused by HSV is dependent on hop variant and the weather. It can take up to three to five growing seasons before visible symptoms of infection are seen which can lead to propagation and planting of infected root pieces. Symptoms of HSV are seen as a delay in early season with pale growth when compared to healthy tissue. As the season progresses, the length of internodes of infected bines are reduced by as much as two-thirds with the degree of stunting more severe under warmer conditions. As bines mature, development of lateral branches is inhibited leading to reduced yield through smaller cones and overall decrease in cone production. The only know pathways for transmission of HSV are through propagation of infected plants and mechanical transmission. Observations from the Pacific Northwest indicate that agricultural operations such as pruning, thinning, and mechanical leaf stripping are the primary mode of transmission once HSV has become established in a hopyard. Use of certified, virus tested, clean plants is the best option to limit the chances of HSV becoming established in a hopyard.

If HSV infections are found, and the number of infected plants is limited, they should be removed as soon as possible trying to remove as much root tissue as possible. Because of the long latent period before symptoms are seen, removal of

Table 9.8.4. Japanese beetle management options.

Management Options	*Guideline*
Scouting/Thresholds	In Midsummer, scout hopyard to determine the presence of Japanese Beetle. Scouting should be continued through the preharvest period.
Resistant Varieties	none
Cultural Management	Hopyards adjacent to pastures or large areas of sod are at higher risk of infestation by Japanese Beetle
Chemical Treatment	See table below for options.

Common Name	Resistance Group No.	Trade Name	Formulation[a]	Days to Harvest (PHI)	Restricted-Entry Interval (REI)	EPA Registration Number
🐝**Azadirachtin +** 🐝**pyrethrins**	3A	Azera Insecticide	EC	–	12 hours	1021-1872
🐝**Pyrethrin**	3A	PyGanic EC1.4	EC	Until dry	12 hours	1021-1771
	3A	PyGanic EC5.0	EC	0	12 hours	1021-1772

[a]Formulation abbreviation: EC = emulsifiable concentrate

🐝 Active ingredient meets EPA criteria for acute toxicity to bees.

JAPANESE BEETLES are distinguished by a metallic green abdomen and copper outer wings. Tufts of white hairs are arranged along the side of the ½-inch body and behind the wing tips. Adults cause damage by feeding on the foliage and occasionally the cones. There is one generation per year, with the peak of adult activity occurring in midsummer. Hopyards adjacent to pasture or large sod fields are particularly at risk from Japanese beetle as the Japanese beetle lay their eggs in these areas where the grubs feed on the grass roots. The use of pheromone baited traps has not been shown to be an effective means of managing Japanese beetle populations. The pheromone used in these traps is especially effective and has the ability to lure Japanese beetle adults from outside the area, potentially increasing the problem. PyGanic EC1.4 and PyGanic EC5.0 are the only insecticides registered for use on hops in NY that explicitly include Japanese beetle on the label. Some products with the active ingredient azadirachtin are labeled on hops and include generic beetles on the label and may provide some control of Japanese beetle.

9.8.2 Minor and Sporadic Insect Pests

ROOT WEEVIL (ALFALFA SNOUT BEETLE, BLACK VINE WEEVIL AND STRAWBERRY ROOT WEEVIL). The larval stage of various forms of weevil can be a significant pest to hop plants in the Eastern United States. Larvae are legless white grubs with tan heads. These larvae will overwinter 2 to 30 inches deep in the soil. They feed on plant roots throughout the winter with the most damage being done previous to the pupal stage, generally in April prior to emergence as adults in May. Once the adult emerges it comes out of the soil and begins feeding on the hop leaves. The weevil has a wide range of hosts, therefore the adult stage is not considered to be a significant pest to the hop plant. The adult weevil is capable of laying an average of 290 eggs in a season. (Baird, et al. 1992)

Weevils of most concern in the Northeast include the Alfalfa Snout Beetle, Black vine weevil, and Strawberry root weevil. Due to the weevils spending a majority of their lifecycle underground, conventional insecticide applications are rarely effective. If insecticides are used they should target the larval and adult stages that occur above ground.

Biological control using native entomopathogenic nematodes has been shown to be effective in controlling Alfalfa snout beetle in New York alfalfa fields. It is reasonable to expect that they will be effective in controlling the black vine weevil and strawberry root weevil as well.

Azadirachtin (best on early larval stages), thiamethoxam, bifenthrin, and bifenthrin + imidacloprid are labeled for chemical control as needed to control the Root Weevils. (See labels for specific directions.)

QUESTION MARK BUTTERFLIES (*Polygonia interrogationis*) get their name from their wings. The forewings of question mark butterflies are hooked. The upper side of the 2.25 -3 inch wings are red-orange with black spots. The color of the top of the hindwing changes depending on the time of year. In the summer, it is mostly black with a short tail, the winter form has a lot of orange and a longer, violet-tipped tail. The underside is light brown; the hindwings have a pearly-white question mark in the center, giving the butterfly its name. When the caterpillars appear, they must find a host plant to feed on. Caterpillar host plants include American and red elms; hackberry; hops; and nettles. Upon maturity, adult question mark butterflies will feed on rotting fruit, tree sap, carrion, and animal waste. Only if these are unavailable do they feed on milkweed and asters. Some adults will stay in the northern United States to hibernate, while others will migrate south.

Chapter 10 – Pesticide Index

Table 10.1. Fungicides labeled for use in hops.

Common Name	Resistance Group No.	Trade Name	Formulation[a]	Days to Harvest (PHI)	Restricted-Entry Interval (REI)	EPA Registration Number
Ametoctradin + dimethomorph	45, 40	*[NY]†Zampro	SC	7	12 hours	7969-302
***Bacillus amyloliquefaciens* strain D747**	44	Double Nickle 55	WDG	0	4 hours	70051-108
	44	Double Nickle LC	LC	0	4 hours	70051-107
***Bacillus subtilus* QST 713**	N/A	Serenade ASO	F	0	4 hours	69592-12
	N/A	Serenade Max	WP	0	4 hours	69592-11
***Bacillus pumilus* strain QST 2808**	N/A	Sonata	F	0	4 hours	69592-13
Boscalid + pyraclostrobin	7, 11	Pristine	DG	14	12 hours	7969-199
Basic copper sulfate	M1	Basic Copper 50W HB	D	0	48 hours	42750-168
	M1	Cuprofix Ultra 40 Disperss	DF	14	48 hours	70506-201
Copper hydroxide	M1	Champ DP Dry Prill	DG	14	48 hours	55146-57
	M1	Champ Formula 2 Flowable	L	14	48 hours	55146-64
	M1	Champ WG	G	14	48 hours	55146-1
	M1	Dupont Kocide 2000	DF	14	48 hours	352-656
	M1	Dupont Kocide 3000	DF	14	48 hours	352-662
	M1	Kentan DF	DF	14	48 hours	80289-2
	M1	Nu-Cop 3L	L	14	48 hours	42750-75
	M1	Nu-Cop 50DF	DF	14	48 hours	45002-4
	M1	Nu-Cop 50WP	WP	14	24 hours	45002-7
	M1	Nu-Cop HB	G	14	48 hours	42750-132
Copper octanoate	N/A	Cueva Fungicide Conc.	F	Up to day of harvest	4 hours	67702-2-70051
Copper oxychloride + copper hydroxide	M1	Badge SC	SC	14	48 hours	80289-3
Copper oxychloride + basic copper sulfate	M1	C-O-C-S WDG	G	0	48 hours	34704-326
Cuprous oxide	N/A	Nordox 75 WG	WG	14	12 hours	48142-4
Cyazofamid	21	Ranman	L	3	12 hours	71512-3-279
Cymoxanil	27	Curzate 60 DF	DF	7	12 hours	352-592
Dimethomorph	40	Forum	L	7	12 hours	241-427
Famoxadone + cymoxanil	11, 27	Dupont Tanos	DF	7	12 hours	352-604
Fosetyl al	33	Aliette	WDG	24	12 hours	264-516
Hydrogen dioxide+ Peroxyacetic acid	N/A	Oxidate	L	0	Until spray has dried	70299-12
Mandipropamid	40	Revus	L	7	4 hours	100-1254
Mefenoxam	4	Ridomil Gold SL	L	45	48 hours	100-1202
Metrafenone[c]	U8	Vivando	SC	3	12 hours	7969-284
Mineral oil	N/A	Drexel Damoil	oil	0[b]	4 hours	19713-123
	N/A	Biocover UL	oil	0[b]	4 hours	34704-806
	N/A	Glacial Spray Fluid	oil	0[b]	4 hours	34704-849
	N/A	Suffoil-X	EC	-	4 hours	48813-1-68539
	N/A	Omni Oil 6E	oil	0[b]	12 hours	5905-368