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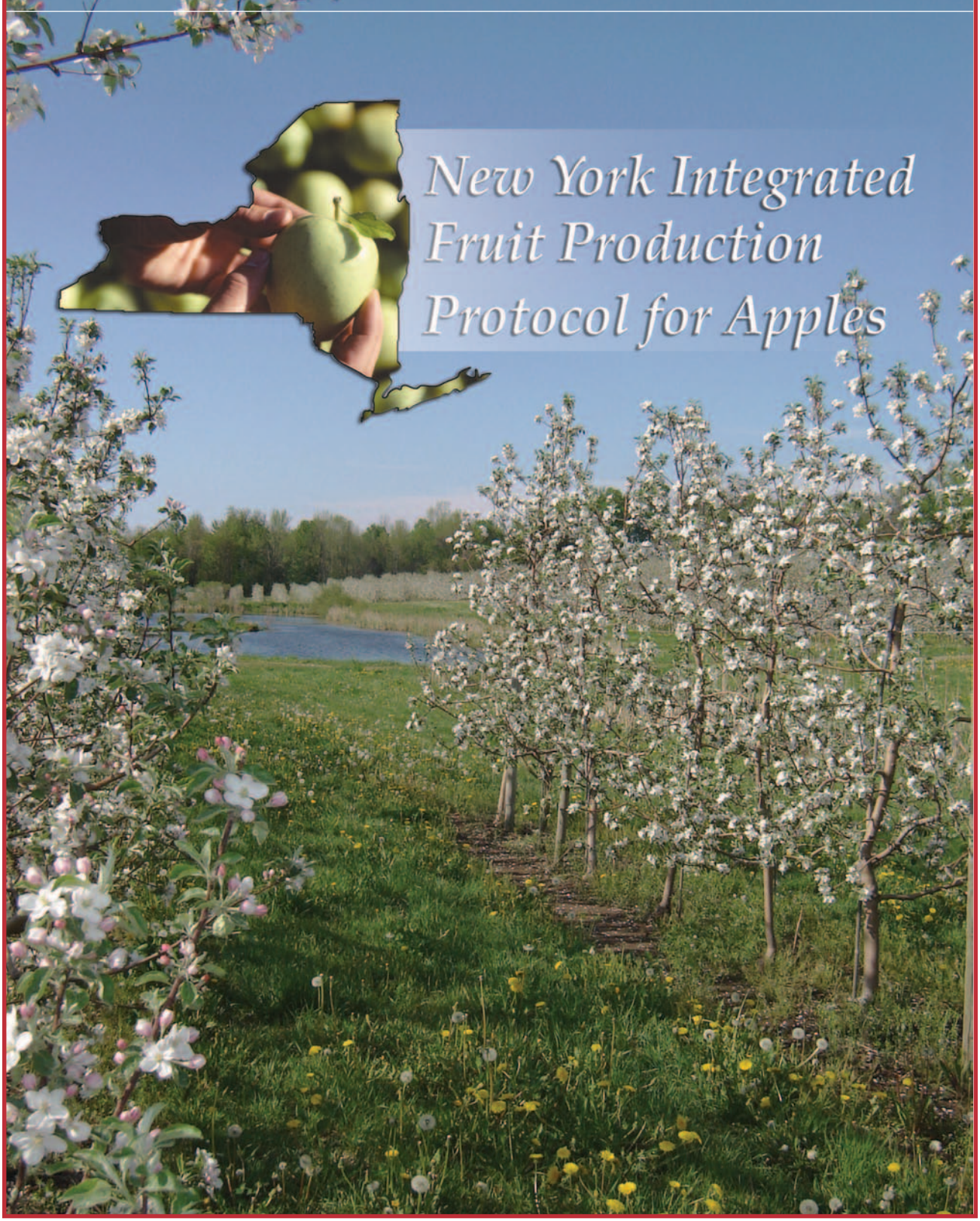

Contents

New York Integrated Fruit Production Protocol for Apples

Foreword

The New York (NY) apple industry developed a comprehensive strategic plan in 2001 calling for NY State apple growers to become the premier suppliers of high quality apples to domestic and foreign customers in a manner that is in harmony with the environment. Goals of the plan include improved NY yields, consistent fruit quality, enhanced marketing efforts and for Cornell to develop an integrated fruit production (IFP) program for apples to assure safe fruit and environmental conservation.

Fruit consumers and buyers are seeking environmental and food safety characteristics in the food they purchase. They want to have an assurance that the fruit and fruit products they consume are produced in an environmentally friendly manner, using a minimum of plant production chemicals leaving a minimum of residue on the fruit. In 2003, members of the Cornell University Tree Fruit Work Group developed an initial draft of this integrated fruit production (IFP) protocol for apples. It outlines eco-friendly insect, mite, disease, vertebrate and weed pest management, orchard establishment, training, fertilization and fruit thinning practices to assure apple buyers and consumers that NY apples are safe and are produced in an environmentally sound manner. Individuals from the Apple Research and Development Board, independent private consultants, packinghouse personnel, and growers then reviewed the initial draft and their comments were incorporated.

The NY-IFP protocol is a dynamic and flexible document. The fruit production environment is constantly changing. For instance, pests or diseases that a few years ago appeared to be innocuous suddenly can lead to serious crop losses. Therefore, the NY-IFP protocol will be capable of integrating new strategies that are justifiable and reconcilable with the principles of integrated fruit production as it addresses pest management, crop production, food safety, environmental conservation, and market preservation. Thus a yearly revision of the NY-IFP protocol is envisioned.

To assure consumers and apple buyers that NY apples are delivering on the promises of food safety and eco-friendly production as outlined in this NY-IFP protocol, interested members of the NY apple industry will need to develop internal controls and independent third party audits.

Acknowledgements

The Cornell University Tree Fruit Work Group of Cornell Cooperative Extension would like to acknowledge the contributions and input received from the apple industry in New York during the process of developing this publication. Specifically to those apple growers, independent private consultants, agri-chemical company crop specialists, storage operators, packers and shippers who provided their time to review and revise this document we extend our sincere appreciation. Funding was provided by the NYS Agricultural Experiment Station Competitive HATCH Funds; the Apple Research and Development Program; and the NYS Specialty Crops Program.

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I. Introduction

Terence Robinson, Dept of Horticultural Sciences

1. Definition of Integrated Fruit Production

Integrated Fruit Production (IFP) is defined as the economically successful production of high quality fruit with the best possible protection of the agroecosystem, human and domestic animal health, wildlife and the environment. Crop protection methods are preferred that keep the use of agrochemicals to a minimum.

2. Food Safety Protection

A primary goal of the IFP guidelines is the assurance of safe and healthy fruit for human consumption. This is accomplished by adherence to Good Agricultural Practices (GAP's) all along the food production chain; from the orchard, to the storage and packing plant to the grocery store. The NY-IFP guidelines incorporate GAP's from the Cornell GAP's program.

3. Conservation of the Orchard Environment

A second aim of IFP is conservation of the orchard environment, its habitats and wildlife. They must not be detrimentally altered nor polluted. As far as possible, a balanced and natural orchard environment with a diverse ecosystem of plants and animals must be created and conserved. Particular attention should be devoted to headlands, windbreaks, and water resources. Diversity of composition and structure should be the aim, using or encouraging native species where possible. NY-IFP orchards will benefit from the development and implementation of a professionally formulated conservation assessment and plan. The Agricultural Environmental Management program of the Soil and Water Conservation Districts, the Department of Environmental Conservation, and the USDA Natural Resources Conservation Service programs can provide assistance in this effort.

II. Integrated Production Measures

1. Site, Rootstock, Cultivars and Planting Systems

The establishment of a new orchard planting requires careful consideration of all components including site characteristics, the cultivar/rootstock combinations, and the planting system. The components should fit together in a harmonious fashion that is both economically and environmentally sound. Most importantly the planting system must produce sufficient quantities of high quality fruit to cover costs associated with production.

Michelle Leinfelder, Dept of Horticulture

A cover crop planted on the orchard site and incorporated into the soil will improve organic matter content while suppressing replant disease and weeds.

The new orchard should be situated on an appropriate site with excellent air drainage or proximity to a large body of water to minimize crop loss or damage due to winter cold or frost. Orchards on slopes should be planted with rows parallel to the slope contour where possible and groundcover should be quickly established between rows to prevent erosion. New orchards should not be planted near abandoned orchards and old orchards should be removed in a manner that minimizes soil erosion and compaction.

Site preparation should include crop rotation out of apples for at least one year. Planting a cover crop in the year before orchard establishment and incorporating the cover crop into the soil will improve soil organic matter content, suppress replant disease, weeds, and, depending on cover crop species, reduce nematodes (Table 1).

The cultivar or variety chosen should be of high quality, and have market appeal. As soon as available, the least susceptible, most tolerant or resistant varieties and rootstocks to insects, mites, or diseases should be chosen. Whenever possible, plant materials should be certified stock and true to type. Always choose varietal strains with well-known characteristics to avoid specific cosmetic sprays to correct deficiencies in color, size, fruit finish, etc. The variety chosen should be regular cropping and appropriate for the geographic area and the new orchard site.

Stephen Hoying, Lake Ontario Fruit Program

A high-density orchard planting system with individual tree stakes, planted with grass ground cover in the row middles.

Cultivar, rootstock and plant spacing should be selected with the objective of generating a compact yet open tree canopy volume to maximize light interception and fruit production. Starting with quality trees appropriate for the planting system and an appropriate plant spacing will minimize the need for severe pruning or chemical growth control. The entire volume of the tree must produce high quality fruit. An open canopy minimizes microclimatic conditions that favor insect infestation and disease development. The orchard system should be planted in single rows to minimize the weed suppression area requiring herbicide treatment and provide for optimum spray deposition in the canopy.

Table 1. Cover Crops and Rotational Crops Useful in Orchard Site Preparation

Cover or Rotation Crop	Organic Matter	Nematode Suppression	Weed Suppression	Areas of Concern
Sudan grass	Yes	Yes	Yes	When mature, tough to plow down.
Buckwheat	Yes	No	Yes	Mow or plow down before seed production.
Oilseed rape & other mustards	Yes	Only if tilled under green	Yes	Only certain varieties suppress nematodes and/or other pathogens.
Winter rye	Yes	No	Yes	Plow down or kill before it seeds.
Turfgrass	Yes	No	Yes	Preplant establishment can be useful.
Clovers, vetches, legumes	Yes	No	Yes	Good for green manure N source, plow down before it seeds.
Corn	No	No	Yes	Herbicide carryover could injure trees.

2. Soil Management, Tree Nutrition and Irrigation

Properly maintaining the soil structure, organic matter levels, fertility, soil fauna and micro-flora will help maintain healthy trees that more effectively resist pest problems. Nutrients and organic matter must be recycled where possible. Improving organic matter content of the soil helps maintain soil moisture and nutrients, contributing to more efficient water use, increased nutrient retention, and reduced non-point-source pollution from leached chemical fertilizers. Only the minimum quantities of fertilizers promoting high yields of quality fruit may be used, as justified by chemical analysis of soil or leaves. Thus over-fertilization should be avoided preventing loss of fruit quality, nutrient leaching into groundwater, risk of ground water pollution with nitrates and risk of estuary pollution from nitrates and phosphates. Preservation and conservation of water and soil resources must be maximized and non-point-source pollution must be minimized. The goal of fertilization and irrigation in integrated production is to minimize offsite nutrient losses, maintain soil nutrients within the optimal range, and to achieve this as far as possible through natural cycles while promoting yields of high quality fruit.

Ian Merwin, Dept of Horticulture

Soil on the new orchard site should be of good tilth with appropriate pH, organic matter, and nutrient content levels to minimize the need for excessive additions of fertilizer or lime before or after planting. Soil must be sampled and chemically analyzed prior to planting and pH and/or nutrient content deficiencies corrected. Soil depth should support a minimum of three feet of unrestricted root growth through berming, installation of drainage, deep ripping to eliminate hardpans, or a combination, done before planting.

Planting system with irrigation line. Within the tree row weed growth is suppressed, not eliminated, through May and June.

Terence Robinson, Dept of Horticultural Sciences

Trees are trained and pruned to achieve a balance between vegetative growth and cropping. Open canopies promote light, air and spray penetration.

The site should also be free of soil pathogens that would require soil sterilization. High populations of plant parasitic nematodes should be reduced prior to planting by the use of resistant cover crops (Table 1). Apple replant should be controlled with allelopathic cover crops, if possible. Moving replant tree rows into the previous orchard grass lanes has reduced replant disease symptoms on many rootstocks, and is recommended where feasible. Several of the Cornell-Geneva rootstocks (G30, G16, CG6210, CG4210, and others) have shown tolerance or resistance to apple replant disease, and are recommended for replant sites. If severe apple replant disease and/or high populations of plant parasitic nematodes persist after treatment with cover crops, preplant fumigation with approved soil fumigants is allowed only in the planting row.

After planting, soil must be analyzed for plant nutrient levels every 3 years and leaf tissue must be analyzed every year to determine nutrient and fertilizer requirements. A plan must be implemented to correct nutrient deficiencies by additions of fertilizer or soil conditioning agents, as warranted by the soil and leaf analysis results. Nitrogen requirements can also be judged by shoot length, fruit color and leaf color. Nutrient levels must be maintained within the range published in the *Cornell Pest Management Guidelines for Commercial Tree-Fruit Production* (www.nysaes.cornell.edu/ent/treefruit).

To limit groundwater contamination with nitrates and other nutrients, additions of fertilizer must consider the soil texture and organic matter content of the soil. To maintain tree nutritional status the maximum allowed additions *per year* are as follows: 100 lb N/acre, 50 lb P_2O_5/acre, 150 lb K_2O/acre, 50 lb MgO/acre and 4 lb B/acre. Applications of more than 50 lb N/acre must be split into two applications. The same rule applies to other major nutrient applications with high non-point-source polluting potential, such as phosphates. Nitrogen fertilizer requirements can be reduced substantially as soil organic matter content increases, as trees mature and fill their space in the orchard, and where irrigation is possible. The use of fertigation to deliver dilute fertilizer solutions precisely to the root zone is encouraged. Biomass fertilizers are desirable in integrated production because they increase organic matter and release nutrients over a longer term. The level of nutrients in biomass fertilizers should be determined and used to calculate the maximum amounts of biomass fertilizers to apply per year. Fertilizers, composts or manures contaminated with toxic or environmentally hazardous substances such as heavy metals or pathogenic-organisms, sewage sludge or sewage compost are not permitted under integrated production.

Irrigation can supplement natural rainfall to provide the optimum water needs of the tree. Trees must be supplied with adequate soil moisture to ensure balanced growth and high quality fruit. However, excessive soil moisture can result in root rots, root asphyxiation, poor fruit quality and nutrient leaching. Irrigation water should not be applied when soils are at or near field capacity. The rate of application of irrigation water should never exceed the infiltration rate of the soil to reduce runoff and soil erosion.

3. Tree Training and Crop Management

Trees should be trained and pruned to achieve a balance between vegetative growth and cropping. In addition, pruning should result in compact yet open canopies that allow light and spray penetration to the entire canopy. A balance between vegetative growth and fruit production will lead to regular cropping each year, high fruit quality and minimal pruning. Yearly growth of external extension shoots between 8 and 16 inches (20 and 40 cm) in length is desirable. Excessive growth should be controlled with cultural methods such as adjusting winter pruning, reducing nitrogen fertilization, allowing competition of orchard ground cover in the weed suppression strip, reducing irrigation, root pruning and/or limb renewal pruning. Excessive growth can also be controlled using plant growth regulators (see Appendix).

Regular yields of good quality fruit are essential for economic success of the commercial orchard. The most important management practice to achieve regular cropping each year and to avoid biennial bearing is fruit thinning. The most reliable method of controlling biennial bearing and maintaining good fruit quality is chemical fruit thinning. Naturally occurring plant growth regulators and synthetic analogs are preferred, but for very hard to thin varieties other products are allowed (see Appendix). Plant growth regulators can be used to enhance fruit quality, limit russetting, limit sunburn and control pre-harvest fruit drop. In addition, kaolin clay can be used to reduce russet and sunburn.

4. Integrated Pest Management (IPM)

The aim is to protect the tree and its fruit from weeds, insects & mites, diseases and animals using ecologically and economically sound management practices. This means that practices are chosen to enhance safeguards to the environment and human health while minimizing the unjustified use of agrochemicals. Priority is given to cultural, biological, and genetic management practices. Planting varieties and rootstocks that are resistant to major diseases such as apple scab, fire blight, powdery mildew, and Phytophthora root and collar rot, as well as woolly apple aphid is the first and best option. Sites should be selected that are distant from heavily wooded lots or hedgerows that contain plants that may serve as alternate hosts for pathogens or insect pests of concern; or alternate hosts can be removed, but not at the cost of destroying the habitat of native wildlife or compromising soil integrity that may promote soil erosion. Consult the *Elements of IPM for Apples in NYS*, that outlines the IPM practices for apples, beginning on page 9. It is also published online (www.nysipm.cornell.edu/elements/apple/).

Paul Curtis, Dept. of Natural Resources

A metal guard protects the tree trunk from vole damage. Such exclusion practices are preferred under IFP.

Elements of IPM for Apples in New York State

www.nysipm.cornell.edu/elements/apple

IPM Elements provide a basis for self-assessment of your apple IPM practices. Practicing 80% of all the Apple IPM Elements qualify a crop as "IPM-grown" (excluding those not applicable (NA) to your orchard).

I. Site, Rootstock, Cultivars and Planting Systems	Check if Practiced
1. Select new orchard sites that have good air drainage or proximity to large bodies of water for frost protection.	☐
2. Site selection should consider non-point-source pollution from orchard-applied fertilizers and agrochemicals and how soil type, slope, watersheds, and groundwater relate to surface runoff, tile drainage, and persistence in and leaching through the soil profile.	☐
3. Whenever possible, avoid selecting sites near abandoned orchards where pests and diseases can be harbored.	☐
4. Remove abandoned orchards to reduce sources of pest infestations and disease inoculum in a manner that minimizes soil erosion.	☐
5. Do not plant new apple orchards immediately after old apple orchard removal. Practice crop rotation out of apples for at least one year, or plant a cover crop (Table 1) in the year before planting and incorporate into the soil to improve organic matter content, suppress replant disease, weeds, and, depending on cover crop species, reduce nematodes.	☐
6. New orchards should include size-controlling rootstocks to improve spray coverage and reduce amount of spray material applied per tree row volume.	☐
7. Select apple rootstocks that are adapted to local soil conditions and resistant to Phytophthora root and crown rot and fire blight. Plant disease resistant cultivars that have market-appeal, as soon as they are available.	☐
8. Plant single rows to promote light penetration, air circulation, optimal spray coverage, and rapid drying.	☐
9. Establish groundcover between rows quickly to prevent erosion and suppress weeds.	☐

II. Soil Management, Tree Nutrition and Irrigation	Check if Practiced
1. New orchard soils should have good tilth and fertility, and adequate soil drainage should be provided to prevent root diseases and promote healthy root development.	☐
2. Before planting, chemically analyze new orchard soils and correct pH, phosphorus and potassium.	☐
3. Chemically analyze soil and leaf tissue at appropriate regular intervals and add fertilizer, either to (1) maintain tree nutritional status or (2) correct a nutrient deficiency, based on the soil or leaf analysis results and *Cornell Guidelines.* Keep records.	☐
4. To maintain tree nutritional status, add fertilizer, based on soil and leaf analysis results, and do not exceed the yearly maximum amounts of 100 lb N/acre, 50 lb P_2O_5/acre, 150 lb K_2O/acre, 50 lb MgO/acre and 4 lb B/acre.	☐
5. Apply all soil nitrogen in spring between bud break and 10 days after petal fall. Applications of more than 50 lb N/acre must be split into two or more applications, especially on soils with low cation exchange capacity.	☐
6. Balance nitrogen applications with tree growth to eliminate late summer and fall growth, to protect against the shoot blight phase of fire blight and winter injury.	☐
7. For irrigated orchards, use trickle or drip irrigation so that water quantity and placement minimizes disease development, optimizes water use, and minimizes erosion.	☐

III. Tree Training and Crop Management	Check if Practiced
1. Prune annually during the dormant season to promote light penetration, air circulation, optimal spray coverage and rapid drying; chip and recycle prunings in orchard middles with flail mower.	☐
2. Whenever spray coverage and pest management suffers from dense canopies, summer prune densely foliated, vigorous trees in a manner that does not negatively impact fruit size or finish.	☐
3. Use appropriate fruit thinning to promote annual bearing and improve management of sooty blotch, flyspeck, and obliquebanded leafroller.	☐

IV. Pest Monitoring, Forecasting, and Management	Check if Practiced
1 Alternate hosts for apple insect and disease pests near commercial orchards should be removed as much as is feasibly possible and in a way that preserves the habitat of native wildlife and soil quality.	☐
2. Regularly monitor pests (weeds, insects, mites, diseases & vertebrates) and their damage to assess their levels. Use visual assessments, pheromone traps, sticky traps, etc.	☐
3. Keep records of all monitoring information, sampling dates, pest or damage levels, trap catches, thresholds used for each block, etc.	☐
4. Base pesticide treatments against pests on established thresholds, pest forecast models, weather conditions, established presence of the pest, and history of damage in the orchard or on fruit at harvest. Consult *Cornell Guidelines.*	☐
5. Keep records of pesticide applications, including: date, time, weather, operator, sprayer, field identification (farm, orchard, block, rows – as applicable), targeted pest, pesticide name and EPA number, formulation, REI, PHI, rate applied, and number of acres treated. Computer software, such as *TracApple* (www.nysipm.cornell.edu/trac/), can streamline record-keeping.	☐
6. Keep detailed records of tree row volume (TRV) calculations whenever pesticide sprays are applied on this basis.	☐
7. Use only pesticides registered in NewYork State and approved for the target pest and crop. Consult NYS current product registrations at PIMS (pmep.cce.cornell.edu/pims/current).	☐
8. Among registered pesticides of comparable efficacy, base selection on the optimal combination of (1) being least toxic to humans, livestock, wildlife and the environment, (2) selectivity, having low toxicity to key natural enemies, (3) having shortest residual persistence in the environment, and (4) reasonable cost. A way to guide selection is to consider those with the lowest Environmental Impact Quotient (EIQ) (ipm.cornell.edu/nysipm/publications/eiq/) value or to use the Natural Resources Conservation Service Windows Pesticide Screening Tool, WIN-PST software available at www.wcc.nrcs.usda.gov/pestmngt/winpst.html.	☐
9. Apply insecticides, miticides, fungicides, bactericides and herbicides in accordance with resistance management program guidelines when using pesticides at risk for pest resistance development.	☐

A. Groundcover and Weed Management	
1. Manage groundcover in a manner to reduce soil erosion, nutrient runoff, and herbicide use.	☐
2. In the row middles, use close mowing to manage weeds.	☐
3. Eliminate broadleaf plants that harbor insect pests and virus diseases from sodded row middles by prudent use of selective, broadleaf herbicides.	☐
4. Maintain adequate weed suppression in the tree row in a strip less than one third the between row spacing or less than one fourth in irrigated orchards.	☐
5. Base herbicide rates and selections on weed surveys. Keep records.	☐
6. Keep records of location and identity of difficult to manage weeds.	☐

B. Insect and Mite Management *See Table 2 for Specific Practices*

1. Arthropod monitoring methods and thresholds should conform to Cornell Cooperative Extension New York State IPM Program guidelines. ☐
2. Use pheromone traps and phenological developmental models to inform management decisions for problem insects as necessary, such as obliquebanded leafroller, codling moth, oriental fruit moth, plum curculio, spotted tentiform leafminer, San Jose scale, apple maggot, etc. ☐
3. When applicable, mating disruption is used as a management tactic. ☐
4. Release and conserve predatory insects or mites by using selective pesticide programs. ☐
5. Sample fruit at harvest from blocks to assess and record damage levels of direct-feeding pests and optimize future management programs. ☐

C. Disease Management *See Table 3 for Specific Practices*

1. Cultural practices for disease management, where practical, should include removal of overwintering inoculum, pruning and removing cankers, and weed and canopy management to promote air circulation and rapid drying. ☐
2. Disease management, monitoring methods and thresholds should conform to Cornell Cooperative Extension New York State IPM Program guidelines. ☐
3. Use disease development and forecast models to inform management decisions for problem diseases as necessary, such as apple scab, fire blight, etc. ☐
4. Scout orchards for the shoot blight phase of fire blight. Prune out infections where practical and remove infected prunings and trees from the orchard. ☐
5. To preserve predatory mites, use EBDC fungicides (mancozeb, metiram, thiram and zineb) prior to bloom only or not at all. ☐
6. Sample fruit at harvest from blocks to assess and record disease levels and optimize future management programs. ☐

D. Vertebrate Management *See Table 4 for Specific Practices*

1. Use appropriate exclusion fencing (barrier, electric, invisible fencing with dogs), or exclusion netting, trunk guards, habitat manipulation, and orchard sanitation (eliminate dropped apples and brush) whenever possible. ☐
2. Reduce vole and rabbit populations with close and regular mowing of drive lanes, orchard middles, and surrounding fields to minimize available habitat and food sources. Eliminate unmowable areas within the orchard. ☐
3. Enhance natural predator populations (kestrels, owls, fox, etc.) by manipulating or providing habitat to assist with vertebrate management. ☐
4. Monitor for rodents to determine the need for rodenticides. When needed, apply rodenticides in bait stations, rather than broadcast treatments. ☐
5. Conduct vertebrate pest population reduction through shooting or trapping only as defined by New York State Department of Environmental Conservation regulations. ☐

V. Safe and Efficient Spray Application Methods — Check if Practiced

1. Use drift-reducing sprayers (tunnel, sensor, tower) or sprayers modified to direct the air (towers, deflectors, angled fans, side baffle plate, air induction nozzles). ☐
2. Select nozzles that optimize droplet size and don't create too many fine droplets. Nozzles must point towards the target canopy. ☐
3. Use buffer zones near water, neighboring crops, properties and other sensitive locations. ☐

V. Safe and Efficient Spray Application Methods, cont.	Check if Practiced
4. Spray only when wind, temperature and humidity conditions are suitable for spraying.	☐
5. Inspect, maintain, and calibrate crop and herbicide sprayers once per year, or more often if needed, to ensure mechanical reliability and accurate spray delivery. Keep records as described in the *Orchard Spraying* website (www.nysaes.cornell.edu/ent/faculty/landers/pestapp/apple.htm).	☐
6. Sprayers should only be operated by certified applicators, as defined by New York State Department of Environmental Conservation regulations, wearing appropriate personal protective equipment (PPE).	☐
7. Sprayer application records should include details of the sprayer such as nozzles fitted, pressure, forward speed and application rate.	☐
8. Thoroughly clean sprayers after use or between different product applications.	☐

VI. Harvest and Fruit Storage	Check if Practiced
1. Bins of harvested fruit should not be left in the orchard overnight.	☐
2. Remove any soil and sod stuck to bin runners prior to stacking bins of fruit.	☐
3. Use a sanitation system to kill bacteria, yeasts, and fungal spores in water flumes.	☐
4. As bins are emptied on the packing line, any decayed fruit left inside the bins are removed and trashed.	☐
5. Remove empty bins from the packing area as soon as possible to prevent their contamination with airborne spores.	☐
6. Remove culled fruit and other debris from the packing area and from the packing house floors daily.	☐

VII. Post Harvest Treatments	Check if Practiced
1. Use postharvest drench treatments only when such treatments are essential for controlling superficial scald or carbon dioxide injury.	☐
2. Whenever possible, apply calcium treatments as field sprays rather than as postharvest treatments.	☐
3. Fit drencher reservoir tanks with appropriate agitation systems to keep postharvest treatment chemicals in suspension and regularly change solutions as per the chemical label.	☐
4. Remove all solid residues from the bottom of the drencher reservoir tank before the tank is refilled.	☐

VIII. Education of Growers and Employees	Check if Practiced
1. Attend two or more regional or national tree fruit meetings or conferences.	☐
2. Maintain membership in an appropriate grower association and in a local county Cornell Cooperative Extension Association.	☐
3. Have access to the current year's copy of the *Cornell Pest Management Guidelines for Commercial Tree-Fruit Production* (www.nysaes.cornell.edu/ent/treefruit).	☐
4. Participate in an IPM extension/research project.	☐

Deborah Breth, Lake Ontario Fruit Program

Monitor insect populations with sweep nets, sticky cards or pheromone traps.

In IFP systems, pests (weeds, insects, mites, diseases and vertebrates) and their damage must be monitored regularly and recorded. Scouting methods must be based on scientifically sound principles appropriate to the region or locality. The decision to treat or not must be based on established thresholds or through the use of forecasting. Where thresholds or forecasters do not exist, treatment must be based on, at least: (1) the established presence of the pest as determined via scouting; (2) historical or consistent observations of injury in the orchard or to fruit at harvest; or (3) environmental conditions that promote the proliferation of the pest population.

Major Pests of Apple in New York

Insects	Diseases	Weeds
American plum borer	Apple rusts	Annual broadleaves
Apple aphid	Apple scab	Annual grasses
Apple maggot	Bitter rot	Nutsedge
Apple rust mite	Black rot	Perennial broadleaves
Codling moth	Blister spot	Perennial grasses
Comstock mealybug	Blossom end rot	Woody perennials
Cutworm	Crown & collar rot, Phytophthora	
Dogwood borer	Fire blight	
European apple sawfly	Nectria twig blight	
European corn borer	Nematodes	
European red mite	Powdery mildew	
Green fruitworms	Sooty blotch & flyspeck	
Internal lepidopterans	Senescent breakdown	
Lesser appleworm	Storage rots	
Mullein plant bug	White rot	
Oriental fruit moth		
Oystershell scale		
Plum curculio		
Potato leafhopper		
Rosy apple aphid		
San Jose scale		
Sparganothis fruitworm		
Spirea aphid		
Spotted tentiform leafminer		
Tarnished plant bug		
Two spotted spider mite		
Variegated leafroller		
White apple leafhopper		
Woolly apple aphid		

Ian Merwin, Dept of Horticulture

A weather station located in the orchard provides information on temperature, rainfall, relative humidity, leaf wetness, etc. to alert you when conditions are favorable for pest outbreaks.

Ian Merwin, Dept of Horticulture

Straw mulch within the tree row can suppress weeds and provide support for vole bait stations.

Deborah Breth, Lake Ontario Fruit Program

Composted bark mulch within the tree row suppresses weeds and close mowing of the drive lanes minimizes vole populations.

In IFP systems, the use of agrochemicals is permitted and should be governed by the absence of an economically viable non-chemical alternative. Pesticides should be applied according to their need as determined using sound IPM strategies, which include scouting, monitoring, trapping and forecasting to determine if and when a pesticide is needed. Agrochemicals should provide excellent to good control of the target pest and be selected based on the optimal combination of (1) being least toxic to humans, livestock, wildlife, and the environment; (2) selectivity, having low toxicity to key natural enemies; (3) having shortest residual persistence in the environment; and (4) reasonable cost. A way to guide selection is to consider those with the lowest Environmental Impact Quotient *EIQ* value or to use the Natural Resources Conservation Service Windows Pesticide Screening Tool, *WIN-PST* software.

In the NY-IFP Appendix, available pesticides identified as meeting the above criteria are in the "green list". Pesticides available for use with restrictions or areas of concern are in the "yellow list". All other products are not permitted ("red list") and are therefore not listed in this document. The following criteria were taken into account in the classification of pesticides into the green, yellow, or red categories: effectiveness, toxicity to humans, toxicity to natural enemies, toxicity to other non-target organisms, pollution of ground and surface water, tendency to stimulate pest increases, target pest selectivity, environmental persistence, incomplete information on environmental fate or non-target effects, and necessity of use.

Pesticides must be used in a manner that does not promote the development of resistance in the target organism. Some general anti-resistance strategies include: (1) use pesticides only when necessary to avoid economic loss or crop injury; (2) use fungicides in a protective rather than a kickback or after-infection mode; (3) where applicable, use tree row volume (TRV) calculations; use the highest labeled rate of a fungicide; however, for arthropods, do not inflate rates beyond those necessary for acceptable control; (4) use spray schedules that incorporate pesticides with different modes of action; (5) regularly calibrate your sprayer; (6) apply pesticides with enough water to ensure adequate coverage; and (7) adjust sprayers to direct spray on to the target (i.e., reduce spray drift).

A. Ground Cover and Weed Management

The goal of ground cover management is to reduce soil erosion and nutrient runoff that contaminates surface water sources and to minimize the use of herbicides (avoiding residual herbicides completely). Secondarily, the aim of groundcover management is to maintain ecological stability and species diversity. Overall bare soil management of orchards is not permitted. Alleyways must be of grass and/or herb mixtures of adequate width to accommodate tractor traffic.

A weed suppression strip can be maintained along the tree row either by herbicides or by the use of mulch or by mechanical cultivation. The width of the weed suppression strip cannot exceed 33% of the between row spacing in un-irrigated orchards or 25% in irri-

gated orchards. When trees are more vigorous than desired, the width of the weed suppression strip should be reduced or eliminated but care must be taken to supply sufficient water to maintain fruit size. It is not necessary to maintain completely weed free strips in the tree row for the entire year. Weed control is most important in May and June. Later in the season some surface vegetation in the strips is desirable. Herbicides are not allowed during the period of one month before harvest. A list of approved herbicides is included in the Appendix.

Biomass mulches of wood chips or bark in the weed control strip can suppress weed growth, reduce the need for irrigation, improve soil quality, and provide a long-term source of nutrients. Close mowing of the orchard drive lanes during summer and fall will help to limit reproduction of field mice or voles. Mechanical cultivation of the weed suppression strip is also an alternative weed control practice as long as tree injury and soil erosion do not occur.

Arthur Agnello, Dept of Entomology

Woolly apple aphid populations build from July when nymphs begin to move to terminals.

B. Insect & Mite Management

Populations of key natural enemies (e.g., phytoseiid mites) must be preserved. This should be achieved through management practices that encourage their natural build-up or, when practical, through artificial introductions, as in the case of predatory mites. Many action thresholds are based on degree day (DD) calculations that are available from the Network for Environment and Weather Awareness (NEWA) (newa.nysaes.cornell.edu), weather monitoring equipment, other sources of weather data, or calculated from daily maximum and minimum temperatures. Lists of approved insecticides and miticides are included in the Appendix. Insect and mite monitoring activities and thresholds are given in Table 2 (pages 16-18) for the most common arthropod pests of apple.

NYSAES

Red sticky sphere traps to monitor apple maggot flies.

C. Disease Management

Cultural practices for disease management should be used where practical and include orchard or field sanitation to remove overwintering sources of inoculum, pruning and removal of cankered limbs to reduce inoculum pressure, and weed and canopy management to facilitate air circulation and promote rapid drying of plant tissues. Planting sites should be chosen that have adequate soil drainage, either naturally or through the installation of drainage tiles. Varieties and rootstocks should be chosen, where practical, that have some level of tolerance or resistance to diseases. Disease forecasting, spray timing and scouting are crucial aspects of disease management in apples. Many action thresholds are based on degree day and forecast models that are available from the Network for Environment and Weather Awareness (NEWA) (newa.nysaes.cornell.edu), weather monitoring equipment, or other weather sources. Lists of approved fungicides, bactericides and soil fumigants are included in the Appendix. Disease management activities are given in Table 3 (pages 18-21) for the most common diseases of apple.

Deborah Breth, Lake Ontario Fruit Program

Nectria twig blight can mimic fire blight infection – look for orange Nectria spore masses on the bark.

D. Vertebrate Management

Close and regular mowing of orchard drive lanes and surrounding fields to minimize available protective habitat and food sources during the growing season is essential to reduce vole and rabbit populations. Enhancing natural predator populations (kestrel, owl, hawks, fox, etc.) by manipulating or providing habitat will assist with vertebrate management, but cannot be relied upon to provide control during vole outbreaks. In areas prone to deer

Paul Curtis, Dept. of Natural Resources

A seven-wire slant fence used to exclude deer from the orchard.

damage, 8-ft-high (2.5 meter) barrier fencing should be considered in orchard establishment costs for long-term (20+ years) protection of fruit trees. Always monitor orchards for vertebrates and their damage. Approved vertebrate control chemicals are included in the Appendix. Table 4 (pages 21-22) lists the mitigation procedures preferred under IFP practices for specific vertebrate pests of apple, categorized into green and yellow methods.

Table 2. Insect & Mite Monitoring and Thresholds
(Sampling forms available at www.nysipm.cornell.edu/publications/apple_man/)

Pest	Activity	Suggested Action Threshold
Apple Maggot (AM)	Volatile-baited sphere traps used to determine need for sprays. Monitoring AM is warranted primarily in orchard blocks without a reliable history of either very light or very heavy AM pressure, or where the likelihood of economic infestation is variable from year to year. In such blocks, monitoring the edge adjacent to the most likely source of immigrating flies is recommended. Place 2 to 3 baited red sticky spheres in each block to be monitored (about 10 to 15 acres in size). Traps have a short range of 10 to 15 meters and AM is unevenly distributed among orchards. Apply an appropriate insecticide within 2 days when an average of 5 flies per trap are exceeded. Resume checking traps 10-14 days after insecticide application.	Avg. 5 adults / trap. *Apple Maggot Monitoring Form* ***(forms available on NYS IPM website)***
Codling Moth (CM)	Pheromone traps used to monitor 1st generation flight. Biofix reached on date of first sustained trap catch. Daily max and min temperatures are monitored from biofix date forward and the 50°F DD model is used to time sprays for 1st and 2nd generations. Weather data and DD calculations are available from NYS IPM NEWA (newa.nysaes.cornell.edu). ***Serious damage caused by codling moth larva, one of the internal lepidopteran pests of apple.*** NYSAES	1st gen: 250 to 360 DD base 50°F after 1st catch biofix. 2nd gen: 1260 to 1370 DD. 
European Red Mite (ERM)	Monitor for and maintain knowledge of predatory mite populations and past history of ERM. Spurs examined for overwintered eggs. In summer, from mid June to mid August, leaves sampled for motiles. Record the number of motiles per leaf.  NYSAES ***Predatory mites feed on European red mites providing effective biological control.***	Overwinter: 10% spurs with eggs. Summer: 2.5 to 7.5 motiles/leaf. *ERM June Sampling Form* *ERM July Sampling Form* *ERM August Sampling Form* ***(forms available on NYS IPM website)***

Table 2. Insect & Mite Monitoring and Thresholds, cont.

Pest	Activity	Suggested Action Threshold
Green Apple Aphids (GAA)	Terminals inspected for infestations and predators during the growing season. Record the percent infested terminals and the percent of infested terminals with aphid predators.	30 to 40% infested, or 50% infested and <20% with predators.
Mullein Plant Bug	Flower-bearing shoots tapped over beating tray for nymphs.	10 nymphs / 40 limbs
Obliquebanded Leafroller (OBLR)  NYSAES *Damage by obliquebanded leafroller feeding on areas where fruit press together.*	Pheromone traps used to monitor 1st summer generation flight. Biofix reached on date of first sustained trap catch. Daily max and min temperatures are monitored from biofix date forward and the 43°F DD model used to time sprays. OBLR sprays for summer brood can be based on past history of fruit damage. **In low-risk blocks** with no prior history of OBLR damage, inspect fruit clusters or expanding terminals for 3rd instar larvae approximately 600 DD base 43°F after biofix. Record the percent of clusters infested with live larvae. **In high-risk blocks** with past history of OBLR damage, time sprays for egg hatch at 360 DD base 43°F after biofix date. Weather data and DD calculations are available from NYS IPM NEWA (newa.nysaes.cornell.edu).	**Low risk blocks:** 3% infested. *OBLR 3% Sampling Form* ***(forms available on NYS IPM website)*** **High risk blocks:** 360 DD base 43°F after 1st catch biofix.
Oriental Fruit Moth  NYSAES *Oriental fruit moth larva, another internal lepidopteran pest, and associated damage.*	Pheromone traps used to monitor 1st generation flight. Biofix reached on date of first sustained trap catch. Daily max and min temperatures are monitored from biofix date forward and the 45°F DD model used to time sprays for the 1st and 2nd generations. Routinely monitor traps for moths and orchards for damage (OFM 45°F DD model in research-mode). Weather data and DD calculations are available from NYS IPM NEWA (newa.nysaes.cornell.edu).	1st gen: 350 to 375 DD base 45°F after first catch biofix. 2nd gen: 1450 to 1500 DD.  Arthur Agnello, Dept of Entomology *Frass at the calyx end are signs of internal lepidopteran feeding.*
Plum Curculio  NYSAES *Plum curculio oviposition scars mar fruit.*	Classify blocks for plum curculio (PC) risk based on past history of fruit infestation. In low-risk blocks, apply a single spray at petal fall. In high-risk blocks, protect fruit at petal fall and apply subsequent sprays to maintain protection until 340 DD base 50°F after the petal fall date. 50°F degree day model used to terminate sprays. Weather data and DD calculations are available from NYS IPM NEWA (newa.nysaes.cornell.edu).	Stop sprays 340DD, base 50°F, after petal fall date.
Rosy Apple Aphid	Fruit clusters examined at pink for RAA nymphs.  NYSAES *Monitor fruit clusters at pink for rosy apple aphid nymphs.*	1% infested clusters.

Pest	Activity	Suggested Action Threshold
San Jose Scale	Daily max and min temperatures are monitored from March 1 forward and the 50°F DD model used to time monitoring or sprays against crawlers. Monitor with sticky tape around limb. Weather data and DD calculations are available from NYS IPM NEWA (newa.nysaes.cornell.edu).	1st gen: 500 DD base 50°F after March 1. 2nd gen: 1451 DD. 1-2 crawlers/trap.
Spotted Tentiform Leafminer  Arthur Agnello, Dept of Entomology *Severe damage by spotted tentiform leafminer can deplete a tree's photosynthetic reserve and reduce yield.*	For 1st generation, examine fruit cluster leaves for eggs or sap-feeding larvae. For 2nd generation, starting in July, examine mature terminal leaves for sap-feeding larvae. Alternatively, start sampling for 2nd generation based on 43°F DD model. Use pheromone traps to monitor 2nd generation flight. Biofix reached on date of first sustained trap catch. Daily max and min temperatures are monitored from biofix date forward and the 43°F DD model used to time start of 2nd gen sampling.	1st gen: 2 eggs per leaf, or 1 mine per leaf. *STLM Pink Sampling Form* *STLM Petal Fall Sampling Form* 2nd gen: 2 mines per leaf. *STLM Summer Sampling Form* Start sampling 690 DD base 43°F. ***(forms available on NYS IPM website)***
White Apple Leafhopper	Fruit cluster or terminal leaves inspected for nymphs (also rose leafhopper).	1 nymph per leaf.

DD – degree days
Consult *Cornell Pest Management Guidelines for Commercial Tree-Fruit Production* (www.nysaes.cornell.edu/ent/treefruit/) for further information.

Table 3. Disease Forecasting and Monitoring

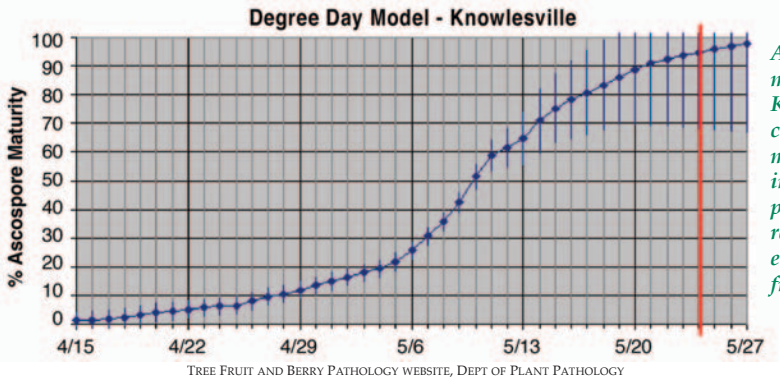
Disease	Activity
Apple scab  David Rosenberger, Dept of Plant Pathology *Apple scab lesions on fruit and leaves of Jerseymac.*	Give special attention to protecting trees from the first significant infection period. Time sprays based on modified Mills table & weather, rain forecasts, tree phenology and ascospore maturity (squash mounts or the 32°F DD model). Time subsequent sprays ahead of rains to control primary scab until 2 wks after petal fall. Weather data and DD calculations are available from NYS IPM NEWA (newa.nysaes.cornell.edu). Record spray dates and infection periods. Scout regularly for primary scab, base further sprays on scouting results. Conduct PAD counts, if below threshold consider a delayed spray program. To reduce over-wintering inoculum, flail mow and/or treat with urea to degrade leaf litter.  Tree Fruit and Berry Pathology website, Dept of Plant Pathology *Apple scab degree day model chart for Knowlesville weather collected by NEWA. The model provides information on the proportion of ascospores released from leaf litter each spring beginning from green tip.*

Table 3. Disease Forecasting and Monitoring, cont.

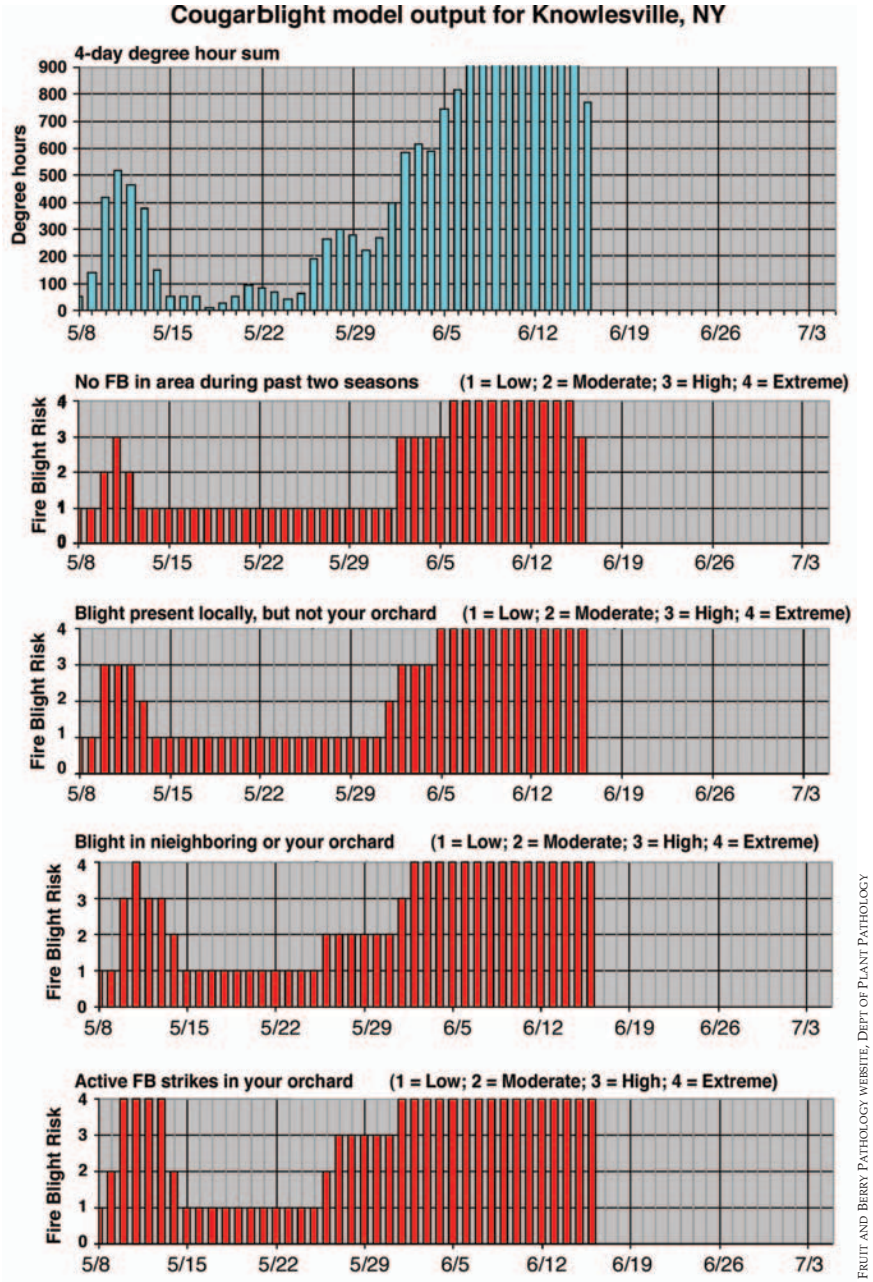
Disease	Activity
Fire blight	Apply copper at green tip if history of fire blight and / or highly susceptible varieties. Time streptomycin sprays for the blossom blight phase of fire blight using MARYBLYT©, Cougarblight, or CCE or advisor alerts. Weather data are available from NYS IPM NEWA (newa.nysaes.cornell.edu). Scout after bloom and prune out infected shoots. After bloom, streptomycin is only applied after a summer hailstorm and only in orchards where fire blight is present or is present in nearby blocks. Choose fire blight resistant varieties and rootstocks as soon as available.

David Rosenberger, Dept of Plant Pathology

Fire blight bacteria can travel down the tree from blossom and shoot infections to infect the rootstock and kill the tree.

David Rosenberger, Dept of Plant Pathology

The shoot blight phase of fire blight can occur during summer, particularly following hail or wind damage to trees.



Tree Fruit and Berry Pathology website, Dept of Plant Pathology

Cougarblight chart for Knowlesville weather collected by NEWA. This fire blight risk-assessment model charts the relative risk of blossom blight infection beginning from first blossom open.

Table 3. Disease Forecasting and Monitoring, cont.

Disease	Activity
Powdery mildew	Time mildewcide* at tight cluster if history of powdery mildew, highly susceptible varieties, mild winters &/or flag shoots. Only apply sprays targeted specifically for powdery mildew from tight cluster until the cessation of terminal growth. Strobilurin fungicides preferred for prebloom sprays. Scout susceptible varieties routinely to monitor spread and the need for treatment. Record the date of cessation of terminal growth.
Apple rusts	If there is history of apple rust, time sprays to cover infection events from pink until 2 to 3 wks after petal fall. If practical and where disease pressure is high, remove nearby *Juniperus* spp. (red cedars, junipers) alternate hosts.
Sooty blotch and flyspeck	These diseases develop gradually during periods of high humidity. Prune, train, and thin to open tree canopy and fruit clusters. Where feasible, remove wild *Rubus* spp. (blackberry, raspberry) alternate hosts from orchard perimeters. Begin sprays after 250 hr of accumulated leaf wetting counted from petal fall. Maintain coverage to within 30 days of harvest whenever disease pressure is high and weather is humid, rainy and cloudy.
Frog-eye leaf spot Black rot on fruit	Most scab sprays are effective against frog-eye leaf spot. For black rot on fruit and when disease pressure is high, apply effective fungicides during the 2-6 wk period after petal fall and during the preharvest ripening period, especially in wet years. Fungicides are ineffective on canker phase of disease; prune out cankers to minimize spread of the disease to leaves, fruit and shoots.
White rot	Like black rot, critical periods for preventing white rot fruit infections are the 2-6 wk period after petal fall and the preharvest ripening period.

David Rosenberger, Dept of Plant Pathology

Scout orchards for characteristic powdery mildew flag shoots and manage the disease from tight cluster through the cessation of terminal growth.

David Rosenberger, Dept. of Plant Pathology

Rust infection sporulating (left) and causing discoloration and deformity (right) on fruit.

Deborah Breth, Lake Ontario Fruit Program

Flyspeck, a summer disease favored by rainy and humid weather.

Table 3. Disease Forecasting and Monitoring, cont.

Disease	Activity
Phytophthora root rot	Establish orchards on well-drained sites and on resistant rootstocks. Avoid moderately to highly susceptible rootstocks (e.g. MM 106). In very wet years and/or in high risk orchards, scout in summer when trees are stressed and treat symptomatic trees.
Bitter rot	Scout for infection mid to late summer, especially following unusually hot, wet weather. If infections are found and wet, warm weather is forecast, apply captan at highest labeled rate before rain.
Storage decays	Sanitize field bins, storage rooms, and packinghouses at the end of each storage season. With good sanitation, no postharvest fungicide is needed after harvest if fruit is kept dry. If fruit are treated with DPA, an effective fungicide should be included in the solution. On the packing line, water flumes should be chlorinated to prevent dissemination of spores.

* Apple scab resistance to DMI fungicides such as Nova, Procure, or Rubigan, applied for powdery mildew, is known to occur in New York. Therefore, it may be necessary to tank mix a fungicide with a different mode of action for control of apple scab, particularly during critical timings such as tight cluster and pink.

DD – degree days
Consult *Cornell Pest Management Guidelines for Commercial Tree-Fruit Production* (www.nysaes.cornell.edu/ent/treefruit/) for further information.

Table 4. Vertebrate Damage Mitigation Practices

Animal Pest	Preferred Practices Under IFP
Beaver	Wire trunk guards, exclusion drift fencing.
Birds	Netting; visual scare device (eye-spot balloons, silhouettes, reflective tape); auditory frightening device (recorded alarm calls, pyrotectics, propane cannon).
Rabbits	Exclusion fencing (individual wire guards or 2 ft. (60 cm) high area exclusion fencing); habitat manipulations including removal of brush piles & protective cover within orchards.
Raccoons	Electrified exclusion fencing.
Voles	Wire trunk guards; close mowing of orchard middles; vegetation reductions (<40% ground cover) under trees; removal of dropped apples and prunings; habitat manipulations including elimination of unmowable areas within orchards; monitor to determine the need for rodenticides.
White-Tailed Deer	Exclusion fencing (8 ft. (244 cm) high-tensile woven wire or 5 to 6 ft. (152 to 183 cm) electric exclusion fencing; peanut-butter baited electric fences; invisible fencing with dogs); habitat manipulation including elimination of protective cover within orchards.
Woodchucks	Exclusion fencing (individual wire guards or electrified exclusion fencing); habitat manipulation including removal of brush piles within orchards.

Table 4. Vertebrate Damage Mitigation Practices, cont.

Animal Pest	Practices where Restrictions and Caution Apply*
Beaver	Population reduction through trapping by licensed trapper or licensed nuisance wildlife control agent.
Birds	Population reduction through shooting by licensed hunter of permitted species in appropriate season (crows, turkeys); or unprotected species (European starlings, English sparrows, pigeons).
Rabbits	Population reduction through shooting by licensed hunters or landowners in appropriate seasons; through trapping by landowner or by licensed nuisance wildlife control agent.
Raccoons	Population reduction through shooting by licensed hunters or landowners in appropriate seasons; through trapping by landowner, by licensed trapper, or by licensed nuisance wildlife control agent.
Voles	Population control through trapping by landowner.
White-Tailed Deer	Population reduction through shooting by licensed hunters, landowners or their agents with nuisance deer permits.
Woodchucks	Population reduction through shooting by licensed hunters or landowners; through trapping by landowner or by licensed nuisance wildlife control agent.

* Conduct shooting and trapping only as defined by New York State Department of Environmental Conservation regulations. Shooting for nuisance wildlife control is allowed only when neighboring occupied buildings are >500 ft. distant; shooting when neighboring buildings are less than 500 ft. distant requires neighbor permission. Also check local ordinances, as shooting and trapping are prohibited in some areas.

Consult *Cornell Pest Management Guidelines for Commercial Tree-Fruit Production* (www.nysaes.cornell.edu/ent/treefruit/) for further information.

PAUL CURTIS, DEPT. OF NATURAL RESOURCES

A PVC pipe bait station places rodenticides in vole runways, protecting non-target species. Bait stations may be more effective for pine voles than for meadow voles.

PAUL CURTIS, DEPT. OF NATURAL RESOURCES

Removing drops from the orchard floor will eliminate a food source for vole population build-up. Drop apples are also an attractant for deer and rabbits.

PAUL CURTIS, DEPT. OF NATURAL RESOURCES

An electric fence to exclude deer from the orchard. These fences work best for blocks less than 10 acres in size.

PAUL CURTIS, DEPT. OF NATURAL RESOURCES

Woven-wire fencing, at least 8 ft. high, provides the best crop protection, especially for large (>25 acres) orchard blocks.

5. Safe and Efficient Spray Application Methods

Growers are recommended to use environmentally safe spraying methods that improve deposition and reduce drift. New designs of sprayers greatly enhance application, are safer to use and easier to maintain. Tunnel sprayers reduce drift considerably and recycle spray. Sprayers fitted with sensor eyes detect the presence of trees and reduce drift. Use of sprayers modified to direct the air, such as with towers, deflectors, angled fans, side baffle plates, and air induction nozzles, will help reduce drift and is encouraged.

Andrew Landers, Dept of Entomology

A tunnel sprayer used over dwarf planting systems prevents drift and can recycle excess spray.

The sprayer should be regularly serviced to ensure correct application. An annual inspection should be carried out to ensure the machine is in good condition. Included in this inspection should be calibration, maintenance and mechanical adjustment. (Refer to the Operator Checklists for Airblast and Boom Sprayers).

Nozzles should be directed into the target area, and operators should ensure the nozzles aren't pointing above or below the trees. The correct nozzles to apply the correct amount per acre should be chosen, to avoid the use of high pressure that results in fine droplets which leads to excessive drift. Airflow should be directed towards the target canopy via deflectors, towers or angled fans. Airflow should be controlled so that excess air isn't produced which delivers the spray too far from the target. The size and shape of the plume of spray should match the target tree.

Operators should be certified to apply pesticides in the state of New York and wear Personal Protective Equipment (PPE) whenever handling and applying pesticides. Wherever possible tractors should be fitted with cabs and adequate filtration to protect the operator. Care must be taken while filling sprayers to avoid operator contamination and environmental pollution.

The spraying operation in the orchard should be carried out in a responsible manner, ensuring good deposition and reduced drift, and an awareness of the safety of others. Applicators should reduce drift towards non-target areas. The sprayer nozzles should be turned off at the end of the row. Buffer zones should be well thought-out to keep spray away from water, neighboring crops and houses. Spraying should only be carried out when conditions are ideal. Avoid spraying when wind conditions are too high (leads to excessive drift) or too low (unpredictable air movement). Operators should avoid spraying when high temperatures and low humidity exist as this can lead to a high evaporation risk. Spraying operations should be timed and materials should be chosen to minimize harm to honey bees. Easily visible warning signs should be posted on sprayed orchard blocks.

Andrew Landers, Dept of Entomology

Sprayers with nozzles oriented to match canopy architecture improve coverage and reduce drift.

Application records should be kept for all types of pesticide applications and should include information on the date, time, weather, operator, sprayer, field indentification (farm, orchard, block, rows — as applicable), targeted pest, pesticide name and EPA number, formulation, REI, PHI, rate applied, and acres treated. The sprayer should be thoroughly cleaned after use or between different product applications. At the end of the growing season store the sprayer in a safe and secure building to ensure a good working condition the following season.

PPE should be stored separately from pesticides. Pesticides should be stored in a secure, frost-free, ventilated storage building. Products must be kept in their original containers on strong shelves. Powders must be stored above liquids. Correct rinsing and disposal of empty containers is a must. An inventory list of products in storage must be kept and an emergency plan must be posted.

Operator Checklist for Airblast Sprayers

Owner_____Operator_____Make_____

Model_____ Serial No_____Date_____

Key: ✔ **Checked/Completed** ✗ **Needs Attention** A **Adjusted** NA **Not Applicable**

Regularly check

Mechanical

- ☐ Is the attachment to tractor secure?
- ☐ Is the chassis and structure free of cracks and rust?
- ☐ Are the wheels and tires in good condition?
- ☐ Are guards, including PTO shaft guard, secure and undamaged?

Hydraulic system

- ☐ Are they free from leaks under pressure?
- ☐ Are the hoses and connections worn or cracked?

Electrical system

- ☐ Is the wiring undamaged & are all connections properly insulated?
- ☐ Do all the lights work properly?

Pneumatic system

- ☐ Is the system free from leaks when working under operating pressures?

Sprayer tank

- ☐ Are the tank/chassis fasteners secure?
- ☐ Free from leaks?
- ☐ Does the lid fit securely and free from leaks?
- ☐ Is the contents gauge clearly legible?

'Spray lines'

- ☐ Are they free from leaks under pressure?
- ☐ No hoses and connectors worn or cracked?
- ☐ Are all valves and filters in good condition?

Nozzles

- ☐ Are all fittings in good condition?
- ☐ Are all nozzles correctly oriented?
- ☐ Are all check valves working properly?
- ☐ Is the spray/distribution pattern visually correct?

Regularly check (cont.)

Controls and valves

- ☐ Are the master on/off switches working correctly?
- ☐ Are left & right section switches functioning?
- ☐ Can you read the pressure gauges easily?
- ☐ Are all labels appropriate and legible?
- ☐ Is the pressure adjustment stable?
- ☐ Pressure gauge reading zero?

Chemical induction system

- ☐ Are the system and controls working properly?
- ☐ Is it free from leaks under pressure?
- ☐ Are all labels appropriate and readable?
- ☐ Is the rinse system and container wash system working properly?

Tank rinse system

- ☐ Is the system functioning properly?

Periodically check

- ☐ Jug test all nozzle outputs.
  Date completed_____
- ☐ Formally complete and file checklist.
  Independent test due_____

Comments/Notes/Specific items requiring attention:

_____

_____

_____

_____

_____

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_____

_____

_____

_____

Operator Checklist for Boom Sprayer

Owner_____Operator_____Make_____

Model_____ Serial No._____Reg. No._____

Date_____Hours/Mileage_____

Key: ✓ **Checked/Completed** ✗ **Needs Attention** A **Adjusted** NA **Not Applicable**

Regularly check

Mechanical

- ☐ Is the attachment to tractor secure?
- ☐ Is the chassis and structure free of cracks and rust?
- ☐ Are the wheels and tires in good condition?
- ☐ Are guards, including PTO shaft guard, secure and undamaged?

Hydraulic system

- ☐ Are they free from leaks under pressure?
- ☐ Are the hoses and connections worn or cracked?

Electrical system

- ☐ Is the wiring undamaged & are all connections properly insulated?
- ☐ Do all the lights work properly?

Pneumatic system

- ☐ Is the system free from leaks when working under operating pressures?

Sprayer tank

- ☐ Are the tank/chassis fasteners secure?
- ☐ Free from leaks?
- ☐ Does the lid fit securely and free from leaks?
- ☐ Is the contents gauge clearly legible?

Boom

- ☐ Is it properly latched when folded for transport?
- ☐ When unfolded, is it straight and level?
- ☐ Does the height adjustment and suspension work properly?
- ☐ Does the boom return to level when displaced to left and right?
- ☐ Are the break-backs functioning freely?
- ☐ Are the mountings and linkages secure and not worn?

'Spray lines'

- ☐ Are they free from leaks under pressure?
- ☐ No hoses and connectors worn or cracked?
- ☐ Are all valves and filters in good condition?

Regularly check (cont.)

Nozzles

- ☐ Are all fittings & turrets in good condition?
- ☐ Are all nozzles correctly oriented?
- ☐ Are all check valves working properly?

Controls and valves

- ☐ Are the master on/off switches working correctly?
- ☐ Are left & right section switches functioning?
- ☐ Can you read the pressure gauges easily?
- ☐ Are all labels appropriate and legible?
- ☐ Is the pressure adjustment stable?
- ☐ Pressure gauge reading zero?

Chemical induction system

- ☐ Are the system and controls working properly?
- ☐ Is it free from leaks under pressure?
- ☐ Are all labels appropriate and readable?
- ☐ Is the rinse system and container wash system working properly?

Tank rinse system

- ☐ Is the system functioning properly?

Periodically check

- ☐ Jug test all nozzle outputs.
  Date completed_____
- ☐ Formally complete and file check sheet.
  Independent test due_____

Comments/Notes/Specific items requiring attention:

_____

_____

_____

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_____

_____

_____

David Rosenberger, Dept of Plant Pathology

Empty bins are washed.

David Rosenberger, Dept of Plant Pathology

Botrytis decay spreads to adjacent fruit during storage and the decayed fruit stuck to bins must be removed.

6. Harvest, Fruit Storage and Packing

Bins of harvested fruit should never be left in the orchard over night in order to avoid the possibility that rodents will find their way into bins before the bins are moved to storage. Forklift operators are provided with appropriate training to minimize the possibility of lifting sod and soil into the bin runners as they move filled bins. If soil becomes wedged into bin runners, it should be thoroughly removed before the bin is stacked on top of another filled bin.

A sanitation system will be used to kill bacteria, yeasts, and fungal spores in water flumes. The system may involve heat treatment, ozone treatment, or a chemical biocide such as sodium hypochlorite (bleach) or hydrogen dioxide. Biocides in water flumes will be maintained at recommended concentrations.

As bins are emptied on the packing line, any decayed fruit left inside the bins are removed and trashed. Empty bins will be removed from the packing area, as soon as possible to prevent contamination with airborne spores, and cleaned and sanitized. Decayed and culled fruit will be removed from the packing area at the end of each day, and floors of the packing area will be cleaned and sanitized before packing operations begin in the morning.

7. Post Harvest Chemical Treatments

Post-harvest drench treatments are used only when such treatments are essential for controlling superficial scald or carbon dioxide injury. Fruit that are not susceptible to superficial scald or carbon dioxide injury will not need fungicide treatment because bin sanitation will reduce the risks from post-harvest decays. Calcium treatments should be applied as field sprays rather than as post-harvest treatments. If fogging technology becomes available, diphenylamine (DPA) could be applied by fogging the material into closed CA rooms rather than as a drench.

Drencher reservoir tanks will be fitted with appropriate agitation systems to keep post-harvest treatment chemicals in suspension. Drench solutions will be changed regularly, according to the DPA label limitations on numbers of bins that can be drenched between changes. All solid residues will be removed from the bottom of the reservoir tank before the tank is refilled.

III. Good Agricultural Practices

In apple produce handling the following sources of hygiene risks to food safety at harvest are recognized: bin and harvest equipment sanitation, water quality used for washes and/or dip tanks, worker hygiene and training, and apples picked up off the ground in orchards. The following risks to food safety during post-harvest handling are also recognized: worker hygiene, packinghouse cleanliness and sanitation, fruit washing operations and packing lines, produce cooling and cold storage, transportation of produce from farm to market, and a trace-back system.

David Rosenberger, Dept of Plant Pathology

Fruit are washed at the end of the flotation line.

Workers are trained to wash hands correctly with soap and potable water. Workers are required to wash hands after using restroom, before starting or returning to work, and before and after eating or smoking. Clean hand washing facilities are accessible to harvest workers within a quarter mile (402 meters) as per US Environmental Protection Agency (EPA) Worker Protection Standard regulations. If running water is not available, 1 gallon of water per worker is supplied. Clean toilet facilities are accessible to harvest workers within a quarter mile (402 meters) as per US Occupational Health and Safety Administration (OSHA) Field Sanitation Standard regulations.

Water used for post-harvest handling of fruit is supplied either from municipal water systems, wells, or surface bodies of water. Water is tested for microorganisms that would indicate a hygiene risk, treated with disinfectant as required, and records are kept.

Under NY-IFP, apples picked up off the ground in orchards are not used for fresh market or unpasteurized juice. Dropped apples are picked up off the ground only after apples on the tree have been harvested, and such apples are only used for juice that will be processed and pasteurized.

David Rosenberger, Dept of Plant Pathology

Packed boxes of fruit are inspected.

IV. Professionally Trained Growers and Employees

1. Grower Training

Knowledgeable and trained growers are the key to the success of the NY-IFP. New York State apple growers have many opportunities for professional growth and improvement. Growers must continue educational efforts to maintain knowledge of the current best management practices in nutrition, pruning, tree training, crop load management, farm employee health and welfare regulations, food safety practices, and IPM. Cornell Cooperative Extension offers yearly meetings in the three major apple growing regions including: Petal Fall/Thinning meetings, Summer Fruit Tours, Harvest Meetings, Winter Fruit Schools, and various other workshops, meetings, and educational programs. In addition, there is the New York Fruit and Vegetable Expo, as well as meetings and programs offered by the New York Apple Association, the Soil and Water Conservation districts, the agrochemical industry, and by private consultants and crop advisors.

Arthur Agnello, Dept of Entomology

Knowledgeable and trained growers are the cornerstone of successful IFP programs.

Growers are required by the New York State Department of Environmental Conservation (DEC) to be Certified Pesticide Applicators and to attend DEC-approved training programs offering re-certification credits. Growers must accumulate 12 re-certification credits over a period of five years to maintain pesticide applicator certification. Research-based educational programs offered at many of the meetings and conferences described in the above paragraph offer growers the opportunity to maintain DEC Applicator Certification.

The NY-IFP is based on information on IPM and apple production practices published each year in *The Cornell Pest Management Guidelines for Commercial Tree Fruit Production* (www.nysaes.cornell.edu/ent/treefruit/). Under NY-IFP, growers need to attend at least two Extension-sponsored meetings and one other meeting each year and they should maintain their Pesticide Applicator's license.

2. Employee Training

All employees must receive general safety training including safety around farm equipment, using ladders for harvest, and potential exposure to other hazards on the farm. All personnel who physically handle or apply pesticides and application equipment must be trained as US EPA Worker Protection Standard (WPS) "handlers". To apply federally restricted pesticides, "handlers" must have a NY State DEC Special Permit and work under the supervision of a private certified applicator on the farm. All other farm workers must be trained as EPA WPS "workers" to ensure safe practices in field operations. All employees must receive training in hygiene as it relates to food safety issues in fresh produce as directed by the Cornell GAP's program. All these requirements are viewed as positive and supportive of IFP practices.

Terence Robinson, Dept of Horticultural Sciences

Trained workers recognize safe practices and avoid accidents.

V. References

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