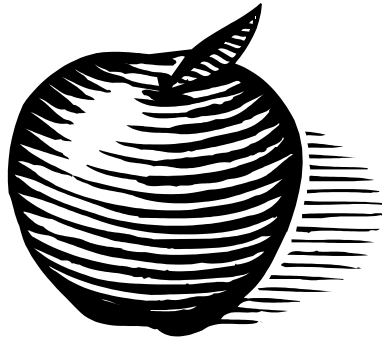


2003

**New England Apple
Strategic Plan**



New England Pest Management Network

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 - efficacy (Insects and Diseases only)
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I. Pest Management Introduction

Background of Apples in New England

The six New England states combine to rank seventh in national production of apples. A total of 16,500 acres produce 162 million pounds of harvested fruit that contribute \$46 million dollars to the New England economy. Three quarters of the fruit is destined for fresh markets while the rest is sent for processing. While only contributing 1.9% to the national production of apples, the apple orchard is an integral part of the New England economy both in direct value and in its attraction and appeal as part of the New England landscape. (NASS 2002)

Apples are susceptible to many types of pests including insects, diseases, weeds, nematodes, and vertebrates. It is critical that these pests be effectively managed to maintain adequate yields of quality fruit that is acceptable to consumers. New England apple growers have adopted innovative integrated pest management (IPM) and other cultural practices designed to manage these pests while reducing pesticide use, improving worker and food safety, and protecting environmental quality. While these methods do allow pesticides to be used more efficiently, they neither eliminate the need for pesticides nor reduce the critical importance of pesticides in apple production. The loss of important pesticide tools due to pest resistance, regulatory, and consumer-driven pressures is a concern for the entire apple industry.

Benefits to the New England Apple Industry

The New England Apple Pest Management Strategic Plan will identify at-risk pesticides and propose future research, regulatory, and education priorities necessary to establish alternative pest management methods in the event of loss. These priorities will be used to inform EPA and state agency decisions and outline a development path for pest management researchers and educators. This information will be of great value in the pursuit of funding to address research and education needs identified through the Strategic Plan. The research and education necessary to establish effective alternative pest management methods requires this funding to account for the diversity of pests and the variety of habitats in apple orchards. The current pest management programs will be made more effective through implementation of actions proposed in this plan.

The Apple Pest Management Strategic Plan Process

A review group of apple growers, researchers, and industry stakeholders throughout New England met for two days in March of 2003 to develop this Strategic Plan based on the 2002 New England Apple Crop Profile. Key pests driving pesticide use were suggested by a discussion and survey of attendees at the New England, New York, Canadian Pest Management Conference held in October 2002 and by input from the Apple Strategic Plan review group. The review group discussed the efficacy and practicality of current pesticides and pest management methods, identified acceptable alternative pest management methods, and listed the necessary research, regulatory and education needed to transition toward the use of these new methods. The pros and cons of each available option, along with opportunities for new technologies, were considered and contingency plans were discussed to prepare for possible future regulatory changes.

II. Summary of the Apple Pest Management Strategic Plan

Key Apple Pest Strategic Issues

Insects and Mites

Apple Maggot is a serious annual problem. To prevent fruit injury, protective sprays are necessary. Apple maggot activity and timing of management may be monitored with baited or non-baited sticky traps.

Plum Curculio is one of the most significant insects attacking tree fruits. Plum curculio is considered a difficult pest to monitor and manage. Most commercial orchards are free of resident populations and are infested by adults moving in from hedgerows and woodlands

The Internal Lepidoptera Codling Moth is an annual problem in potentially every block. The Internal Lepidoptera Lesser Apple Worm has been a persistent problem in low spray blocks. Few sprays are applied specifically against Internal Lepidoptera. Incidental management comes from sprays against Plum Curculio and Apple Maggot. Organophosphate insecticide applications have made Internal Lepidoptera secondary pests. Loss of organophosphate insecticides would increase the significance of these pest species.

Leafrollers are managed by insecticide applications targeted against Plum Curculio and Apple Maggot. Leafroller problems may increase with reduced summer spraying or with pesticide resistance in leafroller populations. May become a problem in very low-spray blocks.

European Red Mites and Twospotted Spide Mites are indirect pests that stress tree productivity. These pests are induced by management practices and disruption of biocontrols. Some biocontrol species complexes are currently resistant to the organophosphate insecticides used to manage major insect pests (Plum Curculio and Apple Maggot). Loss of organophosphate insecticides would require use of alternate insecticides that could create greater risk of biocontrol disruption. European Red Mites are considered the most important mite species attacking tree fruits in North America with Twospotted Spide Mites a sporadic problem in orchards.

Diseases

Apple Scab is an annual threat on 100% of apple trees that are susceptible to the disease. In the Northeast, it is not possible to produce commercially acceptable fruit from susceptible cultivars of apples without a fungicide program to manage this disease. Virtually all commercially acceptable cultivars are susceptible.

Fire Blight outbreaks are sporadic in most parts of New England, but can cause devastating orchard damage that may result in tree death. Some of the newer, commercially acceptable cultivars are highly susceptible to this disease. Speed of disease progression is very rapid, making management timing critical.

Flyspeck and Sooty Blotch cause strictly cosmetic injury important to consumer acceptability. These two diseases are treated as a single pest due to their similar management needs. Flyspeck and sooty blotch prevention drives summer disease management programs in the absence of scab.

Voles

Rodenticide is a supplement to mowing and other ground cover management. Although rodenticide is considered a supplement in vole management, it is an important component of most vole management programs. Cultural controls (primarily repeated mowing) greatly reduce, though not necessarily eliminate, the need for rodenticide application.

Deer

Deer are major orchard pests in New England. Damage prevention is through fencing rather than pesticide application.

Priorities for Apple Pest Management

1. Research

Insects and Mites

Apple Maggot Research Needs:

- Verify effectiveness of insecticide-treated traps
- Investigate economics of insecticide-treated traps versus spray applications.
- Test new insecticides (including bio-pesticides) to determine effectiveness.
- Research potential for biocontrol (including nematodes and diseases).
- Improve monitoring methods such as traps, pheromones and/or plant volatiles.
- Identify repellents for possible use in Apple Maggot management.
- Continue to evaluate spray application strategies, including border spray, designed to reduce pesticide use.
- Develop a site-specific Apple Maggot risk assessment protocol to characterize individual orchards and the surrounding habitat as Apple Maggot harborage.

Plum Curculio Research Needs:

- Evaluate new pest management strategies including trap out.
- Validate and refine Plum Curculio prediction models as tools for predicting the onset and duration of overwintered and field generations.
- Research overwintering biology
- Test new insecticides (including bio-pesticides) to determine effectiveness.
- Research potential for biocontrol (including nematodes and diseases).
- Improve monitoring methods such as traps, pheromones and/or plant volatiles.
- Identify repellents for possible use in pest management.
- Continue to evaluate spray application strategies designed to reduce pesticide use.
- Develop a site-specific pest risk assessment protocol to characterize individual orchards and the surrounding habitat as Plum Curculio harborage.

Internal Lepidoptera Research Needs:

- Test new insecticides to find alternatives to organophosphate and carbamate insecticides.
- Evaluate the relative efficacy of new insecticides and alternative chemistries.
- Evaluate new Internal Lepidoptera management strategies such as pheromone disruption.
- Develop and refine monitoring methods and treatment thresholds.

Leafroller Research Needs:

- Potential for biocontrols including egg parasites.
- Evaluate mating disruption systems

Mites Research Needs:

- Continued evaluation of orchard floor and nutritional management strategies to improve conservation of predator mites.
- Assess impact of insecticides, miticides and fungicides on pest and beneficial mites.
- Develop early season monitoring methods and treatment thresholds.
- Screening and development of new compounds.
- Further understanding of *T. pyri* and other predatory mites biology and environmental requirements to enhance use in New England

Diseases

Apple Scab Research Needs:

- Improve models and techniques that quantify and predict changes in scab risk potential throughout the season.
- Evaluate alternative chemistries for scab management.
- Captan and EBDCs are quite important for resistance management. Their continued availability is a priority in IPM programs.
- Cost effective resistance monitoring tools
- Economics of different strategies needs to be studied.
- Sanitation methods need more study.
- Investigate biocontrol strategies.
- Develop resistant cultivars that are commercially acceptable and adaptable to New England growing conditions.
- Incorporate variations in susceptibility into management strategies.

Fire Blight Research Needs:

- New materials and methods (current management is based on one material that is prone to resistance)
- Resistant rootstocks and cultivars need to be developed and evaluated in New England.
- Biocontrol research
- Improve disease models to make applicable to New England
- Further knowledge of insect vectors and plant damage that opens plant to disease

Flyspeck/Sooty Blotch Research Needs:

- Develop predictive models that are easy to use and applicable to New England conditions.
- Better understanding of epidemiology
- Develop a site-specific risk assesment protocol to characterize individual orchards and the surrounding habitat as disease harborage

Voles

- Evaluate habitat enrichment of vole predators such as birds of prey, coyotes, owls, etc.

Deer

- If an affordable, effective, sprayable deterrent was to become available it could be a useful addition to orchard management programs.

2. Regulatory

Insects and Mites

- Expedite registration of new alternatives as they become available.
- Plum Curculio, Apple Maggot, Internal Lepidoptera: Implement and enforce abandoned orchard and feral tree removal regulations.
- Apple Maggot: Overcome barriers to registration of insecticide-treated traps

Diseases

- Expedite registration of new alternatives as they become available.
- Implement and enforce abandoned orchard and feral tree removal regulations.
- Fire Blight: Need to have more freedom to register antibiotics that we know work before resistance becomes an issue

Voles

- Expedite registration of new alternatives as they become available.

3. Education

Insects and Mites

- Educate consultants, growers, and scouts on proper implementation of products, techniques and strategies.
- Encourage use of IPM techniques through orchard demonstration plots.
- Increase consumer knowledge that IPM programs are environmentally friendly.
- (Plum Curculio, Leafroller) Make consumers aware that cosmetic injury does not affect fruit quality.
- (Mites) Encourage use of *T. pyri* via education and orchard demonstration plots.

Diseases

- Educate consultants, growers, and scouts on proper implementation of products, techniques and strategies.
- Encourage use of IPM techniques through orchard demonstration plots.
- Increase consumer knowledge that IPM programs are environmentally friendly.
- (Apple Scab, Flyspeck/Sooty Blotch) Make consumers aware that cosmetic injury does not affect fruit quality.

Voles

- Educate consultants, growers, and scouts on proper implementation of products, techniques and strategies.
- Increase consumer knowledge that IPM programs are environmentally friendly.

Strategic Issues of Specific Pesticides

Insects and Mites

azinphos methyl (Plum Curculio, Apple Maggot, Internal Lepidoptera, Leafroller)

- Widely used for management of Plum Curculio and Apple Maggot which results in management of Internal Lepidoptera and Leafrollers

kaolin clay (Plum Curculio, Apple Maggot, Internal Lepidoptera, Leafrollers)

- Concerns of possible aluminum content = accumulation

phosmet (Plum Curculio, Apple Maggot, Internal Lepidoptera, Leafrollers)

- Critical material in IPM programs, especially in event of azinphosmethyl loss
- Widely used for management of Plum Curculio and Apple Maggot which results in management of Internal Lepidoptera and Leafrollers

pyriproxyfen (Internal Lepidoptera, Leafrollers)

- Distance only registered for nonbearing trees

spinosad (Apple Maggot, Internal Lepidoptera, Leafrollers)

- Good choice when managing Leafminer simultaneously (Apple Maggot, Leafrollers)

abamectin, bifenazate, clofentazine, difocol, hexythiazox, pyridaben (Mites)

- Valuable in a rotation program for resistance management

difocol (Mites)

- Resistance not stable

oil (Mites)

- Very important to IPM programs
- The first defense against European Red Mite

Diseases

B. subtilis (Fire Blight)

- Utility constrained by need to apply 5 days in advance of infection periods.
- Fire Blight infection periods are quite rare in New England, making routine applications not profitable.
- May provide tool for resistance management
- Protective in case of future blossom infections
- Little experience in New England

captan (Apple Scab, Flyspeck/Sooty Blotch)

- Critical for IPM program for Apple Scab management
- Importance in Apple Scab resistance management
- The long-term standard against which other Apple Scab materials are evaluated
- Not recommended as stand alone with high disease pressure (Flyspeck/Sooty Blotch)

cyprodinil (Apple Scab)

- May be of value if resistance develops to other post-infection materials

dodine (Apple Scab, Flyspeck/Sooty Blotch)

- Good fungicide if no resistance present
- Should be used in a rotation
- Limit use to 1-2 applications per year
- Not a viable management tool for Flyspeck/Sooty Blotch

DMI fungicides: fenarimol, myclobutanil, triflumizole (Apple Scab)

- Reduces number of applications resulting in net savings
- Useful for managing Powdery Mildew and Cedar Apple Rust simultaneously

strobilurin fungicides: kresoxim-methyl, trifloxystrobin (Apple Scab, Flyspeck/Sooty Blotch)

- Reduces number of applications needed to manage Apple Scab
- Best materials available for managing Flyspeck/Sooty Blotch

EBDC fungicides: mancozeb, metiram (Apple Scab, Flyspeck/Sooty Blotch)

- Standard Apple Scab protectant
- Important in resistance management
- Long pre-harvest interval limits summer use (Flyspeck/Sooty Blotch)

EBDC fungicide: maneb (Apple Scab, Flyspeck/Sooty Blotch)

- Not a standard Apple Scab protectant
- Long pre-harvest interval limits summer use (Flyspeck/Sooty Blotch)

prohexadione-calcium (Fire Blight)

- Indirect effects can contribute to a disease management program

streptomycin sulfate (Fire Blight)

- Use of disease models critical for timing of sprays

thiophanate methyl (Flyspeck/Sooty Blotch)

- Provides long-term management

thiram (Apple Scab, Flyspeck/Sooty Blotch)

- Deer repellent
- Not a viable management tool for Apple Scab

III. Strategic Issues for Key Apple Pests

Insects and Mites

1. Apple Maggot

- **Acres Affected:** potential 100%
- **Yield Losses:** 30-100% if not managed
- Serious annual problem
- To prevent fruit injury, protective sprays are necessary.
- Apple maggot activity and timing of management may be monitored with baited or non-baited sticky traps.
- Egg laying results in internal maggot feeding
- Rot producing organisms follow the maggots causing rapid decay of infested fruit.
- In late season cultivars, the injury usually appears as corky spots or streaks in the flesh

Currently Registered Pesticides

PESTICIDE	EFFI-CACY	PROS	CONS	COMMENTS
azadirachtin: Aza-Direct Neemix	x	<ul style="list-style-type: none"> • Approved for organic production 	<ul style="list-style-type: none"> • Toxic to fish • Short residual activity • High cost • Multiple application needed 	<ul style="list-style-type: none"> • Relatively new product • Little experience in New England • Efficacy not documented
azinphos methyl: Guthion Azinphos -M Sniper	3	<ul style="list-style-type: none"> • Easy on beneficial predator mites because they have evolved resistance • Nondisruptive to aphid predators • Useful for managing other pests simultaneously • Low cost • Has better residual efficacy than phosmet • Low visible residue • Reduced rates effective 	<ul style="list-style-type: none"> • Toxic to applicators • Restricted Use- Requires posting for public and worker protection • 14-day REI limits its utility • Low threshold on SARA Title II list • Some processors prohibit use 	<ul style="list-style-type: none"> • Widely used for management of AM and PC, which results in management of Internal Lepidoptera and Leafrollers • Organophosphate
carbaryl: Sevin Carbaryl	3	<ul style="list-style-type: none"> • Useful for managing other pests simultaneously • Short PHI 	<ul style="list-style-type: none"> • Toxic to beneficial insects and mites • Short residual activity • Highly visible residue on fruit • Some processors prohibit use 	<ul style="list-style-type: none"> • Not a primary management tool for this pest (see cons) • Carbamate

diazinon: Diazinon	3		<ul style="list-style-type: none"> • Hard on beneficial predators • Phytotoxic to certain cultivars • Short residual activity • 21 day PHI limits its utility 	<ul style="list-style-type: none"> • Not a viable primary management tool for this pest (see cons) • Organophosphate
dimethoate: Digon Dimate	3		<ul style="list-style-type: none"> • Highly toxic to beneficial aphid predators and predator mites • Phytotoxic to certain cultivars • 28 day PHI limits its utility 	<ul style="list-style-type: none"> • Not a viable primary management tool for this pest (see cons) • Organophosphate
esfenvalerate: Asana	3	<ul style="list-style-type: none"> • Useful for managing other pests simultaneously • Low cost • Aerial application allowed 	<ul style="list-style-type: none"> • Not recommended during AM activity period because destroys and repels beneficial mites and insects • Disruptive to IPM programs • 21 day PHI limits its utility 	<ul style="list-style-type: none"> • Not a viable primary management tool for this pest (see cons)
fenpropathrin: Danitol	3	<ul style="list-style-type: none"> • Useful for managing other pests simultaneously (ERM) 	<ul style="list-style-type: none"> • Not recommended during AM activity period because destroys and repels beneficial mites and insects • Disruptive to IPM programs • Can't be applied within 25 feet of water 	<ul style="list-style-type: none"> • Not a viable primary management tool for this pest (see cons)
indoxacarb: Avaunt	2	<ul style="list-style-type: none"> • Easy on beneficials • Low mammalian toxicity • Short REI 	<ul style="list-style-type: none"> • Resistance potential in other pests at low rates • High cost • 28 day PHI limits its utility 	<ul style="list-style-type: none"> • Relatively new product • Little experience in New England
kaolin clay: Surround	2	<ul style="list-style-type: none"> • Useful for managing other pests simultaneously • Very low mammalian toxicity • Approved for organic production 	<ul style="list-style-type: none"> • High cost • Coverage must be maintained • Very easily washed off by rain • Highly visible residue not easily removed from fruit • Difficult to work with 	<ul style="list-style-type: none"> • Concerns of possible aluminum content = accumulation • May not be viable (see cons)
methomyl: Lannate	2	<ul style="list-style-type: none"> • Useful for managing other pests simultaneously 	<ul style="list-style-type: none"> • Hard on beneficials • Use has induced mite problems • Highly toxic to applicators • Hazardous to aquatic organisms • Phytotoxic to certain cultivars • Short residual activity • Degrades rapidly above pH 7 in tank mix 	<ul style="list-style-type: none"> • Not normally used for AM • Carbamate

oxamyl: Vydate	1		<ul style="list-style-type: none"> • Hard on beneficials • Use has induced mite problems • Highly toxic to applicators • Hazardous to aquatic organisms • Phytotoxic to certain cultivars • Degrades rapidly above pH 7 in tank mix • Strong odor 	<ul style="list-style-type: none"> • Not used for AM (see cons) • Carbamate
phosmet: Imidan	3	<ul style="list-style-type: none"> • Easy on beneficials • Useful for managing other pests simultaneously • Lower mammalian toxicity than Guthion • Good alternative to azinphosmethyl • Not a restricted use material • Moderate PHI 	<ul style="list-style-type: none"> • Visible residue on fruit • Low threshold on SARA Title II list • Some processors prohibit use 	<ul style="list-style-type: none"> • Critical material in IPM programs, especially in event of azinphosmethyl loss • Widely used for management of AM and PC, which results in management of Internal Lepidoptera and Leafrollers • Organophosphate
spinosad: SpinTor Entrust	2	<ul style="list-style-type: none"> • Easy on beneficials • Low mammalian toxicity • Low REI and PHI • Entrust approved for organic production 	<ul style="list-style-type: none"> • Short residual activity 	<ul style="list-style-type: none"> • Good choice when managing Leafminer simultaneously

1=poor, 2=fair, 3=good, x=no efficacy data available

?=not rated for this pest or insufficient information, -=not registered for use at appropriate time for pest

Current Cultural and Biological Aids/Alternatives

METHOD	PROS	CONS	COMMENTS
Trapping may be an effective management tool for some growers.	<ul style="list-style-type: none"> • May reduce insecticide applications 	<ul style="list-style-type: none"> • Labor intensive • Variable results • No effect on other pests 	<ul style="list-style-type: none"> • Effectiveness depends on location, proximity of unmanaged hosts and attractiveness of the cultivar
Insecticide-treated traps may be effective management tool	<ul style="list-style-type: none"> • More effective than traditional traps • May reduce insecticide applications • Not as labor intensive as traditional trapping 	<ul style="list-style-type: none"> • No effect on other pests • Lack of availability 	<ul style="list-style-type: none"> • Still experimental

Remove wild/alternate hosts and abandoned orchards	<ul style="list-style-type: none"> • Can be very beneficial • May reduce pest pressure 	<ul style="list-style-type: none"> • Not practical when hosts are off orchard property • Access can be limited by physical condition of landscape • Costly 	<ul style="list-style-type: none"> • Not enough as a stand-alone technique. • It is a must if trap out is to be attempted.
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Action Items

Research Needs:

- Verify effectiveness of insecticide-treated traps
- Investigate economics of insecticide-treated traps versus spray applications.
- Test new insecticides (including bio-pesticides) to determine effectiveness.
- Research potential for biocontrol (including nematodes and diseases).
- Improve monitoring methods such as traps, pheromones and/or plant volatiles.
- Identify repellents for possible use in AM management.
- Continue to evaluate spray application strategies, including border spray, designed to reduce pesticide use.
- Develop a site-specific AM risk assessment protocol to characterize individual orchards and the surrounding habitat as AM harborage.

Regulatory Needs:

- Overcome barriers to registration of insecticide-treated traps
- Expedite registration of new alternatives as they become available.
- Implement and enforce abandoned orchard and feral tree removal regulations.

Education Needs:

- Educate consultants, growers, and scouts on proper implementation of products, techniques and strategies.
- Encourage use of IPM techniques through orchard demonstration plots.
- Increase consumer knowledge that IPM programs are environmentally friendly.

2. Plum Curculio

- **Acres Affected:** potential 100%
- **Yield Losses:** <1% if managed; >70% in some areas if not managed
- The effective time for management of this pest is from bloom through four weeks after bloom.
- The plum curculio is one of the most significant insects attacking tree fruits
- Plum curculio is considered a difficult pest to monitor and manage.
- Most commercial orchards are free of resident populations and are infested by adults moving in from hedgerows and woodlands
- The adults can injure the fruit during the early season via feeding and egg laying (oviposition), resulting in scarred fruit and fruit drop.
- Adults can average over 100 feeding and/or egg punctures during their normal life.
- As the fruit matures both types of injury become corky in appearance.
- Early-blooming cultivars are the first to provide suitable locations for feeding and egg laying.
- Adults which successfully emerge in mid-summer can again feed on fruit. This injury appears as small, soft, irregular holes, usually near the calyx of the fruit.

Currently Registered Pesticides

PESTICIDE	EFFI-CACY	PROS	CONS	COMMENTS
azinphos methyl: Guthion Azinphos -M Sniper	3	<ul style="list-style-type: none"> • Easy on beneficial predator mites because they have evolved resistance • Nondisruptive to aphid predators • Useful for managing other pests simultaneously • Low cost • Has better residual efficacy than phosmet 	<ul style="list-style-type: none"> • Toxic to applicators • Restricted Use- Requires posting for public and worker protection • 14-day REI limits its utility • Low threshold on SARA Title II list • Some processors prohibit use 	<ul style="list-style-type: none"> • Widely used for management of AM and PC, which results in management of Internal Lepidoptera and Leafrollers • Organophosphate
carbaryl: Sevin Carbaryl	2	<ul style="list-style-type: none"> • Useful for managing other pests simultaneously • Dual use as thinner 	<ul style="list-style-type: none"> • Toxic to beneficial insects and mites • Short residual activity • Will cause fruit thinning • Some processors prohibit use 	<ul style="list-style-type: none"> • Not a viable primary management tool for this pest (see cons) • Carbamate
diazinon: Diazinon	2		<ul style="list-style-type: none"> • Hard on beneficial predators • Phytotoxic to certain cultivars • Weak residual activity 	<ul style="list-style-type: none"> • Not a viable primary management tool for this pest (see cons) • Organophosphate

dimethoate: Digon Dimate	2		<ul style="list-style-type: none"> • Highly toxic to beneficial aphid predators and predator mites • Not labeled for use on Plum Curculio 	<ul style="list-style-type: none"> • Not a viable primary management tool for this pest (see cons) • Organophosphate
esfenvalerate: Asana	3	<ul style="list-style-type: none"> • Useful for managing other pests simultaneously • Low cost • Aerial application allowed 	<ul style="list-style-type: none"> • Not recommended during PC activity period because destroys and repels beneficial mites and insects • Disruptive to IPM programs 	<ul style="list-style-type: none"> • Not a viable primary management tool for this pest (see cons)
fenpropathrin: Danitol	3	<ul style="list-style-type: none"> • Useful for managing other pests simultaneously (ERM) 	<ul style="list-style-type: none"> • Not recommended during PC activity period because destroys and repels beneficial mites and insects • Disruptive to IPM programs • Can't be applied within 25 feet of water 	<ul style="list-style-type: none"> • Not a viable primary management tool for this pest (see cons)
indoxacarb: Avaunt	3	<ul style="list-style-type: none"> • Easy on beneficials • Low mammalian toxicity • Short REI 	<ul style="list-style-type: none"> • Resistance potential in other pests at low rates • High cost 	<ul style="list-style-type: none"> • Relatively new product • Little experience in New England
insecticidal soap: M-Pede Safer's	1	<ul style="list-style-type: none"> • Approved for organic production 	<ul style="list-style-type: none"> • Toxic to beneficial aphid predators • Phytotoxic to certain cultivars • Very high cost 	<ul style="list-style-type: none"> • Not a viable management tool for this pest (see cons and efficacy)
kaolin clay: Surround	2	<ul style="list-style-type: none"> • Useful for managing other pests simultaneously • Very low mammalian toxicity • Approved for organic production 	<ul style="list-style-type: none"> • High cost • Coverage must be maintained for six week period requiring frequent sprays • Very easily washed off by rain • Difficult to work with 	<ul style="list-style-type: none"> • Concerns of possible aluminum content = accumulation • May not be viable (see cons)
methomyl: Lannate	2	<ul style="list-style-type: none"> • Useful for managing other pests simultaneously 	<ul style="list-style-type: none"> • Hard on beneficials • Use has induced mite problems • Highly toxic to applicators • Hazardous to aquatic organisms • Phytotoxic to certain cultivars • Short residual activity • Degrades rapidly above pH 7 in tank mix 	<ul style="list-style-type: none"> • Not normally used for PC • Carbamate

phosmet: Imidan	3	<ul style="list-style-type: none"> • Easy on beneficials • Useful for managing other pests simultaneously • Lower mammalian toxicity than Guthion • Good alternative to azinphosmethyl • Not a restricted use material 	<ul style="list-style-type: none"> • Low threshold on SARA Title II list • Some processors prohibit use 	<ul style="list-style-type: none"> • Critical material in IPM programs, especially in event of azinphosmethyl loss • Widely used for management of AM and PC, which results in management of Internal Lepidoptera and Leafrollers • Organophosphate
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1=poor, 2=fair, 3=good, x=no efficacy data available

?=not rated for this pest or insufficient information, -=not registered for use at appropriate time for pest

Current Cultural and Biological Aids/Alternatives

METHOD	PROS	CONS	COMMENTS
Use degree-day models to time applications	<ul style="list-style-type: none"> • May reduce insecticide applications 	<ul style="list-style-type: none"> • Degree-day models still give variable results 	<ul style="list-style-type: none"> • Still experimental
Border row spraying rather than entire orchards	<ul style="list-style-type: none"> • May reduce insecticide applications 	<ul style="list-style-type: none"> • Not effective for the first 1-2 sprays • Needs constant monitoring 	<ul style="list-style-type: none"> • Weather and pest pressure dependent • Results variable
Row cropping and annual tillage of adjacent cropland	<ul style="list-style-type: none"> • Suppresses PC by compromising overwintering habitat 	<ul style="list-style-type: none"> • Not practical in New England landscape 	
Remove wild/alternate hosts and abandoned orchards	<ul style="list-style-type: none"> • Can be very beneficial • May reduce pest pressure 	<ul style="list-style-type: none"> • Not practical when hosts are off orchard property • Access can be limited by physical condition of landscape • Costly 	<ul style="list-style-type: none"> • Not enough as a stand-alone technique. • Does not eliminate need for sprays

Action Items

Research Needs:

- Test new insecticides (including bio-pesticides) to determine effectiveness.
- Research overwintering biology
- Research potential for biocontrol (including nematodes and diseases).
- Evaluate new pest management strategies including trap out.

- Improve monitoring methods such as traps, pheromones and/or plant volatiles.
- Validate and refine PC prediction models as tools for predicting the onset and duration of overwintered and field generations.
- Identify repellents for possible use in PC management.
- Continue to evaluate spray application strategies designed to reduce pesticide use.
- Develop a site-specific PC risk assessment protocol to characterize individual orchards and the surrounding habitat as PC harborage.

Regulatory Needs:

- Expedite registration of new alternatives as they become available.
- Implement and enforce abandoned orchard and feral tree removal regulations.

Education Needs:

- Educate consultants, growers, and scouts on proper implementation of products, techniques and strategies.
- Encourage use of IPM techniques through orchard demonstration plots.
- Increase consumer knowledge that IPM programs are environmentally friendly.
- Make consumers aware that cosmetic injury does not affect fruit quality.

3. Internal Lepidoptera: Codling Moth (CM), Oriental Fruit Moth (OFM), Lesser Appleworm (LAW)

- **Acres Affected:** potential 100%
- **Yield Losses:** <5% if managed; 30-40% if not managed
- OP applications have made Internal Lepidoptera secondary pests. Loss of OP's would increase the significance of these pest species.
- CM is an annual problem in potentially every block; LAW has been a persistent problem in low spray blocks.
- CM larvae may cause "stings", which damage only the surface flesh of the fruit or deep inner tunneling results in internal breakdown and possible abortion of the fruit.
- LAW larvae feed primarily on the fruit at either the calyx or stem ends.
- Fruit infested during the first generation of LAW generally fall to the ground during June drop, but fruit infested during the second generation will often contain larvae at harvest.
- Few sprays are applied specifically against CM; incidental management comes from applications against other pests (PC and AM).
- Specific sprays for LAW and OFM are extremely rare with incidental management coming from sprays against Plum Curculio and Apple Maggot.

Currently Registered Pesticides

PESTICIDE	EFFI-CACY	PROS	CONS	COMMENTS
acetamiprid: Assail	1		<ul style="list-style-type: none"> • High cost 	<ul style="list-style-type: none"> • Little experience in New England

azinphos methyl: Guthion Azinphos -M Sniper	3	<ul style="list-style-type: none"> • Easy on beneficial predator mites because they have evolved resistance • Nondisruptive to aphid predators • Useful for managing other pests simultaneously • Low cost • Has better residual efficacy than phosmet 	<ul style="list-style-type: none"> • Toxic to applicators • Restricted Use- Requires posting for public and worker protection • 14-day REI limits its utility • Low threshold on SARA Title II list • Some processors prohibit use 	<ul style="list-style-type: none"> • Widely used for management of AM and PC, which results in management of Internal Lepidoptera and Leafrollers • Organophosphate
B.t. endotoxin: Agree, Dipel, Javelin, MVP, Xentari	2	<ul style="list-style-type: none"> • Easy on beneficials • Nontoxic to mammals • Can be applied during bloom • Some formulations approved for organic production 	<ul style="list-style-type: none"> • More expensive than conventional sprays • Multiple applications necessary • Timing is critical • Most effective against young lepidoptera larvae • Not effective against other pests 	
carbaryl: Sevin Carbaryl	3	<ul style="list-style-type: none"> • Dual use as thinner when used against OFM 	<ul style="list-style-type: none"> • Toxic to beneficial insects and mites • Short residual activity • Will cause fruit thinning • Some processors prohibit use 	<ul style="list-style-type: none"> • Not a viable primary management tool for this pest (see cons) • Carbamate
diazinon: Diazinon	3		<ul style="list-style-type: none"> • Hard on beneficial predators • Phytotoxic to certain cultivars • Weak residual activity • There are less expensive alternatives 	<ul style="list-style-type: none"> • Not a viable primary management tool for this pest (see cons) • Organophosphate
dimethoate: Digon Dimate	3		<ul style="list-style-type: none"> • Highly toxic to aphid predators and predator mites 	<ul style="list-style-type: none"> • Not a viable primary management tool for this pest (see cons) • Organophosphate
esfenvalerate: Asana	3	<ul style="list-style-type: none"> • Useful for managing other pests simultaneously • Low cost • Aerial application allowed 	<ul style="list-style-type: none"> • Destroys and repels beneficial mites and insects • Disruptive to IPM programs 	<ul style="list-style-type: none"> • Not a viable primary management tool for this pest (see cons)
fenpropathrin: Danitol	3	<ul style="list-style-type: none"> • Useful for managing other pests simultaneously • Low cost 	<ul style="list-style-type: none"> • Destroys and repels beneficial mites and insects • Disruptive to IPM programs 	<ul style="list-style-type: none"> • Not a viable primary management tool for this pest (see cons)

indoxacarb: Avaunt	2	<ul style="list-style-type: none"> • Easy on beneficials • Low mammalian toxicity • Short REI 	<ul style="list-style-type: none"> • Resistance potential • High cost 	<ul style="list-style-type: none"> • Relatively new product • Little experience in New England
insecticidal soap: M-Pede Safer's	1	<ul style="list-style-type: none"> • Approved for organic production 	<ul style="list-style-type: none"> • Toxic to aphid predators • Phytotoxic to certain cultivars • Very high cost 	<ul style="list-style-type: none"> • Not a viable management tool for this pest (see cons and efficacy)
kaolin clay: Surround	2	<ul style="list-style-type: none"> • Useful for managing other pests simultaneously • Very low mammalian toxicity • Approved for organic production 	<ul style="list-style-type: none"> • High cost • Coverage must be maintained for four week period requiring frequent sprays • Very easily washed off by rain • Difficult to work with • Not recommended against second generation CM 	<ul style="list-style-type: none"> • Concerns of possible aluminum content = accumulation • Not a viable management tool for these pests (see cons)
methomyl: Lannate	3	<ul style="list-style-type: none"> • Useful for managing other pests simultaneously 	<ul style="list-style-type: none"> • Hard on beneficials • Use has induced mite problems • Highly toxic to applicators • Hazardous to aquatic organisms • Phytotoxic to certain cultivars • Short residual activity • Degrades rapidly above pH 7 in tank mix 	<ul style="list-style-type: none"> • Not normally used for Internal Lepidoptera in an IPM program • Carbamate
methoxyfenoxide: Intrepid	3	<ul style="list-style-type: none"> • Easy on beneficials • Low mammalian toxicity • Low REI 	<ul style="list-style-type: none"> • High cost • Multiple applications necessary • Requires more applications than the OPs • Only manages immature Lepidoptera 	
phosmet: Imidan	3	<ul style="list-style-type: none"> • Easy on beneficials • Useful for managing other pests simultaneously • Lower mammalian toxicity than Guthion • Good alternative to azinphosmethyl • Not a restricted use material • Moderate PHI 	<ul style="list-style-type: none"> • Visible residue on fruit • Sensitive to high pH spray mixes • Low threshold on SARA Title II list • Some processors prohibit use 	<ul style="list-style-type: none"> • Critical material in IPM programs, especially in event of azinphosmethyl loss • Widely used for management of AM and PC, which results in management of Internal Lepidoptera and Leafrollers • Organophosphate

pyriproxyfen: Distance Esteem	2	<ul style="list-style-type: none"> • Easy on beneficials • Low mammalian toxicity • Short REI 	<ul style="list-style-type: none"> • High cost • Multiple applications necessary • Requires more applications than the OPs • Timing is critical • Only manages immature insects 	<ul style="list-style-type: none"> • Distance is only registered for nonbearing trees
spinosad: SpinTor Entrust	1	<ul style="list-style-type: none"> • Easy on beneficials • Low mammalian toxicity • Short REI and PHI • Entrust approved for organic production 	<ul style="list-style-type: none"> • Short residual activity • High cost • Not recommended against second generation CM 	<ul style="list-style-type: none"> • Not a viable management tool for these pests (see cons)

1=poor, 2=fair, 3=good, x=no efficacy data available

?=not rated for this pest or insufficient information, -=not registered for use at appropriate time for pest

Current Cultural/Biological Aids & Alternatives

METHOD	PROS	CONS	COMMENTS
Degree-day models to time applications	<ul style="list-style-type: none"> • May reduce insecticide applications 		
Mating disruption	<ul style="list-style-type: none"> • May reduce insecticide applications in low populations of later generations 	<ul style="list-style-type: none"> • Inconsistent results • Labor intensive • Expensive • Placement of lures is critical 	<ul style="list-style-type: none"> • Might need initial insecticide spray to knock down population
Remove wild/alternate hosts and abandoned orchards	<ul style="list-style-type: none"> • Can be very beneficial • May reduce pest pressure 	<ul style="list-style-type: none"> • Not practical when hosts are off orchard property • Access can be limited by physical condition of landscape • Costly 	<ul style="list-style-type: none"> • Not enough as a stand-alone technique. • Does not eliminate need for sprays

Action Items

Research Needs:

- Test new insecticides to find alternatives to organophosphate and carbamate insecticides.
- Evaluate the relative efficacy of new insecticides and alternative chemistries.
- Evaluate new pest management strategies such as pheromone disruption.
- Develop and refine monitoring methods and treatment thresholds.

Regulatory Needs:

- Expedite registration of new alternatives as they become available.
- Implement and enforce abandoned orchard and feral tree removal regulations.

Education Needs:

- Educate consultants, growers, and scouts on proper implementation of products, techniques and strategies.
- Encourage use of IPM techniques through orchard demonstration plots.
- Increase consumer knowledge that IPM programs are environmentally friendly.

4. Leafrollers: Obliquebanded (OBLR), Redbanded (RBLR)

- **Acres Affected:** potential 100%
- **Yield Losses:** <1% if managed; 60% if not managed
- Managed by insecticide applications targeted against Plum Curculio and Apple Maggot.
- Leafroller problems may increase with reduced summer spraying or with pesticide resistance in leafroller populations.
- May become a problem in very low-spray blocks.
- Overwintering OBLR larvae damage developing fruit prior to and shortly after petal fall
- OBLR damaged fruits drop prematurely, but a small percentage remain on the tree, exhibiting deep corky scars and indentations at harvest.
- The first summer OBLR brood larvae feed on the surface of developing fruit in late July and early August.
- Fruit injured by OBLR later in the season remains on the tree at harvest.
- RBLR damages both foliage and fruit, but foliar damage is not significant except in cases of very severe infestations.
- These RBLR damaged areas eventually cork over, resulting in deformed fruit.
- RBLR damage by the summer broods can be late enough in the season that corking may not occur, leaving exposed tissue susceptible to rot diseases and moisture loss, and the injured fruit do not store well.

Currently Registered Pesticides

PESTICIDE	EFFI-CACY	PROS	CONS	COMMENTS
azadirachtin: Aza-Direct	OBLR x RBLR x	<ul style="list-style-type: none"> • Approved for organic production 	<ul style="list-style-type: none"> • Toxic to fish • Short residual activity • High cost • Multiple application needed 	<ul style="list-style-type: none"> • Little experience in New England • Efficacy not documented
azinphos methyl: Guthion Azinphos -M Sniper	OBLR 2 RBLR 3	<ul style="list-style-type: none"> • Easy on beneficial predator mites because they have evolved resistance • Nondisruptive to aphid predators • Useful for managing other pests simultaneously 	<ul style="list-style-type: none"> • Toxic to applicators • Restricted Use- Requires posting for public and worker protection • Resistance concerns limit applications 	<ul style="list-style-type: none"> • Secondary management from treatment of other pests • Widely used for management of AM and PC, which results in management of Internal Lepidoptera and Leafrollers

		<p>simultaneously</p> <ul style="list-style-type: none"> • Low cost • Has better residual efficacy than phosmet • Low visible residue • Reduced rates effective 	<ul style="list-style-type: none"> • 14-day REI limits its utility • Low threshold on SARA Title II list • Some processors prohibit use 	<ul style="list-style-type: none"> • Organophosphate
<p>B.t. endotoxin: Agree, Dipel, Javelin, MVP, Xentari</p>	<p>OBLR 2 RBLR 3</p>	<ul style="list-style-type: none"> • Easy on beneficials • Nontoxic to mammals • Some formulations approved for organic production • Can be applied during bloom 	<ul style="list-style-type: none"> • More expensive than conventional sprays • Multiple applications necessary • Timing is critical • Most effective against young larvae • Not effective against other pests 	
<p>carbaryl: Sevin Carbaryl</p>	<p>OBLR 2 RBLR 1</p>	<ul style="list-style-type: none"> • Dual use as thinner when used against first generation of both pests 	<ul style="list-style-type: none"> • Toxic to beneficial insects and mites • Short residual activity • Will cause fruit thinning • Some processors prohibit use 	<ul style="list-style-type: none"> • Not a viable primary management tool for this pest (see cons) • Carbamate
<p>diazinon: Diazinon</p>	<p>OBLR 2</p>		<ul style="list-style-type: none"> • Resistance concerns limit applications 	<ul style="list-style-type: none"> • Not viable (see efficacy) • Organophosphate
<p>dimethoate: Digon Dimate</p>	<p>OBLR 1</p>		<ul style="list-style-type: none"> • Resistance concerns limit applications 	<ul style="list-style-type: none"> • Not viable (see efficacy) • Organophosphate
<p>endosulfan: Thiodan Phaser</p>	<p>OBLR 1 RBLR 2</p>			<ul style="list-style-type: none"> • Not known to be used on these pests
<p>esfenvalerate: Asana</p>	<p>OBLR 3 RBLR 2</p>	<ul style="list-style-type: none"> • Useful for managing other pests simultaneously • Low cost • Aerial application allowed 	<ul style="list-style-type: none"> • Destroys and repels beneficial mites and insects • Disruptive to IPM programs 	<ul style="list-style-type: none"> • Not a viable primary management tool for these pests (see cons)
<p>fenpropathrin: Danitol</p>	<p>OBLR 2 RBLR 3</p>	<ul style="list-style-type: none"> • Useful for managing other pests simultaneously • Low cost 	<ul style="list-style-type: none"> • Destroys and repels beneficial mites and insects • Disruptive to IPM programs 	<ul style="list-style-type: none"> • Not a viable primary management tool for these pests (see cons)

indoxacarb: Avaunt	OBLR 2 RBLR 2	<ul style="list-style-type: none"> • Easy on beneficials • Low mammalian toxicity • Short REI 	<ul style="list-style-type: none"> • Resistance potential • High cost 	<ul style="list-style-type: none"> • Relatively new product • Little experience in New England
insecticidal soap: M-Pede Safer's	OBLR 1 RBLR 1	<ul style="list-style-type: none"> • Approved for organic production 	<ul style="list-style-type: none"> • Kills aphid predators • Phytotoxic to certain cultivars • Very high cost 	<ul style="list-style-type: none"> • Not a viable management tool for this pest (see cons and efficacy)
kaolin clay: Surround	OBLR x RBLR x	<ul style="list-style-type: none"> • Useful for managing other pests simultaneously • Very low mammalian toxicity • Approved for organic production 	<ul style="list-style-type: none"> • High cost • Coverage must be maintained • Very easily washed off by rain • No efficacy data • Difficult to work with 	<ul style="list-style-type: none"> • Concerns of possible aluminum content = accumulation • Not a viable management tool for these pests (see cons)
methomyl: Lannate	OBLR 3 RBLR 3	<ul style="list-style-type: none"> • Useful for managing other pests simultaneously 	<ul style="list-style-type: none"> • Hard on beneficials • Use has induced mite problems • Highly toxic to applicators • Hazardous to aquatic organisms • Phytotoxic to certain cultivars • Short residual activity • Degrades rapidly above pH 7 in tank mix 	<ul style="list-style-type: none"> • Not normally used for Leafrollers in an IPM program • Carbamate
methoxyfenozone: Intrepid	OBLR 3 RBLR 3	<ul style="list-style-type: none"> • Easy on beneficials • Low mammalian toxicity • Low REI 	<ul style="list-style-type: none"> • High cost • Multiple sprays necessary • Requires more applications than the OPs • Only manages immature Lepidoptera 	
phosmet: Imidan	OBLR 2 RBLR 3	<ul style="list-style-type: none"> • Easy on beneficials • Useful for managing other pests simultaneously • Lower mammalian toxicity than Guthion • Good alternative to azinphosmethyl • Not a restricted use material • Moderate PHI 	<ul style="list-style-type: none"> • Visible residue on fruit • Sensitive to high pH spray mixes • Low threshold on SARA Title II list • Some processors prohibit use 	<ul style="list-style-type: none"> • Critical material in IPM programs, especially in event of azinphosmethyl loss • Widely used for management of AM and PC, which results in management of Internal Lepidoptera and Leafrollers • Organophosphate
pyriproxyfen: Distance Esteem	RBLR 3	<ul style="list-style-type: none"> • Easy on beneficials • Low mammalian toxicity • Short REI 	<ul style="list-style-type: none"> • High cost • Multiple sprays necessary • Requires more applications than the OPs 	<ul style="list-style-type: none"> • Distance is only registered for nonbearing trees • Not currently used for leafrollers in New England

			<ul style="list-style-type: none"> • Timing is critical • Only manages immature insects 	
spinosad: SpinTor Entrust	OBLR 3	<ul style="list-style-type: none"> • Easy on beneficials • Low mammalian toxicity • Low REI and PHI • Entrust approved for organic production 	<ul style="list-style-type: none"> • Short residual activity 	<ul style="list-style-type: none"> • Good choice when managing leafminer simultaneously

1=poor, 2=fair, 3=good, x=no efficacy data available

?=not rated for this pest or insufficient information, -=not registered for use at appropriate time for pest

Current Cultural and Biological Aids/Alternatives

METHOD	PROS	CONS	COMMENTS
Degree-day models to time applications	<ul style="list-style-type: none"> • May reduce insecticide applications 		

Action Items

Research Needs:

- Potential for biocontrols including egg parasites.
- Evaluate mating disruption systems

Regulatory Needs:

- Expedite registration of new alternatives as they become available.

Education Needs:

- Educate consultants, growers, and scouts on proper implementation of products, techniques and strategies.
- Encourage use of IPM techniques through orchard demonstration plots.
- Increase consumer knowledge that IPM programs are environmentally friendly.
- Make consumers aware that cosmetic injury does not affect fruit quality.

5. Mites: European Red Mite (ERM), Twospotted Spider Mite (TSM)

- **Acres Affected:** potential 100% with regional variation
- **Yield Losses:** 80% if not managed
- Indirect pests that stress tree's productivity.
- These pests are induced by management practices and disruption of biocontrols
- Some biocontrol species complexes are currently resistant to OPs used to manage major insect pests (PC and AM). Loss of OPs would require use of alternate insecticides that could create greater risk of biocontrol disruption.
- ERM are established and considered the most important mite species attacking tree fruits in North America.
- TSM are a sporadic problem in orchards.
- Heavy mite feeding early in the season (late June and early July) can cause leaf bronzing, reduced photosynthesis, fruit size reduction, preharvest drop, poor fruit coloring, and reduced crop potential for the next year.
- Additionally, mite-injured leaves will not respond to growth regulators applied to delay harvest drop.
- Economically damaging TSM populations generally develop during the latter part of the season.

Currently Registered Pesticides

PESTICIDE	EFFI-CACY	PROS	CONS	COMMENTS
(ERM, TSM) abamectin: Agri-Mek	ERM 3 TSM 2	<ul style="list-style-type: none"> • Useful for managing other pests simultaneously (EAS and leafminers) • Low mammalian toxicity 	<ul style="list-style-type: none"> • High cost • Surfactant or oil necessary for application 	<ul style="list-style-type: none"> • Valuable in a rotation program for resistance management
(TSM) azadirachtin: Aza-Direct	TSM x	<ul style="list-style-type: none"> • Approved for organic production 	<ul style="list-style-type: none"> • Toxic to fish • Short residual activity • Very high cost • Multiple application needed 	<ul style="list-style-type: none"> • Little experience in New England • Efficacy not documented
(ERM, TSM) bifenazate: Acramite	ERM 3 TSM 3	<ul style="list-style-type: none"> • Relatively easy on beneficials • Fast acting • Effective against eggs 	<ul style="list-style-type: none"> • Very sensitive to high pH and hard water 	<ul style="list-style-type: none"> • Valuable in a rotation program for resistance management
(ERM, TSM) cinnamaldehyde: Valero	ERM x TSM x	<ul style="list-style-type: none"> • Pleasant odor 	<ul style="list-style-type: none"> • Phytotoxic on some cultivars • Extremely short residual activity • Very high cost • Thorough coverage required • Opened package may have a short shelf-life 	<ul style="list-style-type: none"> • Little experience in New England

			<ul style="list-style-type: none"> • Avoid high pH in spray 	
(ERM, TSM) clofentazine: Apollo	ERM 3 TSM 2	<ul style="list-style-type: none"> • Safe on beneficials • Long residual at high rates • Alternative to oil applications 	<ul style="list-style-type: none"> • Cross resistant with Savey • Not effective against adults 	<ul style="list-style-type: none"> • Best used as ovicide and against immatures • Valuable in a rotation program for resistance management
(ERM, TSM) dicofol: Kelthane	ERM 2 TSM 2	<ul style="list-style-type: none"> • Quick action • Good residual 	<ul style="list-style-type: none"> • Phytotoxic to certain cultivars • Resistance concerns limit applications • High cost • Strong odor 	<ul style="list-style-type: none"> • Valuable in a rotation program for resistance management • Resistance not stable
(ERM, TSM) fenbutatin oxide: Vendex	ERM 2 TSM 2	<ul style="list-style-type: none"> • Easy on beneficial predator mites 	<ul style="list-style-type: none"> • Toxic to fish • Corrosive to eyes and skin • Multiple applications necessary • Slow acting • Temperature dependent 	<ul style="list-style-type: none"> • Potential value in a rotation program for resistance management • Not a viable primary management tool for these pests (see cons)
(ERM, TSM) fenpropathrin: Danitol	ERM 3 TSM 3	<ul style="list-style-type: none"> • Useful for managing other pests simultaneously • Low cost • Fast acting 	<ul style="list-style-type: none"> • Destroys and repels beneficial mites and insects • Disruptive to IPM programs • Resistance expected with repeated use • Do not apply within 25 feet of water 	<ul style="list-style-type: none"> • Not a viable primary management tool for these pests (see cons)
(ERM, TSM) formetanate HCl: Carzol	ERM 2 TSM -	<ul style="list-style-type: none"> • Useful for managing other pests simultaneously (leafminers and mullein plant bug) 	<ul style="list-style-type: none"> • Can't be used after petal fall 	<ul style="list-style-type: none"> • Not recommended for use
(ERM, TSM) hexythiazox: Savey	ERM 3 TSM -	<ul style="list-style-type: none"> • Safe on beneficials • Long residual at high rates • Alternative to oil applications 	<ul style="list-style-type: none"> • Cross resistant with Apollo • Not effective against adults 	<ul style="list-style-type: none"> • Best used as ovicide and against immatures • Valuable in a rotation program for resistance management
(ERM, TSM) insecticidal soap: M-Pede Safer's	ERM 2 TSM 2	<ul style="list-style-type: none"> • Approved for organic production • Good surfactant 	<ul style="list-style-type: none"> • Kills aphid predators • Phytotoxic to certain cultivars • No residual activity • Very high cost • Requires thorough coverage in multiple applications 	<ul style="list-style-type: none"> • Not a viable management tool for this pest (see cons)

(ERM, TSM) oil: Damoil Volck, Amigo, etc.	ERM 3* 3** TSM -* 2**	<ul style="list-style-type: none"> • Easy on beneficials • No resistance • Low cost • Very important to IPM programs • Good surfactant • Amigo approved for organic production 	<ul style="list-style-type: none"> • Time consuming • Timing critical • Thorough coverage required • Difficult to apply due to seasonal conditions (spring) 	<ul style="list-style-type: none"> • Dormant oils are effective against ERM eggs only, not TSM • Very important to IPM programs • The first defense against ERM
(ERM, TSM) oxamyl: Vydate	ERM 2 TSM 2	<ul style="list-style-type: none"> • Useful for managing other pests simultaneously (leafminers) • Fast acting 	<ul style="list-style-type: none"> • Hard on beneficials • Use has induced mite problems • Highly toxic to applicators • Hazardous to aquatic organisms • Phytotoxicity to certain cultivars • Short residual activity • Resistance concerns limit applications • Degrades rapidly above pH 7 in tank mix • Strong odor 	<ul style="list-style-type: none"> • Not a viable management tool for this pest (see cons) • Carbamate
(ERM, TSM) pyridaben: Pyramite	ERM 3 TSM 2	<ul style="list-style-type: none"> • Fast acting • Long residual 	<ul style="list-style-type: none"> • Moderate toxicity to beneficials • Toxic to bees • Need higher rates for TSM • Not effective on adults 	<ul style="list-style-type: none"> • Valuable in a rotation program for resistance management

1=poor, 2=fair, 3=good, x=no efficacy data available *dormant **summer
?=not rated for this pest or insufficient information, -=not registered for use at appropriate time for pest

Current Cultural and Biological Aids/Alternatives

METHOD	PROS	CONS	COMMENTS
Orchard floor groundcover/ habitat management (alternate mix of groundcover, timing of mowing, alternate row mowing)	<ul style="list-style-type: none"> • May reduce insecticide applications 	<ul style="list-style-type: none"> • Aesthetic aspects not pleasing 	<ul style="list-style-type: none"> • Fits into IPM programs
Predatory mites and insects	<ul style="list-style-type: none"> • Provide significant suppression and are capable of making miticide application unnecessary. • Endemic populations available for conservation 	<ul style="list-style-type: none"> • Appropriate <i>T. pyri</i> strain not commercially available and establishment and dispersal is very slow after introduction 	<ul style="list-style-type: none"> • Fits into IPM programs • Maintenance of predatory populations sensitive to chemical applications.

Orchard monitoring of pest and beneficial populations	• May reduce insecticide applications	• Small size of pest difficult to see	• Fits into IPM programs
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Action Items

Research Needs:

- Continued evaluation of orchard floor and nutritional management strategies to improve conservation of predator mites.
- Assess impact of insecticides, miticides and fungicides on pest and beneficial mites.
- Develop early season monitoring methods and treatment thresholds.
- Screening and development of new compounds.
- Further understanding of *T.pyri* and other predatory mites biology and environmental requirements to enhance use in New England

Regulatory Needs:

- Expedite registration of new alternatives as they become available.

Education Needs:

- Encourage use of *T. pyri* via education and orchard demonstration plots
- Educate consultants, growers, and scouts on proper implementation of products, techniques and strategies.
- Encourage use of IPM techniques through orchard demonstration plots.
- Increase consumer knowledge that IPM programs are environmentally friendly.

Diseases

1. Apple Scab

- **Acres Affected:** potential 100%
- **Yield Losses:** 100% if not managed
- Annual threat on 100% of apple trees that are susceptible to the disease.
- In the Northeast, it is not possible to produce commercially acceptable fruit from susceptible cultivars without a fungicide program to manage this disease
- Virtually all commercially acceptable cultivars are susceptible
- Scab may occur on leaves, fruit, leaf and fruit stems, and green twigs.
- Lesions on young fruit turn dark brown to black and become corky or scab-like with time.
- Primary (ascospore) infections must be managed to ease season-long management
- Secondary infections occur throughout growing season if primary management is incomplete
- Infections that occur just before harvest may be symptomless at picking yet develop into storage scab lesions after harvest.

Currently Registered Pesticides

PESTICIDE	EFFI-CACY	PROS	CONS	COMMENTS
basic copper sulfate: Basic Copper Basicop Blue Shield	1	<ul style="list-style-type: none"> • Useful for managing other diseases simultaneously (suppressive effect against fire blight) • Low cost • Foliar nutrient 	<ul style="list-style-type: none"> • Phytotoxic to certain cultivars • Can only be used until ¼ inch green 	<ul style="list-style-type: none"> • Not a viable management tool for this disease (see cons)
captan: Captan Captec	4	<ul style="list-style-type: none"> • Easy on beneficials • Useful for managing other diseases simultaneously • Low resistance risk • Low cost • Anti-sporulant activity useful in case of outbreak 	<ul style="list-style-type: none"> • Visible residue on fruit • Can't apply with or near oil • Long REI limits its utility • B2 carcinogen 	<ul style="list-style-type: none"> • Critical for IPM program for scab management • Importance in scab resistance management • The long-term standard against which other scab materials are evaluated
copper hydroxide: Kocide Champ Champion	2	<ul style="list-style-type: none"> • Useful for managing other diseases simultaneously (suppressive effect against fire blight) • Low cost • Foliar nutrient • Some formulations approved for organic production 	<ul style="list-style-type: none"> • Phytotoxic to certain cultivars • Long residual can lead to tissue damage • Can only be used until ½ inch green 	<ul style="list-style-type: none"> • Not a viable management tool for this disease (see cons)

copper oxychloride sulfate: COCS	2	<ul style="list-style-type: none"> • Useful for managing other diseases simultaneously (suppressive effect against fire blight) • Low cost • Foliar nutrient • Some formulations approved for organic production 	<ul style="list-style-type: none"> • Phytotoxic to certain cultivars • Long residual can lead to tissue damage • Can only be used until ½ inch green 	<ul style="list-style-type: none"> • Not a viable management tool for this disease (see cons)
cyprodinil: Vangard	2	<ul style="list-style-type: none"> • Good in cold weather • 48 hours post-infection activity 	<ul style="list-style-type: none"> • Weak activity against fruit scab • Not broad spectrum • Not anti-sporulant • Requires tank mix after tight cluster 	<ul style="list-style-type: none"> • May be of value if resistance develops to other post-infection materials
dodine: Syllit	4	<ul style="list-style-type: none"> • Low cost • Compatible with oil • Anti-sporulant activity 	<ul style="list-style-type: none"> • Phytotoxic to certain cultivars • Resistance concerns limit applications • Narrow spectrum • Mixes poorly in cold water 	<ul style="list-style-type: none"> • Good fungicide if no resistance present • Should be used in a rotation • Limit use to 1-2 applications per year
fenarimol: Rubigan	4	<ul style="list-style-type: none"> • Useful for managing other diseases simultaneously • Low cost • Potentially 96 hours post-infection activity 	<ul style="list-style-type: none"> • Resistance concerns limit applications • Requires tank mix • Limited protectant ability 	<ul style="list-style-type: none"> • Reduces number of applications resulting in net savings • Useful in managing Powdery Mildew and Cedar Apple Rust simultaneously
ferbam: Ferbam Granuflo	2	<ul style="list-style-type: none"> • Effective against cedar apple rust • Compatible with oil 	<ul style="list-style-type: none"> • Phytotoxic to certain cultivars • Visible black residue on fruit • Weak scab fungicide 	<ul style="list-style-type: none"> • Not a viable management tool for this disease (see cons)
kresoxim-methyl: Sovran	4	<ul style="list-style-type: none"> • Useful for managing other diseases simultaneously • Excellent post-infection activity • Anti-sporulant activity 	<ul style="list-style-type: none"> • Resistance concerns limit applications • High cost • Post-infection activity may be reduced where SI resistance present 	<ul style="list-style-type: none"> • Reduces number of applications needed to manage scab
mancozeb: Dithane Manzate Penncozeb	4	<ul style="list-style-type: none"> • Useful for managing other diseases simultaneously • No resistance • Low cost • Compatible with oil • Nutrient Manganese 	<ul style="list-style-type: none"> • Post-bloom use detrimental to <i>T. pyri</i> • Long pre-harvest interval limits its utility • B2 carcinogen 	<ul style="list-style-type: none"> • Standard protectant • Important in resistance management

maneb: Maneb Manex	4	<ul style="list-style-type: none"> • Useful for managing other diseases simultaneously • No resistance • Low cost • Compatible with oil 	<ul style="list-style-type: none"> • Post-bloom use detrimental to <i>T. pyri</i> • Long pre-harvest interval limits its utility • B2 carcinogen 	<ul style="list-style-type: none"> • Not a standard protectant
metiram: Polyram	4	<ul style="list-style-type: none"> • Useful for managing other diseases simultaneously • No resistance • Low cost • Compatible with oil • Nutrient Zinc 	<ul style="list-style-type: none"> • Post-bloom use detrimental to <i>T. pyri</i> • Long pre-harvest interval limits its utility • B2 carcinogen 	<ul style="list-style-type: none"> • Standard protectant • Important in resistance management
myclobutanil: Nova	4	<ul style="list-style-type: none"> • Useful for managing other diseases simultaneously • Low cost • Potentially 96 hours post-infection activity 	<ul style="list-style-type: none"> • Resistance concerns limit applications • Requires tank mix • Limited protectant ability 	<ul style="list-style-type: none"> • Reduces number of applications resulting in net savings
sulfur: Sulfur	2	<ul style="list-style-type: none"> • Useful for managing other diseases simultaneously (powdery mildew) • Useful for mite suppression • Low resistance risk • Approved for organic production • PHI 0 days 	<ul style="list-style-type: none"> • Disrupts mite predators • Toxic to earthworms • Phytotoxic to certain cultivars • Short residual activity • Highly visible residue on fruit • Requires very frequent spraying for satisfactory management • Strongly acidifies soil • Incompatible with oil 	<ul style="list-style-type: none"> • Not a viable primary management tool (see cons)
thiophanate methyl: Topsin-M	4	<ul style="list-style-type: none"> • Useful for managing other diseases simultaneously • Anti-sporulant activity • PHI 0 days 	<ul style="list-style-type: none"> • Potential predator mite disruption • Resistance concerns limit applications • Must be tank mixed 	<ul style="list-style-type: none"> • Not a stand alone for scab
thiram: Thiram	2	<ul style="list-style-type: none"> • Useful for managing other diseases simultaneously • Compatible with oil • Lower REI than other fungicides • Deer repellent 	<ul style="list-style-type: none"> • Weak scab fungicide • Requires frequent application 	<ul style="list-style-type: none"> • Not a viable management tool for this disease (see cons)
triadimefon: Bayleton	1			<ul style="list-style-type: none"> • Not a viable management tool for this disease

trifloxystrobin: Flint	4	<ul style="list-style-type: none"> • Useful for managing other diseases simultaneously • Excellent post-infection activity • Anti-sporulant activity 	<ul style="list-style-type: none"> • Resistance concerns limit applications • High cost • Post-infection activity may be reduced where SI resistance present 	<ul style="list-style-type: none"> • Reduces number of applications needed to manage scab
triflumizole: Procure	4	<ul style="list-style-type: none"> • Useful for managing other diseases simultaneously • Low cost • Potentially 72 hours post-infection activity 	<ul style="list-style-type: none"> • Resistance concerns limit applications • Requires tank mix • Limited protectant ability 	<ul style="list-style-type: none"> • Reduces number of applications resulting in net savings
ziram: Ziram	1	<ul style="list-style-type: none"> • Useful for managing other diseases simultaneously • Compatible with oil 	<ul style="list-style-type: none"> • Phytotoxic to certain cultivars • Multiple applications necessary • Weak scab fungicide 	<ul style="list-style-type: none"> • Not a viable management tool for this disease (see cons)

1=slight, 2=fair, 3=good, 4=excellent, x=unknown or does not apply

Current Cultural and Biological Aids/Alternatives

METHOD	PROS	CONS	COMMENTS
Autumn assessment of potential inoculum levels	<ul style="list-style-type: none"> • May reduce fungicide applications • Improves effectiveness of IPM program 	<ul style="list-style-type: none"> • Labor intensive during heavy workload period • Techniques are knowledge and data intensive 	<ul style="list-style-type: none"> • private consultants and scouts could be helpful in this area
Spring/Summer monitoring of scab maturity and infection periods	<ul style="list-style-type: none"> • May reduce fungicide applications • Improves effectiveness of IPM program 	<ul style="list-style-type: none"> • Techniques are knowledge and data intensive 	<ul style="list-style-type: none"> • private consultants and scouts could be helpful in this area
Sanitation methods (flailing or elimination of leaves, application of urea) in autumn and/or spring	<ul style="list-style-type: none"> • Reduces risk of scab infection in the spring leading to reduced sprays 	<ul style="list-style-type: none"> • Sometimes leaves don't fall until snowcover • Spring conditions not conducive to mechanical access • Labor intensive 	<ul style="list-style-type: none"> • Does not eliminate need for sprays but may allow for overall reduction in fungicide use.
Remove wild/alternate hosts and abandoned orchards	<ul style="list-style-type: none"> • Potential to reduce inoculum • Also reduces insect pest pressures 	<ul style="list-style-type: none"> • Not practical when hosts are off orchard property • Access can be limited by physical condition of landscape • Costly 	<ul style="list-style-type: none"> • Not enough as a stand-alone technique. • Does not eliminate need for sprays

Plant scab-resistant cultivars.	<ul style="list-style-type: none"> • Cultivars that are resistant to apple scab are available 	<ul style="list-style-type: none"> • None of the scab-resistant cultivars have been widely accepted in the marketplace. 	<ul style="list-style-type: none"> • Resistance may be lost over long term
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Action Items

Research Needs:

- Improve models and techniques that quantify and predict changes in scab risk potential throughout the season.
- Evaluate alternative chemistries for scab management.
- Captan and EBDCs are quite important for resistance management. Their continued availability is a priority in IPM programs.
- Cost effective resistance monitoring tools
- Economics of different strategies needs to be studied.
- Sanitation methods need more study.
- Investigate biocontrol strategies.
- Develop resistant cultivars that are commercially acceptable and adaptable to New England growing conditions.
- Incorporate variations in susceptibility into management strategies.

Regulatory Needs:

- Expedite registration of new alternatives as they become available.
- Implement and enforce abandoned orchard and feral tree removal regulations.

Education Needs:

- Educate consultants, growers, and scouts on proper implementation of products, techniques and strategies.
- Encourage use of IPM techniques through orchard demonstration plots.
- Increase consumer knowledge that IPM programs are environmentally friendly.
- Make consumers aware that cosmetic injury does not affect fruit quality.

2. Fire Blight

- **Acres Affected:** potential 100% over the life of any individual orchard
- **Yield Losses:** potential 100% tree death if not managed
- Outbreaks are sporadic in most parts of New England, but can cause devastating orchard damage that may result in tree death
- In the early stages of infection, blossoms appear water-soaked and gray-green but quickly turn brown or black; generally, the entire cluster becomes blighted and killed.
- The shoot blight phase, which first appears one to several weeks after petal fall, turns the leaves and stem on young, succulent shoot tips brown or black and bend over into a characteristic shape similar to the top of a shepherd's crook or candy cane.
- Shoot blight infections can expand beyond the current season's growth into the older supporting wood, causing dark sunken cankers.
- Entire trees on highly susceptible rootstocks (Mark, M. 9, M. 26) or interstems can wilt and die if this portion becomes infected.
- Some of the newer, commercially acceptable cultivars are highly susceptible to this disease
- Speed of disease progression is very rapid, making management timing critical

Currently Registered Pesticides

PESTICIDE	EFFI-CACY	PROS	CONS	COMMENTS
basic copper sulfate: Basic Copper Basicop Blue Shield	x	<ul style="list-style-type: none"> • Useful for managing other diseases simultaneously (suppressive effect against apple scab) • Low cost • Foliar nutrient 	<ul style="list-style-type: none"> • Phytotoxic to certain cultivars • Can only be used until ¼ inch green 	<ul style="list-style-type: none"> • Not a stand alone management tool for this disease (see cons)
copper hydroxide: Kocide Champ Champion	x	<ul style="list-style-type: none"> • Useful for managing other diseases simultaneously (suppressive effect against apple scab) • Low cost • Foliar nutrient • Some formulations approved for organic production 	<ul style="list-style-type: none"> • Phytotoxic to certain cultivars • Long residual can lead to tissue damage • Can only be used until ½ inch green 	<ul style="list-style-type: none"> • Not a stand alone management tool for this disease (see cons)
copper oxychloride sulfate: COCS	x	<ul style="list-style-type: none"> • Useful for managing other diseases simultaneously (suppressive effect against apple scab) • Low cost • Foliar nutrient • Some formulations approved for organic production 	<ul style="list-style-type: none"> • Phytotoxic to certain cultivars • Long residual can lead to tissue damage • Can only be used until ½ inch green 	<ul style="list-style-type: none"> • Not a stand alone management tool for this disease (see cons)

<i>B. subtilis:</i> Serenade	x	<ul style="list-style-type: none"> • Nontoxic to beneficials • Good activity against blossom blight phase when used in alternation with streptomycin • Approved for organic production 	<ul style="list-style-type: none"> • Has to be used ahead of infection period • Routine applications not profitable considering the rarity of infection periods 	<ul style="list-style-type: none"> • May provide tool for resistance management • Protective in case of future blossom infections • Little experience in New England
prohexadione-calcium: Apogee	x	<ul style="list-style-type: none"> • Can have significant effect on reducing shoot blight • Horticultural impact beneficial on established trees 	<ul style="list-style-type: none"> • Very high cost • Multiple applications necessary • Indirect effect on susceptibility via reduction of shoot growth • Has to be used before known infection • Not effective on blossom blight • Can stunt young trees in year of treatment 	<ul style="list-style-type: none"> • Indirect effects can contribute to a disease management program
Harpin protein: Messenger	x	<ul style="list-style-type: none"> • Induces temporary resistance 	<ul style="list-style-type: none"> • Has to be used ahead of infection period • Results variable 	<ul style="list-style-type: none"> • Still experimental
streptomycin sulfate: Agrimycin Bac-Master Streptrol	4	<ul style="list-style-type: none"> • Most effective alternative 	<ul style="list-style-type: none"> • Resistance concerns limit applications • High cost • Multiple applications may be necessary • Thorough coverage very necessary • Timing critical 	<ul style="list-style-type: none"> • Use of disease models critical for timing of sprays

1=slight, 2=fair, 3=good, 4=excellent, x=unknown or does not apply

Current Cultural and Biological Aids/Alternatives

METHOD	PROS	CONS	COMMENTS
Pruning out cankered limbs and branches during the dormant season.	<ul style="list-style-type: none"> • Primary inoculum sources should be reduced 	<ul style="list-style-type: none"> • Labor intensive • Pruned materials must be burned or buried • Total disease elimination through pruning not possible • Pruning can disrupt tree structure 	<ul style="list-style-type: none"> • Necessary as part of complete management protocol
Pruning out blighted shoots as soon as they appear in the early summer.	<ul style="list-style-type: none"> • inoculum sources should be reduced 	<ul style="list-style-type: none"> • Labor intensive • Pruned materials must be burned or buried • Total disease elimination through pruning not possible 	<ul style="list-style-type: none"> • Necessary as part of complete management protocol

		<ul style="list-style-type: none"> • Pruning can disrupt tree structure • Timing critical 	
Pruning systems and nitrogen fertilization practices that avoid excessive and prolonged shoot growth		<ul style="list-style-type: none"> • Labor intensive • Pruned materials must be burned or buried • Total disease elimination through pruning not possible • Pruning can disrupt tree structure • Nitrogen restriction not suitable for young plantings 	<ul style="list-style-type: none"> • Necessary as part of complete management protocol
Remove wild/alternate hosts and abandoned orchards	<ul style="list-style-type: none"> • Potential to reduce inoculum • Also reduces insect pest pressures 	<ul style="list-style-type: none"> • Not practical when hosts are off orchard property • Access can be limited by physical condition of landscape • Costly 	<ul style="list-style-type: none"> • Not enough as a stand-alone technique. • Does not eliminate need for sprays
Avoid highly susceptible cultivars and rootstocks.	<ul style="list-style-type: none"> • The most effective horticultural practice for minimizing outbreaks 	<ul style="list-style-type: none"> • Certain commercially acceptable cultivars are very susceptible 	<ul style="list-style-type: none"> • Opportunity when planning orchard or new trees • Marketing demands conflict with fire blight management

Action Items

Research Needs:

- New materials and methods (current management is based on one material that is prone to resistance)
- Resistant rootstocks and cultivars need to be developed and evaluated in New England
- Biocontrol research
- Improve computer models to make applicable to New England
- Further knowledge of insect vectors and plant damage that opens plant to disease

Regulatory Needs:

- Expedite registration of new alternatives as they become available.
- Need to have more freedom to register antibiotics that we know work before resistance becomes an issue
- Implement and enforce abandoned orchard and feral tree removal regulations.

Education Needs:

- Educate consultants, growers, and scouts on proper implementation of products, techniques and strategies.
- Encourage use of IPM techniques through orchard demonstration plots.
- Increase consumer knowledge that IPM programs are environmentally friendly.

3. Flyspeck & Sooty Blotch

- **Acres Affected:** potential 33%
- **Yield Losses:** 0.5-1% if managed; potential 60% if not managed in wet years.
- These two diseases are treated as a single pest due to their similar management needs
- Disease incidence and severity can be highly variable among production regions, growing seasons, and individual orchards.
- Sooty blotch appears as dark olive green or sooty-colored fungus colonies on the surface of infected fruit.
- Flyspeck appears as distinct groupings of black, round spots on the surface of the fruit.
- Strictly cosmetic injury important to consumer acceptability
- Prevention of these diseases drives summer disease management programs in the absence of scab

Currently Registered Pesticides

PESTICIDE	EFFI-CACY	PROS	CONS	COMMENTS
captan: Captan Captec	2	<ul style="list-style-type: none"> • Easy on beneficials • Useful for managing other diseases simultaneously • Low resistance risk • Low cost 	<ul style="list-style-type: none"> • Visible residue on fruit • Can't apply with or near oil • Long REI limits its utility • B2 carcinogen 	<ul style="list-style-type: none"> • Important for overall resistance management • Not recommended as stand alone with high disease pressure
dodine: Syllit	1	<ul style="list-style-type: none"> • Low cost • Compatible with oil 	<ul style="list-style-type: none"> • Phytotoxic to certain cultivars • Resistance concerns limit applications Narrow spectrum • Mixes poorly in cold water 	<ul style="list-style-type: none"> • Not a viable management tool
ferbam: Ferbam Granuflo	2	<ul style="list-style-type: none"> • Compatible with oil 	<ul style="list-style-type: none"> • Phytotoxic to certain cultivars • Visible black residue on fruit 	<ul style="list-style-type: none"> • Not a viable management tool for this disease (see cons)
kresoxim-methyl: Sovran	4	<ul style="list-style-type: none"> • Useful for managing other diseases simultaneously 	<ul style="list-style-type: none"> • Apple Scab resistance concern limits applications • High cost 	<ul style="list-style-type: none"> • Strobilurins are the best materials available for managing these pests

mancozeb: Dithane Manzate Penncozeb	4	<ul style="list-style-type: none"> • Useful for managing other diseases simultaneously • No resistance • Low cost • Compatible with oil • Nutrient Manganese 	<ul style="list-style-type: none"> • Post-bloom use detrimental to <i>T. pyri</i> • Long pre-harvest interval limits summer use • B2 carcinogen 	<ul style="list-style-type: none"> • Long pre-harvest interval limits summer use
mane: Maneb Manex	4	<ul style="list-style-type: none"> • Useful for managing other diseases simultaneously • No resistance • Low cost • Compatible with oil 	<ul style="list-style-type: none"> • Post-bloom use detrimental to <i>T. pyri</i> • Long pre-harvest interval limits summer use • B2 carcinogen 	<ul style="list-style-type: none"> • Long pre-harvest interval limits summer use
metiram: Polyram	4	<ul style="list-style-type: none"> • Useful for managing other diseases simultaneously • No resistance • Low cost • Compatible with oil • Nutrient Zinc 	<ul style="list-style-type: none"> • Post-bloom use detrimental to <i>T. pyri</i> • Long pre-harvest interval limits summer use • B2 carcinogen 	<ul style="list-style-type: none"> • Long pre-harvest interval limits summer use
sulfur: Sulfur	1	<ul style="list-style-type: none"> • Useful for managing other diseases simultaneously (powdery mildew) • Useful for mite suppression • Low resistance risk • Approved for organic production • PHI 0 days 	<ul style="list-style-type: none"> • Disrupts mite predators • Toxic to earthworms • Phytotoxic to certain cultivars • Short residual activity • Highly visible residue on fruit • Requires very frequent spraying for satisfactory management • Acidifies soil • Incompatible with oil 	<ul style="list-style-type: none"> • Not useful management tool
thiophanate methyl: Topsin-M	4	<ul style="list-style-type: none"> • Useful for managing other diseases simultaneously • PHI 0 days • Limited visible residue 	<ul style="list-style-type: none"> • Potential predator mite disruption • Resistance concerns with other diseases limit applications 	<ul style="list-style-type: none"> • Provides good long-term management
thiram: Thiram	2	<ul style="list-style-type: none"> • Useful for managing other diseases simultaneously • Compatible with oil • Lower REI than other fungicides • Deer repellent 	<ul style="list-style-type: none"> • Multiple applications necessary 	<ul style="list-style-type: none"> • Rarely used because more effective alternatives available

trifloxystrobin: Flint	4	<ul style="list-style-type: none"> • Useful for managing other diseases simultaneously 	<ul style="list-style-type: none"> • Apple Scab resistance concerns limit applications 	<ul style="list-style-type: none"> • Strobilurins are the best materials available for managing these pests
ziram: Ziram	3	<ul style="list-style-type: none"> • Useful for managing other diseases simultaneously • Compatible with oil 	<ul style="list-style-type: none"> • Phytotoxic to certain cultivars 	

1=slight, 2=fair, 3=good, 4=excellent, x=unknown or does not apply

Current Cultural and Biological Aids/Alternatives

METHOD	PROS	CONS	COMMENTS
Annual pruning to open tree canopies and promote air circulation	<ul style="list-style-type: none"> • Will minimize the conditions favorable to infection. • Improves the spray coverage for any fungicides that may be applied 		<ul style="list-style-type: none"> • Part of normal orchard maintenance
Proper fruit thinning	<ul style="list-style-type: none"> • Important for reducing the development of high-humidity microclimates around clustered fruit • Improves the spray coverage for any fungicides that may be applied 		<ul style="list-style-type: none"> • Part of normal orchard maintenance
Mowing of grass middles and within-row weed management	<ul style="list-style-type: none"> • reduces overall humidity levels within orchards during the summer • reduces alternate hosts 	<ul style="list-style-type: none"> • Counterproductive to maintaining mite predator populations 	
The removal of hedgerows or surrounding woodlots	<ul style="list-style-type: none"> • Improves airflow and reduces humidity • Potential to reduce inoculum • Also reduces insect pest pressures 	<ul style="list-style-type: none"> • Not practical when hosts are off orchard property • Access can be limited by physical condition of landscape • Costly 	<ul style="list-style-type: none"> • Not enough as a stand-alone technique. • Does not eliminate need for sprays
Remove wild/alternate hosts and abandoned orchards	<ul style="list-style-type: none"> • Potential to reduce inoculum • Also reduces insect pest pressures 	<ul style="list-style-type: none"> • Huge number of alternate hosts • Not practical when not on orchard property • Access can be limited by physical condition of landscape • Costly 	<ul style="list-style-type: none"> • Not enough as a stand-alone technique. • Does not eliminate need for sprays

Action Items

Research Needs:

- Develop predictive models that are easy to use and applicable to New England conditions
- Better understanding of epidemiology
- Develop a site-specific risk assesment protocol to characterize individual orchards and the surrounding habitat as disease harborage

Regulatory Needs:

- Expedite registration of new alternatives as they become available.
- Implement and enforce abandoned orchard and feral tree removal regulations.

Education Needs:

- Educate consultants, growers, and scouts on proper implementation of products, techniques and strategies.
- Encourage use of IPM techniques through orchard demonstration plots.
- Increase consumer knowledge that IPM programs are environmentally friendly.
- Make consumers aware that cosmetic injury does not affect fruit quality.

Weeds

Grasses (G), Broadleaf Weeds (BW), Woody Brush and Vines (WBV)

- Management of the orchard floor is an essential and often expensive piece of the overall orchard management scheme.
- Permanent sod, often including a narrow under-tree herbicide strip, is the orchard floor management system most commonly used
- Beyond mowing, a typical orchard weed management program consists of 1 or 2 late spring and early summer post-emergent herbicide applications to tree rows to stunt weed growth but allowing survival and some regrowth for winter ground cover.
- Occasional fall post-emergent herbicide applications are made to manage perennial weed species.
- Post-emergent herbicides effective against grass, broadleaf weeds, and woody perennials are most useful.
- The most commonly used herbicides are glyphosate, paraquat, simazine, diuron, 2-4 D, norflurazon, oryzalin, and sulfosate.
- Weeds compete for soil moisture and nutrients in newly planted and mature orchards.
- Weeds may host pests including plant viruses and can compete for pollinating bees in spring.
- Thick orchard floor cover encourages meadow voles and trunk borers, both of which can be lethal to fruit trees.
- Plant cover on orchard floor in late season prevents nutrients from leaching from soil, prevents erosion, and provides some protection to shallow roots from low winter temperatures.
- Weed management is critically important in new plantings.

Currently Registered Pesticides

PESTICIDE	PROS	CONS	COMMENTS
(G) clethodim: Select	<ul style="list-style-type: none"> • Low persistence in most soils (half life = 3 days) • Low toxicity to bees 	<ul style="list-style-type: none"> • Nonbearing trees only 	<ul style="list-style-type: none"> • Little experience in New England
(G, BW) dichlobenil: Casoron	<ul style="list-style-type: none"> • May use in year of planting trees • No PHI 	<ul style="list-style-type: none"> • Can not treat newly planted trees until at least 4 weeks after planting • Persistent in soil • Volatilizes under warm conditions • Late autumn application only • Expensive • Granular form only requires special equipment; therefore rarely used 	<ul style="list-style-type: none"> • Pre-emergent activity
(G, BW) diuron: Karmex Direx	<ul style="list-style-type: none"> • No PHI • Nontoxic to bees 	<ul style="list-style-type: none"> • May not use until trees are one year old • Moderate to high persistence in soil (half life = 1+ years) • Moderate mammalian toxicity 	<ul style="list-style-type: none"> • Pre-emergent activity

(G) fluazifop: Fusilade	<ul style="list-style-type: none"> • May use in year of planting trees • Low persistence in most soils (half life = < 1 week) • Low toxicity to bees 	<ul style="list-style-type: none"> • 365 PHI 	<ul style="list-style-type: none"> • Post-emergent activity
(G, BW,WBV) glufosinate-ammonium: Rely	<ul style="list-style-type: none"> • Broad range 	<ul style="list-style-type: none"> • May not use until trees are one year old • No residual activity in soil • 14 day PHI • Will kill any vegetation in contact 	<ul style="list-style-type: none"> • Post-emergent activity
(G, BW,WBV) glyphosphate: Roundup Touchdown Glyphomax	<ul style="list-style-type: none"> • Low mammalian toxicity 	<ul style="list-style-type: none"> • May not use until trees are two years old • 14 day PHI • 1-2 week interval before effects on weeds is noticeable 	<ul style="list-style-type: none"> • Widely used, except in first year plantings • Post-emergent activity
(BW) isoxaben: Gallery	<ul style="list-style-type: none"> • May use in year of planting trees 	<ul style="list-style-type: none"> • Nonbearing trees only 	<ul style="list-style-type: none"> • Pre-emergent activity
(G, BW) isoxaben +trifluralin: Snapshot		<ul style="list-style-type: none"> • Nonbearing trees only 	
(G) napropamide: Devrinol	<ul style="list-style-type: none"> • May use in year of planting trees • Nontoxic to bees • Useful in light soils 	<ul style="list-style-type: none"> • Moderately persistent in soil (half life = 56-84 days) • 35 day PHI • Requires significant moisture for incorporation 	<ul style="list-style-type: none"> • Pre-emergent activity
(G) norflurazon: Solicam	<ul style="list-style-type: none"> • May use in year of planting trees • No PHI 		<ul style="list-style-type: none"> • Pre-emergent activity
(G) oryzalin: Surflan	<ul style="list-style-type: none"> • May use in year of planting trees • No PHI • Nontoxic to bees • Low toxicity to birds 	<ul style="list-style-type: none"> • Low to moderately persistent in soil (half life = 20-128 days) • Requires significant moisture for incorporation 	<ul style="list-style-type: none"> • Pre-emergent activity

(BW) oxyfluorfen: Goal	<ul style="list-style-type: none"> • May use in year of planting trees 	<ul style="list-style-type: none"> • Dormant trees only 	<ul style="list-style-type: none"> • Pre-emergent activity
(G, BW) paraquat: Gromoxone Extra	<ul style="list-style-type: none"> • May use in year of planting trees • No PHI • Nontoxic to bees 	<ul style="list-style-type: none"> • Highly persistent in soil (half life = 100 days) • High mammalian toxicity • Restricted use 	<ul style="list-style-type: none"> • Widely used • Post-emergent activity
(G) pendimethalin: Prowl	<ul style="list-style-type: none"> • Nontoxic to bees 	<ul style="list-style-type: none"> • Nonbearing trees only • Moderately persistent in soil (half life = 40 days) • 365 day PHI • High human toxicity 	<ul style="list-style-type: none"> • Pre-emergent activity
(G) pronamide: Kerb	<ul style="list-style-type: none"> • Selective 	<ul style="list-style-type: none"> • May not use until trees are one year old • Moderately persistent in soil (half life = 60 days) • B2 carcinogen • Late autumn application only • Soil incorporated 	<ul style="list-style-type: none"> • Pre-emergent and Post-emergent activity
(BW) simazine: Caliber Simizine	<ul style="list-style-type: none"> • No PHI 	<ul style="list-style-type: none"> • May not use until trees are one year old • Moderately persistent in soil (half life = 28-147 days) 	<ul style="list-style-type: none"> • Most widely used preemergence herbicide
(BW,WBV) sulfosate: Touchdown			<ul style="list-style-type: none"> • Post-emergent activity • Systemic • Similar to glyphosate but moves faster
(BW) terbacil: Sinbar		<ul style="list-style-type: none"> • May not use until trees are three years old • Highly persistent in soil (half life = 50-180 days) • 60 day PHI • Not for use on sandy soils or exposed roots 	<ul style="list-style-type: none"> • Pre-emergent activity

(BW) 2,4-D: Saber Amine4		<ul style="list-style-type: none"> • May not use until trees are one year old • 14 day PHI • High oral toxicity to humans 	<ul style="list-style-type: none"> • Post-emergent activity
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Current Cultural/Biological Aids & Alternatives

METHOD	PROS	CONS	COMMENTS
Excessive weedy vegetation in most orchards is managed by mowing or flailing row middles and application of herbicides within the rows.	<ul style="list-style-type: none"> • Sods reduce soil erosion, improve traffic conditions in wet weather, and increase water infiltration and drainage. reduce reliance on herbicides 	<ul style="list-style-type: none"> • Repeated use of the same or similar weed management practice results in a weed shift to species that tolerate these practices • Mulch tends to have a positive impact on growth and yield, soil moisture and soil quality • Spider mites, voles and climbing cutworms have been a problem when mulch is used. 	<ul style="list-style-type: none"> • A combination of weed management practices or treatments, rotation practices and herbicides are utilized to prevent weed shifts
Use less aggressive orchard floor species	<ul style="list-style-type: none"> • Less mowing required • Less competition with trees for nutrients and water 	<ul style="list-style-type: none"> • Difficult to accomplish in established orchards 	<ul style="list-style-type: none"> • Most useful at time of orchard establishment

Action Items

Research Needs:

- Evaluate impact of orchard floor management on biocontrol of mites in apple orchards.
- Test new herbicides for crop tolerance and efficacy as they become available.
- Determine the potential weed management benefit of cover crops in the row middles and utilization under trees as mulch.
- Determine the impact post-harvest weed competition has on flower bud development and winter hardiness.
- Determine the critical weed-free period resulting in optimum fruit quality, maximum yield, and tree growth.

Regulatory Needs:

- Expedite registration of new alternatives as they become available.

Education Needs:

- Educate consultants, growers, and scouts on proper implementation of products, techniques and strategies.
- Increase consumer knowledge that IPM programs are environmentally friendly.

Voles

- **Acres affected:** Potential 100%, but more likely 25-50%; varies by age of orchard, proximity to alternate habitat and food sources, population levels and winter snow cover, and orchard groundcover management practices.
- **Yield losses:** Can be significant as a result of tree death and/or reduced vigor
- Voles are ubiquitous, however, their populations are typically cyclical with wide variation in numbers.
- Meadow voles use surface vegetation and debris for cover and can easily girdle young trees resulting in tree death.
- Pine voles are largely subterranean and consume fine roots and girdle larger roots, resulting in tree death if severe. They can also girdle tree trunks in the winter under snow.
- Younger trees are most attractive and susceptible to damage.
- Rodenticide is a supplement to mowing and other ground cover management.
- Although rodenticide is considered a supplement in vole management, it is an important component of most vole management programs.
- Cultural controls (primarily repeated mowing) greatly reduce, though not necessarily eliminate, the need for rodenticid application.

Currently Registered Pesticides

PESTICIDE	PROS	CONS	COMMENTS
zinc phosphide PROZAP Hopkins ZP bait	<ul style="list-style-type: none"> • Pelletized version less attractive to nontarget species 	<ul style="list-style-type: none"> • Loses toxicity if bait becomes wet • Baits (corn and oats) may be attractive to nontarget species • Voles that survive a zinc phosphide exposure are less likely to accept bait with the same active ingredient a second time. 	<ul style="list-style-type: none"> • Important component of a vole management program • Oat-based baits are less attractive to nontarget species than corn-based baits.
diphacinone: Ramik	<ul style="list-style-type: none"> • Pelletized version less attractive to nontarget species • Alternative used when voles no longer accept zinc phosphide bait. 	<ul style="list-style-type: none"> • Use only in bait stations • Lack of broadcast application option increases final cost 	<ul style="list-style-type: none"> • Less commonly used than zinc phosphide • State registrations vary

Current Cultural and Biological Aids/Alternatives

METHOD	PROS	CONS	COMMENTS
Physical barriers, i.e. mouse guards, constructed of wire or plastic are most common and recommended, particularly on young trees.	<ul style="list-style-type: none"> • Hardware cloth trunk guards embedded in the ground and extending upwards higher than snow level are usually effective 	<ul style="list-style-type: none"> • Difficult to deploy and maintain • Certain guard types can prevent sprays and sunlight from reaching trunk • Don't prevent subsurface damage • Expensive 	

Frequent mowing to keep the orchard floor 'park-like' will reduce favored habitat for voles.	<ul style="list-style-type: none"> • Can greatly reduce or even eliminate need for autumn rodenticide applications 	<ul style="list-style-type: none"> • Conflicts with management of mite predators • High labor and equipment cost 	
Herbicide tree row strips are effective at reducing desirable habitat near trees.		<ul style="list-style-type: none"> • Conflicts with management of mite predators and erosion control 	
Removing drops from the orchard floor eliminates one food source attractive to voles		<ul style="list-style-type: none"> • Labor intensive • not cost effective 	
Fostering favorable habitat and perches for birds-of-prey and predatory mammals (coyotes, domestic cats, etc.) can be effective at keeping vole populations in check		<ul style="list-style-type: none"> • They will not eliminate the need for management. • May conflict with the use of redenticides i.e. predators may be attracted by the bait 	

Action Items

Research Needs:

- Evaluate habitat enrichment of vole predators birds of prey, coyotes, owls, etc.

Regulatory Needs:

- Expedite registration of new alternatives as they become available.

Education Needs:

- Educate consultants, growers, and scouts on proper implementation of products, techniques and strategies.
- Increase consumer knowledge that IPM programs are environmentally friendly.

Deer

- **Acres affected:** Potential 100%, varies by age of orchard, proximity to alternate habitat and food sources, population levels and winter snow cover.
- Deer are major orchard pests in New England.
- Damage prevention is through fencing rather than pesticide application.
- If an affordable, effective, sprayable deterrent was to become available it could be a useful addition to orchard management programs.

Part V: Appendix - Insecticide and Miticide Efficacy

Pesticide Efficacy for Key Insect and Mite Pests

Efficacy ratings:

0 = not effective, 1 = poor, 2 = fair, 3 = good

? = not rated for this pest or insufficient information

z = not registered for use at appropriate time for pest

blank = not used for this pest, presumably no activity

* = See comment below table

Pesticide		Codling Moth	Leafrollers		Mites	
Active ingredient	Brand name		Oblique-banded	Red-banded	ERM	TSSM
abamectin	Agri-Mek	?	?	?	3	2
acetamiprid	Assail	?	?	?		
azadirachtin	Aza-Direct, Neemix	2	?	?		?
azinophos-methyl ^{OP}	Guthion, Azinophos-M	3	2	3		
B.t. endotoxin	Agree, Dipel, Javelin, MVP, Xentari	2	2	3		
bifentazate	Acramite				3	3
carbaryl ^{Carb}	Sevin, Carbaryl	2	2	1		
chlorpyrifos ^{OP}	Lorsban	z	Z	Z		Z
cinnamaldehyde	Valero				?	?
clofentazine	Apollo				3	2
diazinon ^{OP}	Diazinon	3	2	0		
difocol	Kelthane				1-2	1-2
dimethoate ^{OP}	Digon, Dimate	3	1	0		
disulfoton ^{OP}	Di-Syston					
endosulfan	Thiodan, Phaser	0	1	2		
esfenvalerate	Asana	3	3	2	?	?
fenbutatin oxide	Vendex				2	2
fenpropathrin	Danitol	3	2-3	3	3	3
formetanate HCl	Carzol	z	0	0	2	Z
hexythiazox	Savey				3	Z
imidacloprid	Provado	?	?	?		
indoxacarb	Avaunt	2	2	2		
insecticidal soap	M-Pede, Safer's	0	0	0	2	2
kaolin clay	Surround	2*	1	1		
methidathion	Supracide					
methomyl ^{Carb}	Lannate	3	3	3		
methoxychlor	Methoxychlor	?				
methoxyfenozide	Intrepid	3	3	3		
oil (dormant and summer)	Damoil, Sunspray, Volck, etc.	1	?	?	3/3*	Z/1*

oxamyl ^{Carb}	Vydate	0	?	?	2	2
permethrin	Ambush, Pounce	z	2-3	3		
phosmet ^{OP}	Imidan	3	2	3		
pyrethrin	Pyrenone	1?*	1*	1*		
pyridaben	Pyramite	?	?	?	3	2
pyriproxyfen	Distance, Esteem	2	3	?		
rotenone	Rotenone	1*				
spinosad	SpinTor	2	3	3		
tebufenoxide	Confirm	2	3	3		
thiamethoxam	Actara	1	0	0		

* Efficacy ratings for oil against mites are split into prebloom and postbloom application timing.

Leafminer ratings with * are for adults, only unstarred ratings apply against larval mines.

Kaolin clay ratings are for repellence effect from multiple applications.

^{OP} =Organophosphate, ^{Carb} =Carbamate

Pesticide Efficacy for All Major Insect and Mite Pests

Pest Names Abbreviations

AA = Apple aphid ans spirea aphid

EAS = European apple sawfly

PLH = Potato leafhopper

RAA = Rosy apple aphid

RLH = Rose leafhopper

WAA = Woolly apple aphid

WAL = White apple leafhopper

Efficacy ratings:

0 = not effective, 1 = poor, 2 = fair, 3 = good

? = not rated for this pest or insufficient information

z = not registered for use at appropriate time for pest

blank = not used for this pest, presumably no activity

* = See comment below table

Pesticide		Aphids			Apple Maggot	Dog-wood Borer	Codling Moth	EAS	Green Fruit-worm	Leaf-hopper	
Active ingredient	Brand name	AA	RAA	WAA						PLH	RLH
abamectin	Agri-Mek	?	?		?	?	?	?	?	2	2
acetamiprid	Assail	?	?	?	?	?	?	?	?	?	?
azadirachtin	Aza-Direct, Neemix	2	2	?	?	?	2	?	?	2	2
azinophos-methyl ^{OP}	Guthion, Azinophos-M	1	1	1	3	?	3	3	1	1	1
B.t. endotoxin	Agree, Dipel, Javelin, MVP, Xentari	0	0		0		2	0	3	0	0
bifenazate	Acramite										
carbaryl ^{Carb}	Sevin, Carbaryl	1	1	1	3		2	2	1	3	3
chlorpyrifos ^{OP}	Lorsban	2	3	?	z	3	z	3	3	1	1
cinnamaldehyde	Valero	?	?	?							
clofentazine	Apollo										
diazinon ^{OP}	Diazinon	1	2	3	3		3	2-3	2	1	1

difocol	Kelthane										
dimethoate ^{OP}	Digon, Dimate	2	2	2-3	3		3	1	2	3	3
disulfoton ^{OP}	Di-Syston	?	?	?							
endosulfan	Thiodan, Phaser	3	3	2	0	?	0	?	3	3	3
esfenvalerate	Asana	2	3	1	3		3	3	3	3	3
fenbutatin oxide	Vendex										
fenpropathrin	Danitol	2	2	1	3		3	3	3	3	3
formetanate HCl	Carzol	0	0		Z		Z		0	Z	Z
hexythiazox	Savey										
imidacloprid	Provado	3	1		?		?	?		3	3
indoxacarb	Avaunt	1	0		2		2	2-3	?	3	3
insecticidal soap	M-Pede, Safer's	2-3	1	?	0		0	?	0	1	1
kaolin clay	Surround	1*	0		2*		2*		2*	?	?
methidathion	Supracide		3								
methomyl ^{Carb}	Lannate	2	1	1	2		3	2	3	3	3
methoxychlor	Methoxychlor						?				
methoxyfenozide	Intrepid						3		3		
oil (dormant and summer)	Damoil, Sunspray, Volck, etc.	?	?				1				
oxamyl ^{Carb}	Vydate	2	2	1	1		0	?		2	2
permethrin	Ambush, Pounce	2	3	1	Z		Z	3	3	Z	Z
phosmet ^{OP}	Imidan	1	1	1	3		3	3	1	1	1
pyrethrin	Pyrenone	2-3*	1-2*		1*		1?*		1*	2-3*	2-3*
pyridaben	Pyramite	0	?		?		?	?		2	2
pyriproxyfen	Distance, Esteem	0	3	?	0		2		0	0	0
rotenone	Rotenone	2-3*	1-2*		1*		1*		1*	2-3*	2-3*
spinosad	SpinTor	0	0		2		2	?	3	0	0
tebufenoxide	Confirm	0			0		2		3	0	0
thiamethoxam	Actara	1	3	?			1	2-3		?	3

* Kaolin clay ratings are for repellence effect from multiple applications.

Pyrethrin and rotenone ratings are based on ratings for the two combined in one product, ratings may not apply to each ingredient used alone.

Thiamethoxam and methoxychlor are no longer sold for use on apples in New England.

^{OP} = Organophosphate, ^{Carb} = Carbamate

Pesticide Efficacy for All Major Insect and Mite Pests

continued

Pest Names Abbreviations

ERM = European red mite

MPB = Mullein plant bug

SJS = San Jose scale

TPB = Tarnished plant bug

TSSM = Twospotted spider mite

Efficacy ratings:

0 = not effective, 1 = poor, 2 = fair, 3 = good

? = not rated for this pest or insufficient information
 blank = not used for this pest, presumably no activity
 z = not registered for use at appropriate time for pest

Pesticide		Leafminers	Leafrollers		Mites		MPB	Plum curculio	SJS	TP
Active ingredient	Brand name		Oblique-banded	Red-banded	ERM	TSSM				
abamectin	Agri-Mek	3	?	?	3	2	?	?	?	?
acetamiprid	Assail	?	?	?			?	?	?	?
azadirachtin	Aza-Direct, Neemix	3*	?	?		?	?	0	?	?
azinophos-methyl ^{OP}	Guthion, Azinophos-M	1*	2	3			0-1?	3	2	1
B.t. endotoxin	Agree, Dipel, Javelin, MVP, Xentari	0	2	3				0		0
bifenazate	Acramite				3	3				
carbaryl ^{Carb}	Sevin, Carbaryl	1*	2	1			1-2?	2		1
chlorpyrifos ^{OP}	Lorsban	1*	Z	Z		Z	3	z	?	1
cinnamaldehyde	Valero				?	?				
clofentazine	Apollo				3	2				
diazinon ^{OP}	Diazinon	?	2	0			2-3?	2	?	?
difocol	Kelthane				1-2	1-2				
dimethoate ^{OP}	Digon, Dimate	1*	1	0			?	2		3
disulfoton ^{OP}	Di-Syston									
endosulfan	Thiodan, Phaser	1*	1	2			2?	0		1
esfenvalerate	Asana	3*	3	2	?	?	2-3?	3		3
fenbutatin oxide	Vendex				2	2				
fenpropathrin	Danitol	3*	2-3	3	3	3	?	3	3	3
formetanate HCl	Carzol	3*	0	0	2	Z	3	Z		1
hexythiazox	Savey				3	Z				
imidacloprid	Provado	3	?	?			2-3?	?		?
indoxacarb	Avaunt	2*	2	2			?	3	0	3
insecticidal soap	M-Pede, Safer's	0	0	0	2	2	?	0	1	0
kaolin clay	Surround	2*	1	1				2*		
methidathion	Supracide								3	
methomyl ^{Carb}	Lannate	3	3	3			?	2		1
methoxychlor	Methoxychlor							?		
methoxyfenozone	Intrepid	3	3	3						
oil*	Damoil, Sunspray, Volck, etc.	1*	?	?	3/3*	Z/1*			3	
oxamyl ^{Carb}	Vydate	3	?	?	2	2		0		1
permethrin	Ambush, Pounce	3*	2-3	3				3, z after bloom	1	3

phosmet ^{OP}	Imidan	1*	2	3				3	2	1
pyrethrin	Pyrenone	1-2*	1*	1*				1*	1-2*	1*
pyridaben	Pyramite		?	?	3	2		?		
pyriproxyfen	Distance, Esteem	2	3	?				0	3	0
rotenone	Rotenone							1*		?
spinosad	SpinTor	2	3	3				0	?	0
tebufenoxide	Confirm	1*	3	3				0	0	0
thiamethoxam	Actara	2*	0	0			3	3	0	3

* Efficacy ratings for oil against mites are split into prebloom and postbloom application timing.

Leafminer ratings with * are for adults, only unstarred ratings apply against larval mines.

Kaolin clay ratings are for repellence effect from multiple applications.

Pyrethrin and rotenone ratings are based on ratings for the two combined in one product, ratings may not apply to each ingredient used alone.

Thiamethoxam and methoxychlor are no longer sold for use on apples in New England.

^{OP} =Organophosphate, ^{Carb} =Carbamate

Part V: Appendix - Fungicide and Bactericide Efficacy

Pesticide Efficacy for Key Diseases

Efficacy ratings:

0 = none, 1 = slight, 2 = fair, 3 = good, 4 = excellent
 ? = listed in crop profile but no efficacy data available
 z = not registered for use at appropriate time for pest
 * = See comment below table

Pesticide		Apple Scab	Sooty Blotch & Fly Speck	Fire Blight
Active ingredient	Brand name			
basic copper sulfate	Basic Copper, Basicop, Blue Shield	1	1	
Bacillus subtilis	Serenade			?
benomyl*	Benlate	4	4	
captan ^{B2}	Captan	4	2	
cinnamaldehyde	Valero			
copper hydroxide	Kocide, Champ, Champion	2	1	
copper oxychloride sulfate	COCS	2	1	
cyprodinil	Vangard	2	0	
dodine	Syllit	4	1	
fenarimol	Rubigan	4	0	
ferbam	Ferbam Granuflo	2	2	
fosetyl Al	Aliette			
harpin protein	Messenger			?
kresoxim-methyl	Sovran	4	4	
mancozeb ^{B2}	Dithane, Manzate, Penncozeb	4	4	
maneb ^{B2}	Maneb, Manex	4	4	
metalaxyl	Ridomil			
metiram ^{B2}	Polyram	4	4	
myclobutanil	Nova	4	0	
phosphorus acid	Phostrol			
prohexadione-calcium	Apogee			?
streptomycin sulfate	Agrimycin, Bac-Master, Streptrol			* see comment
sulfur	Sulfur	2	1	
thiophanate methyl	Topsin-M	4	4	
thiram	Thiram	2	2	
triadimefon	Bayleton	1	0	
trifloxystrobin	Flint	4	4	
triflumizole	Procure	4	0	
ziram	Ziram	2	3	

* Benomyl no longer manufactured.

Streptomycin sulfate rating against fire blight not available, but prevention of blossom infections is considered good with precise timing.

^{B2} = Category B2 carcinogen

Pesticide Efficacy for All Major Diseases

Efficacy ratings:

0 = none, 1 = slight, 2 = fair, 3 = good, 4 = excellent

? = listed in crop profile but no efficacy data available

z = not registered for use at appropriate time for pest

* = See comment below table

Pesticide		Apple Scab	Cedar Apple Rust	Bitter Rot	Black Rot	Powdery Mildew	Sooty Blotch & Fly Speck	Fire Blight	Phytophthora Root Crown Rot
Active ingredient	Brand name								
basic copper sulfate	Basic Copper, Basicop, Blue Shield	1	0	?	1	2	1		?
Bacillus subtilis	Serenade							?	
benomyl*	Benlate	4	0	1	4	2	4		
captan ^{B2}	Captan	4	1	3	3	0	2		
cinnamaldehyde	Valero					?			
copper hydroxide	Kocide, Champ, Champion	2	0	?	1	2	1		?
copper oxychloride sulfate	COCS	2	0	?	1	2	1		?
cyprodinil	Vangard	2	0	0	0	1	0		
dodine	Syllit	4	1	0	1	0	1		
fenarimol	Rubigan	4	4	0	0	4	0		
ferbam	Ferbam Granuflo	2	2	1	1	0	2		
fosetyl Al	Aliette								?
harpin protein	Messenger							?	
kresoxim-methyl	Sovran	4	2	2	3	3	4		
mancozeb ^{B2}	Dithane, Manzate, Penncozeb	4	4	4	3	0	4		
maneb ^{B2}	Maneb, Manex	4	4	4	3	0	4		
metalaxyl	Ridomil								?
metiram ^{B2}	Polyram	4	4	4	3	0	4		
myclobutanil	Nova	4	4	0	0	4	0		
phosphorus acid	Phostrol								?
prohexadione-calcium	Apogee							?	
streptomycin sulfate	Agrimycin, Bac-Master, Streptrol							* see comment	
sulfur	Sulfur	2	0	?	1	2	1		
thiophanate methyl	Topsin-M	4	0	1	4	2	4		
thiram	Thiram	2	2	2	1	0	2		
triadimefon	Bayleton	1	4	0	0	4	0		
trifloxystrobin	Flint	4	2	2	3	3	4		
triflumizole	Procure	4	4	0	0	4	0		
ziram	Ziram	2	2	1	1	0	3		

*Benomyl no longer manufactured.

Streptomycin sulfate rating against fire blight not available, but prevention of blossom infections is considered good with precise timing.

^{B2} = Category B2 carcinogen

Part V: Appendix - New technologies

New Apple Pest Management Technologies

Insect and Mite Pests

CHEMICAL	SOURCE	STATUS	PEST
Acequinocly/TM 413	IR4	Pending	Broad spectrum mite control (no rust mite activity). Unique mode of action. Easy on beneficials with long residual activity.
Bacillus thuringensis	IR4	Registered	New strains of Bt are being discovered that have activity against numerous pests.
Beauvaria bassiana	Pipeline	Biopesticide Registration Approved Tolerance Accepted	Mites, leafrollers, thrips, weevils, aphids, leafhoppersI
Beauveria brongniarti	IR4	Potential	Targeted for soil dwelling pests.
Bistrifluron	IR4	Potential	Active against Lepidopteran pests, whitefly. It acts by inhibiting chitin synthesis (Insect Growth Regulator).
Buprofezin	IR4	Pending	Good activity for nymphal stages of leafhoppers, plant hoppers, scales, mealybugs, psylla and whiteflies. Very safe to bees.
canola oil	Pipeline	Biopesticide Registration Approved Tolerance Accepted	MITES, APPLE RED BUG, PLANT BUGS, SCALES, WHITEFLIES, APHIDS, LEAFHOPPERS, PHYLLOXERANS, SAWFLIES, CATERPILLARS, FRUITTREE LEAFROLLER
Checkmate CM-F	IR4	Registered	Codling moth pheromone mimic
Chromafenozide	IR4	Potential	Specific to Lepidopteran pests, novel ecodyosone agonist
Clothianidin	IR4	Pending	Contact and stomach activity. It controls plum curculio, aphids, leafhoppers, apple maggot, leafminers, leafrollers, codling moth, and pear psylla.
Cydia pomonella virus	IR4	Registered	Controls Codling Moth.
Deltamethrin	IR4	Pending	Beetles, bugs, Lepidoptera.
Emamectin Benzoate	IR4	Potential	Effective on larval Lepidoptera. (Beet/fall armyworms, cabbage webworms, corn earworms, imported cabbage worm, cabbage looper.) and leafminers
Etoxazole	IR4	Pending	Insecticide/acaricide for control of Panonychus spp and Tetranychus spp, including hexythiazox resistant mite strains.

			Inhibition of molting, effective on eggs, larvae, & nymphs.
Fenoxycarb	IR4	Pending	Fire ants and a wide range of other insects.
Fenpyroximate	IR4	Pending	Controls mites, including two-spotted, European red, and citrus rust mite and psylla.
Fipronil	IR4	Potential	Controls Coleoptera, Lepidoptera, Diptera, Homoptera, Isoptera, and Thysanoptera. Systemic activity with long residual control.
Flonicamid	IR4	Pending	Effective against aphids, thrips, leafhoppers, plant bug and other sucking pests. Provides rapid antifeeding activity. Non-toxic to beneficials.
Fluacrypyrin	IR4	Potential	Acaricide.
Flufenzin	IR4	Potential	Acaricide.
Lambda-Cyhalothrin	IR4	Pending	Broad spectrum insect control.
Metarhizium anisopliae	IR4	Potential	Controls whitefly, thrips, and mites.
Milbemectin	IR4	Pending	Excellent miticide and also controls aphids, leafminers, thrips, leafhoppers.
Novaluron	IR4	Pending	Effective against Lepidoptera, leaf miner, and some mites. Strictly a contact material, no systemic activity.
Pavois granulosis virus	IR4	Potential	Product controls two generations of susceptible insects.
Spirodiclofen	IR4	Potential	Acaricide that is very active on eggs, larvae, and quiescent stage of Panonychus, Phyllocoptruta, Brevipalpus, Tetranychus species.
Thiacloprid	IR4	Pending	Broad spectrum systemic control of sucking and chewing pests; specifically, aphids, whiteflies, leaf hoppers, plant bugs, pear psylla, weevils, fruit flies, oriental fruit moth, leafminers, and Codling Moth. Very safe to bees.
Thiamethoxam	IR4	Registered	Broad-spectrum activity against soil dwelling pests, sucking pests, and some chewing pests. Effective against aphids, whitefly, thrips, leafhopper and certain beetles. Being marketed for seed, soil, and foliar treatments.
Tolyfluanid	IR4	Potential	Broad spectrum contact fungicide with good acaricidal effectiveness. Particularly suitable for control of resistant pathogen populations.

Diseases

CHEMICAL	SOURCE	STATUS	PEST
Ampelomyces quisqualis isolate M-10	IR4	Pending	Hyperparasite of Powdery mildew.
Bacillus pumilus strain 2808	IR4	Pending	Botrytis, powdery mildews, rusts, Sclerotinia blight, and rots.
BAS 516	IR4	Pending	Broad spectrum activity on Anthracnose, Alternaria, downy mildew, powdery mildew, Botrytis, Sclerotinia, and Monilinia.
Candida oleophila	IR4	Potential	Post-harvest diseases.
Candida saitoana	IR4	Pending	Post-harvest disease control in fruits, both preventative and curative activity
Chitosan	IR4	Registered	Downy and powdery mildew, gray mold and Botrytis.
Coniothyrium minitans	IR4	Registered	Controls Sclerotinia sclerotium and S. minor.
Dithianon	IR4	Pending	SCAB, downy mildew, rust, leaf spot.
Famoxadone	IR4	Potential	Broad spectrum fungicide, including Early blight, downy mildews, and other ascomycetes. Can be combined with Cymoxanil (marketed as Tanos) to pick up Late blight.
Fenbuconazole	IR4	Potential	Powdery mildew, rusts, apple SCAB, brown rot, cotton ball, mummy berry (Monolinia spp.), smuts, bunts, Cladosporium, Mycosphaerella, Cercospora, Septoria, Rhizoctonia, Pyrenophora, Helminthosporium & related genera, and a Colletotrichum sp. - in turf.
Fenhexamid	IR4	Pending	Non-systemic protectant fungicide that is effective against Botrytis cinerea, Monolinia, Sclerotinia sclerotiorum of lettuce.
Fluazinam	IR4	Pending	Broad spectrum disease control: Alternaria, Botrytis, Cladosporium, Colletotrichum, Phytophthora, Plasmopara, Rhizoctonia, Sclerotinia, Venturia, Streptomyces, and some mites.
Fludioxonil	IR4	Pending	Fusarium, Helminthosporium, Rhizoctonia, Aspergillus, Alternaria, Ascochy, Pyrenophora, Tilletia, Sclerotinia, and Septoria.
Glutamic Acid	IR4	Pending	Controls brown rot and supresses shot hole.
Mefenoxam	IR4	Registered	Same spectrum as metalaxyl.
Muscodor albus	IR4	Potential	Fungus produces volatile compounds that are effective against plant pathogenic and bacteria.
Nocobifen-BAS 510	IR4	Pending	Manages powdery mildew, Alternaria, Botrytis, Sclerotinia and Monillia
Oxolinic Acid	IR4	Potential	Controls gram-negative bacteria including rice grain rot, potato black leg, soft rot, and

			fire blight.
Pantoea Agglomerans C9-1	IR4	Pending	Fireblight.
Peroxyacetic Acid	IR4	Registered	Post-harvest decay and rot.
Phosphonic Acid	IR4	Potential	Downy mildew, SCAB, and root rot.
Physpe	IR4	Potential	Bacterial diseases.
Picoxystrobin	IR4	Potential	Wide spectrum of diseases.
Potassium Dihydrogen Phosphate	IR4	Registered	Powdery mildew.
Pseudomonas syringae	IR4	Registered	Controls Fusarium and post harvest storage rots.
Pyraclostrobin	IR4	Pending	Broad spectrum activity on Anthracnose, Alternaria, downy mildew, Cercospora leaf spot, rust, powdery mildew, Septoria, Phytophthora, Pythium, Rhizoctonia.
Pyrimethanil	IR4	Pending	Active against Botrytis spp., Venturia spp., Alternaria solani, Alternaria mali, Sphaerotheca macularis and Monilinia spp.
Simeconazole	IR4	Potential	Effective as seed treatment against Basidiomycetes.
Streptomyces lydicus WYEC 108	IR4	Pending	Controls soil borne plant root rots and damping off fungi.
Tebuconazole	IR4	Potential	Powdery mildew, rusts, smuts, bunts, apple scab, Pyrenophora, Septoria, Coccoomyces, Monilinia, Cercospora, Cercosporidium, Ceratocystis, Guignardia, Sclerotium, Rhizoctonia, Coccoomyces, Rhynchosporium, Colletotrichum, Botrytis, and Rhizopus.
Tolyfluanid	IR4	Potential	Broad spectrum contact fungicide with good acaricidal effectiveness. Particularly suitable for control of resistant pathogen populations.

Weeds

CHEMICAL	SOURCE	STATUS	PEST
Butafenacil	IR4	Pending	Controls important grasses, broadleaf and sedge weeds.
Carfentrazone-ethyl	IR4	Pending	Numerous broadleaf weeds, including cocklebur and water hemp.
Clopyralid	IR4	Pending	Controls a broad spectrum of broadleaf weeds including hard to control Canada thistle.
Colletotrichum gloeosporioides f. sp malvae	IR4	Pending	It is pathogenic to round-leaved mallow, small flowered mallow, common mallow, and velvetleaf.
Flumioxazin	IR4	Potential	Low use rate pre-emergence broadleaf herbicide with contact activity and residual soil activity.
Halosulfuron	IR4	Potential	Nutsedge, velvetleaf, cocklebur, other broadleaf weeds.
Oxadiargyl	IR4	Potential	Broad spectrum weed control, similar to oxidiazinon.
Pelargonic Acid	IR4	Registered	Contact, non-selective broad spectrum foliar applied material
Propyzamide	IR4	Potential	Controls annual grasses and broadleaf weeds.
Sulfentrazone	IR4	Potential	Controls broadleaf and grass species.
Thiazopyr	IR4	Pending	Annual and perennial broadleaf weeds, including crabgrass and nutsedge.

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