New England Pear
Pest Management Strategic Plan

New England Pest Management Network
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Executive Summary

Research, Extension/Education, and Regulatory priorities for pear pest management are highlighted below. The over-riding priority identified by growers at the Pear PMSP meeting was the need to fill critical extension specialist positions in the six states. Key vacancies include plant pathologists in all states and fruit specialists in Connecticut, Rhode Island, and New Hampshire.

Key Pear Pest Strategic Issues

Identified Research Priorities

Top priorities:

- Cultivar evaluation for susceptibility to key pear pests
  While pear psylla is widespread, growers feel there are significant differences among pear cultivars relative to incidence of diseases including pear scab and fire blight and insects including plum curculio

- Assessment of actual risk from pear scab and plum curculio
  Both of these pests are common in most orchards but seldom at high levels. Understanding the biology of these pests on pear in New England and development of action thresholds for pest management intervention are needed.

- New Control Options
  Efficacy testing of new pesticide options, especially insecticides for control of pear psylla is needed to improve management of this pest.

Participants identified other research priorities including:

- Organic pear production
- Development of thresholds for management of Pear Psylla
- Understanding the relationship between orchard fertility management and pear psylla and fire blight
- Development of recommendations for growing systems for pears on dwarfing rootstocks
- Interactive impact (cumulative damage) of aphids, mites, and pear psylla
- Fabrea leafspot biology and control
- Action thresholds for mites on pear

Identified Extension/Education Priorities

Top Priorities:

- Develop a pear pest management guide for New England growers
- Develop a detailed list of cultivar susceptibility to key pear diseases
- Deliver training on proper use of predictive models for pear pests including the Maryland fire blight model

Identified Regulatory Priorities

Top Priorities:

- An increased number of antibiotic treatment options for fire blight are needed
- Protect EBDC fungicides for resistance management in pear
- Establishing an effective vehicle for influencing Fish & Game on deer management and creation of an exclusionary fencing program

I. Introduction

Background of Pears in New England

The 6 New England States combine to rank 8th in national production of pears when these states are viewed as a state-like region. A total of 3,210,000 pounds are harvested in a "normal" year, contributing $2,000,000 to the New England economy. More importantly, this income represents important cash flow to struggling apple orchards that have incorporated pear production to reduce financial risk. All fruit is intended for the fresh market with most of it sold at retail either directly at the farm stand or to other farm stands.

A variety of insect and disease pests as well as vertebrates are problems for New England pear growers. New England growers utilize an Integrated Pest Management approach to managing these pests. Among the practices employed are orchard sanitation, proper pruning, orchard floor management, elimination of outside sources of pests such as "wild" trees and alternative species of plants that support these pests. While these methods support the efficient use of pesticides, they do not eliminate the need for these important orchard management tools. The loss of important pesticide options due to pest resistance, regulatory action, and consumer pressure is a concern for the entire pear industry.

Benefits to the New England Pear Industry

The New England Pear Pest Management Strategic Plan identifies at-risk pesticides and proposes future research, regulatory, and education priorities necessary to establish alternative pest management methods in event of the loss of an important pest management tool. These priorities will be used to inform EPA and state agency decision makers and help 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 this 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 pear orchards. Current pest management programs will be made more effective through implementation of actions proposed in this plan.

The Pear Pest Management Strategic Plan Process

A review group of pear growers, researchers, and industry stakeholders throughout New England met for two days in November of 2003 to develop this strategic plan based on the 2003 New England Pear Profile. Key pests driving pesticide use were identified by the New England Pear Pest Management Tactic survey of growers conducted in 2002 and confirmed by discussion among the PMSP review group.

The 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 action, and education needed to transition toward 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 Pear Pest Management Strategic Plan

Key Pear Pest Strategic Issues

Insects and Mites

1. Pear Psylla. Pear Psylla is the most important insect pest affecting pears in New England. This pest has been difficult to control due to its ability to develop tolerance to insecticide treatments. New control options now offer growers effective psylla management tools. Pear psylla damage to trees is accompanied by sooty mold fungal growth (promoted by the psylla nymph exudate) that covers leaves and drips onto wood. This fungal growth limits photosynthetic activity, further weakening trees. Early season oil treatment to discourage egg deposition is a key control strategy.
2. Plum Curculio. Plum curculio attacks pears; however, it is not as serious a pest for pear as it is for peaches, apples, and other tree fruits in New England. Plum curculio is considered a difficult pest to monitor and control. Most commercial orchards are free of resident populations and are infested by adults moving in from hedgerows and woodlands.
3. Pear Rust Mite. Pear rust mite is a more serious pest problem in southern New England than at the northern production limits of pear. Damage by this pest is difficult to quantify, but can be significant in terms of reduced yield in blocks with high infestation levels.
4. European Red Mite & Two-Spotted Mite. Damage from these mites is variable. In situations where populations are high, reduced tree vigor and heavy pre-

harvest drop are experienced. Early season oils offer good control for European Red Mite, but not for two-spotted mite. Some pear psylla management tools reduce predatory mite populations, fostering summer mite population increases to significant levels.

Diseases

1. Fire Blight. Fire blight is the most significant disease affecting pear. Infection levels in New England are variable from year to year based on whether favorable weather for infection occurs, especially during the blossom period. Antibiotic and copper treatments are available. Antibiotic treatments are used when there is a recent history of fire blight pressure in the orchard and weather conditions are favorable. Pruning (coupled with appropriate tool sanitation) is used to reduce disease inoculum in the orchard.
2. Fabrea Leaf Spot. Fabrea leaf spot is growing in importance in orchards in southern New England. Bosc, one of the two major cultivars grown is susceptible and considerable leaf damage, leading to reduced tree vigor and smaller fruit size and yields.
3. Pear Scab. Pear scab is a common pear disease, affecting most orchards in New England to some degree. While it is not a significant pest in most of those affected orchards, it is a major problem in some. Controls include protective fungicide applications and orchard sanitation (leaf shredding in autumn or spring and ground urea sprays in spring – to hasten leaf decomposition).

Weeds

1. Annual Grasses and Broadleaf Weeds. Control of annual grasses and broadleaf weeds has shifted from a primary focus on soil-applied, pre-emergence herbicides to an increasing reliance on the use of post-emergence application of both selective and non-selective herbicides.
2. Perennial Grasses. The perennial grass Quackgrass is perhaps the most important weed species affecting pear and other tree fruits in New England. Control is achieved with post-emergence application of systemic herbicides.
3. Perennial Woody Weeds. Poison Ivy, wild raspberry, and other woody species will populate under-tree areas when annual grasses and broadleaf weeds and perennial grasses are managed. These can serve as hosts for pests that attack pear trees and interfere with harvest and other orchard management tasks.

Vertebrate and other pests

1. Voles. Rodenticides as a supplement to mowing and other ground cover management are important components of most vole management programs. Cultural controls including mowing, use of herbicides under-tree, and vole guards greatly reduce the need for rodenticide application.
2. Deer. Deer damage to pears in New England is growing as the deer population grows in response to Fish and Game Agency policies and reduced hunter access to deer areas. Pear growers manage deer primarily through the use of

exclusionary fencing. In light deer pressure situations, taste and odor repellents are employed.

Strategic Issues of Specific Pest Management Tactics

Insecticides, Miticides

abamectin, amitraz, pyridaben (pear psylla)

- Valuable in a rotation program for resistance management.

abamectin, amitraz, bifenazate, clofentazine, fenbutatin-oxide, hexythiazox, pyridaben (mites)

- Valuable in a rotation program for resistance management.

azinphos methyl (plum curculio)

- Widely used for management of plum curculio

carbaryl (plum curculio)

- Only fair control
- High toxicity to bees
- Tougher on mite predators than organo-phosphates

difocol (mites)

- Mite resistance to this material is not stable but declines over time.

esfenvalerate (effective for pear psylla and plum curculio)

- Very rough on mite predators

endosulfan (plant bugs)

- Limited pest control spectrum
- Very limited use in New England pear orchards

imidacloprid

- Effective for pear psylla
- Generally soft on predators
- Manages Japanese Beetle

kaolin clay (pear psylla, plum curculio)

- Concern about possible aluminum content
- Difficult to maintain uniform coverage during rainy periods

- Efficacy not documented in New England pear orchards
- OMRI approved for organic use

malathion (plum curculio)
- Not very effective and seldom used

methidathion (scale insects, pear psylla)
- Tough on predators, but relatively effective against scale

K fatty acids (pear psylla)
- Poor to fair efficacy

oil (mites)
- Very important to IPM programs.
- The first defense against European Red Mite

permethrin (effective for pear psylla and plum curculio)
- Risk to mite predator population can lead to increased risk of European Red Mite pressure when used

phosmet (plum curculio)
- Critical material in IPM programs, especially in event of azinphos methyl loss
- Widely used for management of plum curculio

pyriproxyfen (scale insects)
- New, limited experience in New England

thiomethoxam (pear psylla, plum curculio)
- New, limited experience in New England

Fungicides, Bactericides

Bacillus subtillis (fire blight)
- Effectiveness not proven, but an OMRI certified material
- Limited New England experience

Bordeaux mixture (fire blight)
- Phytotoxicity risk for pear leaves and fruit
- Not used close to oil application due to phytotoxicity risk

copper hydroxide (fire blight)
- Fair control of fire blight
- Reduced phytotoxicity compared to copper sulfate

copper sulfate (fire blight)
- Fair control of fire blight
- OMRI certified

harpin protein (fire blight)
- Limited New England experience

fenarimol (Fabrea leafspot, pear scab)
- Good fungicide if no resistance present
- Should be used in a rotation with other fungicides

ferbam (pear scab)
- Poor control of pear scab
- Leaves unsightly residue

kresoxim-methyl (Fabrea leafspot, pear scab)
- Newer material with good efficacy
- Should be used in rotation with other fungicides

mancozeb (Fabrea leaf spot, pear scab)
- Used in fungicide rotation to reduce risk of tolerance
- Supplies manganese and zinc to trees

oxytetracyclene (fire blight)
- Important for control of fire blight especially during bloom and post hail

sulfur (pear scab)
- Provides only fair control
- Toxic to beneficial insects and mites and earthworms

tebuconazole (brown rot)
- Rated as effective but limited New England experience
- Must practice resistance management strategy

streptomycin sulfate (fire blight)
- Resistance management issues
- Used during bloom and post hail event

triflozystrobin (Fabrea leaf spot, pear scab)
- Limited New England experience
- Must practice resistance management strategy

thiophanate methyl (Fabrea leafspot, pear scab)
- Pest tolerance is a major problem in some orchards
- Used in tank mixes with other fungicides

ziram (pear scab)
- Fair to poor control of pear scab
- Heavy residue

Herbicides

Pre-emergent Group

dichlobenil (annual grasses, broadleaf weeds)
- Application in dormant season only
- High leach risk on soils with very low organic matter
- Quickly lost if applied to warm soils

diuron (annual grasses, broadleaf weeds)
- High leaching risk on low organic matter or sandy soils
- Can cause injury to pear trees if organic matter in soil less than 1%

napropamide (annual grasses)
- High leaching risk on low organic matter soils

- Must be incorporated into soil by shallow cultivation or water within 24 hours of application to reduce photo-degradation

norflurazon (annual grasses)
- High leaching risk on low organic matter soils
- High organic matter can reduce activity

oryzalin (annual grasses)
- Often tank mixed with simazine to improve weed control spectrum

oxyflurazon (broadleaf weeds)
- Use limited to dormant season only

pendimethalin (annual grasses)
- Can be used on non-bearing trees only

pronamide (annual grasses)
- Use limited to dormant season only
- High organic matter and leaf litter limit effectiveness

simazine (annual grasses, broadleaf weeds)
- Not recommended on sandy or sandy loam soils low in organic matter

Post-emergent Group

clethodim (annual grasses, perennial grasses)
- For use on non-bearing pear trees only

fluazifop-butyl (annual grasses, perennial grasses)
- Applied to actively growing grasses
- For use on non-bearing trees only
- A single application will generally not kill perennial grasses

glyphosate (annual grasses and broadleaf weeds, perennial grasses and broadleaf weeds, woody weeds)
- Trees must be shielded from spray
- Very effective against hard to control woody weeds

paraquat (annual grasses and broadleaf weeds, perennial grasses and broadleaf weeds)
- Tree must be shielded from spray
- Apply during active weed growth

sethoxydim (annual grasses)

- Bearing and non-bearing trees
- Grasses must be actively growing

Vertebrate and other pests

ammonium salts of C8-18 and C18' fatty acids (deer)

- Very limited effectiveness

putrescent whole egg solids (deer)

- Very limited effectiveness

thiram (deer, rabbits, voles)

- Some limited control
- Skin irritant for some people

zinc phosphide bait (voles)

- Effective
- Water inactivates, limiting off-target species risk
- Broadcast works only for meadow vole

III. Strategic Issues for Key Pear Pests

Key Insects and Mite pests

1. Pear Psylla

- **100%** Acres affected, risk of pear decline
- **Yield Losses:** 0 when controlled

Currently Registered Pesticides

Pesticide	Efficacy	Pros	Cons	Comments
abamectin (Agri-Mek)	Good	• Early season effective • Gets mites and other things	• Expensive	
amitraz (Mitac)	Good	• Relatively inexpensive	• Resistance issues	
esfenvalerate (Asana)	Effective	• Long residual • Less expensive • Manages plum curculio	• Mite predator toxicity is a real problem	• Mite predator toxicity may not be an issue if used pre- petal fall
imidacloprid (Provado)	Effective	• Works on early nymphs • Environmentally soft	• Very expensive • Only works on early nymphs	
K fatty acid salts (M-Pede)	Fair to Good		• Very expensive • Potential phytotoxicity risk	
kaolin clay (Surround)	Good	• Improved fruit color • OMRI approved	• Difficult to maintain good coverage • Visible residue on fruit at harvest • Improves environment for San Jose scale buildup	• Unproven in NE
lambda-cyhalthrin (Warrior)	New	• Will manage plum curculio and plant bugs	• Suppression of pear psylla only	
oil (dormant and summer)	Effective	• Cheap • Limited side effects on predators (non-disruptive)	• Timing is very early when soils and weather many not support application • Summer oils are	

			rougher on predators	
permethrin (Ambush, Pounce)	Good	• Can be used at reduced rate with organo-phosphate • Less expensive • Manages plum curculio	• Mite outbreaks are a risk due to bio-control disruption	
pyridaben (Pyramite)	Good	• Works well late season	• Bee toxicity • Moderately disruptive	
pyriproxyfen (Esteem)	New	• Preliminary trials suggest effective against pear psylla	• Low risk to beneficial insects • Low bee risk	
thiometh-oxam (Actara)	New	• Preliminary trials suggest effective against pear psylla • Manages plum curculio	• Highly toxic to fish • Moderately toxic to bees	

Cultural and Biological Alternatives

Method	Pros	Cons	Comments
Limb sucker removal	• Improves fruit color and reduces sooty blotch as well (helps but not sufficient)	• Labor cost is high	
Nitrogen fertilization program	• Lower rate reduces lush growth that encourages population • Also helps with fire blight	•	

Research Needs:

- How to encourage beneficial insects to help control
- Development of a monitoring system for use in making treatment decisions

Regulatory Needs:

- Retain current and register new effective materials to reduce tolerance issue

Education Needs:

- Proper use of oils including summer oils for psylla management
- Nitrogen fertility management

- Monitoring of psylla population for use in treatment decision-making

2. Plum Curculio

- **Acres Affected:** All
- **Yield Losses:** if controlled, 1-2%; if not controlled – 5% or more

Currently Registered Pesticides

Pesticide	Efficacy	Pros	Cons	Comments
azinphos-methyl (Guthion)	Effective	• Also gets codling moth also gets red banded leaf roller		
esfenvalerate (Asana)	Effective	• Long residual • Less expensive	• Mite predator toxicity is a real problem	
kaolin clay (Surround)	Fair to Good	• Improved fruit color • OMRI approved	• Difficult to maintain good coverage • Visible residue on fruit at harvest • Improves environment for San Jose scale buildup	• Unproven in NE
malathion	Poor	• Short residual • Among OP alternatives, safest for applicators	• Offensive odor • Short residual • Limited effectiveness • Inexpensive	
phosmet (Imidan)	Good	• Soft on predators • Less expensive • 48 hour re-entry (current) • Lower applicator risk than azinphos-methyl	• EPA SARA Title 3 list	
thio-methoxam (Actara)	Good		• Highly toxic to fish • Moderate bee toxicity	• Unproven in NE

Cultural and Biological Alternatives

Method	Pros	Cons	Comments
Monitoring for plum curculio with traps	• Offers potential to limit second treatment to perimeter spray only	• Trapping system unproven for pear	
Trap trees	• Can be used to determine when adults move into orchard	• Unproven for curculio for pear	

Research Needs:

- Monitoring for curculio using traps to reduce 2nd spray to perimeter spray
- Decision model (how long does movement of curculio into orchard last and how long is the treatment applied effective against in-migration)
- Is plum curculio an economically important pest on pear

Regulatory Needs:

- Need to have trap attractants registered for use on traps in orchards (benzaldehyde, grandisoic acid)
- Need to maintain organo-phosphates for resistance management

Education Needs:

- Use of models, monitoring, etc (and people to run and deliver information to growers)
- Maintain positions of Pest Management people

3. Pear Rust Mite

- **Acres Affected:** Not a significant issue for most growers, but can be problematic in specific blocks
- **Yield Losses:** Difficult to quantify

Currently Registered Pesticides

Pesticide	Efficacy	Pros	Cons	Comments
abamectin (Agri-Mek)	Good		• Toxic to fish and wildlife including amphibians and crustaceans • Toxic to bees	
clofentezine (Apollo)	Effective	• Not disruptive to beneficial arthropods • Long residual • Provides alternative for miticide resistance management	• Expensive • Not effective against adults, so is not a rescue treatment • Resistance concern. Cross resistant with Savey.	
dicofol (Kelthane)	Effective	• Relatively inexpensive	• Toxic to fish • Must practice resistance management	
fenbutatin-oxide (Vendex)	Good	• Less expensive • Provides alternative for miticide resistance management	• Slow acting, esp. with cool temperatures • Resistance concern	
formetanate HCl (Carzol)	Good	• Quick knockdown	• Very rough on mite predators • Very expensive • Human risk • Up through petal fall only	
pyridaben (Pyramite)	Good	• Effective as rescue treatment against adults	• Bee toxicity • Moderately disruptive	

Cultural and Biological Alternatives

Method	Pros	Cons	Comments
None Identified			

Research Needs:

- Determine the magnitude of rust mite population and impact on fruit yield and tree health in New England

Regulatory Needs:

- None Identified

Education Needs:

- Education on biology of the pest and its management

4. European Red Mite, Two Spotted Mite

- **Acres Affected:** Not a significant issue in most blocks but can contribute to reduced tree vigor and yields
- **Yield Losses:** Difficult to quantify

Currently Registered Pesticides

Pesticide	Efficacy	Pros	Cons	Comments
bifenazate (Acramite)	Good	• Provides alternative for miticide resistance management	•	
clofentezine (Apollo)	Good	• Not disruptive to beneficial arthropods • Long residual • Provides alternative for miticide resistance management	• Expensive • Not effective against adults, so is not a rescue treatment • Resistance concern. Cross resistant with Savey.	
dicofol (Kelthane)	Good	• Relatively inexpensive	• Toxic to fish • Must practice resistance management	

fenbutatin-oxide (Vendex)	Good	• Less expensive • Provides alternative for miticide resistance management	• Slow acting, esp. with cool temperatures • Resistance concern	
hexythiazox (Savey)	Good	• Not disruptive to beneficial arthropods • Long residual • Provides alternative for miticide resistance management	• Expensive • Not effective against adults, so is not a rescue treatment • Resistance concern. Cross resistant with Apollo.	
oil	Effective	• Not disruptive to beneficial species • Less expensive • Effective on scale insects	• Proper timing required to avoid phytotoxicity • Time consuming compared to other sprays • Early application can harm orchard floor in wet year	
pyridaben (Pyramite)	Good	• Effective as rescue treatment against adults	• Bee toxicity • Moderately disruptive	

Cultural and Biological Alternatives

Method	Pros	Cons	Comments
None Identified			

Research Needs:

- Establishment of action thresholds

Regulatory Needs:

- None identified

Education Needs:

- Population determination/treatment decision-making for mites on pear

Key Diseases

1. Fire Blight

- **Acres affected:** 80% (predominate varieties including Bartlett and Bosc)
- **Yield Losses:** where it occurs, can cause complete tree death (1 year in 5)

:

Currently Registered Pesticides

Pesticide	Efficacy	Pros	Cons	Comments
Bacillus subtilis (Serenade)	Fair to Poor	• OMRI	• Multiple applications • 5 day pre infection (hard to predict)	• Variable effectiveness ranging to ineffective
Bordeaux mixture	Fair	• OMRI certified	• No effect on blossom blight	•
copper hydroxide (Kocide)	Fair	•	• No effect on blossom blight	•
copper sulfate (C-O-C-S)	Fair	• OMRI certified	• No effect on blossom blight	
harpin protein (Messenger)	CE	• May reduce frost risk	• Multiple applications required • Must be applied 5 days pre-infection (hard to predict)	• Variable effectiveness ranging to ineffective
oxytetra-cylene (MycoShield)	Effective	• May be useful post hail or during blossom infections	• 60 day PHI	
streptomycin sulfate (Agri-Mycin, Bac-Master, Streptrol)	Effective	• Protects blossoms and protects post hail event	• Timing challenges • Fire blight bacterium developing resistance • 50 day PHI	• Resistance concerns

Cultural and Biological Alternatives

Method	Pros	Cons	Comments
Pruning including removal and destruction of	• Removes source	• Time consuming • Weather must be dry • Exposure of workers to sanitizing agents	

infected materials		• Narrow time window	
Nitrogen management	• Lower nitrogen levels reduce shoot blight risk	• Does not reduce the primary issue of blossom infections	
Sanitation		• Sterilizing shears after every cut is time consuming and increases user risk	
Use of Maryblight system	• Allows appropriate timing of bacteriacides		

Research Needs:

- Use of Serenade and Messenger (efficacy trials)
- Evaluation of efficacy of tool sterilization and selective pruning including timing as blight management tools
- Determine the role of vectors in fire blight spread (insects, bees, deer, leaf hoppers)

Regulatory Needs:

- Registration of alternative treatments before resistance to current antibiotics develops

Education Needs:

- Delivery of information on proper use of blight predictive models
- Demonstration of appropriate post-infection pruning techniques

2. Fabraea Leaf Spot

- **Acres Affected:** 50%; infection is variable, but this disease is growing in scope and importance in southern sections of the growing region in particular
- **Yield Losses:** difficult to determine, but at least 5-10% in blocks with significant numbers of susceptible cultivars

Currently Registered Pesticides

Pesticide	Efficacy	Pros	Cons	Comments
fenarimol (Rubigan)	Effective	• Manages pear scab	• Expensive	
kresoxim-methyl (Sovran)	Effective	• Compatible with oil • Manages sooty blotch • Manages pear scab	• Very expensive	
mancozeb (Dithane, Manzate, Penncozeb)	Effective	• Supply manganese and zinc to trees • Reduces pear psylla populations • Compatible with oil • Manages pear scab	• Long PHI restricts use to early season	
triflozystrobin (Flint)	Effective	• Compatible with oil • Manages sooty blotch • Manages pear scab	• Very expensive	
thiophanate methyl (Topsin)	Effective	• Also manages pear scab		

Cultural and Biological Alternatives

Method	Pros	Cons	Comments
Use of resistant cultivars	Bartlett relatively resistant	• Bosc very susceptible	

Research Needs:

- Evaluation of cultivars for susceptibility/resistance
- Determine if leaf litter management will reduce disease incidence

Regulatory Needs:

- Need to protect mancozeb for fungicide resistance management

Education Needs:

- Education on the basic biology of the pest in orchards in New England

3. Pear Scab

- **Acres Affected:** All acres affected to some extent
- **Yield Losses:** Level of injury can be severe, affecting 100% of crop in problem blocks

Currently Registered Pesticides

Pesticide	Efficacy	Pros	Cons	Comments
fenarimol (Rubigan)	Effective	• Provides Fabrea leaf spot control	• Moderately expensive • Must practice resistance management strategy	
ferbam (Carbamate, Ferbam)	Fair		• Leaves heavy, visible residue	
kresoxim-methyl (Sovran)	Effective	• Provides Fabrea leaf spot control	• Very expensive • Number of applications allowed in a year limited	
mancozeb (Dithane, Manzate, Penncozeb)	Good	• Provides nutrients manganese and zinc to trees • Important in resistance management strategy	• Long PHI limits use post bloom	
triflozystrobin (Flint)	Effective	• Provides Fabrea leaf spot control	• Very expensive • Number of applications allowed in a year limited	
thiophanate methyl (Topsin)	Effective	• Also effective in managing Fabrea leaf spot	• Resistance management issues	
ziram (Ziram)	Fair	• Has much shorter PHI than EBDC's	• Visible residue	

Cultural and Biological Alternatives

Method	Pros	Cons	Comments
Leaf litter management through sanitation and urea (fall applied to leaf litter)	• Reduce severity of spring infections	• Labor and energy intensive	• Efficacy has been demonstrated for apple scab, not pear scab
Use of resistant cultivars	• Bartlett is relatively resistant)		

Research Needs:

- Evaluation of the extent of risk by cultivar
- Determination of appropriate number and timing of fungicide applications needed for control
- Determine effects of application (and type) of lime on over-wintering fungus

Regulatory Needs:

- None identified

Education Needs:

- None identified

Weeds

1. Annual Grasses and Broadleaf Weeds, Pre-emergence

- **Acres Affected:** All
- **Yield Losses:** Tree growth is directly related to weed pressure under tree. If weeds under tree are not controlled, tree growth and yields will suffer up to 80%.

Currently Registered Pesticides

Pesticide	Efficacy	Pros	Cons	Comments
dichlobenil (Casoron)	Effective	• Grasses & broadleaf weeds	• Very expensive	• Must apply during dormant season
diuron (Direx, Karmex)	Effective	• Inexpensive • Grasses & broadleaf weeds	• Ground water risk • Mite predator risk • Cannot be used year of planting	
isoxaben (Gallery)	Effective	• Broadleaf weeds	• Non bearing trees only	
napropamide (Devrinol)	Effective	• Grasses	• Photodegradable • Moderately expensive • Not as effective for small seeded grasses	
norflurazon (Solicam)	Effective	• Grasses • Moderately expensive	• Established trees only	
oryzalin (Surflan)	Effective	• Grasses • Not photo-degradable • Good for use on young trees • Moderate cost		
oxyfluorfen (Goal)	Effective	• Broadleaf weeds	• Dormant application only	
Pendimeth-alin (Prowl)	Effective	• Grasses	• Non bearing trees only • Moderately expensive	
pronamide (Kerb)	Effective	• Grasses	• Established trees only	• Dormant application only

simazine (Princep)	Effective	• Grasses & broadleaf weeds • Inexpensive • Great for tank mixes	• Ground water risk • Established trees only • Cannot use on sandy soil (phyto-toxicity plus water risk	
trifluralin + isoxaben (Snapshot)	Effective	• Grasses & broadleaf weeds	• Expensive • Non-bearing trees only	

Cultural and Biological Alternatives

Method	Pros	Cons	Comments
Mowing	• Reduces vole cover • Conserves sod cover	• Mowing grass does not eliminate grass competition with trees • Cannot get under tree without damage to tree and fruit (borers, trunk damage) • High fuel use	
Clean cultivation, fall cover	• Limits voles	• Fuel • Low soil organic matter content, complicating phosphorous management • Increase blossom frost risk • Increased winter root low temperature risk	
Mulch	• Controls weeds • Conserves moisture	• Delayed hardening off in autumn • Voles • Expensive and labor intensive	

Research Needs:

- Determine the best approach to orchard floor management under tree

Regulatory Needs:

- None Identified

Education Needs:

- Proper use of herbicides relative to groundwater risk

2. Grasses – Post Emergence

- **Acres Affected:** All
- **Yield Losses:** Up to 80% crop loss due to reduced tree growth and fruit size.

Currently Registered Pesticides

Pesticide	Efficacy	Pros	Cons	Comments
clethodim (Select)	Effective		• Very expensive • No residual activity	• May give quackgrass control
fluazifop (Fusilade)	Fair to good	• Grasses only	• Grass must be at the appropriate stage for kill • Non bearing trees only • Very expensive	
glyphosate (Roundup)	Effective	• Shield trees from spray • Systemic • Also controls broadleaf weeds and woody weeds	• Risk of damage to trees	
gramoxone (Paraquat)	Effective	• Expensive • Bark injury to young trees • Quick knockdown with no residual • Also controls broadleaf weeds	• Human toxicity • Expensive • Bark injury to young trees • No residual	
pronamide (Kerb)	Effective			• Dormant season application only
sethoxydim (Poast)	Fair to Good	• Not as effective as fusillade	• Grass must be at the appropriate stage for kill • Very expensive	
sulfosate (Touchdown)	Effective	• Also controls broadleaf weeds and woody weeds	• Wiper or shielded application only • Bark injury risk	

Cultural and Biological Alternatives

Method	Pros	Cons	Comments
Mowing	• Provide vole control	• Mowing grass does not eliminate competition of grass with trees • Cannot get under tree without damage to tree and fruit (borers, trunk damage)	
Clean cultivation, fall cover	• Reduced vole population	• Fuel costs • Low soil organic matter content, complicating phosphorous management • Increase blossom frost risk • Increased winter root low temp risk	
Mulch	• Organic, does control weeds • Conserves moisture	• Delayed hardening off in fall • Voles • Expensive and labor intensive	

Research Needs:

- Use of steam, hot foam, or flaming as weed control options
- Use of mechanical cultivation under tree

Regulatory Needs:

- None identified

Education Needs:

- None identified

3. Broadleaf and Woody Weeds, Post Emergence

- **Acres Affected:** All
- **Yield Losses:** Difficult to determine, but can be 50% or more. In addition, serves as a plant bug reservoir and increases nematode risk

Currently Registered Pesticides

Pesticide	Efficacy	Pros	Cons	Comments
glyphosate (Roundup)	Effective	• Gets brambles and other tough ones like poison ivy • Systemic	• Timing is important • Slow knockdown • Risk of injury • Shield trees from spray	
paraquat (Gramoxone)	Effective	• Also controls grasses • Quick knockdown • No residual	• Weak on woody weeds • Human toxicity • Expensive • No residual • Bark injury risk to young trees	• Shield trees from spray
sulfosate (Touchdown)	Effective	• Also controls grasses	• Non Bearing trees only • Very Expensive • Wiper or shielded sprayer application only • Bark injury risk	
terbacil (Sinbar)	Effective	• Also gets grasses and broadleaf weeds pre-emergence	• Weak on woody weeds • Expensive	
2,4-D (Amine 4, Saber)	Effective	• Broadleaf weeds only	• High leaching risk on bare ground	• Shield trees from spray

Cultural and Biological Alternatives

Method	Pros	Cons	Comments
Mowing or brush cutting	• Does weaken woody weeds over time	• Labor and energy intensive	

Research Needs:

- Broadleaf weed complex and its interaction with insect and nematode complex

Regulatory Needs:

- Continued availability of key pre-emergence tools including sinbar and simazine

Education Needs:

- Proper timing of application for optimal control of target weed species

Key Vertebrates and other pests

1. Deer

- **Acres affected:** varies based on local deer population and impact of snow cover on access to orchard and alternative food sources
- **Yield losses:** can be devastating to young trees – at least 2 year setback

Currently Registered Pesticides

Pesticide	Efficacy	Pros	Cons	Comments
ammonium salts of C8-18 and C18' fatty acids (Hinder)	Poor		• Does not work well • Very expensive	
putrescent whole egg solids (Deer Away)	Poor		• Does not work well • Very expensive	
thiram	Poor		• Limited control but may repel rabbits and voles somewhat as well • Skin irritant	

Cultural and Biological Alternatives

Method	Pros	Cons	Comments
Fencing, Electric	• Cost effective	• Does not work when pressure is high • Liability • Maintenance	
Fencing, Woven Wire	• Very effective • Exclusionary	• Very expensive • Exclusionary to customers also • Maintenance	
Soap bars, coyote urine, bags of hair	• Relatively inexpensive	• Effective with low pressure only • Crows and ravens eat soap and break leaders while doing so • Soap dripping onto trunk causes voles to chew	

Lethal control	• Does get rid of problem deer, especially if you get the first ones that breach electric fence	• Labor intensive • Neighbor relations • Cold, night, work • Proximity to housing	
Dogs plus invisible fence	• Eliminates visible fence that may alienate customers	• Company liability	

Research Needs:

- None identified

Regulatory Needs:

- Management of deer herd by Fish & Game management agencies (aimed at increasing herd size) is creating a pest problem

Education Needs:

- Pruning to repair deer damage to tree structure

2. Voles

- **Acres affected:** 100%
- **Yield losses:** Meadow and Pine voles are both problems (pine vole is not present in some soils) – losses can be up to 60% or more tree death if not managed

Currently Registered Pesticides

Pesticide	Efficacy	Pros	Cons	Comments
zinc phosphide (Hopkins Zinc Phosphide Bait, Phosvin, KP)	Effective	• Relatively cheap • Water breaks down	• Timing application to appropriate weather is difficult • For pine vole, must use trailbuilder or bait individual holes • Potential non-target risk • Toxic, but Water breaks down • Bait shyness can develop	• Bait stations most effective, but more work and some regulatory issues • Broadcast works only for meadow voles

Cultural and Biological Alternatives

Method	Pros	Cons	Comments
Vole guards	• Effective against meadow vole	• Cost • Deep snow • Injury from wire guards, borer risk, etc. • Plastic guards increase borer risk	
Mowing	• Reduces pressure	• Does not eliminate	
Encourage coyotes, skunks, foxes, raptors and shrews (fishers, weasels, etc)	• Great community relations	• Predator population will not give complete control of voles	

Research Needs:

- How to establish and maintain shrew populations for vole population management
- Determine how many bait stations needed per acre to provide economic control of voles

Regulatory Needs:

- Expanding availability of toxicants

Education Needs:

- None identified

IV. Appendices

Pesticide Efficacy for Insect and Mite Pests

active ingredient	Brand name(s)	PS	PC	PRM	ERM	SI
abamectin	Agri-Mek	2		2-3		
amitraz	Mitac	2				
azinphos-methyl	Guthion	-	3			
carbaryl	Sevin	-	1-2			
endosulfan	Thiodan, Phaser	-				
esfenvalerate	Asana	3	2-3			
imidacloprid	Provado	3				
K fatty acids	M-Pede	1-2				
kaolin clay	Surround	1-2	1			
lambda-cyhalothrin	Warrior	1-2	3			
malathion	Malathion	-	1			
methidathion	Supracide	1-2				2-3
oil	Damoil, Sunspray, UltraFine, Volck Supreme	3			3	2-3
permethrin	Ambush, Pounce	2-3	3			
phosmet	Imidan	-	2-3			
pyridaben	Pyramite	1-2		2-3	2-3	
pyriproxyfen	Esteem					2-3
spinosad	Spintor					
tebufenozide	Confirm					
thiomethoxam	Actara	2	2-3			
bifenazate	Acramite				2-3	
clofentezine	Apollo			3	3	
dicofol	Kelthane			3	2-3	
fenbutatin-oxide	Vendex			2-3	2	
formetanate HCl	Carzol			2-3	2-3	
hexythiazox	Savey				3	

Key to pest name abbreviations:

PS – Pear Psylla
PC – Plum Curculio
PRM – Pear Rust Mite
ERM – European Red Mite
SI – Scale Insects

Key to efficacy abbreviations:

0 – Not Effective
1 - Poor
2 - Fair
3 - Good

New Pest Management Technologies for Insect and Mite Pests

Method	Source	Status	Pests Affected
buprofezin		Applaud, Courier	Pear Psylla, Plum Curculio
clothiandin		Poncho, Clutch	Pear Psylla
fenpyroximate		Fujimite	Pear Psylla
indoxacarb (Avant)		Registered	Plum Curculio
methoxyfenozide (Intrepid)		Registered	Oriental Fruit Moth, Codling Moth
thiacloprid (Calypso)		Registered	Plum Curculio, Pear Psylla
thiamethoxam (Actara)		Registered	Plum Curculio, Pear Psylla
pyriproxyfen (Esteem)		Registered	Scale Insects

Pesticide Efficacy for Diseases

active ingredient	Brand name(s)	FB	FLS	PS
Bacillus subtillis	Serenade	1		
Bordeaux mixture		1		
copper hydroxide	Kocide	1		
copper sulfate	COCS	1		
harpin protein	Messenger	-		
fenarimol	Rubigan		3	3
ferbam	Ferbam			1-2
kresoxim-methyl	Sovran		3	3
mancozeb	Dithane, Manzate, Penncozeb		3	2-3
oxytetracycline	Mcyoshield	2-3		
sulfur	Sulfur			
streptomycin sulfate	AgriMycin, Bac-Master, Streptrol	2-3		
triflozystrobin	Flint		3	3
thiophanate-methyl	Topsin		3	2
ziram	Ziram			1-2

Key to pest name abbreviations
- FB – Fire Blight
- FLS – Fabrea Leafspot
- PS – Pear Scab

Key to efficacy abbreviations:
- 0 – Not Effective
- 1 - Poor
- 2 - Fair
- 3 - Good

New Pest Management Technologies for Diseases

Method	Source	Status	Pests Affected
benzothiadiazole		Trial, unregistered	Fire Blight
Bacillus subtilus (Serenade)		Trial, registered	Fire Blight
oxlinic acid (Starner)		Trial	Fire Blight
Pantoea aqglomerans C9-1		Trial, unregistered	Fire Blight
Pseudomonas fluorescens A506 (BlightBan)		Trial, registered	Fire Blight
tifloxystrobin (Flint)		Trial, registered	Fabrea Leafspot, Pear Scab
zinc sulfate		Trial, unregistered	Bacterial Spot

Pesticide Efficacy for Weeds

active ingredient	Brand name(s)	AG	AB	PG	PBW
clethodim	Select	3	-	2	-
dichlobenil	Casoron	2-3	2-3	-	-
diuron	Direx, Karmex	2-3	2-3	-	-
fluazifop	Fusilade	2-3	-	2	-
glyphosate	Roundup	3	3	3	3
gramoxone	Paraquat	3	3	2-3	1-2
napropamide	Devrinol	2-3	-	-	-
norflurazon	Solicam	2-3	-	-	-
oryzalin	Surflan	2-3	-	-	-
oxyfluorfen	Goal	-	-	-	2-3
pendimethalin	Prowl	2-3	-	-	-
pronamide	Kerb	2-3	-	2-3	-
sethoxydim	Poast	2-3	-	2	-
simazine	Princep	2-3	2-3	-	-
sulfosate	Touchdown	3	3	3	3
terbacil	Sinbar	3	3	2-3	1
trifluralin + isoxaben	Snapshot	3	3	-	-
2,4-D	Amine 4, Saber	-	2-3-		1-2

Key to pest name abbreviations

AG – Annual Grasses
AB – Annual Broadleaf Weeds
PG – Perennial Grasses
PBW – Perennial Broadleaf Weeds and Woody Weeds

Key to efficacy abbreviations:

0 – Not Effective
1 - Poor
2 - Fair
3 - Good

New Pest Management Technologies for Weeds

Method	Source	Status	Pests Affected
clopyralid (Stinger)		Not registered	Broadleaf Weeds
halosulfuron (Sempra)		Not registered	Broadleaf Weeds

Pesticide Efficacy for Vertebrate Pests

active ingredient	Brand name(s)	WTD	V
ammonium salts of C8-18 and C18' fatty acids	Hinder	0-1	
putrescent whole egg solids	Deer Away	0-1	
thiram	Thiram	1	
zinc phosphide	Hopkins Zinc Phosphide Bait, Phosvin, KP		3

Key to pest name abbreviations
- WTD – White Tailed Deer
- V – Voles

Key to efficacy abbreviations:
- 0 – Not Effective
- 1 - Poor
- 2 - Fair
- 3 - Good

New Pest Management Technologies for Vertebrates

Method	Source	Status	Pests Affected
None identified			

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