New England Highbush Blueberry Pest Management Strategic Plan

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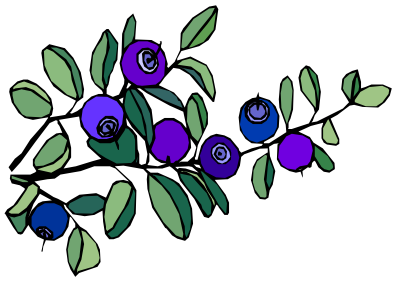

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Executive Summary

The list of key pests for highbush blueberry is not long: two insects, five diseases, and the weeds and vertebrates common to orchard settings. These few key pests, however, are an annual menace and have significant impacts on production, with possible acres affected and/or yield loss up to 100%. Mummy Berry is the most devastating pest in this list with 100% acres affected, up to 90% yield loss without management and as much as 50% yield loss with management. In addition, there are other current and emerging pests that affect the crop to lesser degrees but serious outbreaks have equally damaging results. Blueberry Canker (*Gibbera*) is one such emerging pest that has caused major losses of 75-90% in NH for several years.

The following outlines the most critical research, regulatory, and educational issues as determined by a review group of highbush blueberry growers, researchers, and industry stakeholders during the Pest Management Strategic Plan process.

Research

- Adaptation and approval of the Curveball™ (Pest Management Innovations) for use against Blueberry Maggot is the most desired research objective. The technology is currently used for management of Apple Maggot, a very similar insect. Use of this method would greatly reduce or eliminate the need for chemical spraying for management of Blueberry Maggot.
- Study and development of organic options for management of Mummy Berry are also desired. This is the most devastating pest of highbush blueberry and more management options will be valuable.
- Understanding the lifecycles of and developing management options for Fusicoccum Canker, Blueberry Canker, and Witches Broom will be critical to management of these established and emerging pests.
- Chemical management options for annual grasses are needed that have short REI and PHI times required during harvest. The high percentage of pick-your-own or U-pick operations in New England necessitate that customers be in the fields during or immediately following management activities.
- Birds are the most persistent vertebrate pest of highbush blueberry. Better, more efficient, and less expensive management options, both chemical and organic, are wanted. New and the various current management methods should be examined for efficacy.

Regulatory

- The most desired regulation objective is the change in labeling of the chemicals fenbuconazole (Indar) and propiconazole (Orbit) from section 18 to section 3 status. A label change is critical to allow for ease of use because there are no other fungicides currently as effective against Mummy Berry primary inoculum. This is the most devastating pest of highbush blueberry and more management options will be valuable. The dual activity against Phomopsis Twig Blight is beneficial as well.

Regulatory (continued)

- Voles are key pests in many orchard environments and management options for rodents are limited. Approval of current and new chemistries for use in highbush blueberry fields will provide more management options.

Education

- Growers have a great need for more diagnostic information to be developed and made available. Current sources are inadequate and funding is needed to expand upon them. This is especially critical with new and emerging pests. A diversity of photos of the pest at different stages, insect vectors, and symptoms or signs that may be confused with the pest would be most valuable. Electronic delivery or availability of photos and information is desired.
- Lifecycle information and management options during lifecycle stages for Mummy Berry is requested by growers. An effective management protocol that includes both the primary and secondary inoculum stages is needed.
- Regionally applicable research, coordination, meetings, and education events specific to highbush blueberry production are also desired by growers. Funding for the pursuit of this objective is vital.
- More weed scientists, plant pathologists, entomologists, and production specialists with an understanding of applied practice are essential to pest management. These vocations need to be encouraged and supported to maintain and improve upon the number and quality of professionals in practice.

I. Introduction

Background of Highbush Blueberry in New England

The six New England states combine to rank eighth in national production of highbush blueberries. A total of 1,426 acres produce 1853.8 tons of harvested fruit that contribute $7.2 million dollars to the New England economy. Two-thirds of the fruit is sold through pick-your-own or U-pick operations to the public while the rest is sold wholesale and retail. Very little is sent for processing. While only contributing 2.7% to the national production of highbush blueberries, the highbush blueberry field 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)

Highbush blueberries are susceptible to many types of pests including insects, diseases, weeds, and vertebrates. It is critical that these pests be effectively managed to maintain adequate yields of quality fruit that is acceptable to consumers. The high percentage of pick-your-own or U-pick operations in New England also necessitate that pest management methods allow for customers in the fields during or immediately following management activities. New England highbush blueberry 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 highbush blueberry production. The loss of important pesticide tools due to pest resistance, regulatory, and consumer-driven pressures is a concern for the entire highbush blueberry industry.

Benefits to the New England Highbush Blueberry Industry

The New England Highbush Blueberry 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 highbush blueberry fields. The current pest management programs will be made more effective through implementation of actions proposed in this plan.

The Highbush Blueberry Pest Management Strategic Plan Process

A review group of highbush blueberry growers, researchers, and industry stakeholders throughout New England met for two days in November of 2005 to develop this Strategic Plan based on the 2005 New England Highbush Blueberry Crop Profile. Key pests driving pesticide use were suggested by the 2003 New England Highbush Blueberry Survey which was used to generate the Crop Profile. The survey was sent to 350 growers throughout New England and had a 66% return rate. The list of key pests was edited/approved by the 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 Highbush Blueberry Pest Management Strategic Plan

Key Pest Strategic Issues

Insects

Blueberry Maggot

- Routine management is required once pest is introduced.
- Consumer tolerance is zero in almost all instances.
- Routine management is required if grower is dependent on sale income.
- Pest will build up population from year to year without management.
- Neighboring landscape and hosts influence pest population.
- Malathion is the preferred chemical control method due to a short preharvest interval.
- Hiring third party scouts is not practical for New England blueberry growers.

Cranberry & Cherry Fruitworm

- Management, damage, appearance, and management timing similar for each.
- Cherry Fruitworm dominant in Rhode Island.
- Management timing does not overlap with harvest.
- Consumer presence is not an issue during management.
- Pest will build up population from year to year without management.
- Neighboring landscape and a wide range of hosts influence pest population.
- Management period extended to three weeks or longer due to asynchronous lifecycles.
- Parasitoids and predators do not have a significant effect on keeping pest below threshold level.
- Hiring third party scouts is not practical for New England blueberry growers.

Diseases

Mummy Berry

- Disease is always present but severity can be variable.
- Weather conditions that are favorable to disease are unfavorable to management.
- Plant variety influences disease severity: bloom time in relation to inoculum presence.

Phomopsis Twig Blight

- Higher incidence in southern New England; Sporadic in northern New England.
- Associated with winter injury, wounding and stress.
- Primary method of control is cultural: pruning and irrigation.
- Yield losses can be drastic if not managed.

Anthracnose

- Disease incidence has been increasing over past years.
- Warm temperatures are favorable to disease development.
- Neighboring landscape and a wide range of hosts influence pest population.
- Affects fruit at harvest and spreads readily in storage; Severe infection affects twigs and leaves.
- Disease overwinters on stems.
- Easily identified due to distinctive pink spores on fruit.
- Infection and management occurs at bloom while disease sign is not noticeable until harvest.
- Management for this disease is often a secondary effect of management for other diseases.

Botrytis Blight

- Disease severity can be variable.
- Affects blossom and stem of plant.
- Two phases of disease cause blossom blight and fruit rot.
- Diagnosis can be confused with frost injury and blossom blight phase of Blueberry Scorch.
- High nitrogen applications increase susceptibility of plant to disease.
- Fungicide rotation is necessary to prevent resistance development.

Fusicoccum Canker

- Disease is always present at low levels but severity can be of variable economic importance.
- Higher incidence in northern New England than southern New England.
- Diagnosis can be confusing.
- Pruning is the primary management method.
- Management for this disease is often a secondary effect of management for other diseases.

Weeds

- Yield losses are difficult to quantify.
- Some growers tolerate weeds and don't consider management as an issue.
- Affect plant growth by intercepting nutrients, water and sunlight.
- Neighboring tree roots invading field can also affect plant growth and yield.
- Provide habitat or reservoir for other pests such as voles, insects, viruses and disease.
- Weed growth negatively affects airflow, promoting other pest development.
- Weed blooms attract pollinators that may be affected by chemical management when blueberries themselves are no longer in bloom.
- Can affect allergies and be visually unappealing to customers.

- Annuals (except crabgrass) are generally easier to manage.
- Twining/vining weeds, when present, and crabgrass are of special nuisance to manage.
- Wild brambles, sorrel, clover, cinquefoil, nutsedge, wild buckwheat are more difficult to manage.
- Woody perennials can be an issue, especially when introduced through wood chip mulch.
- Herbicides are usually applied in bands in narrow area around plant, allowing for application of less product per acre than if broadcast.
- There are no adequate alternatives available for glyphosate as a post-emergent management tool.

Vertebrates

Birds

- The most troublesome species are the perching birds (sparrows, swallows, orioles, etc.)
- Turkeys are an increasing pest problem in New England.
- Most bird species are protected, which limits use of lethal control measures.
- There are wide variations in international, federal, state, and county regulations, interpretation and enforcement.
- Netting is the most effective management tool: yield loss is almost 0% with this method.
- Any other methods must be used in combination and varied to be most effective.
- Neighboring landscape providing shelter and nesting sites influence pest population.

Deer

- Damage can be variable.
- Snow depth affects pest access to plants.
- Fall and Winter damage to buds and new growth; Spring damage to new growth.
- There are wide variations in international, federal, state, and county regulations, interpretation and enforcement.
- Fencing is the most effective management tool when pest populations are high.

Voles

- The two species are meadow vole and pine vole.
- Pine voles live underground and do not prefer highly sandy soil.
- Pine voles can live on blueberry roots as their total diet.
- Meadow voles live above ground and prefer a habitat with thick vegetation.
- Meadow voles girdle plant trunks.

Strategic Issues of Specific Pest Management Tactics

Insects

BM = Blueberry Maggot
CF = Cranberry Fruitworm
When pesticide affects multiple key insects, the pests are marked in bold text.

Currently Registered Pesticides

Pesticide	Pest	Pros	Cons	Comments
azadirachtin: Neem, Aza-direct	**BM, CF**	• some OMRI listed products	• expensive • clogs sprayer equipment	•
azinphos-methyl: Guthion	**BM, CF**	• effective • long residual effect • broad spectrum • inexpensive	• broad spectrum • low mammalian LD50 • kills beneficials • long REI compared to other materials (7 days) • BM: seven days to harvest (long residual effect)	• restricted use +/-
B.t. endotoxin: Biobit, Dipel DF, Javelin, Deliver	CF	• not detrimental to beneficials • not toxic to mammals • some products OMRI listed	• narrow window of efficacy (only newly-hatched larvae susceptible) • easily washed off by rain and photodegrades • require multiple applications • short residual effect	• can be effective if applied properly and repeatedly • more effective with certain “stickers” • very important for organic growers (critical use)
carbaryl: Sevin	**BM, CF**	• relatively high mammalian LD50 • broad spectrum • relatively inexpensive	• broad spectrum • especially risky to pollinators of other crops • can cause aphid buildup • BM: long PHI (7 days)	• residual effect shorter than guthion (factor in decision making)
diazinon: Diazinon	CF	• broad spectrum • relatively inexpensive	• broad spectrum • hard on beneficials • potential for leaching into groundwater	• still one product on the market registered • not commonly available product for this pest/crop

Strategic Issues of Specific Pest Management Tactics (continued)

Insects (continued)

Pesticide	Pest	Pros	Cons	Comments
kaolin clay: Surround	BM	• not toxic to mammals or insects • OMRI approved	• expensive • readily washes off – reapplication necessary • need excellent coverage for efficacy (multiple treatments) • coating can be visually unappealing and/or cause concern	• suppression effect only
malathion: Malathion	**BM, CF**	• relatively inexpensive • BM: short PHI (1 day)	• short residual effect • offensive odor to customers of blueberries and other crops • not particularly effective against multiple insect pests	• may effect beneficials (no data) • BM: adding NuLure (Staley's Sauce-base #7) greatly increases efficacy
malathion + NuLure bait	BM	• bait promotes ingestion for internal effect • relatively inexpensive	•	• not widely used • lower chemical rates may be possible
methomyl: Lannate	CF	• broad spectrum • very effective	• broad spectrum • very low LD50 • kills beneficials • extreme protective equipment required (storage, loading, applying) • may be phytotoxic	• restricted use
methoxychlor: Methoxychlor	CF	• long residual activity • relatively high LD50	• broad spectrum • harmful to pollinators	• still one registered product on the market • not commonly available product for this pest/crop
phosmet: Imidan	**BM, CF**	• effective • long residual effect • broad spectrum • relatively inexpensive	• moderate mammalian LD50 • kills beneficials	• BM: 3 days to harvest better than some but not ideal

Strategic Issues of Specific Pest Management Tactics (continued)

Insects (continued)

Pesticide	Pest	Pros	Cons	Comments
pyrethrin: Pyrenone	**BM, CF**	• BM: days to harvest zero • BM: relatively quick effect	• not OMRI listed • efficacy inconsistent (on cranberry)	• relatively expensive for effectiveness • CF: little data available
pyrethrin (without artificial additives): Pyganic	BM	• days to harvest zero • relatively quick effect • OMRI listed	• efficacy inconsistent (on cranberry)	• relatively expensive for effectiveness
pyrethrin + rotenone: Pyrellin	BM	•	• not OMRI listed	• counterproductive to combine components that are active at different rates
pyriproxyfen: Esteem	CF	• effective against both cherry and cranberry fruitworm	• only affects immature stages	• brand new product
spinosad: Entrust	**BM, CF**	• OMRI listed	• expensive • 3 days to harvest • large volume packaging problematic for small acreage	• this product contains more active ingredient
spinosad: Red Sticky Trap + cap with Entrust "Curveball™"	BM	• management tool and a monitoring tool • alternative to spraying	• yet to be fully tested	• product developed for apple maggot and worth testing with blueberry maggot
spinosad: GF120 Naturalyte fruit fly bait	BM	• OMRI listed • REI only 4 hours • days to harvest zero	•	• brand new
spinosad: Spintor	CF	• not OMRI listed	• expensive • large volume packaging problematic for small acreage	•

Strategic Issues of Specific Pest Management Tactics (continued)

Insects (continued)

Cultural and Biological Alternatives

Practices	Pest	Pros	Cons	Comments
Sticky traps	BM	• Red spheres very effective to monitor when/if to use chemicals • easier to see insects on yellow traps • yellow traps cheap and disposable	• customer nuisance • labor cost • difficult to maintain • insect identification sometimes confused with apple maggot • occasionally catch birds • must hang properly	• yellow not as effective and do not last as long as red sphere • other traps not as effective as yellow or red
Pheromone Traps	CF	• useful monitoring tools	• not much better than phenology	• improve efficacy by determining appropriate timing for chemical sprays
NuLure Insect Bait	BM	• bait promotes ingestion for internal effect	• chemical necessary for effect	• not widely used
Handpicking infested fruit	**BM, CF**	• CF: can be somewhat effective	• labor intensive	• BM: can't build up if kept picked • CF: customers will not pick • CF: fall off during mechanical harvest
discing between rows and raking/hoeing under plant	CF	• disrupts overwintering sites • physically damages pests	• labor cost	•
Eliminate wild blueberries	BM	• good if you can access plants and completely remove	•	•

Strategic Issues of Specific Pest Management Tactics (continued)

Diseases

A = Anthracnose
BB = Botrytis Blight
FC = Fusicoccum Canker
MB = Mummy Berry
PTB = Phomopsis Twig Blight
When pesticide affects multiple key insects, the pests are marked in bold text.

Currently Registered Pesticides

Pesticide	Pest	Pros	Cons	Comments
azadirachtin: Neem	MB	•	•	• little used product • some fungicidal properties
azoxystrobin: Abound	A	• very good efficacy	• cannot use if apples nearby -drift issues	•
B. subtilis Serenade	MB	• OMRI approved • highly effective when used properly • alternate chemistry	• persistent coating visually unappealing and/or cause concern • full coverage is necessary • multiple applications necessary • expensive	•
captan: Captan, Captec	**A, BB, FC, MB, PTB**	• established product • inexpensive • broad spectrum	• not OMRI listed • phytotoxicity with diazinon • MB: obvious residue • MB: better against secondary than primary inoculum • FC: poor efficacy	•
captan + fenhexamid: Captevate	**BB, MB**	• MB: good alternative chemistry against secondary inoculum • BB: good activity	• relatively expensive • phytotoxicity with diazinon • MB: not practical against heavy secondary inoculum	•
chlorothalonil: Bravo	**A, BB, FC, MB. PTB**	• broad spectrum • inexpensive • A, FC, PTB: very effective	• risk of groundwater contamination • MB: not as great efficacy as others • MB: persistent coating visually unappealing and/or cause concern • MB: suppressive effect only	• MB: homeowner use

Diseases (continued)

Pesticide	Pest	Pros	Cons	Comments
cyprodinil + fludioxonil: Switch	**A, BB, MB**	• A, BB: good efficacy	• expensive • MB: suppressive effect only	•
fenbuconazole: Indar	**MB, PTB**	• MB: best material available • MB: more effective than Orbit against primary inoculum • MB: very effective against secondary inoculum • PTB: best material available	• same chemical family as Orbit • relatively expensive	• emergency use section 18 label • at EPA for section 3 national label
fenhexamid: Elevate	**BB, MB**	• locally systemic (can penetrate plant tissue) • MB: good alternative chemistry against secondary inoculum • BB: best material available	• relatively expensive • MB: not practical against heavy secondary inoculum	•
fosetyl Al: Aliette	**A, PTB**	• very effective	• expensive	•
propiconazole: Orbit	**MB, PTB**	• MB: the second best option against primary inoculum • MB: effective against secondary inoculum	• same chemical family as Indar • relatively expensive	• emergency use section 18 label • manufacturer pursuing label • PTB: research needed
pyraclostrobin: Cabrio	**A, PTB**	• good efficacy	• expensive	•
pyraclostrobin + boscalid: Pristine	**A, BB**	• good efficacy	• expensive	•

Diseases (continued)

Pesticide	Pest	Pros	Cons	Comments
sulfur: Lime Sulfur	**A, FC, PTB**	• some OMRI listed	• phytotoxicity possible • resistance improbable • very corrosive • very bad odor • PTB: variable efficacy • A: variable efficacy	• PTB: use after pruning • A, FC: efficacy data unavailable
sulfur: Liquid Sulfur	MB	• some OMRI listed	• phytotoxicity possible • resistance improbable	• little used product
ziram: Ziram	**A, BB, FC, MB, PTB**	• inexpensive • zinc sometimes necessary as nutrient • broad spectrum • A, BB: good efficacy	• availability irregular • MB: very little effect	• not used as much as could be • MB: little used product

Strategic Issues of Specific Pest Management Tactics (continued)

Diseases (continued)

Cultural and Biological Alternatives

Practices	Pest	Pros	Cons	Comments
Application of Urea	MB	• effective	• timing critical • only affects mushroom stage • not organic	• works best when combined with cultivation • adds nitrogen to soil
Handpicking infected fruit	A	• fruiting structures do not develop	• labor intensive	•
Handpicking infected fruit	MB	• effective when incidence low	• can become labor intensive	•
Handrake	MB	• disrupts fungal lifecycle (physically destroys)	• labor intensive • can damage roots • can expose buried weed seed • can expose previously buried mummies • can disrupt pre-emergent weed management	•
Mulch	MB	• disrupts fungal lifecycle	• labor intensive • large volume of mulch needed annually • timing critical • not especially effective	• no grass allowed
Pruning	**A, BB, FC, MB, PTB**	• increases airflow • spacing has similar effect • shortens drying time	• labor intensive	•
	A, BB, FC	•	•	• removal of overwintering site
	PTB	•	•	• precursor to chemical application
Resistant varieties	**A, FC, MB, PTB**	•	•	• winter hardiness a more dominant issue when selecting plants
	A, MB, PTB	• less fungicide necessary	•	•
	A	•	•	• fruit and leaf resistance
Destroy wild hosts	MB	• reduces inoculum	• access may be limited	•

Strategic Issues of Specific Pest Management Tactics (continued)

Weeds

Pre = Pre-emergent
Post = Post-emergent

Currently Registered Pesticides

Pesticide	Pest	Pros	Cons	Comments
Corn Gluten Meal	Pre	• some OMRI listed	• adds excessive nitrogen • very high application rates necessary	• not recommended for blueberry
clethodim: Select	Post	• better activity against perennial grasses than Poast	•	• best product for quackgrass • new product
dichlobenil: Casoron	Pre	• good activity against annual perennial broadleaf • widely used • long residual effect • broad spectrum	• timing aspects important • rain can cause run-off • expensive	• granular formulation more effective than WP, preferred by smaller growers • granulation formulation reduces leaching concerns
diuron: Diuron	Pre	•	• phytotoxicity potential	• very not widely used • not recommended
flauzifop: Fusilade	Post	• good activity against annual grasses • safe on crop	• fair activity against perennial grasses • crop injury potential due to required mix with crop oil • not much activity compared to other options • can only apply to young crops (do not apply to crops to be harvested within one year of application)	• not practical • not widely used
glyphosate: Roundup	Post	• activity against annuals and perennial weeds • inexpensive • easy to use • safe for applicator	• crop injury potential • no residual activity • timing is critical to efficacy	• very widely used • critical for spot treatment

Strategic Issues of Specific Pest Management Tactics (continued)

Weeds (continued)

Pesticide	Pest	Pros	Cons	Comments
hexazinone: Velpar L	Pre	• activity against broadleaf weeds perennials, • especially useful for problematic weeds	• high risk of groundwater contamination • safe on mature plants only (3+years)	• regional restriction in Northeast
napropamide: Devrinol	Pre	• safe on new growth • good activity against annual grasses and small seeded broadleaf weeds	• residual effects only good for 12 weeks • needs to be watered in to prevent breakdown • some important weeds not affected	• root growth inhibitor but used on new plantings • widely used
norflurazon: Solicam	Pre	• safe on new growth	• some activity but better products are available • residual effects only good for 12 weeks • needs to be watered in to prevent breakdown	• not widely used
oryzalin: Surflan	Pre	• relatively inexpensive • safe on new growth • does not require watering in	• residual effects only good for 12 weeks • not recommended for high organic matter soil (such as found below mulch)	•
paraquat: Gramoxone	Post	• fast acting • effective burn-down • more effective against tree seedlings than other products	• applicator safety is an issue • restricted use is an issue • offensive odor • expensive • crop injury potential • not effective against perennials	• important niche product for management of tree seedlings • nonionic surfactant recommended
pelargonic acid: Scythe	Post	• effective burn-down • fast acting • zero day PHI	• very odorous • expensive • not very effective at killing growth point • not effective against perennials	•
pronamide: Kerb	Pre	•	• expensive • phytotoxicity potential	• not widely used

Strategic Issues of Specific Pest Management Tactics (continued)

Weeds (continued)

Pesticide	Pest	Pros	Cons	Comments
sethoxydim: Poast	Post	• safe on crop • good activity against annual grasses	• fair activity against perennial grasses with multiple applications • 30 day PHI • crop injury potential due to required mix with crop oil	• generally used
simazine: Princep, Caliber	Pre	• good activity against many broadleaf weeds • some post-emergent activity as well • inexpensive	• phytotoxicity potential in young plants • risk of groundwater contamination • some resistance development issues	•
sulfosate: Touchdown	Post	• activity against annuals and most perennials	• crop injury potential • no residual activity • use on nonbearing plants only • one year PHI	•
terbacil: Sinbar	Pre	• good activity against many broadleaf weeds • some post-emergent activity as well • somewhat inexpensive	• phytotoxicity potential in young plants • risk of groundwater contamination	•

Strategic Issues of Specific Pest Management Tactics (continued)

Weeds (continued)

Cultural and Biological Alternatives

Practices	Pros	Cons	Comments
Mowing	• most effective option in row middles	• requires multiple treatment • seed dispersal can be an issue unless mulching mower used	• standard practice
Mulching	• most effective option around plants • first step in weed management • can be supplemented with chemical options • very effective	• sometimes can encourage pine voles • wood chips can introduce Armillaria • application costs can be high	• standard practice • other benefits (soil moisture retention, etc)
Cultivation	• fairly effective on emerged annual weeds	• not practical with mulch • quick regrowth of perennial weeds • not effective on wet soil • can damage roots	•
Hand weeding	• best option for persistent and noxious weeds	• very labor intensive	•
establish dwarf and/or nonaggressive grasses around plants	• less mowing required • less likely to invade plant rows • attractive • less habitat for voles	• can be difficult to establish • some varieties do not fill in well	•

Strategic Issues of Specific Pest Management Tactics (continued)

Vertebrates

Currently Registered Pesticides

Pesticide	Pest	Pros	Cons	Comments
methyl anthranilate: Bird Shield™	Birds	•	• limited usefulness • 8-10 day PHI • reapplication necessary after rain events • some birds not affected • phytotoxicity possible	• not widely used
Thiram	Deer	• some limited effectiveness	•	• taste repellent
zinc phosphide bait	Voles	• quite effective combined with bait stations	• only available from Pocatello Supply Depot - USDA, APHIS, WS • nontarget death possible • deteriorates rapidly with moisture	•

Cultural and Biological Alternatives

Practices	Pest	Pros	Cons	Comments
Scare eye balloons	Birds	•	• limited effectiveness • variable results	•
Flash Tape	Birds	•	• limited effectiveness • variable results • limited species efficacy • not practical on large scale	• some tapes also have sound components as deterrents
Propane Cannons	Birds	• short term effectiveness	• annoyance to neighbors and customers	•
Owls	Birds	•	• must be moved daily to be effective	• more realistic is better • some incorporate moving head
Netting	Birds	• very effective	• high labor cost • high initial materials cost • coverage can be difficult with certain plantings	• coverage must be complete with anchored edges • with proper maintenance, equipment will last many years

Strategic Issues of Specific Pest Management Tactics (continued)

Vertebrates (continued)

Practices	Pest	Pros	Cons	Comments
Distress Calls	Birds	• good initial effectiveness • attract actual live predators	• annoyance to neighbors and customers	• some models can vary calls to reduce chances of pest acclimation
Shotgun	Birds	•	• neighbor relations • safety issues • legality issues • short term effect	•
People picking	Birds	• fairly effective	• impossible at certain times of day, weather	•
Fire crackers and other pyrotechnics	Birds	• effective at key feeding times	• annoyance to neighbors and customers • safety issues • very short term effectiveness	• works in conjunction with people picking • products are legal for use in agriculture
Bottle rockets	Birds	• very effective against some species	• annoyance to neighbors and customers • safety issues • very short term effectiveness	•
peaceful pyramid	Birds	• limited effectiveness	• very short term effectiveness	•
reflective compact discs	Birds	• relatively effective • inexpensive	• very short term effectiveness	•
“dead crow” method +/- owl	Birds	• warns other crows	• customer relations if visible	•

Strategic Issues of Specific Pest Management Tactics (continued)

Vertebrates (continued)

Practices	Pest	Pros	Cons	Comments
Fence	Deer	• most effective when pest populations high	• cost of setup and maintenance	•
Electric fence	Deer	• can be effective for bears too • single-strand temporary fence less expensive and mobile	• deer can learn to avoid if there is a down period • need to train deer to fence • full multi-strand setup can be initially expensive • maintenance necessary	• risk may not justify expense • can use single-strand + peanut butter/foil bait
Shooting	Deer	• very effective on individuals	• legal issues • safety • neighbor relations • public acceptance	• bowhunting alternative
Traps	Voles	• might have effect in small areas	• labor intensive • proper technique necessary	•

Research priorities

Insects

- Study the efficacy of newer products in comparison with each other and older products.
- Establish which management methods provide suppression and/or control .
- Determine why other available chemicals are not being used.
- Remind that EPA demonstration grants and Sustainable Agriculture Research and Education (SARE) grower grants are available for research.
- Examine the efficacy of using lower rates of chemicals for management of Blueberry Maggot, similar to studies done with apple maggot.
- Confirm and test the efficacy of combinations of NuLure bait with lower rates of malathion or other chemicals for management of Blueberry Maggot.
- Expand research on the efficacy of "Curveball™" combination of red sticky traps with spinosad for management of Blueberry Maggot.

Diseases

- Expand research on efficacy, phytotoxicity, etc. of azadiractin and liquid sulfur as management chemicals for Mummy Berry; Ziram and the use of Orbit for Phomopsis Twig Blight; lime sulfur for Fusicoccum Canker; and Serenade or Oxidate for Botrytis Blight.
- Develop and test different chemistries with activity against primary inoculum for Mummy Berry.
- Develop more management options for Fusicoccum Canker because only two products are currently known to be effective.
- Develop fungicides that eradicate Botrytis Blight instead of prevent disease.
- Explore organic alternatives to current chemical management for Anthracnose.
- Characterize the phenology and weather conditions that promote the development of Botrytis Blight and/or Mummy Berry.
- Explore the relationship of plant stress issues with fungal infection for Phomopsis Twig Blight and/or Fusicoccum Canker.
- Determine the optimum timing for pruning as a management method for Phomopsis Twig Blight, Anthracnose and/or Fusicoccum Canker.
- Identify and evaluate resistant highbush blueberry varieties for Fusicoccum Canker.
- Establish if *Diaporthe* stage of Phomopsis Twig Blight has a role in infection.
- Establish if *Godronia* stage of Fusicoccum Canker has a role in infection.

Research priorities (continued)

Weeds

- Examine effects of neighboring tree roots invading field on highbush blueberry plant growth and yield.
- Develop new crabgrass preventative with PHI less than 10 days.
- Develop alternatives to glyphosate that meet or improve activity, cost effectiveness, ease of use, etc.
- Study phytotoxicity effects of Kerb.
- Wild parsnip, hog parsnip, and related species require study and management options in relation to highbush blueberry fields.
- Better options are needed for management of wild brambles, sorrel, clover, cinquefoil, nutsedge, and wild buckwheat. Hand weeding is not cost effective.
- More and better quackgrass management options are needed in addition to Roundup and Poast.
- Develop and test new chemistries that can provide more management options. Most current chemistries have been available for a long time.
- Examine the use of dwarf and/or nonaggressive grasses between rows as a cultural alternative.

Vertebrates

- Develop and test new chemistries that can provide more management options for birds and voles.
- Explore the efficacy of placement of perches and houses to encourage bird predators to nest and hunt near highbush blueberry fields.
- Expand studies of sound devices that attract bird predators and the timing of their use as management options.
- Measure the cost of using bird netting in relation to income from increased quality and/or volume of the crop and in relation to field size.

Regulatory priorities

Insects

- Smaller volume packaging for chemicals is needed to be practical for the smaller acreage farms typical of New England.
- REI of management chemicals for Blueberry Maggot needs to be no more than 3 days to allow for application during harvest to accommodate the high percentage of pick-your-own or U-pick operations in New England.
- PHI of management chemicals for Blueberry Maggot needs to be no more than 1 day to allow for application during harvest to accommodate the high percentage of pick-your-own or U-pick operations in New England.

Diseases

- A label change for Indar is critical. Indar offers dual protection against Mummy Berry primary inoculum and Phomopsis Twig Blight, which is not available in any other currently registered blueberry fungicide.
- Approve Topsin for use because it is a different chemical family from Orbit or Indar and will provide more management options for Mummy Berry, Phomopsis Twig Blight, Anthracnose, and Botrytis Blight.
- The management chemicals boscalid (BAS510) pyraclostrobin (BAS500) and a combination (BAS516) would be beneficial if approved for Anthracnose.
- Swift approval of different chemistries, when developed, will provide more management options against primary inoculum of Mummy Berry and against Fusicoccum Canker.
- Smaller volume packaging for chemicals is needed to be practical for the smaller acreage farms typical of New England.
- Streamline reporting systems for section 18 use.

Weeds

- Provide incentives to increase the number of applied weed scientists and plant pathologists in practice.
- Approve labeling for hexazinone(Velpar L) for unrestricted use in the Northeast to provide options for management of wild brambles, sorrel, clover, cinquefoil, nutsedge, and wild buckwheat.
- Smaller volume packaging for chemicals is needed to be practical for the smaller acreage farms typical of New England.

Regulatory priorities (continued)

Vertebrates

- Foster and enforce consistency among the varied international, federal, state, and county regulations, interpretation and enforcement for deer and birds.
- Change label for Measurol to allow use in highbush blueberry for bird management.
- Change falconry regulations to allow exercise of captive bird predators in highbush blueberry fields.
- Explore removing voles, particularly Pine voles and Meadow voles, from regulation.

Education priorities

Insects

- Inform growers of other chemicals that are available but are not being used.
- Collect information on why those chemicals are not being used.
- Educate growers on efficacy of new management products in relation to other products, including the “Curveball™” and NuLure baits for Blueberry Maggot.
- Improve awareness of the activity of fungicides in comparison to insecticides.
- Remind that EPA demonstration grants and Sustainable Agriculture Research and Education (SARE) grower grants are available for research.
- Customer education is needed to limit their determination to wander into hazardous areas in fields when chemical management is used during harvest.
- Develop information for growers to hand out to customers with questions about management.

Diseases

- Develop and distribute disease lifecycle information (primary, secondary) and note effective management for lifecycle stages of Mummy Berry.
- Develop and distribute identification information for identification and field diagnosis of pathogens and symptoms for Phomopsis Twig Blight, Anthracnose, Botrytis Blight, and Fusicoccum Canker.
- Increase awareness of Anthracnose as an emerging issue.
- Improve awareness of disease resistant highbush blueberry varieties that are available
- Educate growers on efficacy of new management products in relation to other products.
- Provide information for growers and educators regarding the legal use of discontinued chemical products or phase-out.
- Provide general education about section 18, legal issues, etc. regarding chemical products.
- Remind that Sustainable Agriculture Research and Education (SARE) grower grants are available for research.
- Develop information for growers to hand out to customers with questions about management.

Education priorities (continued)

Weeds

- Educate growers of the need for rotation of herbicide chemistries to prevent resistance and weed population shifts.
- Promote the use of dwarf and/or nonaggressive grasses between rows as a cultural alternative.
- Promote education to increase the number of applied weed scientists and plant pathologists in practice.
- Educate growers on efficacy of new management products in relation to other products.
- Provide information for growers and educators regarding the legal use of discontinued chemical products or phase-out.
- Remind that Sustainable Agriculture Research and Education (SARE) grower grants are available for research.
- Develop information for growers to hand out to customers with questions about management.

Vertebrates

- Create awareness among growers of availability of captive bird predators that may be exercised in highbush blueberry fields.
- Encourage placement of perches and houses to encourage bird predators to nest and hunt near highbush blueberry fields.
- Growers need to report damage to wildlife services to document effect of pests. This may influence further funding towards management issues for these pests.
- Develop information for growers to hand out to customers with questions about bird management.
- A certain tolerance for bird pests may be fostered among growers.
- Develop detailed Vole management plans.
- Foster and enforce consistency among the varied international, federal, state, and county regulations, interpretation and enforcement for deer.

III. Strategic Issues for Key Highbush Blueberry Pests

Key Insect pests

Blueberry Maggot

% Acres Affected: 5% (up to 95% in New Hampshire)
Yield Losses: 30+% without management, up to 5% with management

- Routine management is required once pest is introduced.
- Consumer tolerance is zero in almost all instances.
- Routine management is required if grower is dependent on sale income.
- Pest will build up population from year to year without management.
- Neighboring landscape and hosts influence pest population.
- Malathion is the preferred chemical control method due to a short preharvest interval.
- Hiring third party scouts is not practical for New England blueberry growers.

Currently Registered Pesticides

Pesticide	Efficacy*	Pros	Cons	Comments
azadirachtin: Neem, Aza-direct	1-2	• some OMRI listed products	• expensive • clogs sprayer equipment	•
azinphos-methyl: Guthion	4	• effective • long residual effect • broad spectrum • inexpensive	• broad spectrum • seven days to harvest (long residual effect) • low mammalian LD50 • kills beneficials • long REI compared to other materials (7 days)	• restricted use +/-
carbaryl: Sevin	3-4	• relatively high mammalian LD50 • broad spectrum • relatively inexpensive	• broad spectrum • especially risky to pollinators of other crops • long PHI (7 days) • can cause aphid buildup	• residual effect shorter than guthion (factor in decision making)
kaolin clay: Surround	2	• not toxic to mammals or insects • OMRI approved	• expensive • readily washes off – reapplication necessary • need excellent coverage for efficacy (multiple treatments) • coating can be visually unappealing and/or cause concern	• suppression effect only

malathion: Malathion	2	• relatively inexpensive • short PHI (1 day)	• short residual effect • offensive odor to customers of blueberries and other crops • not particularly effective against multiple insect pests	• adding NuLure (Staley's Sauce-base #7) greatly increases efficacy • may effect beneficials (no data)
malathion + NuLure bait	3	• bait promotes ingestion for internal effect • relatively inexpensive	•	• not widely used • lower chemical rates may be possible
phosmet: Imidan	4	• effective • long residual effect • broad spectrum • relatively inexpensive	• moderate mammalian LD50 • kills beneficials	• 3 days to harvest better than some but not ideal
pyrethrin: Pyrenone	2	• days to harvest zero • relatively quick effect	• not OMRI listed • efficacy inconsistent (on cranberry)	• relatively expensive for effectiveness
pyrethrin (without artificial additives): Pyganic	2	• days to harvest zero • relatively quick effect • OMRI listed	• efficacy inconsistent (on cranberry)	• relatively expensive for effectiveness
pyrethrin + rotenone: Pyrellin	2	•	• not OMRI listed	• counterproductive to combine components that are active at different rates
spinosad: Entrust	1-2	• OMRI listed	• 3 days to harvest • large volume packaging problematic for small acreage	• this product contains more active ingredient
spinosad: Red Sticky Trap + cap with Entrust "Curveball™"	1-2	• management tool and a monitoring tool • alternative to spraying	• yet to be fully tested	• product developed for apple maggot and worth testing with blueberry maggot
spinosad: GF120 Naturalyte fruit fly bait	2	• OMRI listed • REI only 4 hours • days to harvest zero	•	• brand new

* 0=not effective, 1=poor, 2=fair, 3=good, 4=excellent, ?=not known

Cultural and Biological Alternatives

Practices	Pros	Cons	Comments
NuLure Insect Bait	• bait promotes ingestion for internal effect	• chemical necessary for effect	• not widely used
Sticky traps	• Red spheres very effective to monitor when/if to use chemicals • easier to see insects on yellow traps • yellow traps cheap and disposable	• customer nuisance • labor cost • difficult to maintain • insect identification sometimes confused with apple maggot • occasionally catch birds • must hang properly	• yellow not as effective and do not last as long as red sphere • other traps not as effective as yellow or red
Handpicking infested fruit	•	• labor intensive	• can't build up if kept picked
Eliminate wild blueberries	• good if you can access plants and completely remove	•	•

Research Needs:

- Examine the efficacy of using lower rates of chemicals for management, similar to studies done with apple maggot.
- Confirm and test the efficacy of combinations of NuLure bait with lower rates of malathion or other chemicals.
- Expand research on the efficacy of "Curveball™" combination of red sticky traps with spinosad.
- Study the efficacy of newer products in comparison with each other and older products.
- Establish which management methods provide suppression and/or control .
- Determine why other available chemicals are not being used.
- Remind that EPA demonstration grants and Sustainable Agriculture Research and Education (SARE) grower grants are available for research.

Regulatory Needs:

- Smaller volume packaging for chemicals is needed to be practical for the smaller acreage farms typical of New England.
- REI of management chemicals needs to be no more than 3 days to allow for application during harvest to accommodate the high percentage of pick-your-own or U-pick operations in New England.
- PHI of management chemicals needs to be no more than 1 day to allow for application during harvest to accommodate the high percentage of pick-your-own or U-pick operations in New England.

Education Needs:

- Customer education is needed to limit their determination to wander into hazardous areas in fields.
- Inform growers of other chemicals that are available but are not being used.
- Collect information on why those chemicals are not being used.
- Educate growers on efficacy of new management products in relation to other products, including the “Curveball™” and NuLure baits.
- Improve awareness of the activity of fungicides in comparison to insecticides.
- Remind that EPA demonstration grants and Sustainable Agriculture Research and Education (SARE) grower grants are available for research.
- Develop information for growers to hand out to customers with questions about management.

Cranberry Fruitworm

% Acres Affected: 60-80% each; combine 100%
Yield Losses: <20%

- Management, damage, appearance, and management timing similar to Cherry Fruitworm.
- Cherry Fruitworm dominant in Rhode Island.
- Management timing does not overlap with harvest.
- Consumer presence is not an issue during management.
- Pest will build up population from year to year without management.
- Neighboring landscape and a wide range of hosts influence pest population.
- Management period extended to three weeks or longer due to asynchronous lifecycles.
- Parasitoids and predators do not have a significant effect on keeping pest below threshold level.
- Hiring third party scouts is not practical for New England blueberry growers.

Currently Registered Pesticides

Pesticide	Efficacy*	Pros	Cons	Comments
azadirachtin: Neem, Aza-direct	1-2	• some OMRI listed products	• expensive • clogs sprayer equipment	•
azinphos-methyl: Guthion	4	• effective • long residual effect • broad spectrum • inexpensive	• broad spectrum • low mammalian LD50 • kills beneficials • long REI compared to other materials (7 days)	• restricted use +/-
B.t. endotoxin: Biobit, Dipel DF, Javelin, Deliver		• not detrimental to beneficials • not toxic to mammals • some products OMRI listed	• narrow window of efficacy (only newly-hatched larvae susceptible) • easily washed off by rain and photodegrades • require multiple applications • short residual effect	• can be effective if applied properly and repeatedly • more effective with certain “stickers” • very important for organic growers (critical use)
carbaryl: Sevin	3-4	• relatively high mammalian LD50 • broad spectrum • relatively inexpensive	• broad spectrum • especially risky to pollinators of other crops • can cause aphid buildup	• residual effect shorter than guthion (factor in decision making)
diazinon: Diazinon	3	• broad spectrum • relatively inexpensive	• broad spectrum • hard on beneficials • potential for leaching into groundwater	• still one product on the market registered • not commonly available product for this pest/crop

malathion: Malathion	1	• relatively inexpensive	• short residual effect • offensive odor to customers of other crops • not particularly effective against multiple insect pests	• may effect beneficials (no data)
methomyl: Lannate	3	• broad spectrum • very effective	• broad spectrum • very low LD50 • kills beneficials • extreme protective equipment required (storage, loading, applying) • may be phytotoxic	• restricted use
methoxychlor: Methoxychlor	2	• long residual activity • relatively high LD50	• broad spectrum • harmful to pollinators	• still one registered product on the market • not commonly available product for this pest/crop
phosmet: Imidan	4	• effective • long residual effect • broad spectrum • relatively inexpensive	• moderate mammalian LD50 • kills beneficials	•
pyrethrin: Pyrenone	1	•	• not OMRI listed • efficacy inconsistent (on cranberry)	• relatively expensive for effectiveness • little data available
pyriproxyfen: Esteem	3	• effective against both cherry and cranberry fruitworm	• only affects immature stages	• brand new product
spinosad: Entrust	1-2	• OMRI listed	• expensive • large volume packaging problematic for small acreage	• this product contains more active ingredient
spinosad: Spintor	1-2	• not OMRI listed	• expensive • large volume packaging problematic for small acreage	•

* 0=not effective, 1=poor, 2=fair, 3=good, 4=excellent, ?=not known

Cultural and Biological Alternatives

Practices	Pros	Cons	Comments
Handpicking infested fruit	• can be somewhat effective	• labor intensive	• customers will not pick • fall off during mechanical harvest
discing between rows and raking/hoeing under plant	• disrupts overwintering sites • physically damages pests	• labor cost	•
Pheromone Traps	• useful monitoring tools	• not much better than phenology	• improve efficacy by determining appropriate timing for chemical sprays

Research Needs:

- Study the efficacy of newer products in comparison with each other and older products.
- Establish which management methods provide suppression and/or control .
- Determine why other available chemicals are not being used.
- Remind that EPA demonstration grants and Sustainable Agriculture Research and Education (SARE) grower grants are available for research.

Regulatory Needs:

- Smaller volume packaging for chemicals is needed to be practical for the smaller acreage farms typical of New England.

Education Needs:

- Inform growers of other chemicals that are available but are not being used.
- Collect information on why those chemicals are not being used.
- Educate growers on efficacy of new management products in relation to other products.
- Remind that EPA demonstration grants and Sustainable Agriculture Research and Education (SARE) grower grants are available for research.
- Develop information for growers to hand out to customers with questions about management.

Selected Comments on Other Insects

These insects are not considered Key Pests but do warrant special note as emerging issues in New England.

Winter Moth

- very serious in coastal MA, CT, RI
- early season defoliator
- very similar to other species
- larval stage causes the damage
- lay eggs in late fall, early winter, hatch in spring
- oil sprays, B.t., and other insecticides are effective
- timing of management is very critical
- education needed for growers

Scale Insects

- European Fruit Lecanium Scale is emerging pest
    - timing of management is uncertain
    - effects wide range of hosts, especially maples
    - grower education needed for monitoring
- Putnam Scale is a pest in this group
- dormant or delayed dormant oils effective
- pruning can be effective
- regulatory need for language allowing delayed dormant or late fall oil treatments in more products

White Grubs

- Oriental Beetle emerging as new pest in this group
- Admire now registered
- Mach is potential management tool but not registered for blueberries
- nematodes tricky to make effective and expensive to purchase
- milky spore not recommended in NH and VT; may work better in southern NE states
- adult management useful to manage grub population
- grubs attracted to irrigated areas –key for organic growers

Japanese Beetles

- direct pest: defoliation and ripe fruit damage
- days to harvest and customer presence an issue
- Japanese beetle traps not recommended OR possibly effective with plastic underneath traps to prevent eggs being laid OR effective if placed in fields isolated from other turf and combined with a trap crop

Other Insects not considered Key Pests

- Blueberry Tip Borer
- Plum Curculio
- Cherry Fruitworm
- Aphids
- Blueberry Bud Mite

Key Diseases

Mummy Berry

% Acres Affected: 100%
Yield Losses: 90% without management, 40-50% with management

- Disease is always present but severity can be variable.
- Weather conditions that are favorable to disease are unfavorable to management.
- Plant variety influences disease severity: bloom time in relation to inoculum presence.

Currently Registered Pesticides

Pesticide	Efficacy*	Pros	Cons	Comments
azadirachtin: Neem	?	•	•	• little used product • some fungicidal properties
B. subtilis Serenade		• OMRI approved • highly effective when used properly • alternate chemistry	• persistent coating visually unappealing and/or cause concern • full coverage is necessary • multiple applications necessary • expensive	•
captan: Captan, Captec	2	• established product • inexpensive • broad spectrum	• not OMRI listed • obvious residue • better against secondary than primary inoculum • phytotoxicity with diazinon	•
captan + fenhexamid: Captevate	2	• good alternative chemistry against secondary inoculum	• relatively expensive • not practical against heavy secondary inoculum • phytotoxicity with diazinon	•
chlorothalonil: Bravo	1	• broad spectrum • inexpensive	• not as great efficacy as others • persistent coating visually unappealing and/or cause concern • suppressive effect only • risk of groundwater contamination	• homeowner use

cyprodinil + fludioxonil: Switch	2	• very good against Botrytis also	• suppressive effect only • expensive	•
fenbuconazole: Indar	4	• best material available • more effective than Orbit against primary inoculum • very effective against secondary inoculum	• same chemical family as Orbit • relatively expensive	• emergency use section 18 label • at EPA for section 3 national label
fenhexamid: Elevate	1.5	• locally systemic (can penetrate plant tissue) • also active against Botrytis • good alternative chemistry against secondary inoculum	• relatively expensive • not practical against heavy secondary inoculum	•
propiconazole: Orbit	3	• the second best option against primary inoculum • effective against secondary inoculum	• same chemical family as Indar • relatively expensive	• emergency use section 18 label • manufacturer pursuing label
sulfur: Liquid Sulfur	2	• some OMRI listed	• phytotoxicity possible • resistance improbable	• little used product
ziram: Ziram	2	• inexpensive • zinc sometimes necessary as nutrient • broad spectrum	• very little effect • availability irregular	• little used product

* 0=not effective, 1=poor, 2=fair, 3=good, 4=excellent, ?=not known

Cultural and Biological Alternatives

Practices	Pros	Cons	Comments
Mulch	• disrupts fungal lifecycle	• labor intensive • large volume of mulch needed annually • timing critical • not especially effective	• no grass allowed
Handrake	• disrupts fungal lifecycle (physically destroys)	• labor intensive • can damage roots • can expose buried weed seed • can expose previously buried mummies • can disrupt pre-emergent weed management	•
Handpicking infected fruit	• effective when incidence low	• can become labor intensive	•
Application of Urea	• effective	• timing critical • only affects mushroom stage • not organic	• works best when combined with cultivation • adds nitrogen to soil
Pruning	• increases airflow • spacing has similar effect • shortens drying time	• labor intensive	•
Destroy wild hosts	• reduces inoculum	• access may be limited	•
Resistant varieties	• less fungicide necessary	•	• winter hardiness a more dominant issue when selecting plants

Research Needs:

- Develop and test different chemistries with activity against primary inoculum.
- Expand research on efficacy, phytotoxicity, etc. of azadiractin and liquid sulfur as management chemicals.
- Explore phenology and weather relationships to disease development.

Regulatory Needs:

- A label change for Indar is critical. Indar offers dual protection against Mummy Berry primary inoculum and Phomopsis Twig Blight, which is not available in any other currently registered blueberry fungicide.
- Swift approval of different chemistries, when developed, against primary inoculum will provide more management options.
- Approve Topsin for use because it is a different chemical family from Orbit or Indar and will provide more management options.
- Smaller volume packaging for chemicals is needed to be practical for the smaller acreage farms typical of New England.
- Streamline reporting systems for section 18 use.

Education Needs:

- Develop and distribute disease lifecycle information (primary, secondary) and note effective management for lifecycle stages.
- Improve awareness of disease resistant highbush blueberry varieties that are available
- Educate growers on efficacy of new management products in relation to other products.
- Provide information for growers and educators regarding the legal use of discontinued chemical products or phase-out.
- Provide general education about section 18, legal issues, etc. regarding chemical products.
- Remind that EPA demonstration grants and Sustainable Agriculture Research and Education (SARE) grower grants are available for research.
- Develop information for growers to hand out to customers with questions about management.

Phomopsis Twig Blight

% Acres Affected: 20%
Yield Losses: 5%

- Higher incidence in southern New England; Sporadic in northern New England.
- Associated with winter injury, wounding and stress.
- Primary method of control is cultural: pruning and irrigation.
- Yield losses can be drastic if not managed.

Currently Registered Pesticides

Pesticide	Efficacy*	Pros	Cons	Comments
captan: Captan, Captec	2	• established product • inexpensive • broad spectrum	• not OMRI listed • phytotoxicity with diazinon	•
chlorothalonil: Bravo	2.5	• broad spectrum • inexpensive • very effective	• risk of groundwater contamination	•
fenbuconazole: Indar	3	• best material available • broad spectrum (mummy berry)	• relatively expensive • same chemical family as Orbit	• emergency use section 18 label • at EPA for section 3 national label
fosetyl Al: Aliette	3	• very effective	• expensive	•
propiconazole: Orbit	3	•	• same chemical family as Indar • relatively expensive	• emergency use section 18 label • manufacturer pursuing label • research needed
pyraclostrobin: Cabrio	3	• good efficacy • also active against Anthracnose	• expensive	•
sulfur: Lime Sulfur	2	• some OMRI listed	• phytotoxicity possible • resistance improbable • variable efficacy • very corrosive • very bad odor	• use after pruning
ziram: Ziram	2.5	• inexpensive • zinc sometimes necessary as nutrient • broad spectrum	• availability irregular	• not used as much as could be

* 0=not effective, 1=poor, 2=fair, 3=good, 4=excellent, ?=not known

Cultural and Biological Alternatives

Practices	Pros	Cons	Comments
Pruning	• increases airflow • spacing has similar effect • shortens drying time	• labor intensive	• precursor to chemical application
Resistant varieties	• less fungicide necessary	•	• winter hardiness a more dominant issue when selecting plants

Research Needs:

- Research the efficacy of Ziram and the use of Orbit.
- Explore the relationship of plant stress issues with fungal infection.
- Determine the optimum timing for pruning as a management method.
- Establish if *Diaporthe* stage has a role in infection.

Regulatory Needs:

- A label change for Indar is critical. Indar offers dual protection against Mummy Berry primary inoculum and Phomopsis Twig Blight, which is not available in any other currently registered blueberry fungicide.
- Approve Topsin for use because it is a different chemical family from Orbit or Indar and will provide more management options.
- Smaller volume packaging for chemicals is needed to be practical for the smaller acreage farms typical of New England.
- Streamline reporting systems for section 18 use.

Education Needs:

- Develop and distribute disease identification information.
- Improve awareness of disease resistant highbush blueberry varieties that are available
- Educate growers on efficacy of new management products in relation to other products.
- Provide information for growers and educators regarding the legal use of discontinued chemical products or phase-out.
- Provide general education about section 18, legal issues, etc. regarding chemical products.
- Remind that Sustainable Agriculture Research and Education (SARE) grower grants are available for research.
- Develop information for growers to hand out to customers with questions about management.

Anthracnose

% Acres Affected: 5%
Yield Losses: 3%

- Disease incidence has been increasing over past years.
- Warm temperatures are favorable to disease development.
- Neighboring landscape and a wide range of hosts influence pest population.
- Affects fruit at harvest and spreads readily in storage; Severe infection affects twigs and leaves.
- Disease overwinters on stems.
- Easily identified due to distinctive pink spores on fruit.
- Infection and management occurs at bloom while disease sign is not noticeable until harvest.
- Management for this disease is often a secondary effect of management for other diseases.

Currently Registered Pesticides

Pesticide	Efficacy*	Pros	Cons	Comments
azoxystrobin: Abound	4	• very good efficacy	• cannot use if apples nearby -drift issues	•
captan: Captan, Captec	3	• established product • inexpensive • broad spectrum	• not OMRI listed • phytotoxicity with diazinon	•
chlorothalonil: Bravo	2.5	• broad spectrum • inexpensive • very effective	• risk of groundwater contamination	•
cyprodinil + fludioxonil: Switch	3	• good efficacy • very good against Botrytis	• expensive	•
fosetyl Al: Aliette	3	• good efficacy	• expensive	•
pyraclostrobin : Cabrio	4	• good efficacy • also active against Phomopsis	• expensive	•
pyraclostrobin + boscalid: Pristine	4	• good efficacy • also active against Botrytis	• expensive	•
sulfur: Lime sulfur	2	• some OMRI listed	• phytotoxicity possible • resistance improbable • variable efficacy • very corrosive • very bad odor	• efficacy data unavailable

ziram: Ziram	2.5	• good efficacy • inexpensive • zinc sometimes necessary as nutrient • broad spectrum	• availability irregular	• not used as much as could be

* 0=not effective, 1=poor, 2=fair, 3=good, 4=excellent, ?=not known

Cultural and Biological Alternatives

Practices	Pros	Cons	Comments
Handpicking infected fruit	• fruiting structures do not develop	• labor intensive	•
Pruning	• increases airflow • spacing has similar effect • shortens drying time	• labor intensive	• removal of overwintering site
Resistant varieties	• less fungicide necessary	•	• winter hardiness a more dominant issue when selecting plants • fruit and leaf resistance

Research Needs:

- Determine the optimum timing for pruning as a management method.
- Explore organic alternatives to current chemical management.

Regulatory Needs:

- The management chemicals boscalid (BAS510) pyraclostrobin (BAS500) and a combination (BAS516) would be beneficial if approved.
- Approve Topsin for use because it is a different chemical family from Orbit or Indar and will provide more management options.
- Smaller volume packaging for chemicals is needed to be practical for the smaller acreage farms typical of New England.
- Streamline reporting systems for section 18 use.

Education Needs:

- Increase awareness of this pest as an emerging issue.
- Develop and distribute identification information for field diagnosis of pathogens and symptoms.
- Improve awareness of disease resistant highbush blueberry varieties that are available
- Educate growers on efficacy of new management products in relation to other products.
- Provide information for growers and educators regarding the legal use of discontinued chemical products or phase-out.
- Provide general education about section 18, legal issues, etc. regarding chemical products.
- Remind that Sustainable Agriculture Research and Education (SARE) grower grants are available for research.
- Develop information for growers to hand out to customers with questions about management.

Botrytis Blight

% Acres Affected: 30%
Yield Losses: up to 100%

- Disease severity can be variable.
- Affects blossom and stem of plant.
- Two phases of disease cause blossom blight and fruit rot.
- Diagnosis can be confused with frost injury and blossom blight phase of Blueberry Scorch.
- Pruning is a very important management method.
- High nitrogen applications increase susceptibility of plant to disease.
- Management for this disease is often a secondary effect of management for other diseases.
- Fungicide rotation is necessary to prevent resistance development.

Currently Registered Pesticides

Pesticide	Efficacy*	Pros	Cons	Comments
captan: Captan, Captec	3	• established product • inexpensive • broad spectrum	• not OMRI listed • phytotoxicity with diazinon	•
captan + fenhexamid: Captevate	3	• good activity	• relatively expensive • phytotoxicity with diazinon	•
chlorothalonil: Bravo	2	• broad spectrum • inexpensive	• risk of groundwater contamination	•
cyprodinil + fludioxonil: Switch	3	• good efficacy • very good against Anthracnose	• expensive	•
fenhexamid: Elevate	3	• best material available • locally systemic (can penetrate plant tissue) • also active against Mummy Berry	• relatively expensive	•
pyraclostrobin + boscalid: Pristine	4	• good efficacy • also active against Anthracnose	• expensive	•
ziram: Ziram	2	• efficacy OK • inexpensive • zinc sometimes necessary as nutrient • broad spectrum	• availability irregular	• not used as much as could be

* 0=not effective, 1=poor, 2=fair, 3=good, 4=excellent, ?=not known

Cultural and Biological Alternatives

Practices	Pros	Cons	Comments
Pruning	• increases airflow • spacing has similar effect • shortens drying time	• labor intensive	• removal of overwintering site

Research Needs:

- Explore other chemical products that might be effective such as Serenade or Oxidate.
- Characterize the weather conditions that promote the development of Botrytis Blight versus Mummy Berry.
- Determine weather models for Botrytis Blight.
- Develop fungicides that eradicate disease instead of prevent disease.

Regulatory Needs:

- Approve Topsin for use because it is a different chemical family from Orbit or Indar and will provide more management options.
- Smaller volume packaging for chemicals is needed to be practical for the smaller acreage farms typical of New England.

Education Needs:

- Develop and distribute identification information for diagnosis of pathogens and symptoms.
- Educate growers on efficacy of new management products in relation to other products.
- Provide information for growers and educators regarding the legal use of discontinued chemical products or phase-out.
- Remind that Sustainable Agriculture Research and Education (SARE) grower grants are available for research.
- Develop information for growers to hand out to customers with questions about management.

Fusicoccum Canker

% Acres Affected: 20%
Yield Losses: 5%

- Disease is always present at low levels but severity can be of variable economic importance.
- Higher incidence in northern New England than southern New England.
- Diagnosis can be confusing.
- Pruning is the primary management method.
- Management for this disease is often a secondary effect of management for other diseases.

Currently Registered Pesticides

Pesticide	Efficacy*	Pros	Cons	Comments
captan: Captan, Captec	1	• established product • inexpensive • broad spectrum	• poor efficacy • not OMRI listed • phytotoxicity with diazinon	•
chlorothalonil: Bravo	3	• good efficacy • broad spectrum • inexpensive	• risk of groundwater contamination	•
sulfur: Lime sulfur	?	• some OMRI listed	• phytotoxicity possible • resistance improbable • very corrosive • very bad odor	• efficacy data unavailable
ziram: Ziram	2	• inexpensive • zinc sometimes necessary as nutrient • broad spectrum	• availability irregular	• not used as much as could be

* 0=not effective, 1=poor, 2=fair, 3=good, 4=excellent, ?=not known

Cultural and Biological Alternatives

Practices	Pros	Cons	Comments
Pruning	• increases airflow • spacing has similar effect • shortens drying time	• labor intensive	• removal of overwintering site
Resistant varieties	•	•	• winter hardiness a more dominant issue when selecting plants

Research Needs:

- Develop more management options because only two products are currently known to be effective.
- Determine efficacy of new products, including lime sulfur.
- Explore the relationship of plant stress issues with fungal infection.
- Determine the optimum timing for pruning as a management method.
- Identify and evaluate resistant highbush blueberry varieties.
- Establish if *Godronia* stage has a role in infection.

Regulatory Needs:

- Smaller volume packaging for chemicals is needed to be practical for the smaller acreage farms typical of New England.
- Swift approval of different chemistries, when developed, will provide more management options.

Education Needs:

- Develop and distribute identification information for diagnosis of pathogens and symptoms.
- Educate growers on efficacy of new management products in relation to other products.
- Provide information for growers and educators regarding the legal use of discontinued chemical products or phase-out.
- Remind that Sustainable Agriculture Research and Education (SARE) grower grants are available for research.
- Develop information for growers to hand out to customers with questions about management.

Selected Comments on Other Diseases

These diseases are not considered Key Pests but do warrant special note as emerging issues in New England.

Witches' Broom

- important in ME, NH, northern MA (more important than Fusicoccum Canker)
- can kill entire plant if crown infection in young plant
- manage with pruning in older plants
- eliminate alternate hosts (balsam fir)
- currently no chemicals labeled for this pest
- some fungicides might be effective –more research needed (efficacy, timing)
- plant variety resistance research needed
- lifecycle research needed i.e. travel distance factors
- important to report occurrence to specialists where/when

Phytophthora Root Rot

- emerging problem –appearing in susceptible sites
- identification of Phytophthora species that affect blueberries in cases
- research needed on plant variety susceptibility
- some materials available (Ridomil gold, Aliette, Phostrol, Nutriphos)
- resistance development to chemicals is possible
- drainage/site selection most important management tool
- grower education needed

Blueberry Scorch (Virus)

- emerging problem
- plant removal and aphid control only management methods
- grower education needed
- identification is problematic –symptoms only exhibited under specific time/conditions

Blueberry Canker (*Gibbera*)

- emerging problem –research needed
- Northland variety particularly susceptible, widely planted due to cold hardiness (niche problem)
- research on alternatives to Northland variety needed
- Indar may have some effect –research
- major losses possible -NH has seen 75-90% for several years
- grower and specialist education needed

Botryosphaeria Stem Blight

- possibly emerging in Southern New England (found elsewhere)
- grower and specialist education needed

Other Diseases not considered Key Pests

- Blueberry Stunt
- Powdery Mildew
- Mosaic (Virus)
- Red Ringspot (Virus)
- Blueberry Shoestring Disease (Virus)
- Crown Gall
- Coryneum Canker
- Armillaria Root Rot

Weeds

% Acres Affected: 100%
Yield Losses: 5-100%

- Yield losses are difficult to quantify.
- Some growers tolerate weeds and don't consider management as an issue.
- Affect plant growth by intercepting nutrients, water and sunlight.
- Neighboring tree roots invading field can also affect plant growth and yield.
- Provide habitat or reservoir for other pests such as voles, insects, viruses and disease.
- Weed growth negatively affects airflow, promoting other pest development.
- Weed blooms attract pollinators that may be affected by chemical management when blueberries themselves are no longer in bloom.
- Can affect allergies and be visually unappealing to customers.
- Annuals (except crabgrass) are generally easier to manage.
- Twining/vining weeds, when present, and crabgrass are of special nuisance to manage.
- Wild brambles, sorrel, clover, cinquefoil, nutsedge, wild buckwheat are more difficult to manage.
- Woody perennials can be an issue, especially when introduced through wood chip mulch.
- Herbicides are usually applied in bands in narrow area around plant, allowing for application of less product per acre than if broadcast.
- There are no adequate alternatives available for glyphosate as a post-emergent management tool.

Currently Registered Pesticides for Pre-emergent Weeds

Pesticide	Efficacy*	Pros	Cons	Comments
Corn Gluten Meal	0	• some OMRI listed	• adds excessive nitrogen • very high application rates necessary	• not recommended for blueberry
dichlobenil: Casoron --- Broadleaf weeds and some grasses. Suppression of some perennial weeds. --- Established Plantings	3-4	• good activity against annual perennial broadleaf • widely used • long residual effect • broad spectrum	• timing aspects important • rain can cause run-off • expensive	• granular formulation more effective than WP, preferred by smaller growers • granulation formulation reduces leaching concerns
diuron: Diuron	3	•	• phytotoxicity potential	• very not widely used • not recommended

hexazinone: Velpar L	4	• activity against broadleaf weeds perennials, • especially useful for problematic weeds	• high risk of groundwater contamination • safe on mature plants only (3+years)	• regional restriction in Northeast
napropamide: Devrinol --- Annual grasses and small seeded broadleaf weeds --- Transplant Year and Established Plantings	2-3	• safe on new growth • good activity against annual grasses and small seeded broadleaf weeds	• residual effects only good for 12 weeks • needs to be watered in to prevent breakdown • some important weeds not affected	• root growth inhibitor but used on new plantings • widely used
norflurazon: Solicam --- Annual grasses and small seeded broadleaf weeds --- Established Plantings	3	• safe on new growth	• some activity but better products are available • residual effects only good for 12 weeks • needs to be watered in to prevent breakdown	• not widely used
oryzalin: Surflan --- Annual grasses and some small seeded broadleaf weeds --- Transplant Year and Established Plantings	2-3	• relatively inexpensive • safe on new growth • does not require watering in	• residual effects only good for 12 weeks • not recommended for high organic matter soil (such as found below mulch)	•
pronamide: Kerb --- Broadleaf weeds and some grasses.	3	•	• expensive • phytotoxicity potential	• not widely used

simazine: Princep, Caliber --- Broadleaf weeds and some grasses. Suppression of some perennial weeds. --- Transplant Year and Established Plantings	3	• good activity against many broadleaf weeds • some post-emergent activity as well • inexpensive	• phytotoxicity potential in young plants • risk of groundwater contamination • some resistance development issues	•
terbacil: Sinbar --- Broadleaf weeds and some grasses. Suppression of some perennial weeds. --- Established Plantings	3-4	• good activity against many broadleaf weeds • some post-emergent activity as well • somewhat inexpensive	• phytotoxicity potential in young plants • risk of groundwater contamination	•

* 0=not effective, 1=poor, 2=fair, 3=good, 4=excellent, ?=not known

Currently Registered Pesticides for Post-emergent Weeds

Pesticide	Efficacy*	Pros	Cons	Comments
clethodim: Select	4 (grasses)	• better activity against perennial grasses than Poast	•	• best product for quackgrass • new product
flauzifop: Fusilade --- Annual and most perennial grasses --- Transplant Year	3 (grasses)	• good activity against annual grasses • safe on crop	• fair activity against perennial grasses • crop injury potential due to required mix with crop oil • not much activity compared to other options • can only apply to young crops (do not apply to crops to be harvested within one year of application)	• not practical • not widely used
glyphosate: Roundup --- Annual and perennial weeds. --- Established Plantings	4	• activity against annuals and perennial weeds • inexpensive • easy to use • safe for applicator	• crop injury potential • no residual activity • timing is critical to efficacy	• very widely used • critical for spot treatment
paraquat: Gramoxone --- Annual grasses and broadleaf weeds. Suppression of perennial weeds. --- Established Plantings	3 (contact only)	• fast acting • effective burn-down • more effective against tree seedlings than other products	• applicator safety is an issue • restricted use is an issue • offensive odor • expensive • crop injury potential • not effective against perennials	• important niche product for management of tree seedlings • nonionic surfactant recommended

pelargonic acid: Scythe --- Annual weeds. Suppression of perennial weeds --- Transplant Year and Established Plantings	2 (contact only)	• effective burn-down • fast acting • zero day PHI	• very odorous • expensive • not very effective at killing growth point • not effective against perennials	•
sethoxydim: Poast --- Annual and most perennial grasses --- Transplant Year and Established Plantings	3 (grasses)	• safe on crop • good activity against annual grasses	• fair activity against perennial grasses with multiple applications • 30 day PHI • crop injury potential due to required mix with crop oil	• generally used
sulfosate: Touchdown	4	• activity against annuals and most perennials	• crop injury potential • no residual activity • use on nonbearing plants only • one year PHI	•

* 0=not effective, 1=poor, 2=fair, 3=good, 4=excellent, ?=not known

Cultural and Biological Alternatives

Practices	Pros	Cons	Comments
Mowing	• most effective option in row middles	• requires multiple treatment • seed dispersal can be an issue unless mulching mower used	• standard practice
Mulching	• most effective option around plants • first step in weed management • can be supplemented with chemical options • very effective	• sometimes can encourage pine voles • wood chips can introduce Armillaria • application costs can be high	• standard practice • other benefits (soil moisture retention, etc)
Cultivation	• fairly effective on emerged annual weeds	• not practical with mulch • quick regrowth of perennial weeds • not effective on wet soil • can damage roots	•
Hand weeding	• best option for persistent and noxious weeds	• very labor intensive	•
establish dwarf and/or nonaggressive grasses around plants	• less mowing required • less likely to invade plant rows • attractive • less habitat for voles	• can be difficult to establish • some varieties do not fill in well	•

Research Needs:

- Examine effects of neighboring tree roots invading field on highbush blueberry plant growth and yield.
- Develop new crabgrass preventative with PHI less than 10 days.
- Develop alternatives to glyphosate that meet or improve activity, cost effectiveness, ease of use, etc.
- Study phytotoxicity effects of Kerb.
- Wild parsnip, hog parsnip, and related species require study and management options in relation to highbush blueberry fields.
- Better options are needed for management of wild brambles, sorrel, clover, cinquefoil, nutsedge, and wild buckwheat. Hand weeding is not cost effective.
- More and better quackgrass management options are needed in addition to Roundup and Poast.
- Develop and test new chemistries that can provide more management options. Most current chemistries have been available for a long time.
- Examine the use of dwarf and/or nonaggressive grasses between rows as a cultural alternative.

Regulatory Needs:

- Provide incentives to increase the number of applied weed scientists and plant pathologists in practice.
- Approve labeling for hexazinone(Velpar L) for unrestricted use in the Northeast to provide options for management of wild brambles, sorrel, clover, cinquefoil, nutsedge, and wild buckwheat.
- Smaller volume packaging for chemicals is needed to be practical for the smaller acreage farms typical of New England.

Education Needs:

- Educate growers of the need for rotation of herbicide chemistries to prevent resistance and weed population shifts.
- Promote the use of dwarf and/or nonaggressive grasses between rows as a cultural alternative.
- Promote education to increase the number of applied weed scientists and plant pathologists in practice.
- Educate growers on efficacy of new management products in relation to other products.
- Provide information for growers and educators regarding the legal use of discontinued chemical products or phase-out.
- Remind that Sustainable Agriculture Research and Education (SARE) grower grants are available for research.
- Develop information for growers to hand out to customers with questions about management.

Key Vertebrates

Birds

% Acres Affected: 100%
Yield Losses: 25-100% without protection

- The most troublesome species are the perching birds (sparrows, swallows, orioles, etc.)
- Turkeys are an increasing pest problem in New England.
- Most bird species are protected, which limits use of lethal control measures.
- There are wide variations in international, federal, state, and county regulations, interpretation and enforcement.
- Netting is the most effective management tool: yield loss is almost 0% with this method.
- Any other methods must be used in combination and varied to be most effective.
- Neighboring landscape providing shelter and nesting sites influence pest population.

Currently Registered Pesticides

Pesticide	Efficacy*	Pros	Cons	Comments
methyl anthranilate: Bird Shield™		•	• limited usefulness • 8-10 day PHI • reapplication necessary after rain events • some birds not affected • phytotoxicity possible	• not widely used

Cultural and Biological Alternatives

Practices	Efficacy*	Pros	Cons	Comments
Scare eye balloons		•	• limited effectiveness • variable results	•
Flash Tape		•	• limited effectiveness • variable results • limited species efficacy • not practical on large scale	• some tapes also have sound components as deterrents
Propane Cannons		• short term effectiveness	• annoyance to neighbors and customers	•
Owls		•	• must be moved daily to be effective	• more realistic is better • some incorporate moving head

Netting		• very effective	• high labor cost • high initial materials cost • coverage can be difficult with certain plantings	• coverage must be complete with anchored edges • with proper maintenance, equipment will last many years
Distress Calls		• good initial effectiveness • attract actual live predators	• annoyance to neighbors and customers	• some models can vary calls to reduce chances of pest acclimation
Shotgun		•	• neighbor relations • safety issues • legality issues • short term effect	•
People picking		• fairly effective	• impossible at certain times of day, weather	•
Fire crackers and other pyrotechnics		• effective at key feeding times	• annoyance to neighbors and customers • safety issues • very short term effectiveness	• works in conjunction with people picking • products are legal for use in agriculture
Bottle rockets		• very effective against some species	• annoyance to neighbors and customers • safety issues • very short term effectiveness	•
peaceful pyramid		• limited effectiveness	• very short term effectiveness	•
reflective compact discs		• relatively effective • inexpensive	• very short term effectiveness	•
“dead crow” method +/- owl		• warns other crows	• customer relations if visible	•

Research Needs:

- Develop and test new chemistries that can provide more management options.
- Explore the efficacy of placement of perches and houses to encourage predators to nest and hunt near highbush blueberry fields.
- Expand studies of sound devices that attract predators and the timing of their use as management options.
- Measure the cost of using bird netting in relation to income from increased quality and/or volume of the crop and in relation to field size.

Regulatory Needs:

- Foster and enforce consistency among the varied international, federal, state, and county regulations, interpretation and enforcement.
- Change label for Measurol to allow use in highbush blueberry.
- Change falconry regulations to allow exercise of captive predators in highbush blueberry fields.

Education Needs:

- Create awareness among growers of availability of captive predators that may be exercised in highbush blueberry fields.
- Encourage placement of perches and houses to encourage predators to nest and hunt near highbush blueberry fields.
- Growers need to report damage to wildlife services to document effect of pests. This may influence further funding towards management issues for these pests.
- Develop information for growers to hand out to customers with questions about management.
- A certain tolerance for this pest may be fostered among growers.

Deer

% Acres Affected: 10-20%
Yield Losses: sporadic

- Damage can be variable.
- Snow depth affects pest access to plants.
- Fall and Winter damage to buds and new growth; Spring damage to new growth.
- There are wide variations in international, federal, state, and county regulations, interpretation and enforcement.
- Fencing is the most effective management tool when pest populations are high.

Currently Registered Pesticides

Pesticide	Efficacy*	Pros	Cons	Comments
Thiram		• some limited effectiveness	•	• taste repellent

Cultural and Biological Alternatives

Practices	Efficacy*	Pros	Cons	Comments
Fence		• most effective when pest populations high	• cost of setup and maintenance	•
Electric fence		• can be effective for bears too • single-strand temporary fence less expensive and mobile	• deer can learn to avoid if there is a down period • need to train deer to fence • full multi-strand setup can be initially expensive • maintenance necessary	• risk may not justify expense • can use single-strand + peanut butter/foil bait
Shooting		• very effective on individuals	• legal issues • safety • neighbor relations • public acceptance	• bowhunting alternative
Odor/Taste Repellents		• moderate effectiveness for moderate time period • application when customers not in field	• reapplication may be necessary after rain • offensive odor possible • bar soap has very short range	• variation between bar soap brands

Research Needs:

-

Regulatory Needs:

- Foster and enforce consistency among the varied international, federal, state, and county regulations, interpretation and enforcement.

Education Needs:

- Foster and enforce consistency among the varied international, federal, state, and county regulations, interpretation and enforcement.

Voles

% Acres Affected: 80%
Yield Losses: unknown

- The two species are meadow vole and pine vole.
- Pine voles live underground and do not prefer highly sandy soil.
- Pine voles can live on blueberry roots as their total diet.
- Meadow voles live above ground and prefer a habitat with thick vegetation.
- Meadow voles girdle plant trunks.

Currently Registered Pesticides

Pesticide	Efficacy*	Pros	Cons	Comments
zinc phosphide bait		• quite effective combined with bait stations	• only available from Pocatello Supply Depot - USDA, APHIS, WS • nontarget death possible • deteriorates rapidly with moisture	•

Cultural and Biological Alternatives

Practices	Efficacy*	Pros	Cons	Comments
Traps		• might have effect in small areas	• labor intensive • proper technique necessary	•

Research Needs:

- Develop and test new chemistries that can provide more management options.

Regulatory Needs:

- Explore removing voles, particularly Pine voles and Meadow voles, from regulation.

Education Needs:

- Develop detailed Vole management plans.

Other Vertebrates not considered Key Pests

Bears
Raccoons
Squirrels
Coyote
Porcupine
Turkey
Chipmunk
Fox

IV. Appendices

Pesticide Efficacy for Insects

Active ingredient	Brand name(s)	BBM	BM*	BTB	ChF	CF*	PC	SI	WG
azadiractin	Neem, Aza-direct		1-2		1-2	1-2			
azinphos-methyl	Guthion		4		4	4			
B.t. endotoxin	Biobit, Dipel DF, Javelin, Deliver								
carbaryl	Sevin		3-4		3-4	3-4			
diazinon	Diazinon		3		3	3			
endosulfan	Phaser, Thiodan								
endosulfan/---	Thiodan/Cottonseed Oil								
halofenozide	Mach								
imidacloprid	Admire								
kaolin clay	Surround		2		NR	NR			
malathion	Malathion		2		1	1			
malathion + NuLure bait	malathion + NuLure bait		3		1	1			
methomyl	Lannate		3		3	3			
methoxychlor	Methoxychlor		NR		2	2			
petroleum distillate	SunSpray Ultra-fine Oil							3	
petroleum oil	Superior Oil							3	
phosmet	Imidan		4		4	4			
pyrethrin	Pyrenone, Pyganic		2		1	1			
pyrethrin + rotenone	Pyrellin		2		NR	NR			
pyriproxyfen	Esteem		NR		3	3		3	
spinosad	Entrust, Spintor, Curveball™, GF120 Naturalyte fruit bait		2		1-2	1-2			

NR=not registered, 0=not effective, 1=poor, 2=fair, 3=good, 4=excellent, ?=not known

* Key pest
BBM = Blueberry Bud Mite
BM = Blueberry Maggot
BTB = Blueberry Tip Borer
ChF = Cherry Fruitworm
CF = Cranberry Fruitworm
PC = Plum Curculio
SI = Scale Insects
WG = White Grubs

Pesticide Efficacy for Diseases

Active ingredient	Brand name(s)	A*	BB*	CG	FC*	MB*	PTB*	PRR	PM
agrocin	Agrocin	?	?	4	?	?	?	?	?
azadirachtin	Neem	?	0	?	?	?	?	0	1
azoxystrobin	Abound	4	1	?	?	2	2.5	0	1.5
B. subtilis	Serenade								
captan	Captan, Captec	3	3	?	1	2	2	0	?
captan + fenhexamid	Captevate	3	3	?	?	2	2	0	1
chlorothalonil	Bravo	2.5	2	?	3	1	2.5	0	1
cyprodinil + fludioxonil	Switch	3	3	?	?	2	2.5	0	1
fenbuconazole	Indar	0	?	?	?	4	3	0	3
fenhexamid	Elevate	1	3	?	?	1.5	1	0	1
fosetyl Al	Aliette	3	0	?	?	0	3	3	1
iprodione	Rovral	0	3	?	?	0	?	0	?
mefanoxam	Ridomil Gold	0	0	?	?	0	0	4	0
phosphonate	Phostrol	1.5	0	?	?	1	?	3	?
propiconazole	Orbit	0	?	?	?	3	3	0	3
pyraclostrobin	Cabrio	4	1	?	?	1	3	0	1.5
pyraclostrobin + boscalid	Pristine	4	4	?	?	2.5	3	0	?
sulfur	Lime Sulfur	2	1	?	?	2	2	0	2
sulfur	Liquid Sulfur	2	1	?	?	2	2	0	1
thiophanate methyl	Topsin	2	1	?	?	2	2	0	1
ziram	Ziram	2.5	2	?	2	2	2.5	0	1

0=not effective, 1=poor, 2=fair, 3=good, 4=excellent, ?=not known

* Key pest
A = Anthracnose
BB = Botrytis Blight
CG = Crown Gall (Bacteria)
FC = Fusicoccum Canker
MB = Mummy Berry
PTB = Phomopsis Twig Blight
PRR = Phytophthora Root Rot
PM = Powdery Mildew

Pesticide Efficacy for Weeds

Active ingredient	Brand name(s)	Pre-emergent weeds	Post-emergent Weeds
---	Corn Gluten Meal	0	
clethodim	Select		4 (grasses)
dichlobenil	Casaron	3-4	
diuron	Diuron	3	
flauzifop	Fusilade		3 (grasses)
glyphosate	Roundup		4
hexazinone	Velpar L	4	
napropamide	Devrinol	2-3	
norflurazon	Solicam	3	
oryzalin	Surflan	2-3	
paraquat	Gramoxone		3 (contact only)
pelargonic acid	Scythe		2 (contact only)
pronamide	Kerb	3	
sethoxydim	Poast		3 (grasses)
simazine	Caliber 90, Princep	3	
sulfosate	Touchdown		4
terbacil	Sinbar	3-4	

0=not effective, 1=poor, 2=fair, 3=good, 4=excellent, ?=not known

Pesticide Efficacy for Vertebrates

Active ingredient	Brand name(s)	Birds	Deer	Voles
methyl anthranilate	Bird Shield™	x		
thiram			x	
zinc phosphide bait				x

0=not effective, 1=poor, 2=fair, 3=good, 4=excellent, ?=not known

Worker Activities

Notes on timing, importance, and worker exposure to pesticide residue.
REI = Reentry interval

Chemical Application and Worker Protection

- Chemical pest control is applied by means of backpack sprayer and tractor-mounted mist or boom spray equipment. Weed chemicals are applied in bands or as spot treatment. Workers are trained on proper handling and wear personal protective gear when applying pesticides. Chemicals are stored according to federal and state regulations.

Pruning

- Used to maintain a balance between vegetative growth and fruit production that allows for adequate penetration of sunlight, chemical treatments, and air flow.
- Dormant pruning, removal of old canes, and detailed pruning are the most common techniques with some summer pruning activity.
- Pruning involves extensive contact with foliage. Wearing protective clothing can be problematic in summer heat, and heat stroke risk poses more immediate and severe health concerns than pesticide exposure.
- While there is usually some flexibility for timing pesticide sprays, prolonged REIs create scheduling problems for pruning which must be done within a time window.

Mowing, Cultivation, and Mulching

- Methods used to suppress weeds, conserve soil water and nutrients, reduce humidity to discourage fungal diseases, maintain ground conditions for conducting pruning and harvest operations efficiently, and discourage voles and other pests.
- Mulching also is required to protect roots from high temperature injury in summer and cold temperature injury in winter. Mulch is maintained one to two times per year depending on need.
- Cultivation and mowing are done four to six times per growing season depending on need.
- All methods involve very little contact with treated bark and foliage. There is potential for operators to brush against foliage. Pesticide exposure is minimal.

Irrigation

- Becoming increasingly important for new plantings in order to maximize early growth and returns. The need for irrigation is not always predictable.
- Irrigation may begin early in the growing season and can extend into September.
- While there is usually some flexibility for timing summer pesticide sprays, prolonged REIs create scheduling and maintenance problems to get this important work done.

Fertilization

- Leaf tissue analysis and soil sampling are used to determine fertilizer needs once per year or every one to three years.
- Fertilizer is generally applied in a split application of nitrogen, the first is applied at bloom and the second one month later.
- Fertilizing involves very little contact with treated bark and foliage. There is potential for operators to brush against foliage. Pesticide exposure is minimal.

Field activities that may occur during

Budbreak through Bloom:

Cover crop removal (herbicide or tillage)
Scouting for insects, diseases, and weeds
Detail prune for thinning, disease removal, insect removal
Fertilization
Herbicide application (pre- or post-emergent)
Fungicide application
Insecticide application
Irrigation
Strip blossoms from young plants (non-bearing phase)
Bring in bee hives for pollination
Establish sod between rows
Manage row middles (mowing, herbicide application, disking)
Scout for vertebrate pests (add fencing if necessary)
Prepare and repair posts for bird netting

Post-bloom through Harvest:

Scout for insects, diseases, and weeds
Fertilization (foliar feeding)
Post-emergent herbicide application
Hand weed in plant row
Fungicide application
Insecticide application
Irrigation
Mow or cultivate row middles
Hand harvest
Fruit thinning (for young plantings)
Vertebrate control (includes set up and maintenance of bird netting)
Tissue testing (also after harvest)

Post-harvest through Dormancy:

Scouting for insects, diseases, and weeds
Applying herbicide (pre- or post-emergence)
Hand weeding in plant row
Applying fungicide (copper sprays and/or lime sulfur)
Irrigation
Mowing or cultivating row middles
Pruning
Soil & tissue testing
Adjust soil pH
Remove bird netting

V. Acknowledgements and Contacts

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