

**PEST MANAGEMENT STRATEGIC PLAN  
FOR STRAWBERRIES IN  
FL, NC, SC, VA**

Summary of a Workshop held on February 2-3  
Raleigh, NC

North Carolina Strawberry Association  
Southeastern Small Fruit Center  
NCSU Dept. of Horticulture  
Center for Integrated Pest Management  
USDA/Office of Pest Management Policy

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Res - researcher

Ext - extension

Gro - grower

Asc - grower association

Fum - custom fumigator

Con - consultant

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## **CRITICAL NEEDS AND PRIORITIES FOR THE SOUTHEAST STRAWBERRY INDUSTRY**

The workgroup developed a prioritized list of critical research, regulatory, and educational needs for the southeastern strawberry industry. This document may be used to:

- identify the registration needs and priorities of the SE strawberry industry for the EPA and registrants
- seek USDA funding for the research priorities that have been identified; and
- identify the research, regulatory and educational needs within the SE strawberry industry

### **Priority List:**

#### **Research**

1. Methyl bromide replacements and cost-effective alternatives
2. Plant breeding and nursery programs for the Southeast that deal with anthracnose, Botrytis, spider mites, powdery mildew, cyclamen mite, angular leaf spot, black root rot, etc.
3. Cost effective chemical controls for Botrytis and anthracnose, and studies on the epidemiology of these diseases in annual strawberry production systems.
4. Spider mite management
5. Lack of weed control products – look for efficacious herbicides and or cultural methods
6. Monitoring of economic implications of new tools, to maintain farm profitability

#### **Regulatory**

1. Registrations for the following fungicides and herbicides: Azoxystrobin (Quadris), Cyprodinil/Fludioxonil (Switch), quinmerac plus metazachlor (Novall), and Clopyralid (Stinger)
2. Registrations for the following insecticides/miticides: bifenazate, thiomethoxam, hexythiazox, pyridaben, Spinosad
3. Plant certification (both state and imported) for disease/insect free plants
4. Streamlined Section-18 process
5. Loss of Captan will increase incidence of pests and the use of other chemicals

#### **Education**

1. Increasing understanding of pest management tools: uses, rates, when, how, and why
2. Increase skills and understanding of pest identification, life cycles, monitoring, and scouting.
3. Implementation of new tools
4. On-farm demonstration, research, and replication
5. Provide "basic agricultural science" education programs for consumers and growers
6. Awareness and availability of USDA/EPA-funded educational programs
7. Awareness of changes as FQPA is implemented

## The Work Group

More than two dozen strawberry growers, researchers, and extension specialists from North Carolina, Virginia, Florida, and South Carolina met on February 2-3 to develop a “Pest Management Strategic Plan”. The Work Group discussed the implications of possible pest management changes during implementation of the Food Quality Protection Act (FQPA) and developed strategies for dealing with these changes. The goal was to identify what it would take in terms of research, regulatory actions and educational efforts to develop a pest management strategic plan for strawberry growers that could lessen or possibly eliminate use of the “high risk” pesticides in strawberry production. The effort and outcome of this group reflects the Vice President’s call for “a reasonable transition for agriculture” as outlined in his April 8, 1998 memo to the EPA and USDA regarding implementation of the FQPA.

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**The first statement made by the workgroup: “strawberry growers are environmentalists; the land provides our livelihood, if we take care of the land, the land will take care of us”.**

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## Background

The organophosphates, carbamates, and B/2 carcinogens (EPA’s Phase 1 list for tolerance reassessment under FQPA) include many of the important pesticides used in strawberry production in the Southeast United States. These chemistries control many of the key pests (insects, diseases, and weeds) that appear every year as well as some of the pests that appear occasionally in strawberry nurseries and fields. Frequently a single application is used to control two or more key pests simultaneously. These compounds are economical; pest resistance to these is not wide spread; and many do not harm key beneficial species that are part of current IPM programs. These tools are at risk of being lost.

The EPA is in the process of re-registering pesticides under the requirements of the Food Quality Protection Act (FQPA) and the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). The Agency is examining dietary (including drinking water), ecological, residential, and occupational risks posed by the “high risk” pesticides (organophosphates, carbamates, and B/2 carcinogens) especially when used on foods consumed by infants and

children. The Priority List of Pesticides that will undergo reassessment first includes several that have important uses in strawberry production: organophosphates include azinphos-methyl (Guthion), chlorpyrifos (Lorsban), diazinon, malathion, and naled (Dibrom); the carbamates include benomyl (Benlate), carbaryl (Sevin) and thiophanate methyl (Topsin M); and the potential carcinogens include captan, iprodione (Rovral), metam sodium, and telone.

EPA's regulatory focus on these chemistries has created uncertainty as to their future availability. At some point the EPA may propose to modify or cancel some or all uses of these pesticides for use on strawberries. The regulatory studies that EPA requires registrants to complete may result in some companies voluntarily canceling registrations for strawberries. The continued focus on risks from these pesticides may lead some strawberry processors and packers to require that growers not use them. In addition, environmental groups are raising public awareness through campaigns addressing pesticide use and residues. Public awareness can lead to consumer pressure on growers, processors, and packers to grow and sell produce that is free of pesticide residue. At this point no one can predict which of these pesticides will be available for growers in the future.

The risks and concerns regarding the use of these "high risk" pesticides are not going to go away in the near future. Agriculture needs to respond in a proactive manner by developing pest management strategic plans that reflect the needs of growers and show the EPA and the USDA what is required to reduce and/or eliminate the risks and residues associated with pesticide use. The USDA, the EPA, the land-grant universities and the strawberry industry need to proactively identify regulatory, research, and educational needs for replacing the pesticides of concern with cost-effective alternatives as FQPA is implemented. The development of the specific pest by pest "TO DO" list reflects these needs and is a primary goal of this document.

**Several key principles were kept in mind during the meeting:**

1. First and foremost was the welfare of the farmer; any strategic plan developed had to allow for the continued profitability for growers by providing cost-effective alternative pest management tools.

2. Geographical regions had to be considered when developing pest management strategic plans due to differences in production practices, pest complex and pressure, environmental conditions, crop varieties, and marketing opportunities.
3. The big picture needs to be considered. The one chemical at a time process would not work. The workgroup believed that discussing the issues in terms of chemical class, individual commodity, and specific pests would be the most effective way to develop a pest management strategic plan.
4. The group would identify gaps and needs that would become the ATO DO@ list. This ATO DO@ list identifies what is needed in terms of research, regulatory actions, and educational programs as strawberry growers attempt to move away from use of “high risk” pesticides.

## **Methyl Bromide Statement**

Although methyl bromide was not a topic of discussion the strawberry industry believed it important to make a statement regarding its use in strawberry production. Workgroup members prepared the following statement:

“ We firmly believe that methyl bromide has played a significant role in preventing pest invasion of strawberries when used as a pre-plant soil fumigant. Pre-plant soil fumigation with methyl bromide allows strawberry plants to thrive in an environment that promotes vigor and strength by reducing populations of nematodes, soil diseases, soil insects, and weeds. Increased plant vigor and health also helps prevent the invasion of other plant pests that could adversely affect the growth of the strawberry plant.

We believe that the loss of methyl bromide as a soil fumigant in strawberry production will increase the need to use more pesticides and more frequent applications of these pesticides to help control the pests that occur on strawberries. This may create greater risks to surface and ground water, occupational and worker risks, and potentially greater risks to human health in general. The introduction and spread of more pests and diseases will potentially increase with the loss of methyl bromide unless cost-effective alternatives are developed and registered.”

The remainder of this document is the pest by pest technical discussion regarding the role of “high risk” pesticides, the use of alternatives (chemical and non-chemical), and the potential of the new unregistered chemical (pipeline) pest management tools. The pest specific ATO DO@ lists identifies what needs to be accomplished in terms of registrations, research, and education in order for the transition away from “high risk” pesticide use to be a success.

**Attachments:**

Table 1. Efficacy table

Table 2. Toxicity to beneficials

# PEST MANAGEMENT STRATEGIC PLAN

## Strawberry Pests

### **Insect Pests:**

#### **Notes:**

- many of the new chemistries being developed for pest management are very expensive and tend to be species specific rather than broadspectrum
- during the picking season Re-entry Intervals (REIs) and Pre-harvest intervals (PHIs) become important when selecting a pesticide

### **MITES:** Two-spotted Spider Mites (TSM); Cyclamen mites

TSM a major pest (Cyclamen mites are sporadic pests but can be serious, may arrive in nursery stock from California, not a problem in NC); occur during the dormant, mid-winter, pre-bloom, and pre-harvest stages; develop slowly when temperatures are below 60 degrees F., populations develop rapidly when weather is hot and dry; damage plants by removing sap and creating webbing on underside of leaves resulting in less production; matted row production appears to have fewer mite problems.

#### OP insecticides currently used:

- Malathion: not recommended, provides poor to fair control
- Diazinon: not recommended, provides poor to fair control
- Naled (Dibrom): good efficacy when populations are low; harsh on beneficial insects and mites

#### Non-Ops currently used:

- Abamectin: provides excellent control; very expensive; not used in nurseries; 3 day phi; 2 applications made 21 days apart; used as a resistance management tool; possible use as an adulticide
- Dicofol (Kelthane): provides fair to good control; harsh on beneficials
- Bifenthrin: provides good to excellent control; harsh on beneficials
- Fenbutatin-oxide (Hexakis): provides fair to excellent control; soft on beneficials
- Fenpropathrin (Danitol): provides good control; harsh on beneficials
- Propargite (Omite): provides good control; used in plant nurseries only; ovicidal activity; a selective material that is soft on beneficials

#### **Notes:**

- all of the above (except propargite) are primarily applied to control immature mites, are less effective on adults;
- if dicofol, bifenthrin, fenbutatin-oxide, and fenpropathrin are used in nurseries, resistance problems may appear at the grower level

#### Non-chemical pest management methods currently used:

- Mite-free plants from nurseries – difficult to accomplish, the grower/nursery connection is important
- Use of predator mites – work well, harsh pesticides upset this process
- Avoid alternate hosts, especially broadleaf weeds, next to strawberries; in the fall as green plant materials die mites move into nurseries
- Soap - provides fair control



- Crop rotation: provides good control, more research needed
  - Resistant varieties, may provide fair control, more research needed
  - Sanitation and weed control: help in providing good control

Unregistered pest management tools:

- Bifentazate: may provide good control, more research needed
- Chlorfenapyr : efficacy research needed
- Etoxazole: efficacy research needed
- Milbemectin: efficacy research needed
- Hexythiazox: efficacy research needed
- Pyridaben: efficacy research needed
- Spinosad: provides good control, more research needed to fine tune it's use
- Formetanate hydrochloride: currently an IR-4 project, efficacy unknown, more research needed
- Cyhexathin: provides good control, more research needed to fine tune it's use

**Notes:** efficacy has not been determined for these on strawberry but the chemistry or research on other crops suggests possible efficacy against this pest

“TO DO” list for Mites:

Research:

- resistance management research employing new chemistries
- research on newer chemistries regarding efficacy, timing, rates, etc.
- many questions remain on use of predatory mites
- nursery research is a big need especially involving beneficial insects and mites
- development of ovicides
- development of resistant varieties
- look at plants that do not attract mites
- impacts of crop rotation on mite populations

Regulatory:

- expedite registration of hexythiazox (Savey): can be used early season and has long residual activity
- expedite registration of bifentazate (Floramite): a reduced risk pesticide, provides ovicidal activity
- need for a mite-free certification program

Education/Training:

- nurseries need to let growers know what pest management tools were used in the nurseries, will aid in resistance management programs
- use of new tools as they become registered and/or available to growers and nurserymen

**STRAWBERRY APHID:**

May occur during the winter season especially in the upper piedmont regions and when cover crops are used; may occur at the same time as mites; feeding causes leaf stunting and curling, feeding can transmit strawberry mottled virus and secondary disease infections due to honeydew production

OP insecticides currently used:

- \*malathion: used early after which predacious mites are released; also used as a spot treatment, can provide good control
- \*diazinon: can provide good control
- naled: can provide good control
- \*azinphos-methyl: provides fair control; 5 day phi;

**Notes:** \* all of the above are harmful to predatory mites and use will upset IPM programs.

Non-Ops currently used:

- thiodan: can provide good control; slightly disruptive to predatory mites and IPM programs
- pyrethrins:
- bifenthrin: provides fair control; disruptive to predatory mites
- pesticidal soaps: can provide good control
- fenpropathrin: provides fair control; disruptive to predatory mites

Non-chemical pest management methods currently used:

- conservation of ladybugs, lacewings, and syrphid flies
- release of aphid midges
- scouting

Unregistered pest management tools:

- imidacloprid: provides excellent control
- chlorfenapyr: ?
- spinosad: ?
- thiamethoxam: ?

**Notes:** efficacy has not been determined for these on strawberry but the chemistry or research on other crops suggests possible efficacy against this pest

“TO DO” list for strawberry aphid:

Research:

- determine efficacy and fine tune rates, timing, etc. of the unregistered compounds
- identify plants that attract beneficial insects and mites

Regulatory:

- expedite registrations for imidacloprid and spinosad

Education/Training:

- as new tools become registered or available educate users on the specifics of use, rates, timing, expectations, etc.

**CLIPPER WEEVIL (Strawberry Bud Weevil):**

Occurs during pre-bloom and bloom periods; direct pest of the berries; after egg laying female severs the bud from the pedicel; fruit formation does not occur; plasticulture seems to exacerbate this problem

**Notes:** post application activities may include scouting, frost protection, hand weeding, mulching, and bee activity

OP insecticides currently used:

- Chlorpyrifos: provides excellent control
- Diazinon: provides fair control

- Malathion (some use): provides good control
- Azinphos-methyl: provides good control; broadspectrum; controls aphids and clipper with single application; harsh on beneficial

Non-Ops currently used:

- Carbaryl: provides excellent control however is harsh on beneficial organisms and bees
- Methoxychlor (Marlate): provides fair control
- Bifenthrin: provides fair control

Non-chemical pest management methods currently used:

- Management of berries (black and wild) including removal and destruction
- Border treatments when black and wild berries are blooming
- Scouting
- Crop rotation: on a 1-3 year cycle; ½ mile separation between old and new fields
- Sanitation: a useful aid but not a stand alone tool

Unregistered pest management tools:

- Chlorfenapyr: efficacy potential unknown
- Spinosad: efficacy potential unknown
- Thiamethoxam: efficacy potential unknown
- Lambda-cyhalothrin: provides fair control

**Notes:** efficacy has not been determined for these on strawberry but the chemistry or research on other crops suggests possible efficacy against this pest

“TO DO” list for Clipper weevil:

Research:

- determine economic thresholds and damage levels
- develop new monitoring and trapping techniques
- develop a predictive model
- determine efficacy of new unregistered pesticides

Regulatory:

- expedite registration of chlorfenapyr (Pirate)

Education/Training:

- as new tools are developed and registered provide training to end users on rates, timing, application equipment, expectations, etc.

### **FLOWER THRIPS:**

Occur during bloom; problems with this pest are increasing, especially following mild winters; presence of grasses tends to result in higher populations

OP insecticides currently used:

- Malathion: provides fair control
- Naled (Dibrom): provides good control
- Diazinon: provides fair control
- Pyrellin: used in a tank mix with other pesticides; acts as an exciter; very expensive

Non-Ops currently used:

- Methoxychlor: provides fair control; used at night to avoid bees
- Azadirachtin (Neemix): very expensive

- Insecticidal soaps

Non-chemical pest management methods currently used:

- Grass management and weed control
- Sticky traps
- Beneficial mites

**Notes:** the above provide good control but are not stand-alone pest management tools

Unregistered pest management tools:

- Chlorfenapyr: efficacy unknown at this time
- Pyridaben: efficacy unknown at this time
- Spinosad: provides excellent control
- Thiamethoxam: efficacy unknown at this time
- Lambda-cyhalothrin: efficacy unknown at this time

**Notes:** efficacy has not been determined for these on strawberry but the chemistry or research on other crops suggests possible efficacy against this pest

“TO DO” list for Flower thrips:

Research:

- determine economic threshold and damage levels
- develop better detection and scouting methods
- refine trapping methods
- experiment to determine best cover crops
- biocontrol – release of predacious mites
- evaluate efficacy of imidacloprid

Regulatory:

- expedite registration of spinosad and possibly amidacloprid

Education/Training:

- as new tools become available educate end users as to rates, timing, expectations, equipment etc.

### **SPITTLEBUGS:**

Occur in late spring; currently not a serious pest; feed on sap of leaves and fruit; results in leaf distortion, stunting, and reduced yields both in quantity and quality

OP insecticides currently used:

- Azinphos-methyl: provides good control
- Malathion: provides good control
- Diazinon: provides good control

Non-Ops currently used:

- Endosulfan (Thiodan): provides good control
- Fenpropathrin (Danitol): provides fair control
- Carbaryl: provides good control

**Notes:** use of the above non-ops may disrupt established mite IPM programs

Non-chemical pest management methods currently used:

- Mowing/disking of cover crops: not a stand alone management tool
- Biological control agents: several species help reduce populations but are not stand alone management tools

Unregistered pest management tools:

- Chlorfenapyr: ?
- Spinosad: ?
- Thiamethoxam: ?
- Lambda-cyhalothrin: ?

**Notes:** efficacy has not been determined for these on strawberry but the chemistry or research on other crops suggests possible efficacy against this pest

“TO DO” list for Spittlebugs:

Research:

- efficacy studies on non-registered chemistries

Regulatory:

- expedite registration of spinosad and other new chemistries if they are determined to be efficacious

Education/Training:

- educate growers as to use of new tools as they become available

### **STRAWBERRY SAP BEETLE (SSB):**

Occurs on late fruit and during harvest; associated with overripe fruit, mechanically damaged fruit, and parallels botrytis outbreaks; hot, humid weather leads to population increases

OP insecticides currently used:

- Azinphos-methyl: the 21 day REI does not allow use of this product
- Diazinon: provides good control; used after harvest only
- Malathion: provides good control

Non-Ops currently used:

- Carbaryl: also used post-harvest in early summer; use upsets established mite IPM programs
- Fenprothrin: controls mites as well as SSB
- Bifenthrin: controls mites as well as SSB
- Methoxychlor:

Non-chemical pest management methods currently used:

- Sanitation: significant affects but not a stand alone method of control; remove rotten fruit, fruit damaged mechanically, and that showing signs of botrytis fruit rot
- Baited traps: using fermenting materials
- Crop rotation:
- Biological control: natural occurring predators and parasites help manage SSB populations but are not a stand alone management tool

Unregistered pest management tools:

- Chlorfenapyr: ?
- Spinosad: ?; a reduced risk pesticide
- Thiamethoxam: ?; an OP alternative
- Lambda-cyhalothrin: provides fair control

**Notes:** efficacy of the above chemistries has not been formally determined on strawberry pests; chemistry indicates possible activity

“TO DO” list for SSB:

Research:

- research needed on resistant varieties
- efficacy and application research needed on new chemistries
- develop baited traps as a monitoring tool
- determine what effect early season control with carbaryl on emergence of next generation

Regulatory:

- expedite registration of spinosad
- register lambda-cyhalothrin

Education/Training:

- educate growers on use of new chemistries
- on use of baited traps as monitoring tools as they become available

**TARNISHED PLANT BUG (TPB) and STINK BUG:**

Occur from flowering through green fruit stage through harvest; feeding by adults and nymphs results in “cat-facing” of berries; feeding punctures individual seeds

OP insecticides currently used:

- Azinphos-methyl: provides good control; 5 day pre-harvest interval
- Chlorpyrifos: provides good control; used pre-bloom only; 21 day phi
- Malathion: provides good control
- Diazinon: provides fair control; can only be used during green fruit season

Non-Ops currently used:

- Endosulfan: provides good control
- Carbaryl: provides fair control
- Fenprothrin: provides good control
- Bifenthrin: provides good control

Non-chemical pest management methods currently used:

- Sticky traps for monitoring populations: provides good control but not a stand alone management practice
- Vacuuming: can provide good control; used in CA and FL; very expensive
- Weed control will help keep populations from building up

Unregistered pest management tools:

- Chlorfenapyr: ?
- Spinosad: ?; a reduced risk pesticide
- Thiamethoxam: ?; an OP alternative
- Formetanate hydrochloride: ?
- Lambda-cyhalothrin: provides fair control

**Notes:** efficacy of these is not confirmed for this pest but chemistry indicates that it may be effective

“TO DO” list for TPB and stink bug:

Research:

- trapping and monitoring research is needed
- efficacy work needed on new chemistries

Regulatory:

- expedite registration of spinosad and other new chemistries if they appear effective management tools

Education/Training:

- grower education needed regarding life cycles and identification of this pest

### **SLUGS:**

OP insecticides currently used:

- None at this time

Non-Ops currently used:

- Carbaryl: as a bait provides good control; bait applied between plants and around field; very important use
- Lime:
- Metaldahyde: ????
- Kaolin: efficacy is not known

Non-chemical pest management methods currently used:

- Baited traps
- Manage mulch and water: excess of either increases slug problems
- Sanitation: helps in control but not a stand alone management practice
- Weed control

Unregistered pest management tools:

- Chlorfenapyr: efficacy unknown
- Spinosad: efficacy unknown
- Thiamethoxam: efficacy unknown
- Formetanate hydrochloride: efficacy unknown

**Notes:** efficacy has not been determined for the above chemistries on strawberries but the chemistry or research on other crops indicates possible efficacy against this pest

- Imidacloprid: provides good control

“TO DO” list for slugs:

Research:

- determine if diatomaceous earth would be effective in slug control
- develop replacements for methyl bromide

Regulatory:

- expedite registrations for methyl bromide replacements as they are determined to be effective and safe
- expedite registration of imidacloprid

Education/Training:

- educate users in new management tools as they become available

### **ROOT WEEVILS: ( Cribate, Woods, Black vine, and Fuller Rose weevils)**

All season pests; more of a problem in matted row production and on older plantings; immatures feed on roots and crowns; a serious problem in the Pacific north and northwest; methyl bromide may help in controlling this pest

OP insecticides currently used:

- Malathion: provides fair control

- Azinphos-methyl: not used for most weevils; provides fair control of the Fuller Rose Weevil
- Chlorpyrifos: provides fair control

**Notes:** all Ops are used to control adult root weevils

Non-Ops currently used:

- Carbofuran: provides good control of BVW and FRW; used as a pre-plant drench
- Bifenthrin: provides fair control; used in adult root weevil control
- Carbaryl: provides fair control; used in adult root weevil control

Non-chemical pest management methods currently used:

- Crop rotations of 1-3 year cycles
- Sanitation:

Unregistered pest management tools:

- Chlorfenapyr: ?
- Spinosad: ?
- Thiomethoxam: ?
- Lambda cyhalothrin: ?

**Notes:** : efficacy has not been determined for the above chemistries on strawberries but the chemistry or research on other crops indicates possible efficacy against this pest

“TO DO” list for root weevils:

Research:

- resistant varieties
- entomophagous nematodes
- Beauvaria bassiana
- Thiomethoxam:

Regulatory:

- expedite registration of spinosad
- register other new chemistries as they are proven effect and safe

Education/Training:

- educate end users as new management tools are registered and become available

### **WHITE GRUBS: Japanese beetle and False Japanese beetle:**

OP insecticides currently used:

- None at this time

Non-Ops currently used:

- Beauvaria sp.:
- Bacillus popillae: provides good control

Non-chemical pest management methods currently used:

- Traps for control
- Water as a monitoring tool
- Sanitation
- Weed control

Unregistered pest management tools:

- Chlorfenapyr:
- Spinosad:



- Thiamethoxam:
- Lambda-cyhalothrin

**Notes:** efficacy has not been determined for the above chemistries on strawberries but the chemistry or research on other crops indicates possible efficacy against this pest

“TO DO” list for white grubs:

Research: ?

Regulatory: ?

Education/Training: ?

### **ARMYWORMS: Fall Armyworm, Southern armyworm, Corn earworm, and Beet armyworm:**

Occur late summer into the fall; a problem in nurseries and greenhouses where plants are being propagated and in off season production; Beet armyworm is harder to control than the others

OP insecticides currently used:

- Azinphos-methyl: provides good control
- Malathion: provides fair control

Non-Ops currently used:

- Bt: must be used early when worms are young
- Thiodan: provides good control
- Methomyl (Lannate): provides good control; disrupts and increases spider mites; limits predaceous mites
- Bifenthrin:

Non-chemical pest management methods currently used:

- Sticky traps:

Unregistered pest management tools:

- Chlorfenapyr: provides good control
- Spinosad: provides good control
- Thiamethoxam: ??
- Lambda cyhalothrin: provides good control
- Methoxyfenozide: ??

**Notes:** efficacy has not been determined for the above chemistries on strawberries but the chemistry or research on other crops indicates possible efficacy against this pest

“TO DO” list for Armyworm complex:

Research:

- use of pheromones in monitoring programs
- spinosad: fine tune application knowledge
- lambda cyhalothrin: fine tune application knowledge
- chlorfenapyr: fine tune application knowledge

Regulatory:

- expedite registration of spinosad and chlorfenapyr

Education/Training:

- educate end users in timing, rates, equipment, expectations, etc as new materials are developed and registered
- explain and demonstrate use of pheromone monitoring tools as they become available

### **FIRE ANTS:**

A big problem in “pick your own” operations; problems are increasing; fire ants will eat the fruit; also feed on lepidoptera larvae

OP insecticides currently used:

- Chlorpyrifos: provides good control
- Diazinon: provides good control

Non-Ops currently used:

- None available at this time

Non-chemical pest management methods currently used:

- Sanitation

Unregistered pest management tools:

- Chlorfenapyr:
- Spinosad:
- Thiamethoxam:

**Notes:** efficacy has not been determined for the above chemistries on strawberries but the chemistry or research on other crops indicates possible efficacy against this pest

“TO DO” list for fire ants:

Research:

- Baits as mound treatments
- Baits as growth regulators

Regulatory:

- ?

Education/Training:

- Education programs are on going as the pest expands to new areas
- Educate end users as new bait technologies become available and cost effective

### **FRUIT FLIES:**

Not an eastern problem

**May be a problem in Florida – Florida reviewers need to add the info if this is a pest . Also discuss any export issues as they may relate to Mediterranean fruit flies and pesticide use if export issues are of any concern to the industry.**

OP insecticides currently used:

?

Non-Ops currently used:

?

Non-chemical pest management methods currently used:

?

Unregistered pest management tools:

?

“TO DO” list for fruit flies:

Research:

?

Regulatory:

?

Education/Training:

?

### **Whitefly:**

An increasing problem in most crops; although not common nurseries can be a source; are potential vectors of disease

OP insecticides currently used:

- Azinphos-methyl: provides poor control
- Malathion: provides fair control
- Naled: provides fair control

Non-Ops currently used:

- Abamectin: provides excellent control
- Endosulfan: provides fair control
- Fenpropathrin: provides good control
- Insecticidal soap: provides fair control
- Pyrethrin: acts as an exciter; mixed with other pesticides

Non-chemical pest management methods currently used:

- Sticky traps

Unregistered pest management tools:

- Pyridaben: ?
- Spinosad: ?
- Thiamethoxam: ?
- Imidacloprid: provides excellent control
- Lambda-cyhalothrin: ?

**Notes:** efficacy has not been determined for the above chemistries on strawberries but the chemistry or research on other crops indicates possible efficacy against this pest

“TO DO” list for whiteflies:

Research:

- Beauveria bassiana: efficacy and application methods
- Develop monitoring techniques
- Biocontrol with parasites: determine impact, efficacy, practicality, etc.
- Determine potential as disease vectors

Regulatory:

- expedite registration of imidacloprid and lambda-cyhalothrin

Education/Training:

- educate growers in use of new technologies as they are developed and become available; includes monitoring methods, use of parasites, etc.

### **LEAFHOPPERS:**

Are present all season but are more problematic in late summer and fall

OP insecticides currently used:

- Azinphos-methyl: provides good control
- Diazinon: provides good control
- Chlorpyrifos: provides good control
- Malathion: provides good control
- Naled: provides fair control

Non-Ops currently used:

- Abamectin: provides good control
- Bifenthrin: ?
- Insecticidal soap: provides fair control
- Thiodan: provides good control
- Fenpropathrin: provides fair control
- Methomyl (Lannate): provides good control
- Methoxychlor: provides good control

Non-chemical pest management methods currently used:

- Avoid planting alfalfa next to strawberry fields
- Mowing
- Sticky traps
- Weed control

Unregistered pest management tools:

- Imidacloprid: ?
- Lambda-Cyhalothrin: provides fair control
- Thiamethoxam: ?
- Spinosad: ?
- Chlorfenapyr: ?

**Notes:** efficacy has not been determined for the above chemistries on strawberries but the chemistry or research on other crops indicates possible efficacy against this pest

“TO DO” list for leafhoppers:

Research:

- efficacy work and fine tune use patterns of lambda-cyhalothrin
- efficacy studies with imidacloprid
- develop monitoring techniques
- determine disease vectoring potential of leafhoppers

Regulatory:

- expedite registration of imidacloprid and lambda-cyhalothrin if determined to be cost effective and safe

Education/Training:

- train end users in use of new tools as they become available
- demonstrate new monitoring methods as developed

### **CRICKETS and GRASSHOPPERS:**

Damage potential not fully understood; vector botrytis in fall fruiting crop; feed on green material; clipping of plant parts

OP insecticides currently used:

- Malathion: provides fair control
- Diazinon: provides good control
- Chlorpyrifos: provides good control

Non-Ops currently used:

- Carbaryl: provides good control
- Thiodan: provides fair control
- Bifenthrin: ?
- Fenpropathrin: provides fair control

Non-chemical pest management methods currently used:

- Weed control
- Use as fish bait

Unregistered pest management tools:

- Possibly spinosad and thiamethoxam

**Notes:** efficacy has not been determined for the above chemistries on strawberries but the chemistry or research on other crops indicates possible efficacy against this pest

“TO DO” list for crickets and grasshoppers:

Research:

- develop economic threshold levels
- evaluate vectoring potential
- evaluate efficacy of spinosad and thiamethoxam

Regulatory:

- ?

Education/Training:

- demonstrate and implement knowledge of economic thresholds as they are refined

### **STRAWBERRY LEAFROLLER (SLR):**

A minor pest; occurs during summer months; damage potential is unknown at this time; some varieties seem more attractive to SLR than others; control may occur from pesticide applications for other pests

OP insecticides currently used:

- Chlorpyrifos: provides fair control

Non-Ops currently used:

- Carbaryl: provides good control

Non-chemical pest management methods currently used:

- Predators (Big-eyed bug, Damsel bug, minute pirate bug) help in reducing populations

Unregistered pest management tools:

- Chlorfenapyr: ?
- Spinosad: ?
- Thiamethoxam: ?
- Lambda-cyhalothrin: provides good control
- Methoxyfenozide:

**Notes:** efficacy has not been determined for the above chemistries on strawberries but the chemistry or research on other crops indicates possible efficacy against this pest

“TO DO” list for SLR:

Research:

- determine damage potential of this pest
- varietal studies; plant breeding programs
- explore feasibility of developing effective pheromone traps

Regulatory:

- possible expedited registration if new materials are found to be cost effective and safe

Education/Training:

- demonstration of new varieties as they are developed
- demonstrate use of pheromone traps as they become cost effective and available

**STRAWBERRY ROOTWORM:**

Minor pest that builds up over time; more of a problem in matted row production; causes shot-holing in the fall; feeding reduces vigor of the plants; not so much of a problem in plasticulture production

OP insecticides currently used:

- None used at this time

Non-Ops currently used:

- Carbaryl:

Non-chemical pest management methods currently used:

- Crop rotation

Unregistered pest management tools:

- None at this time

“TO DO” list for strawberry rootworm:

Research:

?

Regulatory:

?

Education/Training:

?

=====

**MAJOR ORGANOPHOSPHATES USED IN STRAWBERRY PRODUCTION:**

MALATHION  
DIAZINON  
CHLORPYRIFOS

Table 1: Efficacy ratings for various pest management tools against strawberry pests. Table developed by the Strawberry Transition workgroup members.

Rating scale: E = excellent; G = good; F = fair; P = poor; ? = research needed;  
 ... = not used; \* = used but not a stand alone management tool

Pests:	TSM	FAW	SAW	CEW	SSB	FF	TPB	SBW	SA	CW	WW	BVW	FRW	WG	MSB	SLR	PLH	thrips	slugs	whiteflies	crickets	fire ants	
<b>Pest Management Tools:</b>																							
<b>Registered materials:</b>																							
Abamectin	E	..	..	..	..	..	..	..	G	..	..	..	..	..	F	..	G	F	..	E	..	..	
Azinphos-methyl	..	G	G	G	..	F	G	G	F	..	..	..	F	F	G	F	G	F	..	P	F	..	
Bifenthrin	G -E	F	F	F	G	..	G	F	F	F	F	F	F	..	F	G	F	F	..	G	F	..	
Bt	..	G	G	G	..	..	..	..	..	..	..	..	..	..	..	G	..	..	..	..	..	..	
Carbaryl	..	P	P	F	G	..	F	E	..	F	F	F	F	F	G	G	G	P	G	..	G	..	
Carbofuran	..	..	..	..	..	..	..	..	..	..	..	G	G	G	..	..	..	..	..	..	F	?	
Chlorpyrifos	..	..	..	..	..	..	G	E	F	F	F	F	F	F	F	F	G	F	..	..	G	G	
Diazinon	P- F	..	..	..	G	..	F	F	G	F	F	F	F	G	G	F	G	F	..	..	G	G	
Dicofol	F- G	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
Endosulfan	..	G	G	G	F	..	G	G	G	F	F	F	F	F	G	G	G	F	..	F	F	..	
Fenbutatin-oxide	F- E	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
Fenpropathrin	G	F	F	F	G	..	G	F	F	F	F	F	F	..	F	G	F	F	..	G	F	..	
Kaolin	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
Malathion	P- F	F	F	F	G	G	G	F	G	F	F	F	F	F	G	F	G	F	..	F	F	F	
Methomyl	..	G	G	G	..	..	..	..	F	F	F	F	F	..	F	G	G	F	..	F	F	..	
Methoxychlor	..	F	F	F	G	..	F	F	F	F	F	F	F	..	F	G	G	F	..	F	..	..	
Naled	P- F	..	..	..	F	G	F	..	G	..	..	..	..	..	F	F	F	G	..	F	..	..	







**Key to Pest Abbreviations:**

TSM = TWOSPOTTED SPIDER MITE  
FAW = FALL ARMYWORM  
SAW = SOUTHERN ARMYWORM  
CEW = CORN EARWORM  
SSB = STRAWBERRY SAP BEETLE  
FF = FRUIT FLIES  
TPB = TARNISHED PLANT BUG  
SBW = STRAWBERRY BUD WEEVIL  
SA = STRAWBERRY APHID  
CW = CRIBATE WEEVIL  
WW = WOODS WEEVIL  
BVW = BLACK VINE WEEVIL  
FRW = FULLER ROSE WEEVIL  
WG = WHITE GRUB  
MSB = MEADOW SPITTLEBUG  
SLR = STRAWBERRY LEAFROLLER  
PLH = POTATO LEAFHOPPER



Beneficial insects/mites:																				
Pest Management Tools:	Aphid midge	Bacillus popillae	Mites	Big-eyed bug	Damsel bug	Entomopathic Nematodes	Green lacewings	Ladybird beetles	Minute pirate bug	Parasites	Spiders	Syrphid fly larvae								
Thiamethoxam	?	?	?	?	?	?	?	?	?	?	?	?								
* Formetanate hydrochloride	?	?	?	?	?	?	?	?	?	?	?	?								
* Imidachloprid	H	...	O	S	S	O	S	H	S	S	S	S								
* Lambda-cyhalothrin	H	?	?	H	H	O	H	H	H	H	H	H								
* Methoxyfenozide	?	?	?	?	?	?	?	?	?	?	?	?								
Maxicrop	?	?	M	?	?	?	?	?	?	?	?	?								
Cyxeatin	?	?	?	?	?	?	?	?	?	?	?	?								
<b>* = current IR-4 projects</b>																				
<b>Cultural/Non-chemical:</b>																				
Avoid planting alfalfa	O	O	O	S	S	O	S	S	S	S	S	M								
Baited traps	O	O	O	O	O	O	O	O	O	O	O	O								
Crop rotation	O	O	O	S	S	S	S	S	S	S	M	S								
Delayed plowing	O	O	O	O	O	H	O	O	O	O	S	O								
Mowing/disking cover crops	O	O	S	M	M	O	M	M	M	M	H	S								
Resistant varieties	O	O	O	O	O	O	O	O	O	O	O	O								
Sanitation	O	O	O	S	S	S	O	S	S	S	H	S								
Sticky traps	O	O	O	S	S	O	S	O	S	S	O	O								
Use of certified pest-free plants	O	O	O	O	O	O	O	O	O	O	O	O								
Weed control	O	O	O	H	H	O	H	H	H	M	H	H								
<b>Biological controls:</b>																				
Aphid midges	...	O	O	O	O	O	S	S	O	O	O	S								
Bacillus popillae	O	...	O	O	O	O	O	O	O	O	O	O								
Beneficial mites	O	O	...	O	O	O	O	S	O	S	O	O								
Big-eyed bug	O	O	O	...	O	O	S	S	O	O	S	S								
Damsel bug	O	O	O	O	...	O	S	S	O	O	S	S								
Entomopathic nematodes	O	O	O	O	O	...	O	O	O	O	O	O								
Green lacewings	O	O	O	O	O	O	...	S	O	O	S	S								
Ladybird beetles	O	O	S	O	O	O	O	...	O	S	S	O								

Beneficial insects/mites:	Aphid midge	Bacillus popilliae	Mites	Big-eyed bug	Damsel bug	Entomopathic Nematodes	Green lacewings	Ladybird beetles	Minute pirate bug	Parasites	Spiders	Syrphid fly larvae									
Pest Management Tools:																					
Minute pirate bug	0	0	0	0	0	0	0	S	::	S	0	0									
Parasites	0	0	0	0	0	0	0	0	0	S	0	0									
Spiders	0	0	0	0	0	0	S	S	0	S	0	0									
Syrphid fly larvae	0	0	0	0	0	0	0	0	0	0	0	::									