US Environmental Protection Agency
Office of Pesticide Programs

Petition for 3 Year Extension of Exclusive Data Use for Spirodiclofen

November 5, 2012

Title

Petition for a Three-Year Extension of Exclusive Use Data Protection for Spirodiclofen As Provided For Under FIFRA Section 3(c) (1) (F) (ii)

Data Requirement
Not Applicable

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STATEMENT OF NO DATA CONFIDENTIALITY CLAIMS

No claim of confidentiality is made for any information contained in this study on the basis of its falling within the scope of FIFRA, Section 10(d)(1)(A)(B), or *(C)*. However, these data are the property of Bayer CropScience and, as such, are considered to be trade secret and confidential for all purposes other than compliance with FIFRA Section 10. Submission of these data in compliance with FIFRA Section 10 does not constitute a waiver of any right to confidentiality which may exist under any other statute or in any country other than the USA.

Company: Bayer CropScience

Agent:

Laura Phelps
Registration Manager
Bayer CropScience

Date: November 5, 2012

The above statement supersedes all other statements of confidentiality that may occur elsewhere in this report.

GOOD LABORATORY PRACTICE COMPLIANCE STATEMENT

This report does not meet the requirements for EPA FIFRA Good Laboratory Practice Standards, 40 CFR Part 160, and differs in the following way:

(1) This report is not subject to Good Laboratory Practices.

Submitter:

Laura Phelps
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Bayer CropScience

Date: November 5, 2012

1.0 Introduction

Bayer CropScience, the sole registrant of the proprietary miticide, spirodiclofen, is hereby petitioning the Environmental Protection Agency for a three-year extension of exclusive use data protection, as provided under FIFRA Section 3(c) (1) (F) (ii).

FIFRA Section 3(c) (1) (F) (ii) states that:
The period of exclusive data use provided under clause (i) shall be extended 1 additional year for each 3 minor uses registered after the date of enactment of this clause and within 7 years of the commencement of the exclusive use period, up to a total of 3 additional years for all minor uses registered by the Administrator if the Administrator, in consultation with the Secretary of Agriculture, determines that, based on information provided by an applicant for registration or a registrant, that -

- *(I) there are insufficient efficacious alternative registered pesticides available for the use;*
- *(II) the alternatives to the minor use pesticide pose greater risks to the environment or human health;*
- *(III) the minor use pesticide plays or will play a significant part in managing pest resistance; or*
- *(IV) the minor use pesticide plays or will play a significant part in an integrated pest management program.*

Further, in a Question & Answer document [http://www.epa.gov/pesticides/minoruse/#questions] concerning the exclusive use extension policy, the Agency clarifies that only one of the four criteria is necessary to qualify for consideration:

"To qualify to be considered under § 3(c)(1)(F)(ii) of FIFRA for an extension of the exclusive use period, the minor uses must be registered within the first 7 years from the start of the exclusive use period and meet one of the four criteria listed in FIFRA § 3(c)(1)(F)(ii)."

Additionally, in the same Question & Answer document, the Agency states that all minor-use crops contained in a given crop grouping potentially qualify for consideration:

"If the data for the representative crops in a crop grouping have been submitted and support establishment of the crop grouping, the Agency will count the non-representative minor crops within a crop grouping provided that they were registered within 7 years of the commencement of the initial exclusive use period for the active ingredient and the registrant is marketing the product for the minor crops. However, the non-representative minor crops must meet one of the four criteria identified in § 3(c)(1)(F)(ii) in order to be eligible to be considered for extension of exclusive use data protection."

As described in this petition, spirodiclofen meets the criteria cited in FIFRA Section 3(c) (1) (F) (ii). For the purposes of this discussion, specific information will be provided relative to Criterion IV. Spirodiclofen Technical (EPA Reg. No 264-830) and the end-use product ENVIDOR® 2 SC Miticide (EPA Reg. No 264-831) were first granted US registration by the EPA on June 30, 2005.

2.0 Spirodiclofen Minor Use Crop Candidates and Residue Data

Residue trials were conducted in crops and the crop group representative crops, including major and minor crops, to support the numerous minor crops on which spirodiclofen is currently registered. Table 1 shows the minor use crop candidates included in this petition for extension of exclusive use of data and the corresponding residue data used to support the registration of these minor crops. Of the seventeen, one minor use, hops, was requested by the Washington Hop Commission on behalf of its member growers, pursued by IR-4, and subsequently registered by EPA in May 2008 (Appendix 19, Reference 72).

All of the following seventeen minor use crop candidates, supported by residue data from either individual crop or representative crops of crop groups, were registered within the requisite seven years period (prior to June 30, 2012) and added to the spirodiclofen technical and end-use product labels.

Table 1. Spirodiclofen Minor Use Crop Candidates

Candidate No.	Crop Candidate	Bearing / Harvested Acres 2011/2012[1]	Residue Data to Support	MRID #	Date Registered	Crop Group No.	Document Section Number
1	Grapefruit	73,400	Grapefruit	45696612	Jun 2005	10	4.1
2	Lemon	55,000	Lemon	45696612	Jun 2005	10	4.1
3	Lime	1,251[2]	Orange, Grapefruit, Lemon	45696612	Jun 2005	10	4.1
4	Key Lime	Not Listed	Orange, Grapefruit, Lemon	45696612	Jun 2005	10	4.1
5	Kumquat	183[2]	Orange, Grapefruit, Lemon	45696612	Jun 2005	10	4.1
6	Pummelo	Not Listed	Orange, Grapefruit, Lemon	45696612	Jun 2005	10	4.1
7	Tangerine	52,600	Orange, Grapefruit, Lemon	45696612	Jun 2005	10	4.1
8	Avocado	59,950	Avocado	47630101	Apr 2010	N/A	4.2
9	Cherry, Sweet and Tart	120,820	Cherry	45696605	Jun 2005	12	4.3
10	Nectarine	28,400	Cherry, Peach, Plum	45696605	Jun 2005	12	4.4
11	Peach	112,480	Peach	45696605	Jun 2005	12	4.5
12	Pear	54,400	Pear	45696606	Jun 2005	11	4.6
13	Filbert (Hazelnut)	29,500	Almond, Pecan	45696521	Jun 2005	14	4.7
14	Pistachio	153,000	Almond, Pecan	45696521	Jun 2005	14	4.8
15	Mango	2,259[2]	Avocado	47630101	Apr 2010	N/A	4.9
16	Papaya	1,300	Avocado	47630101	Apr 2010	N/A	4.10
17	Hops	30,808	Hops	47105301	May 2008	N/A	4.11

[1] USDA National Agricultural Statistics Service. http://www.nass.usda.gov

[2] USDA Census of Agriculture. 2007 data (report run in 5 year intervals) http://www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_2_US_State_Level/

Registrations have been granted on other minor use crop candidates, however, this petition is only for the 17 listed minor-use crops. Supported by the following details, Bayer CropScience believes that these 17 minor crop registrations qualify spirodiclofen for an additional three years of exclusive use (one year for each three minor crop uses up to a maximum of three years exclusive use for nine qualifying minor crops).

3.0 Product Introduction and Overview

Spirodiclofen is a unique, selective, foliar miticide belonging to the chemical class of tetronic acids, developed exclusively by Bayer CropScience. The product has a new and unique mode of action classified as a lipid biosynthesis inhibitor (LBI) and **is the only miticide registered for use on perennial crops within IRAC Group 23**. As shown in Table 2 below, a compilation of information taken from miticide product labels, product brochures, and product information sheets, **spirodiclofen is one of the few miticides on the market today that is active on eggs, nymphs and adult growth stages.** Developed under the experimental code BAJ 2740, the active ingredient is contained within a two pound active ingredient suspension concentrate formulation known as Envidor® 2SC Miticide.

Table 2. Activity of Registered Miticides on Mite Developmental Growth Stages

MITICIDE	IRAC Group	Egg	Nymph	Adult
Abamectin	6	-	X	X
Propargite	12C	X	X	-
Hexythiazox	10A	X	X	-
Etoxazole	10B	X	X	-
Fenpyroximate	21A	-	X	X
Bifenazate	UN	X	X	X
Milbemectin	6	-	X	X
Dicofol	UN	-	X	X
Fenpropathrin	3	-	X	X
Fenbutatin oxide	12B	-	X	X
Pyridaben	21A	X	X	X
Acequinocyl	20B	X	X	X
Spirodiclofen	**23**	**X**	**X**	**X**

In both developmental testing and commercial usage, spirodiclofen has shown excellent levels of efficacy against key phytophagous mites which infest a variety of both major and minor-use perennial crops. These include members of the family *Tetranychidae* including, but not limited to, Twospotted spider mite (Appendices and References 1,2,3,4,7), Pacific spider mite (Appendices and References 5,6), European red mite (Appendices and References 1,2,3,4,8,9), Citrus red mite (Appendices and References 10,11,12), Yuma spider mite (Appendix and Reference 15), Willamette spider mite (Appendix and Reference 16), Texas citrus mite (Appendix and Reference 17), and Persea mite (Appendix and Reference 18); members of the family *Eriophyidae* including, but not limited to, Citrus rust mite (Appendix and Reference 13), Apple rust mite (Appendix and Reference 2), and Pear rust mite (Appendix and Reference 14); and members of the family *Tenuipalpidae* including, but not limited to, Citrus flat mite (Appendix and Reference 17). Although some of the data contained in appendices and referenced were generated on major crops, these same species occur on the various minor-use crops discussed within this document; it is generally accepted within pest management practitioners and the academic community that performance would be equivalent across crops for a given product. (Note: Many references are also included as appendices in this document for ease of review; due to the high number of references in this document, as well as the numbers of pages in some references, not all can be included and for those not included, it is recommended that the reviewer access the cited document via the internet URL provided.)

In a wide array of both internal and external studies, some of which are contained in the appendices and references, as well as from actual commercial usage since registration, the performance of spirodiclofen has equaled or exceeded currently used miticides in the market from different chemical classes such as abamectin, bifenazate, dicofol, pyridaben, hexythiazox, clofentezine, propargite, and fenbutatin-oxide. Resistance of spider mites to abamectin, pyridaben, and several other miticides has been well documented in various states within the U.S., as well as in several countries. In many crops, both major and especially minor use, mites have been exposed to a limited number of active ingredients for many years and although not all have been documented, control problems are being reported more frequently, which may indicate the evolution of resistant mite populations. When chemical control is necessary, spirodiclofen provides an additional rotation partner to reduce the excessive selection pressure on all commercially available products and helps to preserve these chemical classes for continued use in the future. The long-residual activity from a single application of spirodiclofen often minimizes the need for a follow-up application with another product and thus minimizes environmental loading. These product features, coupled with the unique mode of action which has shown no cross resistance to other miticides currently in the market, makes spirodiclofen an attractive option for inclusion in IPM systems for management of economically important phytophagous mites.

FIFRA Criterion IV: The minor use pesticide plays or will play a significant part in an integrated pest management program.

The USDA has defined Integrated Pest Management (IPM) as, "A sustainable approach to managing pests by combining biological, cultural, physical, and chemical tools in a way that minimizes economic, health, and environmental risks". IPM programs are the preferred approach to phytophagous mite management. An important component of the biological element of IPM is the conservation, preservation, and/or augmentation of natural enemies of not only the target pest but other injurious pests as well. This approach does not preclude the use of miticides but rather encourages the judicious use of them on an as-required basis. In the case of phytophagous mite pests, the main challenge for products having miticidal activity is their selectivity towards predacious mites and their compliance with current IPM systems where they should only be used as a corrective tool when beneficial arthropods can no longer maintain population densities below the economic injury level.

Laboratory, semi-field and field investigations with spirodiclofen during product development, as well as since commercial introduction in 2005, have shown excellent selectivity towards beneficial arthropods used in current IPM programs across both major and minor-use crops. As noted in the California Department of Pesticide Regulation Public Report 2007-1 for spirodiclofen "test data demonstrate a reduced negative impact on beneficial predatory mites and other beneficial insects, such as lacewings and parasitic wasps" (73).

In many established IPM systems for phytophagous mite management on both major and minor-use crops, *Typhlodromus pyri* is a key naturally-occurring predacious mite, being able to exert a strong regulating influence on the density of the pest population if populations are not excessive. Laboratory and field investigations have shown spirodiclofen to have varying degrees of toxicity to this predatory mite (19,20,21,22,23), ranging from slightly harmful to harmful; this stands to reason, as spirodiclofen is a selective miticide. Effects in many referenced field trials can often be attributed to either direct effects of the toxicant or indirectly by the elimination of the prey.

Other naturally occurring predacious mites such as *Amblyseius fallacis* (20,24,25,26,27), *Zetzellia mali* (19,20,21,24,25), *Galendromus occidentalis* (27,28), *Phytoseiulus persimilis* (29,30) are also important components in IPM systems across many major and minor-use crops. Spirodiclofen has shown minor to moderate impacts on these species. Generally effects on the target phytophagous mite population are more dramatic than that of the predacious mite population (source), creating a more favorable predator:prey-ratio so that economic damage can be avoided going forward, biological systems can flourish, thus preserving the IPM system.

Many beneficial species such as *Stethorus punctum* (24,25,27), *Rodolia cardinalis* (26), and Anthocorids (22), are also important components in IPM systems and spirodiclofen has shown little to no impact on these groups. Spirodiclofen also has negligible effects on the whitefly parasitic wasp *Encarsia* (30).

Table 2, taken from "Beneficial Arthropods in Washington Vineyards: Screening The Impact of Pesticides on Survival and Function"(27) is a summary of the safety of selected miticides to three predatory mite and two lady beetle species. (Note: IRAC Group and colors added by author to highlight differences, with red being harmful, yellow being moderately harmful, and green being safe.)

Table 2. Effects of Miticides on Beneficial Arthropods

MITICIDE (IRAC Group)	*Galendromus occidentalis*	*Neoseiulus fallacis*	*Amblyseius andersoni*	*Stethorus picipes*	*Harmonia axyridis*
Abamectin (6)	H	H	H	H	H
Cyhexatin (12B)	H	H	-	-	-
Propargite (12C)	S	S	MH	H	S
Hexythiazox (10A)	S	S	S	S	S
Fenpyroximate (21A)	H	H	H	H	H
Bifenazate (UN)	S	S	MH	S	S
Milbemectin (6)	H	H	H	H	MH
Biomite (N/A)	H	H	H	H	S
Dicofol (UN)	H	H	-	-	S
Fenbutatin oxide (12B)	MH	S	S	-	S
Acaritouch (N/A)	MH	S	S	-	-
Pyridaben (21A)	H	H	-	-	H
Acequinocyl (20B)	S	S	S	-	S
Spirodiclofen (23)	S	S	S	S	-

S = SAFE = Less than 33% mortality expected when field rate used; MH = MODERATELY HARMFUL = 33-66% mortality expected when field rate used; H = HARMFUL = 66-100% mortality expected when field rate used.

In summary relative to effects on beneficial arthropods utilized in IPM systems across many different major and minor-use crops, spirodiclofen creates a more favourable predatory:prey ratio that does not compromise the IPM compatibility of the product. Beneficial populations are maintained and can perform their natural function to keep pest populations below the economic threshold and thus lessen pesticide environmental loading. This IPM compatibility enables spirodiclofen to play a key regulating role when chemical treatments are warranted in IPM systems in perennial crops.

4.0 Minor-Use Crop Specific Discussions

4.1 Grapefruit, Lemon, Lime, Key lime, Kumquat, Pummelo, and Tangerine

These seven minor-use crops are often included in the broad general crop terminology "citrus" within literature and publications, covering many different citrus types. Other members are contained in the term "citrus" however virtually no published information exists on those members for inclusion in this document due to their very small acreage relative to other members. All citrus types are plagued by varying degrees of mite infestations.

In Florida, citrus mite pests can include citrus red mite, Texas citrus mite, sixspotted mite, broad mite, citrus rust mite, and pink citrus rust mite; these mite pests are typically controlled by both non-chemical (native and introduced exotic natural enemies) and chemical methods (31,32). Citrus grown for fresh fruit can receive up to 3-4 applications, timed according to post-bloom, summer, and fall periods. Within Florida's recommendations, it is advised that only one application of a given mode of action be made against mite pests due to the high propensity for development of resistance (33) – this is consistent with product stewardship measures and the established use recommendations included on the spirodiclofen label for all registered crops (70,71).

In California, citrus mite pests can include citrus red mite, citrus flat mite, twospotted spider mite, citrus bud mite, broad mite, citrus rust mite, Texas citrus mite, and Yuma spider mite. IPM is used quite extensively and represents the strongest IPM system in the state. Many mite pests are generally kept in check by natural enemies, including *Euseius, Stethorus, Conwentzia*, and *Scolothrips* species, except when broad-spectrum insecticides are used for control of other pests, thereby eliminating these natural enemies and allowing phytophagous mite populations to surge. Some mite pests of citrus have no biological control agents and population management is solely dependent upon chemical treatments. Other non-mite pest populations are under biological control by other species and can include parasitic wasps and flies, *Rodolia cardinalis*, and generalist predators (34).

Spirodiclofen has shown excellent efficacy against mite pests which plague citrus (10,11,12,13,15,17) while preserving the beneficial arthropod populations found in IPM systems, as discussed in the introductory area of this document. These features have been recognized by university researchers and extension specialists and they have recommended the product in pest management guides (33). Spirodiclofen is the highest recommended product for management of citrus rust mite in the University of California Pest Management Guidelines based on the usefulness in an IPM program, taking into account efficacy and impact on natural enemies and honeybees (Appendix 20, Reference 35).

4.2 Avocado

Avocados are grown predominately in California with minor production occurring in Florida. California avocados use relatively few chemicals to control insect pests and beneficial insects are used as part of an IPM approach in which harsh chemicals are avoided to maintain proper predator/prey ratios.This necessitates that the industry carefully follow recommended IPM practices. The persea mite is a fairly recent pest introduction in the California avocado production area and can cause serious damage to the foliage, in some instances defoliation if infestation pressure is high. Biological control agents of persea mite include *Galendromus, Neoseiulus, Euseius*, and *Stethorus* species. If biological control is disrupted due to chemical control of other pests, predominantly avocado thrips, populations of persea mite generally increase to densities requiring chemical treatment (36). Persea mite can be quite effectively controlled by applications of spirodiclofen (18) and has shown low impacts on many of the predators typically found in avocado production systems, as discussed in the introductory area of this document, as well as in University of California Pest Management Guidelines (Appendix 21, Reference 37; Appendix 22, Reference 38).

4.3 Cherry

Sweet and tart cherries are produced in many different states across the northern portions of the U.S. Cherries are plagued by various mite species including European red mite, twospotted spider mite, Pacific spider mite, McDaniel mite, and cherry rust mite. These phytophagous mite species can cause significant damage if biological control, typically accomplished by *Galendromus, Typhlodromus* and *Stethorus*, is disrupted (39,40,41). Spirodiclofen has shown excellent control of many of these mite species (1,2,3,4,5,6,7,8,9), as well as varying degrees of impact on the beneficial predators as discussed in the introductory area of this document. This excellent level of efficacy, coupled with the low to moderate impact on beneficials, has served as the basis for recommending spirodiclofen for use in IPM systems on cherries in many states (41,42,43).

4.4 Nectarine

California ranks first in the production of nectarines, accounting for 96% of the U.S. production, with some production occurring in other states. Twospotted spider mite, Pacific spider mite, brown mite, and European red mite can be serious pests of nectarines. Predators, including *Galendromus, Scolothrips*, and *Stethorus* species, are very important components of IPM programs and these species typically maintain acceptable levels of mite populations except when harsh products are used for other pest infestations in nectarines (44,45). When this occurs, effective chemical controls must be employed to maintain mite infestation levels below the economic injury level. Spirodiclofen effectively controls the mite pests which infest nectarines (1,2,3,4,5,6,7,8,9) and coupled with the low to moderate impact on beneficials as discussed in the introductory area of this document, has led to it being included in many pest management guidelines and recommendations (42,46,47,48).

4.5 Peach

California ranks first in the production of peaches, accounting for 71% of the U.S. production, with minor levels of production occurring in numerous other states. Like nectarines, Twospotted spider mite, Pacific spider mite, brown mite, and European red mite can be serious pests of peaches and predators, including *Galendromus, Scolothrips*, and *Stethorus* species, are very important regulators of phytophagous mite population densities (49,50). When chemical control agents are warranted, spirodiclofen is among the highest recommended (42,51,52,53) due to its high level of efficacy against mite pests infesting peach (1,2,3,4,5,6,7,8,9), as well as its low to moderate impact on beneficials as discussed in the introductory area of this document.

4.6 Pear

Pears are produced in many different states across the U.S., with the largest concentration found in the Pacific Northwest. Mite pests that infest pears include European red mite, twospotted spider mite, Pacific spider mite, brown mite McDaniel mite, and pear rust mite. The majority of these mite pests are generally regulated by *Galendromus, Zetzellia, Scolothrips, Stethorus*, and various species of lacewings and minute pirate bugs (54,55,56); however pear rust mite has no biological control agent to maintain population densities within acceptable ranges and thus must be managed solely by chemical treatments (57). Spirodiclofen has shown high levels of efficacy against mite pests infesting pear (1,2,3,4,5,6,7,8,9,14). Excellent efficacy, coupled with selectivity toward various predatory arthropods mentioned previously, has led extension specialists to place spirodiclofen in various pest management and crop production recommendations (42,58).

4.7 Filbert (Hazelnut)

Oregon is the nation's leading filbert (hazelnut) producer. This crop is plagued by mite pests, including the filbert bud (Big bud) mite. Biological control agents have been introduced for management of mite pests (59) although chemical control is still necessary in some circumstances. Although no published efficacy data exists, testing with spirodiclofen has shown excellent control of Big bud mite and has led to the issuance of a 2(ee) recommendation by Bayer CropScience. This, coupled with the selectivity of mite biological control agents found in hazelnuts, has led to the listing of spirodiclofen in the hazelnut pest management recommendations (60).

4.8 Pistachio

California is the nation's leading producer of pistachio and the second largest producer worldwide. The predominant mite pest on California pistachio is the citrus flat mite and occasionally the crop is infested with twospotted and/or Pacific spider mite. Beneficial predators include *Scolothrips, Typhlodromus, Stethorus, Orius,* and lacewings (61). No specific recommendations are in place for management of citrus flat mite (or other mites) but control may be warranted if orchards are in close proximity to citrus or pomegranates (62). If control is warranted, spirodiclofen has shown excellent control of the target mite pests (1,2,3,4,5,6,7,17), as well as demonstrated moderate to good selectivity toward the predators of these mite pests as discussed in the introductory area of this document.

4.9 Mango

Mango is produced on very small acreage, predominately in south Florida. Avocado red mite, mango spider mite, mango bud mite, and tumid mite are all known to infest the crop (63,64). Predacious arthropods, predominately phytoseiid mites, are utilized in the crop but exact species composition is unknown. In testing against mango bud mite, spirodiclofen has shown very effective control of this pest and effects on predatory mites appears to be equal to all other miticides tested (65). Although testing has not occurred on the other species known to infest mango, it is anticipated, based on the excellent levels of efficacy observed on all other mite pests on other crops, that spirodiclofen would provide comparable levels of control.

4.10 Papaya

Like mango, papaya is also produced on very small acreage, the majority being in Hawaii and Florida. The crop is infested by twospotted spider mite and based on available information, no specific biological control agents are mentioned (66,67,68). Spirodiclofen has been evaluated specifically for control of twospotted mites infesting papaya, showing excellent control, and well as no significant differences in predatory mites (composition unknown) between the treatment and untreated (69). This information, coupled with results of testing against twospotted mites on other crops (1,2,3,4,7) and the moderate to good selectivity on beneficial arthropods as discussed in the introductory area of this document, indicates that spirodiclofen would have an excellent fit in IPM systems in papaya.

4.11 Hops

Hops are grown on very small acreage in the Pacific Northwest states of Idaho, Oregon, and Washington (74,75). Twospotted spider mite can be a serious pest of hops and populations are generally maintained at low levels by predatory mites, except when beneficial populations are disrupted due to applications of broad-spectrum insecticides. Spirodiclofen provides excellent control of twospotted hops on many perennial crops (1,2,3,4,7), as well as good selectivity on the predatory mites *Galendromus* and *Neoseiulus* (76). These product attributes were recognized by university researchers and others involved with the hops industry which lead to the submission of a Pesticide Clearance Request to the IR-4 Project, the conduct of a residue program by IR-4 and subsequent regulatory approval by EPA (72). Spirodiclofen is now listed as a recommended product for management of twospotted mite on hops in the Pacific Northwest (77).

5.0 Conclusions

Spirodiclofen has shown excellent levels of efficacy against a very broad range of mite pests that infest both major and minor-use perennial crops in developmental testing and commercial usage. The properties of spirodiclofen, including its new mode of action and minimal impacts on predatory and parasitic arthropods, make it an excellent fit in IPM programs on both major and minor-use crops.
As noted in the CDPR Public Report 2007, "Envidor 2 SC Miticide can be used in Integrated Pest Management (IPM) programs because it is active on multiple mite life stages, its limited action on predatory mites and beneficial insects, and its compatibility as a tank mix with many other chemicals. There are a number of other active ingredients registered as miticides. However, an effective integrated pest management strategy requires the flexibility of a large number of comparable, but not exactly equivalent, pesticides in order to reduce the development of resistance" (73).

Spirodiclofen provides a much needed resistance management tool to extend the life of the other limited, commercially-available miticides in minor-use perennial crops. All minor-use crops and phytophagous mite pests discussed within this document, as well as others, are contained within the Envidor® 2SC Miticide marketing product label (70) or FIFRA Section 2(ee) recommendation (71). Although justification is not included as a part of this document, it is also important to note that various members of the IR-4 Project have recognized the benefit of spirodiclofen for many other minor-use crops aside from hops and several Pesticide Clearance Requests have been submitted; residue programs have been conducted, petitions have been submitted and are pending approval within EPA (72).

Supported by the information contained and references cited within this document, we feel that spirodiclofen satisfies criterion IV for granting the three-year extension of exclusive use data protection as provided under FIFRA Section 3(c) (1) (F) (ii).

6.0 References

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Appendices

(B3)

CHERRY (TART): *Prunus cerasus* L. 'Montmorency'

CHERRY, CONTROL OF SPIDER MITES AND EUROPEAN RED MITES, 2002

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Twospotted spider mite (TSSM): *Tetranychus urticae* (Koch)
European red mite (ERM): *Panonychus ulmi* (Koch)

This trial was conducted at the Northwest Michigan Horticulture Research Station in Traverse City, MI in cooperation with MSU-Extension District IPM agent Gary Thornton. Three-tree plots were arranged in a RCB design with four replications. The test materials were applied at threshold on 16 Aug to mature Montmorency tart cherry trees with an FMC 1229 airblast sprayer calibrated to deliver 60 gpa. A maintenance application of Asana XL was made on 2 Aug for control of cherry fruit fly. Mite evaluations were made on 13 , 20 , 28 Aug, 4, and 10 Sep by picking 50 randomly selected leaves from the middle tree of each replicate and passing the leaves through a mite-brushing machine. Motile forms of Twospotted spider mite (TSSM), European red mite (ERM) and predaceous mites were then counted with the aid of a microscope. All mite data are reported as the mean number of mites per leaf, and were analyzed using ANOVA and means separation by LSD at $P = 0.05$.

While, all treatments provided significant levels of TSSM control compared to the untreated check (Table 1.), Acramite and Pyramite brought motile numbers down more quickly than the other treatments. The GWN-1549 treatments began to lose control by the 10 Sep evaluation, however, there did appear to be some level of rate response between the two GWN-1549 treatments. Though ERM populations were not particularly high in this trial (Table 2.), all treatments did provide significant levels of control compared to the untreated check.

Table 1.

Treatment/formulation	Amt. form/acre	Application timing	Pre-count 13 Aug	No. TSSM motiles/leaf 4 DAT 20 Aug	12 DAT 28 Aug	19 DAT 4 Sep	25 DAT 10 Sep
Untreated check	---	---	8.7a	26.1a	25.6a	27a	13.9a
Acramite 50W	12 oz	16 Aug	6.8a	5.0c	0b	0b	0c
Acramite 50W	16 oz	16 Aug	13.4a	1.8c	0b	0b	0c
Mesa .078EC	20 oz	16 Aug	7.7a	2.6bc	0.6b	0.3b	0.6c
BioCover UL	1 gal	16 Aug					
GWN-1549	8 oz	16 Aug	8.7a	6.8b	7.7b	1.7b	9.4ab
GWN-1549	12 oz	16 Aug	7.8a	5.3bc	3.6b	1.1b	3.2bc
Envidor 240SC	10 oz	16 Aug	7.5a	4.3bc	0.3b	0.1b	0.1c
Pyramite 60W	8.8 oz	16 Aug	10.9a	2.0c	0.6b	0.5b	0.6c

Treatment means are presented as actual counts, statistical differences were calculated using log-transformed data.
Means followed by same letter do not significantly differ (*P* = 0.05, LSD).

Table 2.

Treatment/formulation	Amt. form/acre	Application Timing	Pre-count 13 Aug	No. ERM motiles/leaf 4 DAT 20 Aug	12 DAT 28 Aug	19 DAT 4 Sep	25 DAT 10 Sep
Untreated check	---	---	0.3a	3.9a	0.6a	8a	2.1a
Acramite 50W	12 oz	16 Aug	0.4a	1.8a	0.5a	0.1b	0.2b
Acramite 50W	16 oz	16 Aug	0.2a	1.3a	0.8a	0.2b	0b
Mesa .078EC	20 oz	16 Aug	0.1a	0.9a	0.4a	0.1b	0b
BioCover UL	1 gal	16 Aug					
GWN-1549	8 oz	16 Aug	0.5a	1.6a	0.7a	0.8b	0b
GWN-1549	12 oz	16 Aug	0.9a	1.9a	0.6a	1.8b	0b
Envidor 240SC	10 oz	16 Aug	1.2a	1.2a	0.3a	0.8b	0b
Pyramite 60W	8.8 oz	16 Aug	0.9a	0.7a	0.6a	0.4b	0b

Treatment means are presented as actual counts, statistical differences were calculated using log-transformed data.
Means followed by same letter do not significantly differ (*P* = 0.05, LSD).

(A1)

APPLE: *Malus domestica* Borkhausen, 'Fuji'

EFFICACY OF REGISTERED AND EXPERIMENTAL MITICIDES, 2004

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Twospotted spider mite (TSM): *Tetranychus urticae* Koch
European red mite (ERM): *Panonychus ulmi* (Koch)
Western predatory mite (WPM): *Galandromus occidentalis* (Nesbitt)
Stigmaeid predatory mite (ZM): *Zetzellia mali* (Ewing)
Apple rust mite (ARM): *Aculus schlechtendali* (Nalepa)

This experiment was conducted in a 6-yr-old block of apple trees located at the Tree Fruit Research and Extension Center in Wenatchee, WA. The block consisted of three-tree plots separated by spaces, with one tree each of the cultivars 'Golden Delicious', 'Fuji', and 'Delicious'. The center 'Fuji' tree was used for all mite samples. Plots were staggered in adjacent rows to minimize drift. The experimental design was a RCB with 12 treatments and 4 replicates. Treatments were applied on 13 Aug with an airblast sprayer calibrated to deliver 200 gpa. Twenty-five leaves per tree were collected from each replicate and kept cool during transportation and storage. The mites were brushed from the leaves with a leaf brushing machine and collected on a revolving sticky glass plate. The composite leaf sample on the plate was counted using a stereoscopic microscope. Mite populations were sampled before and ca. weekly after treatment until mite population declined in the checks. Mite populations are reported as a composite of tetranychid (TSM, ERM) or predatory mites (WPM, ZM). Data were analyzed with analysis of variance and mean separation used the Waller-Duncan *k*-ratio *t*-test.

Mite pressure in this test was very high, with densities of 112-150 mites per leaf before treatments were applied and declining thereafter (Table 1). The population was comprised almost exclusively of TSM. Acramite at all rates and formulations provided fast knockdown of mites by 6 DAT (19 Aug). The low rate of Envidor (14 fl oz) and FujiMite also provided good control by that time, although populations were significantly higher than the Acramite treatments. The Zeal treatment was slower than the others, with significantly higher populations at 6 DAT, but good control by 13 DAT (26 Aug). Pyramite provided significantly poorer control than the other materials on this date; however, it should be noted that the rate used (6.6 oz) is below the rate recommended on the label for this species (8.8-13.2 oz). There were no treatment differences in predatory mite populations by 6 DAT (Table 2). By 13 DAT, the check had significantly higher populations, presumably because of the higher prey population at that time. None of the acaricides had predatory mite populations that differed significantly. There was a moderate ARM population in the plot pre-treatment, which declined slightly over the following 2 wk (Table 3). Envidor (18 fl oz rates only), Acramite, and Agri-Mek suppressed rust mite populations. The 14 fl oz rate of Envidor, FujiMite, Zeal, and Pyramite were not significantly different from the check at 6 DAT. The latter three materials appear to have the least effect on ARM.

Table 1.

Treatment/ formulation	Rate amt product/acre	Tetranychid mites/leaf			
		10 Aug	19 Aug[a]	26 Aug[a]	2 Sep[a]
Envidor 240SC	14.0 fl oz	150.80a	1.92d	0.00e	0.00b
Envidor 240SC	18.0 fl oz	130.45a	0.71def	0.05cde	0.00b
Envidor 240SC	18.0 fl oz	141.94a	0.27efg	0.04de	0.00b
+ Saf-T-Side oil	0.02% v/v				
Acramite 75W	0.5 lb	123.29a	0.00g	0.00e	0.00b
+ Silwet L-77	0.02% v/v				
Acramite 75W	0.67 lb	116.60a	0.13fg	0.00e	0.00b
+ Silwet L-77	0.02% v/v				
Acramite 50W	0.75 lb	123.22a	0.04g	0.00e	0.00b
+ Silwet L-77	0.02% v/v				
Acramite 50W	1.0 lb	121.88a	0.09g	0.01de	0.00b
+ Silwet L-77	0.02% v/v				
FujiMite 5%EC	1.0 qt	126.74a	1.03de	0.01de	0.00b
Zeal 72WDG	2.0 oz	121.60a	4.59c	0.98b	0.02ab
Pyramite 60WP	6.6 oz	135.02a	11.40b	0.24c	0.03ab
Agri-Mek 0.15EC	16.0 fl oz	112.20a	0.19fg	0.13cd	0.00b
+ Saf-T-Side oil	0.25% v/v				
Untreated check	---	137.20a	62.00a	14.66a	0.05a

Means within columns not followed by the same letter are significantly different (Waller-Duncan *k*-ratio *t*-test, *k*-ratio=100).
[a]Data transformed log(x+0.5) due to unequal variances.

Table 2.

Treatment/ formulation	Rate amt product/acre	Predatory mites/leaf			
		10 Aug	19 Aug	26 Aug[a]	2 Sep
Envidor 240SC	14.0 fl oz	0.00a	0.09a	0.00b	0.00a
Envidor 240SC	18.0 fl oz	0.04a	0.16a	0.00b	0.00a
Envidor 240SC	18.0 fl oz	0.35a	0.06a	0.01b	0.00a
+ Saf-T-Side oil	0.02% v/v				
Acramite 75W	0.5 lb	0.49a	0.20a	0.00b	0.00a
+ Silwet L-77	0.02% v/v				
Acramite 75W	0.67 lb	0.21a	0.15a	0.00b	0.00a
+ Silwet L-77	0.02% v/v				
Acramite 50W	0.75 lb	0.24a	0.12a	0.08b	0.04a
+ Silwet L-77	0.02% v/v				
Acramite 50W	1.0 lb	0.02a	0.07a	0.00b	0.00a
+ Silwet L-77	0.02% v/v				
FujiMite 5%EC	1.0 qt	0.00a	0.12a	0.00b	0.00a
Zeal 72WDG	2.0 oz	0.29a	0.23a	0.07b	0.08a
Pyramite 60WP	6.6 oz	0.12a	0.15a	0.01b	0.02a
Agri-Mek 0.15EC	16.0 fl oz	0.28a	0.04a	0.01b	0.00a
+ Saf-T-Side oil	0.25% v/v				
Untreated check	---	0.08a	0.17a	0.29a	0.05a

Means within columns not followed by the same letter are significantly different (Waller-Duncan *k*-ratio *t*-test, *k*-ratio=100).
[a]Data transformed log(x+0.5) due to unequal variances.

Table 3.

Treatment/ formulation	Rate amt product/acre	Apple rust mites/leaf			
		10 Aug	19 Aug	26 Aug	2 Sep[a]
Envidor 240SC	14.0 fl oz	42.1a	34.9ab	1.5cd	0.00b
Envidor 240SC	18.0 fl oz	74.2a	6.8b	2.7bcd	0.00b
Envidor 240SC	18.0 fl oz	70.4a	12.0b	2.0cd	0.00b
+ Saf-T-Side oil	0.02% v/v				
Acramite 75W	0.5 lb	97.4a	13.4b	0.7d	0.00b
+ Silwet L-77	0.02% v/v				
Acramite 75W	0.67 lb	76.4a	15.8b	1.6cd	0.00b
+ Silwet L-77	0.02% v/v				
Acramite 50W	0.75 lb	99.2a	16.4b	3.7bcd	0.00b
+ Silwet L-77	0.02% v/v				
Acramite 50W	1.0 lb	29.9a	4.9b	1.7cd	0.00b
+ Silwet L-77	0.02% v/v				
FujiMite 5%EC	1.0 qt	61.2a	26.4ab	7.1bc	0.06b
Zeal 72WDG	2.0 oz	101.8a	26.6ab	8.7b	1.36a
Pyramite 60WP	6.6 oz	75.6a	31.4ab	8.8b	0.39ab
Agri-Mek 0.15EC	16.0 fl oz	66.6a	13.3b	4.8bcd	0.00b
+ Saf-T-Side oil	0.25% v/v				
Untreated check	---	71.2a	61.5a	36.1a	0.29ab

Means within columns not followed by the same letter are significantly different (Waller-Duncan *k*-ratio *t*-test, *k*-ratio=100).
[a]Data transformed log(x+0.5) due to unequal variances.

Appendix 3

(A10)

APPLE: *Malus domestica* Borkhausen, 'Delicious'

ACARICIDE EVALUATION, 2005

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European red mite (ERM): *Panonychus ulmi* (Koch)
Twospotted spider mite (TSSM): *Tetranychus urticae* Koch
Mite predator (AF): *Amblyseius fallacis* (Garman)

This experiment was conducted in a 2.1 acre block of 20-yr-old trees on M.7A rootstock. Trees measured 12 ft in height and 10 ft in width and were planted at a spacing of 12 × 18 ft. The experimental design consisted of four single-tree replications per treatment in a RCB design, with each replicate surrounded by at least one unsprayed tree on each side. Treatments were applied as complete sprays to both sides of the trees on 9 May (late petal fall, treatment 1 only), 27 May (treatments 2 and 3), and 28 Jun (treatments 4-11) with a Swanson DA500A airblast sprayer, which traveled at 2.6 mph and delivered a spray volume of 100 gpa. Other materials applied separately to all treatments were Agri-Mycin, Asana, Calcium Chloride, Calypso, Captan, Dithane DF, Flint, Imidan, Intrepid, Kop-Hydroxide, Solubor, Sovran, Supracide, Topsin-M, Warrior, and Ziram. Control of ERM and TSSM, and effect of treatments on AF was determined by sampling 25 leaves per tree, removing mites with a mite-brushing machine, and counting motile stages with a binocular microscope. Data were subjected to ANOVA and means were separated using LSD ($P = 0.05$).

Pest pressure was moderate for ERM and very low for TSSM. Densities of AF increased from very low to very high from late June to late July. An early season application of Agri-Mek + Damoil (9 May), Apollo (27 May) or Zeal (27 May) maintained ERM populations below threshold (= 5 mites/leaf) through early July, followed by an increase above threshold in all three treatments in mid-July (Table 1). Accumulated mite-days were lowest for Agri-Mek + Damoil, followed by Apollo and Zeal, but differences among these three treatments were not significant. For threshold based treatments applied on 28 June, Zeal, Envidor and Fujimite provided excellent knockdown of ERM, reducing the population from 13-15/leaf to 2-4/leaf in 8 days (7 days after application). Accumulated mite-days were slightly lower with Envidor than with Zeal and Fujimite, but the difference was not significant. Two rates of Kanemite provided good control of ERM for the first week after application, but populations began to increase after two weeks. The higher rate of Kanemite provided significantly better control of ERM than the lower rate by the end of July, resulting in significantly lower accumulated mite-days. GWN-1715, Nexter and Envidor + Choice provided the best control of ERM, resulting in the lowest accumulated mite-days. TSSM populations were very low (<1/leaf) in all treatments, with Envidor and Envidor + Choice resulting in the lowest accumulated mite-days (Table 2). AF accumulated mite-days were highest in early season treatments of Apollo and Zeal, and threshold-based treatments of Kanemite (Table 3).

Table 1.

Treatment/ formulation	Rate amt product/acre	Rate lb(AI)/acre	Time of application	ERM/leaf 27 Jun	5 Jul	11 Jul	18 Jul	25 Jul	Accumulated mite-days[a]
Agri-Mek 0.15EC +	296 ml +	0.013 +							
Damoil	3.8 l	--	9 May	0.4e	0.4c	6.3bcd	8.6bcd	0.4b	106.5c
Apollo 42SC	178 ml	0.188	27 May	0.6e	2.5abc	12.9ab	5.2cd	0.3b	141.0c
Zeal 72WDG	57 g	0.09	27 May	0.9de	2.8abc	8.7bc	12.9bc	1.0b	173.0c
Zeal 72WDG	57 g	0.09	28 Jun	12.9ab	1.9abc	4.7c-f	7.5cd	0.5b	149.1c
Envidor 2SC	533 ml	0.281	28 Jun	12.5ab	3.0abc	2.8def	4.3d	0.1b	119.2c
Envidor 2SC +	533 ml +	0.281 +							
Choice Weather Master	1894 ml	--	28 Jun	3.6bcd	2.5abc	3.8c-f	4.1d	0.8b	87.8c
Fujimite 5EC	947 ml	0.104	28 Jun	14.7a	4.0ab	2.5ef	7.0cd	0.2b	152.1c
Kanemite 15SC	622 ml	0.21	28 Jun	2.4cde	2.9ab	8.6bc	27.0b	12.1a	316.5b
Kanemite 15SC	918 ml	0.30	28 Jun	4.4bc	3.0abc	5.8cde	9.8bcd	1.1b	148.4c
GWN-1715 75WP	147 g	0.24	28 Jun	4.9bc	1.2bc	3.0def	5.4cd	0.2b	85.9c
Nexter 75WP	125 g	0.21	28 Jun	5.3bc	1.0bc	2.1f	4.0d	1.5b	75.3c
Untreated check	--	--	--	4.2bcd	6.5a	16.6a	44.8a	1.3b	488.3a

Means in a given column followed by the same letter are not significantly different (LSD, $P > 0.05$).
[a]27 Jun to 25 Jul.

Table 2.

Treatment/ formulation	Rate amt product/acre	Rate lb(AI)/acre	Time of application	Twospotted spider mites/leaf 27 Jun	5 Jul	11 Jul	18 Jul	25 Jul	Accumulated mite-days[a]
Agri-Mek 0.15EC +	296 ml +	0.013 +							
Damoil	3.8 l	--	9 May	0.1bc	0.0c	0.3abc	0.0ab	0.0b	3.0bc
Apollo 42SC	178 ml	0.188	27 May	0.1bc	0.1bc	0.4ab	0.0b	0.0b	3.4bc
Zeal 72WDG	57 g	0.09	27 May	0.0c	0.2abc	0.3a-d	0.2ab	0.0b	5.1abc
Zeal 72WDG	57 g	0.09	28 Jun	0.9a	0.0c	0.0e	0.0b	0.0.b	3.7bc
Envidor 2SC	533 ml	0.281	28 Jun	0.2bc	0.1bc	0.0e	0.0b	0.0b	1.6c
Envidor 2SC +	533 ml +	0.281 +							
Choice Weather Master	1894 ml	--	28 Jun	0.1bc	0.2bc	0.0e	0.0b	0.0.b	1.4c
Fujimite 5EC	947 ml	0.104	28 Jun	1.1a	0.7a	0.1cde	0.0b	0.0b	9.5ab
Kanemite 15SC	622 ml	0.21	28 Jun	0.1bc	0.6ab	0.1cde	0.0.b	0.5a	7.2abc
Kanemite 15SC	918 ml	0.30	28 Jun	0.3bc	0.9a	0.1b-e	0.4a	0.0b	10.9a
GWN-1715 75WP	147 g	0.24	28 Jun	0.3b	0.1bc	0.0de	0.1ab	0.0b	2.5c
Nexter 75WP	125 g	0.21	28 Jun	0.1bc	0.4abc	0.0e	0.0b	0.1b	3.2bc
Untreated check	--	--	--	0.1bc	0.4abc	0.5a	0.2ab	0.0b	7.7abc

Means in a given column followed by the same letter are not significantly different (LSD, $P > 0.05$).
[a]27 Jun to 25 Jul.

Table 3.

Treatment/ formulation	Rate amt product/acre	Rate lb(AI)/acre	Time of application	*Amblyseius fallacis*/leaf 27 Jun	5 Jul	11 Jul	18 Jul	25 Jul	Accumulated mite-days[a]
Agri-Mek 0.15EC +	296 ml +	0.013 +							
Damoil	3.8 l	--	9 May	0.00a	0.00a	0.02b	0.24cd	1.70a-d	7.8cde
Apollo 42SC	178 ml	0.188	27 May	0.00a	0.00a	0.08ab	0.72bc	2.08a-d	12.8b-e
Zeal 72WDG	57 g	0.09	27 May	0.00a	0.05a	0.04ab	0.42bcd	3.00ab	14.1bcd
Zeal 72WDG	57 g	0.09	28 Jun	0.02a	0.00a	0.00b	0.18d	1.78a-d	7.6cde
Envidor 2SC	533 ml	0.281	28 Jun	0.02a	0.05a	0.08ab	0.48bcd	0.63d	6.5de
Envidor 2SC +	533 ml +	0.281 +							
Choice Weather Master	1894 ml	--	28 Jun	0.00a	0.00a	0.06ab	0.30cd	1.00cd	6.0de
Fujimite 5EC	947 ml	0.104	28 Jun	0.02a	0.08a	0.02b	0.20cd	0.73d	4.7e
Kanemite 15SC	622 ml	0.21	28 Jun	0.00a	0.05a	0.02b	0.60bcd	3.65a	17.5ab
Kanemite 15SC	918 ml	0.30	28 Jun	0.00a	0.08a	0.12a	0.90ab	2.40abc	16.0abc
GWN-1715 75WP	147 g	0.24	28 Jun	0.00a	0.00a	0.04ab	0.24cd	0.80d	4.7de
Nexter 75WP	125 g	0.21	28 Jun	0.00a	0.00a	0.00b	0.34bcd	1.50bcd	7.6cde
Untreated check	--	--	--	0.02a	0.05a	0.08ab	1.92a	2.73ab	23.9a

Means in a given column followed by the same letter are not significantly different (LSD, $P > 0.05$).
[a]27 Jun to 25 Jul.

(A38)

PEAR: *Pyrus communis* (L)., 'D'Anjou'

LATE-SEASON CONTROL OF TWOSPOTTED SPIDER MITES ON PEARS, 2005

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European red mite (ERM): *Panonychus ulmi* (Koch)
Pear rust mite (PRM): *Epitrimerus pyri* (Nalepa)
Twospotted spider mite (TSM): *Tetranychus urticae* Koch
Western predatory mite (WPM): *Galandromus occidentalis* (Nesbitt)

Experimental and registered miticides were evaluated for control of TSM in a 16-yr-old planting of 'D'Anjou' trees (Pear Sunnyslope Block; tree spacing 20 × 20 ft) at the Mid-Columbia Agricultural Research and Extension Center, Hood River, Oregon. During the season the block was treated with two applications of Asana and one application of Assail to induce mite populations and decrease pear psylla. Rate calculations were based on a spray volume of 400 gpa. Miticides were applied 30-31 Aug to single-tree plots in a RCB design with four replicates. Trees were sprayed to runoff using a hydraulic handgun sprayer operating at 200 psi. Treatments were evaluated by collecting 25 spur leaves per tree, a total of 100 leaves per treatment, on 25 Aug (pre-treatment sample), 2, 8, 13, 21 and 28 Sep. Leaves were brushed with a leaf-brushing machine to remove eggs and motile stages onto a glass plate where they were counted using a stereomicroscope. Data were subjected to ANOVA and means were separated using Fisher's Protected LSD ($P = 0.05$).

TSM continued to build through the end of August and beginning of September due to high temperatures. All treatments were equally effective against TSM motiles 7 d after treatment and maintained low populations for the duration of the test (Table 1). ERM was present but in lower numbers compared to TSM. All treatments reduced ERM populations (Table 2). Predatory mites, primarily WPM, were rarely found, even in the untreated check. This was likely due to the prior use of the Asana to stimulate spider mites. PRM was present in moderate numbers in all treatments (Table 3). The two miticides with known rust mite activity, Envidor and FujiMite, did not lower PRM compared to the untreated check and the other miticide treatments in the test.

Table 1.

Treatment/formulation	Rate amt product/acre	TSM motiles per leaf 25 Aug Pre	2 Sep 3 DAT	8 Sep 7 DAT	13 Sep 14 DAT	21 Sep 21 DAT	28 Sep 28 DAT
Kanemite 15SC[a]	31 fl oz	9.64a	4.40c	1.96b	0.96b	0.44b	0.16b
Kanemite 15SC[a]	21 fl oz	10.28a	5.08bc	3.56b	2.08b	1.12b	0.56b
Envidor 2SC + Omni Supreme Spray[a]	16 fl oz + 0.50% v/v	9.00a	6.36bc	3.20b	0.32b	0.36b	0.52b
Envidor 2SC + Omni Supreme Spray[a]	18 fl oz + 0.50% v/v	7.36a	7.68bc	1.92b	0.84b	0.12b	0.60b
Zeal 72WDG[a]	2 oz	9.00a	5.64bc	2.08b	0.20b	0.16b	0.04b
Zeal 72WDG[a]	3 oz	8.68a	6.72bc	4.04b	0.36b	0.16b	0.04b
FujiMite 5EC + Omni Supreme Spray[b]	1 pt + 0.25% v/v	8.08a	7.16bc	3.48b	0.84b	1.08b	0.92ab
FujiMite 5EC + Omni Supreme Spray[b]	2 pt + 0.25% v/v	7.68a	9.44ab	1.52b	0.84b	0.08b	0.36b
Acramite 50WS + Silwet L-77[b]	1 lb + 0.02% v/v	8.72a	6.16bc	4.76b	1.48b	0.60b	0.32b
Acramite 75WG + Silwet L-77[b]	0.67 lb + 0.02% v/v	7.04a	8.76abc	4.60b	0.56b	1.68b	0.52b
Untreated check	--	7.32a	13.24a	11.52a	6.52a	4.92a	1.56a

Means within columns followed by the same letter are not significantly different (Fisher's LSD test, *P* > 0.05).
[a]Treatment applied on 30 Aug.
[b]Treatment applied on 31 Aug.

Table 2.

Treatment/formulation	Rate amt product/acre	ERM motiles per leaf 25 Aug Pre	2 Sep 3 DAT	8 Sep 7 DAT	13 Sep 14 DAT	21 Sep 21 DAT	28 Sep 28 DAT
Kanemite 15SC[a]	31 fl oz	0.16ab	0.04b	0.00b	0.08b	0.00a	0.08ab
Kanemite 15SC[a]	21 fl oz	0.24ab	0.12ab	0.16b	0.16b	0.08a	0.00b
Envidor 2SC + Omni Supreme Spray[a]	16 fl oz + 0.50% v/v	0.04ab	0.20ab	0.12b	0.16b	0.00a	0.16ab
Envidor 2SC + Omni Supreme Spray[a]	18 fl oz + 0.50% v/v	0.00b	0.05ab	0.00b	0.04b	0.00a	0.00b
Zeal 72WDG[a]	2 oz	0.08ab	0.04b	0.04b	0.00b	0.08a	0.00b
Zeal 72WDG[a]	3 oz	0.24ab	0.20ab	0.04b	0.16b	0.00a	0.04ab
FujiMite 5EC + Omni Supreme Spray[b]	1 pt + 0.25% v/v	0.12ab	0.20ab	0.12b	0.08b	0.00a	0.32a
FujiMite 5EC + Omni Supreme Spray[b]	2 pt + 0.25% v/v	0.32ab	0.16ab	0.08b	0.00b	0.00a	0.04ab
Acramite 50WS + Silwet L-77[b]	1 lb + 0.02% v/v	0.32ab	0.08ab	0.08b	0.16b	0.12a	0.16ab
Acramite 75WG + Silwet L-77[b]	0.67 lb + 0.02% v/v	0.08ab	0.12ab	0.16b	0.04b	0.12a	0.12ab
Untreated check	--	0.36a	0.48a	0.40a	0.68a	0.08a	0.20ab

Means within columns followed by the same letter are not significantly different (Fisher's LSD test, *P* > 0.05).
[a]Treatment applied on 30 Aug.
[b]Treatment applied on 31 Aug.

Table 3.

Treatment/formulation	Rate amt product/acre	PRM motiles per leaf 25 Aug Pre	2 Sep 3 DAT	8 Sep 7 DAT	13 Sep 14 DAT	21 Sep 21 DAT	28 Sep 28 DAT
Kanemite 15SC[a]	31 fl oz	16.80b	32.40ab	44.90a	13.00ab	3.30ab	1.40ab
Kanemite 15SC[a]	21 fl oz	42.90ab	17.00b	41.30a	3.20b	2.50ab	2.20a
Envidor 2SC +	16 fl oz +	19.60b	10.90b	20.80a	9.50b	2.70ab	2.20a
Omni Supreme Spray[a]	0.50% v/v						
Envidor 2SC +	18 fl oz +	24.80b	27.70ab	28.40a	13.10ab	2.60ab	1.20ab
Omni Supreme Spray[a]	0.50% v/v						
Zeal 72WDG[a]	2 oz	32.20b	24.90ab	30.10a	10.50ab	4.10ab	1.10ab
Zeal 72WDG[a]	3 oz	25.60b	14.50b	18.00a	9.60ab	1.50b	0.10b
FujiMite 5EC +	1 pt +	39.70ab	47.80a	29.30a	21.80a	5.20a	1.80ab
Omni Supreme Spray[b]	0.25% v/v						
FujiMite 5EC +	2 pt +	17.50b	30.50ab	32.20a	15.50ab	3.60ab	2.50a
Omni Supreme Spray[b]	0.25% v/v						
Acramite 50WS +	1 lb +	44.80ab	13.70b	51.10a	17.30a	2.90ab	1.40ab
Silwet L-77[b]	0.02% v/v						
Acramite 75WG +	0.67 lb +	76.00a	28.00ab	26.20a	11.80ab	4.40a	2.00ab
Silwet L-77[b]	0.02% v/v						
Untreated check	--	25.10b	27.90ab	51.30a	11.70ab	4.70a	1.90ab

Means within columns followed by the same letter are not significantly different (Fisher's LSD test, $P > 0.05$).
[a]Treatment applied on 30 Aug.
[b]Treatment applied on 31 Aug.

Appendix 5

(D1)

ALMOND: *Prunus dulcis* (Miller) D. A. Webb

PACIFIC SPIDER MITE CONTROL IN ALMOND, 2006

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Pacific spider mite: *Tetranychus pacificus* McGregor

Pacific spider mite is one of the most important arthropod pests of almonds in California. On non-bearing trees, mite-induced defoliation can cause stunting; on mature trees it can cause sunburn to fruit and scaffolds and result in yield reductions the following year. This trial was conducted near Blackwell's Corner, Kern Co. CA, to evaluate the effects of miticides on mite density in two-year old, non-bearing almond trees. Approximately 110 acres of trees were divided into 50, 2.1 acre plots that each contained 6 rows by approximately 30 trees in a 21 by 24 ft spacing. Each plot was assigned to one of nine treatments or an untreated check in a RCBD with 5 blocks. Plots were sprayed at night on 14 Jul 2006 using commercial air-blast sprayers at 200 gpa. All treatments were combined with either 1% 415 Oil or 16 fl oz of the non-ionic surfactant Exit. Mite densities were evaluated in each plot prior to treatment on 13 Jul and then 3, 6, 13, 20, 27, and 33 DAT on 17, 20, and 27 Jul and 3, 10, and 16 Aug. On each evaluation date, two leaves were randomly collected from each of 20 trees in the center two rows of each plot. Leaves were transported to a laboratory where the total number of Pacific spider mite motiles (larvae, nymphs, and adult) and eggs were counted, average numbers per plot calculated and data were analyzed by ANOVA using transformed data (squareroot (x + 0.05)) with means separated by LSD (P = 0.05). The only modification to this protocol was that due to heavy defoliation, the 27 DAT data for the untreated check were collected 25 DAT, after which the plots were oversprayed and removed from the trial. ANOVA of the data on 33 DAT include only the 9 treatments. Numbers of predatory mite motiles and eggs were also recorded, but are not reported since only 4 were found during all evaluation dates.

There were no significant differences in pretreatment counts which ranged from 0.4 to 4.8 motile stages of mites per leaf (Table 1). On 3, 6, 13, and 20 DAT all treatments resulted in significant reductions in mite density compared to the untreated check and there were no significant differences among treatments. By 27 DAT Envidor, Fujimite and Omite maintained mite densities below 2/leaf at a level significantly lower than Acramite or the untreated check; other miticides were also lower than the untreated check but were not statistically different from the other treatments. By 33 DAT, mite densities in plots treated with Fujimite and Omite were the only ones with mite densities ≤ the densities when the trial began (2.3 mites per leaf average in the pretreatment counts). All treatments caused significant reductions in spider mite eggs through 27 DAT (Table 2). These reductions, and the relationships among treatments closely paralleled the results previously described for motile forms of spider mites. As with data on motile forms of mites, Fujimite and Omite plots consistently had the lowest egg densities.

Table 1

Treatment/ formulation	Rate amt product per acre or v/v	Pacific spider mite motiles/leaf						
		Pretreatment counts	3 DAT	6 DAT	13 DAT	20 DAT	27 DAT	33 DAT
Acramite 50WS + 415 Oil	1 lb + 1% v/v	3.7a	0.1a	0.1a	0.9a	2.4a	11.1b	20.6c
Ecotrol 10EC + Exit	96 fl oz + 16 oz	4.3a	0.1a	0.0a	0.0a	0.4a	3.4ab	6.8ab
Envidor 2SC + 415 Oil	18 fl oz + 1% v/v	3.1a	0.2a	0.2a	0.2a	0.4a	0.7a	3.5ab
Fujimite 5EC + 415 Oil	32 fl oz + 1% v/v	1.4a	0.1a	0.0a	0.0a	0.2a	1.0a	1.4a
Kanemite 15SC + Exit	31 fl oz + 16 oz	0.9a	0.3a	0.1a	1.8a	2.2a	9.8ab	13.8bc
Omite 6E + Exit	64 fl oz +16 oz	1.7a	0.0a	0.0a	0.1a	0.1a	1.5a	1.4a
Onager 1EC + Exit	20 fl oz + 16 oz	0.9a	0.1a	0.2a	1.8a	2.7a	14.7ab	14bc
Vendex 50WP + Exit	2.5 lb + 16 oz	1.7a	0.1a	0.0a	0.2a	0.2a	3.8ab	3ab
Zeal 72WDG + Exit	3 oz + 16 oz	0.4a	0.2a	0.3a	0.5a	0.5a	3.7ab	6.5ab
Untreated check		4.8a	1.9b	3.6b	27.5b	55.9b	76.6c[a]	-

Means in a column not followed by the same letter are significantly different (*P* < 0.5, LSD) after square root (x + 0.5) transformation of the data. Untransformed means are shown.
[a]Due to mite-induced damage the 27 DAT data for the untreated check were collected on 8 Aug (25 DAT), after which the untreated checks were oversprayed and removed from the trial.

Table 2

Treatment/ formulation	Rate amt product per acre or v/v	Pacific spider mite eggs/leaf						
		Pretreatment counts	3 DAT	6 DAT	13 DAT	20 DAT	27 DAT	33 DAT
Acramite 50WS + 415 Oil	1 lb + 1% v/v	2.1a	0.1a	0.2a	1.0a	4.1b	6.2a	7.8d
Ecotrol 10EC + Exit	96 fl oz + 16 oz	1.9a	0.0a	0.0a	0.2a	0.5ab	4.2a	3.2abcd
Envidor 2SC + 415 Oil	18 fl oz + 1% v/v	3.2a	0.1a	0.0a	0.3a	0.5ab	0.7a	2.1abc
Fujimite 5EC + 415 Oil	32 fl oz + 1% v/v	2.0a	0.0a	0.0a	0.0a	0.1a	1a	0.1a
Kanemite 15SC + Exit	31 fl oz + 16 oz	0.3a	0.3a	0.0a	2.0a	2.3ab	5.8a	3.9bcd
Omite 6E + Exit	64 fl oz +16 oz	1.8a	0.1a	0.0a	0.0a	0.2a	1.5a	0.4ab
Onager 1EC + Exit	20 fl oz + 16 oz	1.0a	0.2a	0.0a	1.8a	3.5ab	7.6a	5.2cd
Vendex 50WP + Exit	2.5 lb + 16 oz	0.8a	0.2a	0.0a	0.2a	1ab	4.4a	1.3abc
Zeal 72WDG + Exit	3 oz + 16 oz	1.2a	0.4a	0.1a	0.2a	1ab	2.1a	2.9abc
Untreated check		3.4a	1.4b	2.2b	27.0b	36.5c	*48.1b	-

Means in a column not followed by the same letter are significantly different (*P* < 0.5, Fisher's protected LSD) after square root (x + 0.5) transformation of the data. Untransformed means are shown.
* Due to mite-induced damage the 27 DAT data for the untreated check were collected on 8 Aug (25 DAT), after which the untreated checks were oversprayed and removed from the trial.

Appendix 6

(B1)

PEACH: *Prunus persica* (L.), 'Batsch'

PACIFIC SPIDER MITE CONTROL IN PEACH, 2007

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Pacific spider mite: *Tetranychus pacificus* McGregor

During the early summer of 2007 a trial was conducted near Arvin, Kern Co., CA to determine the effects of miticides on the density of Pacific spider mite in peaches. A total of 160 trees were organized into a RCBD with 5 blocks of 15 treatments and an untreated check. Plot size was one row by two trees and treatments were applied on 4 Jun using a Schaben, gas-powered sprayer equipped with a hand gun at 150 psi. Applications were made at 200 gpa. Mite populations were evaluated before treatments on 31 May and 7, 14, and 21 DAT. On each evaluation date, 10 leaves were collected, taken to a laboratory and evaluated under magnification to determine the total number of Pacific spider mite motiles (juveniles + adults) and eggs. Data for each plot were converted into average Pacific spider mite motiles per leaf and average Pacific spider mite eggs per leaf, and were analyzed by ANOVA using transformed data (square root (x + 0.5)) with means separated by Fisher's Protected LSD ($P = 0.05$).

There were no differences in mite densities in the pretreatment counts (Table 1). On all three post-treatment evaluation dates, the four treatments of abamectin products—Agri-Mek, both rates of Zoro, and Abba—provided the best overall control. In the 7 and 14 DAT evaluations, Zeal, Acramite, and the two Envidor treatments resulted in mite densities higher than, but statistically equivalent to the abamectin treatments. Vendex and Onager provided some control that was statistically comparable to the Envidor, Zeal and Acramite treatments, but not as good as the top abamectin treatments. Apollo and the four treatments of oil products—415 Oil, Ecotrol, and both rates of QRD 400— performed poorly, and in most cases resulted in mite densities statistically equivalent to the untreated check. By 21 DAT, only the four abamectin treatments had mite densities that were still below precounts. Treatment effects on spider mite eggs (Table 2) paralleled the effects on motiles. Abamectin treatments provided excellent reductions in eggs through the duration of the trial. Of the remaining treatments, some resulted in significant reductions in mite densities compared to the untreated check, though in seven cases egg densities already surpassed those of the precounts by 7 DAT, and in all cases by 14 DAT.

Table 1.

Treatment/ formulation	Rate form product/acre or v/v	Mean no. of mites per leaf			
		Precounts	7 DAT	14 DAT	21 DAT
Abba 0.15EC + 415 Oil	10 fl oz + 1%	6.8a	1.5abc	2.1ab	3.2ab
Agri-Mek 0.15EC + 415 Oil	10 fl oz + 1%	7.3a	0.1ab	0.4a	2.6a
Zoro 0.15EC + 415 Oil	10 fl oz + 1%	6.8a	0.2ab	0.8a	2.8ab
Zoro 0.15EC + 415 Oil	20 fl oz + 1%	4.8a	0.1a	0.7a	1.0a
Zeal 72WDG + 415 Oil	3 oz + 1%	7.8a	2.5abcd	8.4ab	16.7abcd
Acramite 50WS + Oil	1 lb + 1%	2.9a	0.4abc	5.4ab	23.9cd
Envidor 2SC + Induce	18 fl oz + 0.25%	5.8a	0.8abc	6.8ab	10.3abc
Envidor 2SC + 415 Oil	18 fl oz + 1%	1.3a	1.9abc	12.2abc	21.1bcd
Vendex 50WP + Dyne-Amic	2 lb + 0.25%	4.6a	2.0abcd	17.5bcd	31.4cd
Onager 1EC + Induce	20 fl oz + 0.25%	6.3a	4.2bcde	19.0bcd	27.9cd
Apollo 42SC + Sylgard	8 fl oz + 0.012%	7.7a	7.8de	41.4def	33.4cde
415 Oil	2%	4.3a	4.9cde	37.8def	36.5def
Ecotrol 10EC + Induce	6 pt + 0.25%	5.6a	9.3ef	37.5cde	42.8def
QRD 400 25EC	4 pt	6.5a	8.7ef	77.5f	83.6fg
QRD 400 25EC	8 pt	8.8a	17.6f	63.3ef	73.6efg
Untreated check	---	4.2a	16.0f	64.1ef	85.8g

Means in a column followed by the same letter are not significantly different ($P > 0.05$, Fisher's protected LSD) after square root (x + 0.5) transformation of the data. Untransformed means are shown.

Table 2.

Treatment/ formulation	Rate form product/acre or v/v	Mean no. of mite eggs per leaf			
		Precounts	7 DAT	14 DAT	21 DAT
Abba 0.15EC + 415 Oil	10 fl oz + 1%	8.8a	0.2ab	0.9ab	0.9a
Agri-Mek 0.15EC + 415 Oil	10 fl oz + 1%	4.0a	0.03a	0.2ab	0.8a
Zoro 0.15EC + 415 Oil	10 fl oz + 1%	5.0a	0.1a	0.4ab	0.8a
Zoro 0.15EC + 415 Oil	20 fl oz + 1%	7.1a	0.03a	0.1a	0.6a
Zeal 72WDG + 415 Oil	3 oz + 1%	8.6a	5.6cd	13.6abcde	17.5b
Acramite 50WS + 415 Oil	1 lb + 1%	3.4a	0.4ab	6.6abc	19.8bc
Envidor 2SC + Induce	18 fl oz + 0.25%	5.6a	3.6bcd	10.4abcd	18.6bc
Envidor 2SC + 415 Oil	18 fl oz + 1%	1.9a	4.0abc	12.1abcd	29.4bc
Vendex 50WP + Dyne-Amic	2 lb + 0.25%	4.1a	3.6bcd	16.2cde	17.5bc
Onager 1EC + Induce	20 fl oz + 0.25%	4.6a	6.7cd	12.2bcde	16.3bc
Apollo 42SC + Sylgard	8 fl oz + 0.012%	5.8a	9.3cde	28.9defg	13.2b
415 Oil	2%	4.7a	7.4cd	37.4efgh	22.1bc
Ecotrol 10EC + Induce	6 pt + 0.25%	6.0a	9.6cde	29.2def	10.1ab
QRD 400 25EC	4 pt	5.2a	9.5cde	49.0fgh	24.3bc
QRD 400 25EC	8 pt	4.1a	18.2e	77.6h	23.4bc
Untreated check	---	3.3a	10.4de	63.6gh	43.3c

Means in a column followed by the same letter are not significantly different ($P > 0.05$, Fisher’s protected LSD) after square root (x + 0.5) transformation of the data. Untransformed means are shown.

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B3

CHERRY (TART): *Prunus cerasus* L. 'Montmorency'

CONTROL OF TWOSPOTTED SPIDER MITES ON TART CHERRY, 2010

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Twospotted Spider Mite (TSSM): *Tetranychus urticae* Koch
Predatory Mite (PM): *Amblyseius fallacis* (Garman)

This study was set up to evaluate the efficacy of miticides for control of TSSM in tart cherries. The trial was conducted at the Northwest Michigan Horticulture Research Station in Traverse City. One-tree plots were established in a mature block of well-pruned Montmorency tart cherry trees, and treatments then assigned in a RCB design with 4 replications. Test materials were applied at “A” First Cover (26 May) and “B” threshold (4 Aug). All applications were made with an FMC 1229 airblast sprayer calibrated to deliver 60 gpa at 3 mph. A pre count was made on 2 Aug. Post-application evaluations were made on 12 Aug (8 DAA) “Days After Application” 18 Aug (14 DAA), 26 Aug (22 DAA) and 7 Sep (34 DAA). On each date, 25 randomly selected leaves were picked from each replicate, brought back to the lab, and passed through a mite-brushing machine. Motile forms of TSSM and AF were then counted with the aid of a stereo microscope. All mite data are reported as the mean number of mites per leaf. Transformed treatment means were analyzed using ANOVA and means separation by Duncan’s New MRT at P = 0.05.

Pre-count TSSM populations were somewhat variable, but all treatments except Actara significantly reduced motiles by 14 DAA (Table 1). The Agri-Mek formulations appeared to have longer residual activity than Agri-Flex and Endigo. AF populations were in some cases lower in treatments than the untreated check, but generally followed TSSM trends (Table 2).

Table 1.

			TSSM Mites per Leaf[a]				
Treatment/ Formulation	Rate amt prod/acre	Application Timing	Pre 2 Aug	8 DAA 12 Aug	14 DAA 18 Aug	22 DAA 26 Aug[b]	34 DAA 7 Sep[b]
Untreated check			7.5ab	9.2b	17.1a	6.3bc	1.5bc
Agri-Mek 0.15 EC	20 fl oz	B	15.5ab	4.7bc	3.0bc	5.6bc	1.0bc
+ Damoil	0.25 % v/v	B					
Envidor 240 SC	18 fl oz	B	14.0ab	1.8c	2.2bc	1.8c	0.4bc
Movento 240 SC	9 fl oz	A	10.3ab	1.9c	1.0c	1.4c	0.2c
+ R-11	0.25 % v/v	A					
+ Envidor 240 SC	18 fl oz	B					
Zeal 72 WDG	2 oz	B	8.6ab	3.5c	1.7bc	1.4c	0.3bc
Agri-Mek 0.70 SC	3 fl oz	B	18.7ab	5.2bc	2.3bc	2.0c	0.1c
+ Damoil	0.25 % v/v	B					
Agri-Flex 1.55 EC	7.5 fl oz	B	9.6ab	4.6bc	3.9b	10.6ab	1.8bc
+ Damoil	0.25 % v/v	B					
Actara 25 WDG	5.5 oz	B	25.5a	25.9a	17.8a	15.4bc	1.3bc
Endigo 2.06 ZC	6 fl oz	B	5.1b	2.8c	4.9b	20.7a	24.5a
Actara 25 WDG	1.75 oz	B	16.6ab	2.0c	3.3bc	11.2ab	4.7b
+ Endigo 2.06 ZC	6 fl oz	B					

Means followed by same letter do not significantly differ (*P*=0.05, LSD)
[a] Statistical differences calculated using log transformed data; data presented are actual counts
[b]ANOVA may not be valid as the data failed Bartlett's test for homogeneity

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Table 2.

Treatment/ Formulation	Rate amt prod/acre	Application Timing	AF Mites per Leaf [a] Pre 2 Aug	8 DAA 12 Aug	14 DAA 18 Aug	22 DAA 26 Aug	34 DAA 7 Sep
Untreated check			0.0a	0.8ab	1.1ab	1.8ab	0.3b
Agri-Mek 0.15 EC	20 fl oz	B	0.2a	0.0c	0.2d	1.0bc	0.4b
+ Damoil	0.25 % v/v	B					
Envidor 240 SC	18 fl oz	B	0.2a	0.1c	0.1d	0.6c	0.2b
Movento 240 SC	9 fl oz	A	0.0a	0.1c	0.2d	0.2c	0.2b
+ R-11	0.25 % v/v	A					
+ Envidor240 SC	18 fl oz	B					
Zeal 72 WDG	2 oz	B	0.2a	0.3bc	0.2d	0.3c	0.2b
Agri-Mek 0.70 SC	3 fl oz	B	0.0a	0.2bc	0.4cd	0.5c	0.2b
+ Damoil	0.25 % v/v	B					
Agri-Flex 1.55 EC	7.5 fl oz	B	0.1a	0.2bc	0.7bc	2.9 a	0.7b
+ Damoil	0.25 % v/v	B					
Actara 25 WDG	5.5 oz	B	0.1a	1.0a	1.6a	2.3ab	1.0ab
Endigo 2.06 ZC	6 fl oz	B	0.0a	0.0c	0.2d	0.7c	1.8a
Actara 25 WDG	1.75 oz	B	0.1a	0.0c	0.2d	0.5c	1.3ab
+ Endigo 2.06 ZC	6 fl oz	B					

Means followed by same letter do not significantly differ (*P*=0.05, LSD)
[a] Statistical differences calculated using log transformed data; data presented are actual counts
[b]ANOVA may not be valid as the data failed Bartlett's test for homogeneity

(A30)

APPLE: *Malus domestica* Borkhausen, 'Red Delicious'

CONTROL OF EUROPEAN RED MITES ON APPLE, 2006

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European red mite (ERM): *Panonychus ulmi* (Koch)

This trial was designed to determine the efficacy of different rates and timings for various new miticides. Two-tree plots were established in a 19 yr old 'Red Delicious' apple block (Brown Block) at the Trevor Nichols Research Complex in Fennville, MI and treatments arranged in a RCB design with four replications. Tree spacing was 18 x 20 ft, with a minimum of one buffer tree and one buffer row separating all plots. Regular foliar maintenance applications of Scala, Procure, Nova, Penncozeb, Flint, Asana XL, Guthion, Lannate LV, Vangard, Ziram, and Mora-Leaf 20-20-20 were applied separately to the entire orchard. In addition, Touchdown, Roundup Ultra and Sinbar were banded under the trees for weed control. Test materials were applied at various timings that included Petal fall+10d (30 May), ERM threshold (2-3 mites per leaf; 27 Jul), and post-threshold (14 Aug) as indicated in the tables. All treatments were applied with an FMC 1029 tractor-mounted airblast sprayer calibrated to deliver 100 gpa at 2.5 mph.

To determine when the orchard had reached ERM threshold, mite populations were monitored weekly by sampling untreated trees. Evaluations of all plots were conducted on 24 Jul (prior to threshold application), 4 Aug (11 days after threshold application, DAA), 10 Aug (17 DAA), 17 Aug (24 DAA), and 23 Aug (30 DAA), by picking 50 randomly selected leaves from each replicate for a total of 200 leaves per treatment. Mites and eggs were removed with a mite-brushing machine and counted under a stereo microscope. All mite data are reported as the mean number of mites or eggs per leaf (Tables 1. and 2., respectively), and % control (Table 3.). Mean percent control of ERM motiles was calculated using the Henderson-Tilton formula; % control = $[1 – ((n^{\text{control plot before treatment}} * n^{\text{treated plot after treatment}})/(n^{\text{control plot after treatment}} * n^{\text{treated plot before treatment}}))]*100$, and all data were analyzed using ANOVA and means separation by Duncan's New MRT at *P* = 0.05.

Mite populations were relatively low throughout the season, none-the-less all treatment compounds provided significant control of ERM through the final evaluation on 23 Aug (Table 1). The Envidor petal fall application provided season long control of mites, but only ERM threshold applications (27 Jul) of Envidor, GWN-1960 30SC, Onager and Nexter resulted in zero ERM motiles at the 23 Aug sampling period. Zeal, Envidor, Kanemite, GWN-1960 30SC, Onager and Nexter all provided % Control values of over 70% by the 23 Aug end-of-season evaluation (Table 2).

Table 1

Treatment/ formulation	Rate product/acre	Application timing[a]	ERM motiles/leaf[b] Pre-count 24 Jul	6 DAA 4 Aug[c]	17 DAA 10 Aug[c]	24 DAA 17 Aug[c]	30 DAA 23 Aug[c]
Check			1.46ab	0.49ab	3.42abc	1.55a	1.15a
Nexter 75WP	6.6 oz	B	1.67ab	0.06b	0.04d	0b	0b
Zeal 72WDG	2 oz	B	1.81ab	0.08b	0.33cd	0.06b	0.02b
Acramite 50WS +	0.75 lb	B	2.35ab	0.02b	0.60bcd	0.08b	0.16b
Choice L	3 qt/100 gal	B					
Acramite 50WS +	1 lb	B	1.30ab	0.10b	0.41bcd	0.01b	0.35b
Choice L	3 qt/100 gal	B					
Kanemite 15SC +	25 fl oz	B	2.51ab	0b	0.97a-d	0.23b	0.21b
Choice L	0.25 % v/v	B					
Kanemite 15SC +	31 fl oz	B	3.09a	0.19b	1.32a-d	0.01b	0.14b
Choice L	0.25 % v/v	B					
Envidor 2SC	16 fl oz	B	2.45ab	0.06b	0.49bcd	0b	0b
Envidor 2SC	18 fl oz	A	0.33b	0.08b	0.58bcd	0.23b	0.23b
Onager 1E	16 fl oz	B	0.82ab	0.08b	0.10d	0.02b	0b
GWN-1960 30SC	2.6 fl oz	C	2.88a	1.13a	4.59a	0.08b	0.06b
GWN-1960 30SC	4.3 fl oz	C	1.87ab	0.80a	3.63ab	0.41b	0.02b
GWN-1960 30SC	8.5 fl oz	C	1.65ab	0.91a	1.38a-d	0.10b	0b

Means followed by same letter do not significantly differ (*P* ≤ 0.05, Duncan's New MRT).
[a] A = 30 May (petal fall+10 d); B = 27 Jul (2-3 mites/leaf); C = 14 Aug.
[b] Statistical differences calculated using square-root transformed data; data presented are actual counts.
[c] ANOVA may not be valid as the data failed Bartlett's test for homogeneity.

Table 2

Treatment/ formulation	Rate product/acre	Application timing[a]	% control ERM motiles[b c] 6 DAA 4 Aug	17 DAA 10 Aug	24 DAA 17 Aug	30 DAA 23 Aug
Check			0	0	0	0
Nexter 75WP	6.6 oz	B	97.1a	98.3a	7.05a	75.0a
Zeal 72WDG	2 oz	B	80.3ab	69.3ab	67.7ab	73.1ab
Acramite 50WS+	0.75 lb	B	93.0a	73.7ab	70.6ab	66.9abc
Choice L	3 qt/100 gal	B				
Acramite 50WS+	1 lb	B	74.6ab	81.3ab	66.1ab	33.8bc
Choice L	3 qt/100 gal	B				
Kanemite 15SC+	25 fl oz	B	100.-a	60.6ab	71.2ab	7.00abc
Choice L	0.25 % vol:vol	B				
Kanemite 15SC+	31 fl oz	B	72.0ab	62.0ab	70.8ab	62.2abc
Choice L	0.25 % vol:vol	B				
Envidor 2SC	16 fl oz	B	63.2ab	60.1ab	7.05a	7.05a
Envidor 2SC	18 fl oz	A	69.4ab	26.3b	28.8b	28.3c
Onager 1E	16 fl oz	B	41.5ab	60.6ab	50.0ab	50.0abc
GWN-1960 30SC	2.6 fl oz	C	23.3b	36.6b	71.9ab	72.2abc
GWN-1960 30SC	4.3 fl oz	C	44.0ab	30.7b	39.4ab	67.2abc
GWN-1960 30SC	8.5 fl oz	C	51.9ab	43.6b	72.3ab	75.0a

Means followed by same letter do not significantly differ (*P* = 0.05, Duncan's New MRT)
[a] A = 30 May (Petal fall + 10d); B = 27 Jul (2-3 mites/leaf); C = 14 Aug
[b] Statistical differences calculated using arcsine square-root transformed data; data presented are actual counts
[c] Henderson-Tilton % control = $[1 - ((n^{\text{control plot before treatment}} * n^{\text{treated plot after treatment}}) / (n^{\text{control plot after treatment}} * n^{\text{treated plot before treatment}}))]*100$

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B8

PEACH: *Prunus persica* L. 'Blushing Star'

EUROPEAN RED MITE CONTROL ON PEACH, 2010

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European red mite (ERM): *Panonychus ulmi* (Koch)

Mite control sprays were applied on 2 Aug to 13-yr-old 'Blushing Star' peach trees at the Rutgers Agricultural Research and Extension Center using a Rears airblast sprayer (28 inch fan, 180 psi) delivering 100 gpa and pulled through the orchard at 2.6 mph. The experiment was blocked according to mite density and was replicated four times. Trees were spaced 20 × 20 ft. Twenty-five leaves were collected from each tree for a total of 100 leaves per treatment for each sample date. Mites and eggs were brushed onto sticky glass plates and counted using a stereomicroscope. A pre-treatment sample was collected on 2 Aug. Post treatment samples were collected on 6, 9, 16, 23 and 30 Aug. Mite abundance was moderate and building at the start of the experiment. However, 1.50 inches of rain fell between the 16 Aug and 23 Aug counts possibly reducing mite populations. Abundance data were transformed [log(X+1)] before analysis of variance, ANOVA. Treatments means were separated using Tukey's Honest Significant Difference, at $P \leq 0.05$ level. This research was supported by industry gift of pesticide and/or research funding.

There were no statistical differences in the pre-treatment mite levels. All treatments provided initial reduction of motile ERM and ERM eggs by 6 Aug. All treatments were significantly different than the untreated check by the 9 Aug count (Table 1 and 2).

Table 1

Treatment/ formulation	Rate amt product/acre	Avg. no. motile European red mites/leaf					
		2 Aug	6 Aug	9 Aug	16 Aug	23 Aug	30 Aug
Envidor 2SC	18.0 oz	4.4ns	3.1b	0.2b	0.0b	0.0b	0.0ns
Acramite 50WS	1.0 lb	5.0	5.0ab	0.3b	0.0b	0.0b	0.0
+ Tactic	8.0 oz						
Nexter	5.0 oz	4.6	3.6ab	0.4b	0.0b	0.0b	0.0
Portal	2.0 pt	4.4	3.4ab	0.6b	0.0b	0.0b	0.0
Untreated check	---	5.1	6.6a	6.3a	3.6a	0.1a	0.0

Column means followed by the same letter are not significantly different (Tukey's Honest Significant Difference, P ≤ 0.05), ns = not significant (ANOVA).

Table 2

Treatment/ formulation	Rate amt product/acre	Avg. no. European red mite eggs/leaf					
		2 Aug	6 Aug	9 Aug	16 Aug	23 Aug	30 Aug
Envidor 2SC	18.0 oz	7.0ns	5.1ab	0.0b	0.0b	0.0ns	0.0ns
Acramite 50WS	1.0 lb	5.8	5.0ab	0.1b	0.0b	0.0	0.0
+ Tactic	8.0 oz						
Nexter	5.0 oz	6.4	5.5ab	0.0b	0.0b	0.1	0.0
Portal	2.0 pt	6.7	4.6ab	0.0b	0.0b	0.0	0.0
Untreated check	---	6.4	8.6a	9.2a	3.5a	0.2	0.1

Column means followed by the same letter are not significantly different (Tukey's Honest Significant Difference, P ≤ 0.05), ns = not significant (ANOVA).

(D13)

ORANGE: *Citrus sinensis* (L.) Osbeck, 'Washington' navel

EFFECTS OF ACARICIDES ON CITRUS RED MITE AND THE PREDACIOUS MITE *EUSEIUS TULARENSIS*, 2005

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Citrus red mite: *Panonychus citri* (McGregor)
Predatory mite: *Euseius tularensis* Congdon

In the spring of 2005, we compared the efficacy of various formulations, rates, and combinations of five acaricides, Nexter, Onager, Kanemite, Agri-Mek, and Envidor with and without 0.5 or 1.0% narrow-range oil with a water-treated check against citrus red mite and it's primary natural enemy, the predatory mite *Euseius tularensis*. Treatments were applied to 22-yr-old 'Washington' navel orange trees at the Lindcove Research and Extension Center, Exeter, CA on 3 May 2005 in 300 gpa water and using 350 psi with a Bean hand-sprayer. The experimental design consisted of six single-tree replicates per treatment and each was buffered on four sides by untreated trees. Five leaves from the periphery of four corners of each tree (20 leaves per tree) were collected. We recorded the number of adult female citrus red mites and motile stages of *E. tularensis* found on both sides of each leaf. Treatments were assigned on 11 Apr according to pre-treatment densities of citrus red mite established from field collections. Sampling was conducted weekly for five weeks following treatment, until the mean number of citrus red mites found in the control trees was <1.0/leaf. Data were transformed using $\log_{10}$ (x+1), analyzed using ANOVA, and the means were separated according to LSD ($P \leq 0.05$).

All treatments significantly reduced the citrus red mite populations below the economic threshold during the 4 wk after treatment (Table 1). Nexter with oil, Envidor with oil, and the high rate of Kanemite demonstrated the greatest efficacy one wk after acaricide applications. Higher rates of Onager, and Kanemite were more effective than lower rates. Addition of spray oil improved the efficacy of Envidor only on one sampling date. No significant differences in efficacy were observed for the two formulations of abamectin (Agri-Mek and MK 936). Populations of the predatory mite, *E. tularensis*, were reduced by all acaracide treatments on one or more dates during the 4 wk after treatment (Table 2). The number of *E. tularensis* needed to assist with biological control of citrus thrips (*Scirtothrips citri*) during May and early Jun is 0.5 predatory mites/leaf. Most treatments suppressed the mites below this threshold during the 4 wk after treatment.

Table 1.

Treatment/ formulation	Rate amt product/acre	Mean no. of adult female citrus red mites/leaf					
		11 Apr	13 May	23 May	31 May	6 Jun	13 Jun
Water check	---	1.79a	5.00a	4.43a	6.10a	2.10a	0.38ab
Nexter 75 WP +NR 415 oil	5.2 oz 0.5% v/v	1.77a	0.21e	1.29de	1.14e	0.57cd	0.48ab
Nexter 75 WP + Onager +NR 415 oil	3.3 oz 16.0 fl oz 0.5% v/v	1.76a	0.59cde	1.43cd	1.49cde	0.53de	0.13b
Nexter 75 WP + Onager +NR 415 oil	3.3 oz 20.0 fl oz 0.5% v/v	1.78a	0.50cde	0.96def	1.38de	0.29de	0.07b
Onager +NR 415 oil	20.0 fl oz 0.5% v/v	1.74a	0.65cde	0.57f	0.48f	0.14e	0.11b
Kanemite 15 SC	21.0 fl oz	1.73a	1.15bc	2.32bc	2.35bcd	1.34b	0.76a
Kanemite 15 SC	31.0 fl oz	1.78a	0.38de	1.16def	1.07ef	0.36de	0.33ab
Agri-Mek 0.15EC +NR 415 oil	10.0 fl oz 1.0% v/v	1.80a	1.45b	3.06ab	3.10b	0.98bc	0.31ab
MK 936 0.15EC +NR 415 oil	10.0 fl oz 1.0% v/v	1.77a	1.53b	3.26ab	2.47bc	1.16b	0.42ab
Envidor 240 SC	13.0 fl oz	1.77a	0.93bcd	1.25de	0.73ef	0.28de	0.12b
Envidor 240 SC +NR 415 oil	13.0 fl oz 0.5% v/v	1.77a	0.26e	0.68e	0.63ef	0.38de	0.19ab

Means within columns followed by the same letter are not significantly different (LSD, $P > 0.05$) after $\log_{10}(x+1)$ transformation. Untransformed means are listed.

Table 2.

Treatment/ formulation	Rate amt product/acre	Mean no. of motile *E. tularensis*/leaf					
		11 Apr	13 May	23 May	31 May	6 Jun	13 Jun
Water check	---	0.00a	0.36a	0.75a	0.90a	0.86a	0.22c
Nexter 75 WP +NR 415 oil	5.2 oz 0.5% v/v	0.00a	0.08cd	0.19c	0.22b	0.21cd	0.13c
Nexter 75 WP + Onager +NR 415 oil	3.3 oz 16.0 fl oz 0.5% v/v	0.00a	0.15bcd	0.54ab	0.38b	0.34c	0.10c
Nexter 75 WP + Onager +NR 415 oil	3.3 oz 20.0 fl oz 0.5% v/v	0.00a	0.06d	0.31bc	0.25b	0.13d	0.13c
Onager +NR 415 oil	20.0 fl oz 0.5% v/v	0.01a	0.13bcd	0.28bc	0.32b	0.18cd	0.23c
Kanemite 15 SC	21.0 fl oz	0.02a	0.24ab	0.43abc	0.42b	0.28cd	0.25bc
Kanemite 15 SC	31.0 fl oz	0.00a	0.08cd	0.53abc	0.37b	0.22cd	0.32abc
Agri-Mek 0.15 EC +NR 415 oil	10.0 floz 1.0% v/v	0.01a	0.20bcd	0.43bc	0.43b	0.56b	0.58a
MK 936 0.15EC +NR 415 oil	10.0 fl oz 1.0% v/v	0.02a	0.20bc	0.33bc	0.34b	0.30cd	0.58ab
Envidor 240 SC	13.0 fl oz	0.03a	0.18bcd	0.39bc	0.33b	0.24cd	0.19c
Envidor 240 SC +NR 415 oil	13.0 fl oz 0.5% v/v	0.03a	0.15bcd	0.23bc	0.26b	0.31c	0.16c

Means within columns followed by the same letter are not significantly different (LSD, $P > 0.05$) after $\log_{10}(x+1)$ transformation. Untransformed means are listed.

Appendix 11

(D5)

ORANGE: *Citrus sinensis* (L.) Osbeck, 'Fukumoto' navel

EFFICACY OF ACARICIDES FOR CONTROL OF CITRUS RED MITE, 2007

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Citrus red mite: *Panonychus citri* (McGregor)
Predatory mite: *Euseius tularensis* (Congdon)

Various rates of eight acaricides were applied with and without adjuvants to a 19-year-old Fukumoto' navel orchard in northern Kern county to compare their efficacy against citrus red mite and selectivity favoring the predatory mite *Euseius tularensis.* A bean hand sprayer was used at 300 psi to apply the acaricides diluted in 200 gpa on 23 Apr 2007 to each of six trees per treatment. Data was collected from five leaves from the periphery of four corners of each sample tree (20 leaves per tree). The numbers of adult female citrus red mites on both sides of the leaf, as well as motile stages of *E. tularenis* found on the underside of each leaf were recorded. Treatments were assigned based on pre- treatment densities of citrus red mite on 16 Apr 2007. Sampling continued once per week for 8 wk following treatment, until the mean number of citrus red mites found in the control trees was < 0.01 per leaf. Data were analyzed using ANOVA after log(x + 1) transformation of numbers and the means were separated according to LSD (*P* = 0.05).

The mean number of citrus red mite females per leaf during the pre-treatment count averaged 4 mites/leaf. All treatments significantly reduced citrus red mite densities for 7 weeks after treatment compared to the water check (Table 1). Movento and Envidor showed the greatest level of control of citrus red mite. All treatments significantly suppressed the predatory mite *E. tularensis* through the 8 wk sampling period compared to the water check (Table 2).

Table 1.

Treatment/ formulation	Rate amt form/acre	Mean no. of female citrus red mites per leaf								
		16 Apr	30 Apr	7 May	14 May	21 May	29 May	5 Jun	11 Jun	20 Jun
Water check		4.28a	2.55a	4.18a	6.03a	6.17a	3.78a	1.40a	1.40a	0.17ab
FujiMite 5 EC	2.0 pts	4.28a	0.04 d	0.26cd	0.75bc	0.77 b	1.04b	0.28b	0.28b	0.24a
+ NR 415 oil	+ 0.5%									
Zeal 72 WDG	3 oz	4.27a	0.31bc	0.33cd	0.53cde	0.21de	0.66c	0.20bc	0.20bc	0.08c
Envidor 240 SC	12.0 oz	4.28a	0.05d	0.11d	0.15f	0.13e	0.13e	0.08d	0.08d	0.04c
+ Induce	+ 0.25%									
Envidor 240 SC	20.0 oz	4.21a	0.10cd	0.20cd	0.31ef	0.14e	0.18e	0.05d	0.05d	0.06c
+ Induce	+ 0.25%									
Movento 240 SC	10.0 oz	4.19a	0.07d	0.25cd	0.35def	0.22de	0.30de	0.06d	0.06d	0.06c
+ Induce	+ 0.25%									
Movento 240 SC	10.0 oz	4.23a	0.24bcd	0.37c	0.33ef	0.30de	0.18e	0.04d	0.04d	0.07c
+ NR 415 oil	+ 0.25%									
Zoro	10.0 oz	4.23a	0.18bcd	0.80b	0.70bcd	0.21de	0.22 de	0.04d	0.04d	0.16b
+ NR 415 oil	+ 0.5%									
Zoro	20.0 oz	4.23a	0.08d	1.06b	0.99b	0.36cd	0.25de	0.06d	0.06d	0.17ab
+ NR 415 oil	+ 0.5%									
Agri-Mek 0.15 EC	10.0 oz	4.18a	0.34b	1.05b	0.73bc	0.58bc	0.63c	0.14cd	0.14cd	0.16b
	+ 0.5%									
Kanemite 15 SC	31.0 oz	4.18a	0.13cd	0.25cd	0.40cdef	0.27de	0.46cd	0.09cd	0.09cd	0.08c

Means within a column followed by the same letter are not significantly different (LSD, *P* = 0.05) after $\log_{10}(x + 1)$ transformation. Untransformed means are listed.

Table 2.

Treatment/ formulation	Rate amt form/acre	Mean no. of *Euseius tularensis* per leaf								
		16 Apr	30 Apr	7 May	14 May	21 May	29 May	5 Jun	11 Jun	20 Jun
Water check		0.01a	0.07a	0.16a	0.18a	0.25a	0.25a	0.24a	0.05a	0.06a
FujiMite 5 EC + NR 415 oil	2.0 pts + 0.5%	0.03b	0.00b	0.00b	0.03b	0.01c	0.06b	0.03b	0.01b	0.00d
Zeal 72 WDG	3 oz	0.01ab	0.04ab	0.03b	0.02b	0.02c	0.03bc	0.03b	0.00b	0.01cd
Envidor 240 SC + Induce	12.0 oz + 0.25%	0.06b	0.01b	0.00b	0.01b	0.01c	0.00c	0.00b	0.00b	0.01cd
Envidor 240 SC + Induce	20.0 oz + 0.25%	0.01b	0.00b	0.02b	0.01b	0.00c	0.01c	0.00b	0.00b	0.02bcd
Movento 240 SC + Induce	10.0 oz + 0.25%	0.02ab	0.03ab	0.03b	0.02b	0.02c	0.01c	0.02b	0.00b	0.01cd
Movento 240 SC + NR 415 oil	10.0 oz + 0.25%	0.03ab	0.04ab	0.02b	0.02b	0.01c	0.01c	0.01b	0.02ab	0.03bc
Zoro + NR 415 oil	10.0 oz + 0.5%	0.00b	0.00b	0.00b	0.01b	0.00c	0.01c	0.00b	0.01b	0.01cd
Zoro + NR 415 oil	20.0 oz + 0.5%	0.03b	0.01b	0.01b	0.03b	0.01c	0.02bc	0.01b	0.01b	0.00d
Abamectin 0.15 EC	10.0 oz + 0.5%	0.03b	0.02b	0.03b	0.06b	0.07b	0.04bc	0.03b	0.00b	0.04ab
Kanemite 15 SC	31.0 oz	0.03b	0.02b	0.00b	0.03b	0.03bc	0.02bc	0.03b	0.01b	0.02bcd

Means within a column followed by the same letter are not significantly different (LSD, $P = 0.05$) after $\log_{10}(x + 1)$ transformation. Untransformed means are listed.

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(D6)

ORANGE: *Citrus sinensis* (L.) Osbeck, 'Atwood' navel

CITRUS RED MITE ACARICIDE EFFICACY TRIAL, 2008

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Citrus red mite: *Panonychus citri* (McGregor)

Various rates of acaricides were applied with and without adjuvants to a 49-year-old 'Atwood' navel orchard near Exeter, California to compare their efficacy against citrus red mite. A Bean hand sprayer was used at 300 psi to apply the acaricides treatments diluted in 200 gpa on 25 Apr 2008 to each of the six trees per treatment. Data was collected from five leaves from the periphery of four corners of each sample tree (20 leaves per tree). The numbers of adult female citrus red mites on both sides of the leaf were recorded. Treatments were assigned based on pre-treatment densities of citrus red mite on 17 March 2008. Sampling continued once per week for 9 weeks following treatment, until the mean number of citrus red mites found in the control trees was <0.30. Data was analyzed using ANOVA after log(x+1) transformation of numbers and the means were separated according to LSD (P=0.05).

FujiMite significantly reduced citrus red mite densities 1 wk after treatment and showed significant suppression of mites on all but one date through 27 May compared to the water treatment. Envidor 12 and 20 oz treatments significantly reduced citrus red mite densities 3 wk through 8 and 9 wk, respectively. QRD + Silwet L-77 significantly reduced citrus red mite densities on 3 of 9 post treatment dates, while QRD 416 alone did not significantly reduce citrus red mites.

Treatment/ formulation	Rate form/ acre	Mean no. of adult female citrus red mites/leaf									
		17 Mar	1 Apr	7 Apr	14 Apr	21 Apr	28 Apr	5 May	12 May	19 May	27 May
Water control	---	0.92a	0.48ab	0.56ab	1.60a	1.31a	3.04a	4.18a	4.46a	0.82a	0.28a
FujiMite 5 EC + NR 415 oil	2.0 pts + 0.33%	0.93a	0.14c	0.18b	0.16c	0.13c	0.41bc	0.52c	1.04d	0.18d	0.03c
QRD 416	2.0 qt	0.92a	0.58a	0.77a	1.05a	0.98ab	2.77a	3.59a	3.75ab	0.53ab	0.19ab
QRD 416 + Silwet L-77	2.0 qt + 0.025%	0.93a	0.40abc	0.32b	0.51bc	0.88ab	2.12a	2.62a	2.80b	0.43b	0.22ab
QRD 416	4.0 qt	0.93a	0.40abc	0.72ab	1.13ab	1.28a	2.83a	3.50a	3.34ab	0.49ab	0.23ab
Envidor 240 SC + Induce	12.0 oz + 0.25%	0.92a	0.30abc	0.30ab	0.33c	0.43bc	0.76b	1.14b	1.61c	0.41bc	0.20ab
Envidor 240 SC + Induce	20.0 oz + 0.25%	0.92a	0.16bc	0.38ab	0.17c	0.20c	0.31c	0.73bc	1.16cd	0.18cd	0.08bc

Means within a column followed by the same letter are not significantly different (LSD, *P* = 0.05) after $\log_{10}(x+1)$ transformation. Untransformed means are listed.

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D18

ORANGE: *Citrus sinensis* (L.) Osbeck, 'Valencia'

ACARICIDAL CONTROL OF CITRUS RUST MITE, 2010

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Citrus rust mite (CRM): *Phyllocoptruta oleivora* (Ashmead)

CRM remains an important pest of fresh market citrus in the United States and elsewhere. Feeding by this pest causes a characteristic "russeting" that can reduce packout. This trial was conducted at the University of Florida Southwest Research and Education Center in Immokalee, Florida, on 15-yr-old 'Valencia' orange trees planted at 15 x 22 ft spacing on double-row beds running north-south. A RCB design was used to assign 4 replications of each of the 8 treatments and an untreated check to 4-tree plots separated by one tree within the row with treated rows separated by an untreated buffer row. Applications were made 21 Jun using a Durand Wayland 3P-10C-32 air blast speed sprayer with an array of four # 5 T-Jet stainless steel cone nozzles per side operating at a pressure of 200 psi delivering 130 gpa at a tractor speed of 1.5 mph. Four fruit were sampled from each of five trees for a total of 20 fruit per plot. A 14X Bausch & Lomb Hastings hand lens was used to view an area of approximately 1.0 cm^2, referred to as the "lens field", on two partially shaded areas on each sampled fruit and total number of mites per fruit recorded. A pre-treatment sample of four fruit per plot prior to the treatment application resulted in an average of 0.71 ± 1.19 (mean ± SD) mites per lens field. Post treatment evaluations were made at 3, 10, 17, 24 31, 38 45, 52, 59, and 66 DAT. Populations on untreated trees and trees treated with 435 Oil alone had collapsed at this point and the trial was terminated. All data were subjected to ANOVA for treatment effect on CRM with means separated using LSD ($P = 0.05$).

All products tested significantly reduced the number of CRM observed compared to the untreated check from 3 to 31 DAT but were not different from each other. At 38, 45, 52 DAT all treatments again provided significant reduction in mite numbers compared to the untreated check. However, the 435 Oil alone treatment was significantly less effective than other treatments and not different from untreated control at 52 DAT. At 59 DAT only the Envidor and Agri-Flex treatments had significantly fewer mites than the untreated control and 435 Oil alone treatment but were not significantly different from all the other treatments. At 66 DAT, fewer mites than the untreated control were only seen on fruit treated with Movento + 435 Oil treatment.

Treatment/ formulation	Rate amt product/acre or v/v	CRM per lens field									
		3 DAT	10 DAT	17 DAT	24 DAT	31 DAT	38 DAT	45 DAT	52 DAT	59 DAT	66 DAT
Untreated check	0.78a	1.89a	2.05a	3.11a	6.95a	11.42a	8.94a	5.49a	1.11ab	0.24bc	
435 Oil	3%	0.04b	0.40b	0.41b	1.05b	0.78b	3.67b	2.36b	5.36a	1.83a	0.39a
Envidor 2 SC	16.0 oz	0.01b	0.09b	0.05b	0.01b	0.01b	0.02c	0.03c	0.55b	0.14c	0.19bcd
Agri-Mek 0.15 EC + 435 Oil	10.0 oz + 3%	0.11b	0.06b	0.04b	0.13b	0.04b	0.23c	0.26c	0.60b	0.23bc	0.11cd
Movento 240 SC + 435 Oil	10.0 oz + 3%	0.02b	0.13b	0.04b	0.01b	0.04b	0.07c	0.01c	0.16b	0.23bc	0.08d
Agri-Flex + 435 Oil	8.5 oz + 3%	0.01b	0.08b	0.03b	0.03b	0.04b	0.00c	0.06c	0.26b	0.13c	0.15bcd
NAI 2302 15 EC + 435 Oil	27.0 oz + 3%	0.06b	0.09b	0.07b	0.01b	0.28b	0.44c	0.76bc	1.70b	1.02abc	0.28ab

Means followed by same letter within a column are not statistically significant (LSD, $P > 0.05$)

(A36)

PEAR: *Pyrus communis* L., 'D'Anjou'

PEAR RUST MITE CONTROL AT PINK AND PETAL FALL, 2006

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Pear rust mite (PRM): *Epitrimerus pyri* (Nalepa)

Registered miticides were evaluated for control of PRM in a 17-yr-old planting of 'D'Anjou' trees (Pear Sunnyslope; tree spacing 20 × 20 ft) at the Mid-Columbia Agricultural Research and Extension Center, Hood River, Oregon. The test included Envidor 2SC at two different timings (pink and petal fall) and with or without the addition of 0.25% vol:vol of Omni Supreme Spray, a horticultural mineral oil. The standard treatment at pink was Nexter 75WP and the standard at petal fall was Agri-Mek 0.15EC plus 0.25% oil. Rate calculations were based on a spray volume of 400 gpa. Miticides were applied on 11 Apr for the pink timing and 1-3 May for the petal fall timing to single-tree plots in a RCB design with four replicates. Trees were sprayed to runoff using a hydraulic handgun sprayer operating at 200 psi. Treatments were evaluated by collecting 25 spur leaves per tree, a total of 100 leaves per treatment, on a weekly basis beginning in May. Leaves were brushed with a leaf-brushing machine to remove motile stages onto a glass plate where they were counted using a stereomicroscope. Data were analyzed with analysis of variance and mean separation used Fisher's Protected LSD test.

All treatments initially controlled populations of PRM compared to the untreated check (Table 2). The petal fall applications (Agri-Mek, Envidor and Envidor plus oil) provided control for up to 12 wk after treatment (Table 2). Control with pink treatments did not last as long. The standard Nexter lasted for 7 wk, Envidor for 10 wk, and Envidor plus oil for 12 wk after treatment. PRM populations began to decrease in all treatments including the untreated check by 9 Aug (Table 2). Fruit damage was rated in terms of fruit surface covered with russet (0-15%, 15-30% and >30%) at harvest (5 Sep). All treatments had lower russet compared to the untreated check (Table 3). Both applications of Envidor without oil at pink or petal fall had fruit russet similar to the standard Agri-Mek (Table 3). The petal fall application of Envidor with oil and Nexter at pink had higher fruit russet than the other treatments (Table 3).

Table 1

No.	Treatment/formulation	Rate amt product/acre	Timing	Application date
1	Envidor 2SC	18 fl oz	pink	11 Apr
2	Envidor 2SC +	18 fl oz +	pink	11 Apr
	Omni Supreme Spray	1 gal		
3	Nexter 75WP	7 oz	pink	11 Apr
4	Envidor 2SC	18 fl oz	petal fall	1 May
5	Envidor 2SC +	18 fl oz +	petal fall	3 May
	Omni Supreme Spray	1 gal		
6	Agri-Mek 0.15EC + HMO	10 fl oz +	petal fall	3 May
	Omni Supreme Spray	1 gal		
7	Untreated check	---	---	---

Table 2

Trt. No.	Pear rust mites per leaf												
	12 May	25 May	31 May	5 Jun	13 Jun	20 Jun	28 Jun	5 Jul	13 Jul	18 Jul	26 Jul	3 Aug	9 Aug
1	1.1b	1.7b	0.9b	1.2ab	0.0b	0.1a	4.2ab	15.9a	52.3a	34.6ab	46.9ab	33.3b	7.7a
2	0.3b	0.0b	0.1b	0.1b	0.1b	0.2a	2.3ab	2.2b	8.3b	13.1bc	13.2abc	20.0bc	30.2a
3	1.3b	2.4b	0.9b	2.7a	1.2ab	0.4a	6.8ab	17.4a	58.4a	42.8a	21.7abc	20.1bc	17.7a
4	0.0b	0.0b	0.0b	0.1b	0.0b	0.1a	0.2b	0.4b	1.1b	2.2c	0.7c	5.6c	41.0a
5	1.0b	0.7b	0.0b	0.7ab	0.0b	0.0a	0.4b	1.4b	3.0b	3.0c	0.6c	10.5c	44.3a
6	0.8b	0.9b	0.2b	0.7ab	0.0b	0.0a	0.4b	0.3b	1.8b	1.4c	2.2bc	6.5c	8.5a
7	13.6a	8.4a	3.4a	2.7a	1.4a	1.5a	8.3a	9.3ab	34.0ab	44.5[a]	51.0a	62.7a	8.7a

Means within columns followed by the same letter(s) are not significantly different (Fisher's Protected LSD Test at $P < 0.05$).

Table 3

No.	Treatment/formulation	Rate amt product/acre	Timing	Application date	% fruit with percentage surface russet		
					Clean (0%)	1 – 15%	15 – 30%
1	Envidor 2SC	18 fl oz	pink	11 Apr	67a	33c	0a
2	Envidor 2SC + HMO	18 fl oz	pink	11 Apr	76a	24c	0a
	Omni Supreme Spray	1 gal					
3	Nexter 75WP	7 oz	pink	11 Apr	49b	51b	0a
4	Envidor 2SC	18 fl oz	petal fall	1 May	72a	28c	0a
5	Envidor 2SC + HMO	18 fl oz	petal fall	3 May	45b	55b	0a
	Omni Supreme Spray	1 gal					
6	AgriMek 0.15EC + HMO	10 fl oz	petal fall	3 May	64a	35c	1a
	Omni Supreme Spray	1 gal					
7	Untreated check	---	---	---	25c	74a	1a

Means within columns followed by the same letter(s) are not significantly different (Fisher's Protected LSD Test at $P \leq 0.05$).

(D9)

MANDARIN: *Citrus reticulata* Blanco, 'Clemenules'

YUMA SPIDER MITE CONTROL IN CITRUS, 2005

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Yuma spider mite: *Eotetranychus yumensis* (McGregor)

This experiment was conducted in a 4-yr-old commercial block of Clementine mandarins located in western Kern County, CA. A total of 75 trees were organized into a RCB design with five blocks of 13 treatments, a water check and an untreated check. Treatments, with the exception of Special Electric Sulfur, were applied on 26 Aug 2005 using a Schaben gas-powered sprayer equipped with a single-nozzle hand wand. Applications were made in 200 gpa of water at 100 psi. The Special Electric Sulfur was applied by placing it into a sock which was shaken and beaten over and within the tree canopy. Mite populations were evaluated prior to treatments on 25 Aug and then again 4 DAT (29 Aug), 7 DAT (1 Sep), 14 DAT (8 Sep), and 21 DAT (15 Sep). On each evaluation date, 10 leaves were randomly collected from each tree, placed in a paper bag in a cooler, and returned to the lab for evaluation. The total number of Yuma spider mite eggs and motiles (juveniles and adults) were counted. Mites per leaf were averaged for each tree and analyzed by ANOVA using transformed data (squareroot (x + 0.5)) with means separated by Fisher's Protected LSD at $P \leq 0.05$.

Table 1 shows the effects of miticide treatments on the number of motile (juvenile + adult) Yuma spider mites. There were no significant differences in pre-counts of spider mites. Data 4 DAT showed that all insecticide treatments (except for the water only check) significantly reduced the number of mites compared to the untreated check. The three treatments that reduced mites to the greatest extent 4 DAT were Danitol, Fujimite, and the high rate of Kanemite. By 7 DAT, Danitol, the high rate of Vendex, and Zeal had significantly lower mite densities compared to the water check and the untreated check. Data from 14 DAT was similar to that of 7 DAT with Danitol and the high rate of Vendex still having the lowest mite densities. By 21 DAT the mite densities in all treatments, including the untreated control, were very low (0.2 to 1.5 mites per leaf). This was primarily the result of large numbers of predatory thrips that entered the plot from an adjacent block of almonds that was heavily infested with Pacific spider mite. The Agri-Mek treatment had a significantly higher number of mites compared to the water and untreated checks, probably due to its efficacy against the predatory thrips. However this small increase (1.5 mites per leaf compared to 0.5 mites per leaf in the untreated check) could be considered inconsequential from a mite management perspective. Table 2 shows the effects of miticides on the mean number of Yuma spider mite eggs per leaf. There were no significant differences in pre-counts. By 4 DAT, the Danitol treatment exhibited the lowest egg density, significantly lower than the water check Beginning with data 7 DAT the number of spider mite eggs in all plots, including the untreated check, were <1.5 eggs per leaf. There were no significant differences in egg densities among treatments for the 7 DAT, 14 DAT, and 21 DAT evaluation dates.

Table 1.

Treatment/ formulation	Rate amt product/acre	Mean no. motile (juvenile + adult) mites per leaf				
		Pre	4 DAT	7 DAT	14 DAT	21 DAT
Agri-Mek 0.15EC + NR-415 Oil	15 fl oz + 1% v/v	29.5a	1.2abc	0.8ab	1.0ab	1.5c
Danitol 2.4EC	20 fl oz	26.2a	0.3a	0.2a	0.2a	0.6ab
Envidor 240SC	18 fl oz	37.5a	3.5bcd	0.6ab	0.5ab	0.4ab
Fujimite 5EC	2 pt	26.0a	0.5a	0.8ab	1.0ab	0.4a
Kanemite 15SC	21 fl oz	28.8a	1.7abc	1.0ab	0.8ab	0.3a
Kanemite 15SC	31 fl oz	28.0a	0.6a	0.5ab	0.5ab	0.2a
Nexter 75WP	10 oz	22.0a	2.4bcd	1.7bcd	1.4bc	0.5ab
Onager 11.8EC	20 fl oz	36.8a	2.1abc	1.0ab	0.7ab	0.2a
Vendex 50WP	2 lb	28.7a	1.2ab	1.1abc	0.8ab	0.3a
Vendex 50WP	4 lb	18.6a	2.0abc	0.2a	0.3a	0.3a
Zeal 72WDG	3 oz	30.4a	1.0ab	0.4a	0.7ab	0.4a
Evergreen EC 60-6	8 fl oz	31.1a	3.9cd	3.4d	2.5d	0.3a
Special Electric Sulfur	125 lb	30.2a	5.2de	1.7bcd	1.3bc	1.0bc
Water check	--	48.2a	7.9ef	1.6bcd	0.6ab	0.6ab
Untreated check	--	20.7a	9.9f	2.6cd	2.1cd	0.5ab

Means in a column followed by the same letter are not significantly different (*P* > 0.5, Fisher's protected LSD) after square root (x + 0.5) transformation of the data. Untransformed means are shown.

Table 2.

Treatment/ formulation	Rate amt product/acre	Mean no. eggs per leaf				
		Pre	4 DAT	7 DAT	14 DAT	21 DAT
Agri-Mek 0.15EC + NR 415 Oil	15 fl oz 1% v/v	7.1a	1.6abc	0.5a	0.8a	1.1a
Danitol 2.4EC	20 fl oz	8.2a	0.1a	0.1a	0.1a	0.2a
Envidor 240SC	18 fl oz	8.2a	2.5abc	0.6a	0.6a	0.1a
Fujimite 5EC	2 pt	4.7a	0.3ab	0.6a	0.7a	0.4a
Kanemite 15SC	21 fl oz	6.4a	1.7abc	0.9a	1.0a	0.1a
Kanemite 15SC	31 fl oz	9.9a	0.3ab	0.5a	0.6a	0.1a
Nexter 75WP	10 oz	4.1a	1.7abc	1.3a	1.6a	0.4a
Onager 11.8EC	20 fl oz	7.3a	2.6abc	1.5a	1.1a	0.2a
Vendex 50WP	2 lb	6.9a	0.8abc	1.1a	1.1a	0.3a
Vendex 50WP	4 lb	3.2a	1.4abc	0.1a	0.3a	0.2a
Zeal 72WDG	3 oz	4.4a	2.6abc	0.6a	0.6a	0.3a
EverGreen EC 60-6	8 fl oz	4.6a	4.6cd	1.0a	1.5a	0.3a
Special Electric Sulfur	125 lb	5.8a	3.0bcd	1.1a	0.9a	0.6a
Water check	--	9.3a	3.3bcd	0.5a	0.6a	0.3a
Untreated check	--	3.7a	7.4d	1.0a	1.2a	0.3a

Means in a column followed by the same letter are not significantly different (*P* > 0.5, Fisher's protected LSD) after square root (x + 0.5) transformation of the data. Untransformed means are shown.

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(C15)

GRAPE: *Vitis vinifera* L. 'French Colombard'

WILLAMETTE SPIDER MITE CONTROL IN GRAPE, 2008

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Willamette spider mite: *Eotetranychus willamettei* Ewing

During the summer of 2008 a trial was conducted near Arvin, Kern Co., CA to determine the effects of miticides on the density of Willamette spider mite in grapes. A 3.5 acre portion of a mature vineyard with 8' × 12' spacing was divided into 75 plots, each 4 rows by 10 vines long. Plots were organized into a RCBD with 5 blocks of 14 treatments and an untreated check. Treatments were applied at 200 gpa on 24 Jun and 26 Jun using an air-blast sprayer. Mite populations were evaluated on 23 Jun (pre-counts), 27 Jun (3 DAT), 2 Jul (6/8 DAT), 9 Jul (13/15 DAT), 16 Jul (20/22 DAT), 23 Jul (27/29 DAT), 30 Jul (34/36 DAT), and 6 Aug (41/43 DAT). On each evaluation date, 10 leaves from the inside of the canopy were collected, taken to a laboratory and processed through a mite brush, and then evaluated under magnification to determine the total number of mite motiles (juveniles + adults). Data for each plot were converted into average mite motiles per leaf, and were analyzed by ANOVA using transformed data (square root (x + 0.5)) with means separated by Fisher's Protected LSD ($P = 0.05$).

Mite densities were low to moderate with precounts averaging 3.7 mites per leaf and the untreated checks never exceeding an average of 12 mites per leaf. All treatments significantly reduced mite densities on at least one evaluation date (Table 1). Plots treated with Fujimite and Onager maintained mite densities < 1 mite per leaf until the end of the trial. Apollo, Brigade, Prevamite (12 fl oz), and Zeal also maintained mite densities < 1 mite per leaf through 34/36 DAT. Agri-Mek and Zoro (12 fl oz) reduced mite densities at 13/15 DAT, but by 20/22 DAT effects were lost. Zoro performed better at the 16 fl oz rate and mite densities were reduced through 34/36 DAT.

Table 1. Effects of miticide treatments on the density of motile spider mites on grape leaves

		Average spider mites per leaf							
Treatment[1]	Rate	Pre	3 DAT	6/8 DAT	13/15 DAT	20/22 DAT	27/29 DAT	34/36 DAT	41/43 DAT
Agri-Mek 0.15EC	12 fl oz	4.3a	0.88a	1.30abc	1.17bcd	1.60bcd	4.10ef	7.60d	15.93f
Agri-Mek 0.15EC	16 fl oz	8.9a	0.80a	1.03ab	0.72abcd	2.73cd	3.65ef	2.38bc	6.08cde
Acramite 50WS	9 oz	0.5a	0.57a	0.47a	0.20a	0.45ab	1.18abcd	1.87ab	4.17abc
Acramite 50 WS	12 oz	0.7a	0.43a	0.37a	0.12a	0.72ab	1.07abcd	0.98ab	3.07abc
Prevamite SC	12 fl oz	0.9a	0.25a	0.12a	0.10a	0.27a	0.72abcd	0.88ab	3.60abc
Prevamite SC	16 fl oz	9.6a	1.75a	0.25a	0.17a	0.15a	0.88abc	1.95ab	2.83abc
Apollo 42SC	8 fl oz	2.5a	---	0.28a	0.10a	0.20a	0.33a	0.13a	1.43ab
Brigade 10WSB	16 oz	1.8a	---	0.12a	0.02a	0.07a	0.62ab	0.40ab	3.28abc
Envidor 2SC	18 fl oz	2.3a	---	2.47bc	1.92d	1.22abc	1.93bcde	1.78ab	5.02bcd
Fujimite 5EC	2 pt	2.1a	---	0.42a	0.03a	0.17a	0.43ab	0.08a	0.88a
Onager	20 fl oz	3.6a	---	0.18a	0.07a	0.15a	0.28a	0.18ab	0.98a
Zeal 72 WDG	2 oz	2.4a	---	0.57ab	0.23abc	0.22a	0.30a	0.63ab	2.43abc
Zoro 0.15EC	12 fl oz	7.9a	---	1.20abc	0.63abc	1.83bcd	3.03def	5.08cd	10.72ef
Zoro 0.15EC	16 fl oz	7.2a	---	1.43abc	1.92cd	0.72ab	2.27cde	1.88abc	9.18de
Untreated check	---	0.5a	1.92a	3.15c	3.44e	2.78d	5.12f	7.48d	11.87ef

[1]Latron B-1956 used as a surfactant at 0.0156% v/v
Means in a column followed by the same letter are not significantly different ($P > 0.5$, Fisher's protected LSD) after square root (x + 0.5) transformation of the data. Untransformed means are shown.

(D5)

LEMON: *Citrus limon* (L.) Burm.f., 'Limoneira 8A Lisbon' on *Citrus volckameriana* rootstock

EFFICACY OF ENVIDOR ON MITES OF CITRUS, 2005

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Texas citrus mite (TCM): *Eutetranychus banksi* (McGregor)
Citrus flat mite (CFM): *Brevipalpus lewisi* McGregor

Envidor was evaluated with and without the addition of a narrow range horticultural oil for control of TCM and CFM in lemons relative to the commercial standards Agri-Mek and Kelthane. The test was conducted at the Yuma Mesa Agricultural Center near Somerton, AZ. The test was a RCB design with four replicates. Each plot was 25 ft wide and 75 ft in length consisting of three 10-yr-old lemon trees. Treatments were applied on 21 Apr 2005 using an air-assisted vertical boom delivering 100 gpa at 80 psi. TCM were monitored by collecting 10 leaves per plot and counting the number of eggs, larvae, and adult mites with a dissecting microscope. CFM were monitored by collecting 10 fruit per plot and counting the number of eggs, larvae, and adult mites with a dissecting microscope. On 20 Apr, TCM averaged across plots: 6.25 eggs, 1.1 larvae, 7.45 adults, and 8.55 motiles per leaf. Data were subjected to ANOVA and means were separated using an *F*-protected LSD ($P \leq 0.05$).

At 7 DAT, all of the miticides had fewer TCM eggs, larvae, adults and motiles per leaf than the untreated (Table 1). Among the miticides, Envidor + Oil had fewer TCM eggs than Kelthane, and Envidor + Oil and Kelthane had fewer motiles than Agri-Mek. At 14, 20 and 27 DAT, all the miticides had fewer TCMs than the untreated with the exception of Oil alone at 14 and 27 DAT which did not differ from the check in the number of larvae and eggs respectively. Additionally at 14 DAT, Envidor + Oil had fewer eggs than Oil alone, and Envidor + Oil and Kelthane had fewer larvae than Oil alone. At 20 DAT, Envidor + Oil had fewer TCM eggs than Agri-Mek. At 27 DAT, Envidor + Oil and Kelthane had fewer eggs than Oil alone, and Kelthane, Envidor at 20 fl oz product/acre, and Envidor + Oil all had fewer TCM adults and motiles than Agri-Mek. By 33 DAT, the TCM population declined quickly due to hot temperatures. At that time the only significant differences from the check were for TCM larvae where all of the miticides had less.

For CFM, all of the miticides had fewer motile mites than the untreated at 7, 14, 20 and 27 DAT (Table 2). There were no detectable differences among the miticides. Additionally, on 11 May, 20 DAT, the miticides had fewer eggs, larvae and adult CFM than the untreated check. By 33 DAT, there were no detectable differences among the treatments. Overall, Envidor + Oil, Envidor at 20 fl oz product/acre and Kelthane appeared to be the best treatments, while Oil alone and Agri-Mek appeared a little weaker.

Table 1.

		Texas citrus mites per leaf																			
		28 Apr (7 DAT)				5 May (14 DAT)				11 May (20 DAT)				18 May (27 DAT)				24 May (33 DAT)			
Treatment/ formulation	Rate amt product/acre	Eggs	Larvae	Adults	Motiles	Eggs	Larvae	Adults	Motiles	Eggs	Larvae	Adults	Motiles	Eggs	Larvae	Adults	Motiles	Eggs	Larvae	Adults	Motiles
Agri-Mek 0.15EC	10 fl oz																				
+ NR-415 Oil	+ 5 gal	4.55bc	1.90b	2.03b	3.93b	0.65bc	0.45bc	0.30b	0.75b	2.85b	1.75b	0.60b	2.35b	3.25bc	1.50b	3.20b	4.70 b	0.10a	0.00b	0.08a	0.08a
Kelthane 4EC	6 pt	6.00b	0.05b	0.03b	0.08c	1.18bc	0.00c	0.00b	0.00b	0.67bc	0.23b	0.18b	0.40b	0.28c	0.25b	0.00c	0.25c	0.00a	0.00b	0.00a	0.00a
Envidor 240SC	12 fl oz	3.20bc	0.33b	0.10b	0.43bc	0.70bc	0.08bc	0.25b	0.33b	0.60bc	0.43b	0.38b	0.80b	1.80bc	0.50b	0.90bc	1.4bc	0.00a	0.00b	0.00a	0.00a
Envidor 240SC	20 fl oz	3.18bc	0.60b	0.00b	0.60bc	0.43bc	0.18bc	0.13b	0.30b	0.13bc	0.05b	0.08b	0.13b	0.20c	0.00b	0.10c	0.10c	0.00a	0.00b	0.00a	0.00a
Envidor 240SC +	20 fl oz																				
+ NR-415 Oil	+ 5 gal	1.73c	0.18b	0.00b	0.18c	0.05c	0.00c	0.00b	0.00b	0.00c	0.00b	0.00b	0.00b	0.28c	0.00b	0.03c	0.03c	0.00a	0.00b	0.00a	0.00a
NR-415 Oil	5 gal	2.80bc	0.95b	1.55b	2.50bc	4.40b	8.28ab	2.33b	10.60b	1.63bc	2.93b	2.70b	5.63b	5.20ab	1.13b	2.50bc	3.63bc	0.08a	0.00b	0.03a	0.03a
Untreated check	--	14.08a	7.55a	9.68a	17.23a	11.30a	16.48a	12.40a	28.88a	10.73a	31.20a	18.33a	49.53a	7.68a	4.73a	8.80a	13.53a	0.70a	0.20a	0.10a	0.30a

Means in a column followed by the same letter are not significantly different (*P* > 0.05, F-protected LSD).

Table 2.

		Citrus flat mites per fruit																			
		28 Apr (7 DAT)				5 May (14 DAT)				11 May (20 DAT)				18 May (27 DAT)				24 May (33 DAT)			
Treatment/ formulation	Rate amt product/acre	Eggs	Larvae	Adults	Motiles	Eggs	Larvae	Adults	Motiles	Eggs	Larvae	Adults	Motiles	Eggs	Larvae	Adults	Motiles	Eggs	Larvae	Adults	Motiles
Agri-Mek 0.15EC	10 fl oz																				
+ NR-415 Oil	+ 5 gal	0.03a	0.20a	0.18a	0.38b	0.15a	0.38a	0.20a	0.58b	0.15b	0.15b	0.03b	0.18b	0.00a	0.00a	0.03a	0.03b	0.00a	0.00a	0.03a	0.03a
Kelthane 4EC	6 pt	0.23a	0.03a	0.00a	0.03b	0.08a	0.00a	0.00a	0.00b	0.00b	0.00b	0.00b	0.00b	0.00a	0.00a	0.03a	0.03b	0.00a	0.00a	0.00a	0.00a
Envidor 240SC	12 fl oz	0.00a	0.20a	0.23a	0.43b	0.00a	0.15a	0.00a	0.15b	0.08b	0.05b	0.00b	0.05b	0.00a	0.00a	0.00a	0.00b	0.00a	0.00a	0.00a	0.00a
Envidor 240SC	20 fl oz	0.03a	0.45a	0.18a	0.63b	0.00a	0.10a	0.00a	0.10b	0.05b	0.03b	0.05b	0.08b	0.00a	0.00a	0.00a	0.00b	0.00a	0.00a	0.00a	0.00a
Envidor 240SC	20 fl oz																				
+ NR-415 Oil	+ 5 gal	0.00a	0.30a	0.23a	0.53b	0.03a	0.13a	0.00a	0.13b	0.05b	0.05b	0.00b	0.05b	0.00a	0.00a	0.00a	0.00b	0.00a	0.00a	0.00a	0.00a
NR-415 Oil	5 gal	0.00a	0.08a	0.35a	0.43b	0.05a	0.25a	0.10a	0.35b	0.18b	0.15b	0.15b	0.30b	0.00a	0.00a	0.08a	0.08b	0.15a	0.00a	0.00a	0.00a
Untreated check	--	0.03a	0.53a	0.88a	1.40a	0.30a	0.88a	1.25a	2.13a	0.85a	1.65a	0.90a	2.55a	0.18a	0.35a	0.48a	0.83a	0.05a	0.18a	0.05a	0.23a

Means in a column followed by the same letter are not significantly different (*P* > 0.05, F-protected LSD).

Management and Resistance Monitoring of Avocado Thrips and Persea Mite

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Technical Assistance: Alan Urena, Lindsay Robinson, Deane Zahn, and Pamela Watkins, UC Riverside

Persea mite was discovered attacking avocados in southern California in 1990. Avocado thrips was found in two isolated avocado groves, one in Orange Co. and the other in Ventura Co., in June 1996. Since then, these have become the two major arthropod pests of avocados in California although populations of each can vary in severity a good deal from year to year. Although it was an unusual year, according to Witney (2009), estimates of direct losses from avocado thrips damage to fruit and control costs for this insect combined to exceed $50 million in 2006.

Abamectin (Agri-Mek and several generic formulations) has been the major pesticide used for control of both avocado thrips and persea mite since it was first made available for use on avocados in 1999. Delegate was registered for use against avocado thrips in 2007 and Danitol in 2010. Envidor was registered for use against persea mite in 2011 and Zeal will be soon. We are concerned about the heavy reliance on abamectin over the past 12 years because both thrips and mite species are notorious for their ability to develop pesticide resistance.

The objectives of our research are three-fold: (1) screen new pesticides potentially useful in control of avocado thrips and persea mite so as to find, and help move towards registration, products with chemistries different from the effective products we currently have available; (2) monitor for possible resistance of avocado thrips and persea mite to current products and newer materials once they are introduced; and (3) other research as needed to optimally manage these and other pests of avocado.

Brief Summary of Recent Research Results

Screening for New Avocado Thrips Control Materials

We have developed a fairly efficient means of screening new products for potential use against avocado thrips. Many products show limited efficacy against avocado thrips and screening trials rapidly eliminate them from the need for future testing. Products that have shown promise in recent experimental trials and warrant further testing include spirotetramat (Movento), cyazypyr, NNI-0101, NAI-2303, and a product whose identity cannot be disclosed at present (secrecy agreement).

Field Studies with Movento

Movento is in a relatively new class of chemistry (but the same as Envidor that was recently registered for persea mite control) that shows promise against a number of pests. This material was recently registered for use against citrus thrips, California red scale, and mites on citrus in California and has looked strong in recent trials against a variety of other pests including psyllids and leafminers. It is quite close to registration on avocados but we are still trying to learn how to use it effectively as plant systemic uptake does not appear to occur as easily on avocado as it does on citrus.

Movento is an interesting material in that the formulation that is sprayed on the plant has almost no toxicity but it is taken up into the plant and converted to the toxic enol derivative. Thus, only plant feeding species should be impacted by this pesticide or possibly natural enemies that derive a toxic dose by feeding on poisoned prey or hosts.

Spring PCA Cooperator Field Trials with Agri-Mek vs. Delegate vs. Danitol

Danitol is a pyrethroid insecticide that was registered in 2010 for use on avocados. Delegate was registered in 2007 but relatively few pest control advisors have used this material to date. We believe Agri-Mek (and generic abamectins) is being overused and because of resistance concerns, wanted to develop comparative data on how Delegate and Danitol might work in control of avocado thrips.

With the assistance of 6 PCAs, we set up 6 field avocado thrips field trials in spring 2009, 3 in the south (Escondido, Valley Center, Irvine) and 3 in the north (2 in Somis, Goleta). 2009 trial data was reported at the spring CAC-CAS meetings in SLO, Ventura, and Temecula in April 2010 and a fruit scarring summary was reported in our June 2010 progress report. Similar trials were run at two field sites in spring 2010 and fruit scarring data are shown in Table 1 below.

Table 1. Percent of fruit with economic or sub-economic (any) avocado thrips scarring at 2010 field trial sites.

Location	Treatment	# of fruit evaluated	% sub-economic thrips scarring	% economic thrips scarring
Escondido	Control	600	33.3	4.0
	Agri-Mek	600	2.8	0.0
	Danitol	600	5.7	0.7
	Delegate	600	4.0	0.5
Somis	Control	181	95.0	68.5
	Agri-Mek	300	8.0	0.0
	Danitol	300	0.0	0.0
	Delegate	300	7.0	0.0

What did we learn from the 2009 and 2010 field trials? First, each of these 3 materials (Agri-Mek/ generic abamectins, Delegate, and Danitol) are quite effective in controlling avocado thrips, even when applied under the challenging circumstances of helicopter application (Escondido; ground application was used at Somis). Each material has its strengths and weaknesses and we encourage PCAs and growers to try both Delegate and Danitol as possible alternatives to abamectin so as to lessen the pressure for resistance evolving to this class of chemistry. Ideally, growers should rotate between different classes of chemistry so that ALL of these products will remain effective.

Evaluation of Persea Mite Control Materials

We have also developed a fairly good means of screening new products for efficacy against persea mite and to date, have run 6 field trials. As a result, 3 new and effective materials are moving towards registration on avocado (Envidor registered in 2010, Zeal registration is expected late 2011, and FujiMite registration expected in 2012). These 3 materials all are different chemistries and each is different from Agri-Mek, making the likelihood of cross-resistance low.

Fall 2010 PCA Cooperator Persea Mite Trials

Two persea mite field trials were applied by PCA cooperators in fall 2010. Unfortunately (from the perspective of the field trials), a major heat event occurred late September and drastically reduced persea mite levels at both sites. At one of the sites in Saticoy, we obtained useful data showing that control via abamectin versus Envidor was similar (Table 2 below). Both products were effectively reducing persea mite levels until the >105°F temperatures on 27 September also contributed to population decline (thus, evaluation during the latter portions of the trial was compromised somewhat).

Table 2. Results of a fall 2010 persea mite trial in Saticoy (100 gpa application of both products on 12 September 2010; Epi-Mek 0.15 EC applied at 15 fl oz/a + 3% NR-415 oil; Envidor 240 SC at 20 fl oz/a without oil)

Date of count	9-8	9-20	9-28	10-7	10-22	11-5
Days pre or post-treatment	-4	+8	+16	+25	+40	+51
	Mean number of motile persea mite per leaf (half-vein method)					
Untreated control	38.2	69.1	35.7	17.9	26.3	3.6
Epi-Mek + oil	57.2	22.4	8.2	2.1	0.4	0.0
Envidor	49.0	26.7	2.3	0.6	0.0	0.0

Acknowledgments
We would like to thank the pest control advisors who assisted with the 2009 and 2010 avocado thrips and persea mite field spray trials.

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Appendix 19

The IR-4 Project

Search IR-4 Go

Food Crops | Ornamentals | Biopesticides & Organic Support | Public Health | International Activities | Directory | Outreach Materials

Facilitating Registration of Sustainable Pest Management
Technology for Specialty Crops and Minor Uses

General Search of Food Request Database

Found 18 records **[Click on the PR# to see more details]**

Print (IR-4 Report)

Prnum (Priority) = Protocol	Pesticide(MFG)	Commodity (Crop Group)	Project Status	Performance Data Available	Req States
XXXXX	SPIRODICLOFEN (BAYER)	APPLE (11-10 = POME FRUIT GROUP)	DATA MINING PROJECT - NO PCR RECEIVED	YES	
09326 A	SPIRODICLOFEN (BAYER)	AVOCADO (99 = MISCELLANEOUS COMMODITY)	USE REGISTERED	YES	FL CA
10039 A	SPIRODICLOFEN (BAYER)	BANANA (99 = MISCELLANEOUS COMMODITY)	COMPLETE WITH ON-GOING TRIALS	YES	FL
09679 A	SPIRODICLOFEN (BAYER)	BLUEBERRY (13-07B = BUSHBERRY SUBGROUP)	NOTICE OF FILING ISSUED/PROPOSAL	YES	MI
XXXXX	SPIRODICLOFEN (BAYER)	CHERRY, SOUR (12-12 = STONE FRUIT GROUP)	DATA MINING PROJECT - NO PCR RECEIVED	YES	
10276	SPIRODICLOFEN (BAYER)	CURRANT (RED) (13-07B = BUSHBERRY SUBGROUP)	NOTICE OF FILING ISSUED/PROPOSAL	NO	WA
10482 A	SPIRODICLOFEN (BAYER)	DATE (99 = MISCELLANEOUS COMMODITY)	COMPLETE WITH ON-GOING TRIALS	YES	CA
08733 B	SPIRODICLOFEN (BAYER)	GRAPEFRUIT (10-10C = GRAPEFRUIT SUBGROUP)	USE REGISTERED	NO	TX
09329 A	SPIRODICLOFEN (BAYER)	GUAVA (99 = MISCELLANEOUS COMMODITY)	NOTICE OF FILING ISSUED/PROPOSAL	NO	FL
08968 A	SPIRODICLOFEN (BAYER)	HOPS (99 = MISCELLANEOUS COMMODITY)	USE REGISTERED	YES	WA
09327 A	SPIRODICLOFEN (BAYER)	LYCHEE (99 = MISCELLANEOUS COMMODITY)	NOTICE OF FILING ISSUED/PROPOSAL	NO	HI FL
09325 D	SPIRODICLOFEN (BAYER)	MANGO (99 = MISCELLANEOUS COMMODITY)	USE REGISTERED	YES	FL
09268	SPIRODICLOFEN (BAYER)	ORANGE (10-10A = ORANGE SUBGROUP)	USE REGISTERED	YES	CA
09328 C	SPIRODICLOFEN (BAYER)	PAPAYA (99 = MISCELLANEOUS COMMODITY)	USE REGISTERED	YES	HI FL
09525	SPIRODICLOFEN (BAYER)	PEACH (12-12 = STONE FRUIT GROUP)	USE REGISTERED	YES	GA
XXXXX	SPIRODICLOFEN (BAYER)	PEAR (11-10 = POME FRUIT GROUP)	DATA MINING PROJECT - NO PCR RECEIVED	YES	

10729	SPIRODICLOFEN (BAYER)	PERSIMMON (99 = MISCELLANEOUS COMMODITY)	NOTICE OF FILING ISSUED/PROPOSAL	NO	HQ
09330 A	SPIRODICLOFEN (BAYER)	SUGAR APPLE (99 = MISCELLANEOUS COMMODITY)	COMPLETE WITH ON-GOING TRIALS	NO	FL

How to Manage Pests

UC Pest Management Guidelines

Citrus
Citrus Rust Mite (Silver Mite)

Scientific Name: *Phyllocoptruta oleivora*

(Reviewed 9/08, updated 9/08, corrected 2/09)

In this Guideline:

DESCRIPTION OF THE PEST

This pest is known as the rust mite on oranges and the silver mite on lemons. It is an occasional pest in coastal areas of southern California and is a problem in some years in inland southern California growing areas. Citrus rust mite is about the same size as a bud mite and requires a hand lens to view; it is deeper yellow in color than the bud mite and wedge shaped. A generation may be completed in 1 to 2 weeks in summer, but development slows or stops in winter, depending on temperature.

DAMAGE

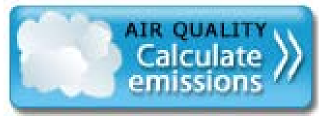
The rust mite feeds on the outside exposed surface of fruit that is 0.5 inch (1.3 cm) or larger. Feeding destroys rind cells and the surface becomes silvery on lemons, rust brown on mature oranges, or black on green oranges. Rust mite damage is similar to broad mite damage, except that somewhat larger fruit are affected. Most rust mite damage occurs from late spring to late summer.

MANAGEMENT

Citrus rust mite tends to occur together with BROAD MITE but usually in greater numbers. Both species thrive in warm, humid conditions. Monitor rust mite from early spring through summer. On orange trees, look for rust mites on young foliage in early spring; by late spring, most of the population will be on fruit. On lemon, rust mites are mostly on fruit throughout the season. To identify previous infestations, check outside fruit for scarred rind tissue. To assess current season levels, examine small green fruit on the inside of the canopy. A 10X to 15X hand lens is necessary to identify these minute mites. They usually feed in protected places, such as the stylar end of the fruit. When populations are high, the mites move over the entire fruit. No effective natural enemies are known, but general mite predators feed on rust mites at times.

Once you find one or more infested fruit and if rust mites were a problem the previous year, watch the orchard closely. Threshold levels depend on last year's rust mite problems and current market conditions. If the population increases quickly or if scarring appears, a treatment is generally required. In some cases, the infestation is localized and a spot treatment may be sufficient for control.

Common name (trade name)	Amount to Use (type of coverage)**	R.E.I.+ (hours)	P.H.I.+ (days)



The following materials are listed in order of usefulness in an IPM program, taking into account efficacy and impact on natural enemies and honey bees. When choosing a pesticide, also consider information relating to environmental impact. Not all registered pesticides are listed. Always read label of product being used.

A. SPIRODICLOFEN

(Envidor) 2SC	13 fl oz/acre (OC or IC)	12	7

RANGE OF ACTIVITY: Pests: narrow (mites); Natural enemies: predatory mites
PERSISTENCE: Pests: intermediate; Natural enemies: intermediate
MODE OF ACTION GROUP NUMBER[1]: 23
COMMENTS: Works by contact with the mite so thorough coverage is important. Only one application per season allowed.

B. DIFLUBENZURON*

(Micromite) 80WGS	6.25 oz/acre (OC or IC)	12	21

RANGE OF ACTIVITY: Pests: intermediate (katydids, peelminer, leafminer, grasshoppers); Natural enemies: predatory beetles
PERSISTENCE: Pests: intermediate; Natural enemies: intermediate
MODE OF ACTION GROUP NUMBER[1]: 15
COMMENTS: Not registered for use on lemons.

C. ABAMECTIN*

(Agri-Mek, etc.)	10 fl oz/acre (OC or IC)	12	7

RANGE OF ACTIVITY: Pests: intermediate (citrus thrips, mites, leafminers); Natural enemies: predatory mites and thrips
PERSISTENCE: Pests: intermediate; Natural enemies: intermediate
MODE OF ACTION GROUP NUMBER[1]: 6
. . . PLUS . . .
NARROW RANGE OIL

(415)	0.25%	4	when dry

MODE OF ACTION: Improves translaminar movement and persistence of insecticide.
RANGE OF ACTIVITY: Pests: broad (unprotected stages of insects/mites); Natural enemies: most
PERSISTENCE: Pests: short; Natural enemies: short
COMMENTS: For use on all varieties. Apply in 50–200 gal water/acre. To avoid potential phytotoxicity of oil to the fruit, do not apply 30 days before or after a sulfur application and do not apply to small fruit (less than 1 inch in diameter) on a day when the ambient temperature has or is expected to exceed 95°F or when the relative humidity has or is expected to drop below 20%.

D. MICRONIZED SULFUR#

(Thiolux 80%)	20 lb/acre (OC or IC)	24	0

RANGE OF ACTIVITY: Pests: broad (mites, citrus thrips); Natural enemies: most
PERSISTENCE: Pests: intermediate; Natural enemies: intermediate
MODE OF ACTION: Not available.
COMMENTS: For use on all varieties. Do not apply during or preceding high temperatures. Do not apply in any spray containing oil or within

21 days of a previous oil spray. May lead to citrus red mite or mealybug flareups.

E. WETTABLE SULFUR# 45–60 lb/acre (OC or IC) 24 0
RANGE OF ACTIVITY: Pests: narrow (mites and citrus thrips); Natural enemies: most
PERSISTENCE: Pests: intermediate; Natural enemies: intermediate
MODE OF ACTION: Not available.
COMMENTS: For use on all varieties. Apply from Nov. thru May when monitoring indicates a need. Do not apply more than 6 lb/100 gal water. Do not apply during or preceding high temperatures or within 2 months of a previous oil spray. Do not apply oil 60–90 days after a sulfur treatment. Not recommended for use in the San Joaquin Valley.

F. FENPROXIMATE
(Fujimite) 5EC 1–4 pt (OC or IC) 12 14
RANGE OF ACTIVITY: Pests: narrow (mites); Natural enemies: predatory mites
PERSISTENCE: Pests: intermediate; Natural enemies: intermediate
MODE OF ACTION GROUP NUMBER[1]: 21
COMMENTS: Do not make more than 2 applications/season and allow 14 days between applications. Use allowed under a Supplemental Label.

G. CHLORPYRIFOS*
(Lorsban) 4E 9-12 pt/acre (OC to IC) 5 days see comments
RANGE OF ACTIVITY: Pests: broad (many insects); Natural enemies: most
PERSISTENCE: Pests: short (low rates), intermediate (high rates); Natural enemies: short (low rates), intermediate (high rates)
MODE OF ACTION GROUP NUMBER[1]: 1B
. . . PLUS . . .
NARROW RANGE OIL
(415) 0.25% 4 when dry
RANGE OF ACTIVITY: Pests: broad (unprotected stages of insects/mites); Natural enemies: most
PERSISTENCE: Pests: short; Natural enemies: short
MODE OF ACTION: Improves translaminar movement and persistence of insecticide.
COMMENTS: Addition of chlorpyrifos to dilute oil gives faster control than oil alone, but rate of control for subsequent applications will diminish as resistance develops. It also causes thrips outbreaks, especially if used early season, and may lead to ridging of fruit. Apply this material in Sept.-Oct. only if several pests, such as citrus bud mite, citrus thrips, and ants, need to be controlled in addition to citrus bud mite. Do not apply chlorpyrifos in combination with spray oil when temperatures are expected to exceed 95°F (85–90°F in coastal areas). Preharvest interval is 21 days for up to 7 pt of chlorpyrifos/acre or 35 days for rates above 7 pt/acre. **Caution**: Serious hazards are associated with oil treatments to green lemons because of phytotoxicity after sweating; check label for preharvest interval.

** OC - Outside coverage uses 100–250 gal water/acre.
IC - Intermediate coverage uses 250–600 gal/acre.
+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.
* Permit required from county agricultural commissioner for purchase or use.
# Acceptable for use on organically grown produce.
1 Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group number should be alternated with chemicals that have a Group number

other than 1B. Mode of action Group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/.

PRECAUTIONS

PUBLICATION

UC PEER REVIEWED

UC IPM Pest Management Guidelines: Citrus
UC ANR Publication 3441
Insects, Mites, and Snails
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Appendix 21

How to Manage Pests

UC Pest Management Guidelines

| More pests | More crops | About guidelines |

Avocado

Relative Toxicities of Insecticides, Miticides, and Molluscicides Used in Avocados to Natural Enemies and Honey Bees

(Reviewed 1/07, updated 1/11)

In this Guideline:

- Publication
- Glossary

Common name (trade name)	Mode of action[1]	Selectivity[2] (affected groups)	Predatory mites[3]	General predators[4]	Parasites[4]	Honeybees[5]	Duration of impact to natural enemies[6]
abamectin (Agri-Mek)	6	moderate (mites, thrips)	M	M[7]	M/H	II	moderate to predatory mites and long to affected insects
Bacillus thuringiensis ssp. *aizawai*	11	narrow (caterpillars)	L	L	L	IV	none
Bacillus thuringiensis ssp. *kurstaki*	11	narrow (caterpillars)	L	L	L	IV	none
boric acid bait (Gourmet)	—	narrow (ants)	L	L	L	IV	none
copper sulfate (Bordeaux mixture) trunk spray	—	narrow (snails)	L	L[7]	L	IV	long as a barrier
fenpropathrin (Danitol)	3	broad (insects, mites)	H	H	H	I	—
imidacloprid (Admire)	4A	narrow (sucking insects)	—	L	L	I [8]	long
insecticidal soap (M-Pede)	—	broad (exposed insects, mites)	L	L	L	IV	short
iron phosphate (Sluggo)	—	narrow (snails and slugs)	L	H[7]	L	IV	short
malathion	1B	broad (insects, mites)	H	H	H	II	moderate
metaldehyde (Deadline)	—	narrow (snails and	L	H[7]	L	IV	short

		slugs)					
oil, narrow-range	—	broad (exposed insects, mites)	L	L	L	III	short
pyrethrin (PyGanic)	3	moderate (insects)	—	M	M	III	short
pyrethrin/ piperonyl butoxide (Pyrenone)	3/—	moderate (insects)	—	M	M	III	short
sabadilla (Veratran-D)	—	narrow (feeding thrips)	L	L	L	IV	short
spinetoram (Delegate)	5	narrow (thrips)	M	M[9]	L/M	III	moderate[10]
spinosad (Success, Entrust)	5	narrow (thrips)	M	M[9]	L/M	III[11]	moderate[9]
spirodiclofen (Envidor)	23	narrow (mites)	L	—	—	I	—
sulfur	—	narrow (mites)	L/H	L	H	IV	moderate

H = high M = moderate L = low — = no information

1 Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group number should be alternated with chemicals that have a Group number other than 1B. Mode of action Group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/.

2 Selectivity: *Broad* means it affects most groups of insects and mites; *narrow* means it affects only a few specific groups.

3 Generally, toxicities are to western predatory mite, *Galendromus occidentalis.* Where differences have been measured in toxicity of the pesticide resistant strain versus the native strain, these are listed as pesticide-resistant strain/native strain.

4 Toxicities are averages of reported effects and should be used only as a general guide. Actual toxicity of a specific chemical depends on the species of predator or parasite, environmental conditions, and application rate.

5 Ratings are as follows: I-Do not apply to blooming plants; II-Apply only during late evening; III-Apply only during late evening, night, or early morning; and IV-Apply at any time with reasonable safety to bees. For more information, see *How to Reduce Bee Poisoning From Pesticides* (700 KB, PDF), Pacific Northwest Extension Publication PNW591.

6 Duration: *Short* means hours to days; *moderate* means days to 2 weeks; and *long* means many weeks or months.

7 Toxic to predatory decollate snail.

8 Remove bee hives from avocado orchards before to application; hives may be returned only after the avocado bloom period has ended.

9 Toxic against some natural enemies (predatory thrips, syrphid fly and lacewing larvae, beetles) when sprayed and up to 5-7 days after, especially for syrphid fly larvae.

10 Residual is moderate if solution is between pH of 7 to 8.

11 Safe to bees 2 hr after application has dried.

PRECAUTIONS

PUBLICATION

UC IPM Pest Management Guidelines: Avocado
UC ANR Publication 3436
General Information
Acknowledgements: This table was compiled based on research data and experience of University of California scientists who work on a variety of crops and contribute to the Pest Management Guideline database, and from Flint, M. L. and S. H. Dreistadt. 1998. *Natural Enemies Handbook: An Illustrated Guide to Biological Pest Control*, ANR Publication 3386.

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How to Manage Pests

UC Pest Management Guidelines

Avocado
Persea Mite

Scientific name: *Oligonychus perseae*

(Reviewed 1/07, updated 1/11)

In this Guideline:

MITE PESTS OF AVOCADO—GENERAL INFORMATION

Spider mites (family Tetranychidae) and predatory mites (Phytoseiidae) are tiny 8-legged arthropods. Persea mite is a key pest of California-grown avocados. Avocado brown mite and sixspotted mite are sporadic pests. Several beneficial mites are important predators of pest mites and certain insects. Natural enemies and certain management strategies vary among pest mites. Identify the pest and natural enemy species in your grove and learn their biology so you can manage these pests appropriately as needed. For details about sampling techniques, see MONITORING PERSEA AND SIXSPOTTED MITES.

DESCRIPTION OF THE PEST

Persea mite (family Tetranychidae) is a key pest that occurs in most avocado-growing areas of California except the Central Valley. It is most damaging to Hass, Gwen, and a few other varieties. Esther, Pinkerton, and Reed are of intermediate susceptibility. The Bacon, Fuerte, Lamb Hass, and Zutano varieties are much less affected. Many ornamentals and weeds also host persea mite. When persea mites were first introduced into California in the early 1990s, individual mites from heavy populations on avocado trees were seen drifting onto leaves of adjacent stone fruit trees, although they did not feed. Since that time, however, populations have been reduced and persea mites have not been observed on stone fruit trees or fruit, and *Prunus* species are not known to be a host of this mite.

Persea mite develops from an egg through a six-legged larval stage and two eight-legged nymphal stages before becoming an eight-legged adult. Adult females have an oval-shaped body that is slightly flattened and elongated. Females and immatures are yellowish or greenish with two or more small dark blotches on their abdomen. Old females that have ceased oviposition turn darker green and become somewhat smaller and inactive. Males are smaller than reproductive females. Males are somewhat pear-shaped, slightly flattened, and yellowish with or without small dark spots. Persea mites feed and reproduce mostly beneath webbed patches or silk-covered "nests."

Each female lays about 2 to 4 dozen eggs during her life. Eggs are round, pale yellow, and develop red eye spots as they mature. Egg to adult female development time is about 2 to 3 weeks when temperatures average 77° to 63°F. Generation time can be accurately estimated by monitoring degree-days.

Cool winter temperatures slow persea mite population growth. Mite densities are lowest about March and gradually increase through spring feeding on new leaf flush. Populations generally peak in July and August. Persea mite populations are suppressed, and populations may decline rapidly, when the daily high temperature is 100°F or more on several consecutive days and humidity is low.

DAMAGE

High persea mite populations cause premature leaf drop and defoliation. Defoliation leads to sunburned bark and fruit, aborted or dropped fruit, and severely stressed trees, which later reduces yields.

Persea mite feeding on the underside of leaves causes discrete circular chlorotic to brown spots on the lower leaf surface. These spots become visible on the upper leaf surface. Persea mite colonies are small and can become very numerous. Each colony can produce dense webbing, which resembles a silvery spot on the underside of the leaf. High persea mite populations can often be recognized by numerous brown-spotted, green leaves hanging from trees and on the ground beneath infested trees. Heavily infested canopies can appear lighter colored overall when viewed from a distance.

Persea mite damage early in the season can be confused with sixspotted mite damage. Sixspotted mite webbing is less dense and usually does not occur in small circular patches. Sixspotted mite feeding causes brown to purplish irregularly shaped blotches, in comparison with the roundish, mostly scattered spots created by persea mite. Damage from sixspotted mites is generally confined to areas immediately adjacent to veins, while persea mite often feeds throughout the lower leaf surface. Persea mite also sometimes feeds on the upper leaf surface, but mite feeding on the upper leaf surface is usually caused by avocado brown mite. Avocado brown mite feeding causes the upper leaf surface to appear bronzed or scorched and damage does not occur in discrete circular spots.

MANAGEMENT

Minimize tree stress to reduce the effect of persea mite feeding on trees. Appropriate irrigation frequency and amounts, good management of avocado root rot and other key pathogens, and harvesting fruit early will reduce the adverse impact of mite feeding. If treating, whenever possible choose pesticides that have low residual toxicity or are non-toxic to natural enemies.

In the early stages of a significant infestation, highly refined or narrow-range petroleum oils or certain other materials can be applied. Treat only where necessary and leave unsprayed areas to conserve beneficials and provide refuges from which natural enemies and pesticide-susceptible pests can recolonize treated trees. Maximize the interval between treatments and alternate applications among pesticides with a different mode of action to reduce the rate at which pesticide resistance develops.

Biological Control

Numerous predators feed on persea mite. Predaceous mites include *Amblyseius* (=*Neoseiulus) californicus, Euseius hibisci, Galendromus annectens,* and *G. helveolus.* Black hunter thrips *(Leptothrips mali)*, sixspotted thrips *(Scolothrips sexmaculatus)*, brown lacewings *(Hemerobius* spp.) and green lacewings *(Chrysopa* and *Chrysoperla* spp.), dustywings (family Coniopterygidae), a predatory midge *(Feltiella* sp., Cecidomyiidae), a rove beetle *(Oligota oviformis,* Staphylinidae), and the spider mite destroyer lady beetle *(Stethorus picipes)* are other common predators. Most predators are not highly effective because of persea mites' protective webbed nests. However, conserve natural enemies because they can reduce persea mite populations, and predators often provide good biological control of avocado brown mite and sixspotted mite.

Commercially available predators include predatory mites *(Amblyseius californicus, Galendromus annectens,* and *G. helveolus,* family Phytoseiidae) and green lacewing larvae *(Chrysoperla* spp.). Often relatively few predaceous mites are present through the winter because populations of their persea mite prey have been suppressed by hot summer weather. Introducing *Galendromus helveolus* helps to control persea mite if sufficient numbers of predators are introduced and releases are well-timed. If predator releases are planned, monitor persea mites regularly in late February through summer and release predaceous mites when about 50% of leaves have one or more active-stage pest mites. To check the viability of purchased predaceous mites, gently pour some mites and any shipping substrate into a clear jar and look for an abundance of fast-moving mites, which indicates predators arrived in good condition.

Cultural Control
Eliminate or reduce persea mite alternate host plants growing near avocado, including mite-susceptible ornamentals, non-commercial fruit trees, and weeds. Provide trees with appropriate irrigation and other good cultural care to maintain the flush of new growth and compensate for mite-induced leaf drop. However, be careful not to overfertilize. Excess fertilization, especially with quick-release formulations, may increase persea mite populations and damage during late spring and summer due to increased foliar nitrogen. Spraying the underside of leaves with a forceful stream of water can reduce mite populations on a few small trees where this is feasible. Whitewash trunks and major limbs to protect bark and wood from sunburn after premature leaf drop

Organically Acceptable Methods
Biological and cultural controls and sprays of certain oils are acceptable for use on an organically certified crop.

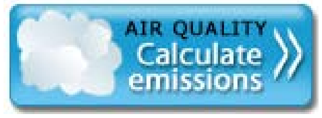
Monitoring and Treatment Decisions
Inspect leaves for mites, mite damage, and natural enemies about every 7 to 10 days from mid-March through at least August, and perhaps through October. Coordinate monitoring and treatment decision-making for persea mite and avocado thrips, which are usually the key invertebrate pests feeding on leaves. Mite monitoring frequency, and the need for treatment and choice of material, can be affected by thrips management decisions. Certain materials applied (usually earlier in the season) to control avocado thrips can also control or suppress mite populations (which are usually treated later in the season if needed). Some materials can adversely impact natural enemies, so applying a less selective material early for thrips may increase the need to later treat mites. Only one application per season may be permitted or recommended for certain materials (e.g., abamectin) to reduce the development of pesticide resistance. Rotate among chemical classes when making multiple applications to reduce the development of pesticide resistance.

Consider the effect of weather on treatment decision-making. Heavy winter rains and high winds can substantially reduce subsequent mite populations and damage. Persea mite populations are suppressed or may crash when the daily high temperature is 100°F or more on several consecutive days and humidity is low.

There are no research-based thresholds for when persea mite treatment is warranted. Develop treatment guidelines satisfactory for your situation by keeping good records and adapting your monitoring and management methods as appropriate. Regularly monitor and record mite densities and compare these numbers from year-to-year with records of your control actions and their effectiveness. See MONITORING PERSEA AND

SIXSPOTTED MITES for additional information.

Common name (trade name)	Amount to use	R.E.I.+ (hours)	P.H.I.+ (days)



When choosing a pesticide, consider information relating to the impact on natural enemies and honey bees and environmental impact. Not all registered pesticides are listed. Always read label of product being used.

Common name (trade name)	Amount to use	R.E.I.+ (hours)	P.H.I.+ (days)
A. GALENDROMUS MITES#	2,000/tree	—	—
. . . or . . .			
NEOSEIULUS CALIFORNICUS#	2,000/tree	—	—

COMMENTS: Make a single release of 2,000 mites/tree, or two releases each of 1,000 mites/tree, when regular monitoring of leaves for mite presence-absence shows that about 50% of leaves have one or more active-stage pest mites, typically in spring or early summer. The most effective release strategy is to dispense predator mites and carrier (e.g., corn grits) in small paper cups attached to branches. Attach 4 cups per tree evenly distributed around the canopy on avocado branches that are shaded from the sun. Add about 250 to 500 predators per cup depending on the release rate. The predators will disperse from the cups.

Common name (trade name)	Amount to use	R.E.I.+ (hours)	P.H.I.+ (days)
B. ABAMECTIN*			
(Agri-Mek 0.15 EC and others)	Label rates	12	14

MODE OF ACTION GROUP NUMBER[1]: 6
COMMENTS: Use with 1-2% narrow range (415) oil in a minimum of 50 gal water/acre for aerial applications and 100 gal water/acre for ground applications. On large trees aerial applications may require larger volumes of water to achieve desired efficacy. Control may last 3 or more weeks. Only use in an alkaline or slightly acidic solution. Do not tank mix with nutrients. To avoid promoting pesticide resistance, do not make more than one application of any abamectin product per year in each grove.

Common name (trade name)	Amount to use	R.E.I.+ (hours)	P.H.I.+ (days)
C. SPIRODICLOFEN			
(Envidor 2 SC)	18–20 fl oz	12	2

MODE OF ACTION GROUP NUMBER[1]: 23
COMMENTS: Only one application is allowable per crop season.

Common name (trade name)	Amount to use	R.E.I.+ (hours)	P.H.I.+ (days)
D. FENPROPATHRIN*			
(Danitol 2.4 EC)	16–21.33 fl oz	24	1

MODE OF ACTION GROUP NUMBER[1]: 3

Common name (trade name)	Amount to use	R.E.I.+ (hours)	P.H.I.+ (days)
E. NARROW RANGE OIL#	Label rates	see label	see label

MODE OF ACTION: Contact including smothering and barrier effects.
COMMENTS: Requires good coverage to be effective. Check with certifier to determine which products are organically acceptable.

\+ Restricted entry interval (R.E.I.) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (P.H.I.) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

\# Acceptable for use on organically grown produce.

* Permit required from county agricultural commissioner for purchase or use.

1 Rotate chemicals with a different mode-of-action Group number, and do not use products with the same mode-of-action Group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a Group number of 1B; chemicals with a 1B Group

number should be alternated with chemicals that have a Group number other than 1B. Mode of action Group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Web site at http://www.irac-online.org/.

— Not applicable.

IMPORTANT LINKS

- Photos of pest mites and their damage
- Photos of natural enemies of mites

PRECAUTIONS

PUBLICATION

UC PEER REVIEWED

UC IPM Pest Management Guidelines: Avocado
UC ANR Publication 3436
Invertebrates
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