# Controlling ACP and other pests as critical as ever

By Jawwad A. Qureshi and Philip A. Stansly

ore than a decade has passed since 2006, when huanglongbing (HLB) or citrus greening disease was identified in Florida. By then, the disease had already spread widely and went unrecognized due to high psyllid populations and a disease incubation period of months or years between infection and symptom expression. Nevertheless, management of the Asian citrus psyllid (ACP) vector is still critical to reduce disease severity in infected trees and spread into new plantings.

Research-based tactics for individual and area-wide ACP control have greatly reduced psyllid populations, helping mature citrus to maintain production and new plantings to survive and produce in spite of HLB. Tolerant or resistant plants and bactericides may reduce, but probably never eliminate, the need for ACP control. Nevertheless, challenges remain due to the rapidity of vector reproduction, dispersal and disease transmission. Therefore, management of ACP in all habitats including organic and conventional citrus, urban areas and abandoned citrus is critical for area-wide reduction of this vector-disease complex and for sustainable citrus production.

### **YOUNG CITRUS**

ACP requires newly developing buds and young shoots of citrus to develop and reproduce. Young trees flush more frequently compared with mature trees and therefore face a greater risk of infestation by ACP and HLB infection. Consistent and longerlasting protection from ACP provided by soil-applied, systemic insecticides interspersed with sprays of different chemistry is necessary. The systemic neonicotinoid insecticides, imidacloprid, thiamethoxam and clothianidin, may provide up to six to eight weeks of protection, but even this is not sufficient because of label restrictions that



Figure 1. Durand Wayland AF100-32 air blast speed sprayer



**Figure 2.** Proptec rotary atomizer sprayer for low-volume application

limit the amount of these products that can be used.

Furthermore, these insecticides all have the same 4A mode of action (MoA), so rotation is needed to delay resistance. Cyantraniliprole (Verimark<sup>®</sup>), a new insecticide with a different MoA (28), would be another systemic option if it were not so expensive. Foliar sprays of different MoAs are needed.

Planting on reflective mulch provides additional protection to young trees by further reducing ACP colonization and therefore HLB pressure. It is an effective tool to augment current control measures for young trees based primarily on insecticides.

#### **MATURE CITRUS**

Dormant/Winter Sprays: ACP reproduction is rapid. Up to 700 to 800 eggs per female are possible under favorable conditions in spring and summer when temperatures are optimal and flush is abundant. Emigration of infected ACP at the end of spring flush is the main event in the annual movement of HLB. Much of this movement can be preempted by controlling ACP in winter, when populations are down due to lower temperatures and lack of flush needed for reproduction. This weak link in the ACP life cycle is best exploited with sprays of organophosphate and/or pyrethroid insecticides prior to spring flush.

In the interest of resistance management and conservation of beneficials, these insecticides are not recommended during the rest of the year (except for border sprays). Area-wide dormant sprays with these products reduced ACP populations 15-fold in spring compared with an untreated grove. Natural enemies such as ladybeetles and lacewings, which contribute to control of ACP and other pests such as citrus leafminers, aphids and mites, are relatively unaffected by these dormant sprays.

We are testing conventional and organic programs for ACP management to expand options for all growers. Three separate organic programs

- rotations of organic insecticides applied alone, with horticultural mineral oil or with insecticidal soap - are being compared with a standard conventional program for ACP control and conservation of beneficials in a block of Valencia and Hamlin oranges. Dormant sprays of the natural pyrethrum PyGanic EC 5.0 alone (17 oz./acre) or with 435 oil (2% v/v) or M-Pede (2% v/v) applied in November, December and January, and Danitol 2.4 EC applied at 16 oz./acre in January all significantly reduced ACP through March. By then, adults started to escalate above a provisional growing season threshold of 0.1 per tap sample. Danitol provided more ACP reduction than PyGanic, especially when applied both in November and in January.

Thus, two dormant sprays were better than one. PyGanic with M-Pede or 435 oil performed better than PyGanic alone. There is no threshold for dormant sprays, which are critical for year-round ACP control.

The last two winters were warm with some rain events, which resulted in unexpected flush and greater than normal populations of ACP. It may be necessary to add another dormant spray under such conditions.

Growing Season Management of ACP: Factors to consider for control of ACP during the growing season include abundance of nymphs or adults, other pests which also need to be controlled, cost, and effects on beneficials. Just seeing one or two adults per 50 taps or single infested flush may not be sufficient to justify spraying an entire block. Thresholds based on annual accumulation of ACP in mature blocks with high HLB incidence have been developed (see Citrus Industry magazine, February 2015). Flush protection is critical because when an infected female has access to a new bud or shoot, it not only lays eggs, but injects the pathogen into those soft tissues, thus spreading the infection to the tree, its progeny and other colonizing adults.

We have been using a provisional 0.1 adults per tap sample threshold

## CRDF Planning Directions and Processes



By Harold Browning

s we move through the current production and harvest season, the Citrus Research and Development Foundation (CRDF) has been initiating plans and activities to continue delivering HLB solutions in 2017. This article summarizes some of the directions that CRDF is taking.

- CRDF is implementing results of strategic planning concluded in 2016. Initiative 1 is short-term solutions (less than 3 years to grower delivery). Initiative 2 is medium/long-term solutions requiring more than 3 years. Subcommittees of the Executive Committee are evaluating these two initiatives, and discussions will occur at 2017 committee and board meetings to make these the highest priorities for CRDF investment.
- CRDF initiated in-house review of all active and recently ending projects to determine progress and value to continue. Each year, CRDF conducts this portfolio review, beginning with project managers and the Scientific Advisory Board. Reviews and recommendations from these first steps are provided to the Research Management Committee and the Commercial Product Delivery Committee (CPDC). The board ultimately determines the final recommendations to invite new or revised proposals for CRDF review. An additional outcome of the portfolio review is to identify research results to advance to the field through the CPDC.
- ➤ At its December board meeting, CRDF approved a project for an independent, comprehensive review of HLB research conducted over the recent decade in Florida, but also to include research sponsored by other institutions and funding programs. This 1-year evaluation will provide further direction for the topics that most likely will lead to HLB solutions, and recommend specific priorities to accomplish delivery of solutions to growers. Publication of the full report of this comprehensive review is slated for early 2018.
- CRDF has intensified oversight of research and delivery topics, reducing the breadth of individual projects being funded and encouraging more team efforts toward field evaluation. A significant component of current CRDF activity is the conduct of field trials and grower evaluations to advance early results. Project managers will report regularly in 2017 on progress in these priority areas.
- Finally, CRDF continues to coordinate with the California Citrus Research Board, the U.S. Department of Agriculture's (USDA) National Institute of Food and Agriculture Specialty Crop Research Initiative, Citrus Disease Research and Extension Program and the USDA's Animal and Plant Health Inspection Service HLB Multi-Agency Coordination Group. Where different groups are working independently, teams can be encouraged to rapidly bring forth best options for management of citrus in the presence of HLB.

Please visit citrusrdf.org to follow CRDF activities and programs.

Harold Browning is Chief Operations Officer of CRDF. The foundation is charged with funding citrus research and getting the results of that research to use in the grove.



Column sponsored by the Citrus Research and Development Foundation

for the three organic programs and one conventional program described above. Organic insecticides rotated with M-Pede or 435 oil used 50 percent less insecticide while providing better control than organic insecticides alone. Reduction of ACP was still greater with the conventional program, but not always significantly so, compared with programs using organic insecticides with M-Pede or 435 oil.

We have been testing these spray applications mostly at 100 gallons per acre using a Durand Wayland AF100-32 air blast speed sprayer, and sometimes at 10 gallons per acre using a Proptec rotary atomizer sprayer, and have seen good results with both (see figures 1 and 2, page 16). Best yields were obtained using organic insecticides with 435 oil or conventional insecticides and did not differ between the two programs (see Figure 3, page 19). Yield did not improve with organic

**Table 1:** Time of the year and potential choices of insecticides for sprays using rotation of single MoA to control Asian citrus psyllid (ACP) and other pests of citrus.

Nov-Dec     Dormant     Organophosphates Phosmet Dimethoate     18       Mindan     ACP***, root weevils*, rustmites*     ACP***, root weevils*, rustmites*       Jan     Dormant     Pyrethroids     3       Fenpropathrin     Danitol     ACP***, root weevils*, rustmites*, spidermites*, mealybugs*       Zeta-cypermethrin     Mustang     ACP***, root weevils*, rustmites*, spidermites*       Feb-Mar     Growing:     Fenpropathrin     Baythroid     ACP***, root weevils*       Feb-Mar     Fenpropathrin     Baythroid     ACP***, root weevils*     rustmites**, spidermites*       Feb-Mar     Growing:     Fenpropathrin     Baythroid     ACP***, root weevils*       Bioom     Fenproximate     21A     Portal*     ACP***, rustmites**, spidermites**       Post-Bioom     Fenproximate     21A     Portal*     ACP***, leafminers***, root weevils*       Apr     Mineral oil     Unknown     435 Oil     ACP***, leafminers***, root weevils*       Apr     Mineral oil     Unknown     435 Oil     ACP***, leafminers***, root weevils*       Apr     Mineral oil     Unknown     435 Oil     ACP***, nustmite	Month	Season/ Tree Stage	Active Ingredient	IRAC MOA <sup>a</sup>	Product Trade Name⁵	Pest Targets and Product Efficacy (+++ high, ++ medium, + low)
Phosmet     Imidan     ACP***, root weevils*, rustmites*       Dimethoate     Dimethoate     ACP***, scales*, mealybugs*       Chlorpyrifos     Lorsban     ACP***, scales*, mealybugs*       Jan     Dormant     Pyrethroids     3       Zeta-cypermethrin     Mustang     ACP***, root weevils*, rustmites*, spidermites*, mealybugs*       Zeta-cypermethrin     Mustang     ACP***, root weevils*, rustmites**, spidermites*       Feb-Mar     Growing:     Fenpyroximate     21A     Portal:     ACP***, rustmites**, spidermites**       Bloom     Fenpyroximate     21A     Novento*     Lafminers***, rustmites**, root weevils*       Feb-Mar     Growing:     Fenpyroximate     21A     Movento*     Lafminers***, rustmites***, root weevils*       Feb-Mar     Growing:     Fenpyroximate     21A     Movento*     Lafminers***, root weevils*       Post-Bloom     Cyatramiliprole     28     Exirel     ACP***, leafminers***, root weevils*       Apr     Mineral oil     Unknown     435 Oil     ACP***, leafminers***, root weevils*       Apta     ACP***, leafminers***, root weevils*     Fenpyroximate     21A	Nov-Dec	Dormant	Organophosphates	1B		
Dimethoate     Dimethoate     Dimethoate     DCP***, scales*, mealybugs**       Chlorpyrifos     Lorsban     ACP***, scales*, mealybugs**     root weevils*, rustmites*, leafminers*       Jan     Dormant     Pyrethroids     3     Fenpropathrin     Danitol     ACP***, root weevils*, rustmites*, spidermites*, spidermites*, spidermites*       Zeta-cypermethrin     Mustang     ACP***, root weevils*     Baythroid     ACP***       FebMar     Fenproximate     21A     Portal*     ACP***, root weevils*       Bioom     Fenproximate     21A     Portal*     ACP***, rustmites**, spidermites**       Bioom     Fenproximate     21A     Portal*     ACP***, rustmites**, spidermites**       Post-Bloom     Fenproximate     21A     Portal*     ACP***, rustmites**, spidermites**       Post-Bloom     Cyantraniliprole     23     Movento*     Leafminers***, root weevils*       Apr     Mineral oil     Unknown     435 Oil     ACP***, rustmites**, spidermites**       Vay-June     Spirotetramat     23     Movento*     ACP***, rustmites**, spidermites**       Vay-June     Spirotetramat     23 <td< td=""><td></td><td>Phosmet</td><td></td><td>Imidan</td><td>ACP<sup>+++</sup>, root weevils<sup>+</sup>, rustmites<sup>+</sup></td></td<>			Phosmet		Imidan	ACP <sup>+++</sup> , root weevils <sup>+</sup> , rustmites <sup>+</sup>
Chlorpyrifes     Lorsban     ACP+++, scales-t, mealybugs*+ root weevils*, rustmites*, leafminers*       Jan     Dormant     Pyrethroids     3       Fenpropathrin     Daniol     ACP+++, root weevils*, rustmites*, spidermites*, mealybugs*       Zeta-cypermethrin Beta-cyfluthrin     Mustang     ACP++, root weevils*       Feb-Mar     Growing:     Fenpropathrin     Mustang     ACP++, root weevils*       Bloom     Fenpropathrin     Bustang     ACP++, root weevils*     ACP++, rastmites**, spidermites**, meanybugs*       Feb-Mar     Growing:     Fenpyroximate     21A     Portal*     ACP++, restmites**, spidermites**, root weevils*       Bloom     Difubenzuron     15     Micromite*     ACP++*, aphids***, nealybugs*, leafminers**       Post-Bloom     Cyarutaniliprole     28     Exirel     ACP+**, root weevils*       Apr     Mineral oil     Unknown     435 Oil     ACP+**, rustmites**, spidermites*, root weevils*       Apar     Chitheramita     21A     Portal*     ACP+**, leafminers***, root weevils*       Apar     ACP***, leafminers***, root weevils*     Crastraniliprole     28     Exirel     ACP***, leafminers***, root weevils			Dimethoate		Dimethoate	ACP <sup>+++</sup> , scales <sup>+</sup> , mealybugs <sup>+</sup>
Jam     Dormant     Pyrethroids     3       Penpropathrin     Danitol     ACP+++, root weevils+, rustmites+, spidermites+, mealybugs*       Zeta-cypermethrin     Mustang     ACP+++, root weevils+       Beta-cyfluthrin     Bathroid     ACP+++, root weevils+       Bloom     Fenproximate     21A     Portals     ACP+++, nastmites++, spidermites++       Feb-Mar     Bloom     Fenproximate     21A     Portals     ACP+++, nastmites++, spidermites++       Bloom     Fenproximate     21A     Portals     ACP+++, nastmites++, spidermites+++       Post-Bloom     Cyantraniliprole     28     Exirel     ACP+++, nastmites++, spidermites++       Post-Bloom     Vantraniliprole     28     Exirel     ACP+++, nastmites++, spidermites++       Apr     Mineral oil     Unknown     435 Oil     ACP+++, nastmites++, spidermites++       Fenproximate     21A     Portal*     ACP+++, nastmites++, spidermites++       Offlubenzuron     15     Micromite*     ACP+++, nastmites++, spidermites++       Operatore     28     Exirel     ACP+++, nastmines+++, nastmites++, spidermites++      Operatore			Chlorpyrifos		Lorsban	ACP <sup>+++</sup> , scales <sup>+</sup> , mealybugs <sup>+++</sup> root weevils <sup>+</sup> , rustmites <sup>+</sup> , leafminers <sup>+</sup>
Fenpropathrin     Danitol     ACP+**, root weevils*, rustmites*, spidermites*, mealybugs*       Zeta-cypurmethrin     Baythroid     ACP+**, root weevils*       Bioom     Fenpyroximate     21A     Portal*     ACP+**, root weevils*       Bioom     Diflubenzuron     15     Micromite*     ACP+**, leafminers**, rustmites***, root weevils**       Post-Bioom     Portal*     ACP+**, leafminers**, rustmites***, root weevils**       Post-Bioom     Cyantraniliprole     28     Exirel     ACP+**, leafminers***, root weevils**       Apr     Mineral oil     Unknown     435 Oil     ACP***, nustmites**, spidermites*, leafminers**, root weevils**       Toffnybrad     21A     Portal*     ACP***, nustmites**, spidermites**, root weevils**       Apr     Mineral oil     Unknown     435 Oil     ACP***, rustmites**, spidermites**, root weevils**       Toffnybrad     21A     Apta     ACP***, rustmites**, spidermites**, root weevils**     Toffnybrad       Toffnybrad     21A     Apta     ACP***, rustmites**, root weevils*     Toffnybrad       Toffnybrad     21A     Apta     ACP***, rustmites**, root weevils*     Toffnybrad       Toffnybrad	Jan	Dormant	Pyrethroids	3		
Zeta-cypermethrin     Mustang     ACP+**, root weevils*       Beta-cyfluthrin     Baythroid     ACP+**       Feb-Mar     Growing: Bloom     Fenpyroximate     21A     Portal*     ACP+**, rustmites**, spidermites**       Bloom     Diflubenzuron     15     Micromite*     ACP+**, leafminers**, rustmites***, root weevils**       Post-Bloom     Cyantraniliprole     28     Exirel     ACP+**, leafminers***, root weevils*       Apr     Mineral oil     Unknown     435 Oil     ACP+**, leafminers**, root weevils*       Apr     Mineral oil     Unknown     435 Oil     ACP+**, leafminers**, root weevils*       Cyantraniliprole     28     Exirel     ACP+**, leafminers**, root weevils*       Cyantraniliprole     28     Exirel     ACP+**, nustmites**, root weevils*       Cyantraniliprole     28     Exirel     ACP+**, nustmites**, root weevils*       Cyantraniliprole     28     Exirel     ACP+**, nustmites**, root weevils*       Tolfenpyrad     21A     Apta     ACP+***, nustmites**, spidermites**, mealybugs**, leafminers*       Fupyradifurone     4D     Sivanto*     ACP+***, nustmites***, spidermites**, me			Fenpropathrin		Danitol	ACP <sup>+++</sup> , root weevils <sup>+</sup> , rustmites <sup>+</sup> , spidermites <sup>+</sup> , mealybugs <sup>+</sup>
Beta-cyfluthrin     Baythroid     ACP***       Feb-Mar     Growing: Bloom     Fenpyroximate     21A     Portal*     ACP***, testmites**, spidermites**       Bloom     Diflubenzuron     15     Micromite*     ACP***, testmites**, spidermites**, root weevils**       Post-Bloom     Variation     4D     Sivanto*     ACP***, testmites**, spidermites**, root weevils**       Apr     Mineral oil     Unknown     435 Oil     ACP***, testmites**, spidermites*, testmites**, root weevils*       Apr     Mineral oil     Unknown     435 Oil     ACP***, testmites**, spidermites*, testmites**, root weevils*       Apr     Mineral oil     Unknown     435 Oil     ACP***, testmites**, spidermites**, testmites**, root weevils*       Apr     Kircel     ACP***, testmites**, spidermites*, spidermites**, root weevils**     root weevils**       Apr     Ziral     Portal*     ACP***, testmites**, spidermites**, root weevils**       Yaptraniliprole     28     Exirel     ACP***, testmites**, spidermites**, spidermites**       Flupyradifurone     4D     Sivanto*     ACP***, testmites**, spidermites**, mealybugs**, testmites**, cales****       May-June     Spirotetramat     23			Zeta-cypermethrin		Mustang	ACP <sup>++</sup> , root weevils <sup>+</sup>
Feb-Mar Growing: Bloom Fenpyroximate Diffuberzuron 15 15 15 16 16 10 15 16 10 16 10 15 10 16 10 10 10 10 10 10 10 10 10 10 10 10 10			Beta-cyfluthrin		Baythroid	ACP <sup>+++</sup>
Bloom     Diflubenzuron     15     Micromite'     ACP+++, leafminers++, rostmites+++, root weevils+ Flupyradifurone     4D     Sivanto*     ACP+++, aphids+++, mealybugs++, leafminers+ Spirotetramat     23     Movento*     Leafminers+++, root weevils+       Post-Bloom     Cyantraniliprole     23     Exirel     ACP+++, leafminers+++, root weevils+       Apr     Mineral oil     Unknown     435 Oil     ACP+++, leafminers++, spidermites++, leafminers+, scales+, mealybugs+       Fenpyroximate     21A     Portal*     ACP+++, leafminers++, root weevils+       Cyantraniliprole     28     Exirel     ACP+++, leafminers++, root weevils+       Cyantraniliprole     28     Exirel     ACP+++, leafminers++, root weevils+       Cyantraniliprole     28     Exirel     ACP+++, leafminers++, root weevils+       Flupyradifurone     4D     Sivanto*     ACP+++, leafminers++, root weevils+       Tolfenpyrad	Feb-Mar	Growing:	Fenpyroximate	21A	Portal°	ACP <sup>++</sup> , rustmites <sup>++</sup> , spidermites <sup>++</sup>
Fluppradifurone     4D     Sivanto:     ACP+++, aphids++, mealybugs+, leafminers+       Post-Bloom     Cyantraniliprole     23     Movento*     Leafminers++, orange dog+++       Post-Bloom     Cyantraniliprole     28     Exirel     ACP+++, leafminers+, root weevils+       Apr     Mineral oil     Unknown     435 Oil     ACP++, rustmites+, spidermites+, leafminers+, scales+, mealybugs+, root weevils+       Fenpyroximate     21A     Portal*     ACP+++, ieafminers++, root weevils+       Cyantraniliprole     28     Exirel     ACP+++, ieafminers++, root weevils+       Cyantraniliprole     28     Exirel     ACP+++, ieafminers++, root weevils+       Cyantraniliprole     28     Exirel     ACP+++, ieafminers++, root weevils+       Flupyradifurone     4D     Sivanto*     ACP+++, ieafminers++, root weevils+       May-June     Spirotetramat     23     Movento*     ACP+++, rustmites++, spidermites++, mealybugs+, scales+++       Abamectin     6     Agri-Mek     ACP+++, ieafminers++, root weevils+       Tolfenpyrad     21A     Apta     ACP+++, rustmites++, spidermites++, spidermites+       Cyantraniliprole     28 <t< td=""><td>Bloom</td><td>Diflubenzuron</td><td>15</td><td>Micromite<sup>c</sup></td><td>ACP<sup>++</sup>, leafminers<sup>++</sup>, rustmites<sup>+++</sup>, root weevils<sup>++</sup></td></t<>		Bloom	Diflubenzuron	15	Micromite <sup>c</sup>	ACP <sup>++</sup> , leafminers <sup>++</sup> , rustmites <sup>+++</sup> , root weevils <sup>++</sup>
Spirotetramat23Movento*Leafminers***, orange dog***Post-BloomCyantraniliprole28ExirelACP***, leafminers***, root weevils*AprMineral oilUnknown435 OilACP**, rustmites*, spidermites*, leafminers*, scales*, mealybugs*Fenpyroximate21APortal*ACP**, rustmites**, spidermites**, leafminers**, root weevils*Diflubenzuron15Micromite*ACP**, rustmites**, spidermites**, root weevils*Cyantraniliprole28ExirelACP***, rustmites**, spidermites**, root weevils*Tolfenpyrad21AAptaACP***, rustmites**, root weevils*Flupyradifurone4DSivanto*ACP***, rustmites**, spidermites**, mealybugs*, scales*, root weevils*May-JuneSpirotetramat23Movento*ACP***, leafminers***, root weevils*May-JuneAptaCpartraniliprole28ExirelACP***, rustmites**, spidermites**, spidermites*May-JuneMicroniliprole28ExirelACP***, rustmites***, spidermites**, spidermites*May-JuneMineral oilCapatraniliprole28ExirelMay-JuneMineral oilCapatraniliprole28ExirelAptaACP***, rustmites**, spidermites**, mealybugs*, scales****Spinetramat23May-JuneMicroniliprole28ExirelACP***, rustmites**, spidermites**, mealybugs*, scales*, root weevils*May-JuneMineral oilUnknown435 OilACP***, rustmites**, spidermites**, mealybugs*, scales****Muly-AugMineral oilUnknown </td <td></td> <td>Flupyradifurone</td> <td>4D</td> <td>Sivanto<sup>c</sup></td> <td>ACP<sup>+++</sup>, aphids<sup>+++</sup>, mealybugs<sup>++</sup>, leafminers<sup>+</sup></td>			Flupyradifurone	4D	Sivanto <sup>c</sup>	ACP <sup>+++</sup> , aphids <sup>+++</sup> , mealybugs <sup>++</sup> , leafminers <sup>+</sup>
Methoxyfenozide18IntrepidPost-BloomCyantraniliprole28ExirelACP+*, leafminers*+*, root weevils*AprMineral oilUnknown435 OilACP*, rustmites*, spidermites*, leafminers*, scales*, mealybugs*Fenpyroximate21APortal*ACP+*, rustmites*, spidermites*, leafminers*, scales*, mealybugs*Cyantraniliprole28ExirelACP+**, leafminers**, root weevils*Organophosphate21APortal*ACP+**, leafminers**, root weevils*Tolfenpyrad21AAptaACP+**, leafminers**, root weevils*Tolfenpyrad21AAptaACP+**, leafminers**, root weevils*Way-JuneSpirotetramat23Movento*ACP+**, nustmites**, spidermites**, spidermites*Vay-JuneSpirotetramat23Movento*ACP+**, leafminers***, root weevils*Tolfenpyrad21AAptaACP+**, nustmites**, spidermites**, spidermites**Vay-JuneSpirotetramat23Movento*ACP+**, nustmites**, spidermites**, spidermites**Flupyradifurone4DSivanto*ACP+**, nustmites**, root weevils*Tolfenpyrad21AAptaACP+**, nustmites**, spidermites**, mealybugs*, scales**July-AugMineral oilUnknown435 OilACP+**, nustmites*, spidermites*, nealybugs*, scales***July-AugMineral oilUnknown435 OilACP+**, nustmites*, spidermites*, mealybugs*, scales***Flupyradifurone4DSivanto*ACP+**, nustmites**, spidermites*, nealybugs*, scales***Organophosphates			Spirotetramat	23	Movento <sup>c</sup>	Leafminers <sup>+++</sup> , orange dog <sup>+++</sup>
Post-BloomCyantraniliprole28ExirelACP+++, leafminers++, root weevils+AprMineral oilUnknown435 OilACP+, rustmites+, spidermites+, leafminers+, scales+, mealybugs+AprFenpyroximate21APortal*ACP++, rustmites+, spidermites++, root weevils+ DiflubenzuronDiflubenzuron15Micromite*ACP+++, leafminers++, root weevils+ Cyantraniliprole28ExirelACP+++, leafminers++, root weevils+ root weevils+ scales+, root weevils+ scales+, root weevils+ folfenpyradWay-JuneSpirotetramat23Movento*ACP+++, leafminers++, rustmites+++, spidermites+ scales++May-JuneSpirotetramat23Movento*ACP+++, leafminers++, rustmites+++, spidermites+ cyantraniliproleMay-JuneSpirotetramat23Movento*ACP+++, leafminers++, rustmites+++, spidermites+ cyantraniliproleMay-JuneMiperal21AAptaACP+++, rustmites++, spidermites++, spidermites+ cyantraniliproleParamat23Movento*ACP+++, rustmites++, spidermites++, spidermites++, rustmites++, spidermites++, spidermites++, rustmites++, spidermites++, spidermites++, spidermites++, spidermites++, spidermites++,			Methoxyfenozide	18	Intrepid	
AprMineral oilUnknown435 OilACP+*, rustmites*, spidermites*, leafminers*, scales*, mealybugs*Fenpyroximate21APortal*ACP+**, rustmites**, spidermites*Diflubenzuron15Micromite*ACP+**, leafminers**, root weevils*Cyantraniliprole28ExirelACP+**, leafminers***, root weevils*Tolfenpyrad21AAptaACP+**, rustmites***, spidermites**Hupyradifurone4DSivanto*ACP+**, rustmites***, root weevils*Flupyradifurone4DSivanto*ACP+**, rustmites***, spidermites*Vay-JuneSpirotetramat23Movento*ACP+**, rustmites***, spidermites*Abamectin6Agri-MekACP+**, rustmites***, spidermites*Tolfenpyrad21AAptaACP+***, rustmites***, spidermites**Tolfenpyrad21AAptaACP+***, rustmites***, spidermites**Flupyradifurone4DSivanto*ACP+***, rustmites***, mealybugs**, leafminers***Flupyradifurone4DSivanto*ACP+***, rustmites***, mealybugs**, leafminers***July-AugMineral oilUnknown435 OilACP+**, rustmites**, spidermites**, leafminers**Sept-OctSpinetoram5DelegateACP+**, rustmites**, spidermites**, nealybugs*, scales*, root weevils*Flupyradifurone4DSivanto*ACP+**, rustmites**, spidermites**, mealybugs*, scales**, root weevils*Sept-OctSpinetoram5DelegateACP+**, rustmites***, spidermites**, mealybugs*, scales**, root weevils*Sept-OctSpinetoram <td></td> <td>Post-Bloom</td> <td>Cyantraniliprole</td> <td>28</td> <td>Exirel</td> <td>ACP<sup>+++</sup>, leafminers<sup>+++</sup>, root weevils<sup>+</sup></td>		Post-Bloom	Cyantraniliprole	28	Exirel	ACP <sup>+++</sup> , leafminers <sup>+++</sup> , root weevils <sup>+</sup>
Fenpyroximate21APortal*ACP+++, rustmites++, spidermites*+Diflubenzuron15Micromite*ACP+++, leafminers++, root weevils+Cyantraniliprole28ExirelACP+++, leafminers++, root weevils*Tolfenpyrad21AAptaACP+++, rustmites++, spidermites++, mealybugs+, scales*, root weevils*Flupyradifurone4DSivanto*ACP+++, rustmites++, spidermites++, spidermites*Way-JuneSpirotetramat23Movento*ACP+++, rustmites++, scales+++Abamectin6Agri-MekACP+++, rustmites++, spidermites*Cyantraniliprole28ExirelACP+++, rustmites++, spidermites*+, spidermites*Tolfenpyrad21AAptaACP+++, rustmites++, spidermites*+, spidermites*Tolfenpyrad21AAptaACP+++, rustmites++, spidermites*+, spidermites*+July-AugMineral oilUnknown435 OilACP+++, rustmites+, spidermites*, leafminers++July-AugMineral oilUnknown435 OilACP+++, rustmites+, spidermites*, leafminers+Spinetoram5DelegateACP+++, rustmites+, spidermites+, leafminers+Vigranophosphates1BMultiple brandsACP+++, rustmites+, spidermites+, mealybugs+, leafminers+Spinetoram5DelegateACP+++, rustmites+, spidermites+, mealybugs+, leafminers+Tolfenpyrad21AAptaACP+++, rustmites+, spidermites+, mealybugs+, leafminers+Spinetoram5DelegateACP+++, rustmites+, spidermites+, mealybugs+, scales*, root weevils+Sept-OctSpinetoram <t< td=""><td colspan="2">Apr</td><td>Mineral oil</td><td>Unknown</td><td>435 Oil</td><td>ACP<sup>+</sup>, rustmites<sup>+</sup>, spidermites<sup>+</sup>, leafminers<sup>+</sup>, scales<sup>+</sup>, mealybugs<sup>+</sup></td></t<>	Apr		Mineral oil	Unknown	435 Oil	ACP <sup>+</sup> , rustmites <sup>+</sup> , spidermites <sup>+</sup> , leafminers <sup>+</sup> , scales <sup>+</sup> , mealybugs <sup>+</sup>
Diflubenzuron15Micromite*ACP+++, leafminers++, rustmites++, root weevils+Cyantraniliprole28ExirelACP+++, leafminers++, root weevils+Tolfenpyrad21AAptaACP+++, rustmites++, soidermites++, mealybugs+, scales+, root weevils+Flupyradifurone4DSivanto*ACP+++, rustmites++, spidermites++, mealybugs+, leafminers+Way-JuneSpirotetramat23Movento*ACP+++, rustmites++, spidermites+Abamectin6Agri-MekACP+++, leafminers+++, root weevils+Tolfenpyrad21AAptaACP+++, leafminers+++, spidermites+Zyantraniliprole28ExirelACP+++, rustmites++, spidermites++, spidermites+Tolfenpyrad21AAptaACP+++, rustmites++, spidermites++, mealybugs+, scales*, root weevils+Flupyradifurone4DSivanto*ACP+++, leafminers++, spidermites++, mealybugs++, leafminers+July-AugMineral oilUnknown435 OilACP+++, rustmites+, spidermites*, leafminers+July-AugMineral oilUnknown435 OilACP+++, rustmites+, spidermites*, leafminers+Sept-OctSpinetoram5DelegateACP+++, rustmites+, spidermites*, mealybugs+, scales*, root weevils+Sept-OctSpinetoram5DelegateACP+++, rustmites+, spidermites*, mealybugs+, scales*, root weevils+Flupyradifurone4DSivanto*ACP+++, rustmites+, spidermites*, mealybugs+, scales*, root weevils+Sept-OctSpinetoram5DelegateACP+++, rustmites+, spidermites*, mealybugs+, scales*, root weevils+S			Fenpyroximate	21 <b>A</b>	Portal⁰	ACP <sup>++</sup> , rustmites <sup>++</sup> , spidermites <sup>++</sup>
Cyantraniliprole28ExirelACP+++, leafminers+++, root weevils*Tolfenpyrad21AAptaACP+++, rustmites++, spidermites++, mealybugs+, scales*, root weevils*Flupyradifurone4DSivanto°ACP+++, aphids+++, mealybugs++, leafminers*May-JuneSpirotetramat23Movento°ACP+++, rustmites++, scales+++ AbamectinAbamectin6Agri-MekACP+++, leafminers++, rustmites+++, spidermites+ Cyantraniliprole28ExirelACP+++, rustmites++, spidermites+Cyantraniliprole28ExirelACP+++, leafminers+++, root weevils+ scales*, root weevils+Tolfenpyrad21AAptaACP+++, rustmites++, spidermites++, mealybugs+, scales*, root weevils+Flupyradifurone4DSivanto°ACP+++, leafminers++, spidermites+, mealybugs+, scales*, root weevils+July-AugMineral oilUnknown435 OilACP+++, rustmites+, spidermites+, leafminers+ scales*, root weevils+July-AugMineral oilUnknown435 OilACP+++, rustmites+, spidermites+, leafminers+, scales*, root weevils+July-AugMineral oilUnknown435 OilACP+++, rustmites+, spidermites+, mealybugs+, scales*, root weevils+Sept-OctSpinetoram5DelegateACP+++, rustmites+, spidermites+, mealybugs+, scales*, root weevils+Sept-OctSpinetoram5DelegateACP+++, rustmites+, spidermites+, mealybugs+, scales*, root weevils+Sept-OctSpinetoram5DelegateACP+++, rustmites+, spidermites+, mealybugs+, scales*, root weevils+			Diflubenzuron	15	Micromite <sup>c</sup>	ACP <sup>++</sup> , leafminers <sup>++</sup> , rustmites <sup>+++</sup> , root weevils <sup>++</sup>
Tolfenpyrad21AAptaACP+++, rustmites++, spidermites++, mealybugs+, scales*, root weevils+Flupyradifurone4DSivanto*ACP+++, aphids+++, mealybugs++, leafminers*May-JuneSpirotetramat23Movento*ACP+++, rustmites++, scales+++ AbamectinAbamectin6Agri-MekACP+++, rustmites++, scales+++ aphiners++, root weevils*Tolfenpyrad21AAptaACP+++, leafminers++, root weevils* acles*, root weevils*Tolfenpyrad21AAptaACP+++, rustmites++, spidermites++, spidermites+ spidermites++, mealybugs+, scales*, root weevils*Flupyradifurone4DSivanto*ACP+++, rustmites++, spidermites++, mealybugs+, scales*, root weevils+July-AugMineral oilUnknown435 OilACP+++, rustmites+, spidermites+, mealybugs+ scales+, root weevils+July-AugMineral oilUnknown435 OilACP+++, rustmites+, spidermites+, mealybugs+, scales+, root weevils+Flupyradifurone4DSivanto*ACP+++, rustmites+, spidermites+, mealybugs+, scales+, root weevils+Sept-OctSpinetoram5DelegateACP+++, rustmites+, spidermites+, mealybugs+, scales+, root weevils+Flupyradifurone			Cyantraniliprole	28	Exirel	ACP <sup>+++</sup> , leafminers <sup>+++</sup> , root weevils <sup>+</sup>
Flupyradifurone4DSivantocACP+++, aphids+++, mealybugs++, leafminers+May-JuneSpirotetramat23MoventocACP+++, rustmites++, scales+++Abamectin6Agri-MekACP+++, leafminers++, rustmites++, spidermites+Cyantraniliprole28ExirelACP+++, leafminers++, root weevils+Tolfenpyrad21AAptaACP+++, rustmites++, spidermites++, mealybugs+, scales*, root weevils+Flupyradifurone4DSivantocACP+++, rustmites++, aphids+++, mealybugs+, scales*, root weevils+Purproxyfen7CKnackScales+++July-AugMineral oilUnknown435 OilACP+++, rustmites+, spidermites+, nealybugs+, scales*, nealybugs+Tolfenpyrad21AAptaScales*, root weevils+July-AugMineral oilUnknown435 OilACP+++, rustmites+, spidermites+, leafminers+, scales*, root weevils+Tolfenpyrad21AAptaScales*, root weevils+Flupyradifurone4DSivantocACP+++, rustmites+, spidermites+, nealybugs+, scales*, root weevils+Sept-OctSpinetoram5DelegateACP+++, rustmites+, spidermites+, mealybugs+, scales*, root weevils+Sept-OctSpinetoram5DelegateACP+++, rustmites+, spidermites++, mealybugs+, scales*, root weevils+Sept-OctSpinetoram5DelegateACP+++, rustmites+, spidermites+, mealybugs+, scales*, root weevils+Flupyradifurone4DSivantocACP+++, rustmites+, spidermites++, mealybugs+, scales*, root weevils+Flupyradifurone5Delegate </td <td></td> <td></td> <td>Tolfenpyrad</td> <td>21A</td> <td>Apta</td> <td>ACP<sup>+++</sup>, rustmites<sup>++</sup>, spidermites<sup>++</sup>, mealybugs<sup>+</sup>, scales<sup>+</sup>, root weevils<sup>+</sup></td>			Tolfenpyrad	21A	Apta	ACP <sup>+++</sup> , rustmites <sup>++</sup> , spidermites <sup>++</sup> , mealybugs <sup>+</sup> , scales <sup>+</sup> , root weevils <sup>+</sup>
May-JuneSpirotetramat23Movento°ACP+++, rustmites++, scales+++ Abamectin6Agri-MekACP+++, leafminers+++, rustmites++, spidermites+ Cyantraniliprole28ExirelACP+++, leafminers+++, root weevils+ Tolfenpyrad21AAptaACP+++, leafminers+++, root weevils+ scales+, root weevils+Flupyradifurone4DSivanto°ACP+++, aphids+++, mealybugs++, leafminers+ Spinetoram5DelegateACP+++, aphids+++, mealybugs++, leafminers+ scales+, root weevils+July-AugMineral oilUnknown435 OilACP+++, rustmites+, spidermites+, leafminers+, scales+, mealybugs+ scales+, mealybugs+July-AugMineral oilUnknown435 OilACP+++, rustmites+, spidermites+, leafminers+, scales+, mealybugs+July-AugMineral oilUnknown435 OilACP+++, rustmites+, spidermites+, leafminers+, scales+, root weevils+Spinetoram5DelegateACP+++, rustmites+, spidermites+, leafminers+, scales+, root weevils+Flupyradifurone4DSivanto°ACP+++, rustmites+, spidermites+, nealybugs+, scales+, root weevils+Sept-OctSpinetoram5DelegateACP+++, rustmites+, spidermites+, mealybugs+, scales+, root weevils+Sept-OctSpinetoram5DelegateACP+++, rustmites+, scales+++Tolfenpyrad21AAptaACP+++, leafminers+++Spirotetramat23Movento°ACP+++, leafminers+++Tolfenpyrad21AAptaACP+++, rustmites+, spidermites++, mealybugs+, scales+, root weevils+			Flupyradifurone	4D	Sivanto <sup>c</sup>	ACP <sup>+++</sup> , aphids <sup>+++</sup> , mealybugs <sup>++</sup> , leafminers <sup>+</sup>
Abamectin6Agri-MekACP++, leafminers++, rustmites++, spidermites+ Cyantraniliprole28ExirelACP+++, leafminers+++, root weevils+Tolfenpyrad21AAptaACP+++, rustmites++, spidermites++, mealybugs+, scales+, root weevils+Scales++, mealybugs++, leafminers++, mealybugs+, scales+, mealybugs++, leafminers+Flupyradifurone4DSivanto*ACP+++, aphids+++, mealybugs++, leafminers+ SpinetoramSpinetoram5DelegateACP+++, leafminers+++Pyriproxyfen7CKnackScales+++July-AugMineral oilUnknown435 OilACP+++, rustmites+, spidermites+, leafminers+, scales+, mealybugs+ scales+, mealybugs+July-AugMineral oilUnknown435 OilACP+++, rustmites++, spidermites+, leafminers+, scales+, mealybugs+ scales+, root weevils+July-AugMineral oilUnknown435 OilACP+++, rustmites++, spidermites+, leafminers+, scales+, mealybugs+ scales+, root weevils+July-AugMineral oilUnknown435 OilACP+++, rustmites++, spidermites+, leafminers+, scales+, root weevils+July-AugMineral oilUnknown435 OilACP+++, rustmites++, spidermites+, mealybugs+, scales+, root weevils+Sept-OctSpinetoram5DelegateACP+++, rustmites+, spidermites+, mealybugs+, scales+, root weevils+Sept-OctSpinetoram5DelegateACP+++, rustmites++, scales+++Spirotetramat23Movento*ACP+++, rustmites++, scales+++Tolfenpyrad21AAptaACP+++, rustmites++, spidermites	May-June		Spirotetramat	23	Movento <sup>c</sup>	ACP <sup>+++</sup> , rustmites <sup>++</sup> , scales <sup>+++</sup>
Cyantraniliprole28ExirelACP+++, leafminers+++, root weevils+Tolfenpyrad21AAptaACP+++, rustmites++, spidermites++, mealybugs+, scales+, root weevils+Flupyradifurone4DSivanto°ACP+++, aphids+++, mealybugs++, leafminers+ SpinetoramSpinetoram5DelegateACP+++, leafminers+++Pyriproxyfen7CKnackScales+++July-AugMineral oilUnknown435 OilACP++, rustmites+, spidermites+, leafminers+, scales+, mealybugs+ TolfenpyradTolfenpyrad21AAptaAcP+++, rustmites++, spidermites++, mealybugs+, scales+, root weevils+Flupyradifurone4DSivanto°ACP+++, rustmites+, spidermites+, mealybugs+, scales+, root weevils+Sept-OctSpinetoram5DelegateACP+++, rustmites+, spidermites+, mealybugs+, scales+, root weevils+Sept-OctSpinetoram5DelegateACP+++, rustmites+, spidermites+, mealybugs+, scales+, root weevils+Flupyradifurone4DSivanto°ACP+++, rustmites+, spidermites+, mealybugs+, scales+, root weevils+Sept-OctSpinetoram5DelegateACP+++, rustmites++, scales++++ root weevils+Flupyradifurone4DSivanto°ACP+++, rustmites++, scales+++ root weevils+Flupyradifurone4DSivanto°ACP+++, rustmites++, scales+++ root weevils+			Abamectin	6	Agri-Mek	ACP <sup>++</sup> , leafminers <sup>+++</sup> , rustmites <sup>+++</sup> , spidermites <sup>+</sup>
Tolfenpyrad21AAptaACP+++, rustmites++, spidermites++, mealybugs+, scales+, root weevils+Flupyradifurone4DSivanto°ACP+++, aphids+++, mealybugs++, leafminers+ SpinetoramSpinetoram5DelegateACP+++, leafminers+++Pyriproxyfen7CKnackScales+++July-AugMineral oilUnknown435 OilACP+++, rustmites+, spidermites+, leafminers+, scales+, mealybugs+Tolfenpyrad21AAptaACP+++, rustmites+, spidermites+, leafminers+, scales+, mealybugs+Tolfenpyrad21AAptaACP+++, rustmites+, spidermites+, nealybugs+, scales+, root weevils+Flupyradifurone4DSivanto°ACP+++, rustmites+, spidermites+, mealybugs+, scales+, root weevils+Sept-OctSpinetoram5DelegateACP+++, rustmites+, spidermites+, mealybugs+, scales+, root weevils+Sept-OctSpinetoram5DelegateACP+++, rustmites+, spidermites+, mealybugs+, scales+, root weevils+Flupyradifurone4DSivanto°ACP+++, rustmites++, scales+++Tolfenpyrad21AAptaACP+++, rustmites++, spidermites++, mealybugs+, scales+, root weevils+Flupyradifurone4DSivanto°ACP+++, rustmites++, spidermites++, mealybugs+, scales+, root weevils+			Cyantraniliprole	28	Exirel	ACP <sup>+++</sup> , leafminers <sup>+++</sup> , root weevils <sup>+</sup>
Flupyradifurone4DSivantocACP+++, aphids+++, mealybugs++, leafminers+ ACP+++, leafminers+++ PyriproxyfenJuly-AugMineral oilUnknown435 OilACP++, rustmites+, spidermites+, leafminers+, scales+, mealybugs+ scales+, mealybugs+July-AugMineral oilUnknown435 OilACP++, rustmites+, spidermites+, leafminers+, scales+, mealybugs+ scales+, root weevils+Tolfenpyrad21AAptaACP+++, rustmites+, spidermites+, mealybugs+, scales+, root weevils+Flupyradifurone4DSivantocACP+++, rustmites+, spidermites+, mealybugs+, scales+, root weevils+Sept-OctSpinetoram5DelegateACP+++, rustmites++, scales+++ scales+, root weevils+Sept-OctSpinetoram5DelegateACP+++, rustmites++, scales+++ scales+, root weevils+Flupyradifurone4DSivantocACP+++, rustmites++, spidermites++, mealybugs+, scales+, root weevils+Flupyradifurone4DSivantocACP+++, rustmites++, spidermites++, mealybugs+, scales+, root weevils+			Tolfenpyrad	21A	Apta	ACP <sup>+++</sup> , rustmites <sup>++</sup> , spidermites <sup>++</sup> , mealybugs <sup>+</sup> , scales <sup>+</sup> , root weevils <sup>+</sup>
Spinetoram5DelegateACP+++, leafminers+++Pyriproxyfen7CKnackScales+++July-AugMineral oilUnknown435 OilACP++, rustmites+, spidermites+, leafminers+, scales+, mealybugs+Tolfenpyrad21AAptaACP+++, rustmites++, spidermites++, mealybugs+, scales+, root weevils+Flupyradifurone4DSivantocACP+++, aphids+++, mealybugs++, leafminers+ organophosphatesOrganophosphates1BMultiple brandsACP+++, rustmites+, spidermites+, mealybugs+, scales+, root weevils+Sept-OctSpinetoram5DelegateACP+++, leafminers+++ scales+, root weevils+Sept-OctImage: Spinetoram5DelegateACP+++, rustmites++, scales+++ scales+, root weevils+Flupyradifurone4DSivantocACP+++, rustmites++, spidermites++, mealybugs+, scales+, root weevils+Flupyradifurone4DSivantocACP+++, rustmites++, spidermites++, mealybugs+, scales+, root weevils+			Flupyradifurone	4D	Sivanto <sup>c</sup>	ACP <sup>+++</sup> , aphids <sup>+++</sup> , mealybugs <sup>++</sup> , leafminers <sup>+</sup>
Pyriproxyfen7CKnackScales+++July-AugMineral oilUnknown435 OilACP++, rustmites+, spidermites+, leafminers+, scales+, mealybugs+ TolfenpyradTolfenpyrad21AAptaACP+++, rustmites++, spidermites++, mealybugs+, scales+, root weevils+Flupyradifurone4DSivantocACP+++, aphids+++, mealybugs++, leafminers+ organophosphatesOrganophosphates1BMultiple brandsACP+++, rustmites+, spidermites+, mealybugs+, scales+, root weevils+Sept-OctSpinetoram5DelegateACP+++, rustmites++, scales+++ roof weevils+Sept-OctSpinetoram21AAptaACP+++, rustmites++, spidermites++, mealybugs+, scales+, root weevils+Flupyradifurone4DSivantocACP+++, rustmites++, spidermites++, mealybugs+, scales+, root weevils+			Spinetoram	5	Delegate	ACP <sup>+++</sup> , leafminers <sup>+++</sup>
July-AugMineral oilUnknown435 OilACP++, rustmites+, spidermites+, leafminers+, scales+, mealybugs+ TolfenpyradTolfenpyrad21AAptaACP+++, rustmites++, spidermites++, mealybugs+, scales+, root weevils+Flupyradifurone4DSivanto°ACP+++, aphids+++, mealybugs++, leafminers+ organophosphatesOrganophosphates1BMultiple brandsACP+++, rustmites+, spidermites+, mealybugs+, scales+, root weevils+Sept-OctSpinetoram5DelegateACP+++, rustmites++, scales+++ root weevils+Spirotetramat23Movento°ACP+++, rustmites++, scales+++ root weevils+Tolfenpyrad21AAptaACP+++, rustmites++, spidermites++, mealybugs+, scales+, root weevils+Flupyradifurone4DSivanto°ACP+++, rustmites++, spidermites++, mealybugs+, scales+, root weevils+			Pyriproxyfen	7C	Knack	Scales <sup>+++</sup>
Tolfenpyrad21AAptaACP+++, rustmites++, spidermites++, mealybugs+, scales+, root weevils+Flupyradifurone4DSivantocACP+++, aphids+++, mealybugs++, leafminers+Organophosphates1BMultiple brandsACP+++, rustmites+, spidermites+, mealybugs+, scales+, root weevils+Sept-OctSpinetoram5DelegateACP+++, leafminers+++Spirotetramat23MoventocACP+++, rustmites++, scales+++Tolfenpyrad21AAptaACP+++, rustmites++, spidermites++, mealybugs+, scales+, root weevils+Flupyradifurone4DSivantocACP+++, aphids+++, mealybugs++, leafminers+	July-Aug		Mineral oil	Unknown	435 Oil	ACP <sup>++</sup> , rustmites <sup>+</sup> , spidermites <sup>+</sup> , leafminers <sup>+</sup> , scales <sup>+</sup> , mealybugs <sup>+</sup>
Flupyradifurone4DSivantocACP+++, aphids+++, mealybugs++, leafminers+Organophosphates1BMultiple brandsACP+++, rustmites+, spidermites+, mealybugs+, scales+, root weevils+Sept-OctSpinetoram5DelegateACP+++, leafminers+++Spirotetramat23MoventocACP+++, rustmites++, scales+++Tolfenpyrad21AAptaACP+++, rustmites++, spidermites++, mealybugs+, scales+, root weevils+Flupyradifurone4DSivantocACP+++, aphids+++, mealybugs++, leafminers+			Tolfenpyrad	21A	Apta	ACP <sup>+++</sup> , rustmites <sup>++</sup> , spidermites <sup>++</sup> , mealybugs <sup>+</sup> , scales <sup>+</sup> , root weevils <sup>+</sup>
Organophosphates1BMultiple brandsACP+++, rustmites+, spidermites+, mealybugs+, scales+, root weevils+Sept-OctSpinetoram5DelegateACP+++, leafminers+++Spirotetramat23Movento°ACP+++, rustmites++, scales+++Tolfenpyrad21AAptaACP+++, rustmites++, spidermites++, mealybugs+, scales+, root weevils+Flupyradifurone4DSivanto°ACP+++, aphids+++, mealybugs++, leafminers+			Flupyradifurone	4D	Sivanto <sup>c</sup>	ACP <sup>+++</sup> , aphids <sup>+++</sup> , mealybugs <sup>++</sup> , leafminers <sup>+</sup>
Sept-Oct     Spinetoram     5     Delegate     ACP+++, leafminers+++       Spirotetramat     23     Movento <sup>c</sup> ACP+++, rustmites++, scales+++       Tolfenpyrad     21A     Apta     ACP+++, rustmites++, spidermites++, mealybugs+, scales+, root weevils+       Flupyradifurone     4D     Sivanto <sup>c</sup> ACP+++, aphids+++, mealybugs++, leafminers+			Organophosphates	1B	Multiple brands	ACP <sup>+++</sup> , rustmites <sup>+</sup> , spidermites <sup>+</sup> , mealybugs <sup>+</sup> , scales <sup>+</sup> , root weevils <sup>+</sup>
Spirotetramat   23   Movento <sup>c</sup> ACP+++, rustmites++, scales+++     Tolfenpyrad   21A   Apta   ACP+++, rustmites++, spidermites++, mealybugs+, scales+, root weevils+     Flupyradifurone   4D   Sivanto <sup>c</sup> ACP+++, aphids+++, mealybugs++, leafminers+	Sept-Oct	t	Spinetoram	5	Delegate	ACP <sup>+++</sup> , leafminers <sup>+++</sup>
Tolfenpyrad 21A Apta ACP+++, rustmites++, spidermites++, mealybugs+, scales+, root weevils+   Flupyradifurone 4D Sivanto <sup>c</sup> ACP+++, aphids+++, mealybugs++, leafminers+			Spirotetramat	23	Movento <sup>c</sup>	ACP <sup>+++</sup> , rustmites <sup>++</sup> , scales <sup>+++</sup>
Flupyradifurone 4D Sivanto <sup>c</sup> ACP <sup>+++</sup> , aphids <sup>+++</sup> , mealybugs <sup>++</sup> , leafminers <sup>+</sup>			Tolfenpyrad	21A	Apta	ACP <sup>+++</sup> , rustmites <sup>++</sup> , spidermites <sup>++</sup> , mealybugs <sup>+</sup> , scales <sup>+</sup> , root weevils <sup>+</sup>
			Flupyradifurone	4D	Sivanto <sup>c</sup>	ACP+++, aphids+++, mealybugs++, leafminers+

<sup>a</sup>Mode of action (MoA) class of the active ingredient according to the Insecticide Resistance Action Committee (IRAC)

<sup>b</sup> Check product label for rates, restrictions and recommended use in citrus. Some products appear multiple times in the table due to their role in controlling different

pests but not to repeat a particular MoA. Neonicotinoids and premixes not included due to resistance concerns. Neonicotinoid use is best reserved for soil drenches on young trees. Premixes expose pests to more than one MoA. Allowed for use on blooming citrus insecticides alone compared to the untreated check, and was significantly less than the check with organic insecticides plus M-Pede, possibly due to a spray on bloom.

The relative effectiveness of conventional insecticides for control of ACP and other pests is listed in Table 1 (page 18). Smart choices which target multiple pests that may be present in significant numbers with one spray of single MoA will reduce unnecessary sprays and attendant costs.

More research and funding is still warranted to investigate the sustainability of these organic programs, their role in managing other pests and integrated use of organic and conventional insecticides.

#### **BIOLOGICAL CONTROL**

Natural enemies including predators, parasitoids, certain fungi and even nematodes play an important role in controlling pests of citrus. Many beneficial insects are rare in citrus groves during winter due to the lack of prey, but increase in spring coincident with new growth and may persist during the growing season.

ACP, citrus leafminers, aphids, weevils and mites colonize flush, as do their natural enemies such as ladybeetles, lacewings, spiders, minute pirate bug, predaceous mites and parasitic wasps, with the potential of keeping these pests under control. Sprays targeted at flush negatively impact beneficial insects, reducing natural control for many pests and often leading to secondary pest outbreaks. Citrus leafminers, aphids and root weevils are associated with canker, tristeza and root rot, respectively. So these diseases increase with increased pest pressure.

We saw that lacewings, spiders and ladybeetles all increased where organic insecticides were used, which may have contributed to ACP reduction. Green lacewings were the most abundant predator and are mobile enough to move in quickly from the surrounding habitats. Ladybeetles, which were formally abundant in our groves, are now rarely seen, presumably due to frequent



Figure 3. Valencia yield (lbs./tree) in organic and conventional programs, 2016.

use of broad-spectrum insecticides. Likewise, the parasitoid *Tamarixia radiata* was released in all plots in the above experiments, but mostly recovered from ACP nymphs in plots sprayed with organic insecticides. Thus, the best time to release Tamarixia would be in the spring flush after dormant sprays. **\*** 

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