Diaprepes Root Weevil Science Advisory Panel Comments and Recommendations
October 26-27, 2005

The Diaprepes Root Weevil Science Advisory Panel (DRW SAP) met in Costa Mesa on October 26 and 27, 2005. The purpose of the meeting was to provide recommendations in response to the finding of multiple adult Diaprepes root weevils (DRW) (*Diaprepes abbreviatus*) in two residential locations in Long Beach and in Newport Beach, California. The Panel members are: Dr. Elizabeth Grafton-Cardwell (UC Riverside), Dr. Catharine Mannion (Univ. Florida), Dr. Clayton McCoy (Univ. Florida), Dr. Herbert Nigg (Univ. Florida), and Dr. Jorge Peña (Univ. Florida). Both Dr. Mannion and Dr. Peña were unable to attend the meeting due to damage caused to their home area of Miami by a hurricane, but they have participated in formulating and reviewing the following comments and recommendations. Input was also provided by Dr. Kris Godfrey (CDFA) and Dr. John Kabashima (UC Coop. Ext.). Following are the comments and recommendations developed during this meeting and discussed with CDFA and with Los Angeles and Orange County Agricultural Commissioner staff.

GENERAL COMMENTS

1. The Panel endorses the policy of aggressively eradicating the current infestations of Diaprepes root weevil discovered in California. The wide host plant range of this beetle and the damage inflicted on these hosts make this insect a very significant threat to the agricultural industry, to nurseries, and to urban and rural landscapes throughout the state. The SAP believes that eradication is possible at the two sites.

HOST CONSIDERATIONS

2. Diaprepes has an extremely wide host range. Diaprepes has been observed infesting or feeding on camphor, calliandra, coral trees, roses, hibiscus, palms, and Indian hawthorn as well as other plants in the infested areas in Newport Beach and Long Beach California. Host preferences need to be studied in California. For example, camphor, coral trees, and Indian hawthorn are not on existing host lists. DRW is encountering hosts it has not been exposed to before in California and is able to do well on them.

3. Host plant identification should be made wherever there is a positive find. A photo ID of plants and the beetle stages should be created for employees.

4. Study of the flushing cycle of favored plant species. The flushing status of the plant can be more important than the species of plant. The full host range of Diaprepes in California is not known. Diaprepes prefers flush for feeding and older foliage for egg laying in citrus. However, this is not the case for some other hosts and on these plants eggs may be deposited on both old and new leaves. The situation in California has many host plants that have very different growing patterns (monocots and dicots) as opposed to only one crop, i.e., citrus.

SURVEY

5. GIS mapping should be made of the find sites. The host plants should be identified, the number of beetles recorded, sexed, and the condition of the plants (i.e., flushing status) should be noted.

6. Weevils should not be left on site. Place all specimens in alcohol before leaving the site.

7. Trapping methods: Currently the survey teams are utilizing visual surveys, beating sheets, and Tedders traps. The SAP recommends that the number and types of traps be increased to include cup traps (solo cup+boll weevil trap on a stake) in the crowns of

trees, hedges and shrubs (collecting both young and old adults) and emergence traps (screened cone on the soil) below various host plants (collect newly emerging adults). The hole in the boll weevil trap should be enlarged to the size of a large sharpie marker. The cup traps should be used in situations where Tedders traps are not appropriate. These additional methods should be used in a subset of the properties; the SAP recommends at least 10 traps per infestation area.

8. Standardize the survey technique: Use the white beating sheet and shake method, standardized in all counties to demonstrate the progress of the program.

TREATMENT

9. The SAP is concerned that CDFA did not spray infested properties immediately after detection. The treatments need to start as soon as possible, because the female beetles are laying eggs now.

10. Emergency treatment of all properties with positive finds.
    a. All plants that can be reached in every infested property
    b. ¼ mile out from the find (valid because of flight distance of adults)
    c. Females are laying eggs now- need to be treated soon

11. Potential treatments:
    a. Nematodes are only 40-50% effective. They must have irrigation before and after application and they need a minimum soil temperature of 70^{o}. In California November to April is the rainy period, but this is also the coldest time of the year so soil temperature may be below 70^{o} during this period. Research suggests that monthly applications are best.
    b. Insecticides
        i. Carbaryl (Sevin) has both a landscape and fruit tree label, and is effective against adults.
        ii. Neonicotinoids
            1. Imidacloprid (Merit) enhances the action of nematodes. Larvae normally void themselves of nematodes in the soil, but they can not groom when exposed to imidacloprid. Use as a soil application for larvae. Merit is both a foliar and a soil formulation.
            2. Thiomethoxam (Flagship, Platinum) has efficacy as a soil application against neonates and reduces adults on the foliage. It has not been tested in combination with nematodes.
            3. Other neonicotinoids are nearing registration for ornamentals and should be studied.
        iii. Pyrethroids
            1. Zeta cypermethrin (Mustang Max) is very effective on adults in the lab and the field.
            2. Cyfluthrin (Baythroid) is very effective on adults.
            3. Fenpropathrin (Danitol, Tame) is not quite as effective as cyfluthrin or zeta cypermethrin on adults.
            4. Bifenthrin (Talstar) both granular soil and foliar with landscape label. The soil formulation kills the neonates dropping to the soil. It can be used as a foliar for adults. Soil application residual activity can last several months.
        iv. Diflubenzuron (Micromite, Dimilin) is very important for egg control. It acts by sterilizing eggs when the eggs are laid on residues and when adult females feed on treated foliage.

12. Treatment timing for insecticides:
    a. If beetles are present, spray both infested properties and adjacents.
    b. Spray both infested and uninfested properties during periods of flushing.
    c. Recommend developing pruning, fertilization, and watering recommendations that limit or synchronize flushing to maximize the effect of insecticides (perhaps limit pruning during critical months of the spring). Limit pruning in the spring so that when the beetles emerge they have flush available, then treat them with insecticides (effectively turn the flush into a trap crop).

13. Treatment recommendations: All life stages need to be controlled, because this is the most effective method of eradicating a pest.
    a. Adults are most effectively killed by pyrethroids or carbaryl.
    b. Eggs are most effectively controlled by Micromite (diflubenzuron). Parasites are also effective against the egg stage but they are sensitive to most of the insecticides that are likely to be applied to other stages, and their efficacy under California conditions has not been studied.
    c. Neonate larvae are most effectively killed by Talstar (bifenthrin). Talstar is a barrier treatment that kills the neonates as they drop to the soil. Treatments should be made on the soil under the canopy of trees or shrubs. Leaf litter should be removed and irrigation applied before and after treatment.
    d. Larvae beyond the first instar can only be controlled by the combination of soil-applied imidacloprid or thiomethoxam and nematodes. Only partial control of larval stages can be expected from these treatments. The commercial formulation of nematodes recommended is *Steinernema riobrave* (Biovector). Treatments of nematodes are applied monthly; imidacloprid is applied once per season. The large larvae will be the most difficult stage to control.

14. Resistance Management: It is important to have a number of insecticides available to rotate in order to avoid resistance. This is especially important in this situation, because it is likely to take 5-7 years to eradicate the population.

15. Nontarget organisms: A number of insecticides should be available to better minimize the impact of any one of these products on natural enemies and nontarget organisms. In addition, some of the insecticides may cause outbreaks of secondary pests such as spider mites, and choices need to be available to avoid this situation on some host plants. For example, coral trees are sensitive to spider mites and camphor trees have persea mite. Carbaryl may flare mites and imidacloprid and some of the pyrethroids can have the same effect. Fenpropathrin has miticidal activity and so it may help reduce this effect.

16. 5-7 years of follow up will be needed because Diaprepes is a slow growing insect (9-18 months to complete the lifecycle), and the treatment program primarily eliminates the adult stage. Larvae that are not killed by insecticides will remain in the soil until the adults emerge. It will take at least 3 years for the cycle to be broken.

17. Immediate control program
    a. Pyrethroid or carbaryl for adults on foliage
    b. Talstar for neonates on the surface of the ground
    c. Flagship for control of larvae in the ground and adults feeding on flush
    d. Obtain an SLN for Micromite to sterilize eggs

18. Control spring 2006
    a. All of the above listed in the immediate control program
    b. Add imidacloprid + nematodes for larval control when root flush begins

OUTREACH

19. Initiate an education program to enlist the public in detection of other infestations. This will include landscapers, master gardeners, home owners and the agriculture industry. Use posters, cards, news releases, etc. Both English and Spanish versions should be developed.

20. Education of nurseries: Need increased Agricultural Commissioners and CDFA inspection of nurseries and tougher punishment (enforcement funds) for illegal movement of plant material.

21. Because of the complexity of the eradication and quarantine efforts it is essential that agencies communicate and work together. Consistency in verbal and written communication to homeowners, landscapers, nurserymen, and the general public is very important.

ORIGIN DETERMINATION

22. Determine the common denominator of infestations. Should go back in time until the common denominator of the two infestations is found (landscapers, nursery, etc.). Was it nursery plants or human mediated transfer? Discuss with homeowners and landscapers the history of plantings.

23. Molecular testing of beetles from the two locales should be done to determine potential origins.

RESEARCH NEEDS

23. Biological control with parasitoids: As long as it is believed that eradication is possible, insecticides and nematodes are the methods of treatment; however, the ground work should be prepared on biological control in case eradication efforts are not successful.

24. Pheromones: A better detection tool is needed and pheromones are a very important part of this. Funding needs to be possibly directed towards ARS researchers in Florida working on the Diaprepes pheromone attractant.

25. Life cycle of Diaprepes in California: The impression should not be given that any infested properties will be left untreated. On the other hand, treatments are not likely to eliminate all of the weevils in the first season, and so important information about the timing of events in the life of Diaprepes and their host associations can be gained by conducting research in conjunction with the eradication efforts. For example, adult emergence traps may be useful in determining peak emergence periods.

26. Insecticide trials: There are a number of insecticides registered for ornamentals in California that have not been screened against Diaprepes in Florida, and so there is no information about their efficacy. It would be helpful to have them tested.

27. Nematodes: The efficacy of nematodes in California soils with and without imidacloprid or thiomethoxam should be examined.