

SMITH, D., G. A. C. BEATTIE, AND R. BROADLEY (eds.). 1997. *Citrus Pests and Their Natural Enemies. Integrated Pest Management in Australia*. Department of Primary Industries, Brisbane, Queensland, Australia. xvi + 282 p. ISBN 0 7242 6695 X. Paperback. Australian \$75.

The high quality of the cover photograph—eggs, nymphs, and adult of a spined citrus bug in beautiful color—immediately caught my eye. As I paged through the book, I realized it was just one of over 400 wonderful color photographs in this book on citrus pests and their natural enemies in Australia! The photographs are of unusually high quality and justify the price of the book. There is much more to admire about this book because it has several features that make it particularly useful, even to pest managers in other countries.

The book includes descriptions of the biology and damage caused by over 100 citrus pests, a taxonomic key to the parasitic wasps of scales and mealybugs in Australian citrus groves, a good index, and a list of relevant references. It begins with a glossary of terms, a brief introduction of the Australian citrus industry, a description of the citrus varieties grown, and the weather conditions in the major citrus growing regions. The book deals with tree diseases, insects, mites, nematodes, snails, and (even) a pest spider! Over 100 pest species are described, and their frequency is categorized as “Major,” “Occasionally important,” or “Minor” in each of the growing regions using color-coded maps. I decided to focus on one section, describing the mite pests of citrus, to determine whether I could use the manual as intended.

Citrus in Australia has several pest mites, including the brown citrus rust mite, *Tegolophus australis*. Photographs show all the life stages of the mite, with discriminating characters to differentiate it from the citrus rust mite, *Phyllocoptruta oleivora*, also a pest in Australia. The photographs were sufficiently good that I could use them to identify the mites in the field using a hand lens. A map showed the importance and distribution of the brown citrus rust mite in Australia. A diagram of the life cycle is given, and photographs illustrate the type of damage these mites do to lemons and Valencia oranges. A separate box labeled “Damage” summarizes the damage to the fruit, leaves, and twigs.

The natural enemies of the brown citrus rust mite are described and a beautiful photograph of the predatory mite *Euseius victoriensis* is given. This phytoseiid mite is described as an effective predator, particularly in inland citrus areas and in sub-coastal Queensland. Other phytoseiid mites are listed as important in other geographic regions, and other natural enemies are mentioned, including predatory stigmatid mites, cecidomyiid fly larvae, and fungal pathogens.

Cultural practices that are important in managing the brown citrus rust mite are included: grass should be planted between tree rows in order that pollen for the predatory mites is consistently available as a supplementary food source. Pollen also can be provided by eucalyptus trees serving as windbreaks. Monitoring is an integral component of the management program. Guidelines are given on how to monitor pest mite densities, an “Action level” is given, and “Appropriate action” is described if the pest population exceeds the action level. A graph takes the number of predatory mites per 100 leaves into account as well as the number of rust mites, and miticides are recommended that are least toxic to the predatory mites. Under the “Additional management” notes, recommendations are made to encourage growth of pollen-producing plants that will provide food to natural enemies (including predatory mites and parasitoids of red scale), discourage growth of plants (broadleaf weeds and legumes) that are hosts of the lightbrown apple moth, *Epiphyas postvittana* (another citrus pest), avoid overzealous mowing by mowing alternate rows every 2 to 4 weeks, and establish

peripheral windbreaks of predator-harboring plants such as eucalyptus, especially in new citrus plantings.

Another interesting section is on aphids, in part because the "brown citrus aphid" recently invaded Florida's citrus. Brown citrus aphid (but called black citrus aphid in Australia), *Toxoptera citricida*, and *Toxoptera aurantii* are described as "minor" pests in Australia. This is of particular interest to Florida's citrus growers because *T. citricida* is expected to transmit tristeza virus to trees grafted on susceptible rootstocks. In Australia, the "Damage" listing does not mention tree loss due to tristeza. The description of natural enemies includes the statement: "Natural enemies are important in controlling citrus aphids." Diverse predator species are pictured, including the transverse ladybird, *Coccinella transversalis*; the common spotted ladybird, *Harmonia conformis*; *Harmonia testudinaria*; the variable ladybird, *Coelophora inaequalis*; the yellow-shouldered ladybird, *Scymnodes lividigaster*; syrphid flies, including *Simosyrphus grandicornis*; and lacewing larvae. A photograph of aphid mummies shows high levels of parasitism resulting from "a small aphelinid wasp"; and both "*Aphidius* spp. and *Aphelinus* spp." are listed as natural enemies of the aphids. In addition, an *Entomophthora* fungus attacks the aphids. The authors state "It is rarely necessary to spray aphids in mature orchards, as the large numbers of natural enemies usually give satisfactory control." It is likely that these aphids are relatively unimportant in Australia due to the combined effects of natural enemies and because the citrus rootstocks recommended are resistant or tolerant to tristeza.

Unusual facts contained within this book include the description of a **pest** spider. Most of us consider spiders as beneficial, but the brown house spider, *Badumna longinqua*, is a pest in Australian citrus groves because the webbing snares numerous **natural enemies** of pest insects. The webs are also a nuisance to fruit pickers.

A section on IPM provides a template for IPM in citrus. The authors note that several components make up a practical IPM program, including identification of pests and their natural enemies, monitoring of pests and their natural enemies, data recording and reporting, decision making, taking appropriate action to manage pests, and reappraisal and research. Each of these components is addressed in this section, with sample data sheets and monitoring guides provided. The monitoring guides are very well constructed with small color photographs of each pest and a color-coded key to their location (i.e., on shoots, flowers, leaves, young fruit, maturing fruit, or twigs and branches). The recommended frequency of sampling for each pest is provided and action levels are given for each pest (i.e., 25%, 50%, 15% infestation levels). The Monitoring Guides are specific to each geographic region (Queensland and coastal New South Wales; inland New South Wales, Sunraysia and Riverland regions; or Western Australia) and are divided into Early Season, Mid-Season, and Late Season.

The acute toxicity of pesticides (insecticides, miticides, and fungicides) to natural enemies is rated as low, moderate, or high. In addition, the residual toxicity is estimated for each product in weeks so that natural enemies can be released safely into groves after a pesticide application. Petroleum spray oils are recommended as solutions to widespread resistance to synthetic pesticides by the pests and to environmental and health problems associated with pesticide use. Spray oils are recommended because their toxicity to vertebrates is low, they have fewer detrimental effects on beneficial insects and mites, they do not stimulate pest outbreaks, no pests have become resistant to them, and they can be broken down within weeks by microbes, oxidation, and UV light. Guidelines are provided for timing applications of spray oils in the different growing regions to control an array of pests, including armored scales, soft scales, mealybugs, whiteflies, thrips, and mites.

This book is very well presented and organized. It is packed with useful information on citrus pests and their natural enemies that will be helpful to biological control

workers and pest managers everywhere. *Citrus Pests and their Natural Enemies* is an outstanding contribution to the IPM literature because it emphasizes ecologically- and biologically-based pest management tactics and is not simply a manual describing how to apply toxic pesticides more efficiently.

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