Classical Biological Control of *Bemisia tabaci* in the United States - A Review of Interagency Research and Implementation

Progress in Biological Control

Volume 4

Published:

Volume 1
H.M.T. Hokkanen and A.E. Hajek (eds.):
Environmental Impacts of Microbial Insecticides – Need and Methods for Risk Assessment. 2004 ISBN 978-1-4020-0813-9

Volume 2
J. Eilenberg and H.M.T. Hokkanen (eds.):
An Ecological and Societal Approach to Biological Control. 2007
ISBN 978-1-4020-4320-8

Volume 3
J. Brodeur and G. Boivin (eds.):
Trophic and Guild Interactions in Biological Control. 2006
ISBN 978-1-4020-4766-4

Forthcoming:

Integration of Insect-Resistant GM Crops within IPM Programs
Edited by J. Romeis, A.M. Shelton and G.G. Kennedy

Use of Microbes for Control and Eradication of Invasive Arthropods
Edited by A.E. Hajek, M. O'Callaghan and T. Glare

Ecological & Evolutionary Relationships among Entomphagous Arthropods and Non-prey Foods
By J. Lundgren

Biocontrol-based Integrated Management of Oilseed Rape Pests
Edited by I.H. Williams and H.M.T. Hokkanen

Biological Control of Plant-Parasitic Nematodes: Building Coherence between Microbial Ecology and Molecular Mechanisms
Edited by Y. Spiegel and K. Davies

Juli Gould • Kim Hoelmer • John Goolsby
Editors

Classical Biological Control of *Bemisia tabaci* in the United States - A Review of Interagency Research and Implementation

Springer

Juli Gould
USDA-APHIS
MA
USA

Kim Hoelmer
USDA-ARS
Newark
DE
USA

John Goolsby
USDA-ARS
Weslaco
TX
USA

ISBN 978-1-4020-6739-6 e-ISBN 978-1-4020-6740-2

Library of Congress Control Number: 2007937656

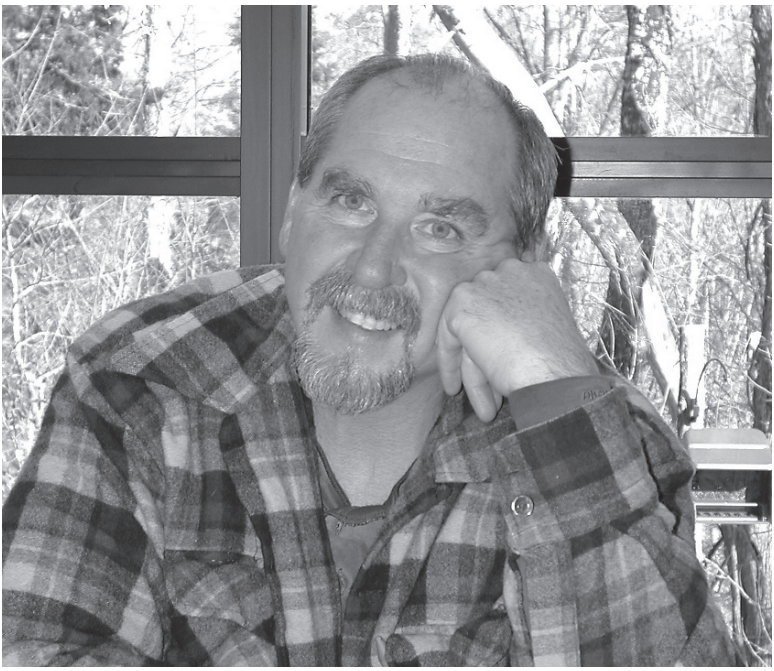
Cover illustrations: A female *Eretmocerus* (an undescribed species native to Florida) feeds on fluids exuding from a *Bemisia tabaci* nymph that has been pierced by the wasp's ovipositor (top picture) and oviposits underneath a *B. tabaci* nymph (bottom picture).
Photograph credits: Mike Rose

Printed on acid-free paper

9 8 7 6 5 4 3 2 1

springer.com

Dedication



This book is dedicated to Mike Rose (1945–2004), an author of Chapter 5, preeminent biological control specialist and inspirational mentor to many of the book's authors. Mike Rose began his career at the University of California, Riverside, in the early 1960s working with Paul DeBach on biological control of whitefly, scale and mealybug pests of citrus. His career continued at Texas A&M University, and even in nominal retirement in Montana he remained very active as a biological control consultant. Mike's expertise in biological control of whitefly and in the aphelinid genus *Eretmocerus* made him a natural leader and proponent of the biological control program for *Bemisia tabaci* in the USA. Mike's influence can be seen in many aspects of the research reported in this book, especially in the taxonomy, quarantine evaluation, and postrelease evaluation of the natural enemies.

Progress in Biological Control

Series Preface

Biological control of pests, weeds, and plant and animal diseases utilising their natural antagonists is a well-established and rapidly evolving field of science. Despite its stunning successes world-wide and a steadily growing number of applications, biological control has remained grossly underexploited. Its untapped potential, however, represents the best hope to providing lasting, environmentally sound, and socially acceptable pest management. Such techniques are urgently needed for the control of an increasing number of problem pests affecting agriculture and forestry, and to suppress invasive organisms which threaten natural habitats and global biodiversity.

Based on the positive features of biological control, such as its target specificity and the lack of negative impacts on humans, it is the prime candidate in the search for reducing dependency on chemical pesticides. Replacement of chemical control by biological control – even partially as in many IPM programs – has important positive but so far neglected socio-economic, humanitarian, environmental and ethical implications. Change from chemical to biological control substantially contributes to the conservation of natural resources, and results in a considerable reduction of environmental pollution. It eliminates human exposure to toxic pesticides, improves sustainability of production systems, and enhances biodiversity. Public demand for finding solutions based on biological control is the main driving force in the increasing utilisation of natural enemies for controlling noxious organisms.

This book series is intended to accelerate these developments through exploring the progress made within the various aspects of biological control, and via documenting these advances to the benefit of fellow scientists, students, public officials, policymakers, and the public at large. Each of the books in this series is expected to provide a comprehensive, authoritative synthesis of the topic, likely to stand the test of time.

Heikki M.T. Hokkanen, Series Editor

Editors Preface

This book reviews interagency research and development of classical (importation) biological control of *Bemisia tabaci* (biotype B) conducted in the USA from 1992-2002. The successful discovery, evaluation, release, and establishment of at least five exotic *B. tabaci* natural enemies in rapid response to the devastating infestations in the USA represents a landmark in interagency cooperation and coordination of multiple disciplines. The review covers all key aspects of the classical biocontrol program, beginning with foreign exploration and quarantine culture, through development of mass rearing methodology, laboratory and field evaluation for efficacy, to field releases, integration with other management approaches, and monitoring for establishment and potential non-target impacts. The importance of morphological and molecular taxonomy to the success of the program is also emphasized. The book's contributors include 28 USDA, state department of agriculture, and university scientists who participated in various aspects of the project.

Bemisia tabaci continues to be a pest of major concern in many parts of the world, especially since the recent spread of the Q biotype, so the publication of a review of the biological control program for the B biotype is especially timely. We anticipate that our review of the natural enemies that were evaluated and which have established in the USA will benefit researchers and IPM practitioners in other nations affected by *B. tabaci.* This book will also serve as a useful reference for scientists in the USA conducting research on the Q biotype of *B. tabaci.* It will complement other recent works on *Bemisia* that deal more broadly with a wide range of subject areas and consequently must treat importation biological control in much less detail. Although the book's theme is *B. tabaci*, the organization and conduct of the project serves as a useful model for programs directed at biological control of other whitefly species, as well as biocontrol programs for other pests. This book should also support and encourage classical biological control inputs into other integrated pest management systems.

We would like to acknowledge Deborah Winograd (USDA-APHIS-PPQ, Center for Plant Health Science and Technology) for her assistance in reviewing the book chapters for grammar, consistency, and reference citations.

Juli Gould
Kim Hoelmer
John Goolsby

Contents

Contributing Authors

Earl R. Andress
USDA-APHIS Pink Bollworm Rearing Facility
3645 E. Chipman Rd., Phoenix AZ 85040 USA

James Brown
California Department of Food & Agriculture, Biological Control Program
3288 Meadowview Rd., Sacramento, California 95832 USA

Albino B. Chavarria
USDA-APHIS-PPQ, Center for Plant Health Science and Technology Laboratory
22675 N. Moorefield Rd., Edinburg, TX, 78541-9398 USA

Matthew A. Ciomperlik
USDA-APHIS-PPQ, Center for Plant Health Science and Technology Laboratory
22675 N. Moorefield Rd., Edinburg, TX, 78541-9398 USA

Nick Colletto
USDA-APHIS Pink Bollworm Rearing Facility
3645 E. Chipman Rd., Phoenix, AZ 85040 USA

Robert M. Faust
USDA-ARS, National Program Staff (retired)
5601 Sunnyside Ave, Beltsville, MD 20705-5103 USA

John A. Goolsby
USDA-ARS, Kika de la Garza Subtropical Agricultural Research Center
Beneficial Insects Research Unit
2413 East Highway 83, Weslaco, Texas 78596 USA

Juli Gould
USDA-APHIS-PPQ, Center for Plant Health Science and Technology Laboratory
Building 1398, Otis ANGB, MA 02542 USA

Thomas J. Henneberry
USDA-ARS Arid Land Agricultural Research Center (retired)
21881 North Cardon Lane, Maricopa, AZ 85238 USA

John M. Heraty
Department of Entomology
University of California, Riverside, CA 92521 USA

Kim A. Hoelmer
USDA-ARS, Beneficial Insect Introduction Research Unit
501 South Chapel St., Newark, DE 19713-3814 USA

Alan A. Kirk
USDA-ARS, European Biological Control Laboratory
Campus International de Baillarguet, CS 90013, Montferrier-sur-Lez
34988 St. Gély du Fesc Cedex, France

Lawrence A. Lacey
USDA-ARS, Yakima Agricultural Research Center
5230 Konnowac Pass Road, Wapato, WA 98951 USA

Benjamin C. Legaspi, Jr.
Florida Public Service Commission
2540 Shumard Oak Blvd. Tallahassee, FL 32399 USA

Jesusa C. Legaspi
USDA-ARS CMAVE – Florida A&M University, Center for Biological Control
6383 Mahan Drive, Tallahassee, Florida 32308 USA

Paul Merten
USDA-ARS, Arid Land Agricultural Research Center
21881 North Cardon Lane, Maricopa, AZ 85238 USA

Eric T. Natwick
ANR UCCE, University of California, Desert Research & Extension Center
1050 East Holton Road, Holtville, CA 92250-9615 USA

Charles H. Pickett
California Department of Food & Agriculture, Biological Control Program
3288 Meadowview Rd., Sacramento, California 95832 USA

Andrew Polaszek
Entomology Department, Natural History Museum
Cromwell Road, London, SW7 5BD U.K.

Mark Quinn
Department of Crop and Soil Sciences, Washington State University
P.O. Box 646420, Pullman, WA 99164-6420 USA

William J. Roltsch
California Department of Food & Agriculture, Biological Control Program
3288 Meadowview Rd., Sacramento, California 95832 USA

Mike Rose*
Department of Entomology, Montana State University (*deceased)
Bozeman, MT 59717 USA

Raul A. Ruiz-Arce
USDA-APHIS-PPQ, Center for Plant Health Science and Technology Laboratory
22675 N. Moorefield Rd., Edinburg, TX, 78541-9398 USA

Michael E. Schauff
USDA-ARS, Plant Sciences Institute, BARC West, Bldg 003, Room 231
10300 Baltimore Ave., Beltsville, MD 20705 USA

David J. Schuster
University of Florida, Institute of Food & Agricultural Sciences
Gulf Coast Research & Education Center
14625 CR 672, Wimauma, FL 33598 USA

Gregory S. Simmons
USDA-APHIS PPQ, Center for Plant Health Science and Technology Laboratory
3645 East Wier Ave., Phoenix, AZ 85040 USA

Don C. Vacek
USDA-APHIS, PPQ, Center for Plant Health Science and Technology Laboratory
22675 N. Moorefield Rd, Edinburg, TX, 78541-9398 USA

Diane Waldner
USDA-APHIS PPQ, Center for Plant Health Science and Technology Laboratory
3645 East Wier Ave., Phoenix, AZ 85040 USA

Stephen P. Wraight
USDA-ARS, Plant, Soil, and Nutrition Laboratory
Tower Rd., Ithaca, NY 14853 USA

Gregory Zolnerowich
Department of Entomology, Kansas Sate University
Manhattan, KS 66506 USA