Pest Control: Operations and Systems Analysis in Fruit Fly Management

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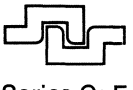

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Pest Control: Operations and Systems Analysis in Fruit Fly Management

Edited by

Marc Mangel

Departments of Agricultural Economics, Entomology and Mathematics
University of California, Davis, California 95616, USA

James R. Carey

Department of Entomology
University of California, Davis, California 95616, USA

Richard E. Plant

Departments of Entomology and Mathematics
University of California, Davis, California 95616, USA

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Preface

These are the proceedings of an Advanced Research Workshop (ARW), sponsored by the NATO Science Panel, entitled "Pest Control: Operations and Systems Analysis in Fruit Fly Management". The ARW was held in Bad Windsheim, Germany during the week of 5 August 1985. The purpose of the ARW was to bring together scientists who are interested in fruit fly problems, but who usually do not have an opportunity to speak with each other, for an intense week of interdisciplinary collaboration. In particular, the group present at the ARW contained a mix of biologists, field ecologists, mathematical modellers, operational program managers, economists and social scientists. Each group has its own professional meetings at which fruit fly problems are discussed, but the point of the ARW was to learn about the problem from the perspective of other fields, which are equally important for the ultimate management of the fruit fly problems. (A list of attendees follows this preface.) It appears that the ARW successfully met its objective of bringing together a group for interdisciplinary considerations of the problems; I hope that the proceedings do as well.

The ARW was structured with formal lectures in the mornings and workshops in the afternoons. For the morning lectures, four different topics were chosen: 1) basic biology and ecology, 2) trapping and detection, 3) control and eradication, and 4) policy issues. Each morning, one lecture from each area was presented. (The following general principle was adopted by the organizing committee: since no one at the ARW would be recognized as a "big shot" by everybody -- because of the interdisciplinary nature of the workshop -- all individuals were treated equally. That meant, for example, that when more people wanted to give morning lectures than were slots available the speakers were chosen randomly. Everyone who attended the ARW was asked to contribute a paper to these proceedings, however.

The purpose of the morning lectures was to provide a formal, overview of the problems of fruit fly management from different perspectives. The afternoon workshops were dedicated to intense, small group collaboration. For the first workshop, four subgroups were formed to consider problems of

biology, trapping and detection, control and eradication, and policy. These subgroups met individually for about 2-1/2 hours and then reported on their deliberations to everyone. The second workshop was dedicated to a "fruit fly war game", patterned after the war game simulations so commonly used by military systems analysts. The third workshop was dedicated to a discussion of resistance to the sterile insect technique (SIT); this topic arose somewhat spontaneously from the group and was not planned at all by the organizing committee. The fourth and fifth workshops were dedicated to an assessment of the state of the science of fruit fly management and the determination of future research needs.

These proceedings are organized as follows. First, the research recommendations are presented. The next three sections contain the formal papers in sections on policy, economics and operations, biology, and modelling. The last section contains a description of the workshop proceedings. I thank the NATO Science Panel for having taken a chance in sponsoring such a unique, interdisciplinary meeting. I believe that their gamble paid off. I thank the organizing committee members (J. Carey, R. Hilborn, G. Norton, R. Plant) and D. Chambers for their help in selecting the attendees at the ARW. Cathy Haider and Ronda Newton did super jobs of typing under deadlines. The Departments of Entomology and Mathematics at the University of California, Davis generously provided staff support and facilities. Most of all, I once again thank each attendee at the ARW for working so hard to make it a success.

Marc Mangel
Director of the ARW
University of California
Davis, California
December 1985

LIST OF ATTENDEES

Martin Aluja-Schunemann, Dept. of Entomology, Ternard Hall, Univ. of Massachusetts, Amherst, Massachusetts 01003, U. S. A.

James Carey, Dept. of Entomology, University of California, Davis, California 95616, U. S. A.

Carrol O. Calkins, Insect Attracts, Behavior and Basic Biology Research Lab., U. S. Department of Agriculture, Post Office Box 14565, Gainesville, Florida 32604, U. S. A.

Gerlad Carlson, Dept. of Economics, North Carolina State University, Raleigh, North Carolina 27695-8110, U. S. A.

Ugo Cirio, ENEA-Laboratory Technologies for the Protection of Agroecosys., C. R. E./Casaccia, CP 2400, 0100 Roma, ITALY.

Roy T. Cunningham, USDA/ARS, Post Office Box 4459, Hilo, Hawaii 96720, U. S. A.

Domiten Debouzie, Lab. Biometri, Univ. Lyon 1, 69622 Villeurbanne, Cedex, France.

L. Demetrius, Max Planck Institute, Goettingen, WEST GERMANY.

Robert V. Dowell, Ph.D., Department of Food and Agriculture, Division of Plant Industry, Analysis and Identification, 1200 "N" Street, Sacramento, California 95814, U. S. A.

A. P. Economopoulos, Entomology Unit/Seibersdorf Lab, IAEA, Wagramerstrasse 5, Post Office Box 200, A-1400 Vienna, AUSTRIA.

Richard Farnsworth, ERS/NRED, 1301 New York Avenue, Room 424, Washington, D. C. 20005, U. S. A.

Brian Fletcher, CSIRO Division of Entomology, 55 Hastings Road, Warrawee, Sydney, NSW 2028, AUSTRALIA.

Wayne M. Getz, Division of Biological Control, University of California, Berkeley, California 94720, U. S. A.

Vicenzo Girolami, Instituto Entomologia, Universita Di Padova, Via Gradenigo 6, 35100 Padova, ITALY.

George Haniotakis, NRC "Demokritos", Dept. of Biology, Post Office Box 60228, Athens, GREECE.

Glenn Hawkes, Dept. of Applied Behavioral Sciences, University of California, Davis, California 95616, U. S. A.

Gordon Hooper, Dept. of Entomology, University of Queensland, St. Lucia, Queensland 4067, AUSTRALIA.

Philip Howse, Chemical Entomology Unit, Building 3, The University, Southampton, UNITED KINGDOM.

Marc Mangel, Dept. of Mathematics, University of California, Davis, California 95616, U. S. A.

A. Meats, School of Biological Sciences, University of Sydney, Sydney, NSW 2006, AUSTRALIA.

Harald Michaelis, LS Tieroekologie, University of Bayreuth, 8580 Bayreuth, WEST GERMANY.

Geoff Norton, Silwood Centre for Pest Management, Imperial College, Silwood Park, Ascot SL5 7PY, UNITED KINGDOM.

Richard E. Plant, Department of Mathematics, University of California, Davis, California, 95616, U. S. A.

Alan S. Robinson, Res. Inst. ITAL, Post Office Box 48, 6700 AA Wageningen, THE NETHERLANDS.

Yoram Rossler, Israel Cohen Institute for Biological Control, Citrus Marketing Board, 27 Keren Kayemet Street, Rehovot 76345, ISRAEL.

Jerry Scribner, 6048 Kenneth Avenue, Carmichael, California 95608, U. S. A.

Masakazu Shiga, Fruit Flies Laboratory, Okinawa Prefectural Agricultural Experiment Station, 4-222, Sakiyama-cho, Naha 903, JAPAN.

Tadashi Teruya, Fruit Flies Laboratory, Okinawa Prefectural Agricultural Experiment Station, 4-222, Sakiyama-Cho, Naha 903, JAPAN.

Shripad Tuljapurkar, Graduate Group in Demography, 2234 Piedmont Avenue, University of California, Berkeley, California 94720, U. S. A.

Pauline van den Driessche, Dept. of Mathematics, University of Victoria, Victoria, British Colombia, CANADA, V8W 2Y2.

Roger J. Wood, Dept. of Zoology, Manchester Univeristy, Manchester M13 9PL, United Kingdom.

I. RESEARCH RECOMMENDATIONS

RESEARCH RECOMMENDATIONS BY SCIENTISTS AT THE NATO ADVANCED RESEARCH WORKSHOP "PEST CONTROL: OPERATIONS AND SYSTEMS ANALYSIS IN FRUIT FLY MANAGEMENT" (5-9 August 1985; Bad Windsheim, Germany)

Fruit flies are an international pest complex, causing widespread crop destruction in both developed and developing countries. Recent outbreaks of medfly in California costs aver $100 M to eradicate an ongoing fruit fly control programs in Mexico, Greece, Okinawa, Guatemala, Israel and Italy cost millions of dollars each year.

A group consisting of field laboratory biologists, mathematical modellers, economists and policy scientists, and operational program managers from around the world met in Bad Windsheim, Germany in August 1985 to discuss the fruit fly problem from the perspective of interdisciplinary research. This group identified three major problem areas which are impending further progress in fruit fly control and eradication. These are:

- Inadequate basic biological data on fruit fly behavior and ecology.

- Outmoded and/or inefficient control or eradication technologies and strategies.

- Lack of understanding of the political, social, and economic constrainings on effective control or eradication strategies.

<u>For these reasons, research is urgently needed in the following areas (not ranked according to priority)</u>:

- Development of methodologies for the assessment of potential losses, effectiveness and costs/benefits of different control and quarantine policies in specific situations.

- Understanding of the public decision making process in response to pest control emergencies.

- Means for monitoring the effectiveness and environmental impact of an ongoing control or eradication program.

- Determining the efficiency and predictive qualities of traps.

- Phermones for trapping, sexing, and control of fruit flies.

- Development of alternative insecticides, improved baits, and approved application strategies.

- Quality control and field effectiveness of flies produced for SIT.

- Genetics of fruit flies with respect particularly to the development of a sexing technique.

- Relative effectiveness of male only releases in sterile insect programs.

- Ecological constraints upon the colonization of a new environment.

- Population biology of fruit flies in the field.

- Evaluation of the potential of cultural and biological control.

- Species interactions between fruit flies and the taxonomy of species complexes.

- Field testing of mathematical models.

- Nutritional studies on fruit flies.

- Integration of fruit fly control into orchard management.

The following specific proposals are made:

THAT SUCH INTERDISCIPLINARY MEETINGS AS THIS ONE BE HELD ON A REGULAR BASIS. The present meeting has provided a unique opportunity for mathematicians, biologists, economists, psychologists, demographers, operational pest control experts, and decision makers to meet together to analyze problems in fruit fly pest control. The opportunity for an exceptionally wide exchange of view on pest control has clearly indicated areas for interdisciplinary action in the future. Such action needs to be monitored and reviewed.

THAT A GENETIC STOCK CENTER FOR FRUIT FLIES BE ESTABLISHED. Genetic studies are inhibited at the present time by quarantine restrictions. A stock center is required and would best be located in a temperate country at a center already active in fruit fly research. Such a center will coordinate genetic and cytogenetic studies of behavior and will facilitate the development of a genetic sexing system.

II. POLICY, ECONOMICS, AND OPERATIONS

PERSPECTIVES ON FUTURE INTEGRATED MANAGEMENT OF FRUIT FLIES IN MEXICO

M.R. Aluja
Department of Entomology
University of Massachusetts
Amherst, MA 01003/USA

P.F. Liedo
Programa Mosca Med
Apartado Postal 576
30700 Tapachula, Chiapas, Mexico

SUMMARY

We analyze the extremely complex problem of fruit fly management in Mexico suggesting the establishment of a long term, well planned and flexible country-wide orchard management program based among others on the following premises: a consideration of the entire fruit fly species complex instead of the common practice of singling out Anastrepha ludens as the unique source of problem; a multistrategy approach in which measures to control fruit flies are integrated with other pest and disease control efforts and all the other agronomic practices used in the orchard; a redirection of the control efforts putting most emphasis in the planting and orchard maintenance phase as opposed to the harvest and marketing phases; the development of novel approaches and the implementation of established control strategies based on ecologically sound principles and that are within the cultural and economic reach of the recipient (more than 70% of the fruit produced in the country comes from small scale, resource poor farmers); a biogeographical division of the fruit growing regions, with the application of management practices adapted to each particular situation; a thorough understanding of the socio-economic, socio-political, cultural and historical milieu of the farmer; the enhancement of alternative means of fruit commercialization through the creation of agroindustries and the enhancement of strong grower associations.

1. GENERAL NOTIONS ABOUT FRUIT PRODUCTION IN MEXICO

Fruit production plays an important role in Mexico's economy. Out of approximately 19,000,000 Ha devoted to agriculture, 10% or approximately 1,900,000 Ha are planted with fruit trees, producing approximately 30% of the total value of agricultural products (DGEA, 1983).

Due to the extreme diversity of the geography and environment, a great variety of fruit species are cultivated or grow in the wild.

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Figure 1 shows the planted surfaces of the most common fruit types commercially grown in Mexico. Note that citrus, mango, apple, peach, guava and papaya, in that order, cover the highest percentage of the planted surface.

Pests and diseases cause important losses in yield and quality of fruit, a situation that has been exacerbated by the dramatic increase of fruit growing areas in the past fourteen years. As Figure 2 indicates, there has been a six-fold increase in the production areas of mangoes, a four-fold increase in the case of peaches and apples and a two-fold increase in the case of papaya (DGEA, 1983).

Fig. 1 - Planted surfaces of the most common fruit types commercially grown in Mexico. MA = Mamey (Calocarpum zapota); ZC = Zapote Chico (Achras zapota); MH = Tejocote (Crataegus mexicana); MP = Jobo (Spondias sp.); PA = Papaya (Carica papaya); GU = Guava (Psidium guajava); PE = Peach (Prunus persica); AP = Apple (Pyrus malus); MG = Mango (Manguifera indica); CI = Citrus (Citrus sp.).

Figures 3 and 4 show the location of the most important fruit-producing areas in Mexico. Citrus is grown in three distinct regions. The coastal desert of the state of Sonora, the subtropical and tropical regions of the states of Nuevo Leon, Tamaulipas, San Luis Potosi and Veracruz, where local mezquite grassland, tropical deciduous forest, thorn forest and tropical evergreen forests are replaced by citrus orchards. There is also a newly developed area in the Yucatan Peninsula, where tropical deciduous and evergreen forests are converted into agricultural land. (See Appendix I for a map of Mexico indicating the state location and name).

Mango is grown principally along both the Pacific and Gulf coasts in habitats where tropical subdeciduous,deciduous and evergreen forests

plus thorn forests are exploited. It is important to note that Spondias sp., Jobo or Mexican Plum (Anacardiaceae), an important alternate host of Anastrepha obliqua, is also grown in the same regions on a semi-commercial basis.

Apples, peaches and tejocote or Mexican hawthorns, have been traditionally grown in the highland areas, where pine-oak forests are the dominant vegetation; in the case of apple there is a new effort to introduce drought-resistant varieties from Israel into the Sonoran desert.

Guava, although found throughout the country, is commercially grown in the central states of Aguascalientes and Zacatecas, where both mezquite-grasslands and pine-oak forests are the native vegetation.

Papaya is grown in essentially the same areas as mango. Finally, there are the various fruit species in the family Sapotaceae, which are grown in the Southeastern rain and tropical evergreen forests and the central state of Mexico in tropical deciduous forests.

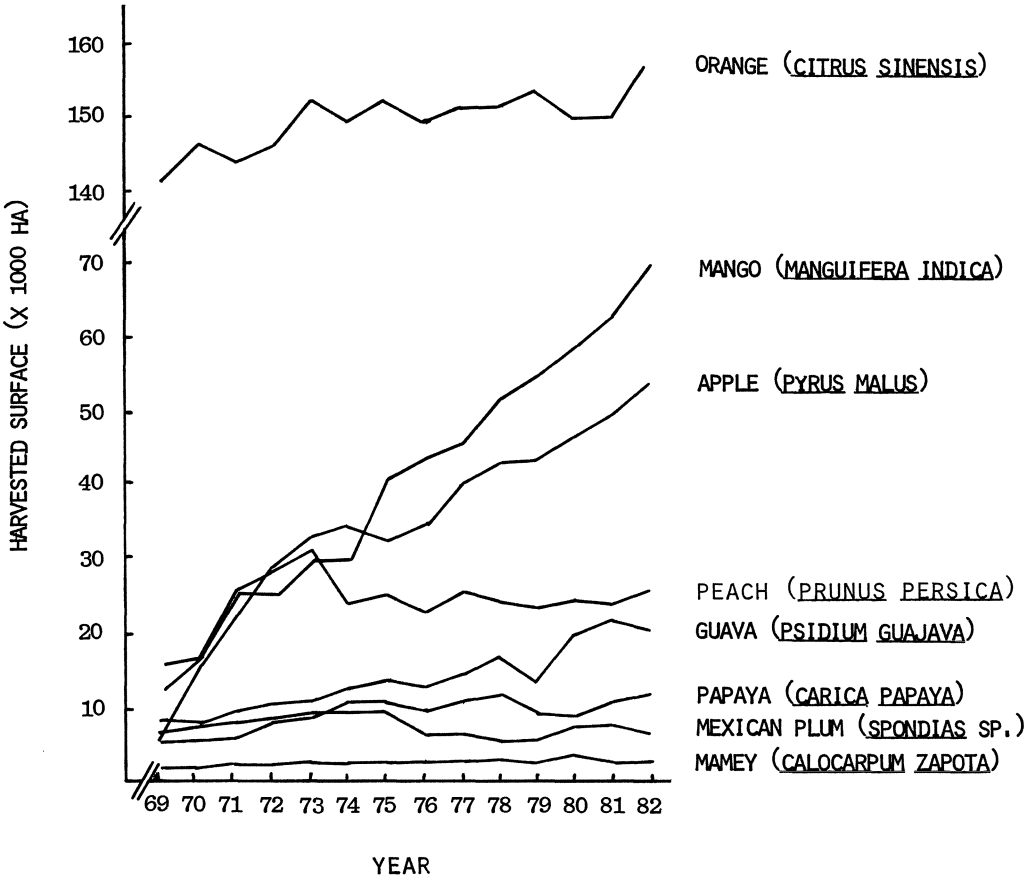

Fig. 2 - Harvested surfaces of the most common fruit types commercially grown in Mexico between the years 1969 and 1982.

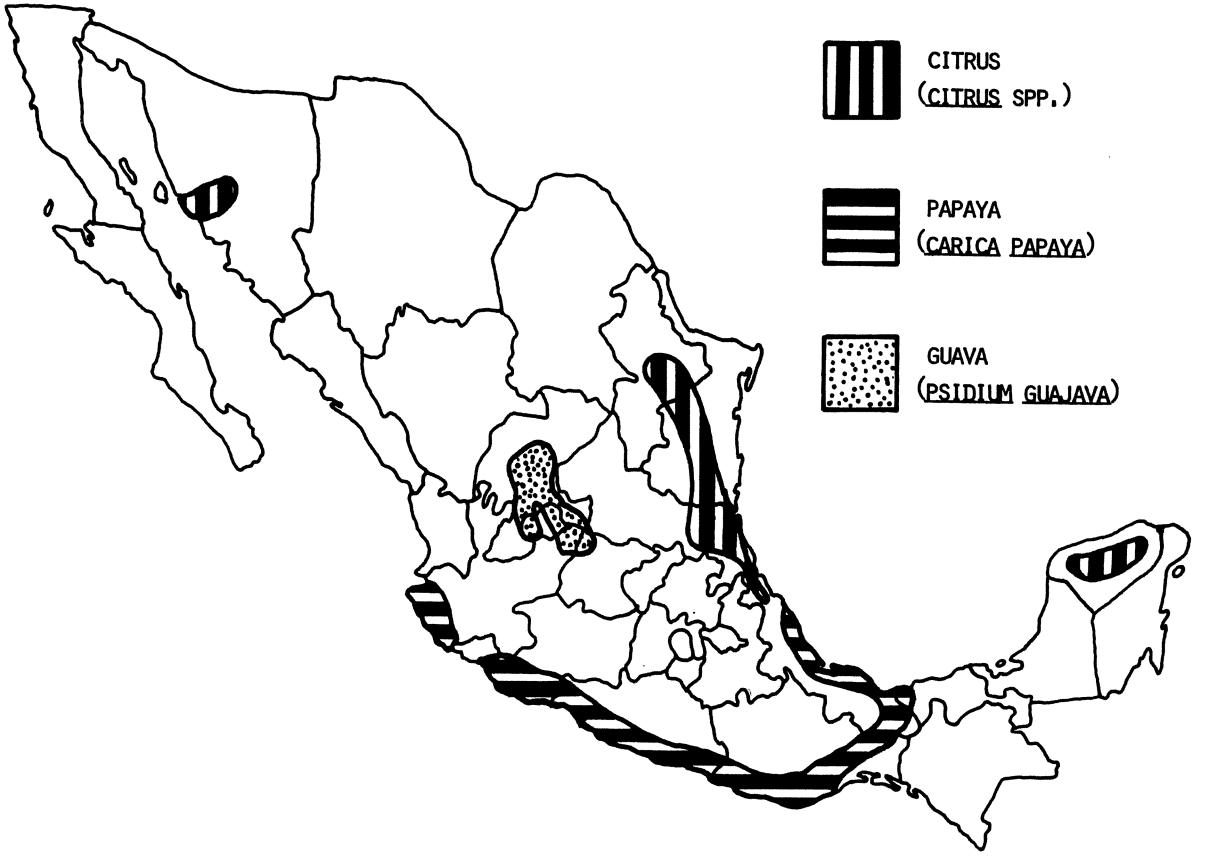

Fig. 3 - Location of the most important citrus, papaya and guava producing areas in Mexico.