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PROPOSAL TYPE

For National Research Initiative Competitive Grants Program Proposals Only

[X] Standard Research Proposal
[ ] Conference
[ ] AREA Award
  [ ] Postdoctoral
  [ ] New Investigator
  Strengthening:
  [ ] Career Enhancement
  [ ] Equipment
  [ ] Seed Grant
  [ ] Standard Strengthening

Project Title: **A Field Guide to Tree Fruit Insect Pests, Beneficials, and Diseases of Eastern North America**

Key Words: **Tree fruit pest management, biological control, photo ID guide, pocket guide, diagnostic keys**

For Higher Education Program Proposals Only:

Need Area: _____

Discipline: _____

REGIONAL IPM PUBLICATIONS FUND

The northeastern US is affected by a suite of tree fruit insect pests, diseases, and beneficial species that is among the largest of the world's production areas. Growers may typically need to be familiar with as many as 25 key species during a given season, plus possibly dozens of additional secondary species on a less frequent but still predictable basis. There are a number of excellent information resources and references available to help familiarize growers, consultants and orchard managers with diseases, pests and beneficial species for the purpose of making informed management decisions; however, most are either too detailed, incomplete, or cumbersome to be used as a convenient field identification guide in the variety of fruit crops likely to be found on modern commercial farms. This project will result in the publication of a comprehensive yet easy-to-use field guide on over 130 arthropod species and 70 diseases occurring in apples, pears, cherries, peaches and nectarines, apricots and plums in the US and Canada east of the Mississippi. For each entry, a single page will contain the species' classification, descriptive biological information, principal period of activity or occurrence, feeding habits or hosts, and number of generations per year, accompanied by high-quality photographs of the adult, immature, and damage (for arthropods) or disease symptoms. Diagnostic keys will help the reader correctly identify pests and diseases on the basis of damage symptoms; a cross-referencing index and a glossary will facilitate finding and explaining the entries. The book will be 200+ pages, and printed in a 4.25 x 7.25-inch "pocket-size" format that is easy to carry.

A PROPOSAL TO THE NORTHEASTERN IPM CENTER
INTEGRATED PEST MANAGEMENT PARTNERSHIP GRANTS PROGRAM
REGIONAL IPM PUBLICATIONS FUND

A FIELD GUIDE TO TREE FRUIT INSECT PESTS, BENEFICIALS, AND DISEASES OF EASTERN NORTH AMERICA

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INTRODUCTION :

Producers of tree fruit crops must overcome a significant number of challenges in their efforts to successfully grow a high quality product and market it profitably to consumers or processors for the domestic and international markets. Crucial among these is the task of maintaining the fruit and the tree in a healthy condition so as to ensure the productive life of the orchard and the quality of the fruit it produces. Pest and disease organisms pose a significant threat to the orchard planting throughout all stages of its development and production, and the complexity of tree fruit/pest ecosystems surpasses that of most other agronomic crops for a number of reasons. Tree fruits are rich food resources, able to be exploited by a number of different organisms, and as perennial crops, cannot benefit from tactics involving pest avoidance in time or space (such as adjusted planting dates or crop rotation).

Orchards are diverse ecosystems containing many microhabitats, which promote pest, host and natural enemy interactions, and are usually located in areas near abundant alternative hosts that can serve as pest reservoirs. Ironically, owing to its long history of fruit production, abundant rainfall and a complex geographic and vegetation profile, the northeastern US is affected by a suite of tree fruit insect pests, diseases, and beneficial species that is among the largest of the world's production areas. Growers in this region may typically need to be familiar with as many as 25 key species of pests, natural enemies, and disease pathogens during a given season, with the potential for encountering dozens of additional secondary species on a less frequent but still predictable basis.

There are a number of excellent information resources and references available to help familiarize growers, consultants and orchard managers with diseases, pests and beneficial species for the purpose of making informed management decisions; however, most are either too detailed, incomplete, or cumbersome to be used as a convenient field identification guide in the variety of fruit crops likely to be found on modern commercial farms. This project will result in the publication of a comprehensive yet easy-to-use field guide on over 130 arthropod species and 70 diseases occurring in apples, pears, cherries, peaches and nectarines, apricots and plums in the US and Canada east of the Mississippi. For each entry, a single page will contain the species' classification, descriptive biological information, principal period of activity or occurrence,

feeding habits or hosts, and number of generations per year, accompanied by high-quality photographs of the adult, immature, and damage (for arthropods) or disease symptoms. A set of diagnostic keys at the front of the book will help the reader to correctly identify pests and diseases on the basis of their damage symptoms to the fruit or tree tissues; a cross-referencing index and a glossary will facilitate finding and explaining the entries. The book will be 200+ pages, and printed in a 4.25 x 7.25-inch "pocket-size" format that is easy to carry.

LITERATURE REVIEW:

Most states and provinces for whom this guide could be a useful IPM reference already have some type of tree fruit pest identification resource, whether in the form of individual fact sheets, incorporated into a fruit production guidelines or pest management book, or online as part of a tree fruit information website. Most of these references give at least one good photograph of the pest or disease, describe the biology of the species or pathogen in some detail, and offer management recommendations in terms ranging from the broadly generic to the exhaustively specific. Representative examples follow:

In New York, the NYS IPM Program has produced a series of "Tree Fruit Fact Sheets" over the past 25 years that currently includes 26 arthropod species and 9 diseases (Cornell University 2003). Individual entries in this series were written by a variety of research and extension faculty over the years, originally as single or gate-folded glossy sheets, 3-hole punched for binder storage. They contain introductory information on pest origin and hosts, detailed descriptions of each life stage and developmental biology, characteristics of pest injury, and information (excluding specific pesticide recommendations) on management approaches. Several high-quality photos of insect stages and pest/disease injury symptoms are provided, along with miscellaneous figures showing disease life cycles, insect silhouettes, and monitoring timetables. These recently have been re-formatted and placed on the IPM website (http://www.nysipm.cornell.edu/factsheets/treefruit/index.html), and the decision has been made not to continue support of the hard copy versions of these publications, so when current inventories of these sheets are depleted, they will no longer be available.

The New England states (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont) jointly publish a regional "New England Apple Pest Management Guide" (Coli 2003), one-third of which is devoted to disease (12 entries), arthropod (31 entries) and vertebrate pests. Detailed sampling and monitoring guidelines are followed by capsule writeups on individual species/pathogens that include black and white drawings, pest biology and developmental specifics, management recommendations, a chart of 16 beneficial species, and 122 color photos of selected species compiled in a separate section. The book is 150+ pages and spiral bound.

The "New Jersey Commercial Tree Fruit Production Guide" (Belding and Lokaj 2003) has a chapter on tree fruit pests and control that provides detailed writeups on 29 diseases and 24 arthropod pests in a book that is 150+ pages and spiral bound.

The biannual Pennsylvania Tree Fruit Production Guide (Crassweller et al. 2001) has extensive writeups covering descriptions, life cycle, damage, monitoring, and management accompanied by grayscale drawings for diseases (32 entries) and arthropod pests (43 entries), plus natural enemies (5 entries). This extensive all-in-one reference is approximately 300 pages and spiral bound.

A standard information source for the mid-Atlantic states (Pennsylvania, New Jersey, West Virginia, Virginia, Maryland) is the "Mid-Atlantic Orchard Monitoring Guide" (Hogmire 1995), a comprehensive collection of information needed to build a complete crop protection program for any tree fruit crop grown in this region. Nearly one-half of this book (which is approximately 350 pages and wire bound) is dedicated to insects, mites, and diseases found in orchard crops, with detailed entries on 60 arthropod pests, 13 natural enemies/groups, and 39 diseases. Each includes an introduction on host range and distribution, descriptions of stages, biology/disease cycles, and injury/symptoms. Two extensive photo gallery groupings (155 arthropods, 75 diseases) are compiled in separate places after their respective text sections.

North Carolina, South Carolina, Georgia and Alabama produced the regional publication, "A Grower's Guide to Apple Insects and Diseases in the Southeast" (McVay et al. 1994), which gives informative entries (description, damage, life history, control) plus color photographs of 23 insect and mite pests, 7 natural enemies, and 19 diseases of apples, plus practical information on sampling, monitoring, cultural considerations, etc. The book is 70 pages and wire bound.

In Michigan, a primary pest reference is "Common Tree Fruit Pests" (Howitt 1993), which devotes 1–3 pages to each of some 70 species of insect and mite pests of orchard crops. Each comprises a section on life stages, host range, injury or damage, factors affecting abundance, life history, monitoring, and control, including several color photos and related graphics. This book is 250 pages and perfect bound. Michigan also has produced pocket guides for apples (Epstein & Gut 2001) and stone fruits (Epstein et al. 2001). Each contains color photos and capsule descriptions to help identify pests, beneficials, and pest damage, plus guidelines for monitoring and thresholds. The 68-page apple pocket guide covers 23 arthropod pests, 17 beneficial species, and 6 diseases; the stone fruit guide addresses 28 arthropod pests, 17 beneficial species, and 19 diseases in 90 pages. Both are 3.25 x 5.0" and wire bound across the top.

Justification. Because of the effort required in documenting, summarizing, and maintaining this quantity of information on individual species, most such references tend to be limited to the major pests and diseases occurring most commonly within the immediate geographical region. This means that pest species other than the most important 20–30 (and considerably fewer for beneficials) are generally not given much attention, which is certainly justifiable from the perspective of optimizing pest management efforts. However, there are almost always lesser known "breakout" or secondary species that can become pests in orchards (thereby disrupting the pest management program until the problem is recognized and attended to) or, worse, appear to be a threat (thereby prompting unnecessary pesticide sprays) but in actuality are either of little concern or else are actually beneficial. A field guide that covers a broad range of insect and mite pests, beneficial species, *as well as diseases*, and found in *all* eastern tree fruit crops, would be a potentially valuable tool for a large number of orchardists, consultants, university and extension specialists, industry representatives and the general public. We intend to incorporate this in a guide that presents adequate information for quick and accurate identification of <u>all</u> the species most likely to be encountered, and their potential threat or value to the orchard and its crop.

A very useful such field guide, in French, dealing solely with the arthropod pests and natural enemies of apples in Québec, was published by Chouinard et al. (2000). This is a spiral-bound booklet, 4.25 x 7.25", which gives descriptive information on more than 55 species, including damage symptoms, life stage descriptions, means of control, feeding habits, period of occurrence, and several good color photographs of each species and (for pests) its injury. The principal investigators were approached by the authors of this publication, who wished to

collaborate on an effort to expand this guide to include diseases, and to extend its scope to all tree fruits grown in eastern North America, producing an English version under the auspices of a US publisher but making use of many of the photos and format elements of the original publication.

OBJECTIVES:

1 - Produce a spiral-bound "pocket" format field guide to a comprehensive list of insect and mite pests, diseases, and beneficial species occurring in all the major tree fruit crops of eastern North America. The guide will present high-quality color photographs of each species and its damage on the same page with information on its occurrence, distribution, feeding habits, physical description, biology and means of control. [Regional IPM Publications]

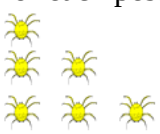
PROCEDURES:

1 - The publication "*Guide d'Identification des Ravageurs du Pommier et de leurs Ennemis Naturels*" (Chouinard et al. 2000) will be translated into English and supplemented by the addition of 75 new entries of arthropod pest and beneficial species occurring in apples, pears, cherries, peaches, plums and apricots throughout the states and Canadian provinces east of the Mississippi. Also, entries for 70 diseases of these orchard crops will be added in a new section.

The guide will be a compilation of short informational text+photos entries separated into three sections, each covering a certain species or group of similar species. The first section will focus on arthropod pests (insects and mites); the second will describe beneficial insects and mites. The third section will be devoted to diseases. For each species or disease, the following information will be contained on a single page together with its photos to facilitate quick referencing. The arthropod information will be presented as follows:

1. Taxonomic classification: Order (plus Suborder, for Hemiptera) and Family
2. Common name
3. Scientific name and authority
4. Length of adult (or in Lepidoptera, the wingspan) and the last larval or nymphal stage
5. Graphic (e.g., a timeline of seasonal crop development) showing the principal period of activity in the crop (for indicated stages)
6. Graphic icons indicating the feeding habits or site of attack: tree branches, blossoms, fruits, trunk, roots, or foliage.
7. Number of generations per year
8. Color photos of the adult and immature forms of the insect (with arrows indicating distinctive characteristics), plus a representative photo of the type of injury caused by pest species.

Impact: The repetition of an icon, in both of the first two sections, will indicate the importance of each pest or predator:


Light (minor pest or predator)
Moderate (secondary pest or predator)
Important (major pest or predator)

In the first section dealing with arthropod pest species, the following information will be given:

Description: Major traits used to identify the insect or mite. Most traits will be indicated on the pictures with arrows. These may not always be unique to a particular species, but are used to distinguish it from other species presented in this guide.

Distribution: General geographic range of occurrence (east of the Mississippi River only) using state and province abbreviations.

Damage: Damage to the fruit or tree caused by the pest.

Similar Species: Species of insects or mites that could be confused with the pest described, with cross-references to the page in the guide where these are covered.

Means of Prevention: A summary of possible control management practices applicable when the pest population exceeds tolerable levels.

The second section, which deals with beneficial species, will include the following information:

Status: Information on the beneficial activity of the predator or parasite with respect to its stages of development.

Distinctive Characteristics: Traits useful in recognizing the insect, spider or mite will usually be illustrated on the pictures with arrows. These characteristics are not necessarily unique to a certain species, but are used to distinguish it from other species presented in the guide. When possible, other characteristics will indicated, which may be positive (☺) or negative (☹), such as the sensitivity of the predator to pesticides.

Tree fruit diseases will be addressed in the third section of the guide. For each disease, a list of fruit hosts and main tissues attacked will be given, followed by a description of the disease symptoms. Also provided will be a description of the disease's geographical range, any similar diseases or disorders with which it could be confused, and a brief description of recommended management tactics.

The sections on arthropod pests and diseases will be preceded by simple field diagnostic keys to aid the user in the identification of the probable causal agent of injury or damage symptoms seen on the fruit or tree tissues. An extensive index will list and cross-reference all common and scientific names of pests, beneficials, diseases and pathogens appearing in the booklet to allow quick location of specific entries using common or scientific names. A glossary of technical terms used also will be provided, along with references to source materials and websites for further information.

The booklet will be published by NRAES (Natural Resource, Agriculture, and Engineering Service), which is a not-for-profit program dedicated to assisting land grant university faculty and others in increasing the public availability of research- and experience-based knowledge.

NRAES is sponsored by fourteen land grant universities in the eastern US, and receives administrative support from Cornell University, where it is located.

LITERATURE CITED:

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Hogmire, H.W., Jr. (ed.) 1995. Mid-Atlantic Orchard Monitoring Guide. Northeast Regional Agricultural Engineering Service (current name: Natural Resource, Agriculture, and Engineering Service), Cooperative Extension, 152 Riley-Robb Hall, Ithaca, NY 14853-5701. 361 pp.

Howitt, A.H. 1993. Common Tree Fruit Pests. Michigan State Univ. Extension NCR 63, E. Lansing, MI. 252 pp.

McVay, J.R., J. F. Walgenbach, E. J. Sikora and T. Sutton (eds.) 1994. A Grower's Guide to Apple Insects and Diseases in the Southeast. Alabama Coop. Ext. Serv. Circ. ANR-838. Auburn Univ. 70 pp.

PROBABLE DURATION:

It is anticipated that the final publication will be printed and ready for distribution within 1 year of any award received from this program.

EVALUATION PLANS:

All of the text for this publication has been written already, and most of the photographs have been either procured or identified. The next stage is for the manuscript to be sent out for reviews (early January 2004). NRAES will coordinate a peer review of the manuscript for technical accuracy and usefulness to the intended audience, and any suggested revisions will be incorporated. Thereafter, the formatting and layout of the booklet will proceed.

COOPERATION AND INSTITUTIONAL UNITS INVOLVED:

All of the work related to the production of this publication will be conducted at Cornell University and NRAES.

KEY PERSONNEL:

The project team consists of Principal Investigators A. Agnello, who will compose, write, and edit the arthropods sections of this field guide, and W. Turechek, who similarly will be responsible for the diseases section. See attached Vitae & Publication Lists.