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THRIPS, A COMPUTERIZED KNOWLEDGEBASE FOR THE IDENTIFICATION AND MANAGEMENT OF THRIPS INFESTING VEGETABLES IN THE UNITED STATES

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Abstract. **A computerized knowledgebase was developed to enable vegetable producers, field technical staff, extension personnel, and other non-entomologists to identify the species of economically important thrips infesting vegetable crops. Thrips infest a wide variety of vegetable crops annually throughout the U.S. They damage produce by their direct feeding and egglaying activities, and reduce crop vigor and productivity through transmission of tomato spotted wilt virus. The software includes details of thrips biology and economic importance, and species-by-species management guidelines. Graphic and textual identification keys are presented, which guide the user through the necessary steps to identify common thrips species either in the field or in the laboratory. Information is also provided on monitoring and management techniques as well as collecting and preservation methods.**

Introduction

Vegetable growers in all parts of the U.S. annually face the risk of crop damage or loss to thrips. This risk has increased over the years with the introduction of new pest species, either by movement of infested plant material or by natural migration. Introduced thrips pests can cause devastating losses, such as those suffered when *Thrips palmi* Karny invaded Homestead, FL in 1990-91, and thus require early detection and appropriate treatment. Movement of the thrips-borne disease, tomato spotted wilt virus, into vegetable crops is a threat and knowledge of the thrips species infesting susceptible crops is a valuable first step in disease management. In the absence of these problems, sound management of thrips can rely on biological control agents or judiciously applied insecticides. In all the above cases, growers and others involved in making pest management decisions need information on the identity of the thrips and beneficial insects inhabiting their fields.

Several printed guides to the thrips have been published over the years (Palmer, 1989; Stannard, 1968). These have been designed largely for entomologists, and usually require a level of expertise beyond the scope of most agricultural professionals. The thrips knowledgebase described here was designed to bring the information needed to identify and manage thrips in vegetable crops to growers, consultants, extension agents, and other agricultural professionals who may lack the training or skills to make full use of the more technically oriented guides. A computerized format was chosen based on two criteria: 1) the results of in-house thrips identification training efforts, which indicated that learning is enhanced by plentiful illustrations and detailed explanation of technical terms, and 2) the success of this approach in presenting information on silverleaf whiteflies, mole crickets, and other insect pests. Development of a thrips identification kit was funded through the USDA's Small Business Innovation Research program as a central part of a complete program for the biological control of the melon thrips, *T. palmi.*

Materials and Methods

The Thrips Knowledgebase was prepared using HyperWriter (NTERGAID, 2490 Black Rock Turnpike, Fairfield, CT 06430). The textual portion of the program was written by Glades Crop Care, Inc. (GCC), drawing from their vegetable pest management experience, or from published articles. Photographic images were provided by GCC and H. T. Hsu (USDA). Detailed drawings for the graphical identification key were made by T. X. Liu. The program is currently in an advanced stage of completion, and will be marketed by early 1998.

Results and Discussion

Following a survey of GCC collection records and published reports on thrips infesting vegetables, seven pest species were chosen for inclusion in the Thrips Knowledgebase. These include the western flower thrips, *Frankliniella occidentalis* (Pergande), the tobacco thrips, *F. fusca* (Hinds), the Florida flower thrips, *F. bispinosa* (Morgan), the eastern flower thrips, *F. tritici* (Fitch), *F. schultzei* (Trybom), the melon thrips, *T. palmi* Karny, and the onion thrips, *T. tabaci* Lindeman. Also included were the grain thrips, *Limothrips cerealium* (Haliday), and the suborder Tubulifera. These were included because of their common occurrence and potential confusion with the pest species. The minute pirate bug, *Orius insidiosus* (Say), was included as the major biological control agent, although others, especially the predatory phytoseiid mites, are also mentioned.

The Thrips Knowledgebase is a 7 MB program that runs under Windows 3.1×, 95, or NT. Within each window in this program, the user is presented with options directing him either to a main menu or to the current menu. Movements within the program are facilitated by clickable screen buttons, which open menus, or by clicking the right mouse button, which returns the user to the previous screen.

With text and hyperlinked illustrations, the user is guided through an introductory section, explaining the purpose of the program, followed by discussions of thrips biology, their economic importance and the nature of their damage to vegetable crops. Also on the main menu are links to the detailed species descriptions, discussions of biological control, field activities for users, a bibliography, and identification keys.

Species descriptions provide information on geographic distribution, a detailed description, including characteristics which can be observed using low (20X) magnification for field identifications, and specifics on host range, economic importance, and management guidelines. Further details on thrips structures used in identifying species are given in the

section containing the identification keys. As the intended market for this program includes non-entomologists, this section contains many links to definitions and drawings explaining and illustrating the specific structures. Identification keys are given in both plain text and hyperlinked graphical formats. In the graphical key, the user is presented with paired drawings clearly illustrating the key couplet. By clicking on the appropriate picture, the next couplet is presented. This process is repeated until an identification is made. Each species appearing in both the textual and graphical keys is linked to the appropriate species description.

The final sections provide information on scouting techniques and considerations, trapping methods, and specimen preservation. Scouting and sampling recommendations are derived from GCC's field experiences. Preservation techniques are presented covering field to laboratory preservation, and the preparation of microscope slide mounted specimens. A list of suppliers accompanies sections where specialized materials are mentioned.

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EVALUATION OF VIRUS-RESISTANT SQUASH VARIETIES

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Abstract. **Aphid-borne viruses affecting cucurbits have been a perennial problem for squash (*Cucurbita pepo* L.) and watermelon [*Citrullus lanatus* (Thunb.) Matsum & Nakai] growers in Florida. Insecticides have been of little or no value in reducing virus spread, and other methods, such as mineral oil sprays, have not been totally effective. Recently, varieties with resistance derived from the incorporation of the coat protein genes of watermelon mosaic virus 2, zucchini yellow mosaic virus, and cucumber mosaic virus have become commercially available. At the same time, zucchini varieties with interspecific resistance or tolerance to one of more of these three viruses have also been released. We evaluated several of these varieties at the Central Florida Research and Education Center in Leesburg in 1996 in order to compare yield and horticultural traits with standard yellow summer squash and zucchini varieties. The transgenic yellow squash varieties 'Prelude II', 'Destiny III', and 'Liberator III' outperformed 'Dixie' at the end of the growing season when virus pressure was high. 'Prelude II' was the most acceptable variety horticulturally. The resistant zucchini varieties 'Dividend', 'Revenue', and 'Tigress' performed well compared with 'Zucchini Elite'. 'Jaguar' and 'HMX5728' (now 'Puma') produced significantly fewer fruit than the other zucchini varieties both in spring and fall trials. Yield differences among zucchini varieties due to viral infection were not detected.**

Squash (*Cucurbita pepo* L.) crops in Florida suffer regular yield losses due to infection with watermelon mosaic virus 2 (WMV 2), zucchini yellow mosaic virus (ZYMV), and the watermelon strain of papaya ringspot virus (PRSV-W). Cucumber mosaic virus (CMV) is not found as often but is also potentially a threat to cucurbit production in Florida. Until recently, resistant varieties have not been commercially available, and other control measures aimed at interfering with transmission by the aphid vectors, such as stylet oil (Webb and Linda, 1993) have not been totally effective. Floating row covers are very effective barriers to virus transmission by aphids (Webb, 1991) but are expensive to use. Insecticides are of little value because insect transmission of these viruses can occur in a matter of seconds during very brief probes of the plant epidermis.

The need to have resistance to several viruses has made it difficult to develop resistant varieties by conventional methods. Only recently, five zucchini varieties with varying levels of interspecific resistance to ZYMV, WMV 2, and CMV have been released after decades of effort. For a number of plant viruses, however, it has been found that incorporating the viral coat protein gene into the plant DNA protects the plant from infection by the virus (Beachy et al., 1990). Several squash varieties have been developed that have pathogen-derived resistance to two or three of the four viruses that commonly infect cucurbits (Tricoli et al., 1995).

Trials were conducted in the spring and fall of 1996, at the Central Florida Research and Education Center in Leesburg, to compare virus resistance and yield of squash varieties that were either genetically engineered to contain the coat protein genes of two or three different viruses or conventionally

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