Orius insidiosus (Say) AND ENTOMOPATHOGENS AS POSSIBLE BIOLOGICAL CONTROL AGENTS FOR THRIPS

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The entomology program in ornamental floriculture at the University of Georgia places primary emphasis on commercial production of flowering and foliage plants under greenhouse conditions. Thrips management is a major part of that program. Several species of foliage and flower inhabiting species are pests on greenhouse crops. The western flower thrips, *Frankliniella occidentalis* (Pergande), has become the most important pest of the thrips complex during this decade. Other thrips species have also become more difficult to control or occur more frequently on greenhouse crops in different areas of the country.

The subject of this paper is the potential use of natural enemies for the management of thrips under greenhouse and other environments. The use of predatory mites for thrips management is discussed in the previous paper and we will focus on two other potential natural enemies: entomopathogens and a hemipteran predator in the genus *Orius*. Neither of these natural enemies have been utilized in commercial programs for thrips control in greenhouses in the United States but both occur as natural enemies limiting populations of thrips in their respective environments. They should both be considered as potential tools for thrips management.

Entomopathogens

Entomopathogens are organisms utilized for management of insect populations and the fungi are the only group of pathogens which have been studied for thrips control. There have been three genera of fungi reported from thrips: *Verticillium*, *Entomophthora*, and *Paecilomyces*. *Verticillium* sp. are widespread with epizootics in many insects but primarily in the Homoptera. *Verticillium lecanii* (Zimmermann) Viegas has been developed into a commercial formulation for application against insects. Two strains have been selected, "Vertelac" for aphid control and a strain for whitefly "Mycotal" (Cavallero 1987). A strain has been isolated which has activity against thrips but it is not commercially available (Gillespie 1987). There are other pathogens which have been developed for commercial use, but not for thrips. These include *Metarhizium* for Homoptera in sugar cane, *Beauveria* for Coleoptera and Lepidoptera, *Nomuraea* for Lepidoptera and *Hirsutella* for mites (Poinar & Thomas 1984). The *Entomophthora* are widespread but are more host specific than the *Verticillium* and have not been developed in a commercial product. The *Paecilomyces* have only been investigated as a potential commercial product in the last few years. They are general pathogens for many insects. In this paper we will compare the advantages and disadvantages of two potential pathogens: *Verticillium lecanii* and *Entomophthora* sp. for use under protected culture.

Verticillium lecanii is non-fastidious and will grow on conventional mycological media (Sabouraud and potato dextrose) and can be produced in fermentation columns allowing commercial production of the pathogen (Hall 1981). It does best at 20-25°C and will not grow at 37°C. The greatest weakness in the commercial use of *V. lecanii* is the need for very high relative humidity for best results, even free moisture on the leaf surfaces in some situations (Milner & Lutton 1986). The need for high humidity limits the practical use of *V. lecanii* unless strains can be selected which are more active at lower relative humidities. *Verticillium lecanii* is compatible with most insecticides and some fungicides (Khalil et al. 1985). The proper timing of applications of *V. lecanii* following application of fungicides (Gardner et al. 1984)

could allow their use even if not compatible. Therefore, *V. lecanii* could be incorporated with conventional pest management programs fairly easily. Under ideal conditions an epizootic can spread through a pest population rapidly and reduce the pest population to near zero. Remaining pests can be infected by spores produced from individuals which have been infected by the initial application of the fungus.

There are two known species of Entomophthorales that could have a potential place in thrips management: *Entomophthora parvispora* and *E. thripidium* (Wilding 1981). These fungi cannot be produced by conventional mycological methods. There has been research to develop culture methods but the lack of these tools prevents needed research into their use. There is not a method to produce the fungus in volume outside of actual insect culture. Therefore, it cannot be commercially produced until techniques are developed. The Entomophthorales fungi are more host specific and only infect a limited number of hosts. This would limit the hazard of infection of non-target insects such as other natural enemies. They germinate best at temperatures between 16 to 27°C, but have a broad range of 5 to 30°C (Wilding 1981). High relative humidities required by *V. lecanii* are not a necessity for Entomophthorales. Conidia have been reported to eject at relative humidity as low as 50% (Wilding 1981). The best results are obtained at higher humidities. There is limited information on the use of these fungi and the compatibility with pesticides and other management strategies. They are effective and need further investigation.

The future for pathogen use depends on the development of strains and mass production. The isolation and production of the toxins produced by fungi might also be a method of taking advantage of the pathogenicity of fungi for insects. Some toxins have been developed for commercial use in insect control, including abamectin (Avid), a material utilized for western flower thrips control. Under greenhouse conditions, with controlled environment, there is an excellent potential for the use of commercial formulations of fungi. In the open environment, such as in a sugarbush, there is less potential for success. The management of thrips in the sugarbush by pathogens would probably have to be directed toward treatment of soil for control of immature thrips.

Orius

Orius is a group of predators commonly referred to as the minute pirate bugs. They are common predators in many agro-ecosystems and feed on many insect and mite hosts. Among their prey are many thrips species and in some ecosystems thrips are their primary prey (Letourneau & Altieri 1983, Isenhour & Yeargan 1981). They colonize a variety of flowering plants, including numerous crops. They are quite mobile and readily move from one area of the greenhouse to another or from native ecosystems into agricultural crops. They have been investigated as possible natural enemies in agro-ecosystems but have not been studied in greenhouse systems. We started an investigation on *Orius* as possible tools for managing thrips populations in ornamental crops grown in the greenhouse in 1985. A natural infestation of a greenhouse population of *Echinothrips americanus* Morgan occurred and *Orius insidiosus* (Say) completely eliminated the thrips population. Soon after that we acquired an *O. insidiosus* culture from a colleague and began looking at it as an alternative management strategy for *Frankliniella occidentalis*, the western flower thrips. Experimentation is being conducted on the use of an *Orius* sp. on greenhouse vegetable crops (L. Gilkeson, personal communication).

There are several advantages to the use of *O. insidiosus* for flower thrips control in protected crops. They are aggressive predators and will seek out thrips even in close protected areas such as deep within the flower. They are attracted to flowers where the major pest of protected crops, *F. occidentalis*, is most abundant. Both adult and immature *O. insidiosus* are predators on all active stages of thrips. The more mature the *O. insidiosus* the more thrips they kill in a 24 hr period and the greater the density of thrips the greater is the number of thrips killed (Isenhour & Yeargan 1981). *O. insidiosus* remain on the plants, when searching for prey, in the greenhouse and spend very little time flying up to the plastic trying to exit. They also feed on other pests of greenhouse ornamentals such as aphids, whiteflies and mites.

There are also disadvantages to the use of *Orius*. The major one is that they cannot be easily mass reared for release in the greenhouse. They must be reared either on living insects and eggs or frozen or fresh killed insect material. An artificial diet would increase the ability to mass rear *O. insidiosus*, but a caging system would also have to be developed to prevent crowding. They will readily feed on siblings if crowded or starved. Large numbers of predators are needed for a successful release program.

Orius are general feeding insects, so they could be detrimental to populations of other natural enemies by feeding on them. The compatibility of *Orius* and natural enemies needs more study. In ornamental crops the habit of searching flowers for prey may be a disadvantage if most of the population is removed when flowers are sold from the greenhouse. This would not be the situation with greenhouse vegetables. In greenhouse vegetable production it would be a real advantage. More research is needed on the management of thrips on protected crops with natural enemies. *O. insidiosus* may fit into the system developed on some of these crops.

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