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TEN YEARS OF THE COTTON APHID FUNGUS SAMPLING SERVICE

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Abstract

The cotton aphid fungus sampling service is an extension-based program that helps growers reduce input costs by predicting natural control of cotton aphids by the entompathogenic fungus, *Neozygites fresenii*. This fungus has been active in reducing aphid populations, particularly outbreak populations, in the Midsouth and Southeast since 1989. The aphid fungus sampling service was started in 1993 in Arkansas and has been enlarged in subsequent years. It now includes participants in Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, and South Carolina. The service is funded by Cotton Incorporated and the University of Arkansas. The service provides extension agents, consultants, researchers, and growers, with precise information on the prevalence of the aphid fungus within their fields and counties. When the fungus is actively decimating aphid populations insecticide application for cotton aphids is generally not warranted with resultant monetary savings for producers.

Introduction

Natural enemies are recognized as important components of IPM of insect pests (Steinkraus 2000). However, generally it has been difficult to quantify and predict the level of control natural enemies will provide in a way that cotton producers can readily use in making treatment decisions. In order to make use of natural enemies in IPM decisions, it is necessary to know the immediate impact of the natural enemies on the pest population and predict the near future impact. If the natural enemies will prevent the pest population from reaching the economic threshold or will reduce the pest population as efficiently as an insecticide, then cotton producers can rely on the natural enemies and reduce chemical input costs. However, this is not as simple as it may seem. It requires extensive basic research on the complex interactions between the natural enemies, pest arthropods, the crop, and the environment.

Since 1989 we have been working to utilize the naturally-occurring fungus, *Neozygites fresenii* (Entomophthorales: Neozygitaceae) to benefit cotton producers in the United States. This fungus has caused regular epizootics each year since 1989 that rapidly reduce cotton aphid populations in June and July across the Midsouth and Southeast cotton production areas of the United States. Basic research was conducted on the geographic distribution and impact of the fungus (Steinkraus et al. 1995), environmental effects on the fungus (Steinkraus and Slaymaker, 1994), the speed with which epizootics reduce aphid populations (Hollingsworth et al. 1995), sampling methods (Steinkraus et al. 1995), and how the fungus spreads so rapidly within and between cotton fields (Steinkraus et al. 1996). Methods were developed to artificially introduce the fungus to cotton fields (Steinkraus et al. 2002), however, unfortunately, the fungus cannot be produced in large quantities on artificial media in the laboratory, therefore, all research has been done with fungus produced in cotton aphids.

In 1993, with support from Cotton Incorporated we began a service to sample cotton fields in Arkansas to determine the fungus levels in cotton aphid (*Aphis gossypii*) populations. Based on the research of Steinkraus and Hollingsworth (1994), and Hollingsworth et al. (1995) it had been shown that when about 15% of the aphid population in a field was infected with the fungus, a relatively rapid decline in the aphid population could be expected within a week or so. By determining the percentage of infected aphids within specific fields, we could predict whether a grower might be able to rely on this natural enemy for control of cotton aphids instead of applying a chemical insecticide. This has the direct effect of reducing imput costs, a major goal of cotton research at present.

Initially the aphid fungus sampling service operated only in Arkansas, but over the years, additional states have expressed interest in participating, and it has expanded to include Alabama, Florida, Georgia, Louisiana, Mississippi, and South Carolina. In each state a cotton or IPM extension agent serves as a coordinator, providing names and addresses of potential participants. Participants may be consultants, researchers, extension agents, or growers. New participants are encouraged to utilize the service through our internet web site (http://www.uark.edu/misc/aphid/). The information about fungus levels in individual fields is immediately faxed to the participant, posted on our website, and is also used extensively in extension newsletters and Agfax reports, to keep the cotton community informed about the progress of fungal epizootics in counties and states.

Materials and Methods

Each spring the extension coordinators in each state (see the authors listed above) are contacted and provided with a list of the previous years participants. The coordinators are asked to revise the list if needed, provide names, addresses, and phone numbers of potential participants. Supplies needed to make the sampling kits and to perform the diagnoses are ordered. These include vials, mailing tubes, Fed-Ex envelopes and address labels, ethanol, slides, coverslips, sampling instructions, and other supplies. Each participant is sent a set of sampling kits prior to cotton planting, and more are available upon request. Participants are requested to collect cotton aphids whenever the are perceived to be a problem or are increasing in the cotton fields they scout. Aphids are collected by placing aphid-infested leaves from 4 to 5 areas of the field into the vials containing 70% ethanol. The participant then sends the vials within the mailing tubes back to the service laboratory at the University of Arkansas via Fed-Ex next day service.

Upon receivings amples, each sample is logged in, and a randomly selected subsample of 50 aphids is removed from each sample. This is done by trained technicians who use fine forceps and a dissecting microscope. Aphids are drained of excess ethanol by placing them on a dry tissue, then 10 aphids are squashed on a slide, 5 per coverslip, and the slides labelled with the sample data. Each aphid is individually diagnosed at 200 or 400x using a phase microscope. The diagnosis method is very accurate and, in addition to providing data on whether a particular aphid is positive or negative for *N. fresenii* infection, the diagnoses provide precise information on the stage of infection of each aphid (early, middle, late). This data is recorded and permits the service to describe not only the percentage infection in the sample, but the stage of the epizootic. It takes skilled technicians about 1 hour to mount and diagnose one sample.

The information for each field is immediately faxed to the participant who sent in the sample and in addition, the information is uploaded onto the service's internet website (http://www.uark.edu/misc/aphid/). Participants use the data to help them make IPM decisions about whether to spray cotton aphids with an insecticide or not. The information on the website can be used by large numbers of people in extension and consulting to determine whether epizootics have been observed in their states or counties yet. Information from the service is also provided to and used in extension newsletters and Agfax reports to inform large numbers of people with the status of fungal epizootics.

Results and Discussion

Each year the sampling service diagnoses fungal prevalence rates from about 300-400 fields. This is about as many samples as the service can handle based on current funding available and time required per sample. Usually the service has 4 technicians working full-time on handling and diagnosings amples between 1 June and 31 July. This is the period when most samples arrive. At most the four technicians can process 24 to 32 samples per day. The graphs in Figure 1 show the percentage of *N. fresenii*-infected aphids in the samples received each year by date samples were collected. In most years a relatively large number of samples are recieved early in the summer in which no fungus is present. This does not mean that the fungus is totally absent from the fields and providing no natural control of cotton aphids. We have unpublished information that suggests that alate aphids flying into cotton fields are sometimes infected and die, resulting in failure to found colonies. While this is of biological control value, in most fields and in most years, little or no fungus has been present prior to 18 June. Whenever no fungus is found in samples IPM decisions should consider application of an insecticide, if the economic threshold for cotton aphids has been reached and no other factors will reduce the aphid population. Starting about the third week of June the fungus becomes more and more important. Generally the first fungus is found each year from samples collected in Louisiana and southern Mississippi. Prevalence is the term for the percentage of the aphid population at a moment in time from a particular field or area that is infected with *N. fresenii*. When prevalence in a particular field is ca. 15% we generally expect a decline in the cotton aphid population within 7-10 days. When prevalence levels are 30% or higher, then

an epizootic is taking place and in almost all cases the fungus will rapidly reduce the aphid population as well as or better than an insecticide. In such cases, the producer can reduce input costs by letting the natural fungus reduce the aphid population. The graphs show that even at dates when many field samples indicate that full-blown epizootics are wiping out the aphid populations in those fields, some fields still have zero percent infection. This indicates the importance of scouting each field whenever possible, and not totally relying on reports of epizootics in some fields.

History of the Sampling Service

In 1989 cotton entomologists (particularly Dr. Phil Tugwell) observed that an unknown factor, presumably a fungus, was causing rapid and massive die-offs of cotton aphids in the Midsouth. In 1990 we collected samples and identified the causal agent as *N. fresenii* (Steinkraus et al. 1991). During 1991-1992 basic research on the geographical distribution of the fungus and the speed of aphid declines was conducted and the cotton community was informed of the existence and value of *N. fresenii* as a biological control organism . In 1993, with the support of Cotton Incorporated the sampling service was initiated in Arkansas and continued in Arkansas alone until 1996. In 1995 a multistate survey was conducted to determine if other states would benefit from the service , and in 1997 with additional support from Cotton Incorporated the service was expanded to include Alabama, Louisiana, and Mississippi. In 1998, it was further expanded to include Georgia, and in in the years 2000-2002 Florida, Missouri, and South Carolina have also participated to some extent.

Value of the Sampling Service

Over the years the service has received much positive feedback from participants. Frequently fields have reached aphid treatment thresholds and based on the information from the sampling service the producer has avoided application of an insecticide, with thousands of dollars of savings. We roughly estimate that the direct value of the service is ca. $600,000 per year in reduced input costs. However, it is the indirect value, from the information placed on the website and used by extension newsletters in Arkansas, Mississippi, and Louisiana, and in Owen Taylor's Agfax, that provides the main value. This we roughly estimate to save input costs for cotton aphids of at minimum several million dollars in the Midsouth and Southeast. Considering that the total cost of the service is below $30,000 per year and participants are not charged for the service, this is a good value.

Future of the Sampling Service

The future of the sampling service is unclear. As long as fungal epizootics occur in cotton aphid populations, and there is interest from the cotton community, and funding continues, the service will continue. Environmental changes, cotton variety changes, new insecticidal chemicals, economics, and new technologies, could all change the situation and increase or decrease interest in the aphid fungus sampling service.

Acknowledgments

Over the years many hourly technicians and others have assisted in the sampling service, too many to list here. The assistance of all of them is gratefully acknowledged. Funding from Cotton Incorporated and the Arkansas Experiment Station are also greatly appreciated.

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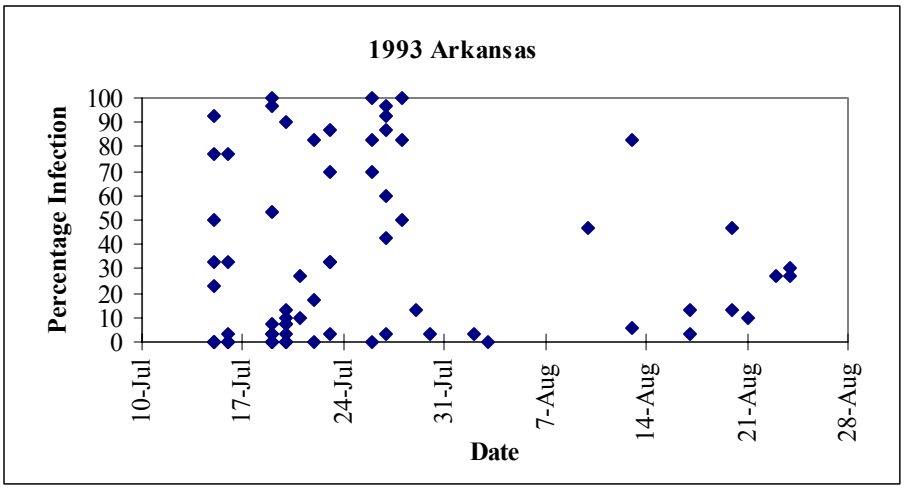
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Percentage Infection
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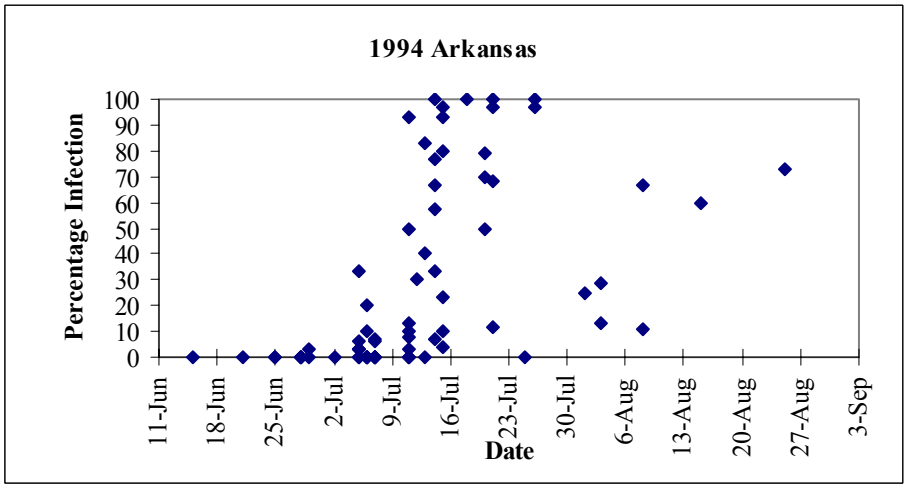
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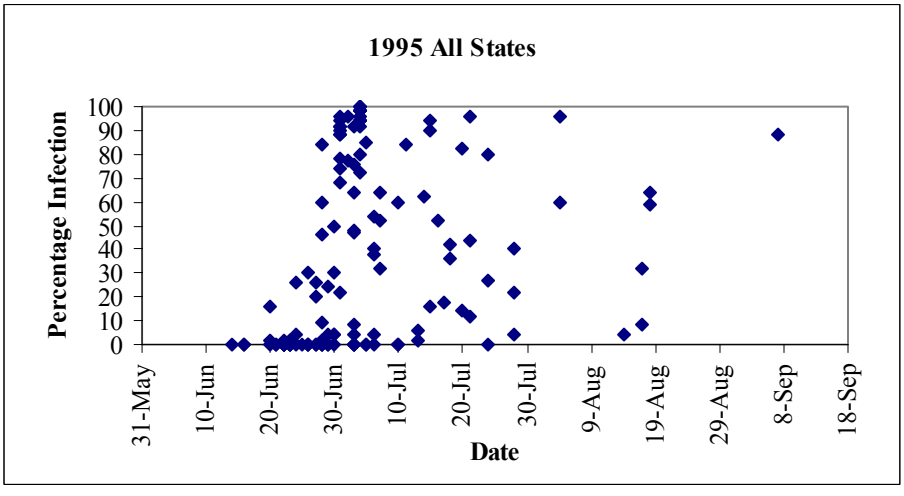
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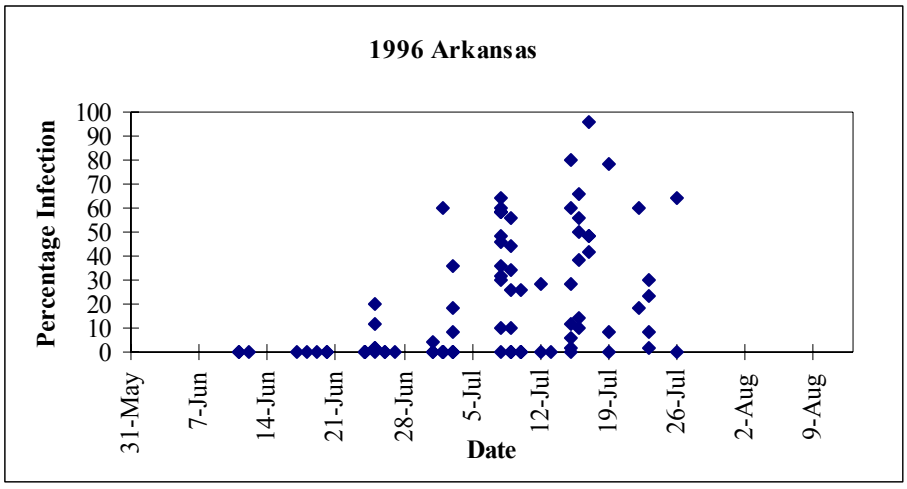
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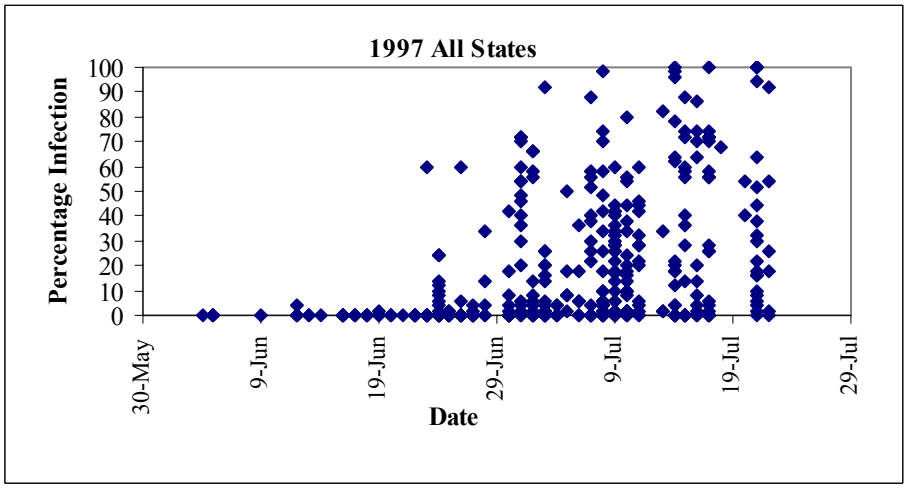
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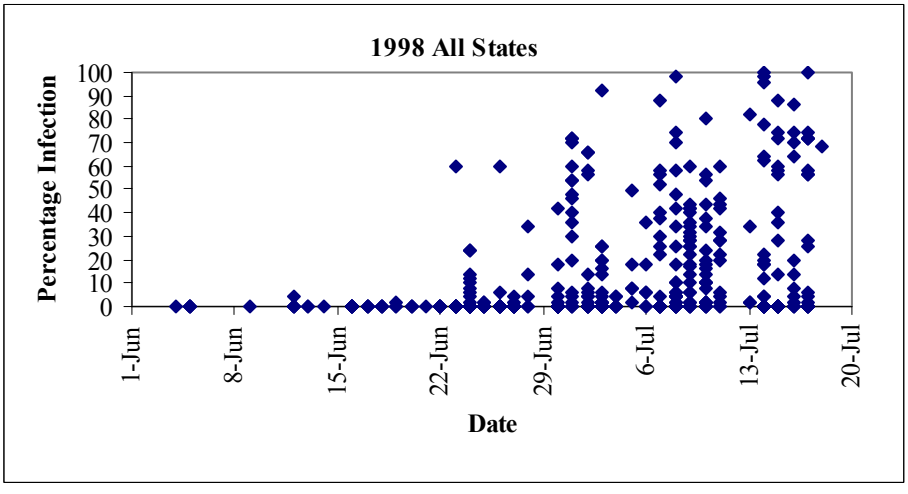
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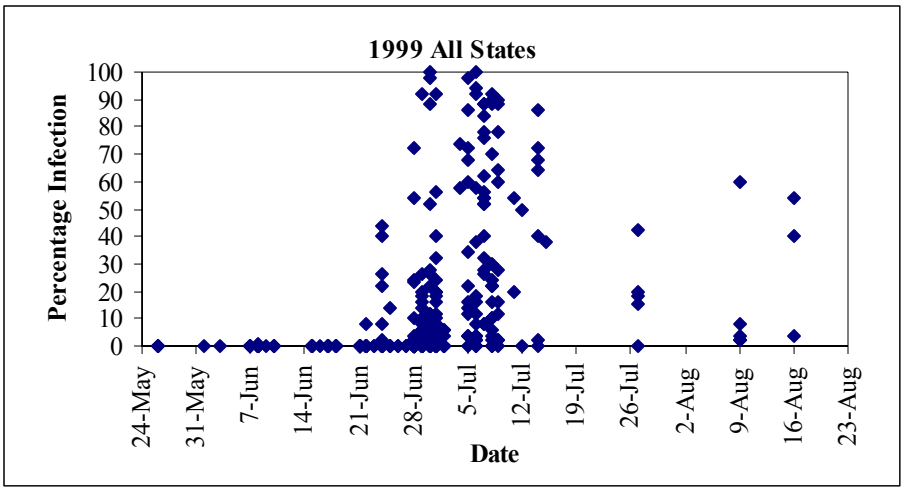
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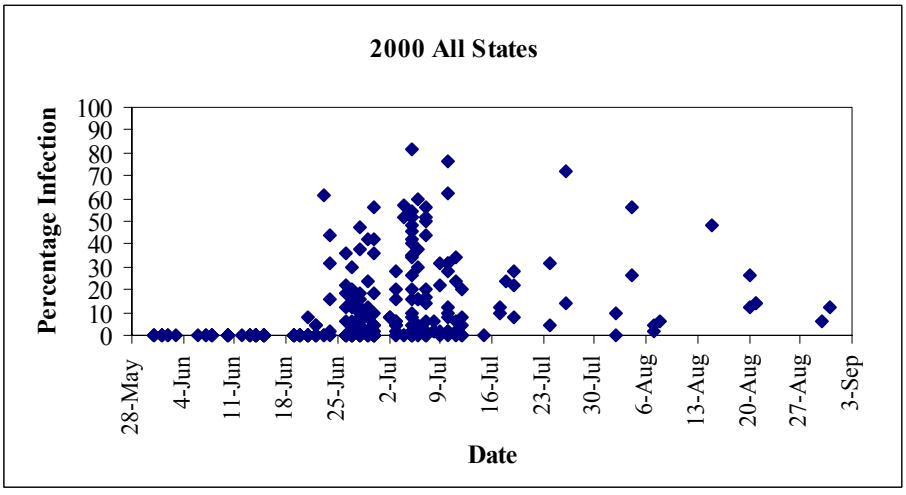
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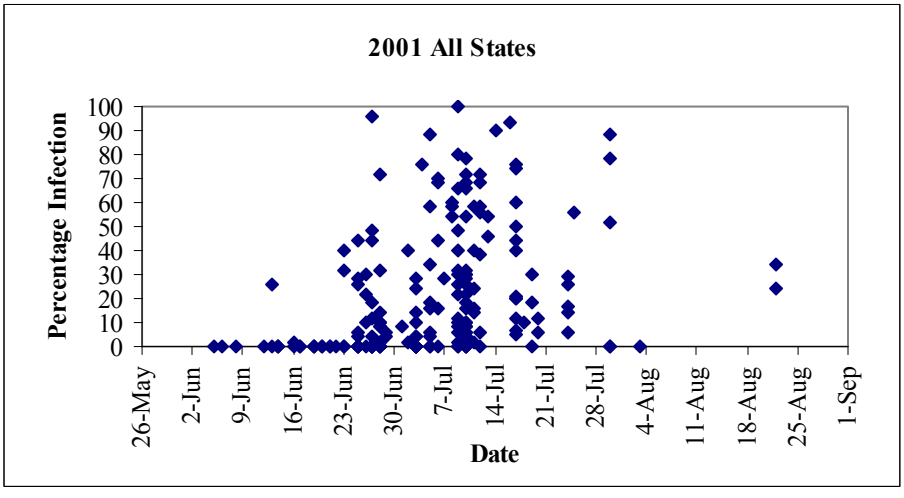
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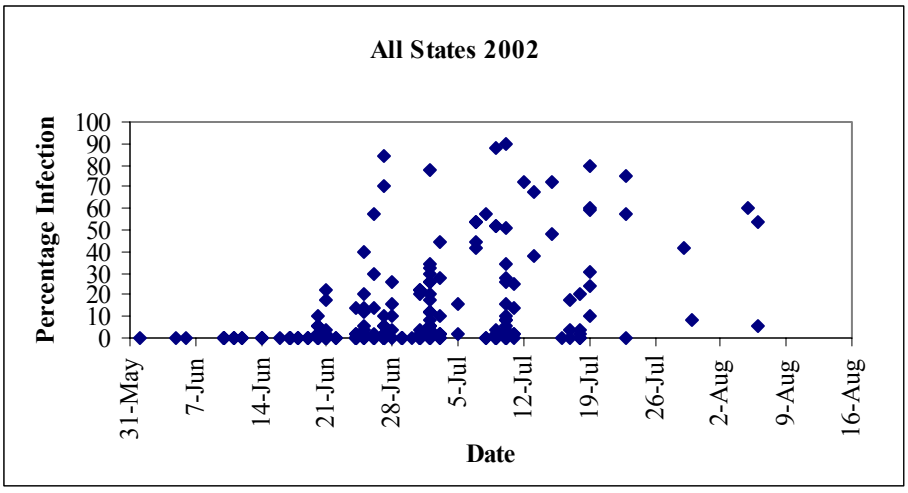

Figure 1. The percentage of *Neozygites fresenii*-infected cotton aphids (prevalence) in each sample by collection date. Whenever prevalence is ca. 15% the aphid population within a particular field is considered to be in the early stage of an epizootic and the aphid population is expected to crash within a week or so. When the prevalence is above ca. 30% the aphid population is in the midst of an epizootic and in almost all cases the fungus will reduce the aphid population as well as, or better, than a chemical insecticide.