APHID MANAGEMENT THRESHOLDS, SAMPLING AND CONTROL SUGGESTIONS

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Abstract

The cotton producers quest for "earliness" presents entomologists with a new challenge. The challenge is to achieve an early crop and manage the early sprays. To meet this challenge, we must learn which insecticides accomplish our goals of earliness and reduce the build up of other pest insects. Early season insecticide applications usually cause damaging aphid infestations. Timing the application at an early stage of the crop's development may be less detrimental to parasites and predators. Yield loss data and reproductive biology dictates that a scout detect a generalized infestation of aphids across a field quickly. The first indication of a generalized infestation of aphids is the appearance of winged adult aphids. To allow producers sufficient time to react to such a population, a treatment threshold may have to be set below a damage threshold. Scouting and thresholds are useless if no control is available. If no control is available for aphids, the some benefits of earliness achieved by controlling insects at first square may be lost to aphid infestations.

Introduction

An examination of the literature of cotton aphids will explain why this presentation will rely heavily on field observations. Aphids appeared in the literature very quickly after the use of calcium arsenate. They remained in the literature for several years while nicotine sulfate was providing some control. After the nicotine sulfate era, cotton aphids seemed to disappear from the literature. What was the reason for this disappearance? The disappearance seems to coincide with the appearance of chlorinated hydrocarbons, organophosphates, and a pest management strategy of not spraying cotton before first bloom. This strategy was adopted for fear of reducing beneficial insects and producing uncontrollable bollworm populations. The credit for the delayed spray pest management strategy is most often attributed to the bollworm complex. Did aphids also contribute to the delayed spray strategy?

Andrews and Kitten (1989) reported reductions in cotton yields caused by aphids infesting cotton after bloom. These aphid populations were induced by applying insecticides at first bloom. Layton (1995) reported yield losses by aphids infesting cotton at the eight node stage. The average differences between treated replicated plots and an untreated check was estimated at 220 lbs. of lint cotton per acre. The average check plant was 4.8 inches shorter than the plants receiving one dicrotophos application. This demonstration was carried out on an aphid infestation on production cotton caused by applications of insecticides applied when the first squares appeared on the cotton plant. These early season applications for control of boll weevils and plant bugs delay in season applications for boll weevils and produce plants with higher fruit retention. High early season fruit retention translates to a crop that is produced faster and one that can be harvested earlier. The faster a crop is produced, the fewer insect applications are required to make the crop. More expensive late season insect application can be avoided. An earlier harvest translates to better harvest conditions. Better harvest conditions translate to a more efficient harvest, better yields, and better lint quality. The result is a more profitable cotton crop (Williford, et al 1995).

If something looks too good to be true, it probably is. What are the negative aspects of attempting to produce an early crop? The early insecticide applications do reduce the beneficial arthropod populations that keep bollworm and aphid populations in check. The risks of increasing bollworm and aphid populations have little economic significance if cheap efficacious insecticides are available to control these insects. These negative factors involved with earliness force the question. Did the lack of insecticides to control bollworms and aphids force entomologists to retreat to delayed applications and the pest management strategies of 1950's, 1960's and 1970's? If efficacious insecticides for aphids and/or bollworms are not available, will cotton producers again be in a retreating position and allow insects to determine the timing of their crops? The challenges facing cotton entomologists are to devise a system where earliness can be achieved with minimum risk of inducing populations of insects that negate the benefits of earliness.

Sampling

An understanding of the population dynamics of aphids is useful when establishing a sample method and treatment threshold. Cotton fields that do not need early applications of insecticides seldom support an aphid population. When early season applications are required, there is a pattern that is often observed in the building of aphid populations. Aphids will be found in widely scattered spots (hot spots) in cotton fields that receive insecticide applications at square initiation. Observations of these "hotspots" during the prebloom period indicate the decisions that will be made later in the crop's management.

If beneficial insects increase in these spots, the spots will be small and will disappear. If the field is located where beneficial insects must move long distances or insecticide applications are needed, these spots will enlarge and

Reprinted from the *Proceedings of the Beltwide Cotton Conference*
Volume 1:106-108 (1996)
National Cotton Council, Memphis TN

winged adults will start to appear. Within days of the appearance of winged adults in the "hot spots," winged adults will be found scattered over the entire field. As these winged adults disperse across fields, aphid populations can increase from less than one aphid per leaf to 100 aphids per leaf in a six-day period. This rapid increase would result in a population that accumulates approximately 300 aphid days in six day periods.

When this explanation of aphid population increase is presented to cotton producers and consultants, one can expect a response. The response sounds like this, "I did not spray and I had aphids." Aphids appear across Mississippi within two week periods once the wing adults start to move. Aphids are a communal or regional problem. The winged aphids seeking new food sources probably do not recognize how a field of cotton was managed. With isolation, differences in aphid management strategies have been observed.

Aphids can disappear as quickly as they appear in the Mississippi River flood plain. An epizootic has occurred every year since 1986, the first year of my aphid studies. A fungus, *Neozygites fresnii*, identified by Steinkraus et al 1991 is now considered the causal agent for these epizootics. Data used by Andrews and Kitten (1989) showing yield loss due to aphids were collected in 1986, 1987, and 1988. Fungal epizootics occurred each year these data were collected. The damaging prebloom population (Layton 1995) also was eliminated by a fungal epizootic.

The aphid population dynamics scenario above is from field observation and historical recall. With the addition of varying populations of parasites and predators, many different scenarios could be possible. The importance of understanding the population increase of early season aphids, and their demise, is crucial to scouting and developing a treatment threshold for aphids.

The most popular method of estimating aphid population size is to pull leaves and count aphids. Aphid population estimates are generally reported as aphids per leaf or aphids per square inch. Once the winged adults move across the entire field, variations among scouting samples are reduced. Winged adults generally mark the point at which aphids have out produced their parasites and predators. Because of the overwhelming increase in aphid populations, the method that we use to estimate the size of the population is over shadowed by the timing of the estimate. Counting the aphids on the first fully expanded leaf or fourth main stem leaf below the terminal is widely used and efficient sample method. The sample data that may be most valuable is the detection of winged adults and their density. Within two day periods each of the winged adults will be surrounded by 6-15, small aphids.

Thresholds

The number of insects infesting a crop that will cause damage beyond the cost of treating with insecticides (damage threshold) will vary with each growing season. Treatment thresholds must be set on some probability that certain number of insects will damage a crop. Spray decisions made early in a crop season deal with establishing yield potential. This yield potential is very susceptible to change due to varying weather conditions that occur after the application is made. Late season spray decisions may deal more with protecting a yield that is in the field. Treatment decisions must also deal with reaction times. The reaction time is the time required to estimate insect numbers in a field and get an insecticide treatment in the field to prevent insect damage.

The damage potential of aphids differs in time. In preblooming cotton, aphid damage expresses itself as a delay. L. R. Wilhoit, et al (1992) showed that leaf area was reduced 50% by aphids attacking cotton at the seedling stage. This reduced leaf area did not produce detectable yield reductions in California. Visible evidence of aphid damage to production cotton before bloom is limited to stunting of the plant, lack of terminal elongation, and honeydew produced by aphids. Often these aphid damaged plants will compete with other plants and eventually attains the height of the undamaged plants. This catching up approach often seems to cost the plants lint production. Aphid "hot spots" in fields during early season are good areas to observe this damage. Layton (1995) in a replicated test on aphid infested, eight node tall cotton, applied one application of insecticide. Aphids were controlled but rebounded to 57 aphids per leaf five days after treatment. The one application increased yields 220 lbs. of lint per acre in Mississippi.

The cotton plant is establishing its yield potential between first square and first bloom. The effect of aphids on yield at this time depends upon the growing conditions that follow these infestations. Thresholds will have to be set to preserve the yield potential. The differences in aphid damage potential at various crop stages will probably be secondary to reproductive potential of aphids when attempting to set some treatment threshold. Aphids will attain threshold numbers so quickly that treatment thresholds may be forced to be set below damage thresholds to allow for cotton producers to react to the aphid population.

Andrews and Kitten (1989) measured the effects of aphid populations after bloom. In this publication, aphid days were used to produce an equation that described the average yield response to aphids over three years. Table one shows the average yield loss due to aphids using the equation from Andrews and Kitten (1989). These data in table one show yield loss per aphid day to be more severe where the aphid day accumulations were lower. The addition of more aphid days was not as detrimental to yield once the aphid day accumulations reached the 500 and one thousand aphid day ranges. At twenty five-hundred aphid days, approximately 28 aphid days are required to reduce seed cotton yields one pound of seed cotton per acre. Fuson, et al 1995, shows a linear relationship between aphid days and yield. This linear relationship's slope shows that 20 aphid days are required to reduce yield one pound of seed cotton per acre. This relationship appears to have been calculated using little data below one thousand aphid days. Using data greater than one thousand aphid days, the yield by aphid day relationship is shown to be near a linear relationship by both Andrews and Kitten (1989) and Fuson, et al (1995).

In a demonstration conducted in 1995 by myself, eight 20 acre fields were treated with insecticide and none had over 10 aphids per leaf on June 23, 1995. This population had been treated previously and the low population was uniformly distributed across the field. On June 25, 1995, the average population on these fields was 29 aphids per leaf. On June 27, the average number of aphids per leaf was 100. These data verify that damaging aphid populations are reached very quickly once their potential is spread across the entire field.

From the discussion above regarding population dynamics and yield losses associated with aphids, treatment thresholds of aphids must be based more on timely detection of a population of aphids rather than the actual number of aphids on leaves. The data on yield effects of aphids after bloom show that quick detection and response are necessary to prevent yield loss. The time difference between one winged aphid per leaf and ten total aphids per leaf can be measured in hours more accurately than days. A treatment threshold that would allow adequate reaction time would probably be between one winged aphid per leaf and ten total aphids per leaf.

Control Suggestions

A knowledge of aphids is necessary to understand how to control aphids. O'Brien, et al (1992) reviewed the taxonomy and biology of the cotton aphid. Cotton aphids reproduce asexually and develop populations quickly. The potential to select and multiply a resistant gene in an aphid population is high. Mortality factors other than insecticides should be allowed to operate on aphid population when possible.

With some new knowledge and new technology, cotton producers can have earliness and not be at the mercy of bollworms and aphids. Since the presentation is based on mid-south experience, these will be mid-south suggestions. The annual occurrence of aphids in the Mississippi delta since the mid 1980's indicates that cotton producers are using early season insecticide applications. This is based on the assumption and some observations that if early season insecticide applications are not used, beneficial arthropods check aphid populations. We have experienced fruit set problems (especially in 1994) and boll weevil trap captures have increased in the last few years. Fruit set and boll weevil suppression have been attainable goals of cotton producers who wish to produce an early cotton crop. Transgenic BT cottons will not alter these goals. Within an area as small as the delta, each cotton producer's problems are different and control suggestions can only be generalized.

The first suggestion is not to employ the wait for the fungus strategy of aphid control. Most producers who employ this strategy, spray for aphids because the crop looks too bad to wait on the fungal epizootic. The result is money spent to control aphids after they had done their damage.

The second suggestion is to use your parasites and predators as much as possible. Ways to use beneficial arthropods are as follows:

1. Apply early season insecticides on time.
2. Know which parasites and predators you want to protect.
3. Use insecticides that are least harmful to the beneficial arthropods.
4. Do not use insecticides for plantbugs and boll weevils that tend to create other insect problems that will be need to be treated. This forces a second application that will further reduce beneficial arthropod populations.
5. Encourage research on how to control early season insects without harming beneficial insects.

Another suggestion is to plan aphid management strategies along with early season insect strategies so that insecticides with different modes of action can be use early and if necessary on aphids. Aphids with their asexual reproduction have the highest potential for insecticide resistance of any of our cotton insect pests. One resistant aphid can produce 140 aphids with the same genetic make up in 11 days.

The cotton industry should encourage the development of safe, effective, and economical aphicides. Using parasites and predators should be our initial plans. However, under heavy boll weevil pressure, producers often have no option but to use insecticides between first square and first bloom. Cotton fields that have recurring plant bug and bollworm populations may have to be treated quickly to preserve parasites and predators. Having a good aphicide to incorporate into such untimely sprays may delay the aphid population long enough so that beneficial arthropods or a fungus epizootic controls aphids. When all good pest management strategies fail for some reason, a good aphicide is needed to preserve the yield potential of a cotton crop.

Table 1. Yield loss in pounds seed cotton per acre for different ranges of aphid day accumulations.

Aphid Day Range	Yield Loss
50-100	71
450-500	10
950-1000	5
1450-1500	3
1950-2000	3
2450-2500	2

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