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Matthew E. O'Neal

Iowa State University, oneal@iastate.edu

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Different thresholds, different states: Why?

Abstract

By now you have heard the story: there are two economic thresholds suggested for managing soybean aphids - 10 or 250 aphids per plant. The difference is remarkable for anyone who has scouted for soybean aphids in Iowa. At 10 aphids per plant, it's hard to imagine a year when we would not treat possibly millions of acres of soybeans in Iowa. Although 10 aphids per plant can reproduce into hundreds if not thousands per plant, this type of dramatic outbreak has not occurred consistently in Iowa. During the 2004 growing season, it was uncommon for fields in Iowa to reach even 100 aphids per plant.

Keywords

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Insects and Mites

Different thresholds, different states: Why?

by Matt O'Neal, Department of Entomology

By now you have heard the story: there are two economic thresholds suggested for managing soybean aphids—10 or 250 aphids per plant. The difference is remarkable for anyone who has scouted for soybean aphids in Iowa. At 10 aphids per plant, it's hard to imagine a year when we would not treat possibly millions of acres of soybeans in Iowa. Although 10 aphids per plant can reproduce into hundreds if not thousands per plant, this type of dramatic outbreak has not occurred consistently in Iowa. During the 2004 growing season, it was uncommon for fields in Iowa to reach even 100 aphids per plant.

So why is one threshold more than the other? And how did two groups of entomologists come to such different conclusions? Let me try to answer some of these questions. In this article, I'll briefly describe how both thresholds were developed. In the spirit of full disclosure, my laboratory at Iowa State University has participated with a larger team of researchers led by David Ragsdale, professor of entomology, University of Minnesota, and has developed the 250 aphids per plant threshold. As I will describe later, we have compared this threshold to ones that are much lower. This very short summary should give you an understanding of how these thresholds were created.

To my knowledge, one of the first discussions of the differences in thresholds was an article in a 2003 edition of *Farm and Home Research* (Vol. 54, No. 4), a publication of the Agriculture Experiment Station at South Dakota State University. The article summarizes some of the field experiments conducted by Mike Catangui, associate professor at South Dakota State University. Catangui is investigating the impact of soybean aphid infestations that occur at different soybean growth stages. This is an important question: are soybeans more susceptible to aphid injury when outbreaks occur in the vegetative or reproductive stages? From what I gather from the article and Catangui's Web site, his approach to answering this question is to cage soybeans and infest them at specific growth stages. From these cage studies and his observations of soybean aphid populations in South Dakota, Catangui reaches the conclusion that aphid populations that go unchecked



During heavy infestations, more than 1,000 aphids may occupy the underside of a soybean leaflet. (Marlin E. Rice)

will increase from 10 to 10,000 aphids per plant. Such unmanaged populations can reduce yields by as much as 30 percent. For a more complete explanation, please visit Mike Catangui's Web site at http://plantsci.sdstate.edu/ent/entpubs/sa_economic_threshold.htm.

It is the use of data from cages alone that, I think, makes it inappropriate to draw inferences regarding thresholds. The fundamental assumption in the cage research is that low populations of soybean aphids will increase to very high populations if left untreated with an insecticide. Based on our field research in Iowa, we cannot make this assumption. In 2005, the soybean entomology laboratory conducted cage studies at several sites in Iowa. We caged soybeans and artificially infested plants within cages with 10 aphids per plant (Figure 1), but we also infested plants that were not caged (Figure 2). Caged aphids will reach 1,000 within two weeks; however, uncaged aphids did not reach this level. Without cages to shelter aphids from predators and to keep winged aphids from dispersing, these populations did not reach thousands per plant. So although basic questions can be addressed with cages (effect of timing of soybean aphid infestation on yield), it is not appropriate to draw conclusions about thresholds from these studies.

In contrast to the studies conducted at South Dakota State University, Ragsdale has selected an experimental design that uses natural infestations to determine when aphid populations reach levels that cause economic damage and should be treated. Within



Figure 1. This series of photos demonstrates how caged (top) and uncaged (bottom) soybean plants were artificially infested with aphids. Once infested, all predators were removed from the cages. Cages were designed so that plants could be examined throughout the 2-week experiment. The number of aphids on each plant was counted every 3 to 4 days and the average number of aphids on 16 caged and 16 uncaged plants was calculated. See Figure 2 below for results.

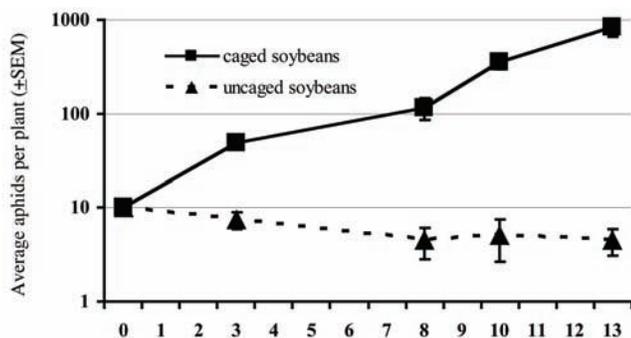


Figure 2. Average soybean aphid population growth on soybeans that were caged (solid line) and uncaged (dotted line) for a 13-day period. Note that the y-axis is on a logarithmic scale. Ten aphids were placed on individual plants on June 17 and the number of aphids counted every 3 to 4 days. All predators were removed from caged plants at the start and at every counting during the experiment. The experiment was terminated after winged aphids were collected on the caged plants on the 13th day after infestation. (SEM = standard error of the mean.)

replicated field plots, treatments are assigned to plots before the field season begins. These treatments are based on the number of aphids that accumulate on the plant over time. If a certain level of aphid exposure is reached, then an insecticide is applied. There are two extreme cases: no aphids and no treatment, representing plants that are completely protected from aphids (no aphids-aphid free) and those left unprotected (untreated). Between these two treatments are several intermediate levels. After the end of the growing season, the yields from the plots are compared to the amount of aphids accumulated on them. A regression analysis reveals the relationship between aphid populations and yield. Based on the yield response from this type of experiment, an economic injury level (EIL) can be calculated. This is the point at which sufficient injury has accumulated on the plant to justify the cost of an insecticide application. The economic threshold is set below this point so that aphid populations can be stopped from growing before they reach the EIL. Assuming that aphid populations double every two days, Ragsdale has suggested that the economic threshold (ET) be set at 250 per plant so that growers would have sufficient time to treat populations before they reach the EIL. To employ this 250 threshold, growers are recommended to treat only if populations are increasing because a population that tops off at 250 per plant is not expected to cause economic injury.

During the 2005 growing season, the soybean entomology laboratory at Iowa State University tested the 250 threshold, comparing it to a much lower threshold (Table 1). What we observed at three locations in Iowa (Figure 3) was that the 250 threshold provided yield protection equivalent to a lower threshold of one aphid per plant (a no aphid treatment). Note that although the yields for the 250 and no aphid treatment were similar, the amount and cost of insecticide application was not similar. We applied insecticide as often as three times during the growing season to create the no aphid treatment (Table 2). We conclude that timing an insecticide application with the 250 ET reduces the amount and subsequent cost of a soybean aphid management program, while providing sufficient protection.

The review of research that led to the 10 and 250 thresholds is incomplete. What is missing is the peer-review process. Both research groups will present their case to anonymous groups of scientists who will have the opportunity to see the data sets and analyses. To date that has yet to be done for either threshold.

Given the urgent need of soybean growers for information regarding soybean aphid management, we have presented our data as quickly as it comes in. As we further study these methods, we will keep our readers and growers informed of how best to manage this pest.

Because of the low numbers of soybean aphids collected in the suction traps in Iowa, it's possible that we will see aphid populations in 2006 reach levels similar to those observed in 2004 (see article in this edition, page 4). I suggest reading an *ICM Newsletter* article from August 22, 2005, "Soybean aphids attack: Does it pay to spray low populations?," IC-494 (22); in that article I discuss a threshold experiment from 2004. We observed maximum populations below 250 and even below 100 aphids per plant at some sites in Iowa. With such low populations, we did not observe any protection in yield when insecticides were applied. However, it is hard to predict how aphid populations will vary in the future based on only four years of experience with this new insect pest. One thing is certain: growers shouldn't count on a return to growing seasons when insects were not a major concern for soybean production in Iowa.

Table 1. Four approaches to aphid management compared in 2005.

Treatment Title	Methodology
Do nothing	No insecticide applied.
Aphid free	Apply insecticide whenever aphids are present.
250 threshold	Apply insecticide when average aphids/plant equals 250.
Speed scouting	Apply insecticide based on speed scouting method.

Table 2. Timing and frequency of insecticide applications during 2005 field experiment.

Treatment	McNay	Ames	Nashua
Aphid free	7-5, 8-4, 8-22	7-6, 8-20	7-4, 8-16
250 threshold	9-3	8-20	8-16
Speed scouting	8-22	8-20	8-4

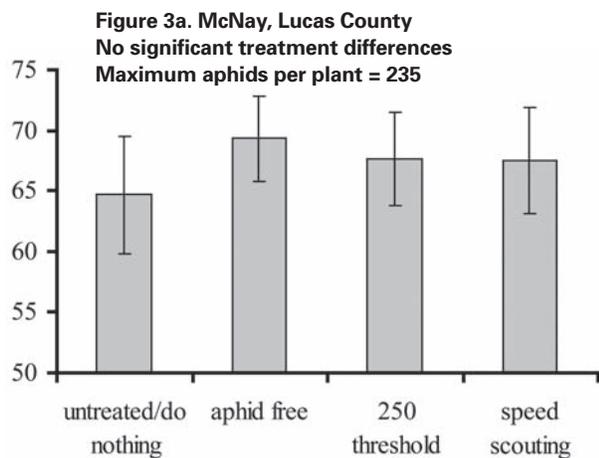
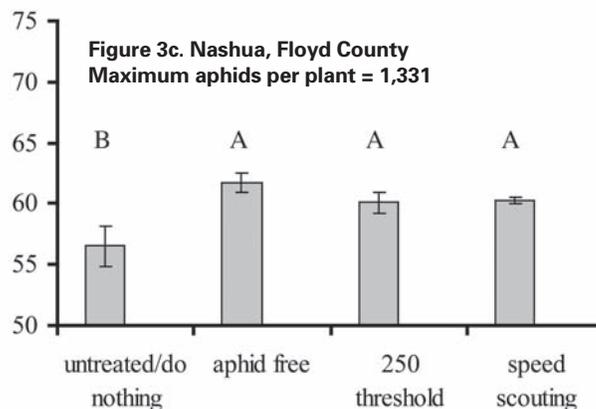
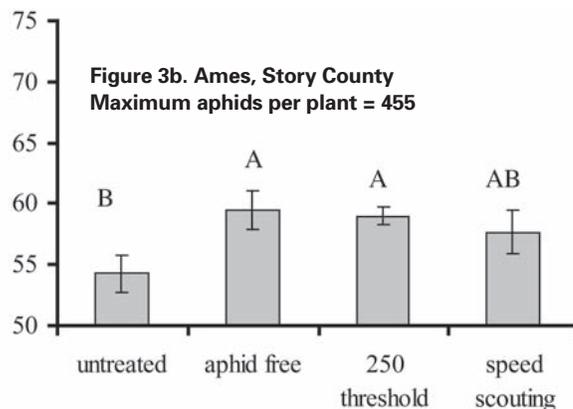


Figure 3. Comparison of four approaches to soybean aphid management conducted in areas of Iowa with differing aphid densities. Fields were infested naturally, and aphid populations were monitored every 7 to 10 days. The maximum number of aphids per plant measured in the controls is listed with each figure. Yields were corrected for 13 percent moisture.



Matt O'Neal is an assistant professor of entomology with research and extension responsibilities for pest management in soybeans.