Soybean Aphids in Iowa—2004

by Marlin E. Rice, Matt O'Neal, and Palle Pedersen

THE SOYBEAN APHID* (Aphis glycines) *has become a major pest in Iowa. The largest infestation of soybean aphid occurred in 2003. Iowa soybean yields during 2003 averaged 32 bushels per acre. This was an average decrease of 16 bushels per acre (or a 32 percent reduction) from the average yield of 48 bushels per acre in 2002. This was the lowest average yield since the floods of 1993. Delayed planting, flooding, and drought were partly responsible for these yield reductions, yet soybean aphids were one of the principal causes for these large yield losses.

Soybean aphids will colonize the upper stem and newly developing leaves on soybeans. *(Marlin E. Rice)*

The soybean aphid has been found in Iowa soybean again in 2004. However, the extent of the potential problem is unknown. This publication reviews what is known about the insect and makes management suggestions for 2004. Included is a new economic threshold based on a review of data from field trials and university research. Entomologists from 11 universities used this information to develop a consensus recommendation for the 2004 growing season.

Origin of Soybean Aphid

The soybean aphid is native to eastern Asia, including China, Indonesia, and Japan. It was first detected in North America in Wisconsin in 2000. It is not known how this insect entered the Midwest, but historical records of aphid interceptions by the USDA suggest that the soybean aphid most likely arrived in the United States from Japan or China, either carried by an international airline passenger or associated with horticultural cargo.

Distribution in Iowa

Entomologists in Wisconsin reported finding widespread and large aphid populations in southern Wisconsin soybean on July 20, 2000. By late August the soybean aphid could be found in Iowa and by mid-September it was detected or assumed to occur in all counties in the eastern half of the state (Fig. 1).

The following summer, soybean aphids were observed in western Iowa in Woodbury County and within two years after entering the state, the soybean aphid had been detected in every Iowa county.

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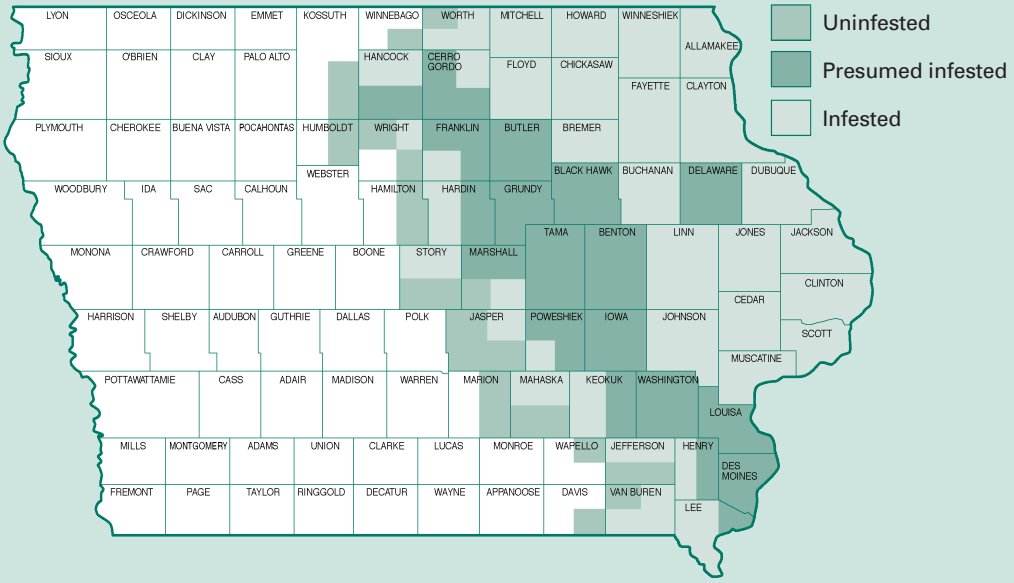


Figure 1. Known distribution of soybean aphid in Iowa, September 8, 2000.

Description of Soybean Aphid

Wingless soybean aphid adults are about 1/16 inch in length, pale yellow or green, and have dark-tipped cornicles (tail pipes) near the end of the abdomen. Aphids feed through piercing-sucking mouthparts and have both wingless and winged forms. The winged form has a shiny black head and thorax with a dark green abdomen and black cornicles. The soybean aphid is the only aphid in North America that will reproduce on soybeans. Therefore, any small colony of aphids found on soybeans must be soybean aphids.

Winged and wingless soybean aphids on a soybean leaflet. *(David Voegtlin)*

Biology and Seasonal Cycle

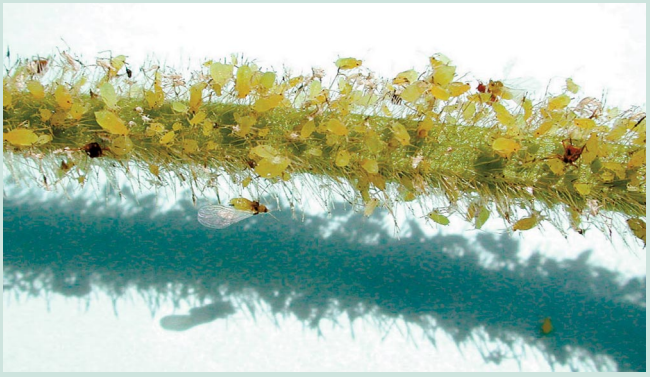
Soybean aphids will lay eggs near bud scales on limbs of buckthorn. *(David Voegtlin)*

The seasonal cycle of soybean aphids is complex. Eggs are laid on buckthorn in the fall and overwinter there. The nymphs hatch in spring, giving rise to wingless females. There may be up to four generations on buckthorn in the spring. These wingless females on buckthorn reproduce without mating (asexually) and the young develop into winged females that migrate in search of soybean or possibly other host plants. Females on soybean reproduce without mating and produce wingless daughters that continue the cycle. During the summer, winged aphids may develop during any generation on soybean, which places much of Iowa soybean at risk from pest invasion because the aphids are easily carried by winds to areas even where the aphid may not overwinter locally.

A large colony of soybean aphids often consists of white, shed skins and brownish carcasses killed by fungal pathogens. *(Marlin E. Rice)*

Soybean aphids reproduce faster in cooler environments. This may be a primary reason why aphids have caused more damage in northern Iowa than southern Iowa. The optimum temperatures for reproduction and longevity are 72–77°F with the relative humidity below 78 percent. During optimum conditions, a soybean aphid population can double in size every 1½ days. When temperatures exceed 81°F, the developmental time is lengthened. The soybean aphid may have as many as 15 to 18 generations annually.

In late summer, the wingless females produce young that develop into both winged females and males. These winged aphids migrate back to buckthorn, where they reproduce sexually. These mated females subsequently lay eggs, beginning a new seasonal cycle that passes through the winter.



Soybean aphids clustering on a soybean stem. *(Marlin E. Rice)*

The first detection of soybean aphids in Iowa has typically occurred near Decorah in northeast Iowa on seedling soybean plants (V1–V2 stage). For the last four years, the first aphids on soybeans have been found on June 18 (2001), June 16 (2002), June 5 (2003), and June 8 (2004).

Injury Symptoms in Soybean

Soybean aphids may distort soybean leaves and heavily infested plants may have yellow leaves. Honeydew, a sticky and shiny liquid excreted by the aphids as a by-product from ingesting large amounts of plant juices, accumulates on the top surface of leaves. Excessive honeydew permits the growth of sooty mold, turning the leaves dark and interfering with photosynthesis in the plant. Heavily infested plants may be stunted. Plants that become stunted during the early reproductive growth stages of soybean may have reduced pod set and seed counts, resulting in lower yields.

Feeding by large soybean aphid populations causes flowers and small pods to abort, reducing the number of pods per plant. Feeding also competes with the soybean plant for nutrients, which reduces the number and size of soybeans per pod. Therefore, protecting flowers (stages R1–R2) and developing pods (stages R3–R4) helps protect soybean yield. These soybean stages typically occur from mid-July into early August in Iowa.

Soybean aphids will lay eggs on buckthorn during the fall. The eggs will overwinter here. *(Marlin E. Rice)*

Host Plants

The primary host is buckthorn (*Rhamnus cathartica* and *Rhamnus alnifolia*). Soybean aphids seem to prefer seedling or sapling trees on which to lay their eggs in the fall. Soybean is a secondary host because the aphids do not reproduce sexually on this plant. Additional secondary hosts include crimson clover and red clover. These are excellent hosts for soybean aphids and will support high levels of aphid reproduction. To a lesser extent, berseem clover and kura clover will support aphid reproduction, while white clover, white sweet clover, and yellow sweet clover can support low levels of reproduction, but they are extremely poor hosts of the soybean aphid.

Soybean aphids excrete large amounts of sticky honeydew that falls on leaves below them. Sooty mold grows on the honeydew and turns the leaves black. *(Marlin E. Rice)*

Transmission of Viruses

The soybean aphid can transmit several viruses including alfalfa mosaic virus, bean yellow mosaic virus, and soybean mosaic virus. The soybean aphid is an efficient transmitter of soybean mosaic virus, requiring from 5 to 30 minutes of feeding time for efficient transmission. Soybean mosaic virus is of primary concern in Iowa because it can cause significant yield loss, although this has not yet been documented in the state. This virus may be more important when it occurs in plants that also are infected with bean pod mottle virus that is transmitted by the bean leaf beetle. Plant-expressed symptoms of these two viruses are similar and cannot be separated visually from each other in the field.

Natural Enemies of Soybean Aphids

Lady beetles (especially the multicolored Asian lady beetle), green lacewings, insidious flower bugs, and other beneficial insects occur in Iowa soybean fields and will eat aphids. These predators probably will be most helpful in June and early July when fields are most likely to have small aphid populations. Their predatory feeding could help suppress early aphid populations. Observations from 2003 suggest that these predators were not able to significantly reduce the aphid population once they reached damaging levels (economic injury level).

The multicolored Asian lady beetle is a major predator of soybean aphids. *(Marlin E. Rice)*

Fungal pathogens also reduce soybean aphid populations. A fungal epidemic was observed in Wisconsin in 2000 and was believed partly responsible for the decline in late-season aphid densities.

Scouting Recommendations

Scouting methods for the soybean aphid are currently being investigated and have not been completely refined for 2004. However, scouting must be conducted to determine aphid presence and abundance.

Begin scouting for soybean aphids, especially in northeastern Iowa, the first week of July. Check the upper two to three trifoliate leaves for aphids. Scout five locations per 20 acres. Field observations should be made weekly. Aphids are most likely to concentrate in the plant terminal. Look for ants or lady beetles on the soybean plant—they are good indicators of the presence of aphids. Lady beetles feed on aphids, while ants tend the aphids and "milk" them for honeydew.

Estimate aphid population size per plant. The best that can be done is to count all the aphids on several leaves and plant terminals to establish what 100 or 250 aphids look like and then use this as a mental reference for gauging populations on other plants.

Large colonies of soybean aphids contain several thousand individuals per leaflet. *(Marlin E. Rice)*

Management Considerations

Do not use insecticides when small populations of soybean aphids are first found in the field. Natural enemies may help suppress small aphid populations.

Determine if the aphid population is increasing or decreasing. Conditions that favor an increase in aphids are cool temperatures, plants under drought stress, and an absence of beneficial insects. Take special note of winged aphids or "broad-shouldered" nymphs that are beginning to develop wings and are nearing the adult stage. If most of the aphids are winged or nearing this stage, they will leave the plant, and maybe the field, and an insecticide may not be needed because the population will rapidly decline. Check for parasitized aphids (mummies). Do not spray the field if a majority of the aphids have turned to mummies.

Use an economic threshold of 250 aphids per plant if the population is increasing and plants are in the late vegetative or early reproduction stages (R1–R4, beginning bloom to full pod). This economic threshold incorporates a seven-day lead time before the aphid population would be expected to increase to 1,000 aphids per plant, which is the economic injury level and the population size that would be expected to cause economic damage (i.e., yield loss that exceeds the cost of control). This recommendation is based on research conducted by entomologists at the University of Minnesota and has been adopted by other university entomologists throughout most of the Midwest. Spraying at the R6 (full seed) stage or later (late August or early September) is unlikely to enhance soybean yield.

Small colonies of soybean aphids often occur on the underside of leaves early in the season. The aphid colony on the left leaflet contains about 115 aphids. *(Marlin E. Rice)*

Aphids attacked by a parasitic wasp larva transform into a "mummy" and die. The adult wasp then emerges through a circular hole chewed in the back end of the aphid. *(Marlin E. Rice)*

Control aphid populations before the symptoms of honeydew, sooty mold, and stunted plants appear in the field. An insecticide may still be of value after these conditions occur, but the optimum time for treatment has passed.

Heavy rains and beneficial insects may reduce low or moderate populations slightly, but insecticides may be the only option in achieving a substantial reduction if the population reaches the conditions stated above.

Aerial application of insecticides is one approach to controlling soybean aphids. *(Marlin E. Rice)*

Insecticide Considerations

Insecticide timing. Insecticide applications made during the early soybean reproductive stages (R1–R4) have shown larger and more consistent yield protection than applications made later in the growing season. On-farm strip-trial data from several midwestern states in 2003 showed that fields sprayed in early August had larger yield gains than fields sprayed in mid-August. For each day delay in spraying during 2003 after August 1, an average of 0.5–0.6 bushel was lost daily. Fields sprayed in late August and early September often showed no yield response to the insecticide application because most of the aphid damage had occurred by this time. In contrast, in northeastern Iowa in 2001, aphid populations increased earlier in the season, and some fields sprayed twice during mid- and late July benefited from both treatments in significant yield increases.

Plants heavily infested with soybean aphids can become stunted and dark from sooty mold. *(Marlin E. Rice)*

Brian Lang, ISU Extension crop specialist, examines the differences in soybean plant height in late July 2001. The rows on the right were sprayed for soybean aphids and the rows on the left were unsprayed. *(Marlin E. Rice)*

Insecticide application. Aphids can be effectively killed with either ground or aerial application; however, the following three elements of insecticide coverage are required for optimum control (98% kill or higher): increased application pressure, increased carrier (water) per acre, and small droplet size. Complete coverage of a soybean plant is essential for optimum aphid control, especially because soybean aphids feed on the underside of leaves and often in the upper third of the plant canopy. If coverage is poor or an insecticide does not give effective control, then the remaining aphids will reproduce and the population could rapidly reach the economic threshold again.

Insecticide and herbicide tank mixing. There are questions regarding the value of tank mixing an insecticide for aphids with the application of glyphosate for weed control in glyphosate-resistant soybeans. This seems like a logical approach to reduce cost; however, it is probably impractical because of timing and application issues. The optimum timing for soybean aphids has been between mid- or late July and early August; the optimum timing for glyphosate in soybean is when the weeds are less than 4-inches tall, which is most likely to be in June. It is unlikely that insecticides applied in June will have residual activity long enough to significantly suppress later soybean aphids. However, such early season applications may increase aphid populations by reducing the numbers of natural enemies. Additionally, insecticide performance is enhanced

with increased pressure and small droplets while glyphosate performance is better with decreased pressure and large droplet size to prevent drift problems.

Insecticide selection. Optimal soybean aphid control and yield protection depends both on product selection and timing of the application. A preferred insecticide would be one that provided the greatest efficacy (percent of killed aphids) with the most residual activity (extended control) and the least environmental impact (mortality of beneficial insects) at the least cost to the producer. There are no perfect insecticides, but there are performance traits that may help determine product selection.

Warrior, a pyrethroid insecticide, has provided the most consistent control among the pyrethroids in many university insecticide trials. Pyrethroid insecticide performance is enhanced during cool temperatures.

Lorsban, an organophosphate insecticide, exhibits a vapor action, especially during high temperatures. This can improve coverage in tall plant canopies or narrow-row or drilled soybeans.

Several insecticides are labeled for soybean aphid (or Chinese aphid on some labels). These are listed in Table 1. Read and follow all label directions, and take special note of the preharvest interval which determines how many days must pass between the insecticide application and legal harvest.

Table 1. Insecticides labeled for soybean aphid (or Chinese aphid)

Product[1]	Rate per acre	Chemical class	Systemic activity	Preharvest interval (days)
Asana XL*	5.8–9.6 oz	Pyrethroid	No	21
Baythroid 2*	2–2.8 oz	Pyrethroid	No	45
Lorsban 4E*	1–2 pt	Organophosphate	No	28
Mustang Max*[2]	2.8–4 oz	Pyrethroid	No	21
Nufos 4E*	1–2 pt	Organophosphate	No	21
Penncap-M*	1–3 pt	Organophosphate	No	20
Warrior*	3.20–3.84 oz	Pyrethroid	No	45

* Restricted-use insecticide
[1] Soybean aphid may not be listed on all generic labels.
[2] "Aids in control," according to the label.

Insecticide evaluation. If an insecticide is sprayed, a small, unsprayed test strip should be left in the field to compare and evaluate against the sprayed areas. The unsprayed test strip will help to determine the real value and performance of the insecticide treatment. Data from Iowa and neighboring states show that not all insecticides provide equal levels of control. The soybean aphid appears to rebound from some insecticides and a high level (98%) of control is desired. High water volume and high pressure also have been suggested as ways to improve soybean aphid control, especially in fields with a dense plant canopy.

Insecticide Test Results

Several universities have evaluated insecticides for soybean aphid control and yield response. One such example, shown in Table 2, illustrates residual control of several insecticides and the resulting yield responses. These data should not be interpreted to imply comparable results under similar or different conditions in Iowa.

Table 2: Soybean aphid insecticide test results, 2003
Courtesy of Ron Hammond, The Ohio State University

Treatment	Rate oz/acre	Average soybean aphids per plant[1]			Yield bu/acre[1]
		4 DAT[2]	11 DAT	18 DAT	
Asana	7.7	333b	225b	216bc	35.1ab
Mustang Max	3.5	267bc	141c	287b	34.1ab
Baythroid	2.4	178cd	115c	227bc	32.8b
Warrior	2.56	125d	140c	156c	36.0a
Furadan	8.0	10e	35d	58d	34.3ab
Lorsban	24.0	10e	34d	58d	33.4ab
Untreated check	—	870a	1208a	1050a	29.0c

[1] Numbers in the same column and followed by the same letter are not significantly different by least significant differences ($P = 0.05$).
[2] DAT = Days after treatment.

Preventive Tactics

In addition to insecticides, some preventive tactics may help reduce aphid problems. Eliminating buckthorn might seem to be a logical approach to reducing soybean aphid populations, but this is impractical. Buckthorn grows widely across Iowa in wooded areas and riverbottoms and has been planted in shelterbelts as windbreaks. If all the buckthorn in a county could be eliminated, winged aphids could still fly in from other counties to infest soybean fields.

Early planting may allow soybeans to escape or delay aphid population buildup and virus disease. This idea is still being tested and results are inconclusive. Additionally, early planting also encourages bean leaf beetle colonization and subsequent bean pod mottle virus infection, so adjusting planting date should be considered carefully before implementation.

Planting seed of resistant plants may also be an option for future management programs. Currently, there are no commercial soybean cultivars known to be resistant to soybean aphid in the United States. However, several species of wild perennial soybeans highly resistant to both the soybean aphid and soybean mosaic virus have been found. The germplasm from these highly resistant accessions could be used in soybean breeding programs and future pest management efforts.

Prognosis for Iowa

The soybean aphid is firmly established as a pest of soybean in Iowa. After a brief four years of experience with the pest and observing its damage potential, it would seem reasonable to expect economic damage to occur somewhere in Iowa every year. The damage is likely to be greater during years when drought and other stresses occur in soybeans. Preemptive field scouting and the timely application of control measures when the aphid population reaches the economic threshold are necessary steps to successfully manage the insect and prevent economic damage.

Additional Information

For more information on soybean aphids, consult the Web site http://www.planthealth.info/soyaphid.htm or contact Marlin Rice at (515) 294-1101.

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