SDSU Extension

iGrow Soybean

BEST MANAGEMENT PRACTICES

Chapter 35:
Soybean Aphid Identification, Biology, and Management

Kelley Tilmon
Buyung Hadi

The soybean aphid *(Aphis glycines)* is a significant insect pest of soybean in the North Central region of the U.S., and if left untreated can reduce regional production values by as much as $2.4 billion annually (Song et al., 2006). The soybean aphid is an invasive pest that is native to eastern Asia, where soybean was first domesticated. The pest was first detected in the U.S. in 2000 (Tilmon et al., 2011) and in South Dakota in 2001. It quickly spread across 22 states and three Canadian provinces. Soybean aphid populations have the potential to increase rapidly and reduce yields (Hodgson et al., 2012).

This chapter reviews the identification, biology, and management of soybean aphid. Treatment thresholds, biological control, host plant resistance, and other factors affecting soybean aphid populations will also be discussed. Table 35.1 provides suggestions to lessen the financial impact of aphid damage.

Table 35.1. Keys to reducing economic losses from aphids.

- Use resistant aphid varieties; several are now available.
- Monitor closely because populations can increase rapidly.
- Soybean near buckthorn should be scouted first.
- Adults can be winged or wingless
- Determine if your field contains any biocontrol agents (especially lady beetles).
- Control if the population exceeds 250 aphids/plant.

Description

Adult soybean aphids can occur in either winged or wingless forms. Wingless aphids are adapted to maximize reproduction, and winged aphids are built to disperse and colonize other locations. Immature soybean aphids resemble adults but are smaller and always wingless. Wingless soybean aphids are pear-shaped, 1/16" long, and range from pale yellow to lime green in color (Fig. 35.1). On late-season soybeans, some aphids may be pale and smaller and often occur on lower leaves of the plant. Adults have dark-tipped cornicles ("tailpipes") at the end of the abdomen (Fig. 35.1). Winged soybean aphids have a dark thorax (central body segment) and cornicles, and transparent wings that extend well past the abdomen.

Figure 35.1. Winged and wingless soybean aphid, *Aphis glycines*. (Photo courtesy of Roy Scott, USDA-ARS)

Biology

On soybean, aphids are all female and reproduce asexually (without mating) by giving live birth to all-female offspring that are themselves only days away from being able to reproduce. This feature gives soybean aphids the ability to increase very rapidly when conditions are favorable. The optimal developmental temperature is 82°F. Under favorable conditions, populations can double every 6-7 days. Their density on soybean can become quite high, sometimes reaching thousands per plant. At other times, depending on conditions, soybean aphids may never exceed a few aphids per plant. When conditions are favorable, populations can increase rapidly and wingless aphids can produce winged offspring, which can then colonize other fields. Population increase often begins during flowering (R1-R2).

Soybean aphids alternate between summer and winter hosts. Soybean acts as the summer host while buckthorn (*Rhamnus* spp.), a shrub common in shelterbelts and woods, serves as the winter host (Fig. 35.2). At the end of the soybean growing season during the early autumn, the aphids migrate to buckthorn. Buckthorn is a critical part of the soybean aphid life cycle—without this plant, they cannot spend the winter in a given area. Common buckthorn *(Rhamnus cathartica* L.*)* is the most widely infested, though it may also overwinter on *R. alnifolia*. Winged females leave soybean in search of buckthorn, where they

Figure 35.2. (Left) Common buckthorn (*Rhamnus cathartica*). Note the serrated leaf edges. **(Right) Soybean aphids on buckthorn leaves.** (Photos courtesy of Chris Evans, Illinois Wildlife Action Plan; Christina DiFonzo, Michigan State University, Bugwood.org)

feed and deposit a generation of wingless females. Winged males from soybean (the only male generation produced during the year) seek these females on buckthorn, where mating, oviposition (egg laying) and overwintering (in the egg stage) occur.

The overwintering egg is cold-hardy and can survive temperatures down to -34°C (-29°F). Eggs hatch during spring and several generations develop on buckthorn. As soybeans germinate, colonies on buckthorn produce winged founder females, which colonize soybeans in the early vegetative growth stage (V1-V5) by late spring/early summer. Soybean fields near buckthorn are often the first to be colonized in early summer, and should be scouted early to detect emerging problems.

Soybean aphids have piercing-sucking mouthparts that are used to feed on phloem sap. Heavily infested plants are stunted (Fig. 35.3) and usually covered with the sugary secretions ("honeydew") that the aphids produce. When honeydew is heavy, it becomes a food source for fungi that produces a layer of black sooty mold on leaf surface (Fig. 35.4). Heavy infestations can result in yellow and wrinkled leaves, stunted plants and aborted pods.

Soybean aphids can transmit plant viruses. They have been shown to transmit both Soybean Mosaic Virus (SMV) and Alfalfa Mosaic Virus (AMV) to soybean, though the frequency of this transmission in the field is unknown. It may also vector diseases to other temporally-visited crops, such as Cucumber Mosaic Virus (CMV) in snap bean and Potato Virus Y (PVY) in potato. Its economic importance as a vector in North American soybean and other crops is yet to be determined.

Figure 35.3. A soybean plant stunted by heavy aphid pressure (thousands per plant). The plant on the right contains the *Rag*1 aphid resistance gene. (Photo courtesy of Roy Scott, USDA-ARS)

Figure 35.4. Sooty mold on soybean leaf surface associated with honeydew secreted by soybean aphids. (Photo courtesy of Christina DiFonzo, Michigan State University, Bugwood.org)

Scouting

Scouts are advised to check fields weekly from mid-June through late August, the period when aphids colonize soybean fields. When scouting for soybean aphids, walk a broad U or X pattern through the field and examine at least 20 to 30 plants, spread out over the field. Aphids can occur in "hot spots," but treatment decisions should be based on a broad sample of randomly-selected plants. Count the number of aphids per plant—early in the season, soybean aphids are usually concentrated on the newest trifoliates, but later in the season they are more evenly distributed on the plant.

Treatment decisions should be based on the action threshold described below. Producers who are near but not at threshold should consider checking the field again before treatment (3-4 days after the initial treatment decision is made). If aphid numbers have decreased, or are still near the economic threshold and have not increased noticeably, or if many natural enemies such as ladybeetles are present, producers may wish to delay treatment, as populations can sometimes decline naturally before reaching damaging levels. A speed scouting protocol is also available. Although this is less accurate, it can reduce the time needed for sampling. http://www.soybeans.umn.edu/crop/insects/aphid/aphid_sampling.htm

Action threshold and economic injury level

During the early to mid-reproductive stages of soybean (R1-R5), the action threshold for treatment is when populations exceed 250 aphids per plant when at least 80% of the plants are infested and the population is still increasing (Ragsdale et al., 2007). Once soybeans reach the R6 growth stage (Chapter 4), soybeans are much less susceptible to yield loss from aphids (and, therefore, many more aphids can be tolerated). Thresholds for R6 soybeans have not been developed because natural aphid infestations in this late growth stage are uncommon, but research to develop R6 treatment guidelines is underway.

In aphid management, it is important to make the distinction between the action threshold and the economic injury level. The economic injury level is the point where the amount of insect injury justifies the control cost. This value varies with both commodity value and control costs. The action threshold, also called the economic threshold, is a lower value—not when economic loss is occurring, but when a decision should be made to take action to keep a pest population from climbing to the economic injury level.

The action threshold builds in time to react to an insect population before it becomes a problem, and is based on how quickly the population can be expected to grow, relative to the economic injury level. With a crop value of $15/bushel and a control cost of $8/acre, the economic injury level is 460 aphids/plant. At this economic injury level, an action threshold (decision point) of 250 aphids/plant allows about four days to make treatment before this injury level is reached. At lower crop values, the economic injury level is also lower, allowing more time between the decision point and the treatment point.

Another important concept in aphid management is the "damage boundary," which is the minimum number of insects required to cause yield loss that can be detected and measured. Research in South Dakota and in other parts of the North Central region indicates that producers are unlikely to see a positive yield return at treatment points below 250 aphids/plant because this value is below the damage boundary. In other words, yield cannot be improved by eliminating pests that are at too low a density to cause measurable yield loss.

Prophylactic or "insurance" insecticide application below the action threshold is not recommended because it may not serve the intended purpose of eliminating future problems. Pest resurgence or secondary pest outbreaks (for example, by spider mites) is a common issue following insurance treatments; a single well-timed application as indicated by scouting and threshold use is more economical than two or more badly timed applications.

Some chemical control options for soybean aphid and other pests described here are listed in Table 35.2. Before applying chemical treatments, check the pesticide labels.

Table 35.2. Pesticides labeled for soybean pests in South Dakota.

Product	Compound	Class	Pre-Harvest Interval	Pests Labeled For								
				SBA	SM	BLB	GH	GC	FA	BA	YA	WBC
Asana XL*	esfenvalerate	pyrethroid	21	+	-	+	+	+	-	-	-	+
Baythroid 2*	cyfluthrin	pyrethroid	45	+	-	+	+	+	+	+	+	-
Dimethoate	dimethoate	organophosphate	21	+	+	+	+	-	-	-	-	-
Lorsban 4E*	chlorpyrifos	organophosphate	28	+	+	+	+	+	-	-	-	+
Mustang Max*	zeta-cypermethrin	pyrethroid	21	+	-	+	+	+	+	+	+	+
Nufos 4E*	chlorpyrifos	organophosphate	28	+	+	+	+	+	-	-	-	+
Penncap-M*	methyl parathion	organophosphate	20	+	-	+	+	+	-	-	-	-
Proaxis*	gamma-cyhalothrin	pyrethroid	30	+	+	+	+	+	+	+	+	+
Warrior*	lambda-cyhalothrin	pyrethroid	30	+	+	+	+	+	+	+	+	+

SBA: soybean aphid; SM: spider mite; BLB: bean leaf beetle; GH: grasshopper; GC: green cloverworm; FA: fall armyworm; BA: beet armyworm; YA: yellowstriped armyworm; WBC: woollybear caterpillars
**Restricted-use insecticide*
Note: The label of any of these pesticides may have changed since this table was compiled. Always check and follow current labels.

Aphid-resistant soybean varieties

Aphid-resistant varieties are becoming increasingly available, and have the potential to be an important management tool as part of an integrated pest management program. Host-plant resistance in the form of both antibiosis (reduced survival and number of offspring) and antixenosis (non-attractive or repellent plants) to the soybean aphid have been discovered.

At least four resistance genes have been identified: *Rag1* (Hill et al., 2004a), *Rag2* (Mian et al., 2008b), and *rag3* and *rag4* (Zhang et al., 2009). [Capital letters indicate a dominant trait and lower case letters indicate a recessive trait.] Rag1 (an abbreviation for Resistance to *Aphis glycines* gene 1), is a single-gene source of antibiosis developed at the University of Illinois. Rag1 soybean lines first became commercially available in the U.S. on a limited basis in 2009; varieties containing other resistance genes are likely to follow. In field trials, the *Rag1* trait significantly reduces aphid populations compared to aphid-susceptible lines.

In spite of the promise of aphid-resistant varieties, it should be noted that *Rag1*-containing soybeans are not aphid-free, and economically relevant populations sometimes occur. Thus, resistant varieties should be considered one part of an integrated pest management program, which also includes scouting and threshold use. Biotypes have already been identified which can overcome *Rag1* and *Rag2* resistance (Kim et al., 2008; Hill et al., 2010). How quickly and to what extent biotypes will arise that significantly limit the usefulness of host plant resistance is not yet known.

Biological control

Field studies of soybean reveal a diverse community of natural enemies, which help suppress soybean aphid colonization and population growth. These natural enemies include ladybeetles, lacewings, pirate bugs, and entomophagous (insect-killing) fungi. One of the most important predators of soybean aphid is the multicolored Asian ladybeetle, *Harmonia axyridis* (Fig. 35.5, left). This ladybeetle is often considered a household nuisance because of its habit of entering houses during the fall for overwintering, but it is one of the dominant soybean aphid predators in the U.S. (Gardiner et al., 2009).

Natural enemies have a significant impact on soybean aphid populations and contribute to their control. In the absence of predation, soybean aphid population growth is significantly faster (2-7 times) (Costamagna and Landis, 2006). Prophylactic application of broad-spectrum pesticides can increase aphid pressure or cause secondary outbreak of other pests such as spider mites by removing the natural enemies that often keep pest populations in check (Ohnesorg et al., 2009; Koch et al., 2010).

Figure 35.5. (Left) Asian ladybeetle (*Harmonia axyridis*). The adults range in color from pale orange-yellow to orange-red, and vary greatly in the number of spots. A pattern of black dots resembling the letter "M" behind the head is typical. **(Right) Asian ladybeetle larva.** (Photos courtesy of Allen E. Knutson, Texas A&M University, Bugwood.org)

References and additional information

Costamagna, A.C., and D.A. Landis. 2006. Predators exert top-down control of soybean aphid across a gradient of agricultural management systems. Ecol. Appl. 16: 1619-28.

Gardiner, M.M., D.A. Landis, C. Gratton, C.D. DiFonzo, M.E. O'Neal, J. Chacon, M.T. Wayo, N.P.Schmidt, E.E. Mueller, and G.E. Heimpel. 2009. Landscape diversity impacts biocontrol services in north-central U.S. soybean. Ecol. Appl. 9: 143-154.

Hill, C.B., Y. Li, and G.L. Hartman. 2004. Resistance to the soybean aphid in soybean germplasm. Crop Sci. 44: 98-106.

Hill, C.B., L. Crull, T. Herman, D.J. Voegtlin, and G.L. Hartman. 2010. A new soybean aphid (Hemiptera: Aphididae) biotype identified. J. Econ. Entomol. 103:509-515.

Hodgson, E.W. , B.P. McCornack, K.J. Tilmon, and J.J. Knodel. 2012. Management recommendations for soybean aphid (Hemiptera: Aphididae) in the United States. J. Integra. Pest Man. 3:E1-e10. http://dx.doi.org/10.1603/IPM11019.

Koch, K.A., B.D. Potter, and D.W. Ragsdale. 2010. Non-target impacts of soybean rust fungicides on the fungal entomopathogens of soybean aphid. J. Invertebr. Pathol. 103: 156-164.

Mian, M.A.R., R.B. Hammond, and S.K. St Martin. 2008. New plant introductions with resistance to the soybean aphid. Crop Sci. 48: 1055-1061.

Ohnesorg, W.J., K.D. Johnson, and M.E. O'Neal. 2009. Impact of reduced-risk insecticides on soybean aphid and associated natural enemies. J. Econ. Entomol. 102: 1816-1826.

Ragsdale, D.W., B.P. McCornack, R.C. Venette, B.D. Potter, I.V. MacRae, E.W. Hodgson, M.E. O'Neal, K.D. Johnson, R.J. O'Neil, C.D. DiFonzo, T.E. Hunt, P. Glogoza, and E.M. Cullen. 2007. Economic threshold for soybean aphid (Hemiptera: Aphididae). J. Econ. Entomol. 100: 1258-1267.

Song, F., S.M. Swinton, C. DiFonzo, M. O'Neal, and D.W. Ragsdale. 2006. Profitability analysis of soybean aphid control treatments in three north-central states. Michigan State University Department of Agricultural Economics. Staff Paper 2006-24.

Tilmon, K.J., E.W. Hodgson, M.E. O'Neal, and D.W. Ragsdale. 2011. Biology of the soybean aphid, Aphis glycines (Hemiptera: Aphididae) in the U.S. J. Integrated Pest Management. 2(1): DOI:10.1603/IPM10016.

Zhang, G., C. Gu, and D. Wang. 2009. Molecular mapping of soybean aphid resistance in PI 567541B. Theor. Appl. Genet. 118: 473-482.

Websites

For biology and management information on a variety of soybean and corn insect and disease pests in the North Central region, and a free smartphone app, available at www.npipm.org

For instructions and a worksheet on soybean speed aphid scouting, available at http://www.soybeans.umn.edu/crop/insects/aphid/aphid_sampling.htm

Acknowledgements

Support for this chapter was provided by South Dakota State University, South Dakota Soybean Research and Promotion Council, and the United Soybean Board.

Tilmon, K., and B. Hadi. 2013. Soybean aphid identification, biology, and management. In Clay, D.E., C.G. Carlson, S.A. Clay, L. Wagner, D. Deneke, and C. Hay (eds). iGrow Soybeans: Best Management Practices for Soybean Production. South Dakota State University, SDSU Extension, Brookings, SD.