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Management of Pyrethroid-resistant Soybean Aphids

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Soybean aphids, *Aphis glycines* (Figure 1), are the most significant insect pest of soybean in Minnesota, Iowa, North Dakota and South Dakota. Insecticide resistance in this pest creates challenges for effective management and profitable soybean production. Resistance is defined as a decrease in susceptibility of a pest population to an insecticide that may result in failures when the product is used according to label recommendations for that pest.

Pyrethroid-resistant populations of soybean aphids have been confirmed in Minnesota, Iowa, North Dakota and South Dakota. Field trials, laboratory bioassays and molecular testing have verified resistance to the pyrethroids bifenthrin and lambda-cyhalothrin. Growers have observed reduced effectiveness of these insecticides in commercial soybean fields.

Due to the mobility of winged aphids, resistant populations may spread to new areas. Extension entomologists recommend using insecticides with other modes of action instead of relying solely on pyrethroids to manage this threat and slow resistance development.

Figure 1. Soybean aphids infesting a soybean leaf. (Photo courtesy of R. Koch, University of Minnesota)

Management Strategies for Resistant Soybean Aphids

In response to the challenge that pyrethroid-resistant soybean aphids pose, we encourage growers, consultants and applicators to evaluate their soybean aphid management practices carefully. Best management practices include the following:

- Treat fields only when needed to reduce insecticide exposure to soybean aphids. This will reduce the selection pressure for further development of resistance.
  - Fields should be scouted on a regular schedule (every seven to 10 days).
  - Use the economic threshold (average of 250 aphids per plant with infestations increasing, and present on 80% of plants in the field) to determine when to apply insecticides.
  - Speed Scouting is another sampling method to determine if foliar insecticides are necessary. A tally threshold of 40 or more soybean aphids means plants are infested, and then the number of infested plants is used to make a treatment decision. A Speed Scouting form must be used (see weblink on last page).
  - Treat within five to seven days of reaching the economic threshold to protect yield.
  - Avoid treating after soybeans reach R6 (full seed set) stage, unless aphid populations are extremely high and plants are under stress (such as drought) in early R6.
- If a field exceeds the threshold, ensure the insecticide is applied correctly.
  - Use an effective (and labeled) insecticide at the full labeled rate.
  - Use proper nozzles, spray volume (15 to 20 gallons per acre by ground; 3 to 5 gallons per acre by air) and pressure (40 pounds per square inch).

- Spray under favorable environmental conditions to promote efficacy and reduce drift.
- After applications, scout fields again after three to five days to ensure the product provided the level of management expected.

- If a field needs to be retreated due to a failure, **rotate to a different insecticide group** for the follow-up application. Tables 1 and 2 list insecticide groups, active ingredients and example trade names of products available for soybean aphid management.
  - Avoid applying a pyrethroid (Group 3A) insecticide as the first foliar application. Select an alternative insecticide group (see Tables 1 and 2).
  - On Feb. 28, 2022, the **U.S. Environmental Protection Agency** (EPA) revoked all food tolerances for the insecticide chlorpyrifos (organophosphate, Group 1B). However, in November 2023, the Eighth Circuit Court of Appeals ruled that the EPA's decision was too broad. The court said that the EPA should have considered whether some uses of chlorpyrifos could still be safe. As a result of the court ruling, chlorpyrifos is currently legal to use on soybeans and a limited number of other crops. The tolerances were reinstated in February 2024. However, this may change again, so staying updated on EPA decisions is essential.
- **Insecticide Premixes:** Use with caution for soybean aphid management.
  - Premixed insecticides may provide short-term pest suppression but are not a preferred strategy for resistance management.
  - Many premixes combine a selective insecticide with a broad-spectrum product. However, these mixtures may not enhance control when soybean aphids are the only pest of concern.
  - Recent field research in Minnesota found reduced control of soybean aphids when using certain premix products.
  - Overreliance on premixes can increase selection pressure on aphids and contribute to insecticide resistance.
  - Select insecticides based on scouting results and rotate modes of action to reduce the risk of resistance development.
- **Insecticide seed treatments** are not viable for managing insecticide-resistant aphid populations.

Table 1. Examples of foliar insecticides with a single active ingredient labeled for soybean aphid management.

IRAC Mode-of-Action Group #	Group	Active Ingredient	Product Examples (Trade Names)
1A	Carbamates	methomyl	Lannate LV, Nudrin LV, others
1B	Organophosphates	acephate	Acephate 97, Orthene 97, others
		chlorpyrifos	Check with your state Department of Agriculture for registered chlorpyrifos products.
		dimethoate	Dimethoate 4E, Dimate 4E, others
3A	Pyrethroids and Pyrethrins	alpha-cypermethrin	Fastac CS
		beta-cyfluthrin	Baythroid XL
		bifenthrin	Bifender FC, Bifenture EC, Brigade 2EC, Discipline 2EC, Sniper, Tundra EC, others
		cyfluthrin	Tombstone Helios
		deltamethrin	Delta Gold
		esfenvalerate	Asana XL
		lambda-cyhalothrin	Grizzly Too, Lambda-Cy AG, LambdaStar, Province, Silencer, Warrior II, others
		permethrin	Permethrin, Perm-UP 3.2 EC, Arctic 3.2 EC, others
		zeta-cypermethrin	Mustang Maxx
4A	Neonicotinoids	clothianidin	Belay
		imidacloprid	Admire Pro, Nuprid 4F Max, others
4C	Sulfoxamines	sulfoxaflor	Transform WG
4D	Butenolides	flupyradifurone	Sivanto Prime
9D	Pyropenes	afidopyropen	Sefina

Note: Insecticides labeled in different states can vary. Please check with your local state pesticide database for a current listing of insecticide products registered for soybeans in your state.

Management Strategies (continued)

- Report suspected cases of insecticide-resistant soybean aphids to a local/regional Extension educator or Extension entomologist (see contact information on back). Before assuming resistance, try to rule out other potential causes for an insecticide failure (such as incorrect rate, application method, or unfavorable environmental conditions).

Until aphid-resistant soybean varieties and other management tactics become more widely available, cost-effective management of soybean aphid will continue to rely on scouting and threshold-based insecticide applications of the few labeled insecticide groups (Table 1).

This short list of insecticide groups is threatened to become even shorter through the continued development of pest resistance to insecticides and potential regulatory actions. The agricultural community would be wise to work together to preserve the effectiveness and continued access to these essential tools to protect crops from insect pests.

Insecticide Resistance Factors

Factors that likely led to the development of insecticide resistance in soybean aphids:

- Frequent infestations – Soybean aphid outbreaks have been more common and severe in parts of Minnesota, North Dakota and nearby states, putting more pressure on these populations and developing insecticide resistance over time.
- Limited number of insecticide groups for soybean aphid management (Table 1) – Management of soybean aphid has relied on foliar applications of only a few insecticide groups, mainly pyrethroids (Group 3A) and organophosphates (Group 1B), since the early 2000s.
- Overreliance of insecticides can result in pests being exposed to insecticides more frequently, which further increases selection pressure. Examples of this include the following:
  - Applying insecticides when pest populations are below the economic threshold.
  - Tank mixing insecticide with herbicide applications regardless of pest populations.
  - Applying insecticides below the labeled rate.
  - Repeatedly applying the same active ingredient or insecticide group within a season.

Table 2. Examples of foliar insecticides with two or more active ingredients (often called premixes or formulated mixtures) labeled for soybean aphid management. Mixtures may be effective for pest suppression, but generally not preferred for insecticide resistance management.

IRAC Mode-of-Action Group #	Group	Active Ingredient	Premix (Trade Names)
28	Diamides	chlorantraniliprole	Besiege
3A	Pyrethroids	lambda-cyhalothrin	
28	Diamides	chlorantraniliprole	Elevest
3A	Pyrethroids	bifenthrin	
1B	Organophosphates	chlorpyrifos	Check with your state Department of Agriculture for registered chlorpyrifos + lambda-cyhalothrin products.
3A	Pyrethroids	lambda-cyhalothrin	
3A	Pyrethroids	bifenthrin	Hero*
3A	Pyrethroids	zeta-cypermethrin	
3A	Pyrethroids	beta-cyfluthrin	Leverage 360
4A	Neonicotinoids	imidacloprid	
3A	Pyrethroids	bifenthrin	Brigadier
4A	Neonicotinoids	imidacloprid	
3A	Pyrethroids	bifenthrin	Skyraider, Swagger
4A	Neonicotinoids	imidacloprid	
3A	Pyrethroids	lambda-cyhalothrin	Endigo ZCX
4A	Neonicotinoids	thiamethoxam	
3A	Pyrethroids	bifenthrin	Ridgeback
4C	Sulfoximines	sulfoxaflor	

Note: Insecticides labeled in different states can vary. Please check with your local state pesticide database for a current listing of insecticide products registered for soybean in your state.

*Hero is a mix of two pyrethroids, and will NOT provide reasonable control of pyrethroid-resistant aphids. Hero performed poorly in our NDSU soybean aphid insecticide trial in 2024, as did all pyrethroids in Table 1.

Contact Your Extension Entomologists:

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  https://extension.sdstate.edu/soybean-aphids-south-dakota

Photo courtesy of P. Beauzay, NDSU

Other Resources:

Insecticide options for resistant soybean aphids, University of Minnesota Extension. https://extension.umn.edu/soybean-pest-management/insecticide-options-resistant-soybean-aphid

North Dakota Field Crop Insect Management Guide. NDSU Extension Service, E1143 (revised). www.ndsu.edu/agriculture/sites/default/files/2022-01/Insect%20Management%20Guide%20E1143-22.pdf

South Dakota Pest Management Guide: Soybeans. South Dakota State University Extension. https://extension.sdstate.edu/south-dakota-pest-management-guides

EPA Update on the Use of the Pesticide Chlorpyrifos on Food. www.epa.gov/pesticide-worker-safety/epa-update-use-pesticide-chlorpyrifos-food#:~:text=The%20U.S.%20Environmental%20Protection%20Agency,to%20EPA%20for%20further%20proceedings.

Iowa State University - blank copies of the Speed Scouting form. https://soybeanresearch.ppem.iastate.edu/files/inline-files/2017_speed_scouting_blank_form_0.pdf

Management Recommendations for Soybean Aphid (Hemiptera: Aphididae) in the United States. Journal of Integrated Pest Management. 3(1): 2012. http://dx.doi.org/10.1603/IPM11019

Biology and Economics of Recommendations for Insecticide-Based Management of Soybean Aphid. Plant Health Progress 17(4): 265-269. http://dx.doi.org/10.1094/PHP-RV-16-0061

Always read, understand and follow the product container's Environmental Protection Agency-approved label directions.

Disclaimer: Insecticides are given as examples only and do not imply endorsement of one product versus another nor discrimination against any product not mentioned by the authors or the universities.

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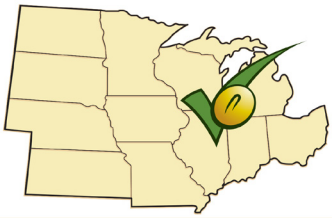

The North Central Soybean Research Program, a collaboration of 12 state soybean associations, invests soybean checkoff funds to improve yields and profitability via university research and extension.

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