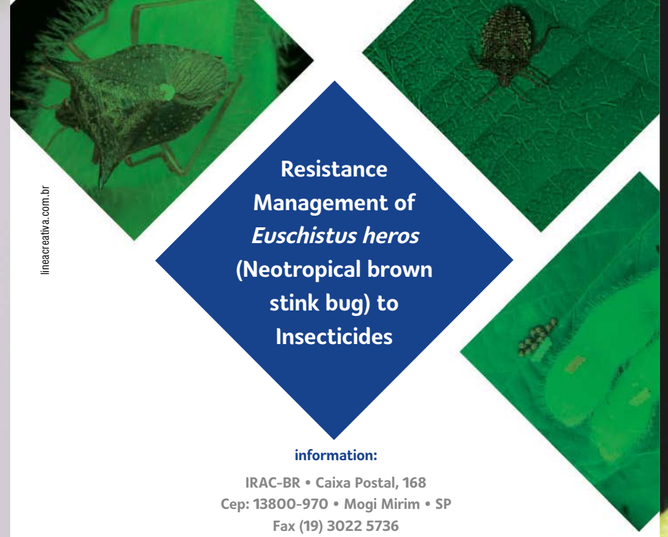
Observations

- Always document the history of insecticide applications in the area, considering the products applied, rates, dates of application and density of *Euschistus heros* before and after the application.
- Towards the end of the crop season, when only few areas with soybean remain in the field, *Euschistus heros* will continually migrate and concentrate in these areas. Control measures at this growth stage may therefore be less effective and should not be confused with resistance.
- Several natural enemies of stink bugs can be found in soybean and they contribute towards reducing population levels. Among them, the most important species are:

Egg parasitoids:
Trissolcus basalis, Telenomus podisi.

Stink bug parasitoids:
Hexacladia smithii.



Resistance Management of *Euschistus heros* (Neotropical brown stink bug) to Insecticides

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Embrapa

Resistance Management of *Euschistus heros* (Neotropical brown stink bug) to Insecticides

IRAC
Comitê de Ação à Resistência a Inseticidas
Brasil

Neotropical Brown Stink bug Euschistus heros

Euschistus heros, is a sucking pest that feeds on seedlings, stems, branches and pods. It causes damages on cotton, corn and soybean crops resulting in:

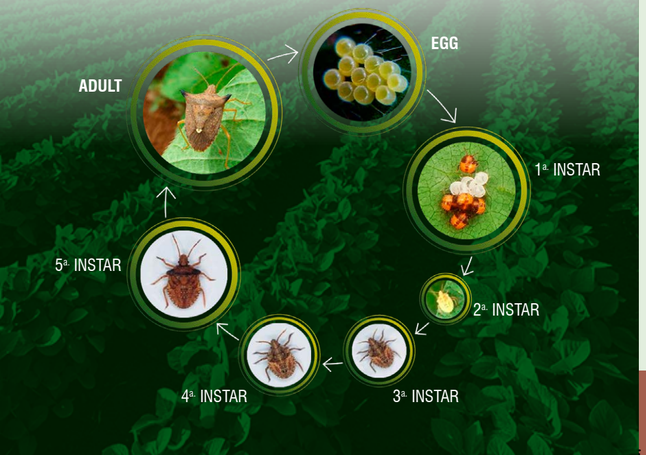
- Yield reduction and abortion of reproductive structures. Besides this, it can inject toxins into the plants.

In Brazil, *Euschistus heros* is considered the most common and more difficult to control stink bug species on soybean especially in warmer regions. In recent years, populations of *Euschistus heros* have been observed at high levels and are a primary target for foliar insecticide applications. The successive exposure to insecticide applications with the same mode of action combined with its genetics as well as biological aspects of *Euschistus heros*, such as reproductive capacity and ability to withstand harsh environmental conditions, have contributed to a shift in insecticide susceptibility that has been observed in the field.

The duration of a generation as well as the length of each development stage is influenced by temperature. It is therefore probable that in regions with higher temperatures the number of generations per season can be higher.

Duration of the different development stages (days) of *Euschistus heros*

STAGE	DURATION AVERAGE	VARIATION
Egg	7	6 - 8
1ª. instar nymph	5	3 - 6
2ª. instar nymph	7	6 - 8
3ª. instar nymph	6	3 -7
4ª. instar nymph	7	4 -11
5ª. instar nymph	7	4 - 8
Adult (longevity)	80	26 - 198
Pre-oviposition period	11	9 - 165
Duration from egg stage until reproductive period of adult	46	37 - 59



Threshold Levels

The Brazilian Agricultural Research Corporation ("Embrapa Soja") threshold recommendations for seed and grain production in soybean are as follows:

- Seed production: 1 or more stink bugs ≥ 0.5 cm in size per linear meter.
- Grain production: 2 or more stink bugs > 0.5 cm in size per linear meter.

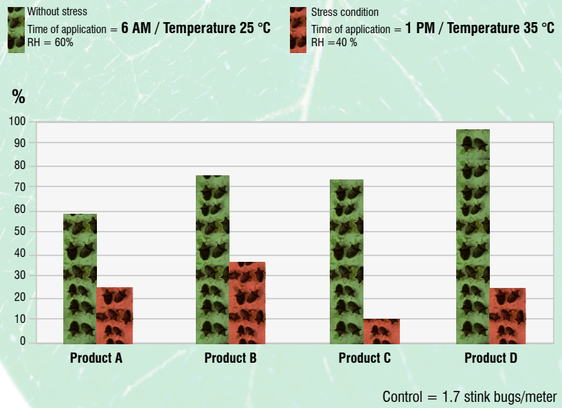
Sampling is conducted by using the beat cloth method. Monitor stink bug adult and nymph densities separately by placing a drop cloth (1-m length) adjacent to a row and shaking plants within that length of the drop cloth to dislodge the insects. The average of multiple 1-m samples should be taken to approximate the density relative to the threshold.

How to prevent resistance

- In the first soybean applications against lepidoptera larvae (e.g. *Helicoverpa* sp.), during the vegetative growth stages BBCH 49 to BBCH 75, avoid using products registered for stink bugs.
- Monitoring efforts should occur with more frequency towards the end of the vegetative growth stage and at the beginning of the reproductive growth stage. Respect the threshold levels recommended by Embrapa Soja.
- Rotate products with different modes of action and monitor the susceptibility of *Euschistus heros* to the insecticide.

Carry out foliar applications early in the morning, as illustrated in the example below:

Control of *Euschistus heros* (% efficacy)
São Martinho/PR



Control = 1.7 stink bugs/meter

IRAC-Brazil recommends applying insecticide mode of actions using a **window approach**. A window is defined by the approximate duration of an insect generation (egg→nymph→adult) or the duration of the effect of a single insecticide application (residual activity). Products of the same MoA must be applied only within a defined window.

It is not always easy to determine the duration of an insect generation. Therefore, in the absence of this information, IRAC-Brazil recommends a window of 30 days for most pest species but a window of 15 days for aphids and mites.

Following a window of any mode of action group, IRAC-Brazil recommends to rotate to a window of applications of effective insecticides with a different mode of action. Nevertheless, the same MoA can be used in a later window but only once a different MoA is used in-between. For better resistance management practice, several effective mode of action groups must be used in an IRM program.

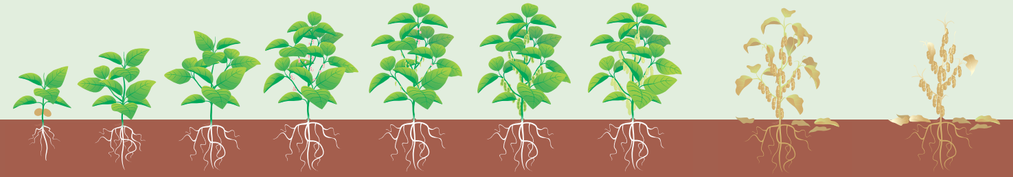
Cross resistance is more common between subgroups. Therefore, the rotation of subgroups must be avoided, and alternative options must be implemented in order to maintain pest susceptibility.

Insecticide Rotation Program

(Different letters represent different modes of action)

Mode of action A
Mode of action B
Mode of action C

1st Window 30 days	2st Window 30 days	3st Window 30 days	
A	A	A	Not Recommended
A	B	A	Recommended
A	B	C	Strongly Recommended



Insecticides grouped by mode of action and registered for *Euschistus heros* control by the Ministry of Agriculture, Livestock and Food Supply (Brazil).

Mode of action of primary target site	Chemical sub-group	Asset
1 Acetylcholinesterase (AchE) inhibitors	**1A** Carbamates	Carbosulfan
	1B Organophosphates	Acephate Fenitrothion
2 GABA-gated chloride channel blockers	**2B** Phenylpyrazoles (Fiproles)	Ethiprole
3 Sodium channel modulators	**3A** Pyrethroids Pyrethrins	*Beta*-Cyfluthrin Bifenthrin Esfenvalerate Fenpropathrim *Lambda*-Cyhalothrin *Zeta*-Cypermethrin
4 Nicotinic acetylcholine receptor (nAChR) competitive modulators	**4A** Neonicotinoids	Acetamiprid Dinotefuran Imidacloprid Thiamethoxam
	4C Sulfoximines	Sulfoxaflor

Always check product labels to determine the mode of action.