Strategies for biological control of FAW in corn crops

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Embrapa Recursos Genéticos e Biotecnologia

Spodoptera frugiperda (Lepidoptera: Noctuidae)

- Found in all seasons
- Difficult to control by conventional methods
- Polyphagous insect

Jan	Feb	Mar	Apr	Mai	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Corn									Corn		
Soybean									Soybean		
Cotton										Cotton	
	Irrigated Cotton										
		Irrigated corn									

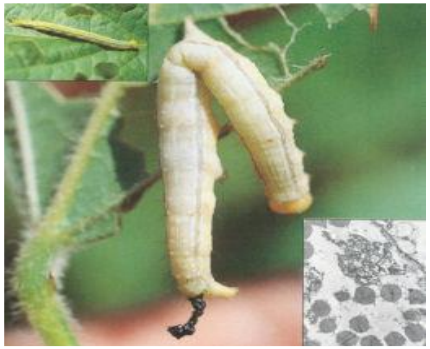
Embrapa has been working for many years with Natural Resources as a potential tool for the control of insect pests, including the fall armyworm

Our research program include..

Insect species (predators and parasitoids) acting on the various development stages of insect pests




Microbial agents such as *Baculovirus* and *Bacillus thuringiensis*




Insect species (predators and parasitoids) acting on the various development stages of insect pests

Our research has been made available:

1- Natural enemies to be produced for both private sector and farmers (Farmer association or agricultural cooperatives)

2- Training : How to set up a bio-factory, how to recognize natural enemies and how to use biological control on the farm

Trichogramma production factory by FARMER ASSOCIATION, Uberlandia, MG, Brazil

Trichogramma production factory in Mali (Embrapa/Cotton 4): Mali, Burkina Faso, Chad, Benin and Togo

Spodoptera training: Integrated Pest Management and Biological Control, Mali, 2016

Positive points

Spodoptera frugiperda **is food source for dozens of natural enemies named in this presentation as Biological Control Agents (BCA)**

In maize crop is possible to find several INSECT SPECIES (parasitoids and predators) NATURALLY feeding on the various development stages of the fall armyworm

Applied Biological Control using egg parasitoid releases such *Trichogramma* or *Telenomus* provide one of the best control measure against *Spodoptera frugiperda* in Brazil

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Egg-larva parasitoid

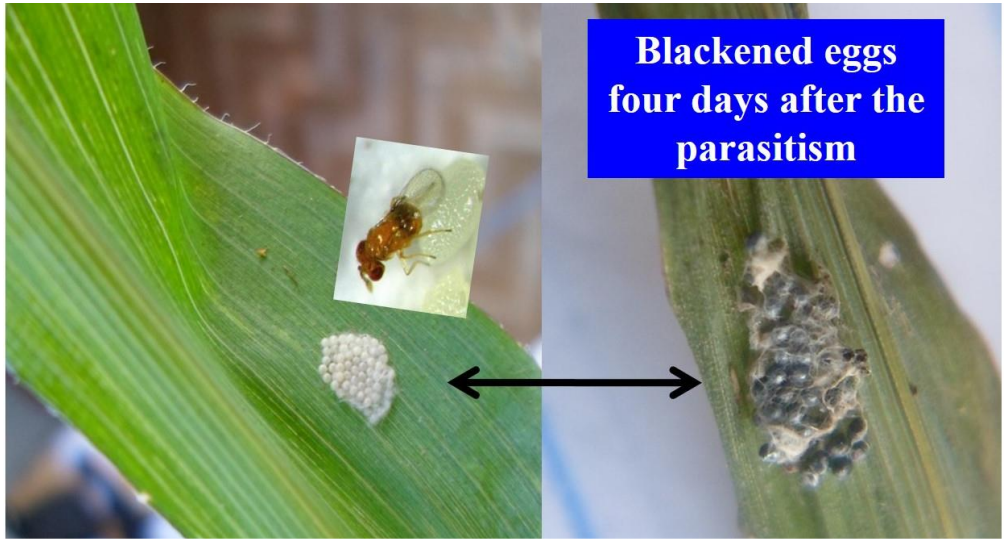
Two larvae that were born on the same day

Chelonus insularis

Female laying egg inside the eggs of fall

Telenomus remus

Trichogramma pretiosum



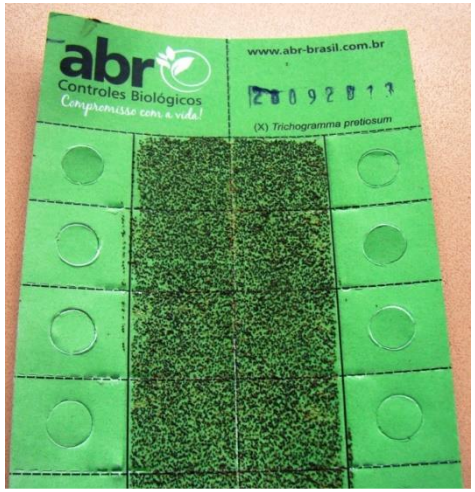
Trichogramma release mode in maize

Manually or by motorcycle

Manual, motorcycle or drone

Pupae in capsules

Trichogramma units



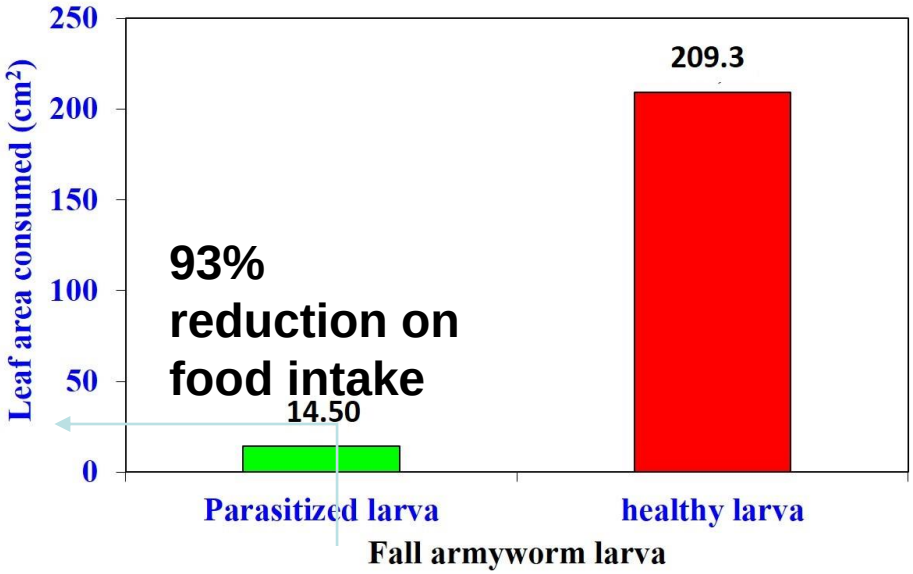
Parasitoid of a small larvae

Campoletis flavicincta

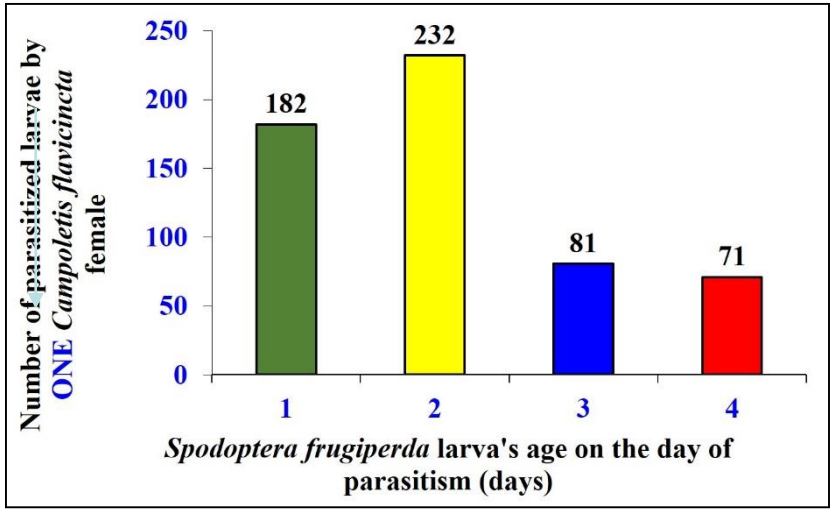
Real size of the larva: TWO mm

Female laying egg inside the fall armyworm larva

Parasitized larvae

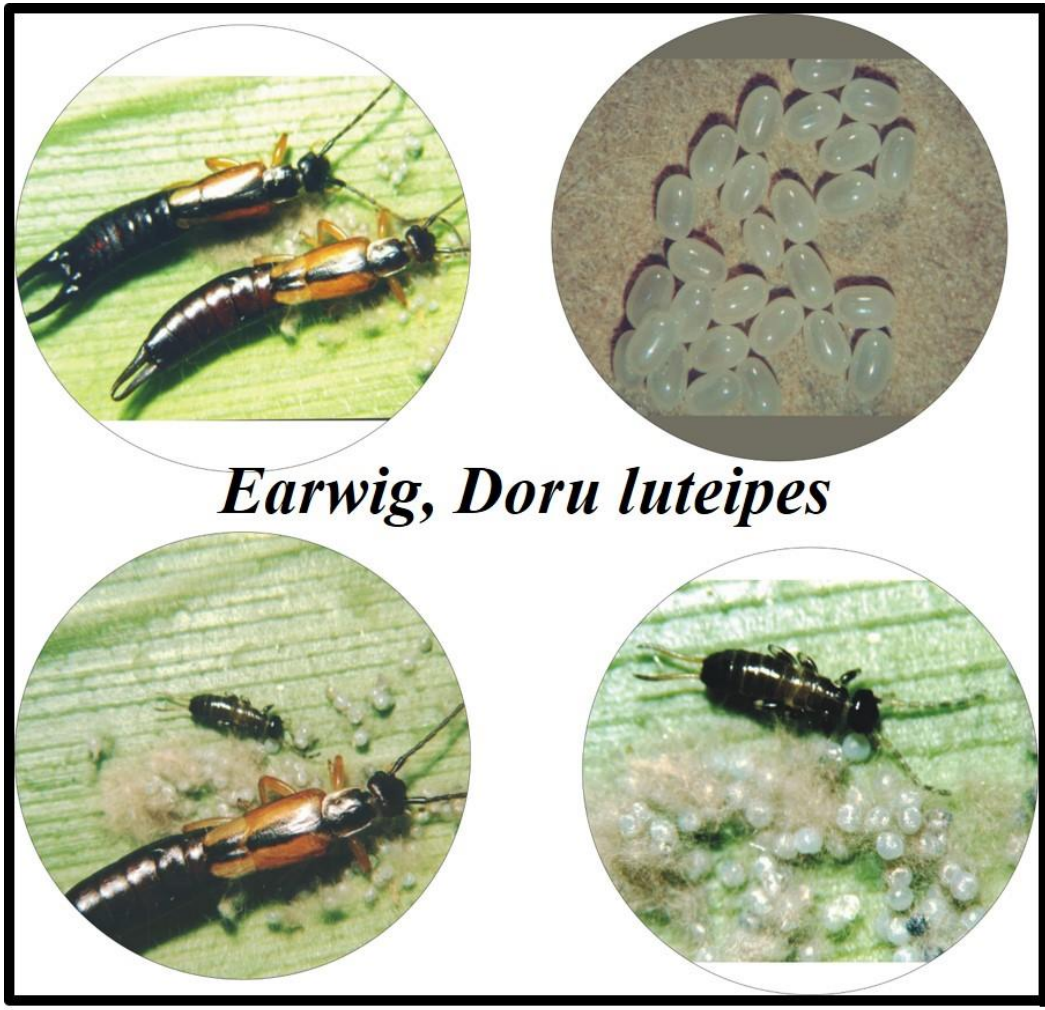


Over 200 parasitized larva/female



Campoletis flavicincta

Predators

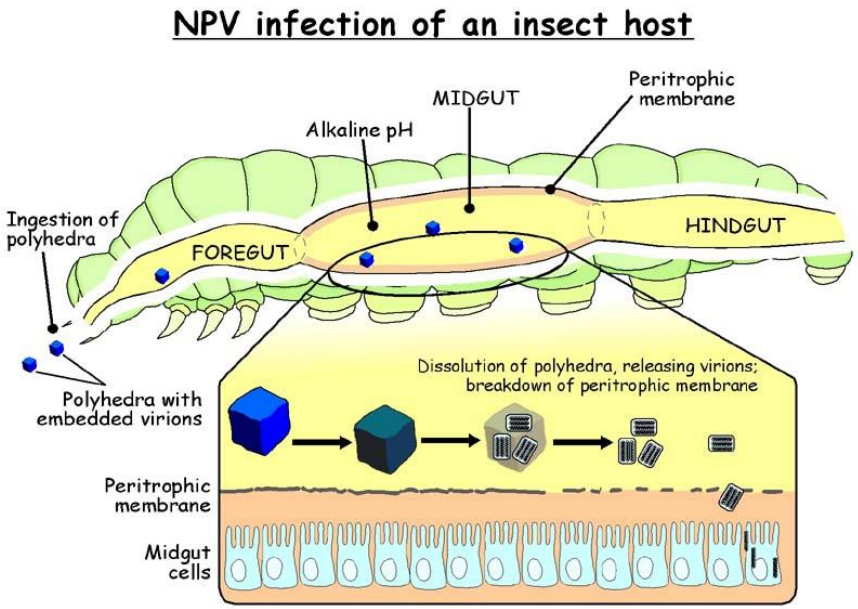


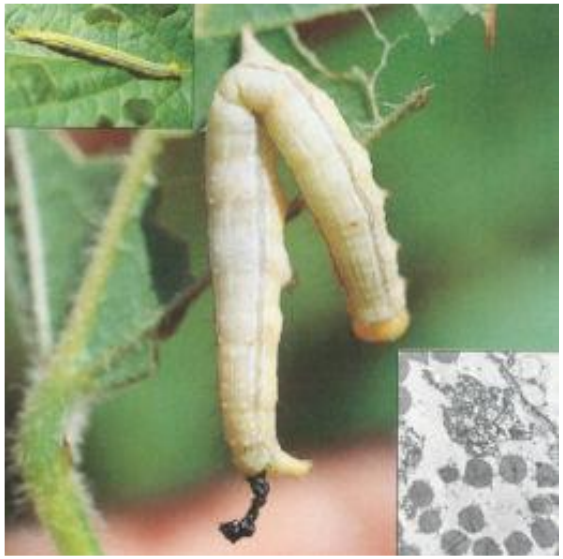
Main natural predator of fall armyworm in Brazil

Above: adults and eggs
Below: female and nymph feeding on egg of *Spodoptera frugiperda*

Spined soldier bug (*Podisus*) nymphs and adult feeding on *Spodoptera* larva

Micro-organisms: Virus

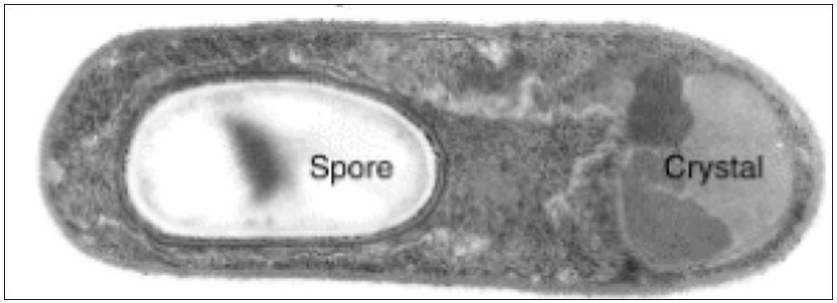




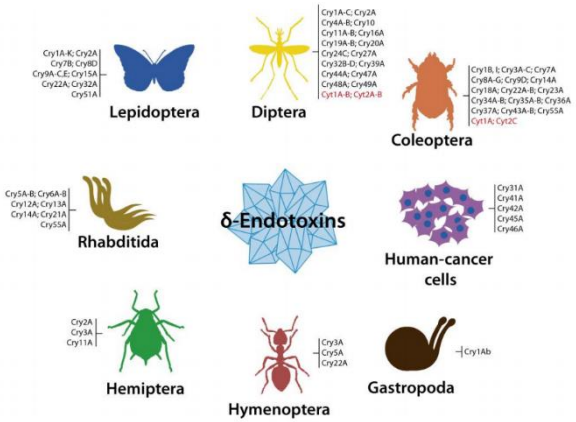
- *Baculovirus spodoptera* for controling FAW

  - Developed by Embrapa Milho e Sorgo

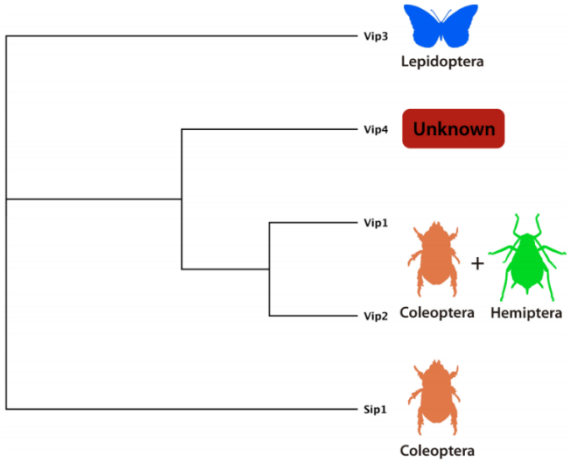
Micro-organisms: *Bacillus thuringiensis*



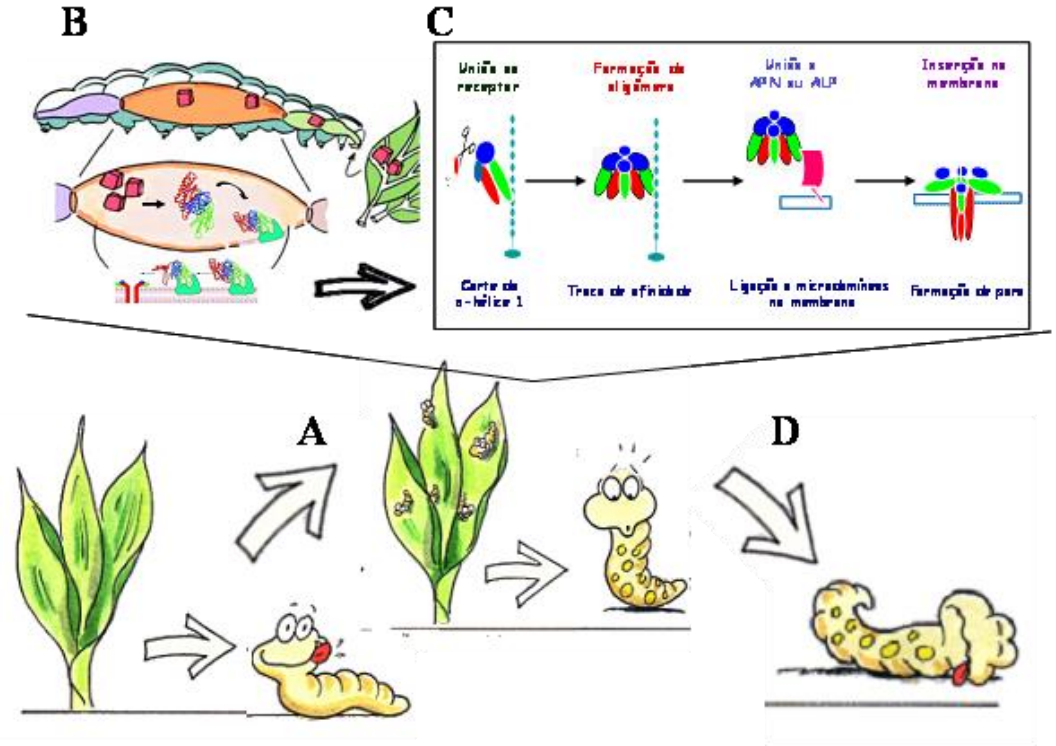
Cry proteins



Sip and Vip proteins

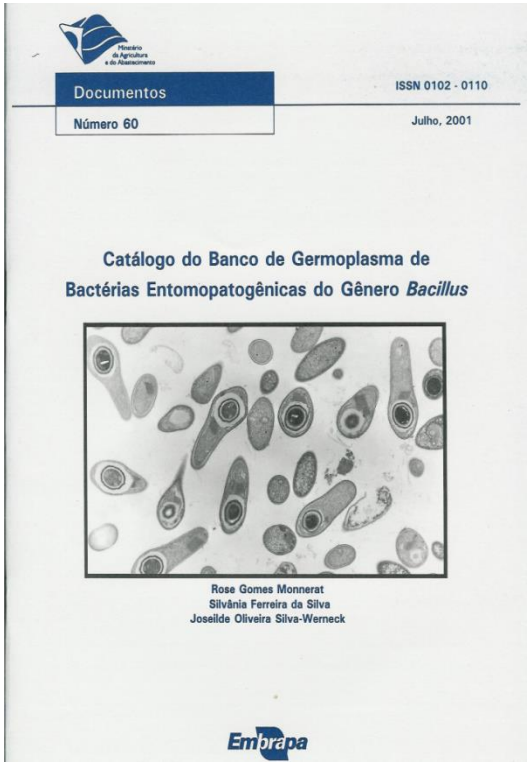


Mode of action of *B. thuringiensis*



(Adaptado de Bravo *et al.*, 2007)

Collection of *Bacillus thuringiensis*



3.100 *Bacillus spp.*

Strain	*S. frugiperda* Susceptible	*S. frugiperda* resistant
S167	62,50%	33,30%
S187	45,80%	33,30%
S233	41,70%	54%
S276	83,30%	54%
S357	41,60%	66,60%
S373	62,50%	29,20%
S411	29,10%	
S424	25%	16,60%
S426	37,50%	16,60%
S437	12,50%	25%
S449	20,80%	33,30%
S477	29,20%	58,30%
S461	50,00%	21%
S462	58,30%	20,83%
S463	83,30%	58,30%
S601	100%	91,70%
S602	37,5%	37,50%
S655	45,80%	33,30%
S906	100%	100%
S907	100%	100%
S1122	54,10%	8%
S1185	65,50%	54,20%
S1256	41,60%	25%
S1257	45,83%	45,80%
S1258	100,0%	100%

Identification of genes

Strains	*S. frugiperda* LC_{50} ng/cm^2	genes
1	936.1 (460.1-2832.3)	*cry1Aa, cry1Ab, cry1C, cry1D, cry1I, n1, n2*
2	13.3 (10.4-29.4)	*cry1Aa, cry1Ab, cry1B, cry1D, cry1I, n3, n4*
3	12.9 (1.5-32.2)	*cry1Aa, cry1Ab, cry1Ac cry1Ad, cry1B, cry1D, cry1I, cry2, n5, n6*
4	1923.9 (1072.6-6058.4)	*cry1Aa, cry1Ac, cry1Ad, cry1C, cry1D, cry1I, n7, n8*
5	358.2 (233.7-597.6)	*cry1Ab, cry1Ac, cry1B, cry1E, cry1G, cry1I, cry2, n9*
6	22.9 (10.5-30.9)	*cry1B, cry1C, cry1D, n10*
7	349.7 (123.9 – 456.7)	*Cry1B, n11, n12, n13*

Gene cloning and expression

Toxinas	*Spodoptera frugiperda* CL_{50} (ng/cm^2)
1Aa	>3500
1Ab	228,39 (46,08-372,65)
1Ac	1342,08 (826,30-2535,13)
1B	>3500
1C	1155,85 (915,46-1502,38)
1F	1641,86 (1011,82-2745,32)
1G	841,40 (708,92-1008,81)
1I	>3500
2Ab2	551,62 (354,90-834,73)

Production

Culture media

Inoculum

Fermentation

Concentration

Formulation

On farm

commercial

•On farm production of Bt

- Training

•On farm production of Bt

- Manual

- On farm production of Bt

Thank you

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