Biological control of sweet potato weevils:

Current status and perspectives for the Caribbean

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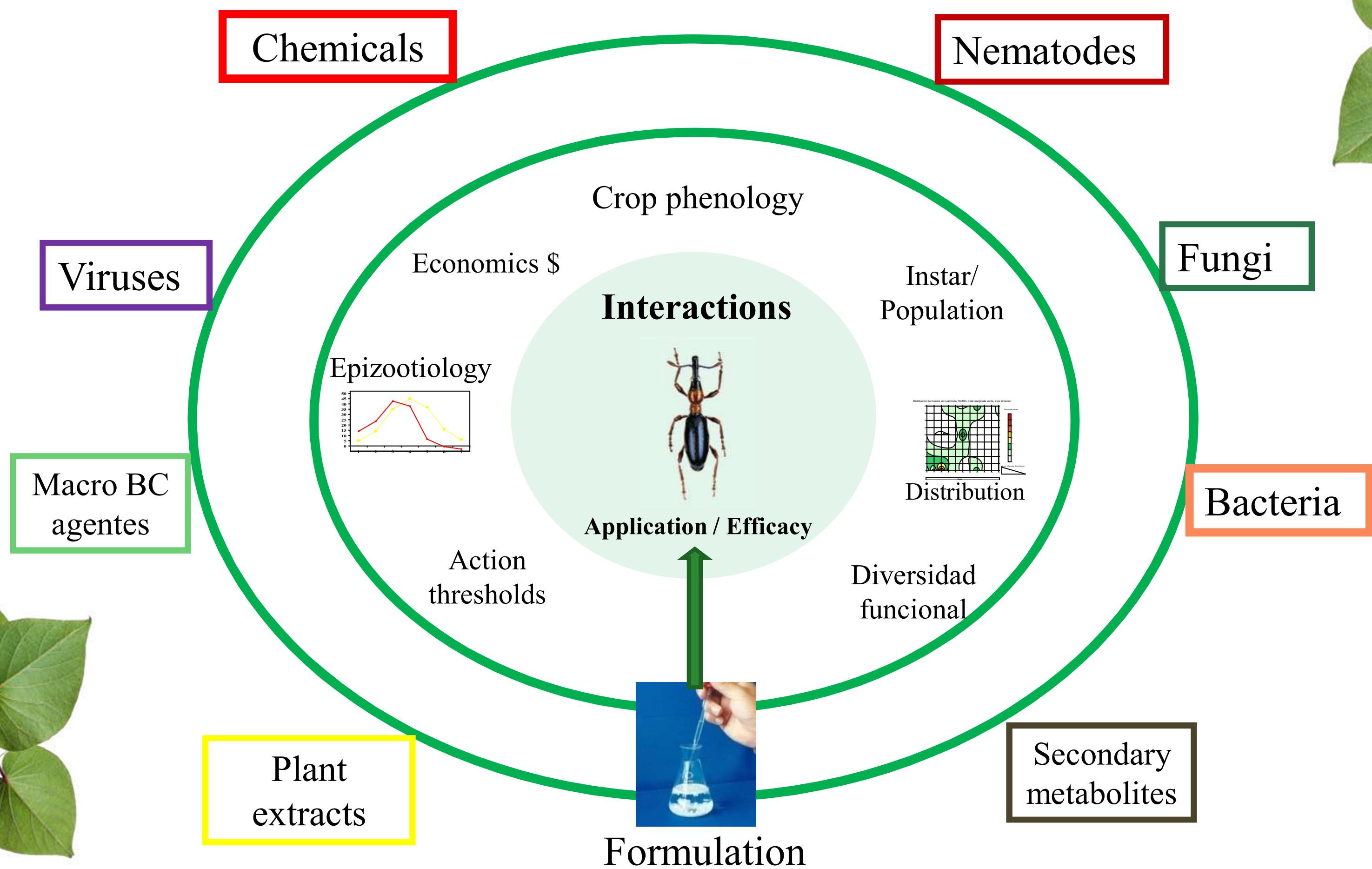
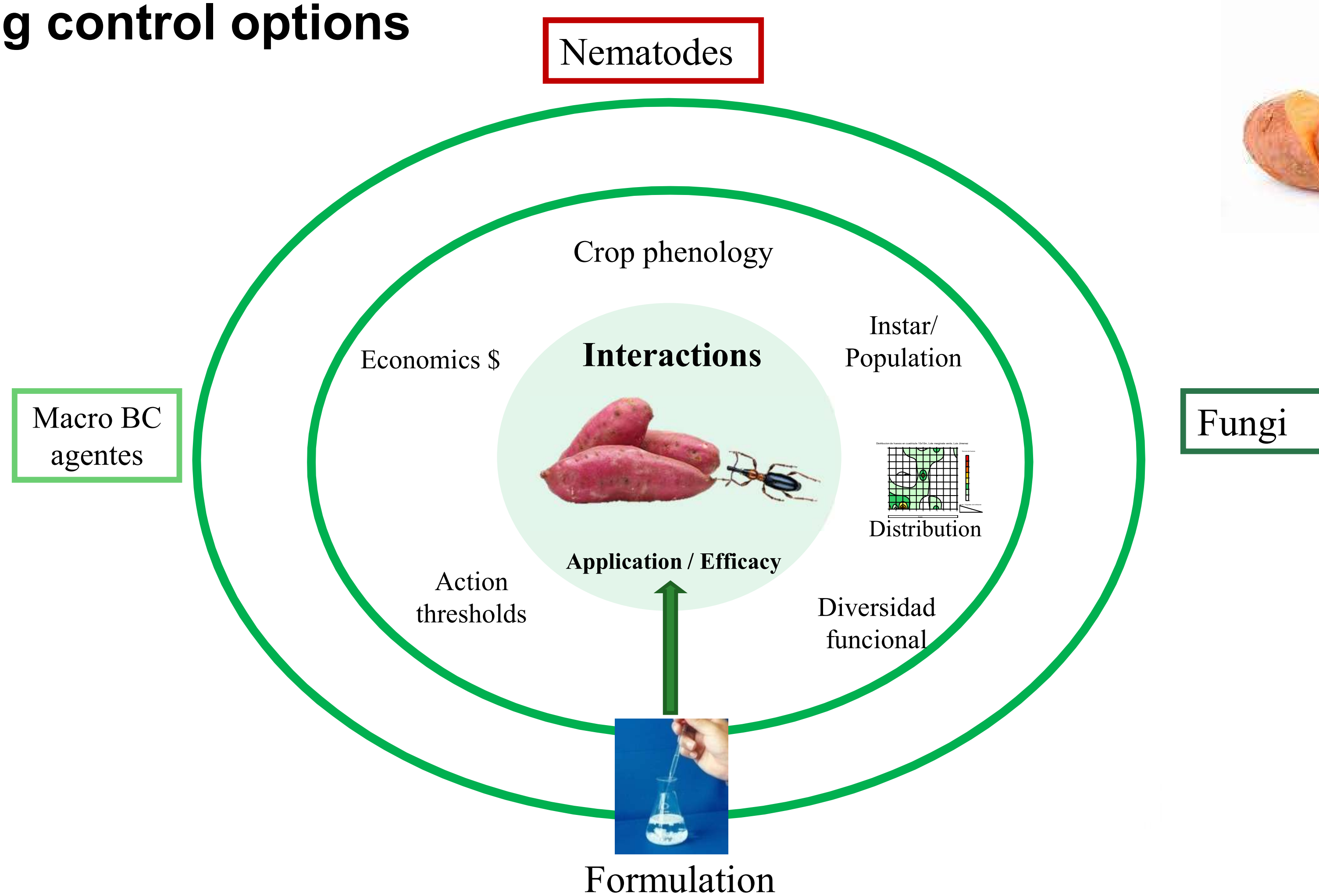
Exploring control options



Exploring control options



Quick facts about sweet potato weevils (SPW) and their biocontrol agents

- There are 2 SPWs reported in the Caribbean: *Cylas formicarius* and *Euscepes postfasciatus*
- Only a few biocontrol agents have been reported in the world:
    - Parasitoids
    - Predators
    - Entomopathogenic fungi
    - Entomopathogenic nematodes

Photo: Cook Island-Bishop Museum

Euscepes postfasciatus

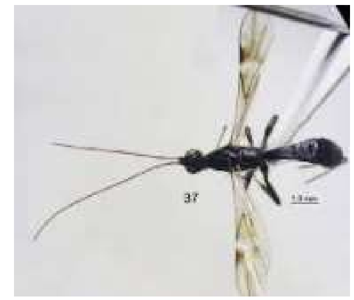
Cylas formicarius

Parasitoids

Name	Host	Country
Bracon yasudai	*Euscepes postfasciatus*	Japan
Bracon sp.	*Cylas formicarius*	Philippines
Braconid: *Rhaconotus* spp.	Weevil larvae	
Eulophidae: *Euderus purpureas*	*Cylas formicarius*	Florida

- Not found in all the countries
- Difficult mass production
- Sample for local acurrence in the Caribbean
- If found: keep conditions for natural augmentation

Bracon yasudai



Rhaconotus sp.

Euderus sp.

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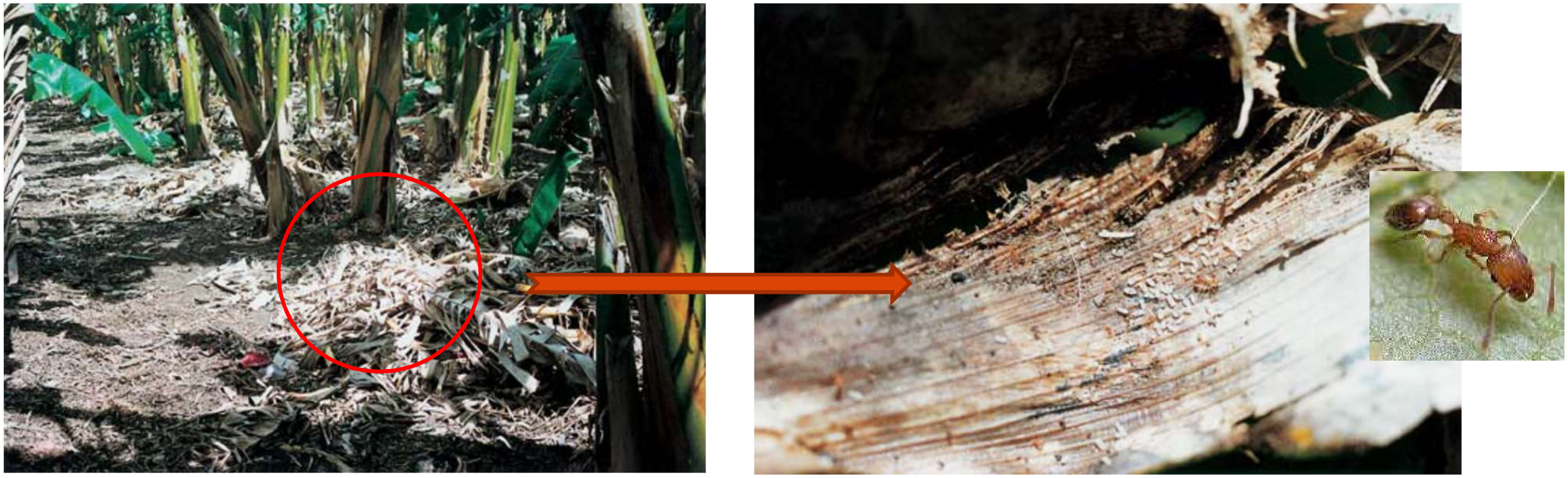
Predators

Predatory ants	Hosts	Country
Tetramorium guineense	Generalistic predators	Cuba
Pheidole megacephala		
Iridomyrmex humilis	Generalistic predators Damaging for humans and livestock	Argentina

Tetramorium guineense

Pheidole megacephala

Field manipulation of ant nests



Nest of *Tetramorium guineense* in banana rotting stems and leaves. Source: Cisneros F. and alcazar, J., 2001

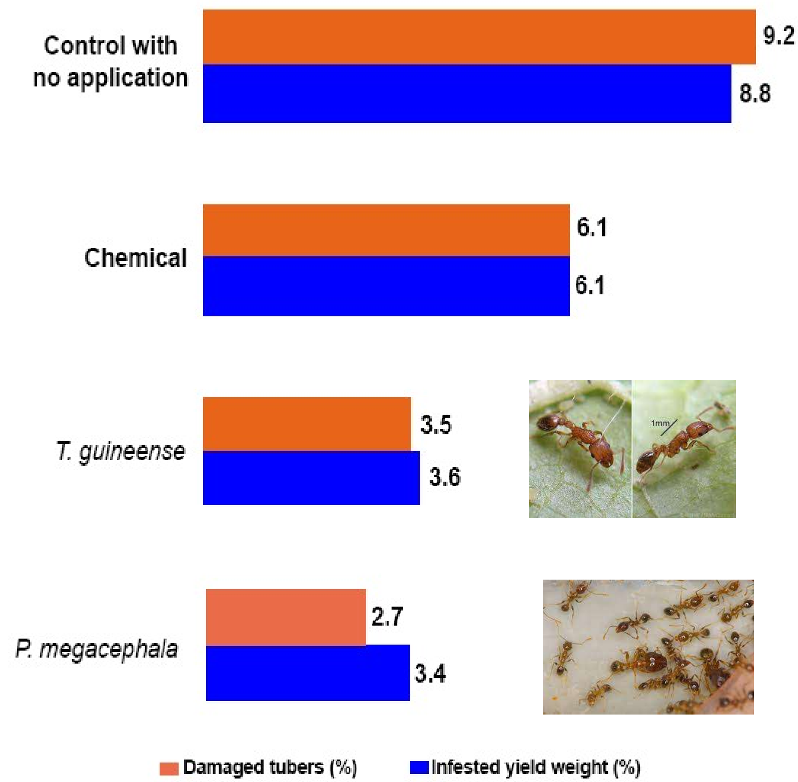
- Highly effective / Non especific predators
- Attack maily adult weevil
- Weed control is needed to reduce pray populations (ea. Aphids)
- Pheidole has show a negative interaction with mealybugs in pinaple

Field manipulation of ant nests

Banana pseudostem trap used in Cuba for collecting ant colonies. Source: Cisneros F. and alcazar, J., 2001

- Ants colonies can be captured with traps (3 to 12 days until the queen moves into the trap)
- Place the ant nests in the sweetpotato plantation 30 days after sowing (eary in the morning)
- Previous irrigation may be necessary (ants need moist soil)
- In Cuba: 100 nests /ha protected under the folliage

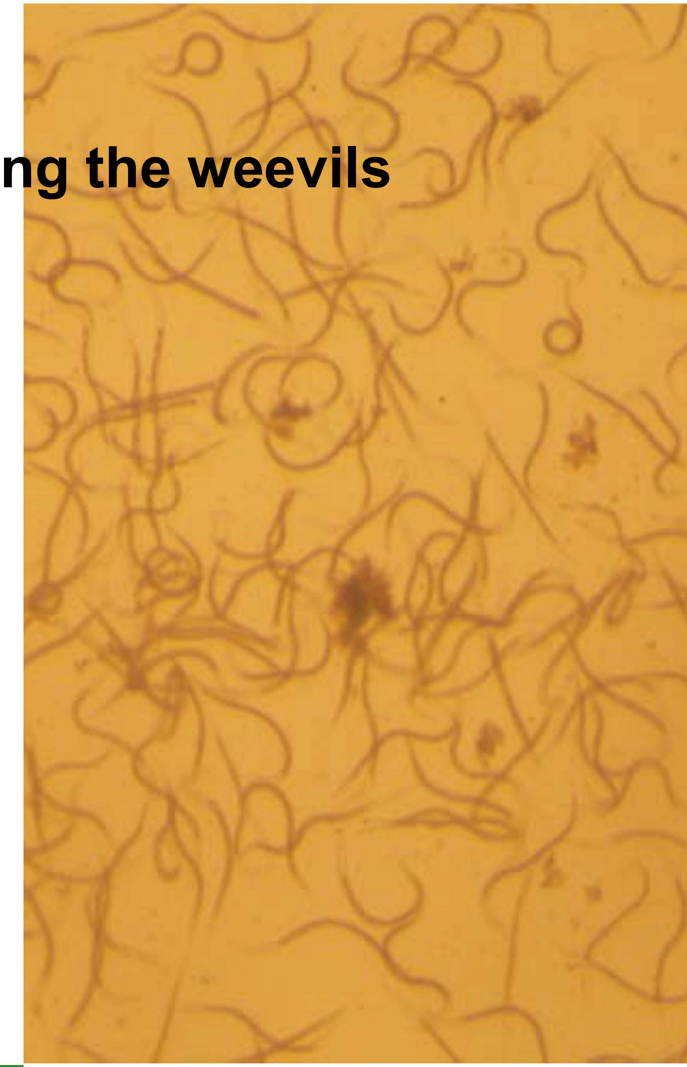
Observed weevil damage on sweet potato trerated with chemical control and nests of predatory ants in Cuba



Tetramorium guineense

Pheidole megacephala

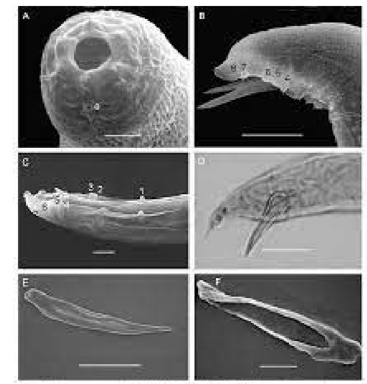
Using entomopathogenic nematodes for controlling the weevils



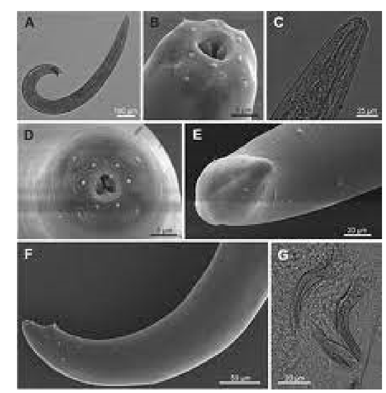
- Families: Steinernematidae and Heterorhabditidae
- Carry and introduce symbiotic bacteria (*Xenorhabdus* and *Photorhabdus*).
- Its host range includes both weevil species
- They can be grown on a large scale
- They can kill in 48 hours
- Can be stored and applied with conventional methods

Entomopathogenic Nematod species reported

Species	Effectivity	Country
Heterorhabditis karii	Higher effectivity (Larvae)	Kenya
Heterorhabditis indica		Kenya
Heterorhabditis bacteriophora		
Steinernema carpocapsae	(les effective) Larvae	Florida
Heterorhabditis sp. H1-24	Not entioned (Adults)	Cuba



Heterorhabditis



Steinernema

Are nematodes a feasible option in the Caribbean countries?

Industrial production of nematodes (Liquid culture)

Gaugler and Han (2002) reported commercial-scale (*c*.10,000-l bioreactors) production costs of US$31 for *S. carpocapsae* and US$42 for *H. bacteriophora* per hectare (2.5 × 109 nematodes/ha).

costs to end-users remain greater than the alternative pest management tactic in most markets. They concluded that growers seemed unlikely to pay a premium to use nematodes when there were familiar, easy-to-use, low-cost alternatives.

10k liter biorreactor: USD 100000.00

Industrialized production of nematodes

Distribution of costs

The high product cost of EPNs is due to the relatively expensive and **lengthy processes** involved in their **mass production**, **formulation**, **storage** and **transport**.

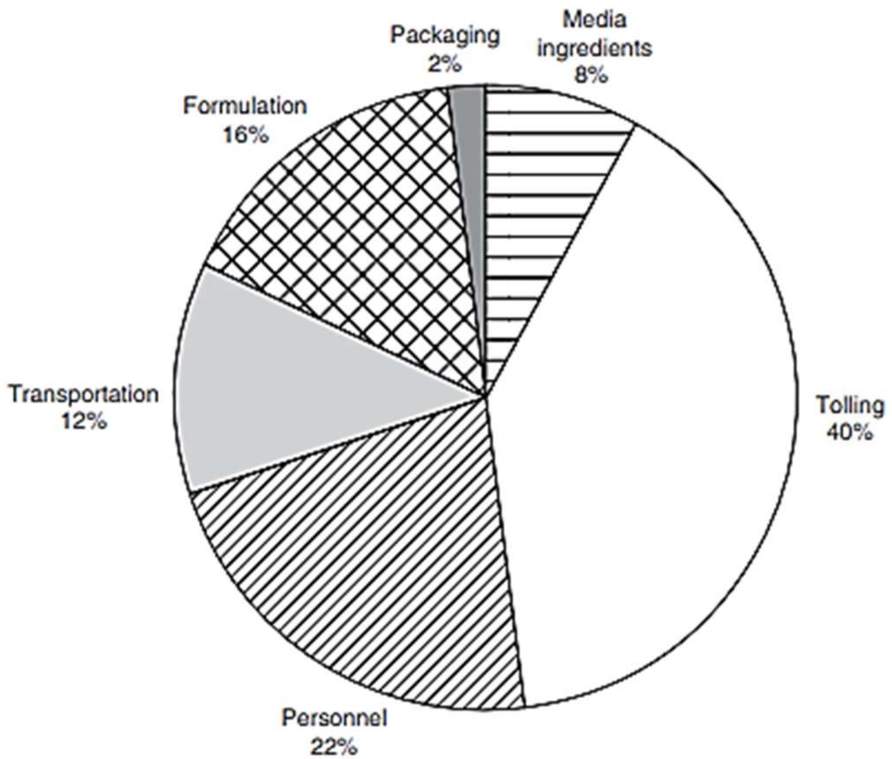
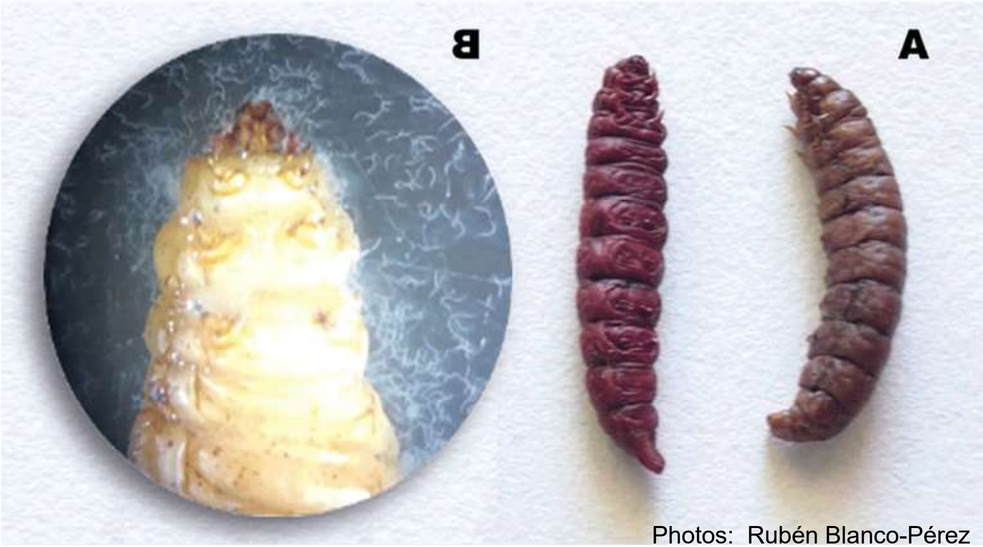


Fig. 14.2. Production cost breakdown for *Heterorhabditis bacteriophora* (HbNJ strain) for mass culture at a toll or contract manufacturer using a 3000-litre bioreactor (S. Franceschini, Italy, 2000, unpublished data).

In vivo production method

- *in vivo Galleria* process, yields between 0.5 e5and 4 e5 IJs/larva
- The *in vivo* process is regarded of lacking economy of scale
- Lack of improved quality while increasing scale, the keep small production?
- *in vivo* nematode production is sensitive to biological variations

(Grewal *et al*.,2005).



Galleria mellonella larvae inoculated with nemoatodes

Rearing method for *Galleria mellonella*

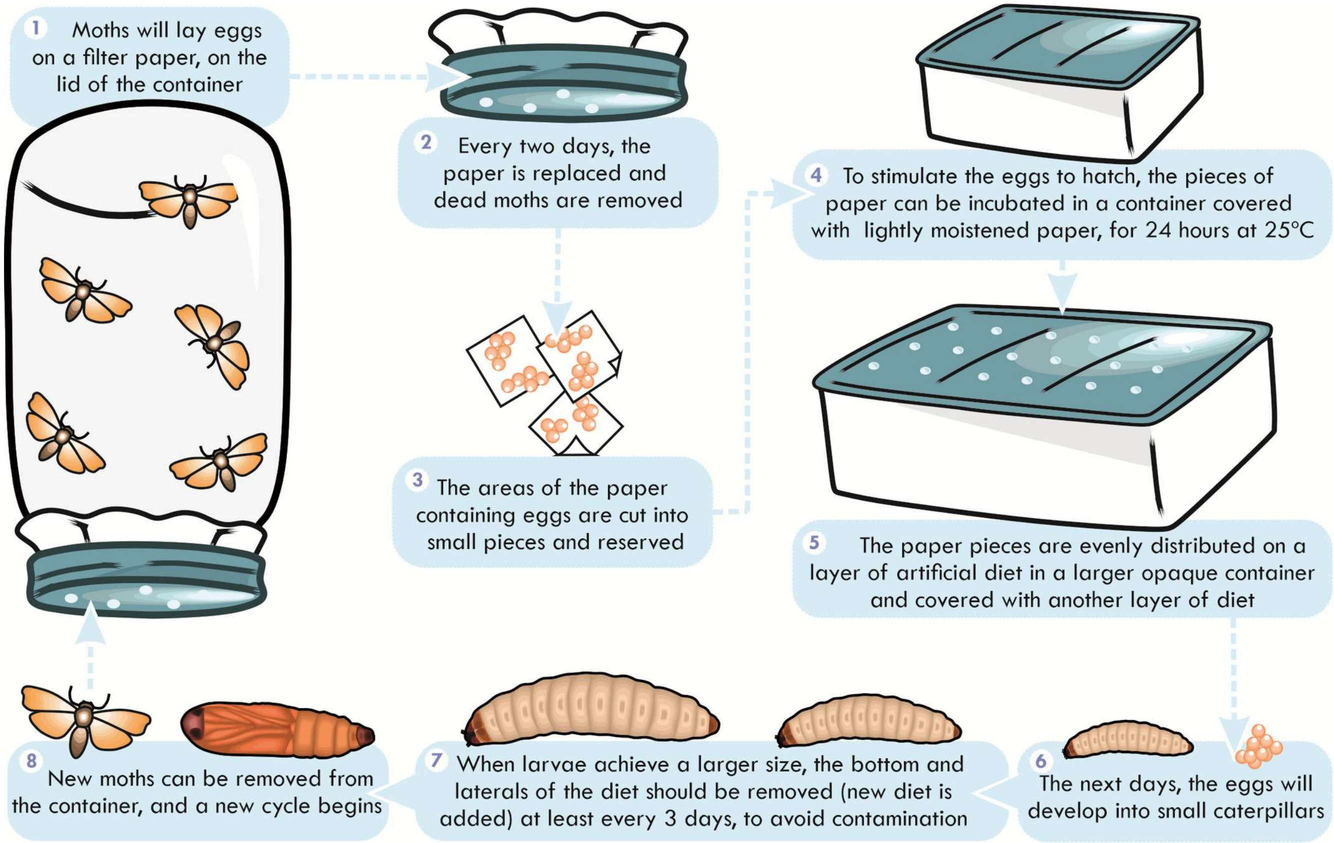


Illustration: Pereira, F. and Rossi, C. 2020

White trap technique for yielding nematodes from parasitised larvae

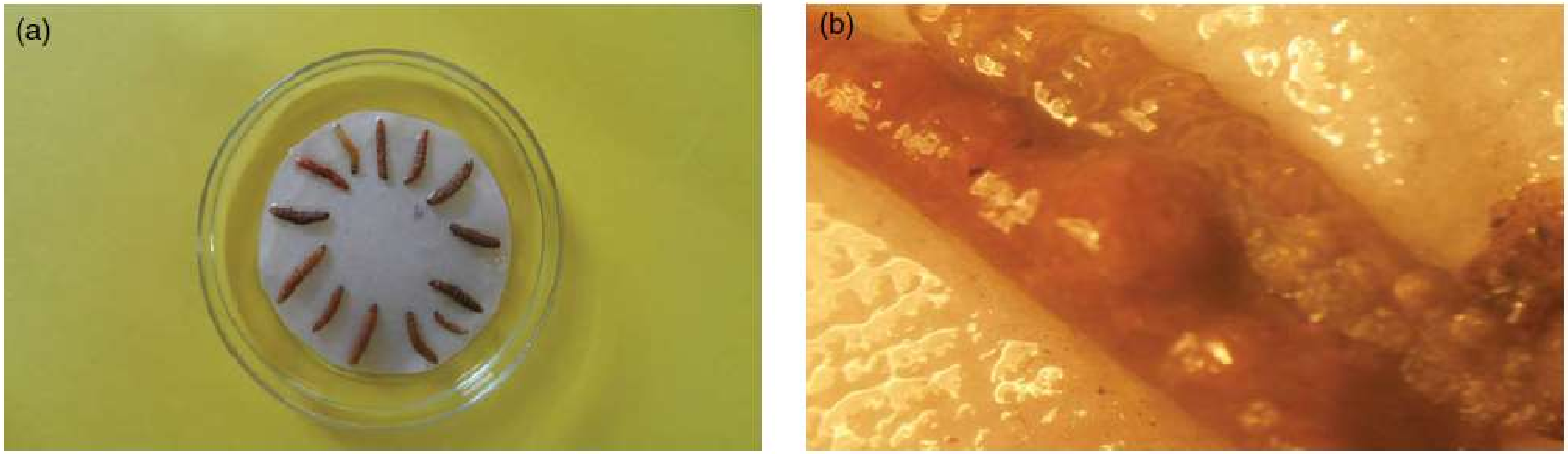


Fig. 13.3. (a) White trap method for harvesting EPNs emerged from insect cadavers; (b) infected juveniles (IJs) inside the bodies of EPN-infected insect larvae.

Size of the host and length of the cycle

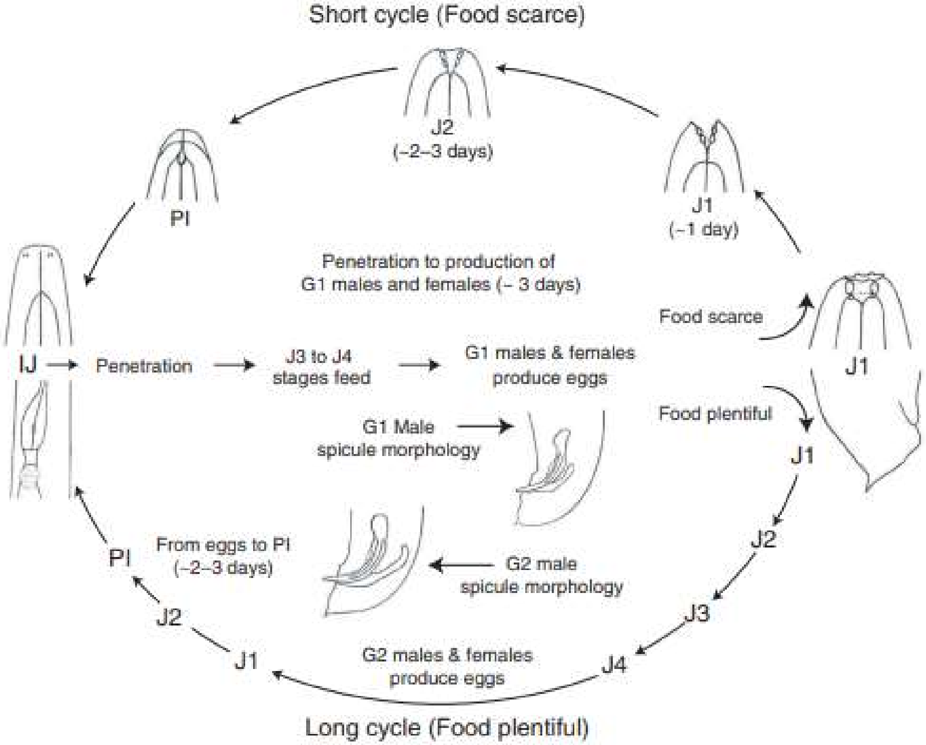


Photo by : Chigurupati Sai Prasanth

Planning a selection proces for nematode strains

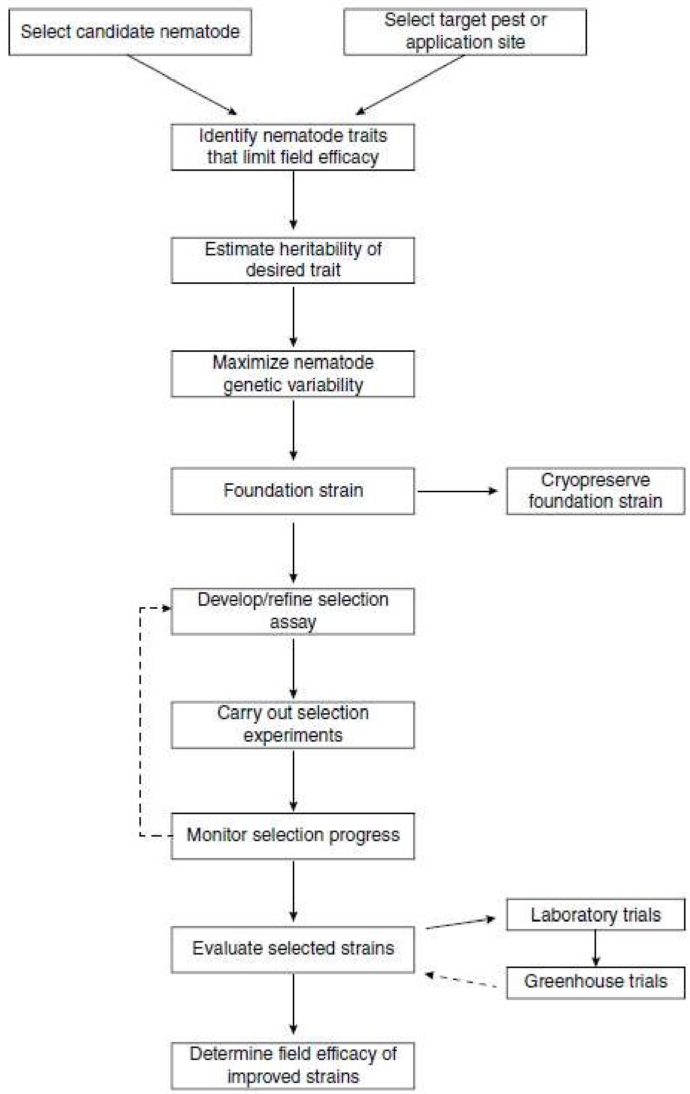
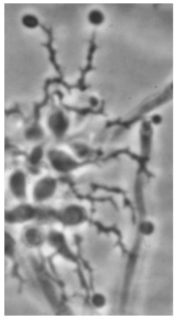
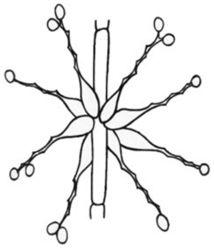


Fig. 26.1. A schematic illustration to design a selection breeding course for entomopathogenic nematodes. (From Gaugler *et al*., 1989; Burnell, 2002.)

Entomopathogenic fungi

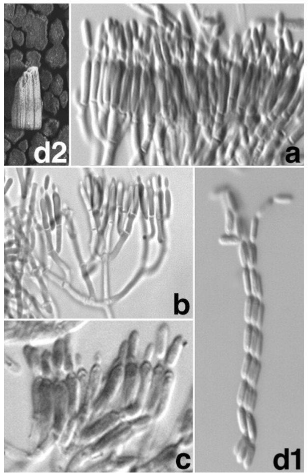
Species	Hosts	Country
Beauveria bassiana	*Cylas* and *Euscepes* (adults)	**China** up to 43% controlof C. puncticollis applying 28 days after planting
Metarhizium anisopliae		





Beauveria bassiana

Photo from jorgeiv93.wordpress.com



Metarhizium anisopliae

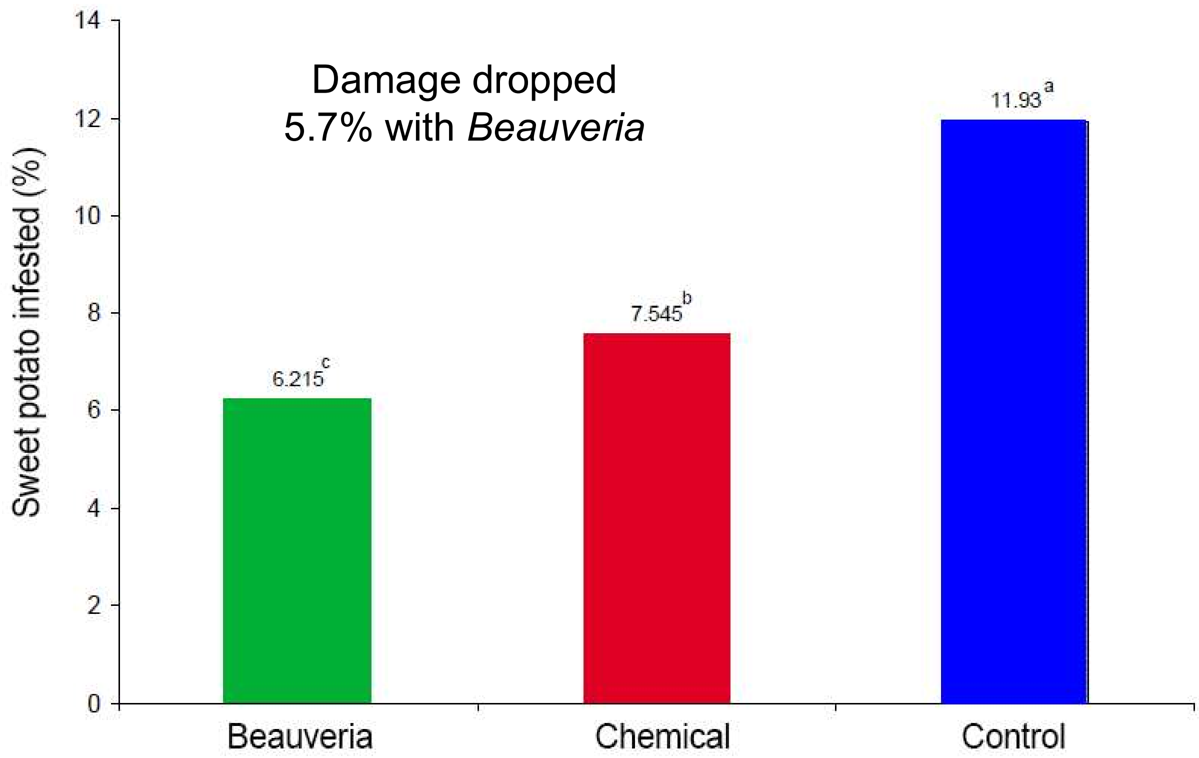
Photo from Dotaona R. et al. 2017

Entomopathogenic fungi

- *Beauveria bassiana* and *Metarhizium anisopliae* have shown effective against adult weevils
- *Metarhizium* produces more conidia at field level
- 48 to 72 hours for killing
- Application methods:
    - Plant dipping (5% conc.)
    - Spraying: 15 days after sowing (10e12 conidia/ha every 7-10 days until establishment)

Photos frm Dotaona R. et al. 2017

Observed effect of the application of B.bassiana for the control of SPW in Cuba



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Generating local strain collections of entomopathogenic fungi and nematodes

Insect bait technique for entommopathogenic fungi and nematod collection

Storage

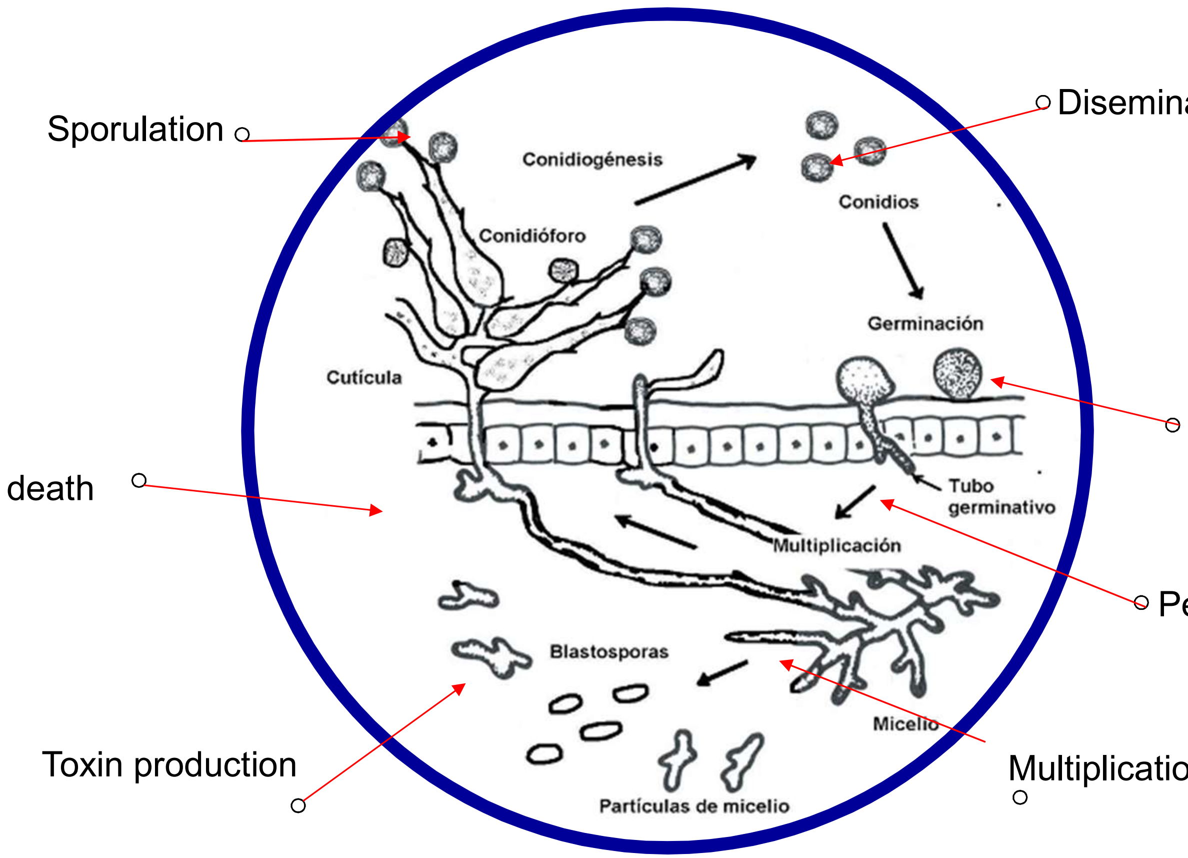
Screening

Formulation

Formulation

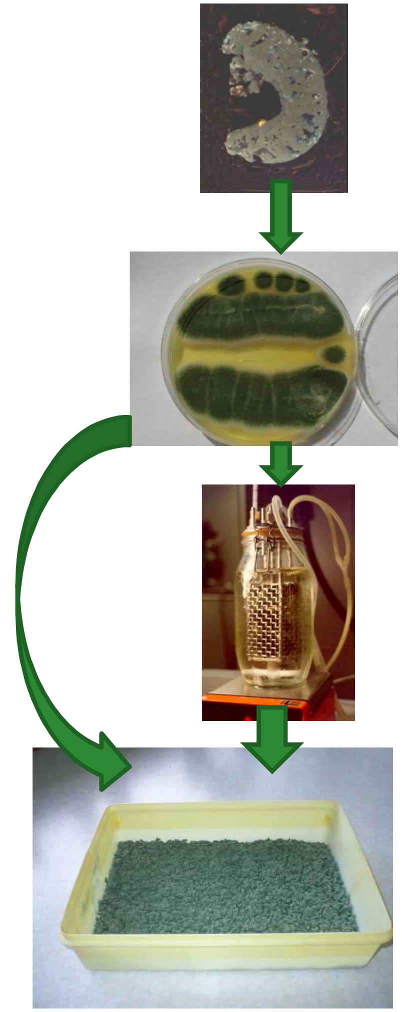
Field use

Life cycle of an entomopathogenic fungus (Deuteromicete)



How to produce entomopathogenic fungi?

1. Isolate from insect or directly from soil using bait insects or media with antibiotics
2. Use monosporic isolates to avoid contaminants and assure genetic homogeneity
3. Inoculate the solid substrate (rice) with a conidial suspension of aprox. 1x10^6 con/ml, 10ml per 100g of substrate in polypropylene bags.
4. Incubate at 24-26 ^{0}C for 10 to 15 days
5. For large production, multiply the inoculum with a 3 day liquid fermentation in nutrient broth



Tentative roadmap for developing a biocontrol programme of SPW in the Caribbean

- Consider the use of the 3 main bicontrol agents identified as effective (predatory ants, entomopathogenic fungi and nematodes)
- **Predatory ants:**
  - Check the existence of *Pheidole* and *Tetramorium* species in the islands
  - Validate the pseudostem trapping method for collecting ant colonies

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Tentative roadmap for developing a biocontrol programme of SPW in the Caribbean

Photo by : Chigurupati Sai Prasanth

- **Entomopathogenic nematodes:**
  - Generate a strain bank isolated from representative soils/environments of the country
  - Screen against weevil larvae and adults
  - Consider Small scale production at community level
  - Analyse the economics and feasibility for a large-scale production system for the region

Tentative roadmap for developing a biocontrol programme of SPW in the Caribbean

Entomopathogenic fungi

- Generate a strain bank isolated from representative soils/environments of the country
- Screen against weevil eggs, larvae, pupae and adults
- Consider Small scale production at community level
- Analyse the economics and feasibility for a large-scale production system for the region

Tentative roadmap for developing a biocontrol programme of SPW in the Caribbean

- **Parasitoids**
  - Run field samplings for parasitoid presence
  - If found:
    - Identify
    - Run studies of efficacy
    - Procure adequate environment for augmentation

شكرا جزيلا
ありがとう
merci
शुक्रिया
zikomo
xie-xie
obrigado
efharistó
kiitos
thank you
tak
gracias
zikomo
asante
urakoze
ke itumetse
danke
terima kasih
dhanyawaad

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