









# The long and challenging road to capitalize on plantbased extracts from the lab to the field

Pierre J. Silvie, Murilo Fazolin, Leandro do Prado Ribeiro, Patrice A. Marchand, Frank Tchuwa, Pierre Martin, Angela Mkindi



# **Plant-based extracts**

Options of use range from the "do-it-yourself" (homemade) preparations - often based on smallholders' **knowledge** and **traditional knowhow-**...

## ...to application of commercial input formulations.

Example (Australia): Sero-X<sup>®</sup> ('complex procedure of extraction') demonstrates efficacy against egg lay and 1st to 3rd instar larvae of cotton boll and native budworms (*Helicoverpa* spp.); adults and nymphs of green mirids (*Creontiades dilutus*); adults and nymphs of yellow mirid (*Campylomma liebknechti*); first instar nymphs of green vegetable bugs (*Nezara viridula*) and adults and nymphs of silverleaf whiteflies (*Bemisia tabaci*). The product has shown to have minimal effect on predatory insect adults.





Clitoria ternatea Fabaceae

### Scheme of obtaining procedure of an Allelochemical-based insecticide product



Product – Transfer of technology

# Some constraints or limitations

- Technical (extraction, efficacy, chemical analysis, standardization, formulation, shelf life, biomass availability/sustainability, effects on NTO, human health and environment);
- Regulatory approval (adaptation, environmental/ecotoxicological aspects).
- **Social** (grower and consumer perception/acceptability, labour demand, gender issue);

# Subjective assessment of constraints





# Level of adoption and uses

**Technology readiness levels (TRLs)** offer a means to rate relevance of these solutions in the process from plant identification and local knowledge to large-scale use of plant extracts.

### **TECHNOLOGY READINESS LEVEL (TRL)**



# *Tephrosia vogelii* (Fabaceae)



# Tephrosia vogelii (Fabaceae)



### **Brazil (Western Amazon)**

# Piper aduncum (Piperaceae)

Domestication and germplasm (680 lines)

Distillation

XII European Congress of Entomology, Heraklion, Crete, 16-20 October 2023

# **Piper aduncum (Piperaceae)**

### **Brazil (Western Amazon)**



Insecticide from **leaves** (essential oil by distillation)





Piper aduncum

# Annona mucosa (Annonaceae)



Insecticide from seeds processing wastes(cold maceration with ethanol)

#### TECHNOLOGY READINESS LEVEL (TRL)

9	ACTUAL SYSTEM PROVEN IN OPERATIONAL ENVIRONMENT
8	SYSTEM COMPLETE AND QUALIFIED
7	SYSTEM PROTOTYPE DEMONSTRATION IN OPERATIONAL ENVIRONMENT
6	TECHNOLOGY DEMONSTRATED IN RELEVANT ENVIRONMENT
5	TECHNOLOGY VALIDATED IN RELEVANT ENVIRONMENT
4	TECHNOLOGY VALIDATED IN LAB
3	EXPERIMENTAL PROOF OF CONCEPT
2	TECHNOLOGY CONCEPT FORMULATED
1	BASIC PRINCIPLES OBSERVED

### **Brazil**



Annona mucosa

### Examples of products based on *Citrus* (Rutaceae) processing wastes

# Commercialized as **foliar fertilizers**, **adjuvants**, **biostimulants**

Other regulations than pesticides

TECHNOLOGY READINESS LEVEL (TRL)





XII European Congress of Entomology, Heraklion, Crete, 16-20 October 2023

### Brazil

# France (CIRAD- La Réunion)

**BIOPIPER : Production durable d'extraits naturels biocides de deux Pipéracées à la Réunion** 



#### 2014-2018



Insecticide from **leaves** (essential oil)

# *Piper borbonense* (Piperaceae)

# France (La Réunion Island)



XII European Congress of Entomology, Heraklion, Crete, 16-20 October 2023

YMENT

0

DEP

ENT

PZ

0

EVE

0

H

EAR

RES

### EU: Basic substances (still long and challenging) pathway





# **Regulation: a key challenge**

### Europe

### Brazil

### time Idem agrotoxic

substances

Decreto N°6913 (23-07-2009)

~ .	Bio
« Especificações de	*Co
referência »	cou
N°9 - Neem	
N°4 – Tephrosia / ants/c	offee

	<i>Salix</i> (cortex)	cayenne
	Sunflower (oil)	Vitis vin
	<i>Urtica</i> sp.	Landes
Biope	Lemon (	
*Comr	Origanu	
countr	Paprika	

Plant species (origin of Basic Substances)				
Approved	Not approved			
<i>llium cepa (</i> bulb extract)	Achillea millefolium			
quisetum arvense	Arctium lappa (aerial parts)			
lustard (seed powder)	Artemisia absinthium			
nion oil	Artemisia vulgaris			
alix (cortex)	Capsicum annuum var. annuum, longum group, cayenne (Oleoresins capsicum)			
unflower (oil)	Vitis vinifera (grape cane tannins)			
rtica sp.	Landes pine (tar)			
icides	Lemon (essential oil)			
ricon with other	Origanum vulgare (essential oil)			
s (Balog et al. 2017)	Paprika extract (capsanthin, capsorubin E 160 c			
	Rheum officinale (root extract)			
	Saponaria officinalis (roots)			
	Satureja montana (essential oil)			

Tanacetum vulgare

### Africa

#### Biopesticides

\*Comparison with other African countries /Recommendations Nigeria (Ashaolu et al. 2022)

"for the approval of biopesticides based on biochemical substances, there is a framework for dossiers adopted by the West African Pesticide Approval Committee, a structure under the supervision of CILSS but operating on behalf of ECOWAS, CILSS and UEMOA, but which has not yet been published and implemented. For plant extract-based **biopesticides,** most registration bodies in West Africa use the same framework as for chemical pesticides" (Ouedraogo S., Crop Life, comm. pers.).

### Guide to registration of **BCA (EPA Ghana, 2011)**

# **Opportunities for developing plant-based extracts**

- Growth of the organic food sector (and organic agriculture)
- Increase of consumer's demand for a safe food product
  - Biocircular economy approach
- Elimination of the market or reduction of synthetic pesticides (Marchand 2022)
  - Low efficacy (pests resistance)
  - Toxicological effects on human and environment
- Increase of the cost of importation of synthetic pesticide (African continent)
- Potential synergy between plant extract and synthetic insecticides



Natural enemy enhancement and botanical insecticide source: a review of dual use companion plants



Amoabeng et al., 2019

https://doi.org/10.1007/s13355-018-00602-0

Fig. 1 A secondary plant species (such as **buckwheat** in this example) can potentially provide dual benefits for pest management, promoting **biological control** and providing **insecticidal compounds** to treat the crop

# References

**Fazolin, M. et al. 2022.** Insecticidal activity of *Piper aduncum oil*: variation in dillapiole content and chemical and toxicological stability during storage. *Acta Amazonica* 52 (3): 179-188.

**Fazolin et al. 2023.** Synergism in two-component insecticides with dillapiole against fall armyworm. *Plants* 12 (17): 3042.

**Marchand P.A. 2015.** Basic Substances: An approval opportunity for Low Concern Natural Products under EU pesticide regulation. *Pest Management Science*, 71(9) : 1197-1200.

**Marchand P.A. 2022.** Evolution of plant protection active substances in Europe: the disappearance of chemicals in favour of biocontrol agents. doi.org/10.1007/s11356-022-24057-7

**Mkindi A.G. et al. 2019.** Phytochemical analysis of *Tephrosia vogelii* across East Africa reveals three chemotypes that influence its use as a pesticidal plant. *Plants* 8, 597

**Ribeiro L. do P. et al. 2017.** The potential use of *Annona* (Annonaceae) by products as a source of botanical insecticides. Boletin SEEA, 2: 26-29.

**Romanazzi G. et al. 2022.** Basic substances, a sustainable tool to complement and eventually replace synthetic pesticides in the management of pre and postharvest diseases: reviewed instructions for users. *Molecules*, 27(11), pp. 3484 doi : 10.3390/molecules27113484

# **Definition basic substances**

REGULATION (EC) No 1107/2009 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 21 October 2009

#### Article 23

#### Approval criteria for basic substances

"For the purpose of paragraphs 2 to 6, a basic substance is an active substance which:

(a) is not a substance of concern; and

(b) does not have an inherent capacity to cause endocrine disrupting, neurotoxic or immunotoxic effects; and

(c) is not predominantly used for plant protection purposes but nevertheless is useful in plant protection either directly or in a product consisting of the substance and a simple diluent; and

(d) is not placed on the market as a plant protection product.

For the purpose of this Regulation, an active substance which fulfils the criteria of a 'foodstuff' as defined in Article 2 of Regulation (EC) No 178/2002 shall be considered as a basic substance".

# **Definition basic substances**

(EC) No. 1107/2009 "Recital 18: Certain substances which **are not predominantly used as plant protection products** may be of value for plant protection, but the economic interest of applying for approval may be limited. Therefore, specific provisions should ensure that such substances, as far as their risks are acceptable, may also be approved for plant protection use." (Marchand, 2015)

"Basic substances are substances that, until now, have not been used as pesticides, but that may be useful in this field. They may not exhibit a negative influence on the health of humans and animals or on the environment. Special requirements have been laid down concerning the testing and data of this type of substance for their use in plant protection" (Czaja et al., 2015)  $\rightarrow$  SANCO/10363/2012, rev. 7 (2013).