Microbial biopesticide development in Africa – *icipe* Experience

Sunday Ekesi
Deputy Director General – R4D
icipe

Regional Consultation Meeting of CABI'S Africa Member Countries.
10-13 June 2025. Emara Ole Sereni Hotel, Nairobi, Kenya

Outline

01 Background – Global development challenges and the burden of pest and pesticide use

02 Availability of microbial germplasm for biopesticide development

03 Biopesticide R4D at *icipe* - Testing, application strategies and scaling

04 Biopesticide product registration and harmonization

05 Concluding remarks / Take home message

MEGA-TRENDS impacting global food security

Climate change

Structural change and unemployment

Increasing competition for natural resources

Migration

Biodiversity loss

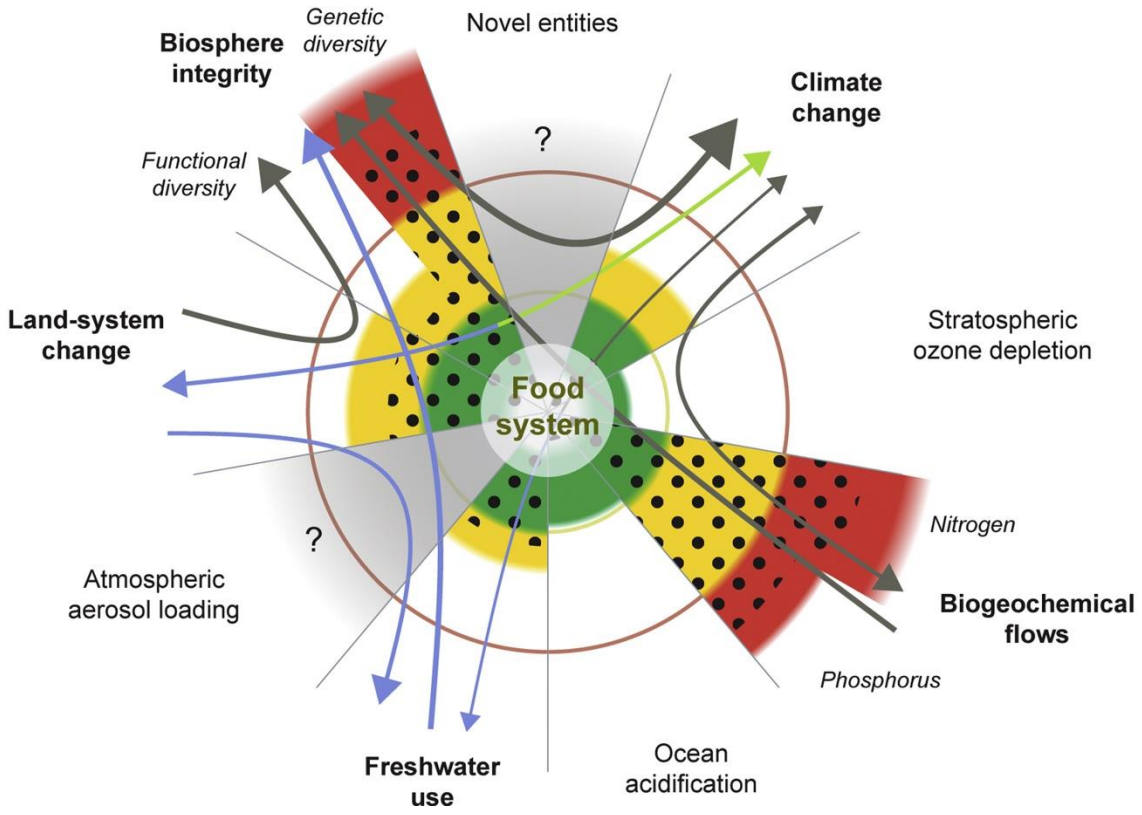
Conflict, crises, natural disaster

Poverty, inequality

Technological innovations

Transboundary pests and diseases

...agriculture is also pushing planetary boundaries



Campbell et al, 2017

Global burden of pests and pathogens

Pest images by G. Goergen

Disease plant images by S. Sevgan

Annually up to 40% of global crop production is lost to pests and pathogens.

Annual agricultural trade losses amount to $220 billion.

Economic cost due to invasive pests alone - $70 billion.

IPPC (2021); Savary et al (2019); Carvajal-Yepes et al., (2019)

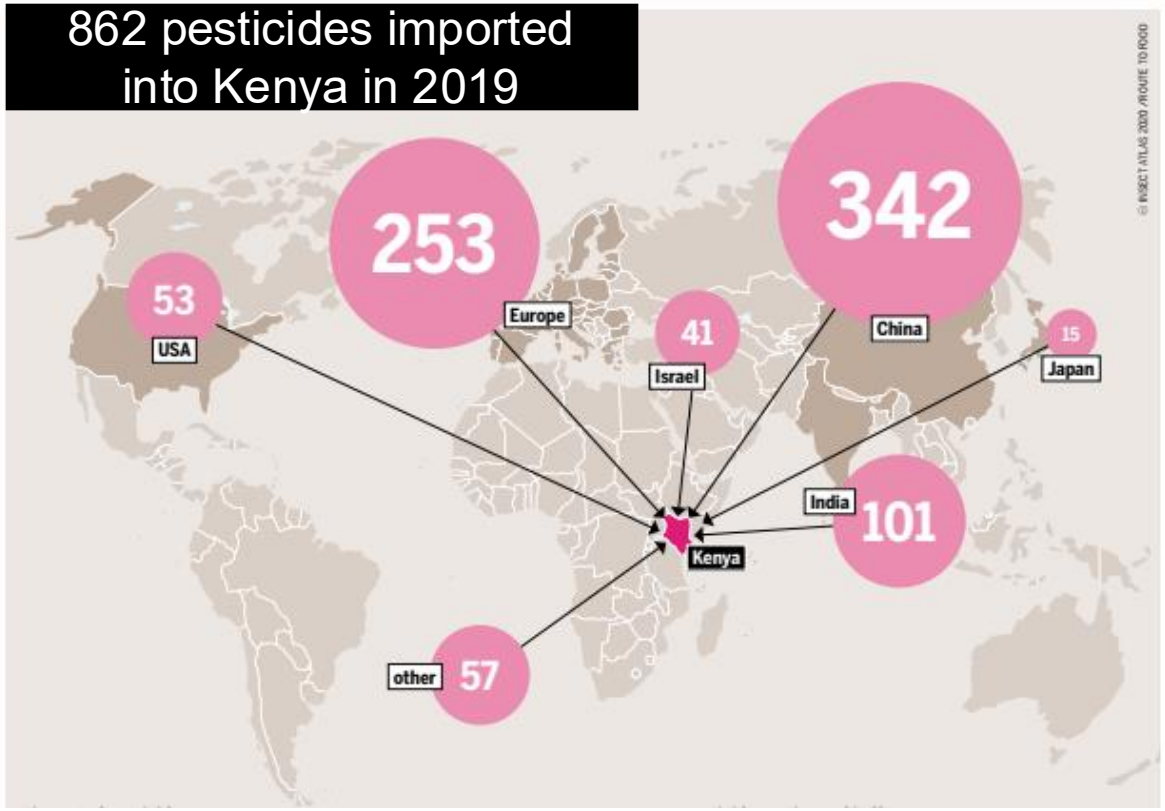
Management – Relies largely on pesticide application

60

synthetic pesticides promoted across Africa for FAW control, only 6 – 7 are ecologically safe

Synthetic pesticide use in Kenya

862 pesticides imported into Kenya in 2019

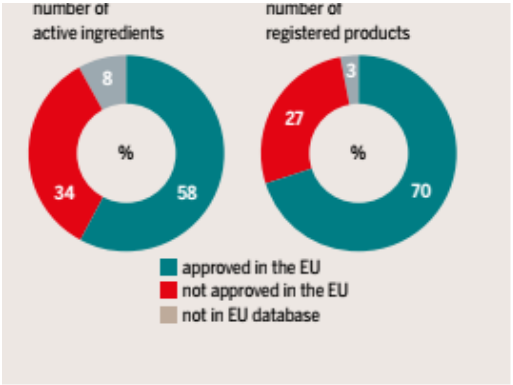


862

No of pesticides imported into Kenya

27%

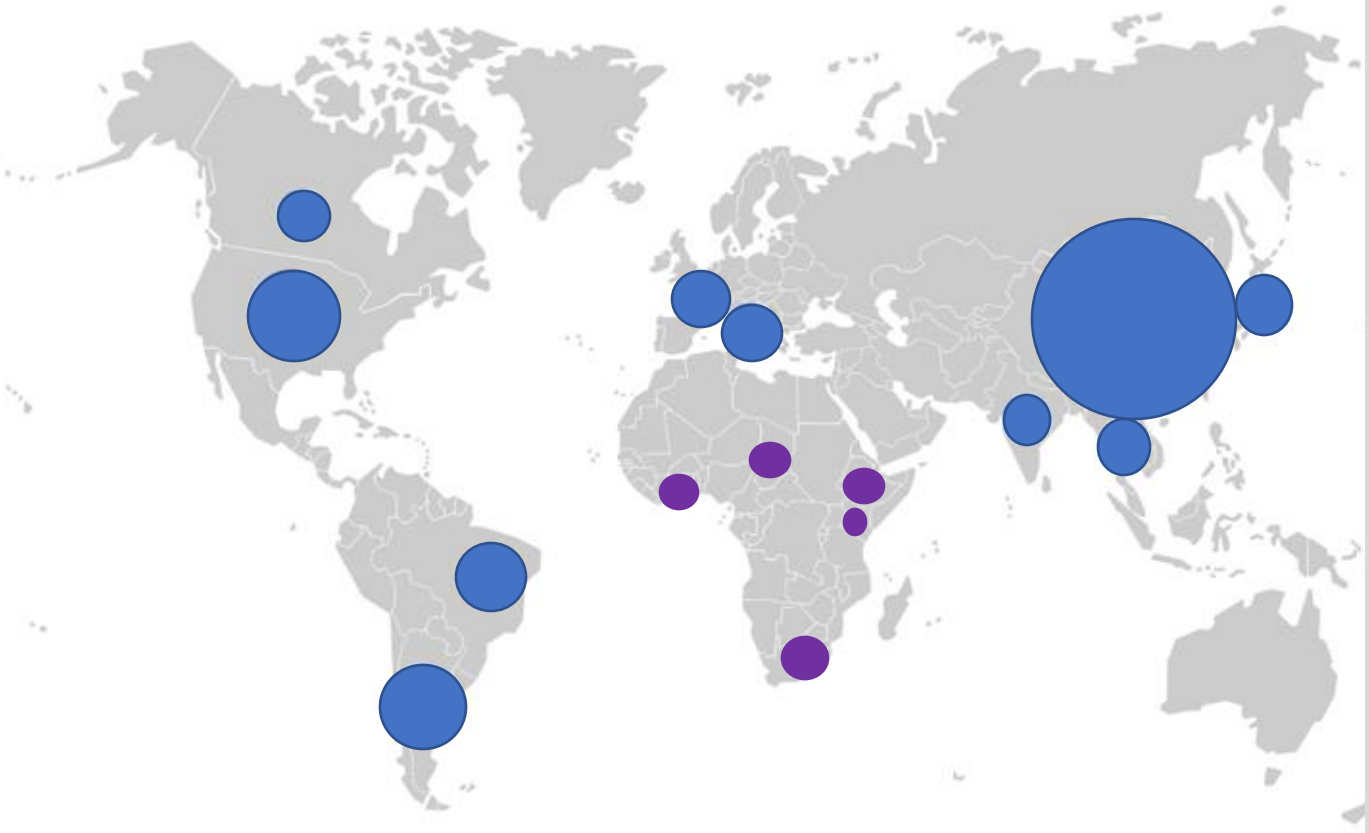
Not approved for use in the EU



Chemnitz et al. 2020 – Insect Atlas

Global volume of pesticides applied on crops

Annual pesticide consumption worldwide – 3.5 billion kg AI per year



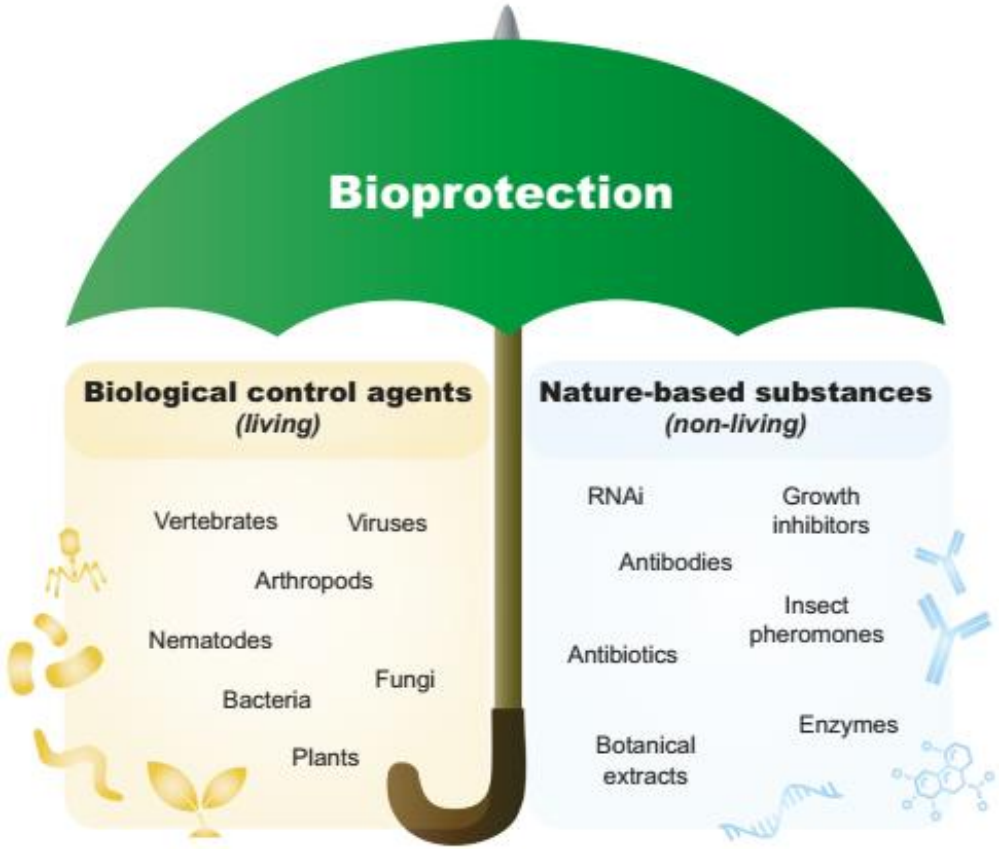
Sources: Pretty and Bharucha, *Insects*, 2015, FAOSTAT, OECD.

*Millions of kg

Top consumers

China	1,806*
USA	386
Argentina	265
Thailand	87
Brazil	76
Italy	63
France	62
Canada	54
Japan	52
India	40
S/Africa	27
Ghana	15
Cameroun	11
Ethiopia	4
Kenya	1.6

Political deafness?



CellPress

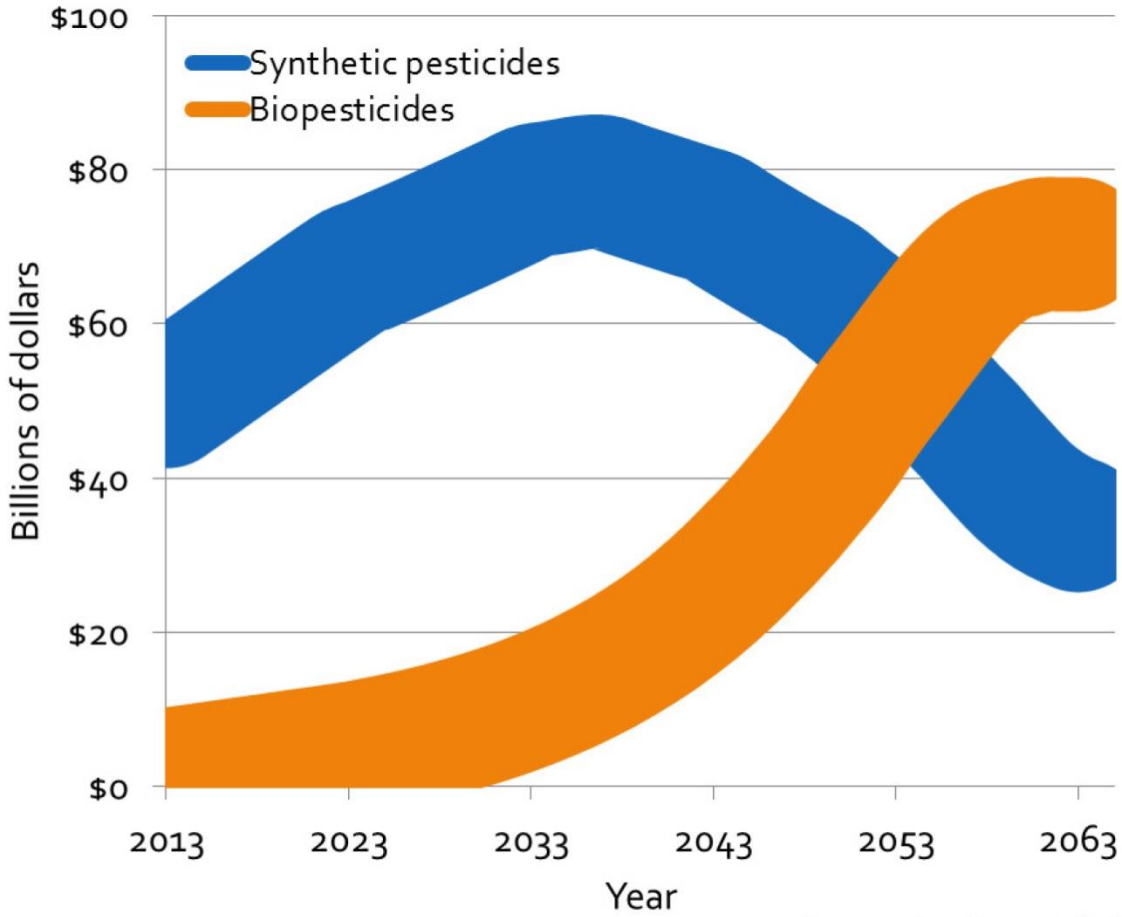
Special issue: Food security

Science & Society

Political deafness may impede transition to biological control

Johan A. Stenberg [1,*,@], Paul G. Becher [1], Mattias Jonsson [2,@], Magnus Karlsson [3], Ingvar Sundh [4] and Maria Viketoft [2]

Hope – Global share of biopesticide market



Source: Lux Research, Inc.
www.luxresearchinc.com

Drivers contributing to increase use in Africa

Industry

- MRL/Standards in export market
- Chemical pesticide ban
- Resistance management
- Short/no phi
- Fits within IPM

Consumer

- Awareness
- Increase acceptance
- Low risk to human, environment and biodiversity

Enablers

- Government support
- Innovative PPP
- Regulatory policy
- Education/partnerships

Africa continental wide policy framework in support of biopesticide

"**NEPAD (2005)** highlighted the promotion and development of biopesticide as a specific priority for agricultural development in Africa"

AUDA-NEPAD
AFRICAN UNION DEVELOPMENT AGENCY

icipe

Repository of *icipe* Microbial Bank

Soil, host plants, seeds and insects

Entomopathogen group	No. of isolates	Genus
Entomopathogenic fungi	311	*Beauveria, Metarhizium, Verticillium, Isaria*, and others
Entomopathogenic bacteria	157	*Bacillus thuringiensis*, *Serratia marcescens* and others
Endophytes	10	*Hypocrea, Trichoderma, Clonostachys,* and *Bionecteria*
Entomopathogenic nematodes	2	*Heterorhabditis* and *Steinernema*
Microsporidian	3	*Nosema, Malamoeba* and *Johenrea locustae*
Baculoviruses	2	*Spodoptera littoralis* NPV and *S. exigua* NPV

Akutse et al. (2019)

Biopesticides development in Africa - pace setter

LUBILOSA

- Exploration
- Screening
- Assess biotic and abiotic factors
- Field testing
- Formulation
- Field persistence
- Mass production
- Eco- and mammalian toxicity testing
- Regulatory approval
- Commercialization

Douthwaite, Langewald & Harris, 2001

icipe

Screening

Contents lists available at ScienceDirect

Biological Control

journal homepage: www.elsevier.com/locate/ybcon

Effect of *Metarhizium anisopliae* inoculation on the mating behavior of three species of African Tephritid fruit flies, *Ceratitis capitata, Ceratitis cosyra* and *Ceratitis fasciventris*

Susan Dimbi [a,b], Nguya K. Maniania [a,*], Sunday Ekesi [a]

J Pest Sci
DOI 10.1007/s10340-016-0781-4

ORIGINAL PAPER

Selection of fungal isolates for virulence against three aphid pest species of crucifers and okra

W. Bayissa[1,2] · S. Ekesi[1] · S. A. Mohamed[1] · G. P. Kaaya[2] · J. M. Wagacha[2] · R. Hanna[3] · N. K. Maniania[1]

Available online at www.sciencedirect.com
SCIENCE DIRECT®
Journal of Invertebrate Pathology 83 (2003) 157–167
Journal of INVERTEBRATE PATHOLOGY
www.elsevier.com/locate/yjipa

Effect of soil temperature and moisture on survival and infectivity of *Metarhizium anisopliae* to four tephritid fruit fly puparia

S. Ekesi,* N.K. Maniania, and S.A. Lux

International Centre of Insect Physiology and Ecology (ICIPE), P.O. Box 30772, Nairobi, Kenya

Received 31 December 2002; accepted 17 March 2003

Annals of Agri-Bio Research **24** (2) : 277-282, 2019

Mass Production of *Metarhizium anisopliae* AUMC 3262 Strain Isolated from Egyptian Habitat and its Virulence against *Spodoptera littoralis* Larvae (Boisd.)

SAIED M. EZZAT[1], ALI A. EL-SHEIKH AND RANA HUSSIEN MOHAMED HUSSIEN*

Department of Pest Physiology, Plant Protection Research Institute, ARC, Giza, Egypt
(e-mail : ranahussien46@gmail.com; Mobile : 201010352139)

OPEN ACCESS Freely available online
PLOS ONE

Colonization of Onions by Endophytic Fungi and Their Impacts on the Biology of *Thrips tabaci*

Alexander M. Muvea[1,2], Rainer Meyhöfer[1], Sevgan Subramanian[2]*, Hans-Michael Poehling[1], Sunday Ekesi[2], Nguya K. Maniania[2]

1 Institute of Horticultural Production Systems, Section Phytomedicine, Leibniz Universität Hannover, Hannover, Germany, 2 Plant Health Division, IPM cluster, International Centre of Insect Physiology and Ecology, Nairobi, Kenya

About **216** articles on screening between 1995-2011 on diverse entomopathogens

Mortality: 5-100%

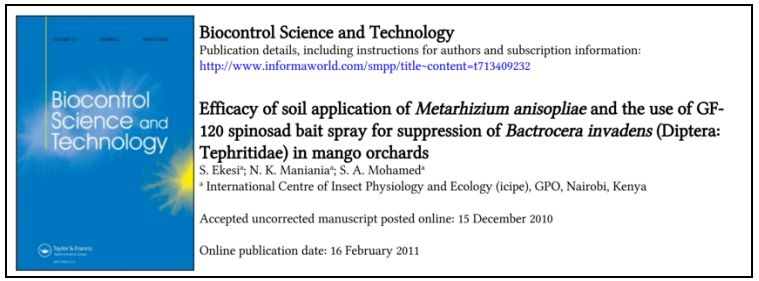
Few have been commercialised!!!

Proven field efficacy – *Metahizium anisopliae* ICIPE 69

Thrips

Fruit fly

Mealybug

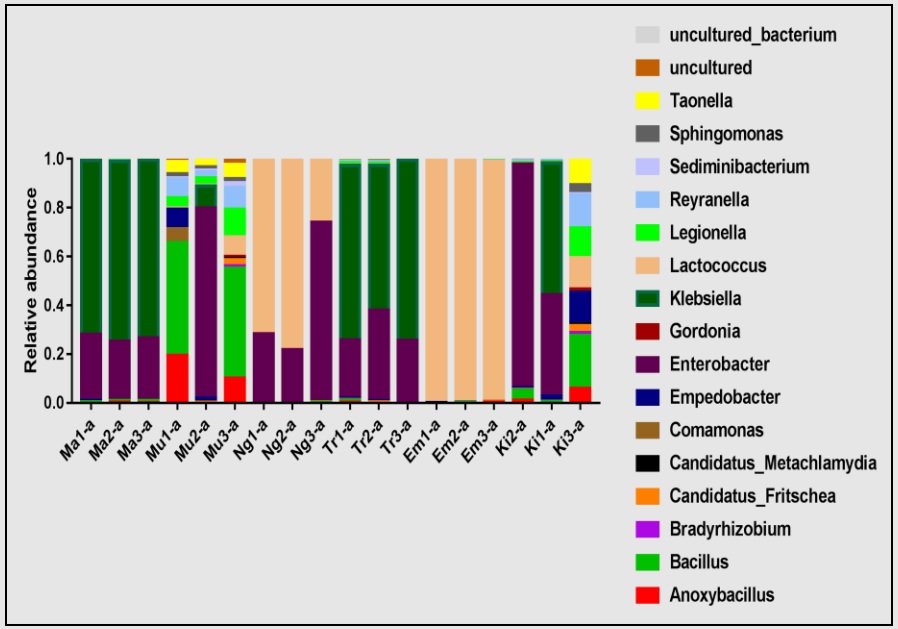


Treatments	Mango yield (kg/ha)	% Yield gain	Monetary gain (US$/ha)
GF-120+Biop	17,765	82	3514
GF-120	12,876	75	2341
Biopesticide	10,114	69	1678
Control	3121		

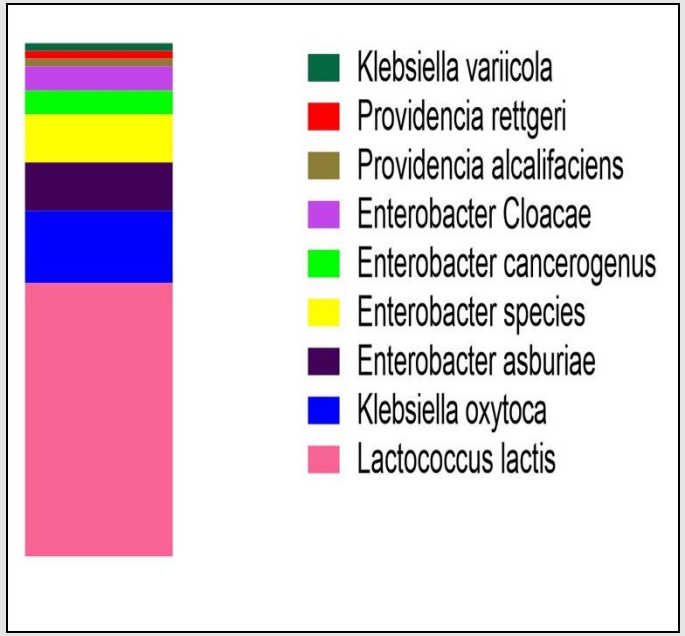
Ekesi et al., 2014

Gut symbiont detection in *Bactrocera dorsalis*

Method: high throughput (16s rRNA) sequencing



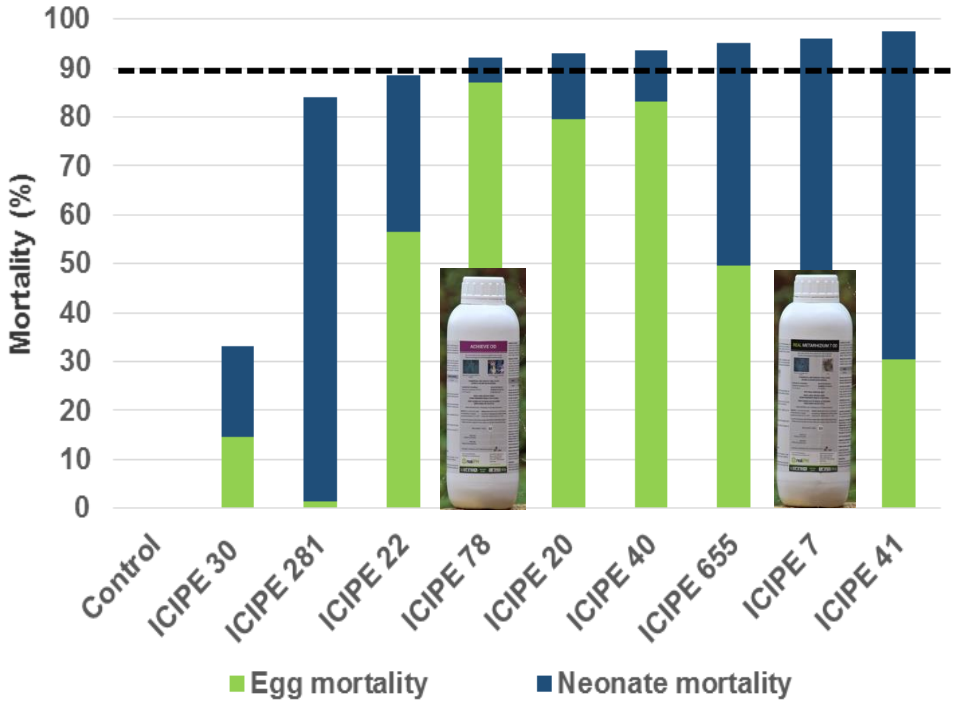
Method: Culture-based isolation



B. dorsalis harbors large diversity of gut bacterial symbionts, dominated by enterobacteriaceae are most dominant

Gichuhi et al. *BMC Microbiol* (2020)

Efficacy of entomopathogenic fungi against Fall armyworm egg and newly emerged larvae



ORIGINAL CONTRIBUTION

WILEY JOURNAL OF APPLIED ENTOMOLOGY

Ovicidal effects of entomopathogenic fungal isolates on the invasive Fall armyworm *Spodoptera frugiperda* (Lepidoptera: Noctuidae)

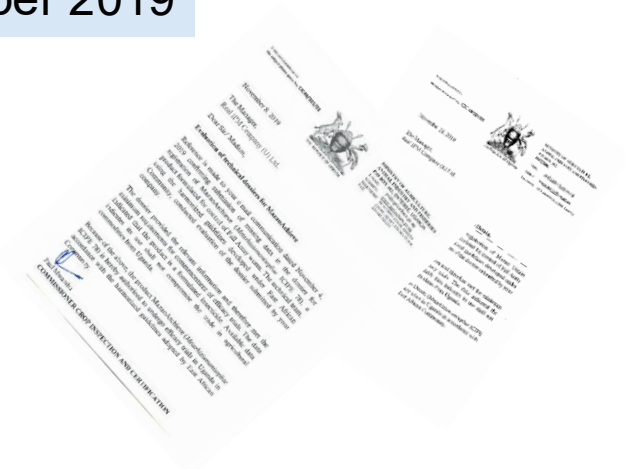
Komivi Senyo Akutse | Jane Wanjiru Kimemia | Sunday Ekesi |
Fathiya Mbarak Khamis | Odhiambo Levi Ombura | Sevgan Subramanian

Extension of label of *Metarhizium* biopesticides (ICIPE 7 & ICIPE 78) for Fall armyworm control

Kenya
28 May 2019

Achieve ® Met 78

Uganda
8 November 2019



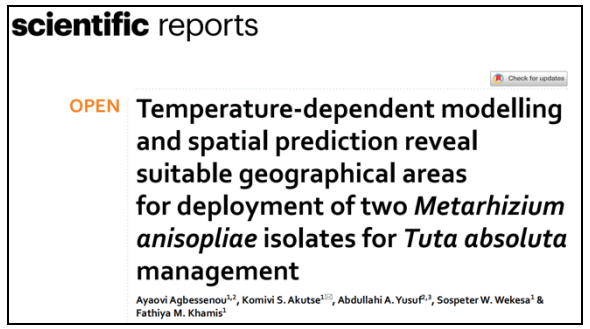
Detain ® Met 7

Tanzania
9 June 2020

Detain ® Met 7

Fall armyworm biopesticide products

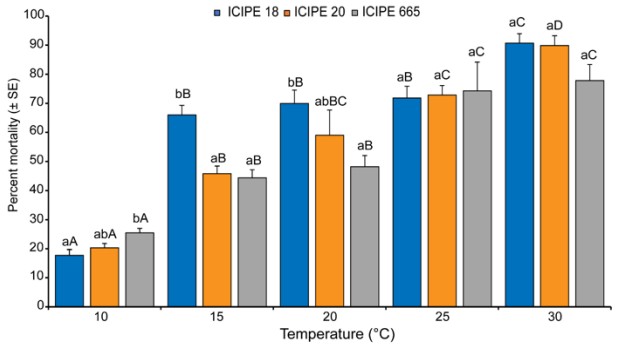
Virulence of *M. anisopliae* isolates to *Phthorimaea (Tuta) absoluta*

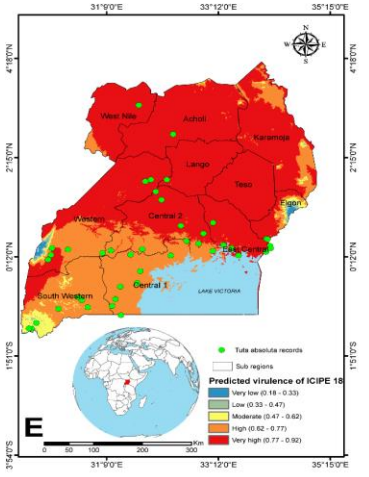

scientific reports

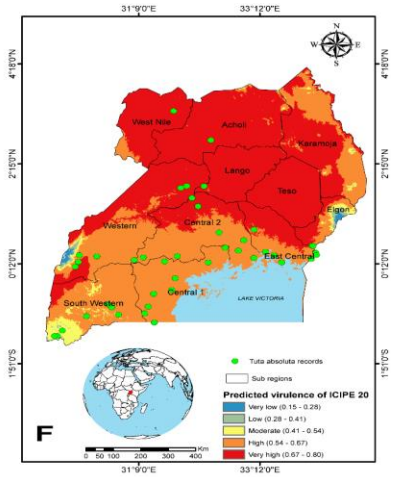
OPEN

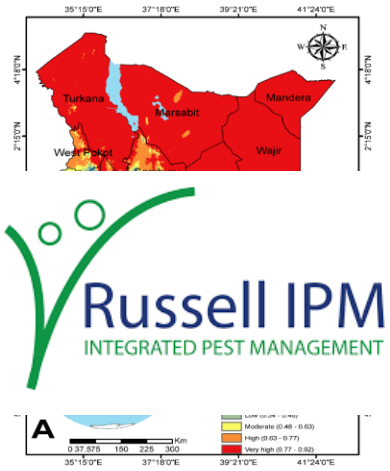
Temperature-dependent modelling and spatial prediction reveal suitable geographical areas for deployment of two *Metarhizium anisopliae* isolates for *Tuta absoluta* management

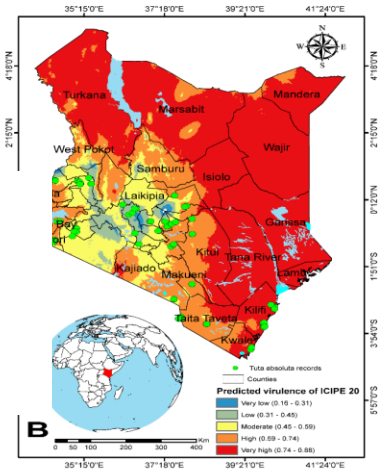
Ayaovi Agbessenou[1,2], Komivi S. Akutse[1✉], Abdullahi A. Yusuf[2,3], Sospeter W. Wekesa[1] & Fathiya M. Khamis[1]

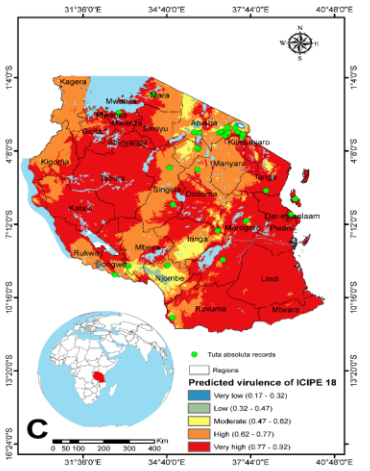


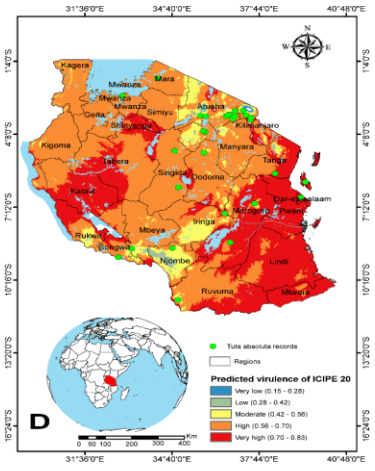




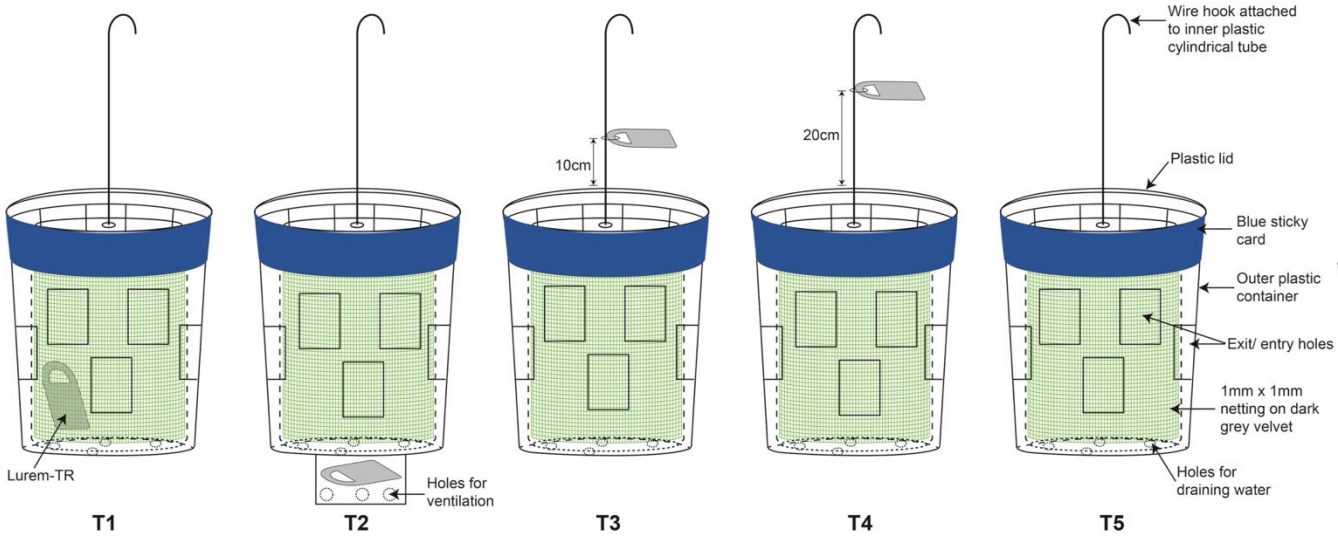


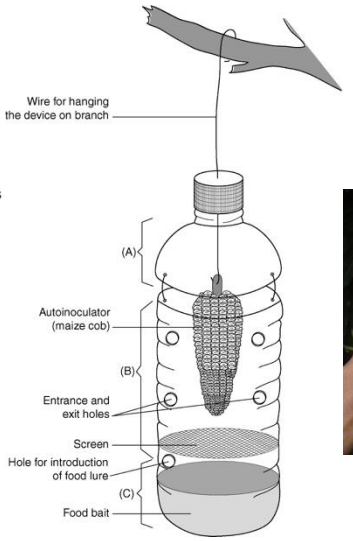


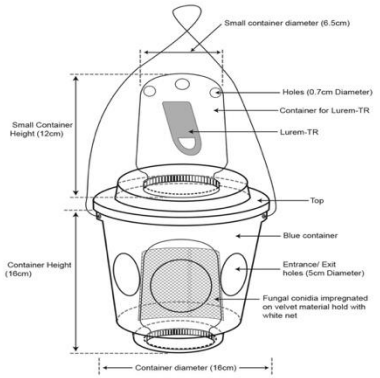




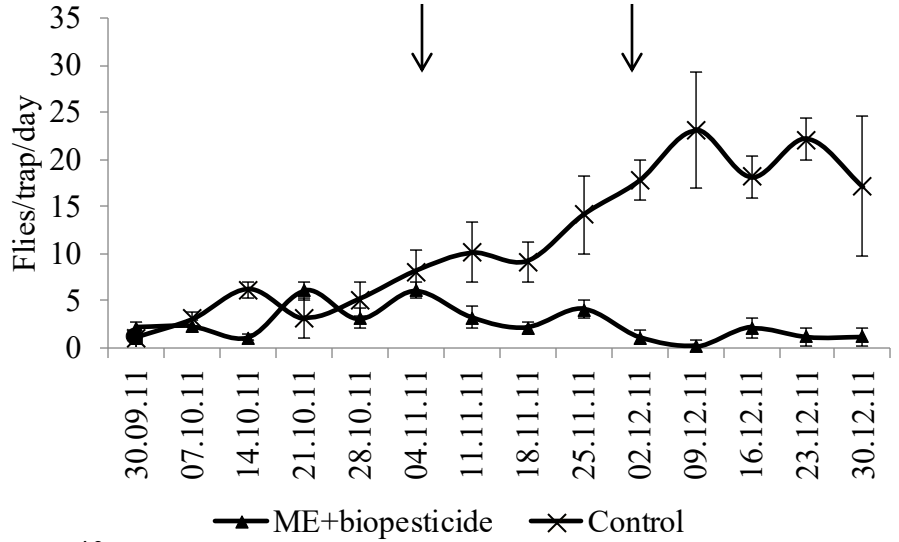
Biopesticide application strategies and integration into IPM in Africa - Autodissemination devices

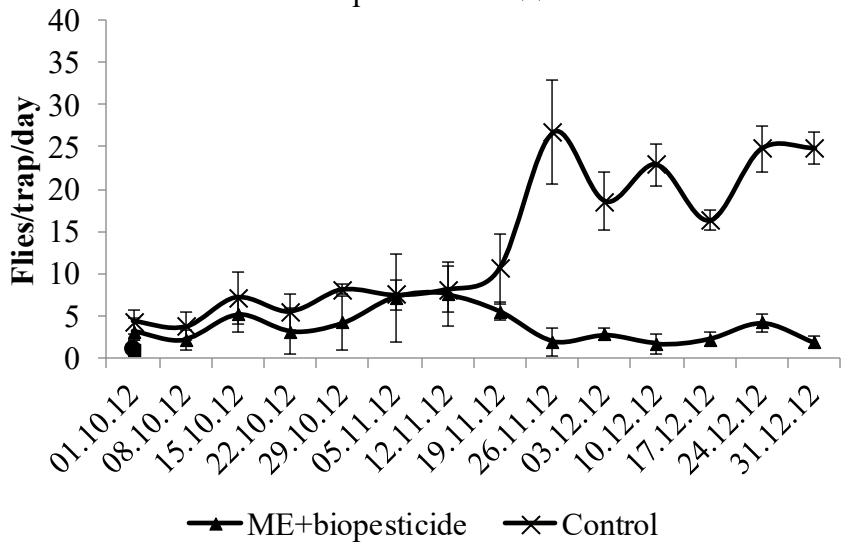


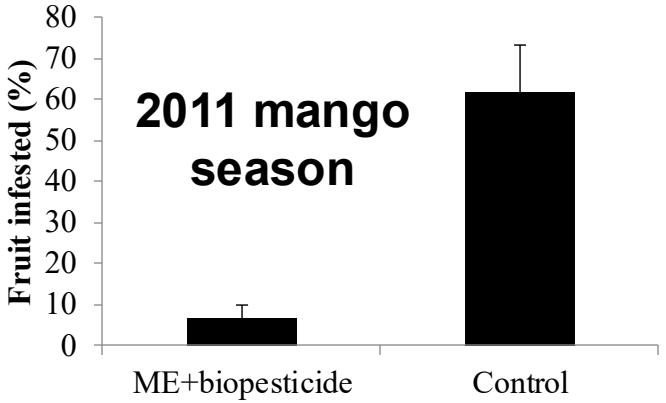


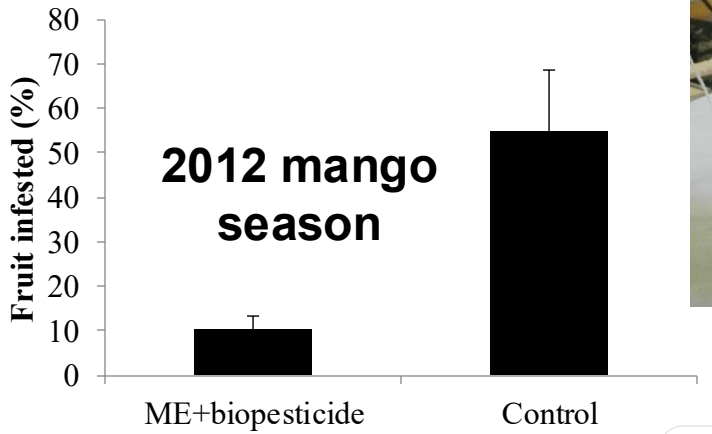


Suppression of *B. dorsalis* with ME + biopesticide bait station



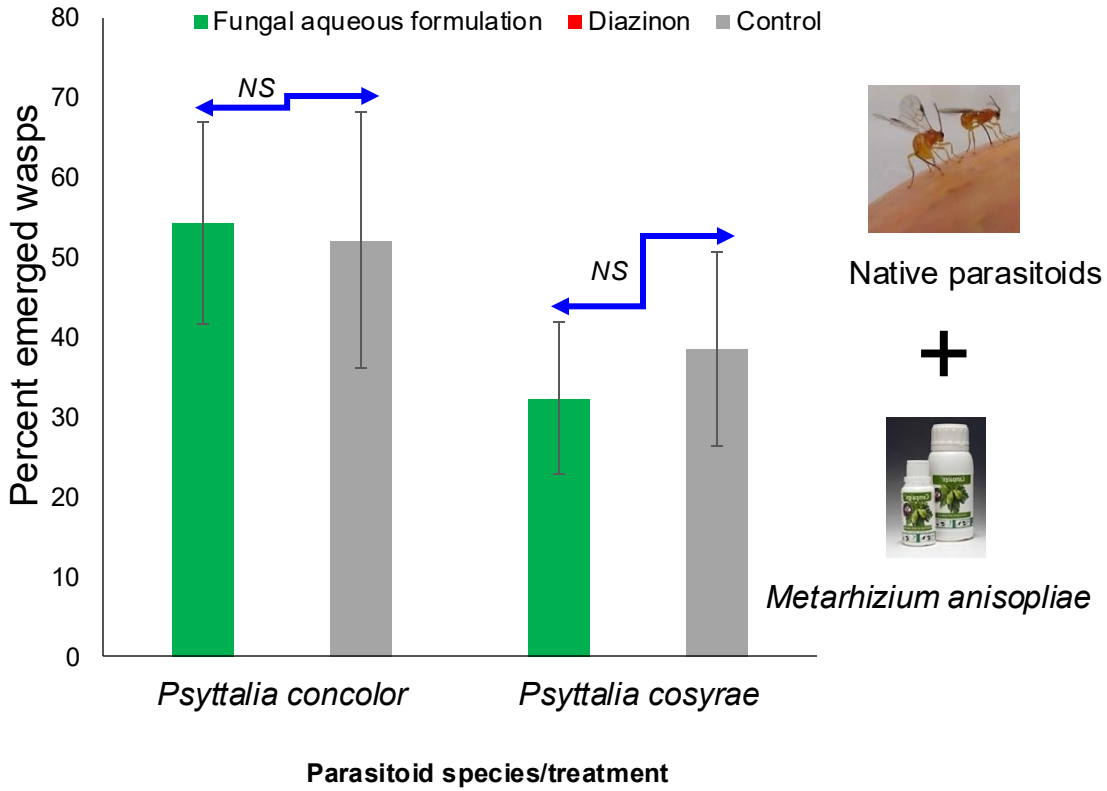






Ekesi et al., 2016

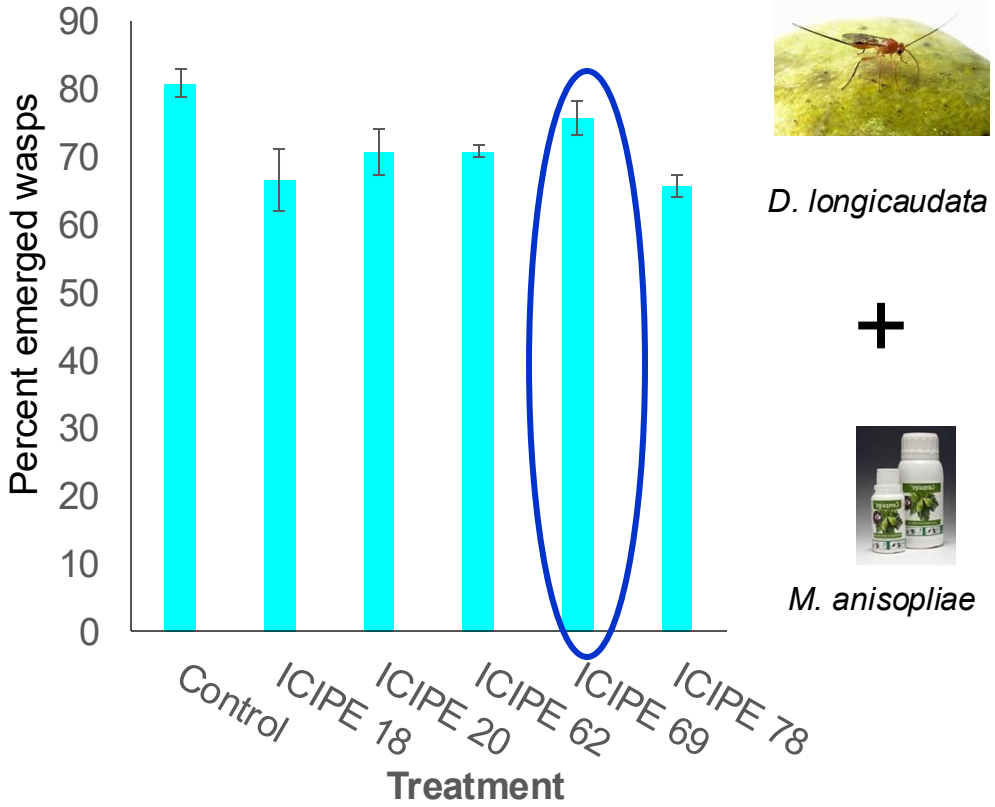
Biopesticide interaction with native and exotic parasitoids



Native parasitoids

+

Metarhizium anisopliae



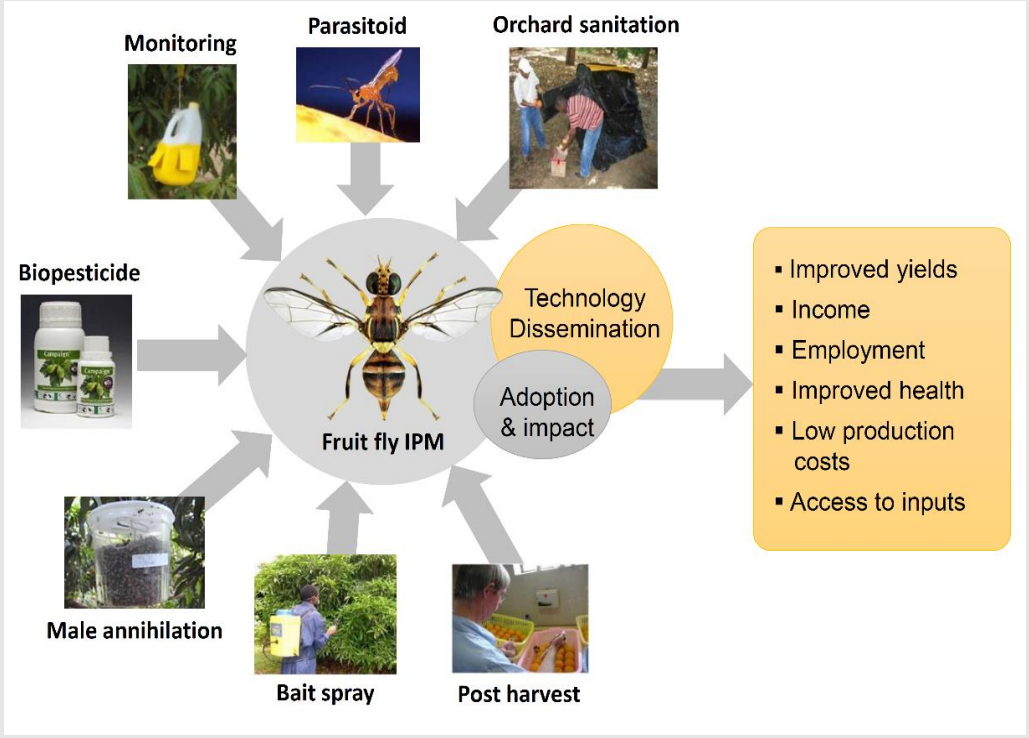
D. longicaudata

+

M. anisopliae

Ekesi S., Maniania K, Mohamed S…(2005). Biol. Cont.

Integration of biopesticide use into fruit fly IPM package



Infestation reduction:
>90%

Benefit-cost ratio:
27:1

Internal rate of return:
29%

Direct & indirect beneficiaries in Africa
>100 M

Ekesi et al. 2016; Niassy et al., 2022

Biopesticides manufactured in Kenya

AI	Trade name
M. anisopliae ICIPE 69	Mazao Campaign®
M. anisopliae ICIPE 78	Mazao Achieve®
M. anisopliae ICIPE 62	Mazao®
M. anisopliae ICIPE 7	Mazao Tickoff®
T. asperellum TRC 900	Mazao Sustain®
B. subtilis BS01	Mazao Regain®
L. lecanii	Lecatech®
P. lilacinus	Mytech®
T. asperellum	Trichotech®
B. bassiana	Beauvitech®
H. armigera SNPV	Helitec SC®

11

biopesticide products manufactured in Kenya

AI	Trade name
T. harzianum	Trianum®
L. muscarium	Mycotal®
M. anisopliae	BioMagic®
T. viride	Biocure®
P. fluorescens	Biocure B®
A. quisqualis	BioDewcon®
L. lecanii	Biocatch®
B. bassiana	Bio-Power®
B. thuringiensis var Kurstaki	Frend 5®
B. thuringiensis var Kurstaki	Halt 50®
B. thuringiensis var Kurstaki	Halt Neo®
P. lilacinus	Bionematon®

AI	Trade name
B. thruingiensis var Kustaki	Delfin®
B. thuringiensis var Kurstaki	Bio-T-Plus®
P. fumosoroseus FE 9901	Pacylos 18®
B. thuringiensis var Aizawa	Xentari®
B. thuringiensis var Kurstaki	Dipel DF®
Myrothecium verrucaria	Diteria DF®
B. thuringiensis var Aizawa	Baciguard®
B. thuringiensis var Kurstaki	Biokil®
B. thuringiensis var kurstaki	BN3®
B. bassiana GHA	Botanigard®
T. harzianum KD	Eco-T®
P. Lilacinus	PL Plus®
T. harzianum	Rootgard®
S. spinosa	Spinosad®

Kenya

30

biopesticide products imported into the country

AI	Trade name
I. fumosoroseus	Preferal®
P. hermaphrodita	Mycotal®
H. bacteriphora	B-Greeb®
S. carpocapsea	C-system®
S. kraussei	K-system®
S. carpocapsea	PalmaLife®
S. feltiae	S-system®
S. carpocapsea	Capsanem®
T. harzianum	Trianum G®
T. harzianum	Trianum P®
Mycorrhiza, Tri. Bacillus	Panoramix®
P. lilacinus	Bionematon®
S. spinosa	Spinosad®
P. resinovorans	Agriphage®

AI	Trade name
CpGV	Capex®
B. amyloliquefaciens	Biogard®
B. bassiana	Bio-Be-Ba®
B. bassiana	Bb Protec®
Granulovirus	Cryptex®
HearNPV	Helicovex®
SpliNPV	Littovir®
M. rileyi	Nomuprotect®
PlxyGV	Plutex®
SfMNPV	Spodovir Plus®
PhopGV	Tutavir®
P. lilacinus	Bionematon®
B. subtilis	Defender®
A. radiobacter	CG-Innoculant®

North Africa

28

biopesticide products imported into North Africa

icipe

Biopesticide use in South Africa

Review

SCI

Received: 17 January 2019 Revised: 27 April 2019 Accepted article published: 10 May 2019 Published online in Wiley Online Library: 9 June 2019

(wileyonlinelibrary.com) DOI 10.1002/ps.5480

Biopesticide based sustainable pest management for safer production of vegetable legumes and brassicas in Asia and Africa

Ramasamy Srinivasan,[a*] Subramanian Sevgan,[b] Sunday Ekesi[b] and Manuele Tamò[c]

South Africa

31

biopesticide products registered in South Africa

23

are imported

So why are few biopesticides manufactured & registered in Africa?

BIOLOGICAL PESTICIDES FOR AFRICA

BIOLOGICAL PESTICIDES FOR AFRICA: WHY HAS SO LITTLE RESEARCH LED TO NEW PRODUCTS TO HELP AFRICA'S POOR?

David Grzywacz, Andrew Cherry, Natural Resources Institute, University of Greenwich, Chatham Maritime, Chatham, Kent. ME4 4TB, England. (D.Grzywacz@greenwich.ac.uk)

Roma Gwynn, Rationale Biopesticide Strategists, 1 Lintlaw Farm, Duns TD11 3QA, Scotland, UK. (rgwynn@biorationale.co.uk)

Factors…

Slower acting

Shorter environmental persistence

Deliberate alignment with pest appearance

More frequent applications

Little local knowledge and by-in

Prices higher than chemical pesticides

Technical knowledge and advisory expertise is weak

Exclusion of private sector

Partnership weakness

Insufficient investment in research capacity

Weak research capacity in scaling up, manufacturing & marketing

Limited funding

Fit into conventional pesticide registration model

Harmonization of registration and trading blocks

Small market size

Enabling environment

Biopesticide products

Metarhizium 62

Aphids

Metarhizium 78

Mites

Metarhizium 7

Ticks

Metarhizium 69

Fruitfly
Thrips
Mealybug

Akutse et al., 2021

KEY FIGURES

137,490 ha
Treated in 2024

330,000
Household beneficiaries in 2020

> 2 M
Awareness amongst households

38
partners

10
Biopesticide products

13
No. of countries registered

>100 publications







EAC SECRETARIAT
Arusha, Tanzania
September 2019

JUMUIYA YA AFRIKA MASHARIKI

THE EAST AFRICAN COMMUNITY

EAC HARMONIZED GUIDELINES FOR THE REGISTRATION OF BIOPESTICIDES AND BIO CONTROL AGENTS FOR PLANT PROTECTION

1. Provide EAC Partner states with a harmonized framework for registering of biopesticides and biocontrol agents
2. Facilitate mutual recognition and sharing of data for registration of biopesticides and biocontrol agents amongst EAC partner states
3. Facilitate best practice in the registration of biopesticides and biocontrol agents for plant protection

Key Provision

Where an applicant submits an application to one Partner State for registration of a product not registered in the region according to this guideline, the product **shall be subjected to two (2) successful cropping seasons trials at two sites in different agro-ecological zones.** Where a commercial crop is only grown in one agro-ecological zone, data from that one zone will suffice.

Conclusions & take-home message

- Diverse isolates of entomopathogens evaluated for the control of arthropod pest of crops.
- Clearly evidence of proven and high levels of efficacy in the field.
- Although several products are being imported into Africa, the region is also witnessing increased level of product manufacturing and registration.
- This has been facilitated by harmonized registration protocols and enhance capacity of registration officers.
- R4D – application strategy, autodissemination, entomovectoring, and integration into IPM.
- More involvement of private sector through PPP.
- Enabling, coherent & supportive policy.
- Foster a culture of system thinking within the context of One Health for biopesticide use.

Thank you

International Centre of Insect Physiology and Ecology

P.O. Box 30772-00100, Nairobi, Kenya
Tel: +254 (20) 8632000
E-mail: icipe@icipe.org
Website: www.icipe.org

Support *icipe*: www.icipe.org/support-icipe

facebook.com/icipe.insects/icipe
twitter.com/icipe
linkedin.com/company/icipe