BIOLOGY AND MANAGEMENT OF FRUIT FLIES IN AFRICA, THEIR RISK OF INVASION AND POTENTIAL IMPACT IN THE NEAR EAST

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Presentation outline

- Background
- Biological, ecological and behavioral traits of the invasive pests
- *Factor s contributing to the risk of fruit flies invasion in the Near East countries*
- Management option, *icipe* experience
- *Lessons and challenges*

Background

- Globally out of 5000 tephritid fly species - about 1400 species develop in fruits, out of these, about 250 species are pests
- In Africa, out of 915 native fruit fly species, 299 species develop in fruits
- Genera native to Africa are
- Most fruits flies are native to specific regions:
  - *Ceratitis* (e.g. *C. cosyra, C. anonae, C. rosa, C. fasciventris, C. capitata)*
  - *Trithrithum*
  - *Some species of Dacus*

Native and invasive pest in Africa

Ceratitis cosyra

B. invadens

Ceratitis fasciventris

Dacus punctatifrons

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- **Fruit flies** cause both direct and indirect damage to horticulture
- **Direct damage**: mango (30-80%), citrus (8-34%).
- **Indirect damage**: Quarantine restrictions (e.g. US federal order 2008, Mauritius, S/Africa, Japan etc)
- **Interceptions** in the EU have been on the rise
- **Socio-economic implications:** food insecurity, loss of jobs, income, employment etc

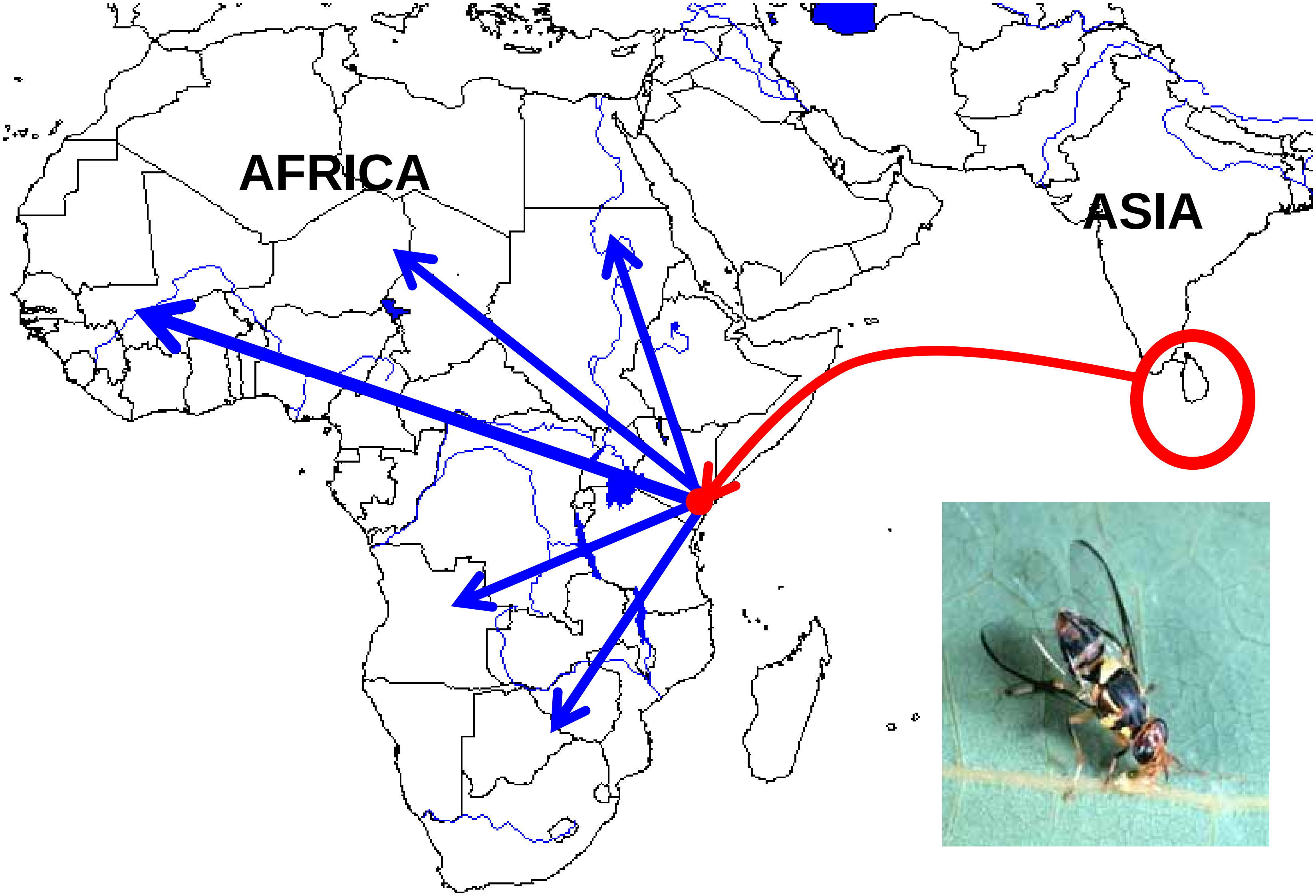
background

Bactrocera invadens

- Putative aboriginal home: Sri Lanka
- Invaded Africa in 2003
- Reported from over 28 African countries
- Over 30 host record but mango is the preferred (**80% loss**)
- Inter-African phytosanitary council of the AU: devastating quarantine pest

Ekesi et al. (2006) Bull. Ent. Res. 96: 379-386

detection and subsequent spread



C- Biological factors

- ❖ highly reproductive rate
- ❖ Shorter generation and doubling time

A- Ecological factors

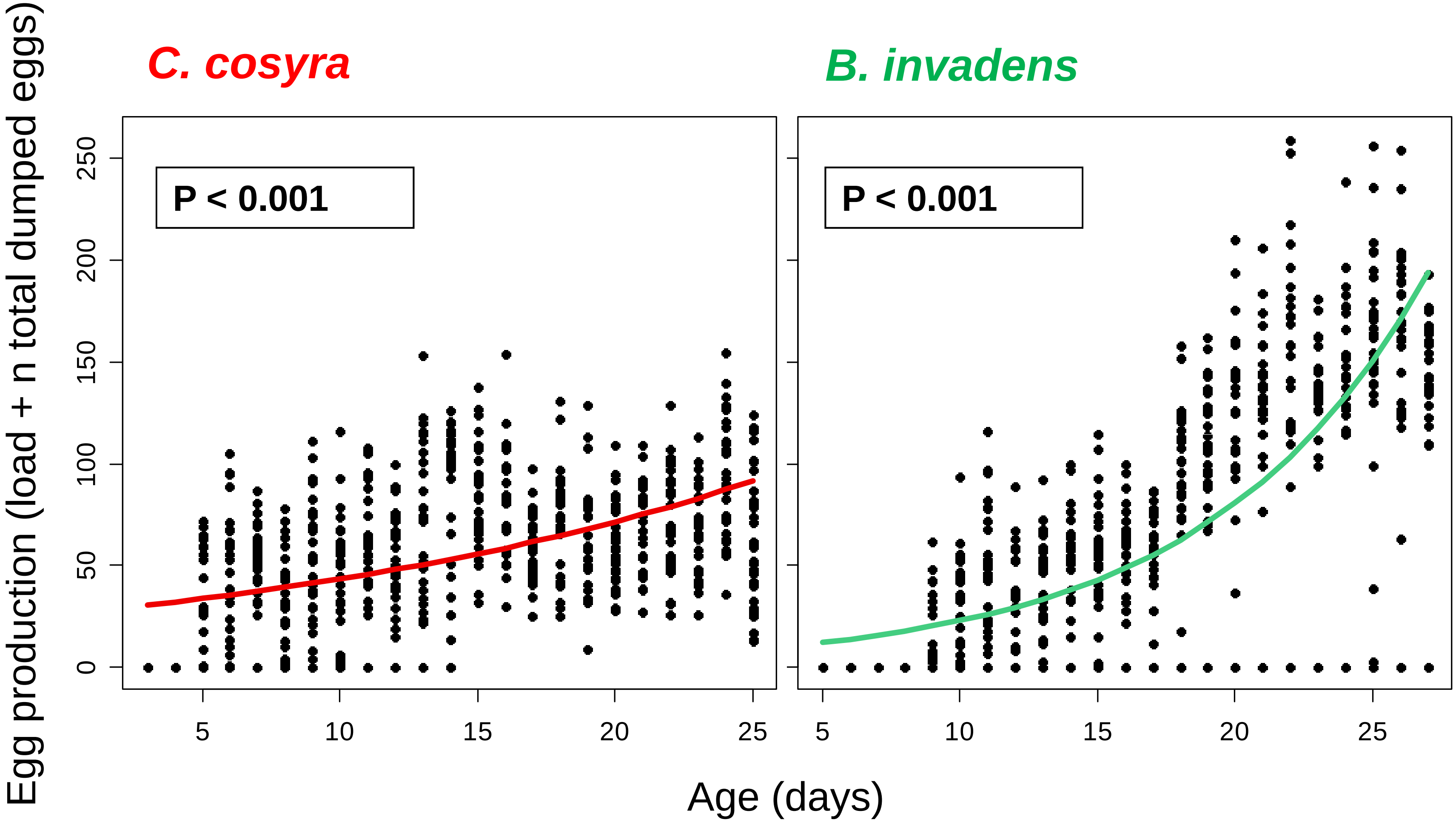
- ❖ Extreme polyphay
- ❖ Lack of co-evolved natural enemies
- ❖ Conducive environ. conditions in Africa.
- ❖ Availability of host/alternative around the year
- ❖ Lack of competitors

B- Behavioural factors

- ❖ high mobility and dispersive powers
- ❖ strong competitor- displaced native fruit flies species
- ❖ Wide adaptability to new environments

High reproductive rate

Effect of age on egg production



Migani et al .J. Appl, Entomolgy accepted

Extreme polyphagy

Host plants (41 hosts in 22 families) – 75 non-infested	*B. invadens* /kg fruit
Garcinia mannii, Terminalia catappa, Ziziphus mauritiana, Irvingia gabenensis, Syzigium jambo	60-88
*Erioborya japonica, Ficus sycomorus, Sclerocarya birrea, Psidium guajava, **Mangifera indica**, Vitellaria paradoxa*	10-22
Diospyros Montana, Saba senegalensis, Maerua duchesnei, Syzigium malaccense, Chrysphyllum albidum, Citrus limon, C. sinensis, C. x paradisi, Citrullus colcynthis, , Annona senegalensis, Lycopersicon esculentum, Citrullus lanatus, Capscium frutescens, Cucurbita maxima	1-9
Momordica charantia, C.reticulata, Persea americana, Blighia sapida, Spondias mombin, Averrohoa carambola, anacardium occidentale, Annona muricata, Cucurbita pepo, Cucumis sativus, Musa x paradisiaca, Sarcocephalus laifolius, Carica papaya, Spondias cytherea, Lagenaria siceraria	< 1

Rwomushana, Ekesi et al (2010) Ann. Ent. Soc. America 101(2): 331-340

Lack of co-evolved natural enemies/lab data

Host species	Parasitoid species					
	P. cosyrae		*P. phaeostigma*		*T. giffardii*	
	Accept	**suit**	**Accept**	**suit**	**Accept**	**suit**
C. capitata	++	+	++	++	++	++
C. cosyra	++	++	+	++	++	+
C. rosa	+	-	+	-	++	-
C. fasciven	+	-	+	-	++	-
C. anonae	+	-	+	-	++	-
B. curibate	+	-	++	-	++	-
D. ciliatus	**NT**	**NT**	++	++	++	++
B. invadens	+	-	+	-	++	–

Strong competitor- displaced native fruit flies species

❖ 34430 Kg of host fruits of *B. invadens* sampled from East/ West Africa

No single parasitoid recovery

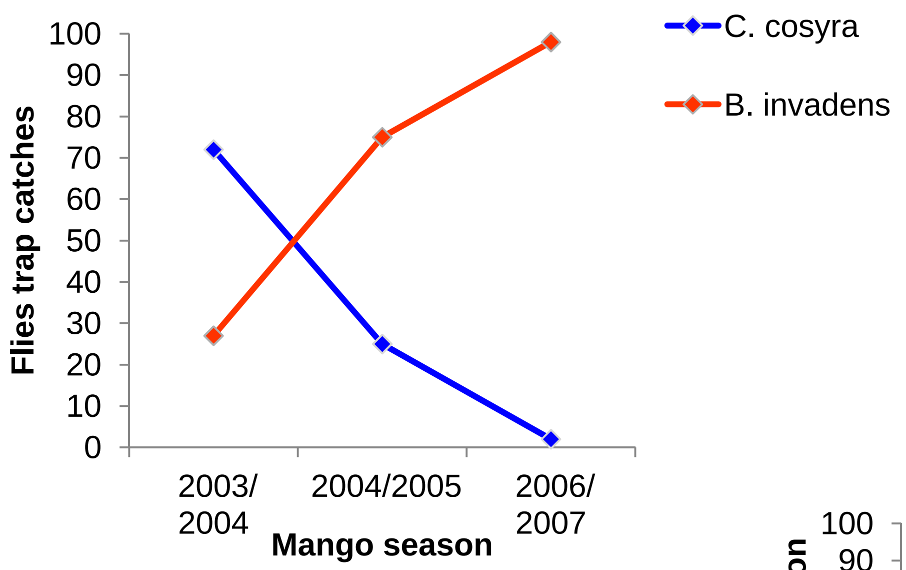
Parasitism of *C. cosyra* and B. *invadens* in Marula

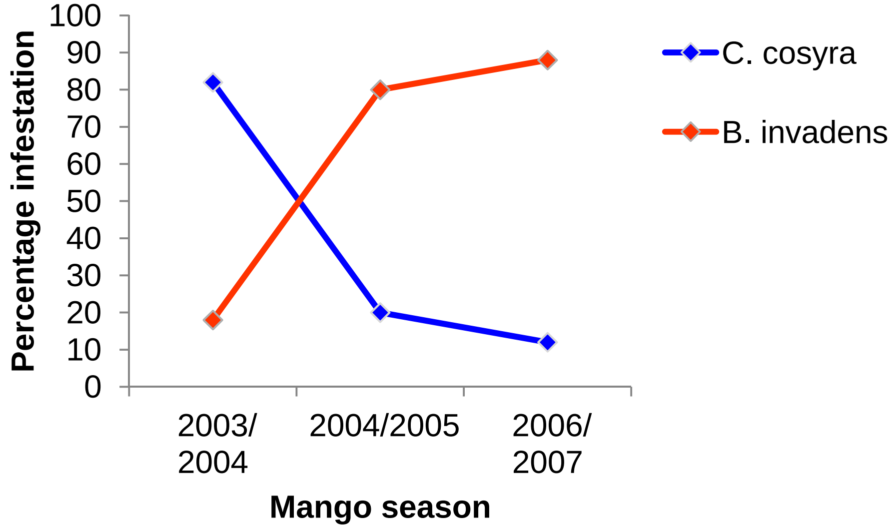
Year	No. fruit	Fruit wt (Kg)	Total No. pupae	No. of Cc pupae	No. of Bi pupuae	No. of Pc	% parasitism
2000	150	3.1	215	152	-	12	5.58
2001	61	1.3	132	38	-	4	3.03
2002	203	3.9	182	101	-	10	5.49
2003	94	1.7	112	54	18	1	0.89
2004	107	2.0	135	41	60	0	0.0
2005	344	6.8	272	54	148	0	0.0
2006	-[a]	-	-	-	-	-	-
2007	156	3.0	208	60	96	0	0.0
2008	338	6.1	256	42	132	0	0.0

Strong competitor- displaced native fruit flies species

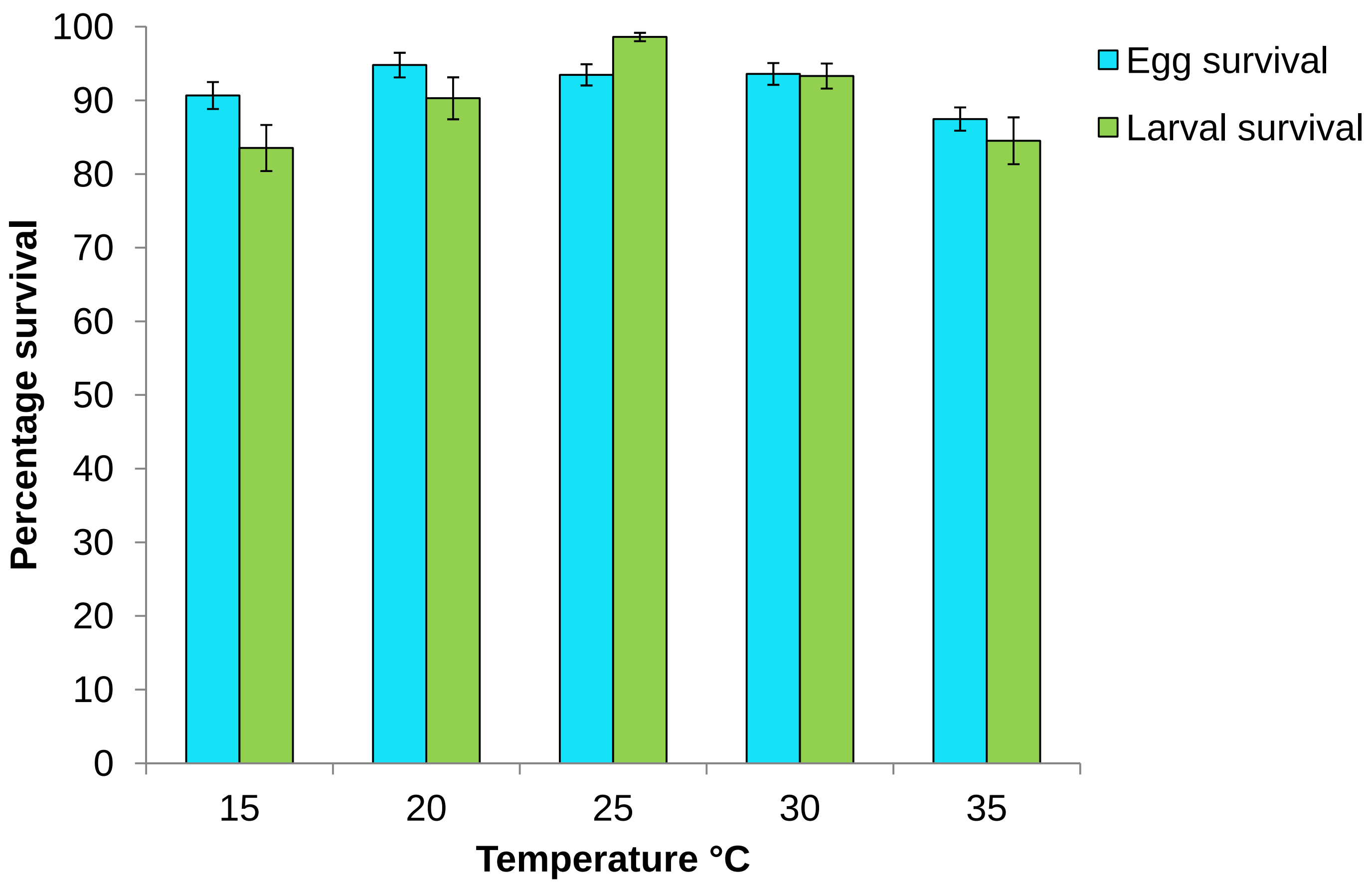
Temp.(°C)	Infestation sequence	Total puparia	No. of adult flies	
			B. invadens	*C. cosyra*
15	Infested the same day	22.0	3.8	Nil
	B 1 day before C	16.0	8.4	Nil
	B 2 days before C	18.3	6.2	Nil
	B 3 days before C	15.0	9.2	Nil
	C 1 day before B	16.0	2.2	Nil
	C 2 days before B	17.6	3.4	Nil
	C 3 days before B	8.0	2.2	Nil
20	Infested the same day	26.0	8.0	1.3
	B 1 day before C	16.5	7.8	Nil
	B 2 days before C	19.8	13.0	Nil
	B 3 days before C	16.4	11.4	Nil
	C 1 day before B	25.3	8.2	15.0
	C 2 days before B	24.6	9.8	12.6
	C 3 days before B	16.4	2.5	13.0
25	Infested the same day	27.0	12.6	2.8
	B 1 day before C	19.3	11.2	1.0
	B 2 days before C	27.3	14.2	1.0
	B 3 days before C	20.0	12.2	1.0
	C 1 day before B	30.6	15.0	14.2
	C 2 days before B	25.0	15.6	7.4
	C 3 days before B	26.5	16.6	8.6
30	Infested the same day	16.3	6.8	1.3
	B 1 day before C	21.6	10.2	2.7
	B 2 days before C	17.2	11.0	1.5
	B 3 days before C	16.6	10.6	1.0
	C 1 day before B	18.6	7.6	2.0
	C 2 days before B	19.4	10.2	3.4
	C 3 days before B	17.8	10.4	3.8

Strong competitor- displaced native fruit flies species/Field data

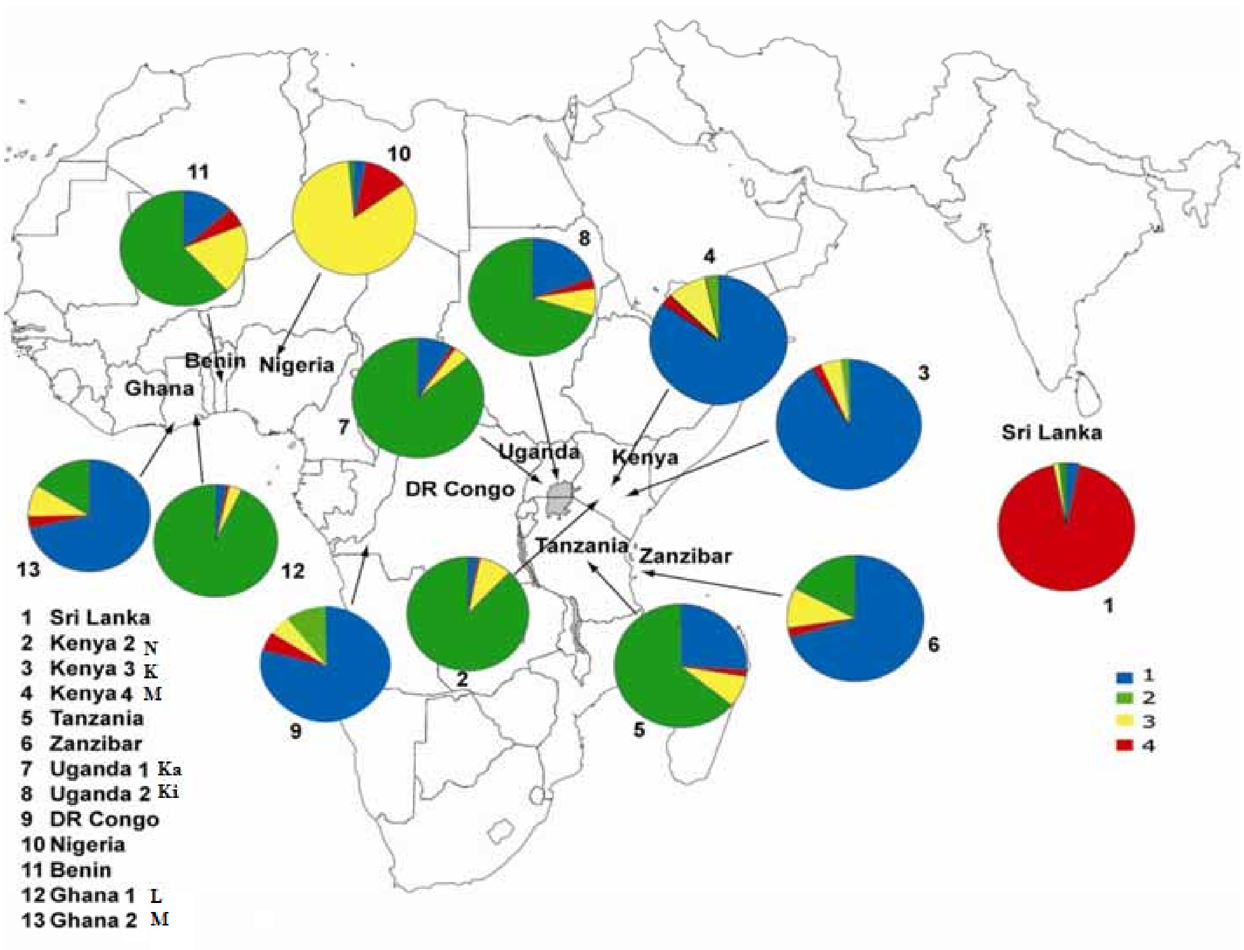




Wide adaptability to new environments



Invasion history of B. invadens

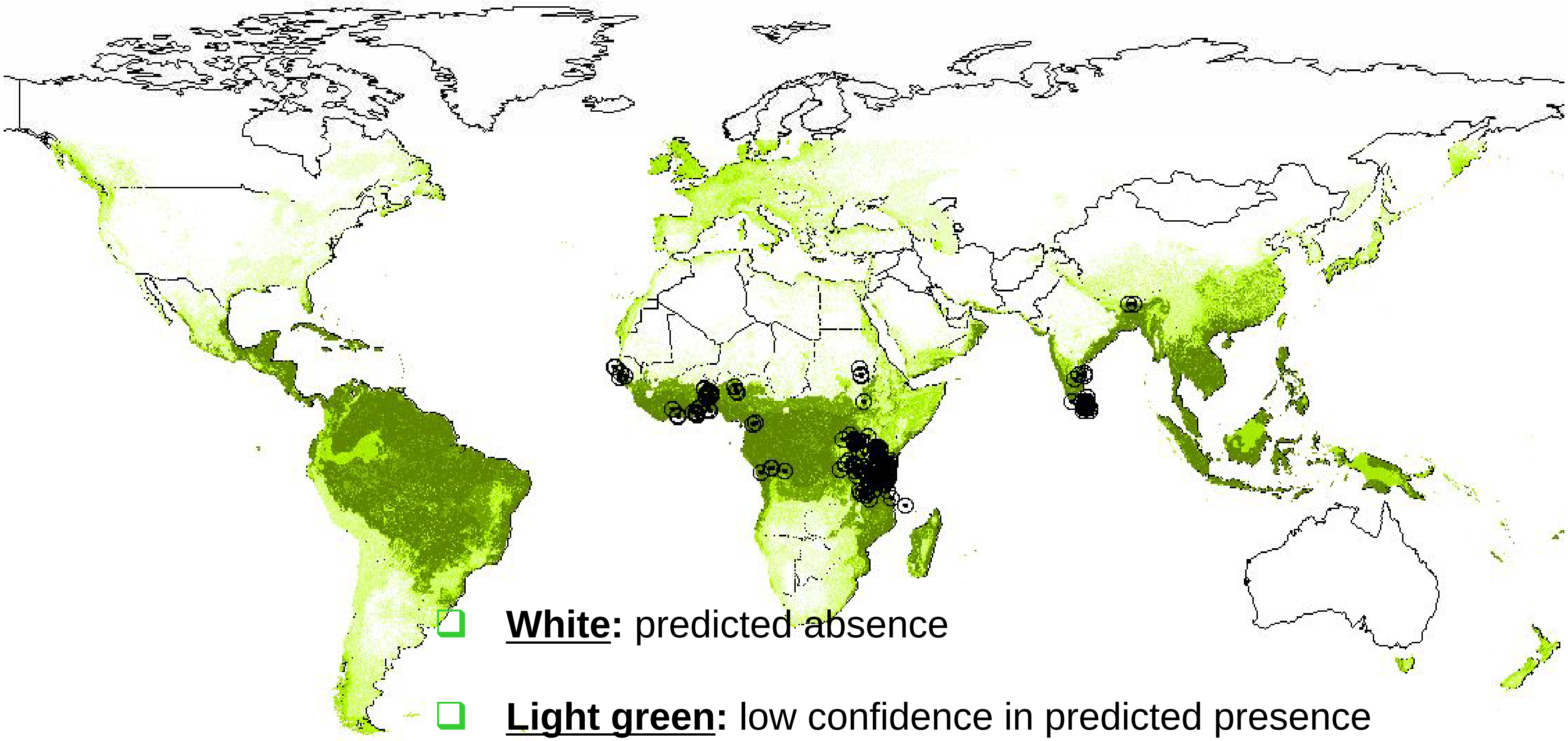


Factor s contributing to the risk of fruit flies invasion in the Near East countries

- Globalization and liberalization of trade

- Ever-growing tourism
- Fragile nature of the quarantine infrastructures
- undertrained phytosanitary personnels in Africa and Near East countries.

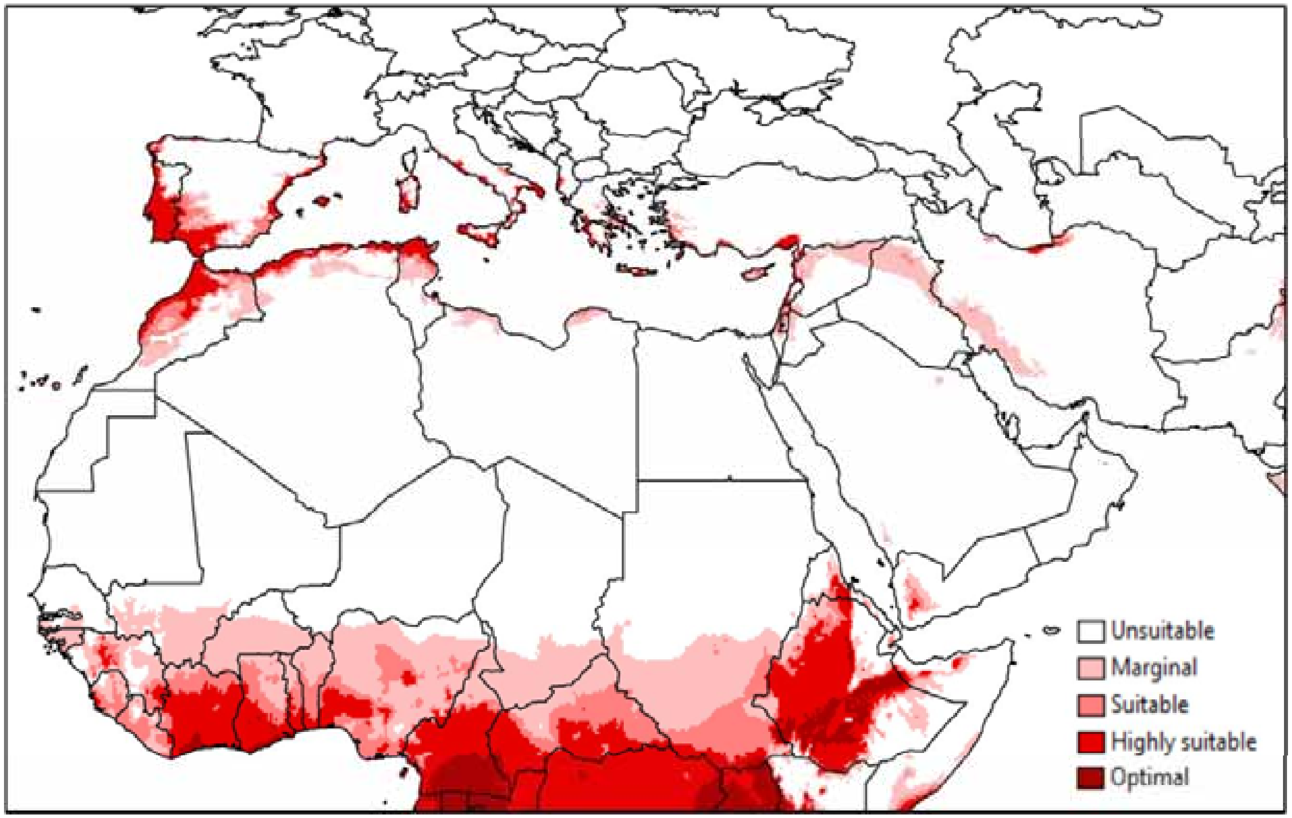
Prediction of etablishemnet of B. invadens in the Near East countries



- **<u>White</u>:** predicted absence
- **<u>Light green</u>:** low confidence in predicted presence
- **<u>Green</u>:** high confidence in predicted presence
- **<u>Dark green</u>:** higher confidence in predicted presence

De Meyer, Ekesi et al. (2010) Bull. Ent. Res. 100: 35-48

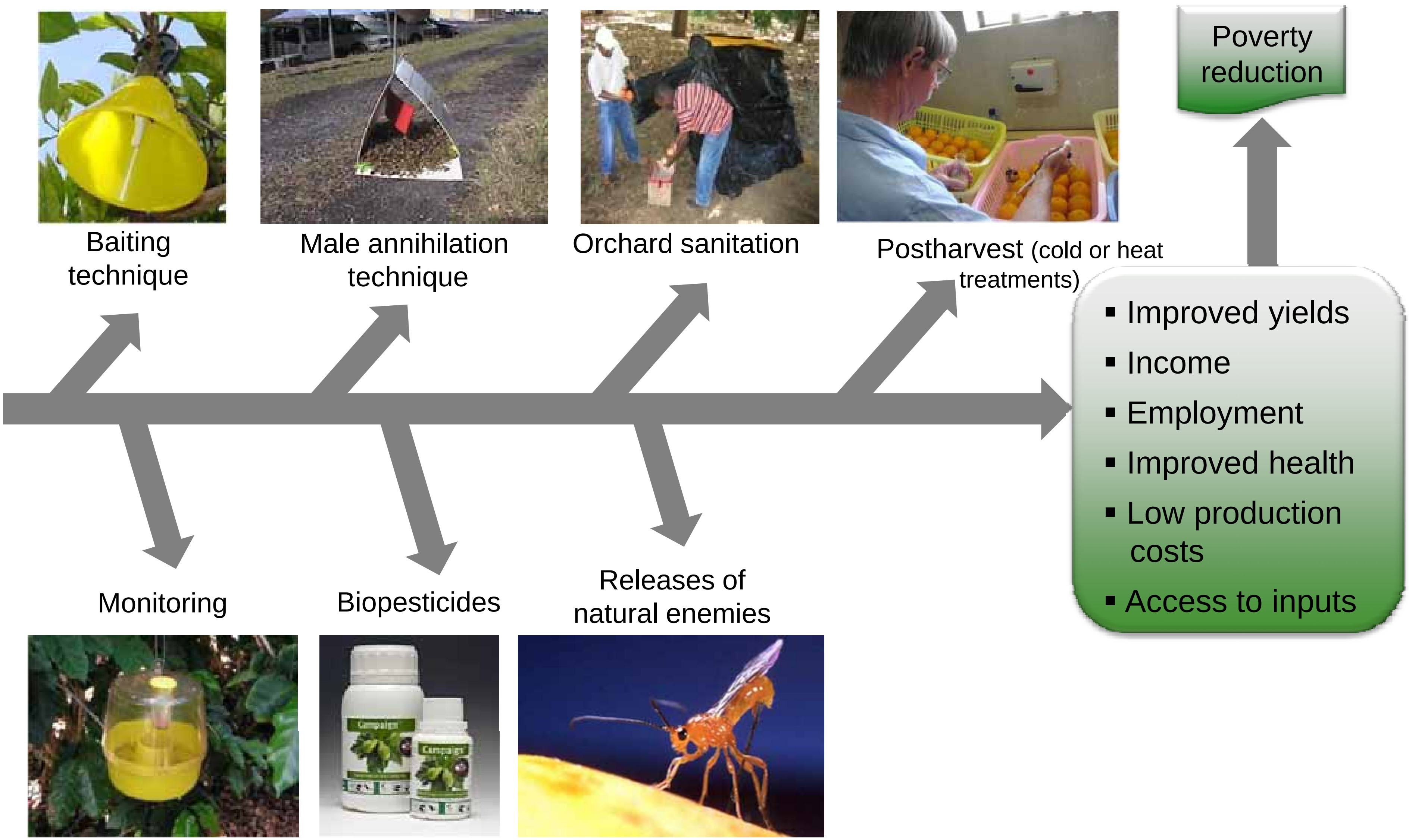
Predictions of establishment of C. rosa in the Near East



De Villiers (2012) Bull. Ent. Res. (Available on CJO doi:10.1017/S0007485312000454)

Management options, *icipe experience*

proven management measures for fruit flies

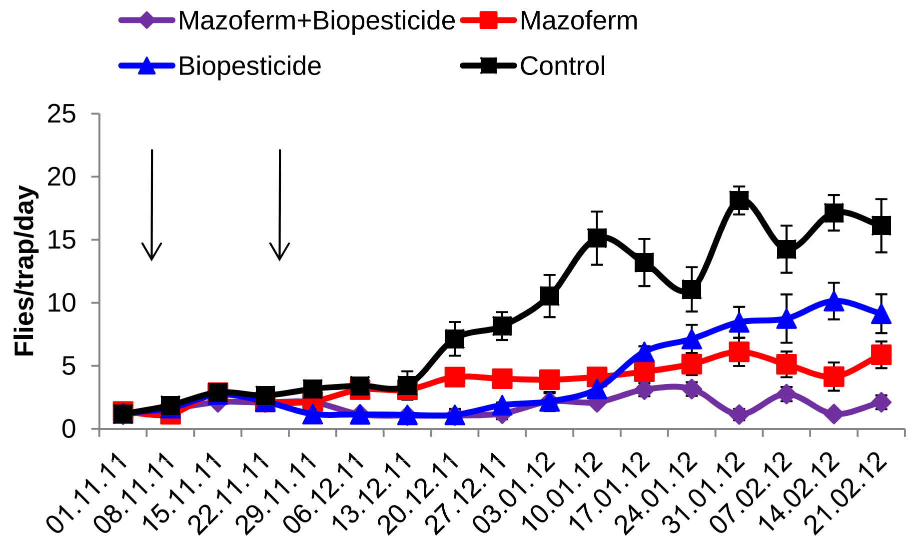


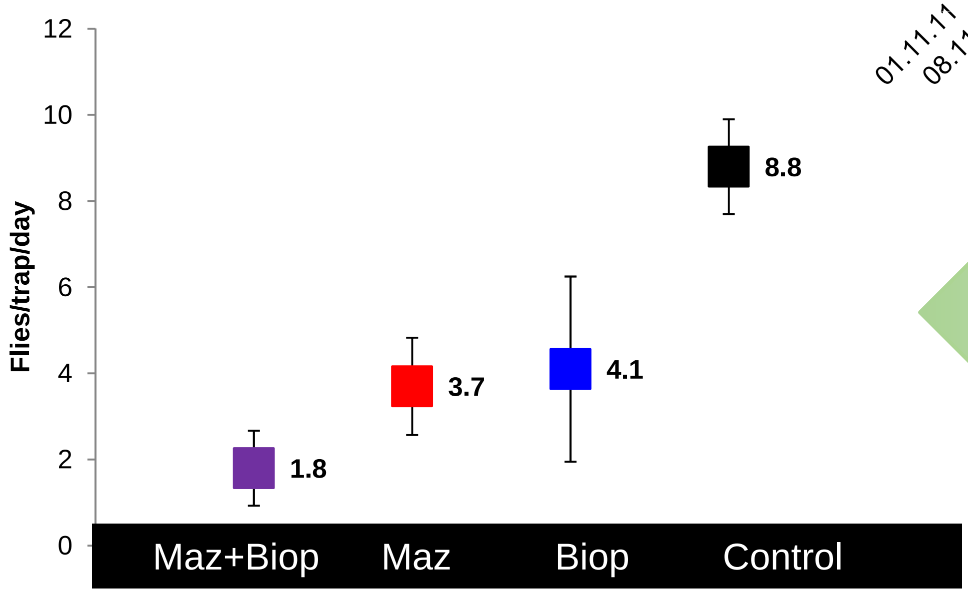
intervention impact on fruit flies

Participatory suppression trials with mango growers at Nthagaiya (Kenya)

Treatments evaluated

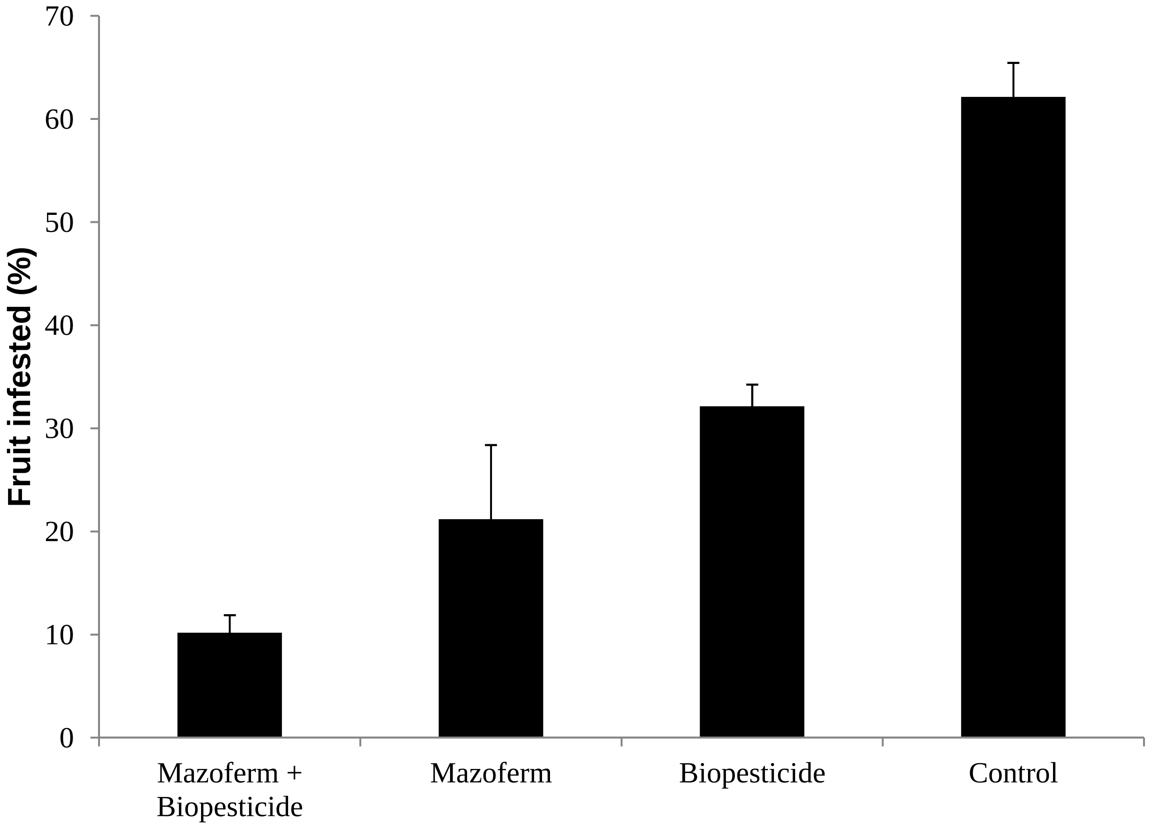
1. Mazoferm+biopesticide
2. Mazoferm alone
3. Biopesticide alone
4. Control





Average catches over season

intervention impact - fruit infestation



Ekesi et al (2011) Biocontr. Sci. Tech. 21 (3) 299 – 316

marketable mango yield & monetary value

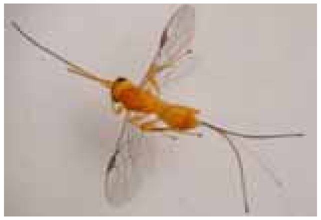
Treatments	Yield (kg/ha)	% Yield gain	Monetary gain (US$/ha)*
Maz+Biop	17,765	82.4	3514.6
Mazoferm	12,876	75.8	2341.2
Biopesticide	10,114	69.1	1678.3
Control	3121		

* Monetary gain based on 2011 farmgate mango buying price of $0.24/kg

parasitoid complex in Sri Lanka

7 parasitoid species emerged: 1,376 of the total of 13,802 puparia; highest % in *S. mauritianum* (33.7%)

Fopius arisanus

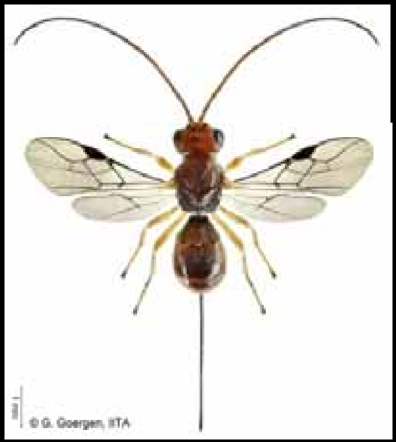


Diachasmimorpha longicaudata

***Spalangia* sp.**

Parasitoids	Plant species
Fopius arisanus	***S. mauritianum*, Mango**
D. longicaudata	***S. mauritianum*, Mango, Banana**
Psyttalia incisi	***T. catappa*, *S. mauritianum*, Mango**
P. fletcheri	***L. acutangula*, *Momordica charantia***
Fopius sp.	***S. mauritianum*, Mango**
Tetrastichus sp.	***S. mauritianum*, Mango, Guava**
Spalangia sp.	***S. mauritianum*, Mango, Guava**
Trichopria sp.	***S. mauritianum*, Mango, Guava**

importation of natural enemies from Hawaii



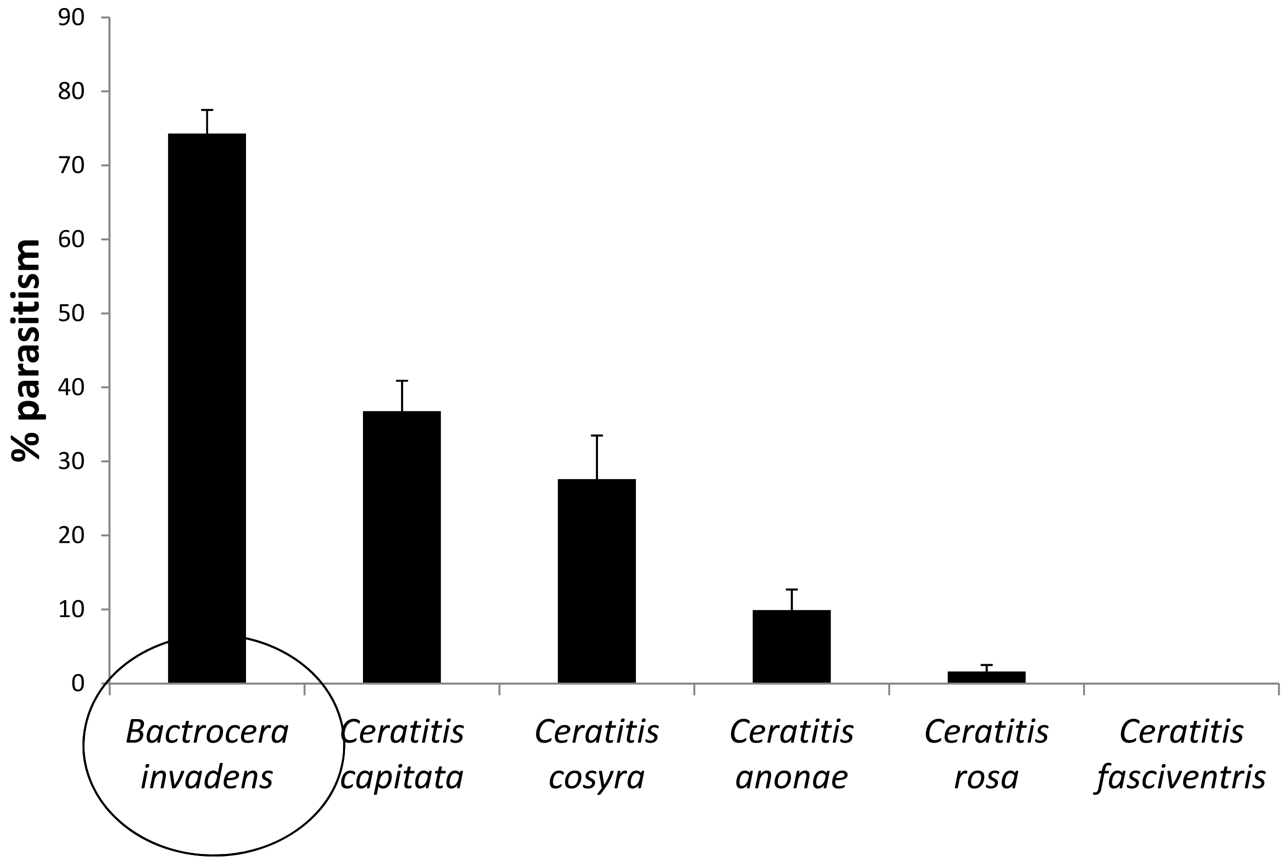
Fopius arisanus

Diachasmimorpha longicaudata

- Both introduced from Hawaii
- Koinoboints
- Credited with outstanding successes in fruit fly biocontrol

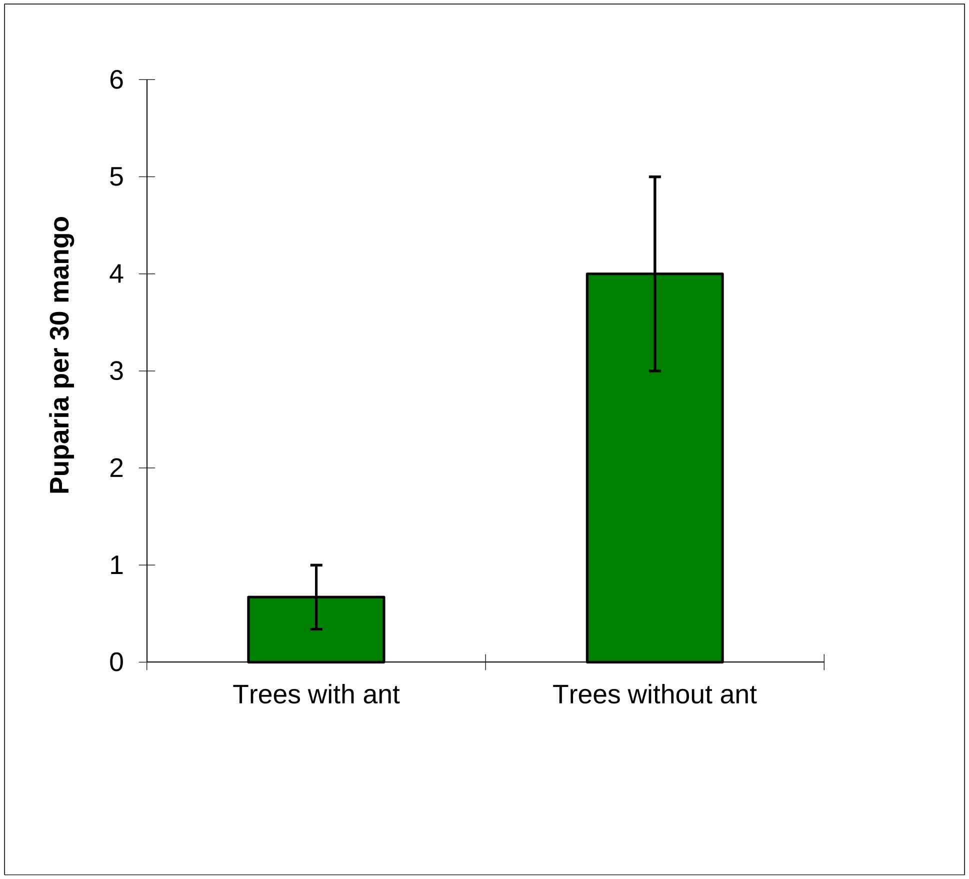
impart of F. arisanus on fruit flies

Fopius arisanus



Mohamed, Ekesi et al. (2011) Biocontr. Sci. Tech. 10: 183-196

Fruit fly management using predatory Weaver ant *Oecophylla longinoda*



Van Mele et al 2007. J. Econ. Ent. 100: 695-701

How ant contribute to the managemnet of Fruit flies

- Disrupt fruit fly egg laying on the fruit
- Disrupt fruit fly mating
- The pheromone act as oviposition deterrent
- Prey on the puparia and puparting larvae.
- Prey on newly emerged flies

post harvest treatment - citrus

Large scale *B. invadens* dis-infestation trials on **Valencia orange** for at 1.1^{0}C for 16 days (2 replications)

Parameters	Control	Treated
No. fruits	1023	4108
No. larvae alive	9619	3
No. larvae dead	456	40,150
Total larvae	10,075	40,153
% larval mortality	4.526	99.9925
% corrected mortality	-	99.9921*

***Probit-9 requirement is 99.9968% mortality**

Grout, Ekesi et al. (2011) J. Econ. Entomol. 104 (4): 1180-1188

Post harvest treatment - citrus

Large scale *B. invadens* dis-infestation trials on **Valencia orange** for at **0.5^{0}C** for 16 days (3 replications)

Parameters	Control	Treated
No. fruits	1649	7379
No. larvae alive	11,059	0
No. larvae dead	1053	65,752
Total larvae	12,112	65,752
% larval mortality	8.1	100
% corrected mortality	-	100*

***Probit-9 requirement is 99.9968% mortality**

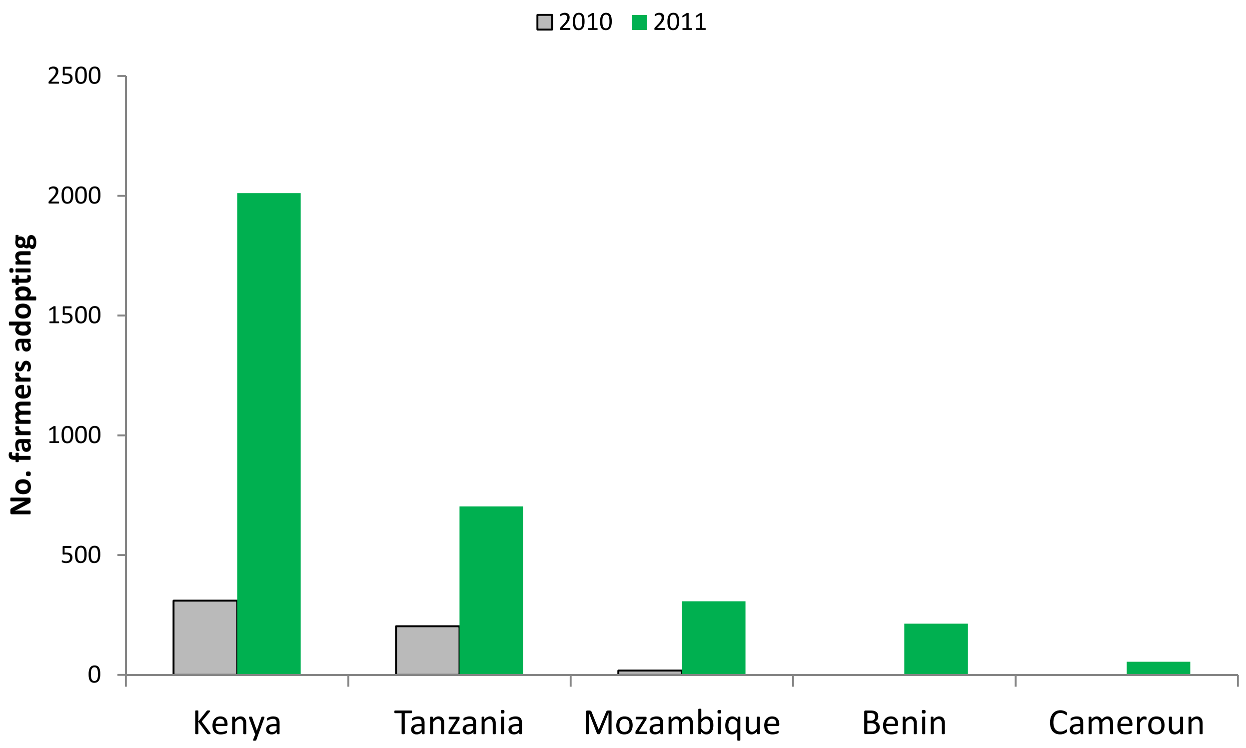
Grout, Ekesi et al. (2011) J. Econ. Entomol. 104 (4): 1180-1188

technology transfer

- Hands-on ToT to extentionists
- Field days organised to expose growers to the technology

- Distribute leaflets and posters on various aspects of fruit fly management distributed
- Radio & TV programmes on fruit fly management

Farmers adoption of technologies



Lessons and challenges

- Single bullet management approach is inefficient
- Work with successful functional farmers group to help technology diffusion
- Standard required for export market should increase adoption of new technologies
- The fragmented nature of the production systems (Area-wide)
- Funding is crucial to large-scale roll out of the technologies
- Expand and sustain quarantine surveillance
- Quarantine expertise needs to be regularly updated
- Stockpiles of materials for response action backed up financial resources, and proper legislative backing

Acknowledgement

- Donors
  - BMZ
  - FAO
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