Biological Pest Control in Tillage Crops?

Potentially how useful are new biological products for field crops

ITLUS Winter Conference, Dec 7th 2017

Dr Michael Gaffney

Senior Research Officer, Entomology & Horticulture,
Horticulture Development Department, Crops, Environment and Land Use Programme, Teagasc Ashtown

Email: Michael.Gaffney@teagasc.ie Tel: 018059781 Twitter: @Mick_Gaffney

Introduction

- Why Biologicals?

'*Estimated that 50% of PPP's registered in EU by 2020 will be 'Biological' in nature*'

Development of aspects related to the development and application of chemical and biological control*

	Chemical Control[a]	Biological Control[b]
Number of 'ingredients' tested	>3.5 million	3,500
Success ratio	1:140,000	01:10
Developmetal Costs ($USm)	256	2
Developmental Time (Yrs)	10	10
Benefit / Cost ratio	2:1	2:5-20:1
Risks of resistance	Large	Nil / Small
Specificity	Small	Large
Harmful Side-effects	Many	Nil / Few

[a] McDougall (2010), Pimentel et al. (1980), Pimentel, (2009)
[b] Bale et al. (2008), Pimentel et al. (1980), Pimentel, (2009)

* **Van Lenteren, J.C. (2012)** BioControl 57:1-20

Introduction

- Why Biologicals?

‘*Estimated that 50% of PPP’s registered in EU by 2020 will be ‘Biological’ in nature*’

- Adoption of Biological Pest Control in the Horticulture sector
- Review some forms of Biological Products
- Potential Constraints and Opportunities

Adoption of BCA's in Irish Horticulture

Current Adoption

Glasshouse Crops
(Tomatoes, Peppers, Herbs) → Use of Predators and Parasitoids widespread

Semi-Protected Crops
(Strawberry, Ornamental Plants) → Nematode use widespread, some adoption of Predatory mites / Beneficial's

Field Vegetables
(Brassicas, Root Crops) → No BCA products routinely used, several available. Use of Nets common

What has driven the adoption of BCAs in Horticulture?

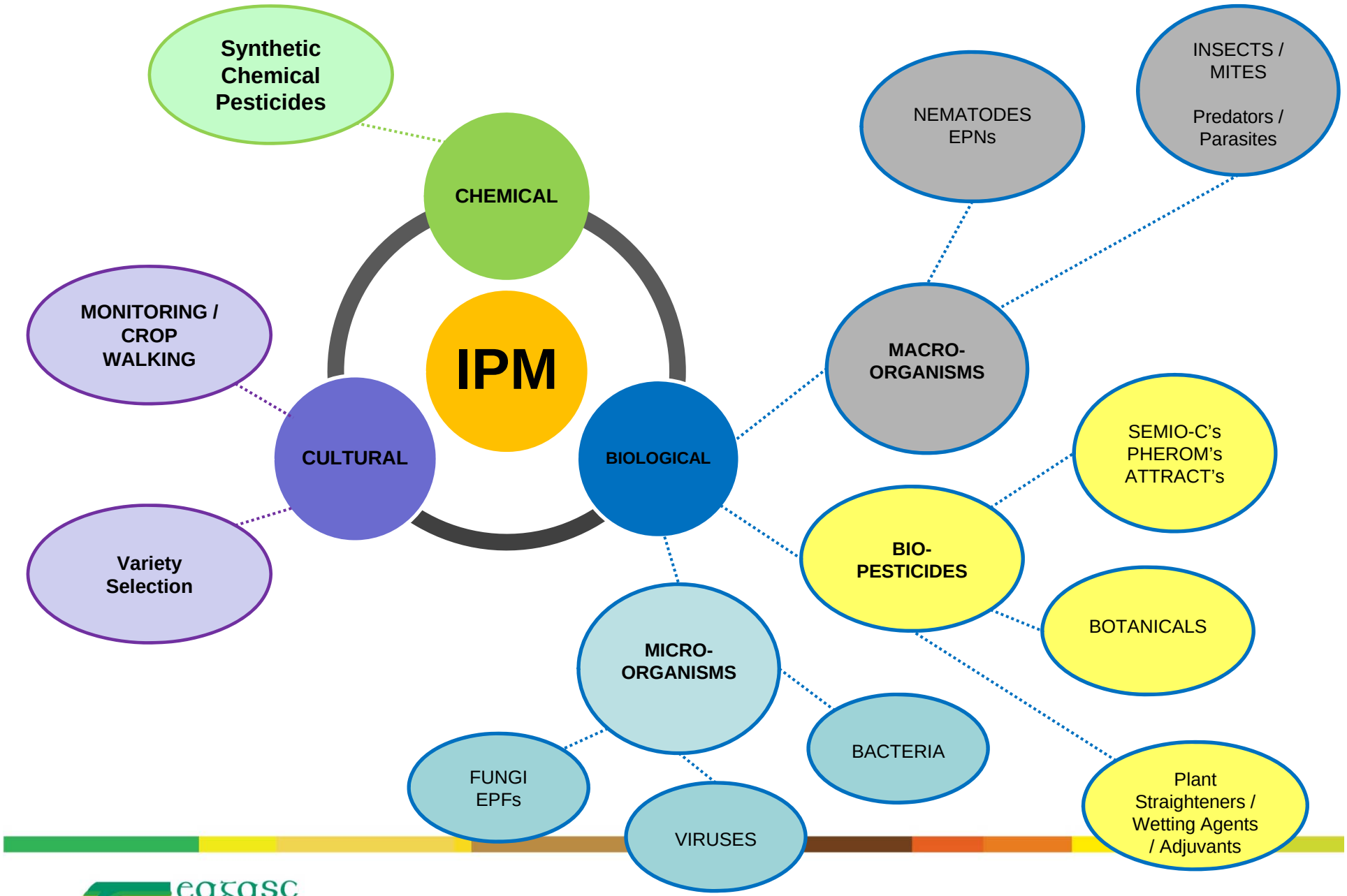
- Reduction in the availability of PPPs (*Directive 91/414/EC*)
- Consumer acceptance *(MRLs, Retailer 'Guidelines')*
- Better knowledge of Pest and Predator/ Parasitoid Biology
- Agronomic advances (*Better Technologies, Increased Yields*)

Pest control challenges ahead as major insecticide is banned

Wednesday 24 February 2016 7:01 Oliver Hill

The loss of key insecticide chlorpyrifos means cereal growers are facing an uphill struggle to protect cereal crops from wheat bulb fly and orange blossom midge this season, and beyond.

Earlier this month the withdrawal of products containing the chlorpyrifos active ingredient, which includes Dursban, Pryinex and Ballad, was announced by the Health and Safety Executive (HSE).


Synthetic Chemical Pesticides
CHEMICAL
IPM
MONITORING / CROP WALKING
CULTURAL
Variety Selection
BIOLOGICAL
MACRO-ORGANISMS
NEMATODES EPNs
INSECTS / MITES
Predators / Parasites
BIO-PESTICIDES
SEMIO-C's PHEROM's ATTRACT's
BOTANICALS
Plant Straighteners / Wetting Agents / Adjuvants
MICRO-ORGANISMS
BACTERIA
FUNGI EPFs
VIRUSES

(1) Macroinvertebrates

Most important (commonly used) invertebrate biological control agents*

Rank	Biological control agent	Family	Target(s)	No. of countries where used	Year of first use
1	*Amblyseius swirskii*	Phytoseiidae	Whiteflies, Thrips, Mites	>20	2005
2	*Aphidius colemani*	Braconidae	Aphids	>20	1991
3	*Aphidoletes aphidimyza*	Cecidomyiidae	Aphids	>20	1989
4	*Dacnusa sibirica*	Braconidae	Leafminers	>20	1981
5	*Diglyphus isaea*	Eulophidae	Leafminers	>20	1984
6	*Encarsia formosa*	Aphelinidae	Whiteflies	>20	1926
7	*Macrolophus pygmaeus*	Miridae	Whiteflies	>20	1994
8	*Neoseiulus cucumeris*	Phytoseiidae	Thrips	>20	1985
9	*Phytoseiulus persimilis*	Phytoseiidae	Mites	>20	1968
10	*Steinernema feltiae*	Steinernematidae	Sciarids	>15	1984

* **Van Lenteren, J.C. (2012)** BioControl 57:1-20

Worldwide use of major augmentative biological control programs*

Natural Enemy	Pest and crop	Area under control (million Ha)	Countries
Trichogramma spp.	Lepidoteran pests in Veg, Cereals and Cotton	10	fromer USSR
Trichoderma spp.	Soil diseases various Crops	5	Brazil, Europe
Trichogramma spp.	Lepidoteran pests in various crops, forests	4	China
Cotesia spp.	Sugarcane borers	3.6	S. America, China
Metarhizium anisopliae	Lepidopteran pests in sugar cane	2	Brazil
Trichogramma spp.	Lepidopteran pests in corn, cotton, sugarcane, tobacco	1.5	Mexico
Trichogramma spp.	Lepidopteran pests in cereals, cotton, sugarcane, pastures	1.2	S. America
AgMNPV	Soybean caterpillar in soybean	1	Brazil
Beauveria bassiana	Coffee berry borer in coffee, whitefly in several crops	1	Brazil
Trichogramma spp.	Ostrinia nubilalis in corn	0.05	Europe

*** van Lenteren et al., 2017, BioControl** DOI 10.1007/s10526-017-9801-4

Potential for Macroinvertebrate applications to field crops?

- Already being conducted at some level (0.6% of Cultivated Land)
- New application technologies offer potential for effective '*spot treatment*'
- Improvements in production technologies critical
- Improvements in '*early warning*' systems needed
- The need to build '*control networks*'

(2) Entomopathogenic Nematodes

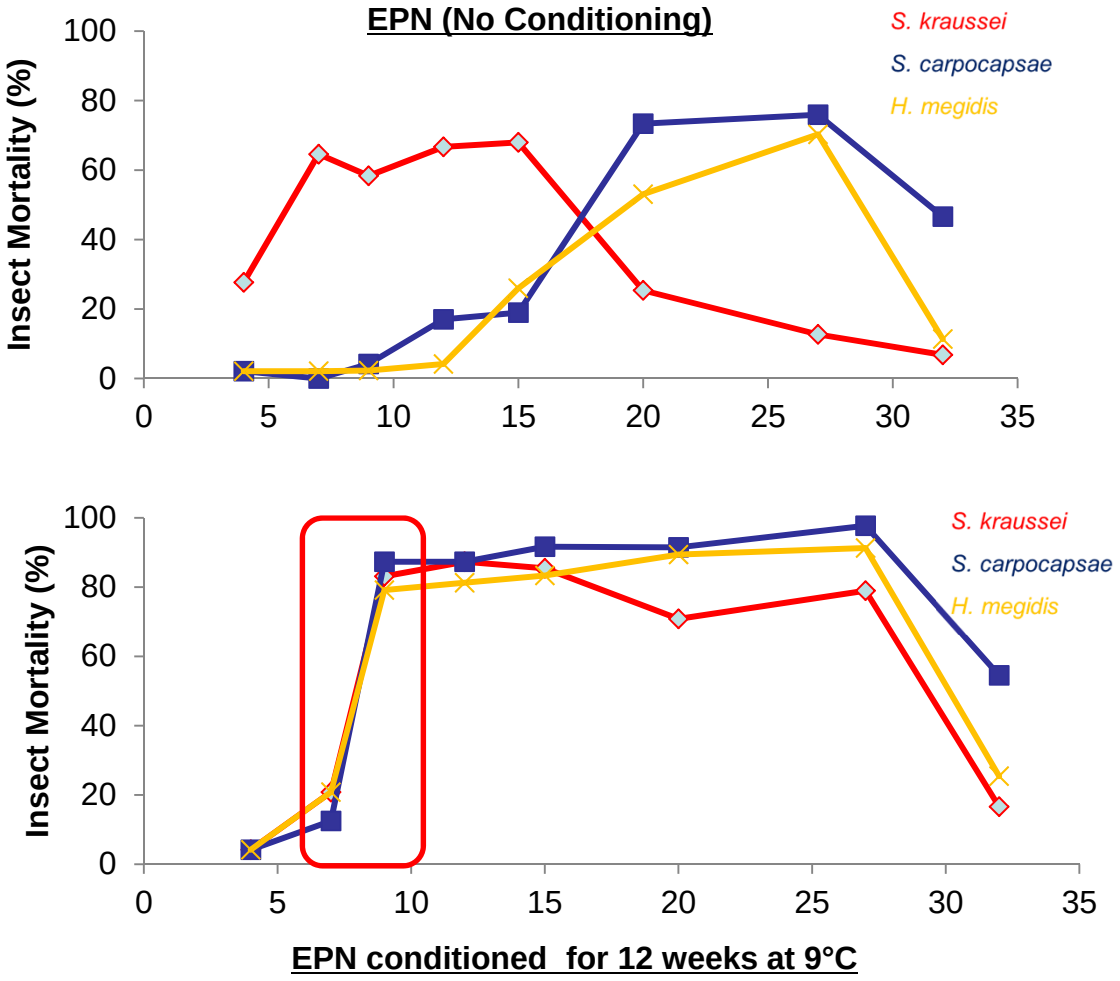
Widely used to control:

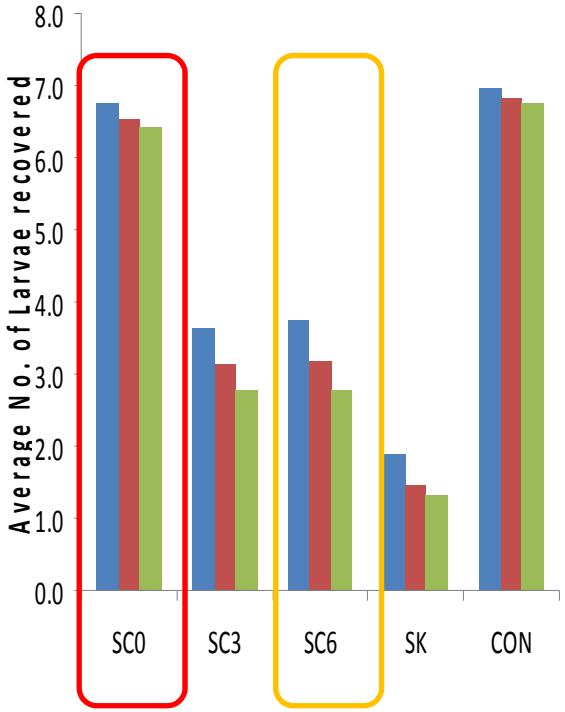
- Vine Weevil – Strawberry, HNS
- Sciarid Flies – Mushroom
- Weevil Pests – Forestry
- Chafers – Turf Grass

Constraints:

- Generally require temperatures above 10 ^{o}C
- Contact with pest is key

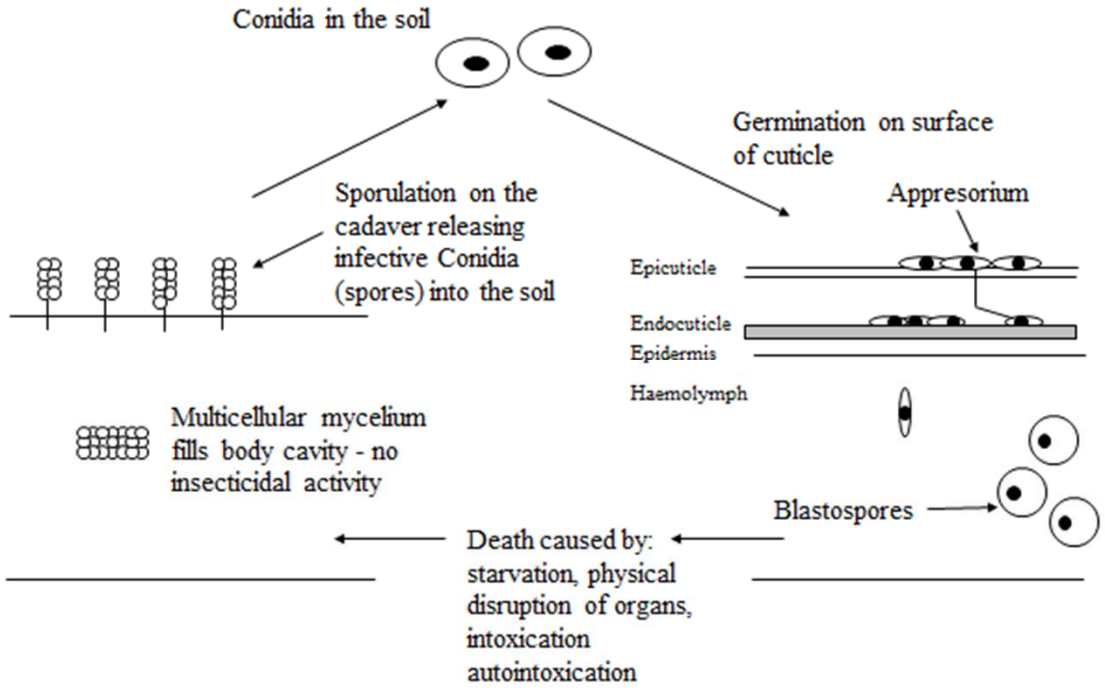
Effect of nematode 'conditioning' on virulence (% insect mortality) of 3 EPN species



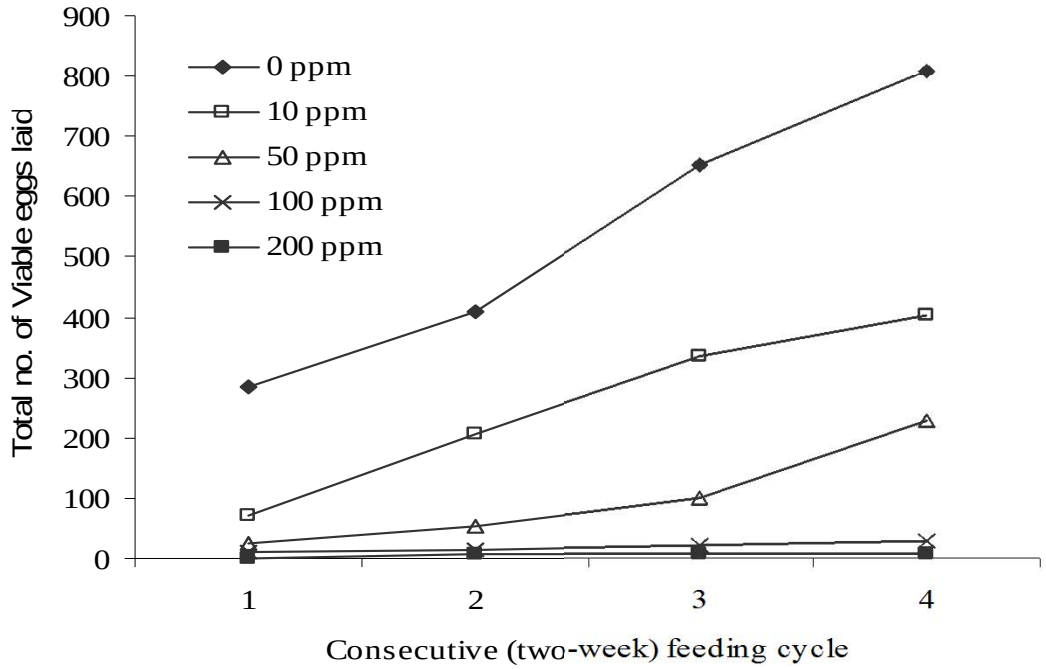


Guy et al., 2017, ***Biological Control***

(3) Entomopathogenic Fungi



(3) Botanicals

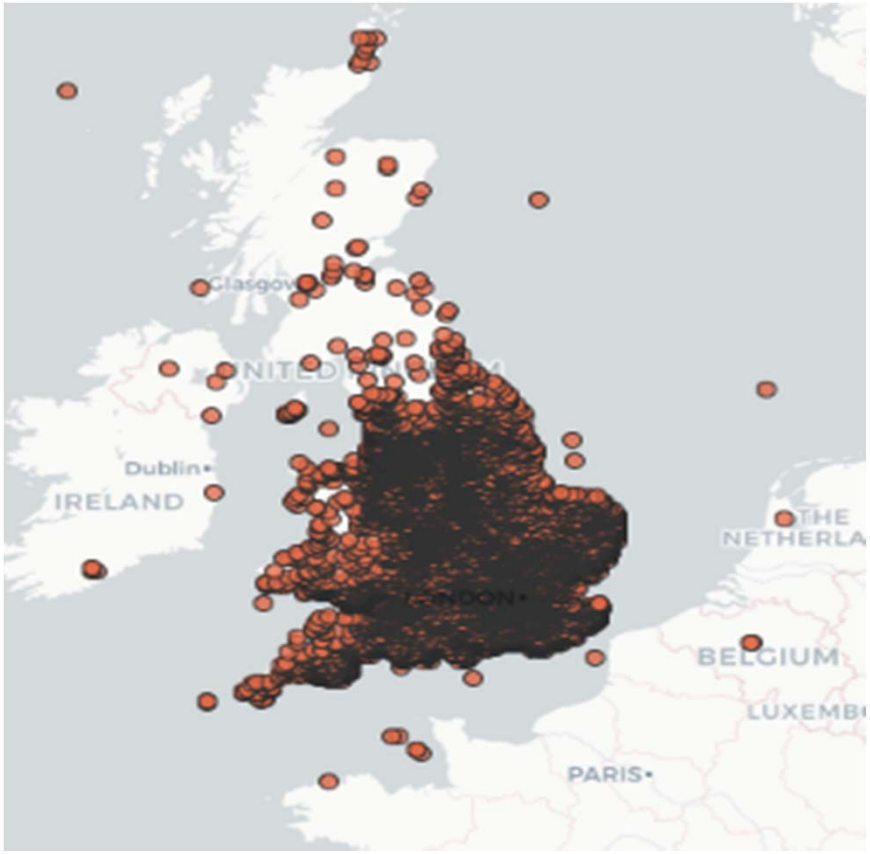


Potential for bio-pesticide applications to field crops?

- Entomopathogenic nematodes have some potential for application in field crops - demonstrated ability on important pests
- Temperature constraints for Entomopathogenic Fungi
- Advances in the field scale application technology of these products is promising
- Potential to access more botanical products (125 EU v 400+ US)
- Advances in the field scale application technology of these products is promising
- Cost and Efficacy will be a constraint

Potential issues with Biological control agents

- *High specificity*
- *Slow to act*
- *By 2010 there have 7000 introductions of exotic arthropod pests in 196 countries*
- *Harmonia axyridis*



Acknowledgment: https://records.NBNAtlas.org

Conclusions

- Economics need to make sense - Crisis will create opportunity
- Although the oldest form of crop protection, Biological Control is still in its commercial infancy
- Recent investments by large crop protection companies has made more products available
- Realistically there is limited potential for biological products in field crops
- New technologies needed for BCAs (RNAi, Crispr gene editing), but most likely will compliment them
- Continued pressure on reducing MRLs in food crops will see an increase in alternative pest control strategies

Thank You

Acknowledgements:

Prof Christine Griffin & Mr Adam Guy, Maynooth University
Dr Gordon Purvis, UCD
Prof Gerben Messelink, Wageningin (Slides 10&11)