EWRN

European Wireworm Research Network

The European Wireworm Research Network

1st Workshop

July 7th 2024
Oslo, Norway

Country Updates: 1st EWRN Workshop

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[Norway by Annette FS (NIBIO)]

NIBIO
NORSK INSTITUTT FOR BIOØKONOMI

Wireworms at the northern margin of potato production in Europe – updates from Norway

Annette Folkedal Schjøll • EWRN wireworm workshop • Oslo, 7. July 2024

Wireworms on the rise in Norway…

- Just a few species considered agricultural pests
- Observed increasing damage to potato due to wireworms
- Wireworm project , 2019-2022
  «Improved Monitoring and Control of wireworms in Norwegian potato production»
  - Species involved and damage caused by wireworms
  - Knowledge on potato cultivars less prone to damage
  - Crop rotation and decision support system
  - Alternative biocontrol method for direct control in field (ATTRACAP™)

Adult click beetles, *Agriotes obscurus*

Wireworm belonging to *Agriotes*

Forskningsmidlene
for jordbruk og matindustri

Photo: A.F.Schjøll & E. Fløistad, NIBIO

NIBIO

Improved Monitoring and Control of wireworms in Norwegian potato production

Project period: 1.3.2019 – 31.12.2022

Funding: «Forskningsmidlene for jordbruk og matindustri (FFL/JA)» the Ministry of Agriculture and Food in Norway, the Potato Industry by BAMA, Gartnerhallen SA og potato producers (tot. 7.0 mill NOK, 20% from the potato industry)

Partners: NIBIO, NMBU, BAMA, Gartnerhallen, NLR, potato producers (A. Holen, E.L-R. Lunden, J.E. Ruud)

International project participants: Dr. Robert Vernon, AAFC (Canada); Prof. Dr. Stefan Vidal, Georg-August-University (Germany); Michael Kastenbutt, Biocare GmBH (Germany); Dr. Jörn Lehmhus, Julius Kühn-Institut (JKI), (Germany)

Canadian wireworm risk rating system

Risk of wireworm damage to a field is dependent on the fields cropping history and wireworm damage in the area

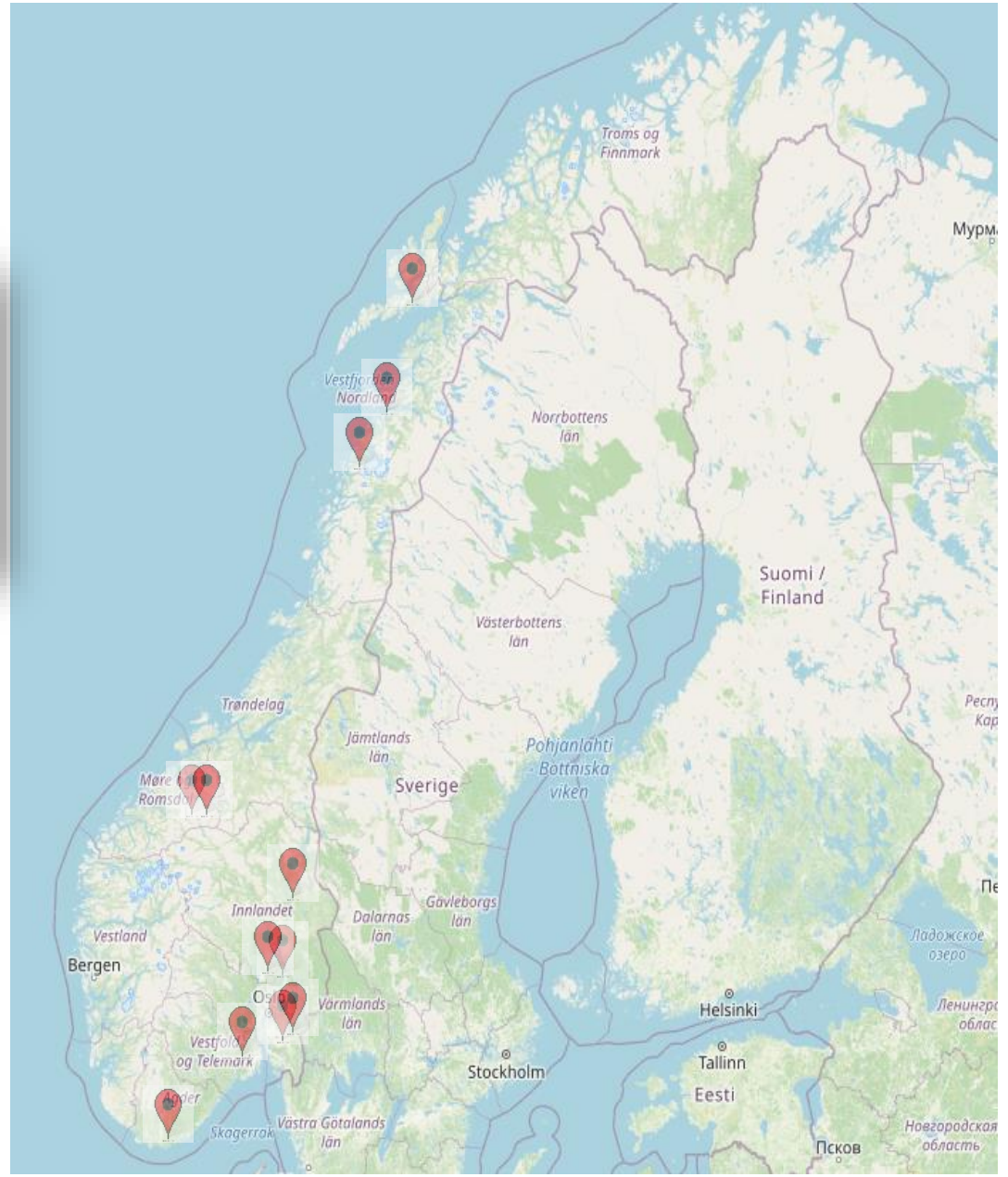
- *Years in preferred crops in the past 4 years (max 10 points)*
- *Nearest wireworm damage in the past 4 years (max 5 points)*

Wireworm risk

0-1 p (no risk)	2-3 p (low risk)	4-6 p (moderate risk)	7-10 p (high risk)	>10 p (extreme risk)
Damage unlikely	Slight damage possible, but sample for WWs to verify	Damage likely - use available WW controls	Damage very likely - avoid potatoes, or use WW controls	High damage - avoid potatoes

Survey of species 2019-2022

- Random potato fields
- Field experiments
- Bait traps
- Collected by hand
- VPT traps (acquired from AAFC, Canada)



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Adult click beetles collected in VPT traps 2019-2020

Species, latin name	Adults in VPT in field margin	Larvae in bait traps in potato field
Agriotes obscurus	Dominating species	Dominating species
Agriotes lineatus	Yes	No
Agrypnus murinus	Yes	No
Athous haemorrhoidalis	No	Yes
Cidnopus aeruginosus	Yes	Yes
Dalopius marginatus	Yes	Yes
Ectinus aterrimus	Yes	No
Hemicrepidius niger	Yes	Dominating species
Hypnoidus riparius	Dominating species	Yes (dominating in some fields)
Selatosomus aeneus	Yes	Yes
Selatosomus cruciatus	Yes	No

Agriotes obscurus

Hypnoidus riparius

Selatosomus aeneus

Selatosomus cruciatus

A. obscurus, H. niger

Agriotes lineatus

Agrypnus murinus

Photos, adults: Henrik Antzée-Hyllseth, NIBIO
Photo, larvae: Annette F. Schjøll, NIBIO

Foto: M. Günther, NIBIO

NIBIO

Foto: M. Günther, NIBIO

NIBIO

Foto: M. Günther, NIBIO

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We still need more wireworm knowledge!

- Life cycles and seasonal population dynamics for the different pest species in Norway
- Define main factors influencing control efficiency under Norwegian conditions?
- Best crop rotation for infested areas
- Testing the new developments from Biocare in Norway?
  - “Fast acting” formulation
- Other crops – is it the same species involved?
- New joint project?

Thank you!

Annette Folkedal Schjøll
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Country Updates: 1st EWRN Workshop

2

Belgium by Willem D (ILVO)

Updates from Belgium

Presenter: Willem Desmedt (ILVO)

1st European Wireworm Workshop | 07/07/2024

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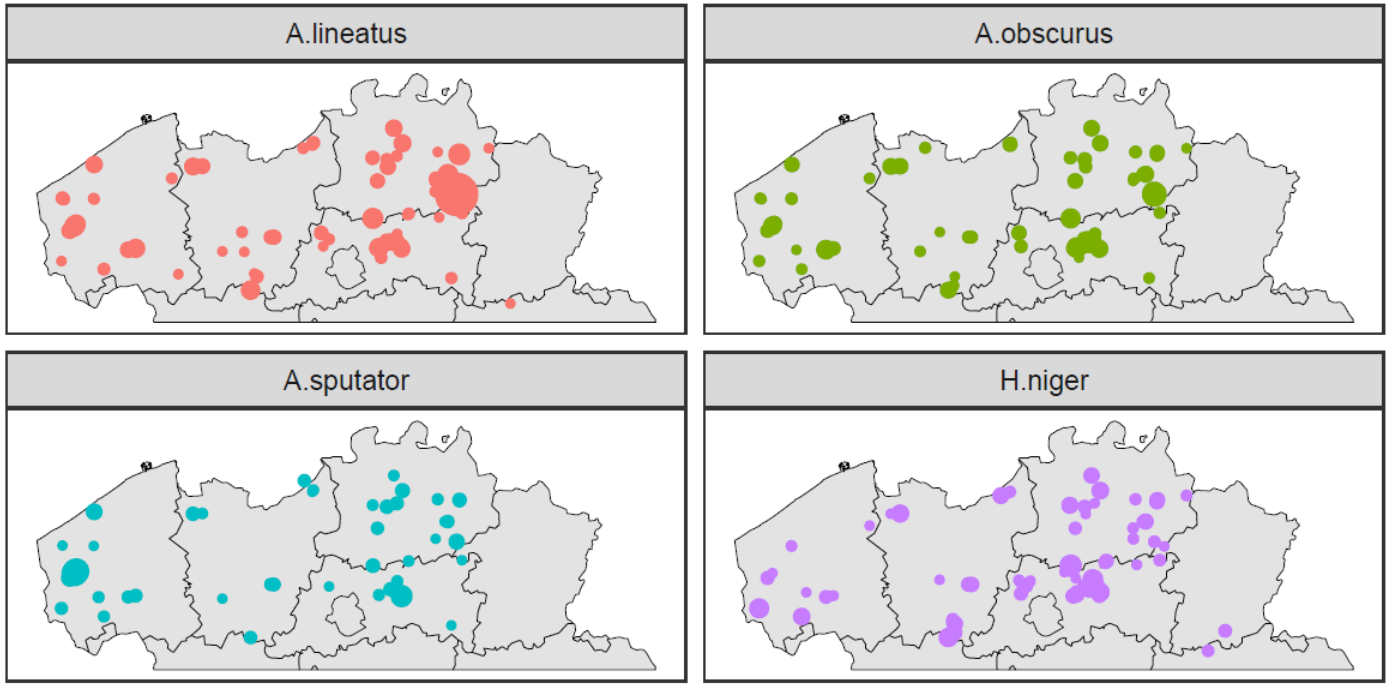
RESEARCH & ADVICE IN AGRICULTURE & HORTICULTURE

ILVO
Flanders Research Institute for Agriculture, Fisheries and Food

The wireworm problem in Belgium

- Big three: *Agriotes lineatus* (> 50%), *A. sputator* & *A. obscurus* (20-25%)
- Also recorded:
  - *Agriotes gallicus, A. acuminatus, A. pallidulus, A. sordidus* (rare)
  - *Hemicrepidius niger*
  - *Adrastus* sp.



The wireworm problem in Belgium

- Damage mainly reported in (sweet) potato, maize and chicory
  - Potato: ± 50% (!) of Flemish arable output by value; annual turnover of processors €1.8 billion.
  - Maize: largest arable crop, predominantly for animal feed
  - Chicory: widely grown in Belgium as a vegetable (‘witloof’) and an industrial crop (inulin)

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The wireworm problem in Belgium

- Research institutes:
  - ILVO: molecular ID, risk modelling, pest biology etc.
  - Gembloux Agro-Biotech/CRA-W: monitoring, behavior/host finding, variety resistance etc.
- Applied Research and Extension organizations:
  - Inagro: all arable crops
  - Viaverda: (sweet) potatoes
  - Praktijkpunt Vlaams-Brabant: chicory
  - Hooibeekhoeve: cereal and fodder crops (including maize)

Management options

1. Risk assessment (e.g. using the AgrioRisk app) + monitoring
2. Preventative measures
   - Avoid susceptible crops
   - Early-maturing varieties if potatoes must be planted
   - Plowing in May-June for mechanical control
3. Curative measures
   - Pyrethroids: tefluthrin (Force), cypermethrin (Sherpa), lamba-cyhalothrin (Karate)
   - Fosthiazate (Nemathorin; only in potato)
   - No licensed options for organic agriculture

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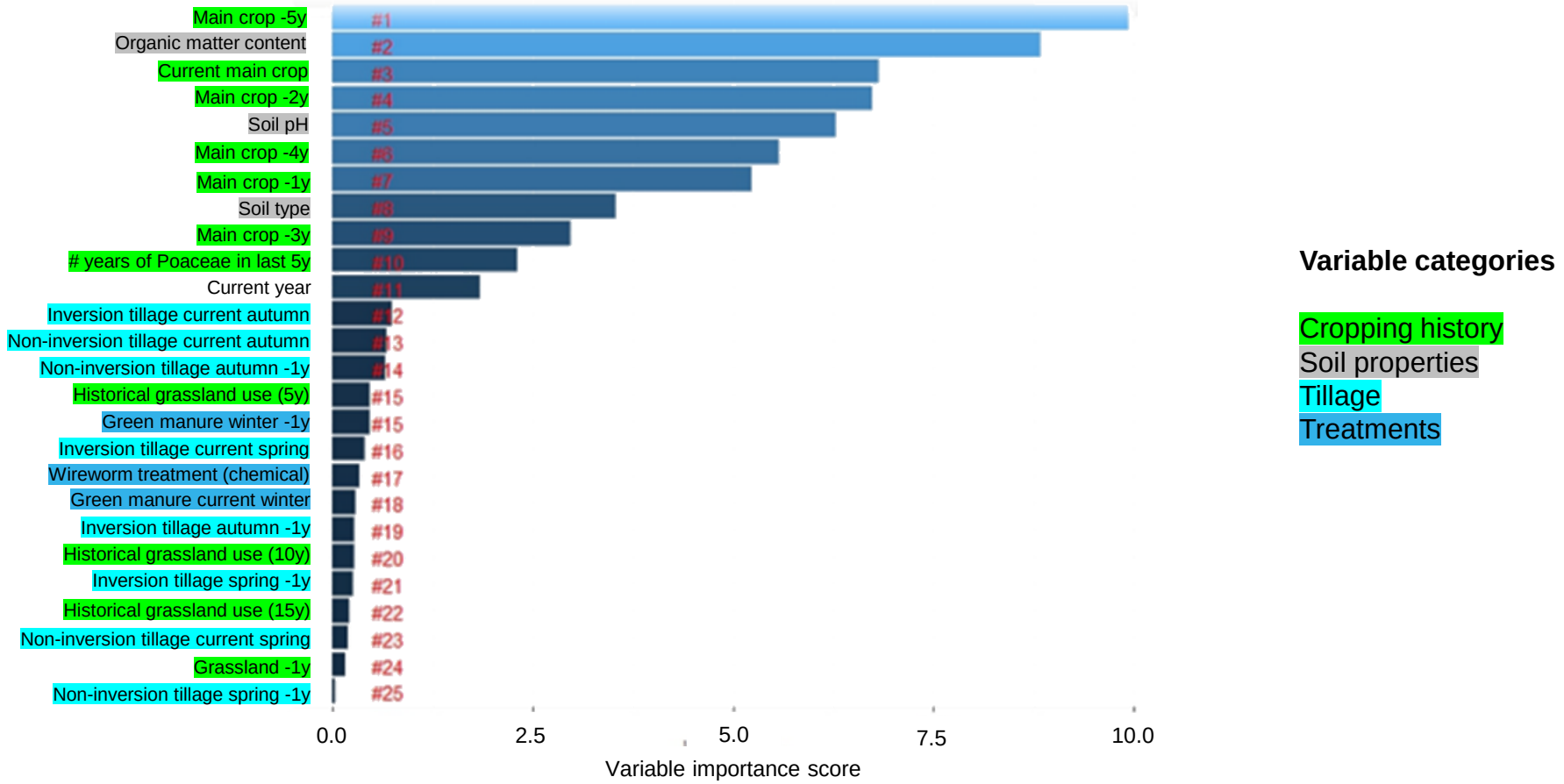
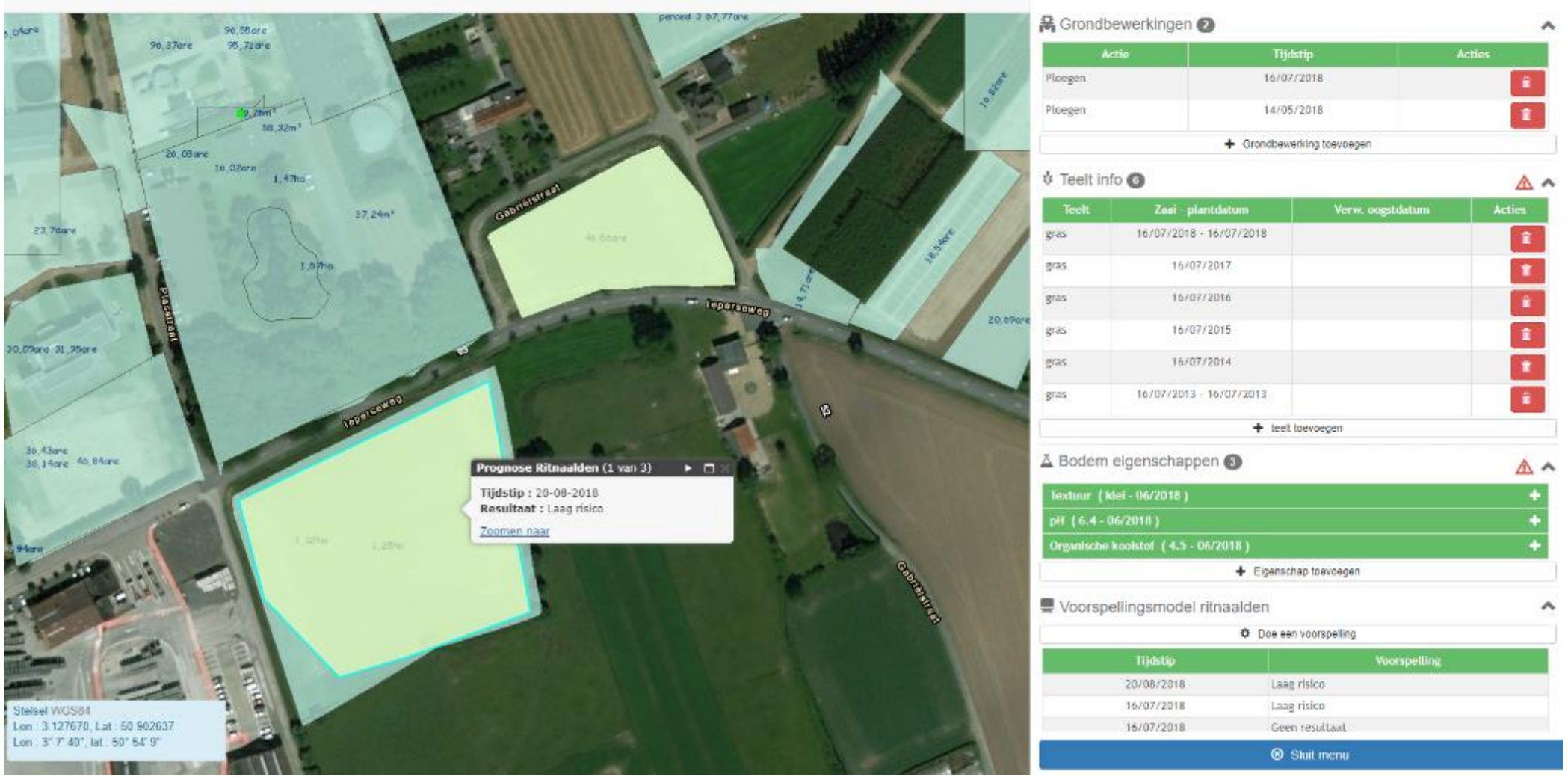
AgrioRisk

- RF model trained on four years (2015-2018) of bait trap monitoring in 235 Flemish potato, chicory and maize fields; +/- 70% accuracy



AgrioRisk


Prognose Ritnaalden (1 van 3)
Tijdstip : 20-08-2018
Resultaat : Laag risico
Zoomen naar
Ieperseweg
Gabriëlstraat
Plaisantel
Stelsel WGS84
Lon : 3.127670, Lat : 50.902637
Lon : 3° 7' 40", lat : 50° 54' 9"
Grondbewerkingen 2
Actie
Tijdstip
Acties
Ploegen
16/07/2018
Ploegen
14/05/2018
Grondbewerking toevoegen
Teelt info 6
Teelt
Zaai - plantdatum
Verw. oogstdatum
Acties
gras
16/07/2018 - 16/07/2018
gras
16/07/2017
gras
16/07/2016
gras
16/07/2015
gras
16/07/2014
gras
16/07/2013 - 16/07/2013
teelt toevoegen
Bodem eigenschappen 3
Textuur (klei - 06/2018)
pH (6.4 - 06/2018)
Organische koolstof (4.5 - 06/2018)
Eigenschap toevoegen
Voorspellingsmodel ritnaalden
Doe een voorspelling
Tijdstip
Voorspelling
20/08/2018
Laag risico
16/07/2018
Laag risico
16/07/2018
Geen resultaat
Sluit menu

Wireworm research projects

- IWT Ritnaalden (2015-2019): wireworm monitoring and management in chicory, potato and maize fields
  - Development of the AgrioRisk application
  - Establishment of damage thresholds for target crops
  - Evaluation of pheromone traps and bait traps
  - Evaluation of biofumigation and attract-and-kill biocontrol products
- Mesurol-free maize (2020-2022): monitoring and management of wireworms in maize

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Wireworm research projects

- ElatPro (2016-2019):
  - Development of LAMP method for molecular ID of *Agriotes obscurus*/*lineatus* and *sputator*
  - Monitoring
  - Evaluation of mechanical control strategies
- Ctrl-Elat (2026-2030?): wireworm management in potato
  - Evaluation of cultural, chemical and biological treatments + metabarcoding to assess impact on soil arthropod communities
  - Improved risk model and application: more data, better integration with databases (input automation), possibly extension to sub-field resolution?
  - Cost-benefit assessment of management options, decision support tools

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Thanks!

Contact:

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Inagro - Kürt Demeulemeester
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Country Updates: 1st EWRN Workshop

3A

Canada by Christine N (AAFC)

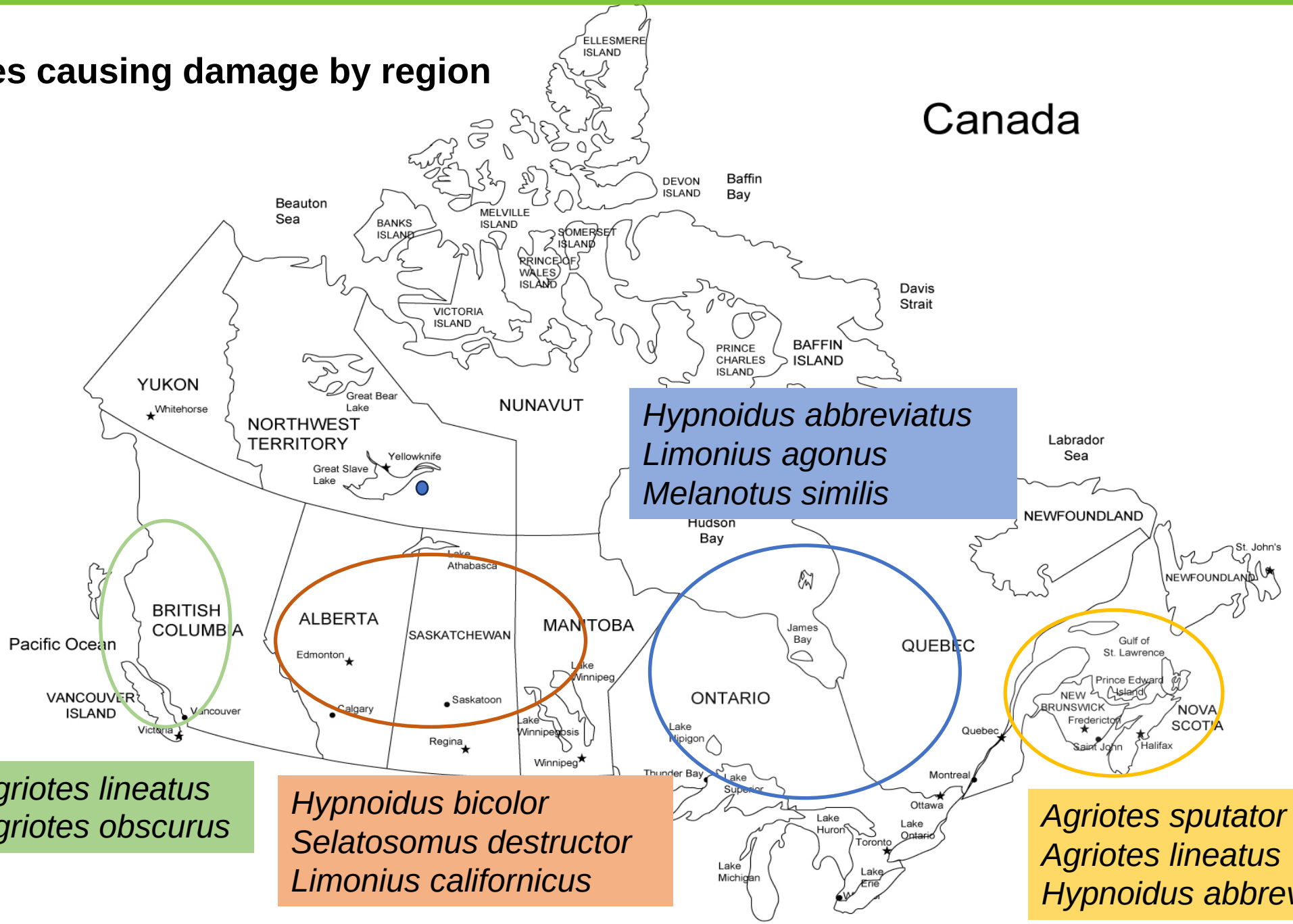
Status of Wireworms and their control in Canada

Christine Noronha

Charlottetown Research and Development Centre

1st European Wireworm workshop July 7th, 2024 – Oslo Norway

Main Species causing damage by region



Hypnoidus abbreviatus
Limonius agonus
Melanotus similis

Agriotes lineatus
Agriotes obscurus

Hypnoidus bicolor
Selatosomus destructor
Limonius californicus

Agriotes sputator
Agriotes lineatus
Hypnoidus abbreviates

Chemical control measures available

Older chemistries

- Organophosphate (Phorate) – needs a smart box application system on sprayer
- Neonicatonoid – only paralyses wireworms
- Pyrethroid (Tefluthrin) – give very low levels damage suppression in potatoes, mainly used in maize crop

New chemistry registered in 2022

- Meta-diamides (Broflanilide)

Prince Edward Island Canada

- Population = 176,113
- Area = 5,686.03 km^2
- Farmed area = 45%
- Main crop = Potatoes
- Over 7 million in losses due to wireworms alone
- *A. sputator* identified as the main species. Rapid spread to new locations observed since 2004

Damage to tubers following a two year crop rotation with brown mustard, buckwheat or barley

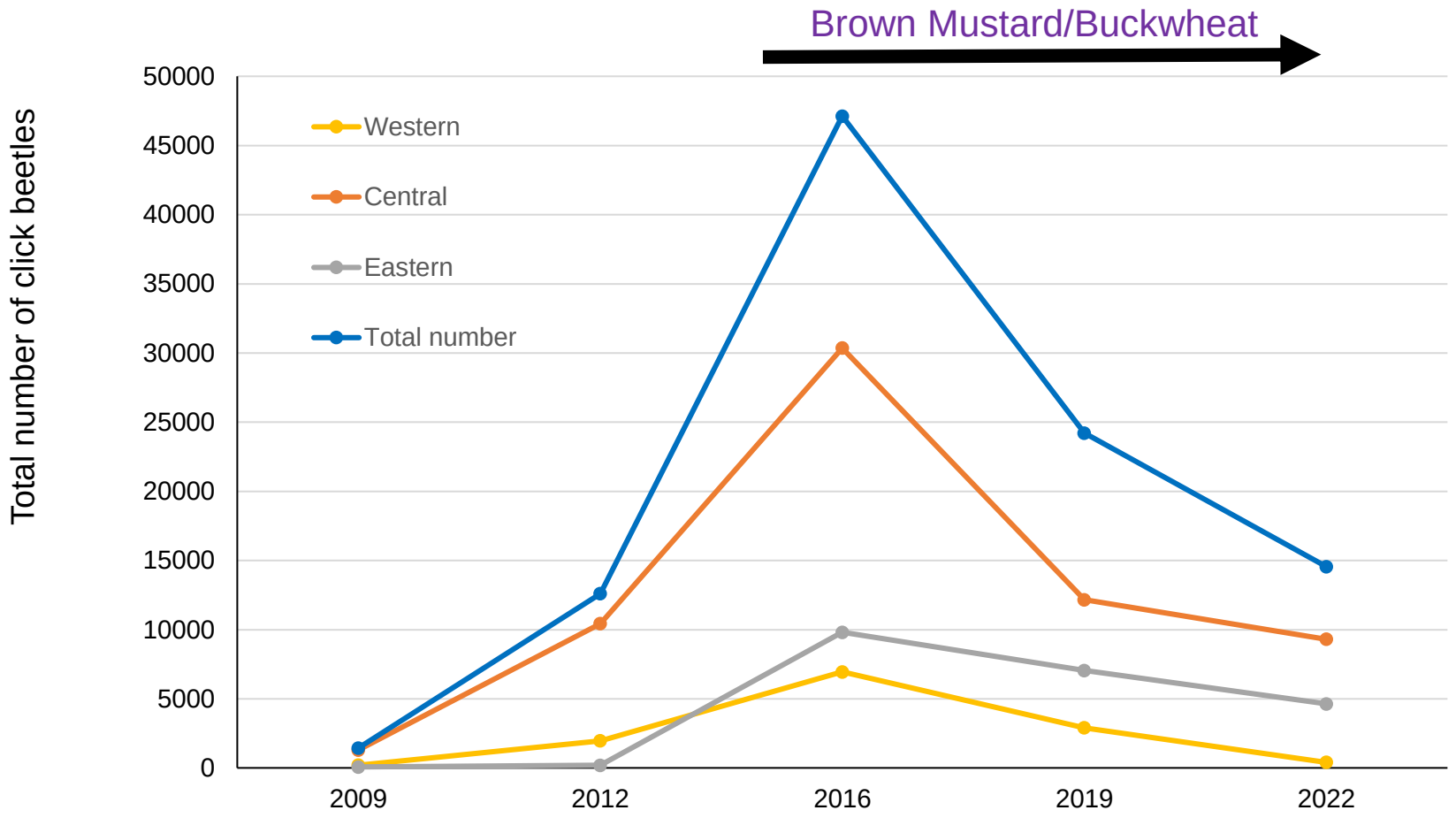
Crop	Percent Marketable tubers	Percent tubers not damaged	Percent tubers lost
Brown Mustard	98%	34%	2%
Buckwheat	93%	30%	7%
Barley	64%	6%	36%

Strategy tested on the following species - *Agriotes sputator*, *A lineatus*, *A obscurus*, *Hypnoidus abbreviates and Limonius agonus*

Click beetle survey sites 2009 (60), 2012, 2016,2019,(85), 2022 (84)

Monitoring the click beetle population in PEI

Combined total number of A.sputator, A. obscurus, and A.lineatus



Monitoring the species spread in PEI

Total number of all species of click beetles trapped

2012 - 12,604
2016 - 47,126
2019 - 24,216
2022 - 14,604

Percent *Agriotes sputator*

2012 - 91%
2016 - 94%
2019 - 96%
2022 - 98% .

Total number of fields with click beetles

2012 -	85 fields	all infested
2016 -	85 fields	all infested
2019 -	85 fields	all infested
2022 -	84 fields	62 infested

Twelve fields with 1000+ beetles in 2016 compared to three fields in 2022.

Thanks to the Entomology Research Team and funding partners

Dr. MD Bahar

Dr. Suqi Liu

Natasha Mosher-Gallant

Nancy Gormley

Students Katie-lynn, Matt, Courtney, Danielle, Marion, Holly, Meagan

Dan Ulrick and Dave Carragher

Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

Canadian Horticultural Council | Conseil canadien de l'horticulture

The voice of Canadian fruit and vegetable growers

Prince Edward Island PEI POTATOES

Les Fermes Cavendish Farms

Prince Edward Island CANADA Agriculture and Fisheries

CANADIAN AGRICULTURAL PARTNERSHIP Innovate. Grow. Prosper.

PARTICIPATING GROWERS




Thank you for listening

Contact information

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Crop Rotation

Table 1. Total market yield, number of undamaged tubers, holes per tuber, tonnes per hectare lost due to wireworm damage and marketable yield for the processing market in a potato crop following a 2 year rotation with brown mustard, buckwheat, barley/clover at Hazelbrook in Prince Edward Island, Canada.

Crops	Total Market yield (t/ha)	Tubers with no Damage (t/ha)	Average Number of Holes per tuber	Tonnes/ha **lost** due to damage (for Processing) (t/ha)	Tonnes/ha Marketable (for Processing) (t/ha)
Brown Mustard	45.6 a[1]	16.2 a	04 a	0.5 a	45.1 a
Buckwheat	45.9 a	12.6 a	06 a	2.6 a	43.3 a
Barley	47.3 a	2.3 b	20 b	16.8 b	30.5 b

Country Updates: 1st EWRN Workshop

3B

Wim van H (ARDC)

Wireworm research in Canada: Pest species, past research, and future directions

Wim van Herk[1], Bob Vernon[2]

[1]Agassiz Research and Development Centre, Agassiz, BC, Canada

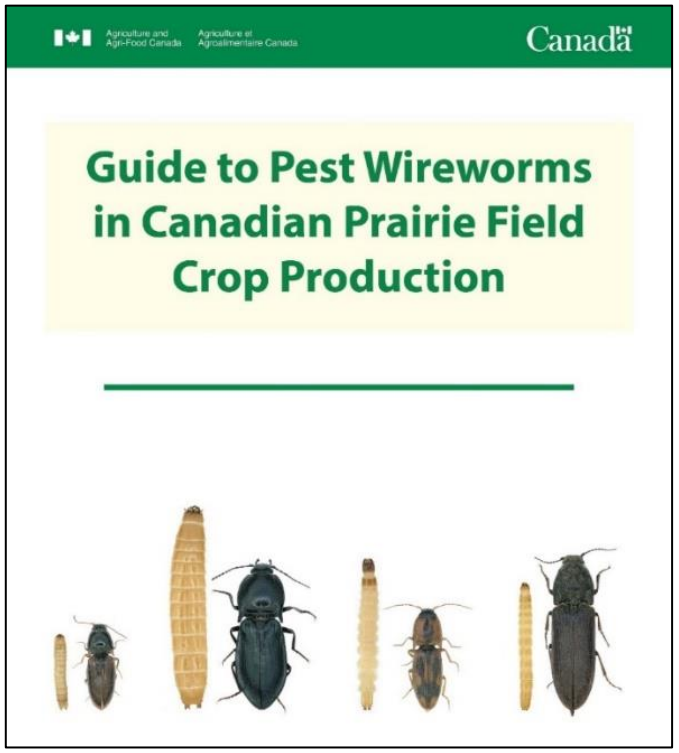
[2]Sentinel IPM Services, Chilliwack, BC, Canada

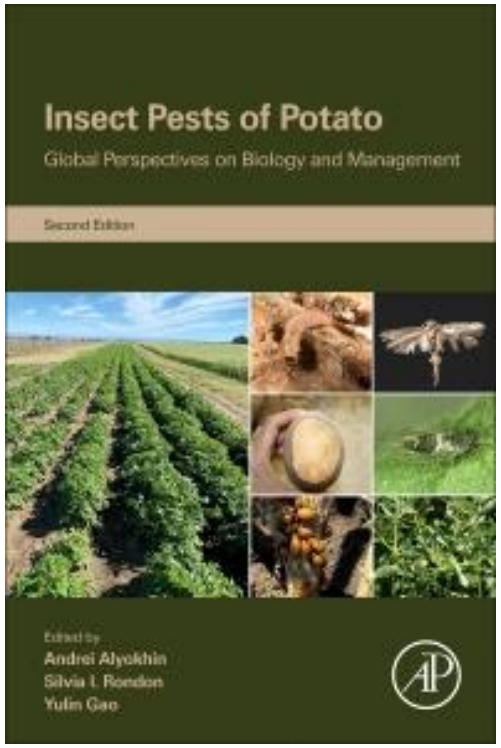
1st European Wireworm Workshop, 7 July 2024, Oslo, Norway

Agriculture and Agri-Food Canada

1. Pest species in Canada
2. Past research
3. Future directions

1. Pest species in Canada





- Vernon and van Herk. 2022. “Wireworms…” *In:* Insect Pests of Potato. 103-148
- Catton et al. 2021. Guide to pest wireworms … AAFC, Lethbridge, Alberta, Canada
- Rashed and van Herk. 2024. Pest elaterids of North America… Ann. Rev. Entomol. 69:1-20

Canadian pest species

c. 30 pest species in > 10 genera

Species differ with region, co-occur in fields, differ in biology…

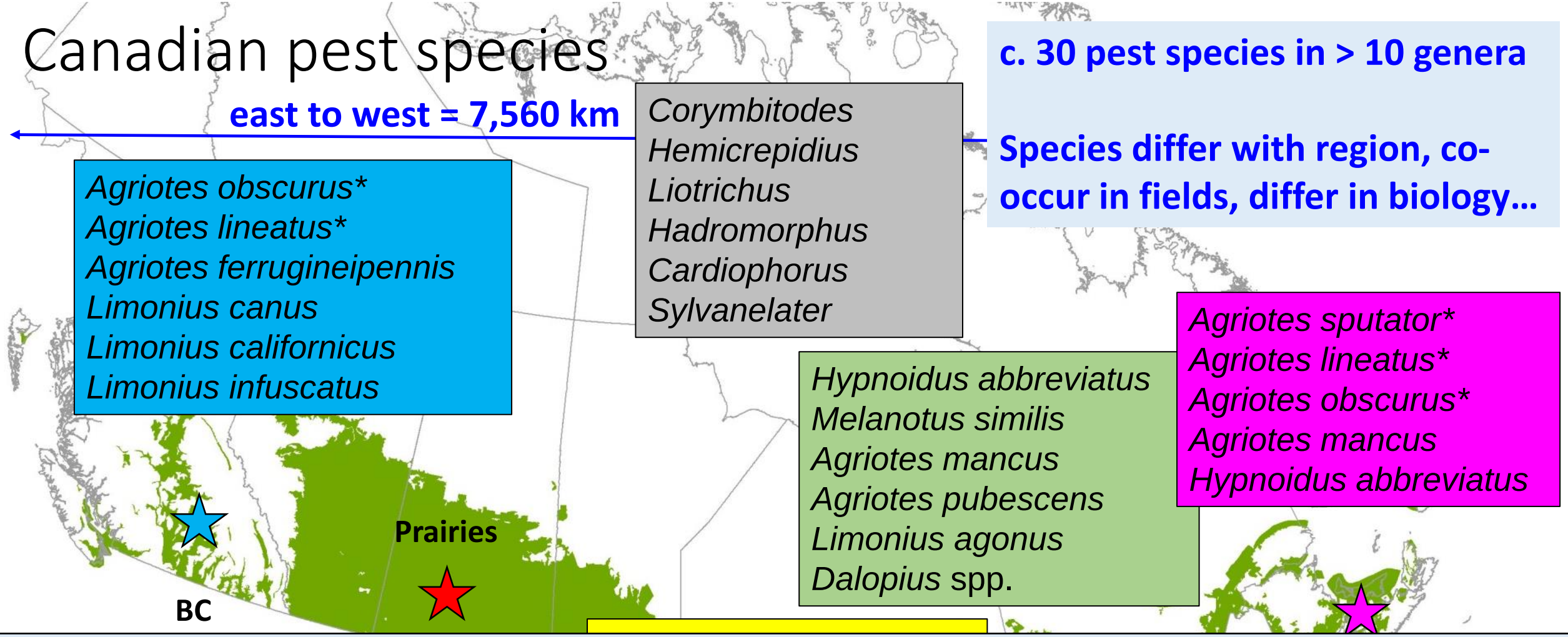
east to west = 7,560 km

Corymbitodes
Hemicrepidius
Liotrichus
Hadromorphus
Cardiophorus
Sylvanelater

*Agriotes obscurus**
*Agriotes lineatus**
Agriotes ferrugineipennis
Limonius canus
Limonius californicus
Limonius infuscatus

Hypnoidus abbreviatus
Melanotus similis
Agriotes mancus
Agriotes pubescens
Limonius agonus
Dalopius spp.

*Agriotes sputator**
*Agriotes lineatus**
*Agriotes obscurus**
Agriotes mancus
Hypnoidus abbreviatus



- Saguez et al, 2017. Wireworm in Quebec field crops: specific community composition in North America. Env Entomol 46:814-825.
- van Herk et al. 2021. Distribution of… *Agriotes obscurus* and *A. lineatus* in British Columbia….J. Asia-Pacific Entomol 24:688-694
- van Herk et al. 2021. Distribution of pest wireworm species in Alberta, Saskatchewan, and Manitoba. Env Entomol 50:663-672.
- Singleton et al. 2022. First record of the invasive wireworm *Agriotes sputator* in Quebec, Pan-Pacific Entomol 98:184-187.
- Smith et al. 2024. Wireworm species associated with corn and soybean agroecosystems in Ontario. Env Entomol (in press)

The *Agriotes* pest complex

Pictures: Julien Saguez, Warren Wong, Jim Moore

"Agriotes mancus" complex, as per Becker 1956

A. lineatus

Introduced, coastal BC, PEI, Nova Scotia, Newfoundland, **dispersing inland**

A. obscurus

Introduced, PEI, Nova Scotia, Newfoundland, **dispersing inland**

A. sputator

native, eastern Canada, well known pest species

A. mancus

native, eastern Canada, unstudied, likely pest species

A. pubescens

native, Southern BC, unstudied, historical pest species

A. ferrugineipennis

Limonius pest complex

Limonius canus LeConte

Western North America ***Eastern, central***

L. infuscatus

L. californicus

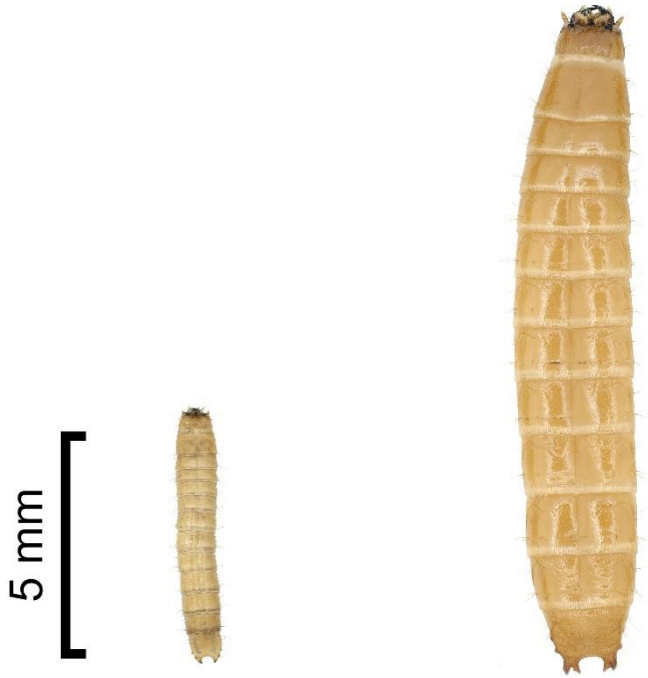
L. canus

L. agonus

t phe

Limonius californicus Mann.

PRAIRIE PEST SPECIES



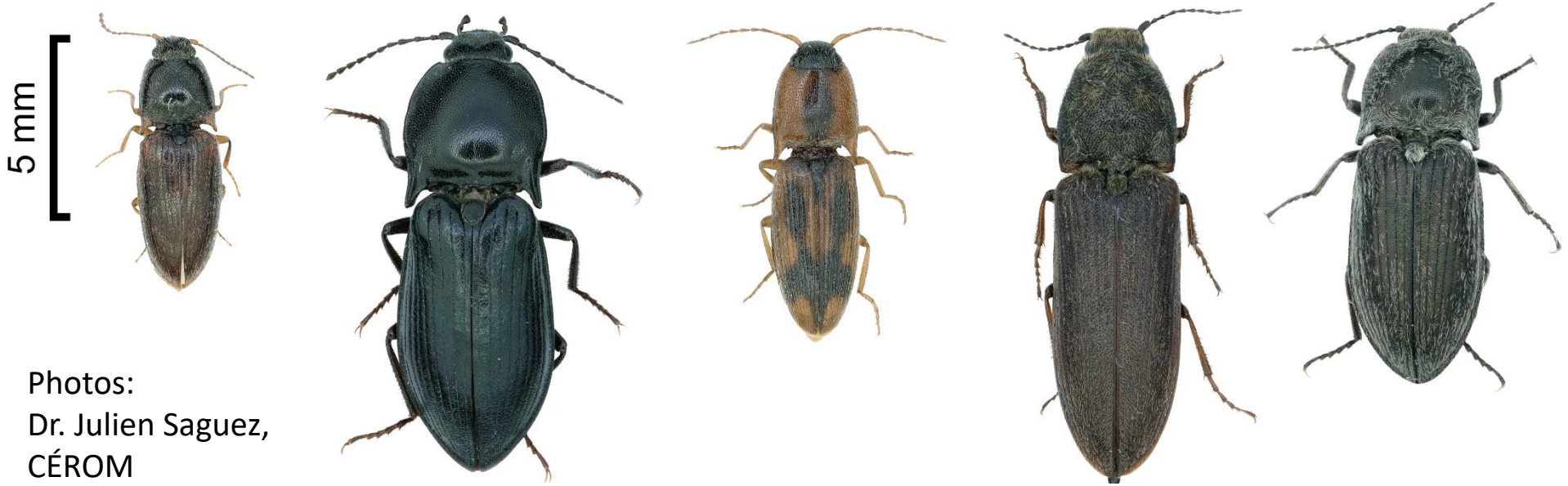
Hypnoidus bicolor

Selatosomus aeripennis destructor

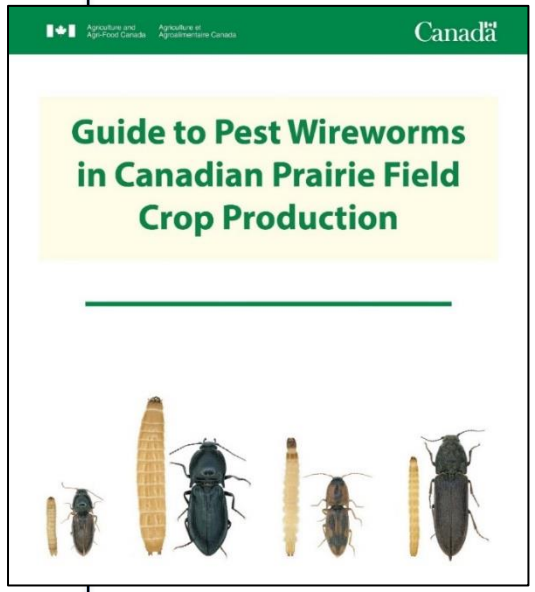
Aeolus mellillus

Limonius californicus

Hadromorphus glaucus



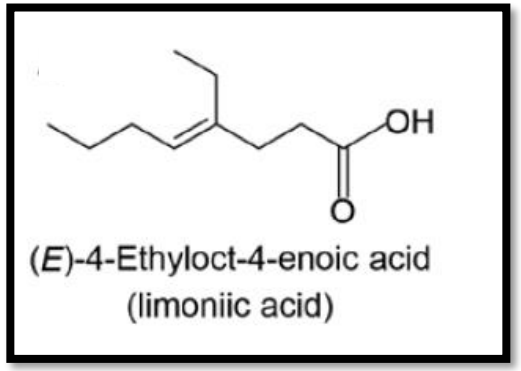
Photos:
Dr. Julien Saguez, CÉROM



Past research

- Insecticide efficacy (larvae, beetles)
  - Tox studies, behaviour response, feeding response, bioassays
  - Field studies with potato, wheat (neonics, diamides, pyrethrins, group 30's)
  - Lab studies, delayed recovery, delayed intoxication, repellency
  - Beetle sprays in field (BC, PEI)
- Mass trapping, mating disruption, trap development (VBT, VPT, BBVPT), beetle movement across landscape, population stability, phenology, egg development, landscape characteristics, etc. for three *Agriotes* species
- Pheromone identification with Drs. Gerhard and Regine Gries, Simon Fraser University (>10 native species)

- Gries *et al.* 2021. J. Chem. Ecol. 47: 123-133
- van Herk et al. 2021. J. Econ. Entomol. 114: 2108-2120



(*E*)-4-Ethyloct-4-enoic acid
(limoniic acid)

Monitoring with pheromones

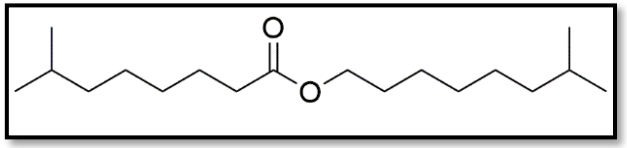
Photo: A. Nikoukar (U Idaho)

Photo: Haley Catton (Lethbridge RDC)

The *Agriotes* pest complex: pheromones

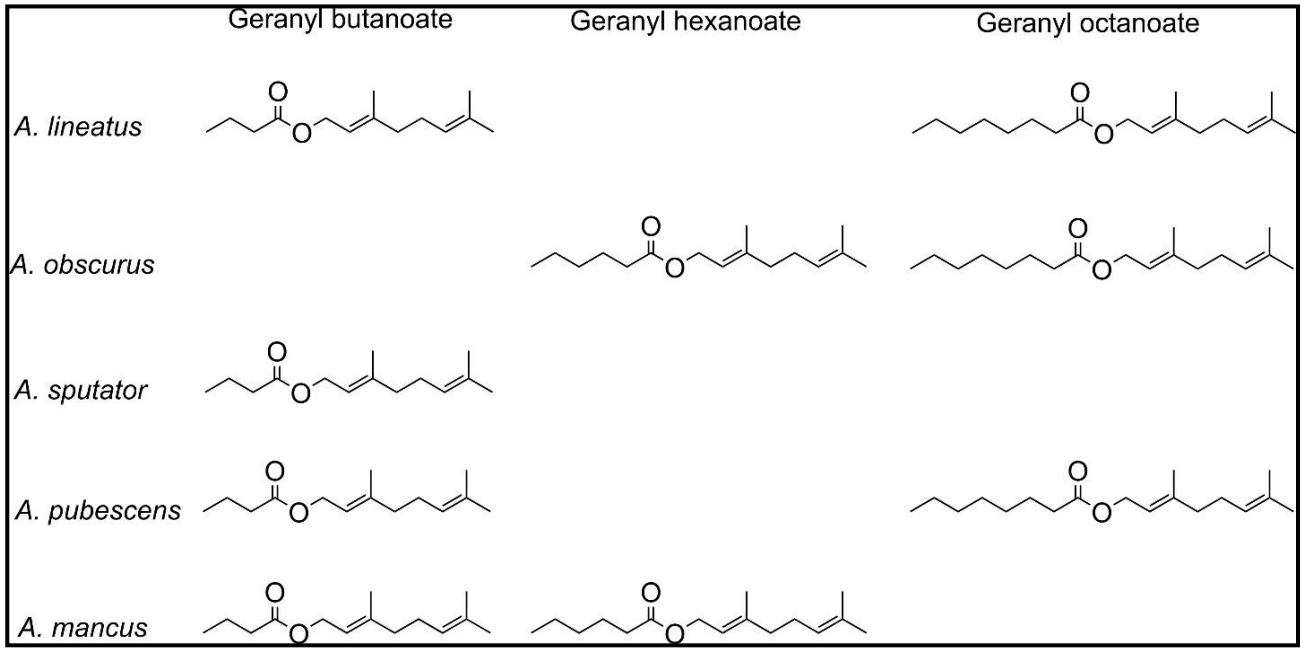
Agriotes ferrugineipennis: 7-methyl-octyl-7-methyl-octanoate

baited traps collected on average **1,200** × **unbaited** traps



"Mancus complex": geranyl esters

species	G-4	G-6	G-8
A. lineatus	x		x
A. obscurus		x	x
A. sputator	x		
A. pubescens	x		x
A. mancus	x	x	



European *A. lineatus* and North American *A. pubescens* have the same pheromone

- Singleton *et al.* 2022. J. Chem. Ecol. 48: 491-501
- Singleton *et al.* 2023. Agric. Forest Entmol. 25:468-476.
- van Herk *et al.* submitted.

Future directions:

- Develop better monitoring, risk-prediction tools
- Determine how we can use the tactics developed for 3 invasive *Agriotes* for > 20 native pest species
  - Monitoring (field scale, landscape)
  - Mass trapping
  - Mating disruption
  - Attract and kill

Headlands (Total Catch)

- H1 (312)
- H2 (460)
- H3 (4229)
- H4 (3973)
- H5 (444)
- H6 (286)
- H7 (2002)
- H8 (2006)

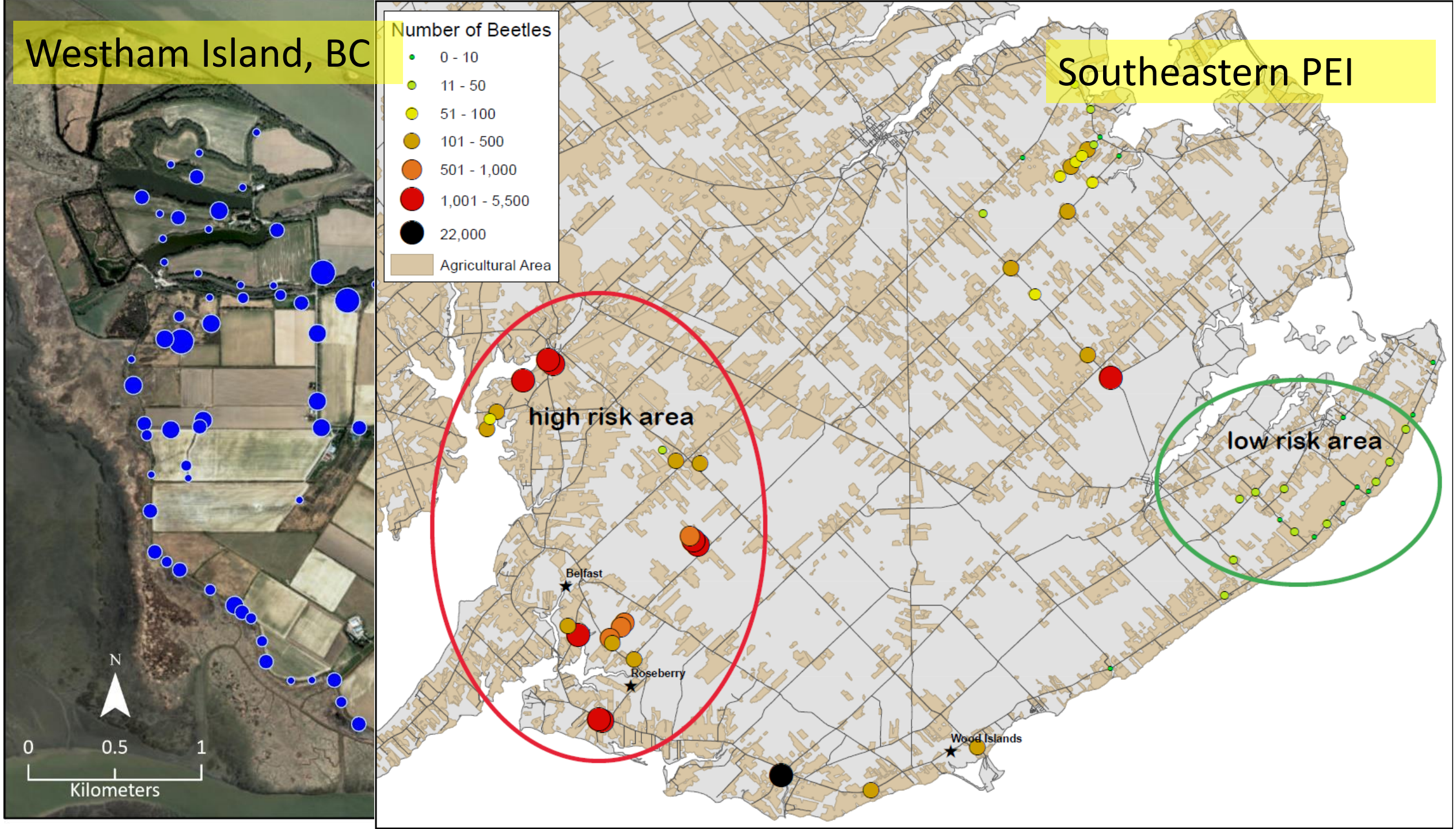
Perimeter (Total Catch)

- P1 (2023)
- P2 (1275)
- P3 (3260)
- P4 (4879)
- P5 (3294)
- P6 (957)
- P7 (1801)
- P8 (2073)

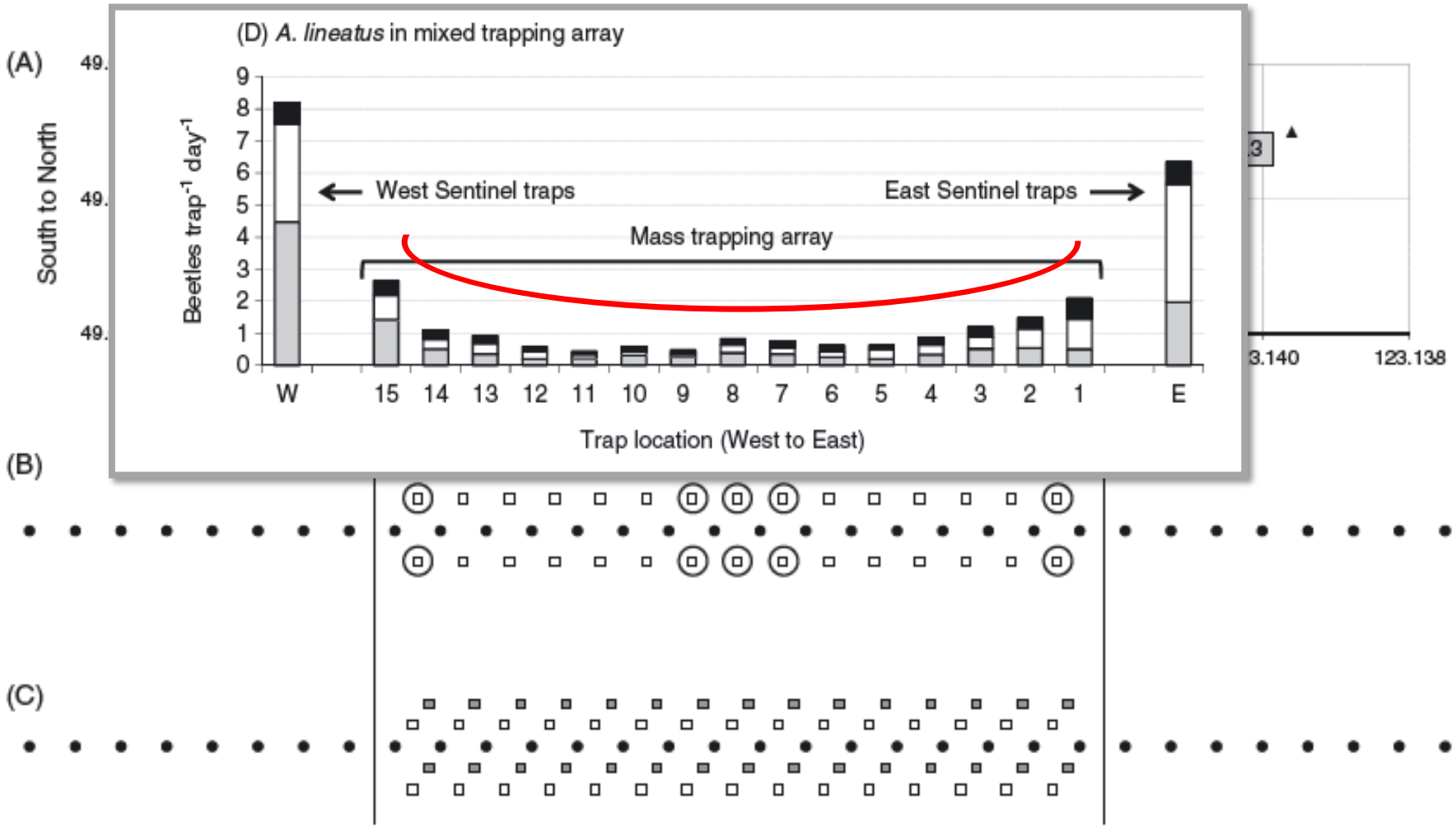
Center (Total Catch)

- C1 (3314)
- C2 (2391)
- C3 (1521)
- C4 (1700)
- C5 (2192)

Identify hotspots, to eliminate populations that move into fields

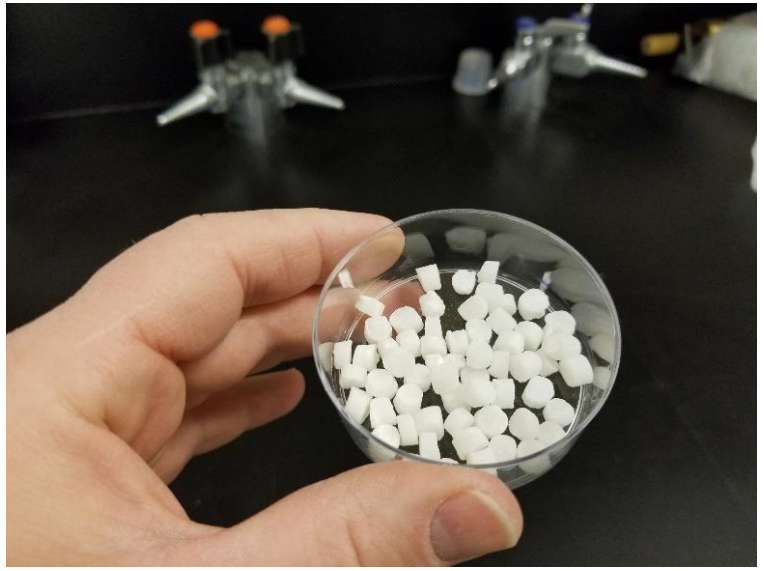

Westham Island, BC
Number of Beetles
0 - 10
11 - 50
51 - 100
101 - 500
501 - 1,000
1,001 - 5,500
22,000
Agricultural Area
N
0
0.5
1
Kilometers
Southeastern PEI
high risk area
low risk area
Belfast
Roseberry
Wood Islands

- Mass trapping



- Vernon et al. 2014. Agric. Forest Entomol. 16: 227-239 (*Agriotes obscurus*, *A. lineatus*, in BC)

- Mating disruption

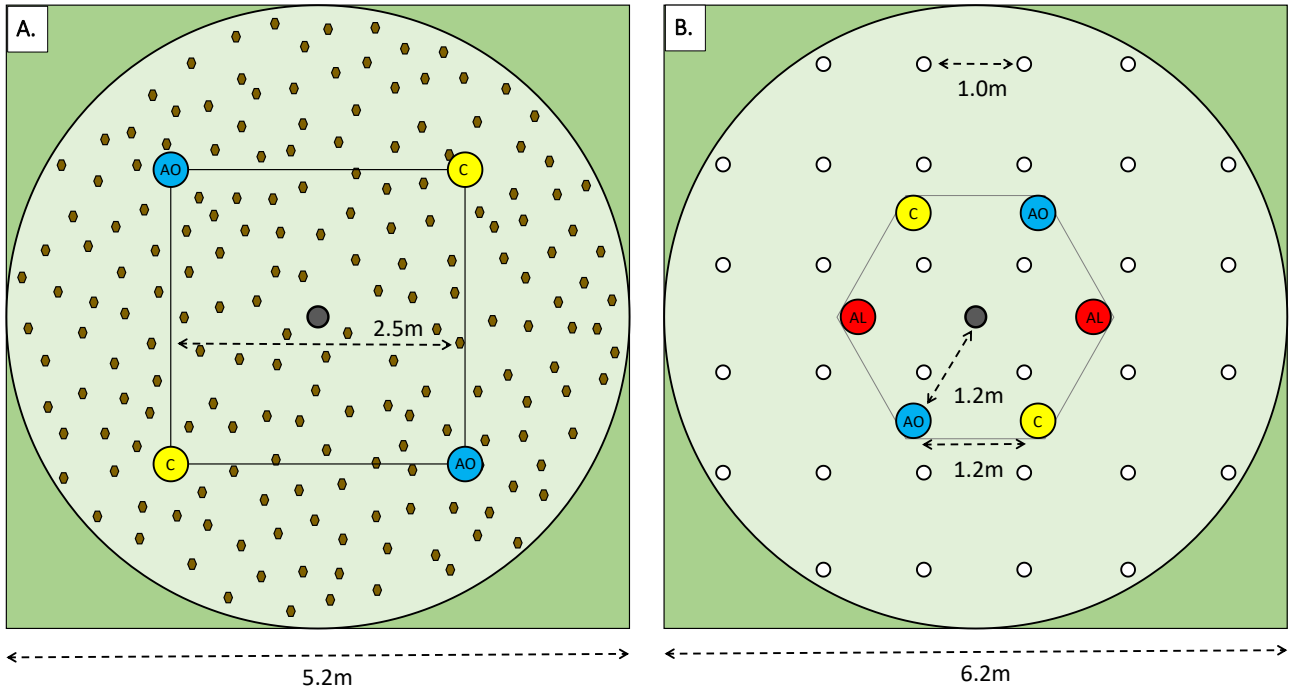


-Todd Kabaluk, Agassiz RDC

-Pheromone granules

-ChemTica

-“pheromone-treated substrate effectively disoriented male AO for > 17 d.”



van Herk et al. 2023. Arthropod Plant Interactions 17:485-506 (*Agriotes obscurus*, *A. lineatus*, in BC)

- Attract and kill
  - *Metarhizium brunneum*

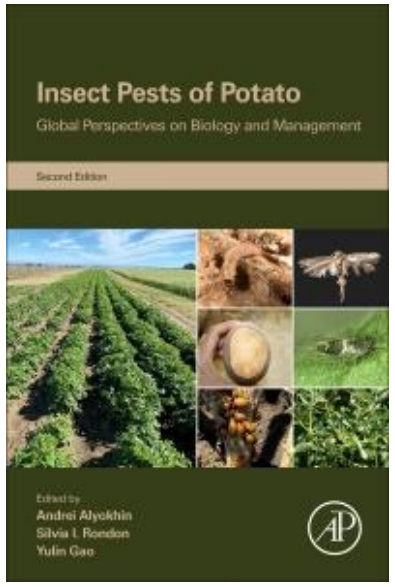
"Pheromone granules applied at 12.7 kg/ha … together [with] … *M. brunneum* LRC112 reduced beetle recapture by 98.2 % compared to *M. brunneum* alone."

Kabaluk et al. 2015 J. Pest Science 88:707-716. (*Agriotes obscurus*, *A. lineatus*, in BC)

A very special thank you to…

Terisha Mitchell, many wonderful students, collaborators, growers, and funders, you, and the symposium organizers

Contact: wim.vanherk@agr.gc.ca



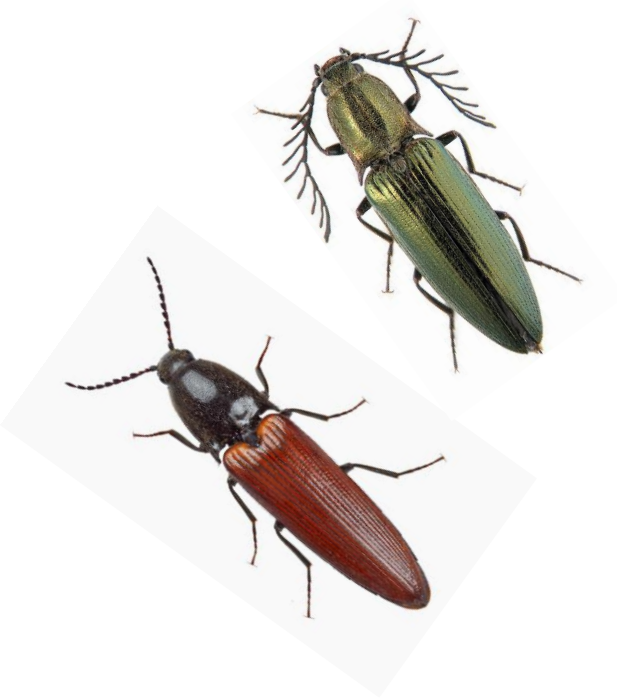
Country Updates: 1st EWRN Workshop

4

Estonia by Koppel M (EULS)

Updates on wireworm problems, research areas and knowledge gaps within Estonia

Mati Koppel, Anne Must, Karin Nurme,
Enno Merivee



www.emu.ee
Eesti Maaülikool
Estonian University of Life Sciences

Major crops at risk of wireworm damage

potato
maize
wheat
carrot
onion
carlic

Research project: Alternative methods in control of wireworm in potatoes (2020-2023)

Initiated and in collaboration with farmers cooperative Talukartul

Talukartul
VILJAKAKS ELUKS

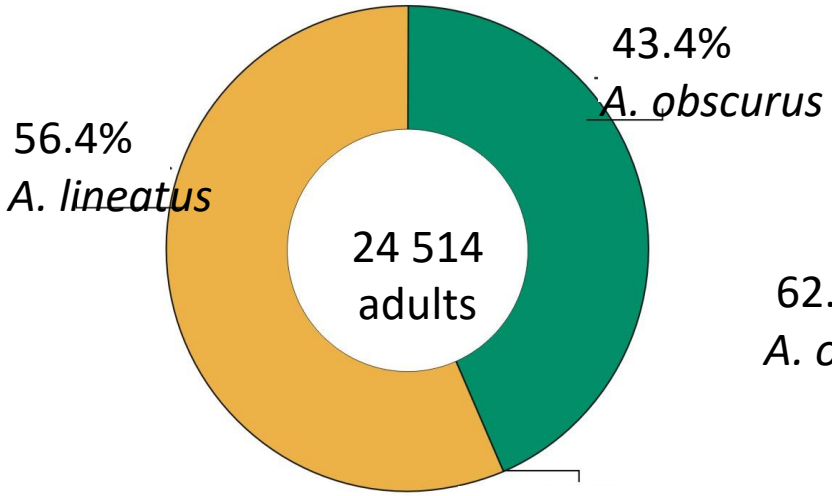
Financed from Rural Development Programme

Euroopa Maaelu Arengu Põllumajandusfond: Euroopa investeeringud maapiirkondadesse

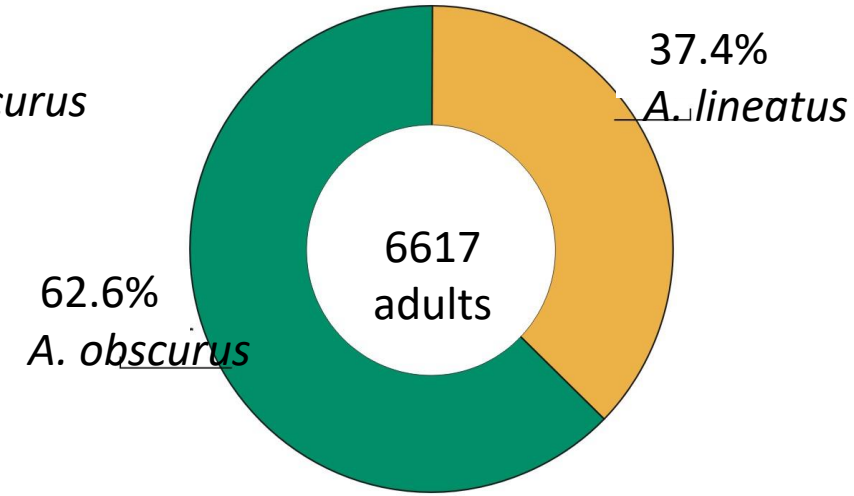
1. Monitoring of wireworms
2. Field and technology trials
3. Video tracking in soil bioassay arena

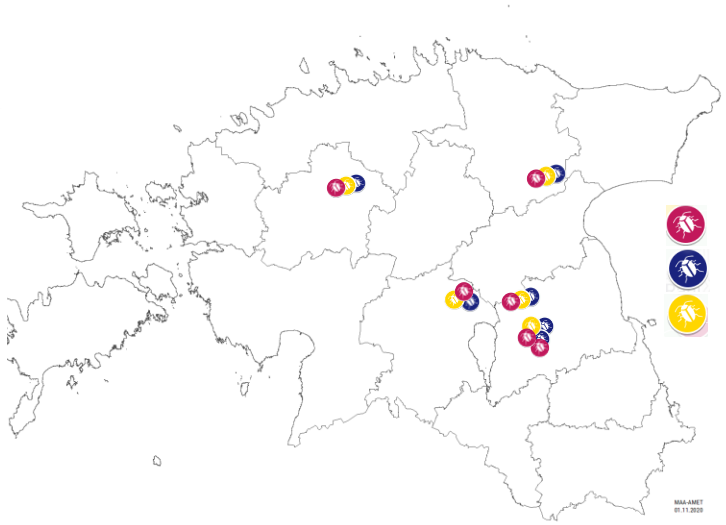
Monitoring of predominant known wireworm species

South Estonia



North Estonia





A.lineatus

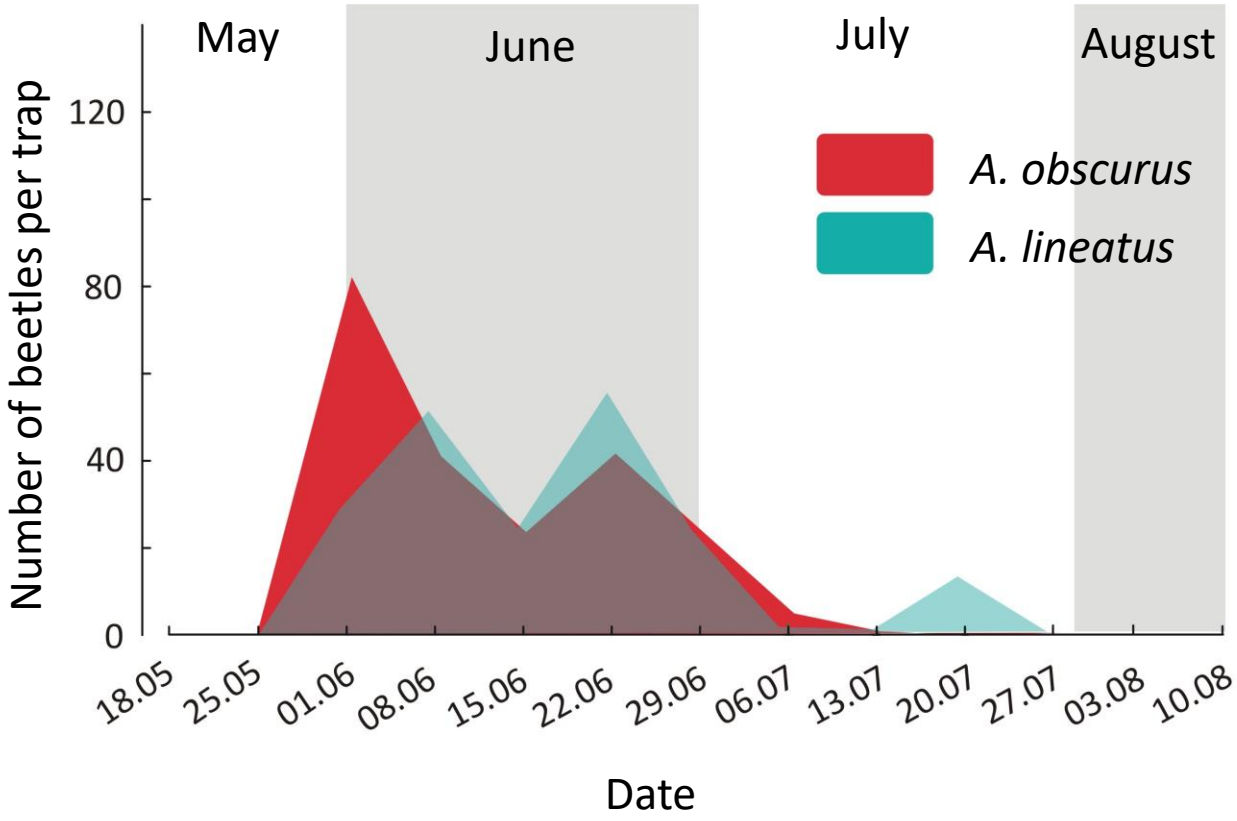
A.obscurus

A. sputator

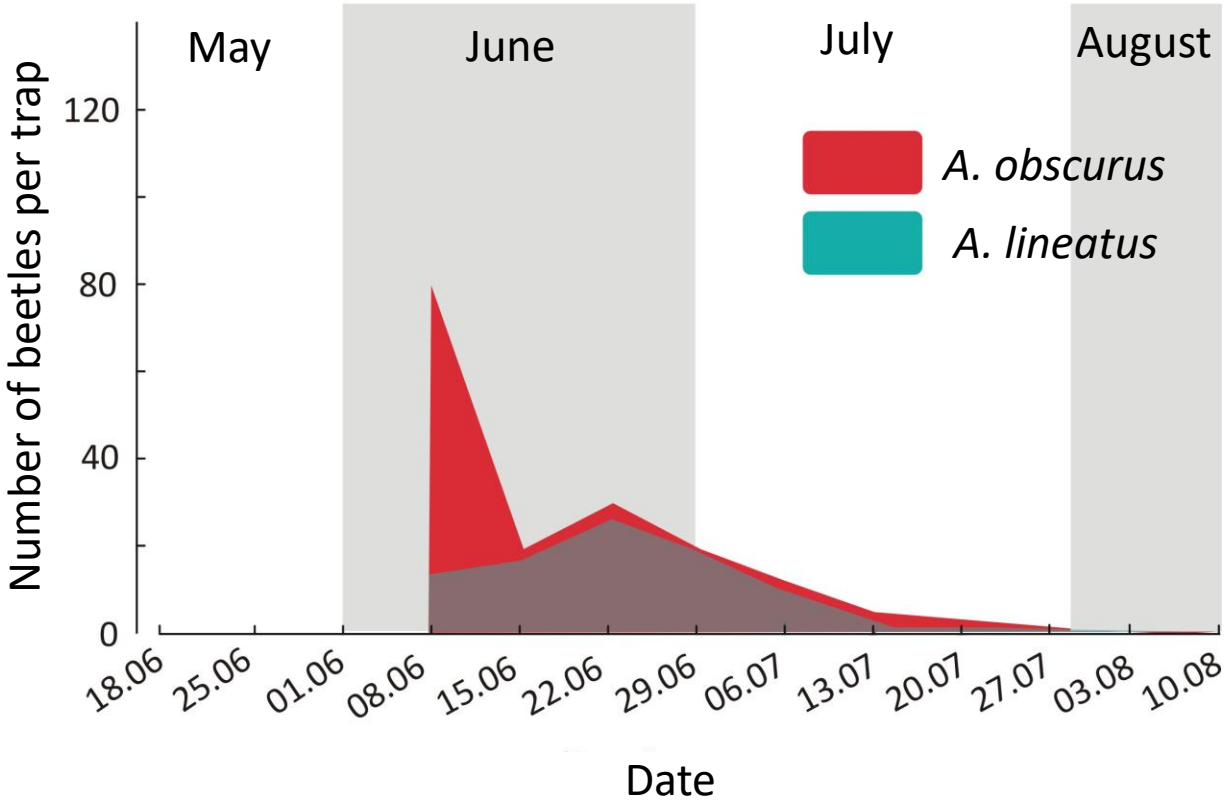
A. ustulatus

Monitoring of predominant known wireworm species

South - Estonia



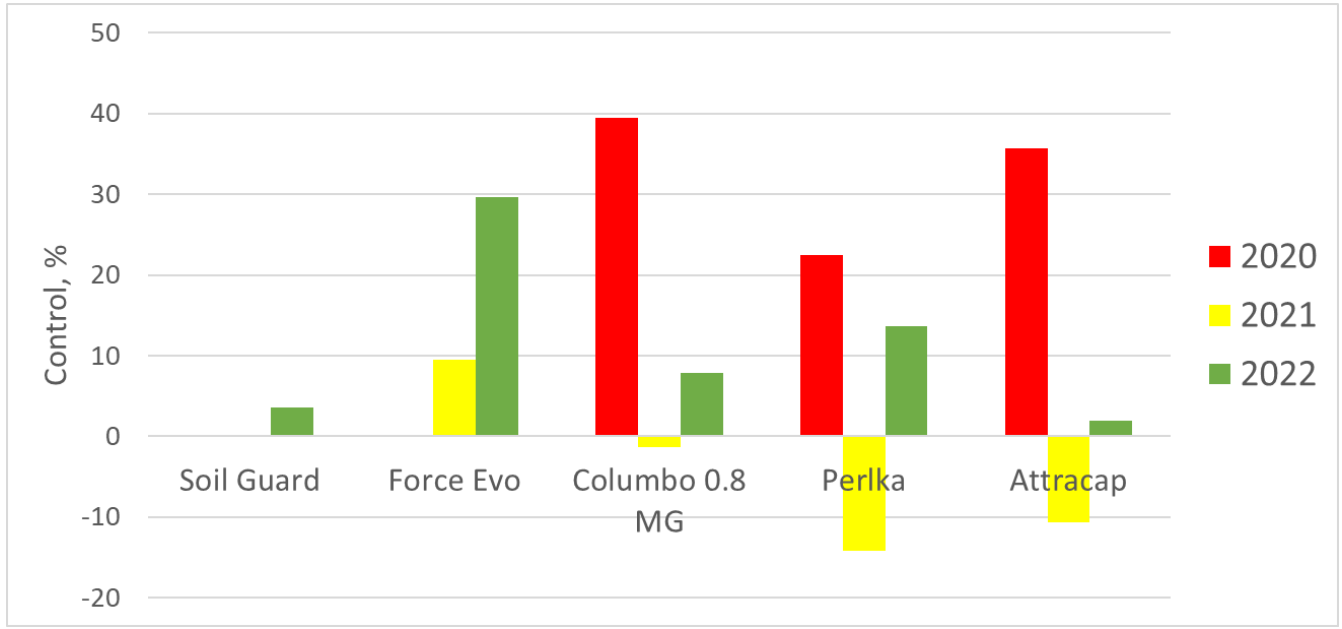
North - Estonia



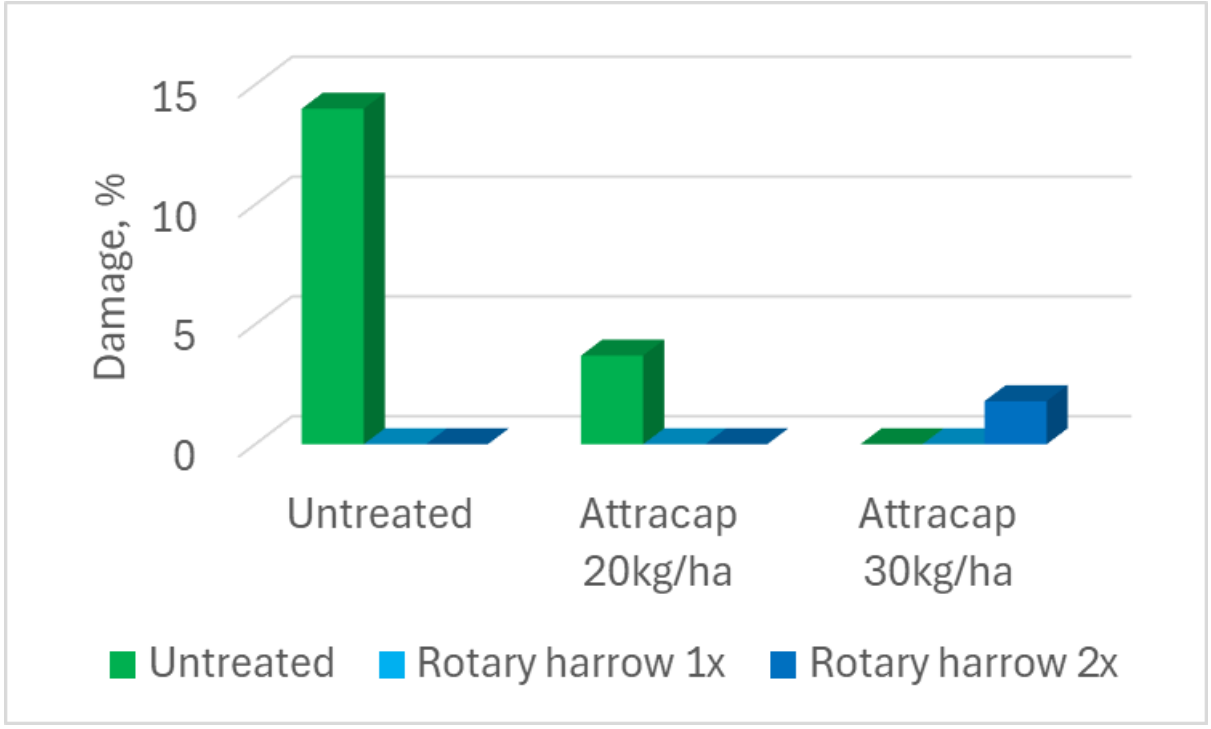
List of authorised products in Estonia:

- Columbo 8.8 MG (cypermethrin) special permission 2019-2021
- Soil Guard (tefluthrin) registered since 2022

Trials on control of wireworm damages on potatoes



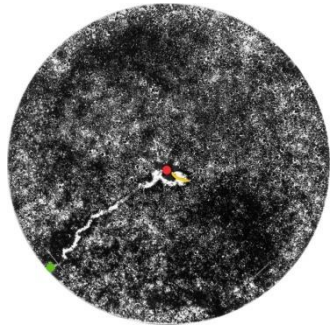
Trials on mechanical soil cultivation (rotary disc harrow)

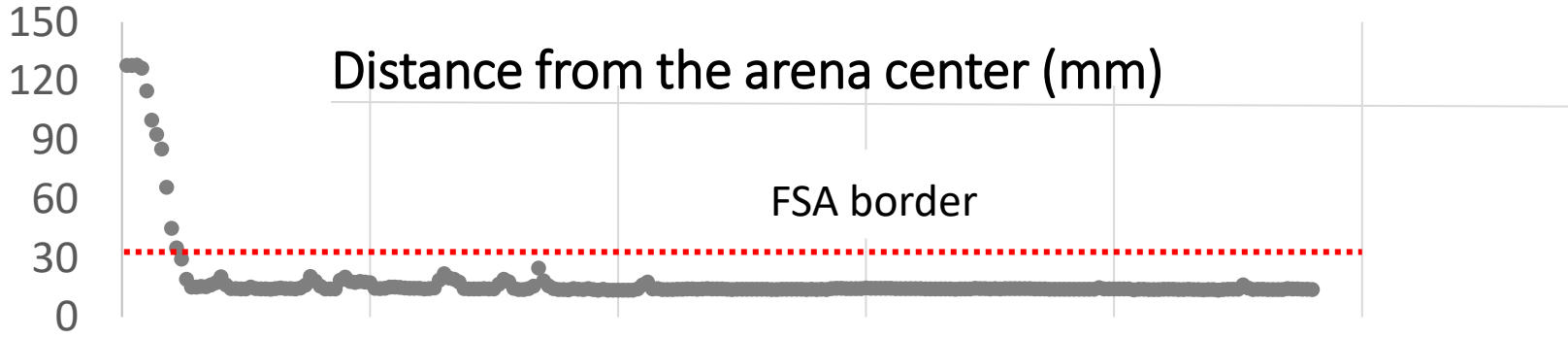


	Untreated	Attracap 20 kg/ha	Attracap 30 kg/ha
Untreated			
Rotary harrow 1x			
Rotary harrow 2x			

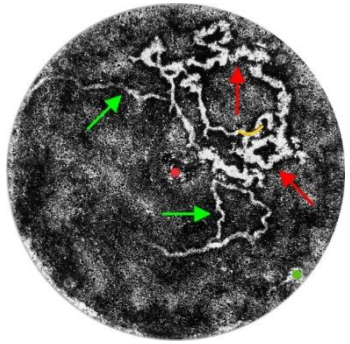
Video tracking in soil bioassay arena

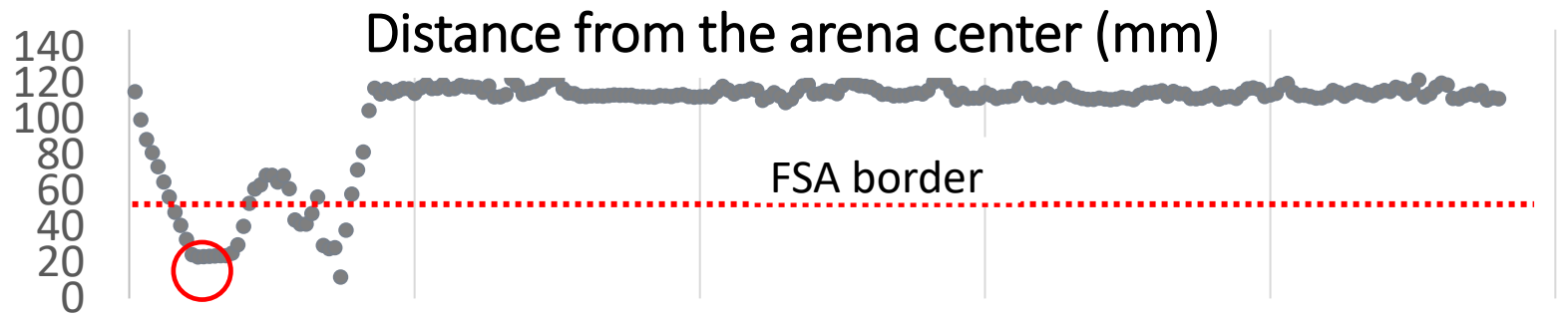
Germinated wheat seeds



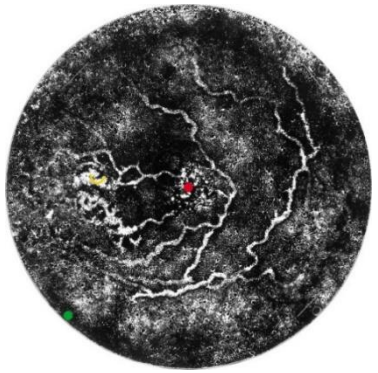


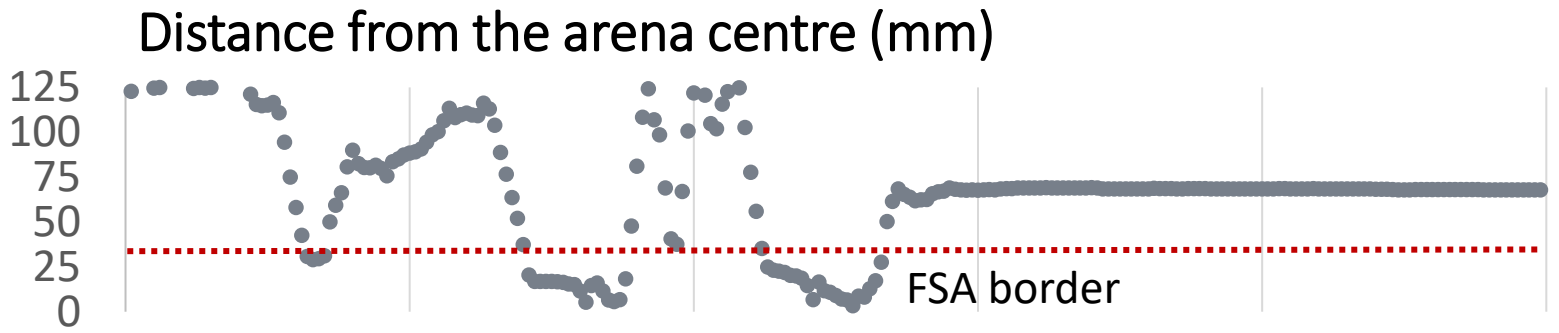
Columbo (cypermethrin)





Goldor Bait (fipronil)





Expectations of Estonia from a European network

Exchange of best practices for Integrated Crop Management

Participation in development of effective (biological) control measures for Nordic conditions

Country Updates: 1st EWRN Workshop

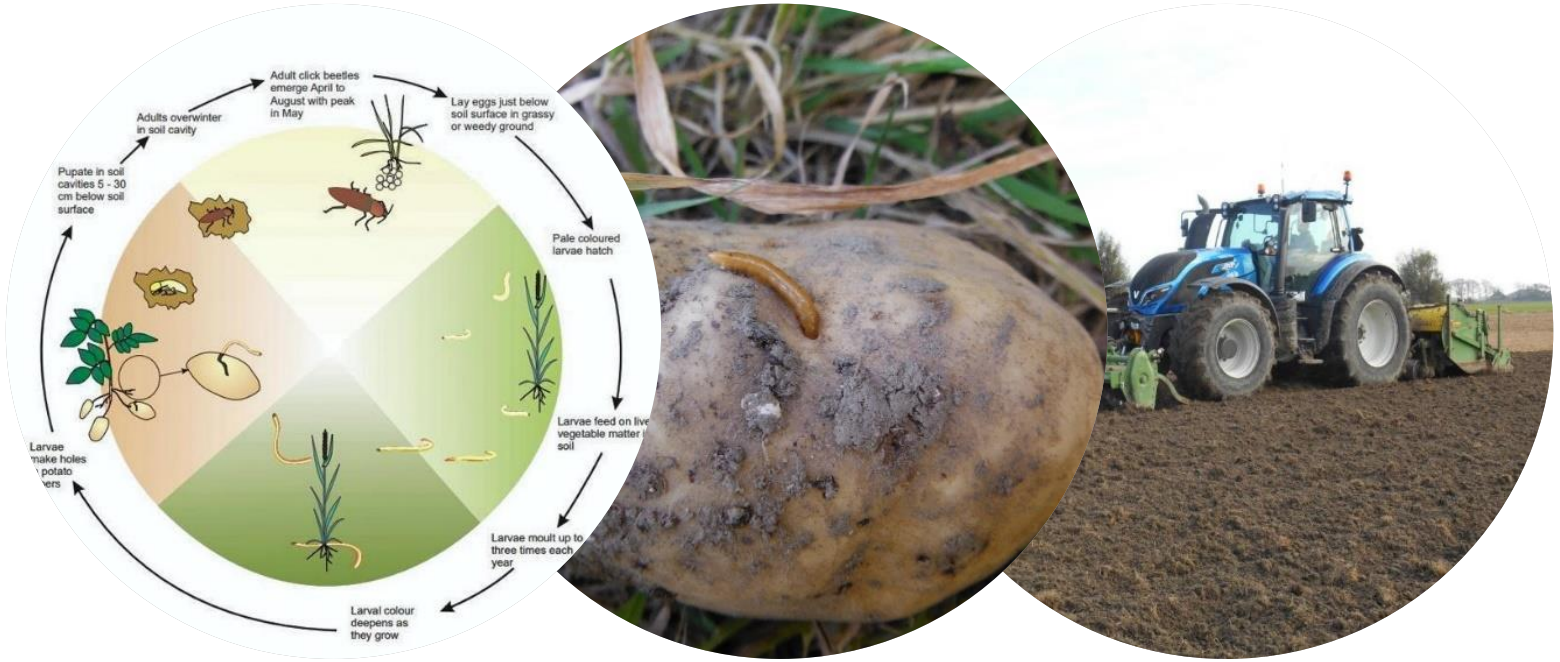
5

Netherland by Hilfred H (WUR)

Integrated Crop Management & wireworms

Tools & tactics to manage wireworm biology and damage

Hilfred Huiting, Klaas van Rozen, Bas Allema & Arjan Mager – 7 July 2024



State of art wireworms in NL

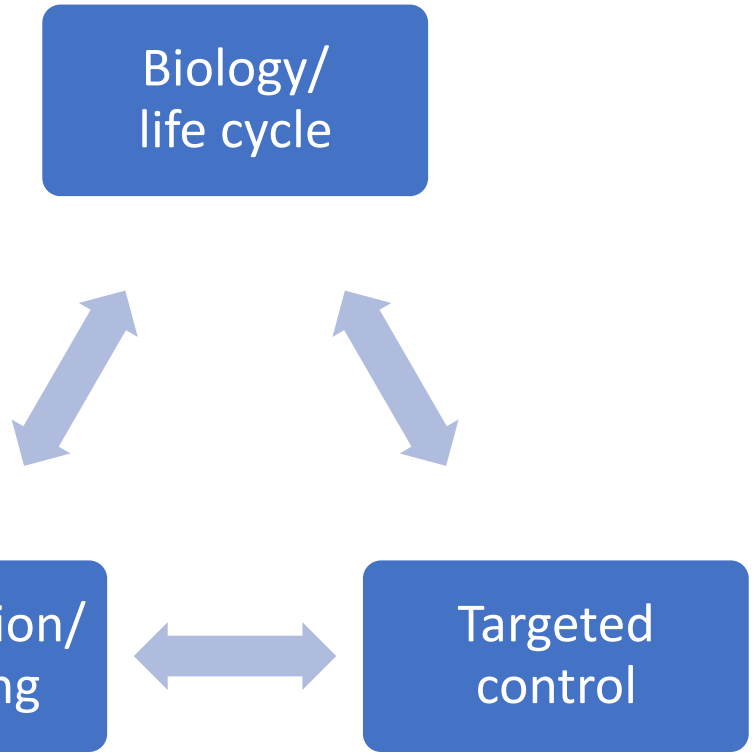
- Current monitoring insufficiently predictive
  - Damage and presence with halved potato tubers
- Reduced tillage and increased cover cropping
- Insecticide use under pressure
  - Steady increase problems over past decade(s)(?)

Current work – public-private partnership

- Project running 2022-2025
  - Advisors, farmers, potato processors
- Work on:
  - Understanding the biology – validation
  - Understanding the field situation
  - Developing new control strategies
- Embed in ICM: Integrated Crop Management

‘solid soil pest approach’

GRONDIGE AANPAK Bodemplagen



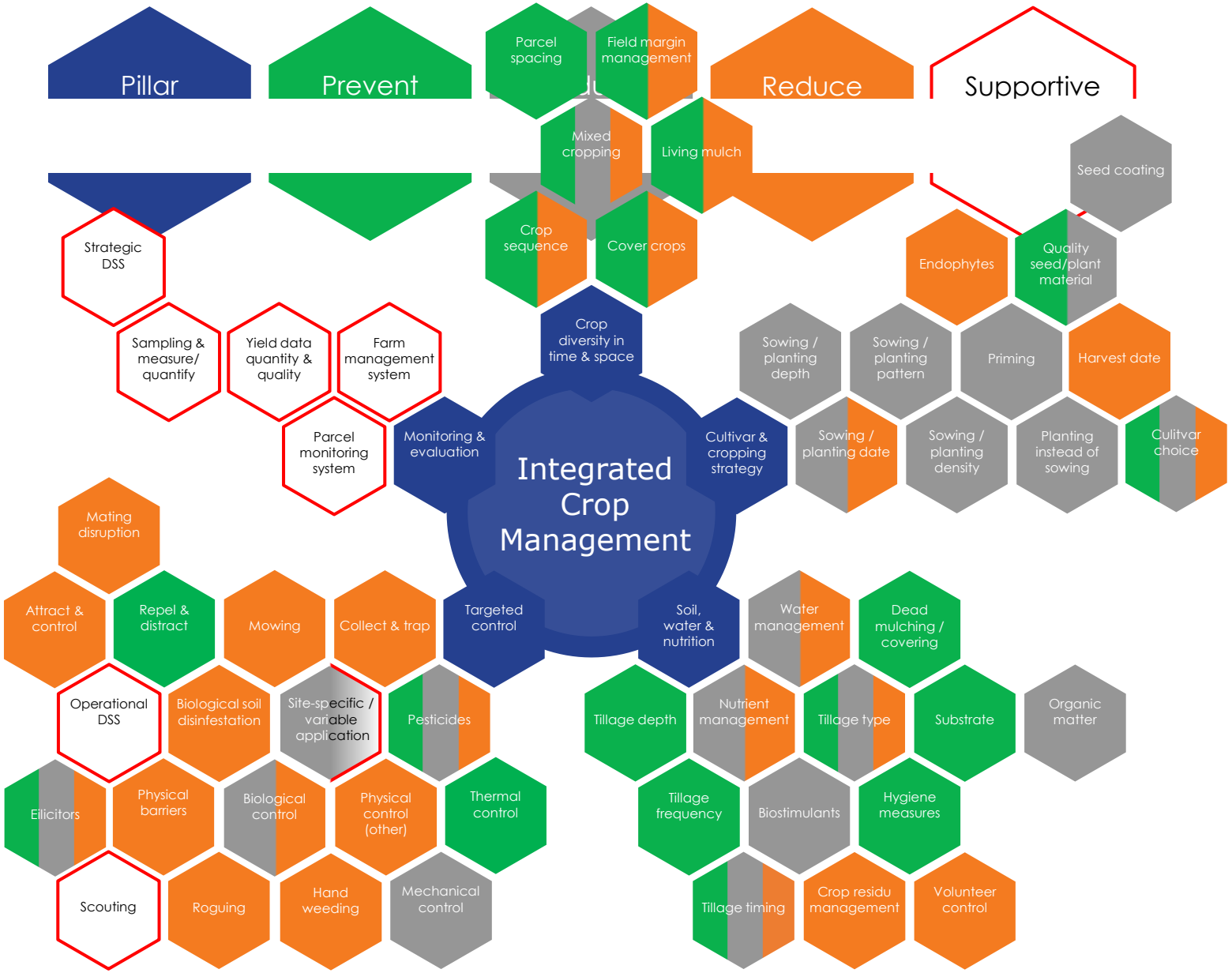
A framework for redesign of cropping systems

ICM - Integrated Crop Management

- Crop diversity
- Robust cultivars
- Soil management
- Direct, smart and precise control techniques
- Proper monitoring & evaluation (and adaptation)

Adapted from: Riemens et al (Eur. J. of Agronomy, 2022) https://doi.org/10.1016/j.eja.2021.126443

A framework for redesign of cropping systems



Focus on understanding biology

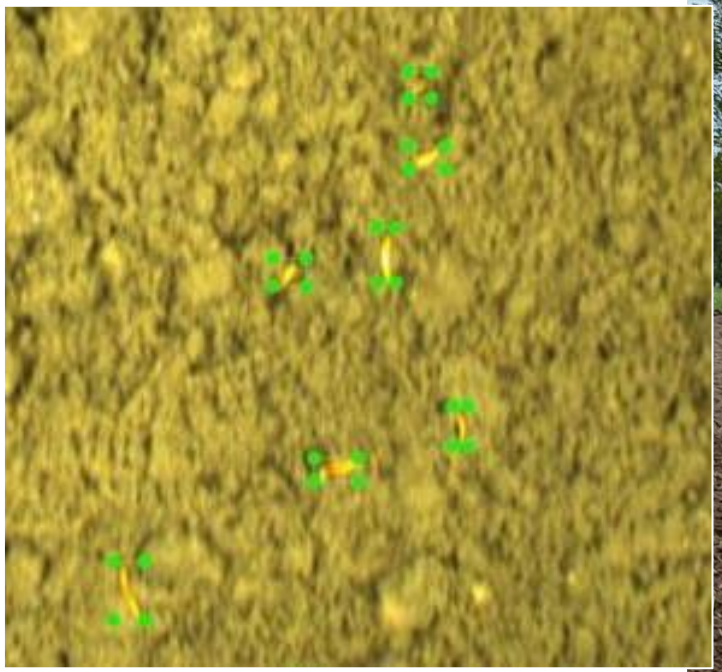
https://edepot.wur.nl/639307

Focus on understanding the field situation

- Dataset compiled of over 600 fields
  +/- wireworm damage
- Get an understanding of
  crucial predictive factors
- Some of the surfacing factors:
  Grassland in previous years – Organic matter –
  Soil moisture table – Soil density – Potato cultivar – Overwintering situation (cover crop)

Focus on understanding the field situation

- First steps to develop recognition algorithm



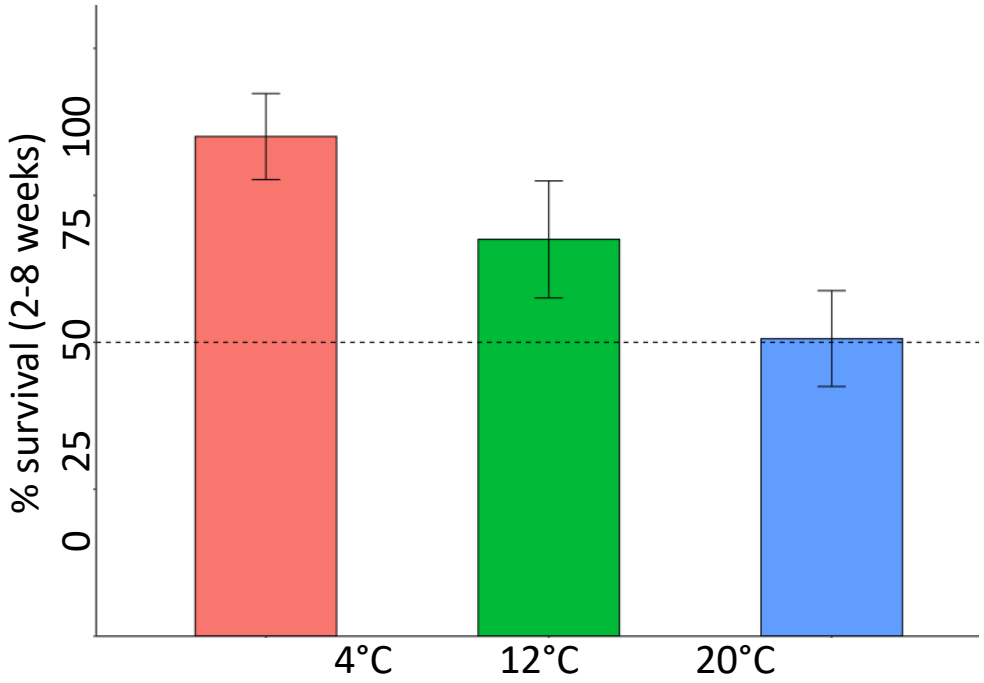
Developing new control strategies

- 1 to 1 substitution insufficient
- Embed alternatives in ICM – focus on agronomy as a whole
  - Effects (cover) crop/cultivar selection
  - Side effects inundation (for nematode control)
  - Soil cultivation practices

Developing new control strategies

- Experiments running to validate brown mustard effects
- Inundation effects

Temperatuur * Inundatieduur			
Factor	LR	Df	p.value
Temperatuur	**10.79**	**2**	**0.004**
Inundatieduur	0.012	1	0.914
Interactie	**11.71**	**2**	**0.003**



Working to get there eventually!

Hilfred.huiting@wur.nl

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Country Updates: 1st EWRN Workshop

6

UK by Martyn C (BA)

Wireworms, the UK position

Martyn Cox Blackthorn Arable Ltd

European Wireworm Research Network 1st Workshop

Oslo, 7th July 2024

BLACKTHORN ARABLE LTD

Species

- The only major study on our species was in 1938-42, England & Wales only.

- Everything done since then indicates that three *Agriotes* species are our major crop pest.

- *Agriotes obscurus* generally present
- *A.lineatus* more in the West, but are in most areas.
- *A.sputator* dominant in the South East, virtually absent in the North.
- Some localised populations of *Athous haemorrhoidalis*.
- *Selatosomus aeneus* and *Ctenicera cuprea* present, no problems known.

- *Adrastus* and *Agrypnus*, not considered to be crop pests.
- *Hemicrepidius hirtus* / niger in peaty soils, pest status?

Crop damage

- **Potatoes are frequently damaged.**
  - Problems less frequent in processing sector, but tolerance higher.
  - Some processing varieties are very susceptible e.g. Innovator (despite TGA)
  - No data on actual level of damage in UK potatoes.

- **Other crops**
  - Cereal crops, becoming increasingly damaged
  - Vegetables: Cauliflowers, Leeks, Lettuces, Onions.
  - Maize.

- Some crops are much more tolerant, spring barley, spring beans , linseed.

Control options

- **In potatoes**
  - Fosthiazate
  - Increasing use of IPM: risk assessment, monitoring, variety, crop duration.
  - Variety + crop duration, a very powerful combination.

- **Other crops**
  - Tefluthrin seed treatments in sugar beet, vegetable crops, cypermethrin in cereals.
  - Entomopathogenic fungi are approved in the UK for some uses.
  - Work for registration with Beauveria bassiana, Lambda cyhalothrin ,Tefluthrin granules (potatoes, maize)
  - Nematodes are being considered as an option.

Research projects

- **Research in potatoes**
  - Cupgra work on varietal susceptibility, companion crops
  - Chemical control and new options (Potato partnership)

- **Projects (no specific crop)**
  - Fera Enigma 1: (Life cycles, monitoring, climate change, survey and DNA identification of species.
  - Rothamsted Research: Semiochemicals, work on improved bait traps.
  - Innovative Farmers: Study on autumn management of stubbles and survival of larvae.
  - EPF and VOC: (Wood et al. Swansea)

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Country Updates: 1st EWRN Workshop

7

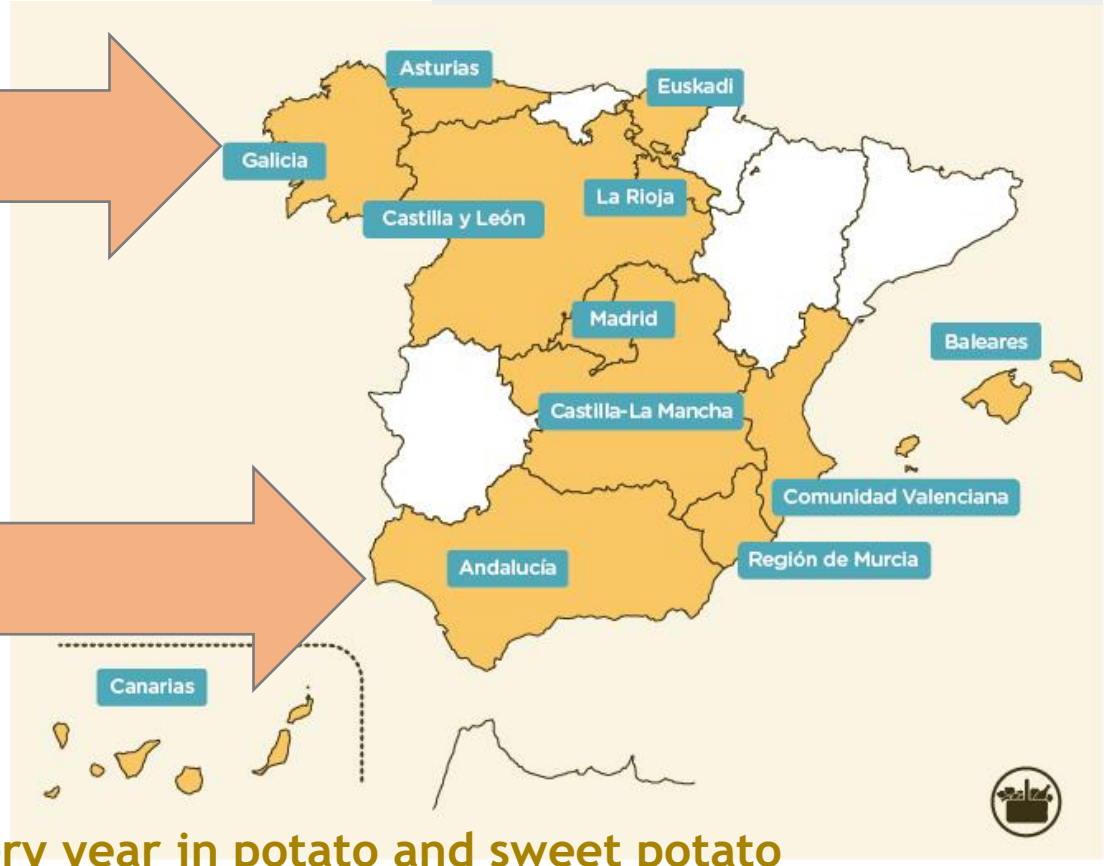
Spain by Amaia OB (NEIKER)

aortizb@neiker.eus

Potato growing areas

In northern Spain (temperate-humid-temperate *Cfb*), the two species usually recorded are:
Agriotes sordidus *(predominant in potato rotation)*
A. lineatus

In Southern Spain (Temperate-Dry-Subtropical *Csa*), it is possible to find:
A. obscurus
A. curtus
A. sputator
on sweet potato, cotton, maize and sugar beet.



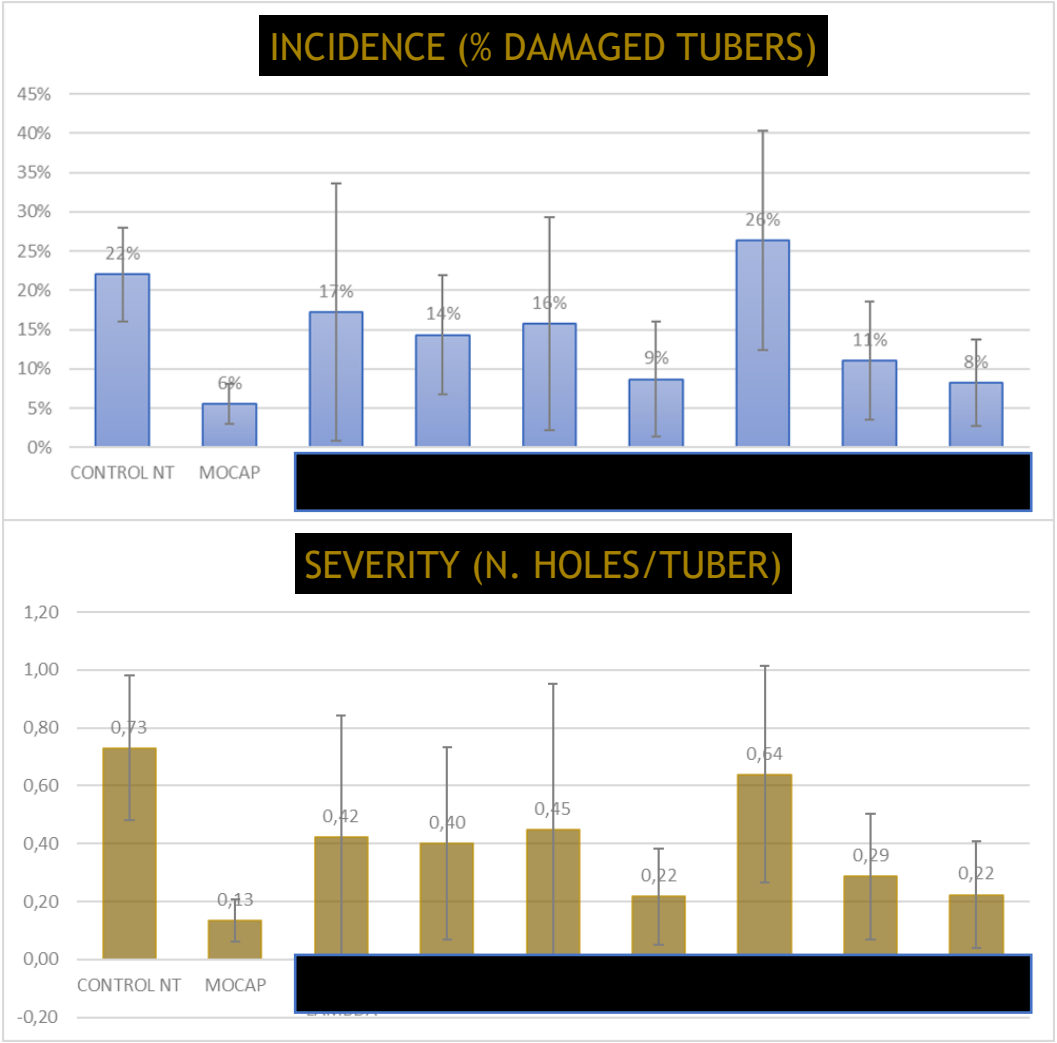
The damage is significant and recurrent every year in potato and sweet potato

- The priority research topics are focused on the evaluation of efficacy of commercial phytosanitaries to reduce the annual incidence and severity of damage.

- Other parameters taken into account in R&D studies are **crop rotation** and, above all, the timing and type of **irrigation** (drip or sprinkler irrigation).

- In Spanish potato breeding programs, varietal susceptibility has not been a priority parameter of selection.

- At the moment there are no projects funded by the Spanish Ministry, although there are projects funded in Spanish regional calls, in Andalusia (IFAPA) and in the Basque Country (NEIKER-BRTA).



So far, none of the products have consistently demonstrated efficacy equal to or greater than those that have been banned in 2019 (Mocap-Etoprophos Organofosforado)

In Spain there are **9 plant protection products** (5 active materials) authorized for potato.

In addition, there are 4 other products registered for crops other than potato.

Source: NEIKER (2019)

Nº Registro	Name	Company	Formula	Crop
ES-00377	MACISTE	SIPCAM	LAMBDA CIHALOTRIN 0,4% [GR] P/P	Potato
20111	NATURALIS	CBC IBERIA	BEAUVERIA BASSIANA (CEPA ATCC 74040) 2,3% (2,3X10E7 ESPORAS VIABLES/ML) [OD] P/V	Potato
22004	NEMATHORIN 10 G	ISK	FOSTIAZATO 10% [GR] P/P	Potato
ES-00067	POINTER GEO	SIPCAM INAGRA	LAMBDA CIHALOTRIN 0,4% [GR] P/P	Potato
ES-01191	SOILGUARD 0.5 GR	SHARDA (España)	TEFLUTRIN 0,5% [GR] P/P	Potato
ES-00521	SPINTOR GR	SBM DEVELOPPEMENT	SPINOSAD 0,4% [GR] P/P	Potato
ES-00068	TRIKA LAMBDA 1	SIPCAM INAGRA	LAMBDA CIHALOTRIN 0,4% [GR] P/P	Potato
ES-01428	TRIKA LAMBDA 2	SIPCAM INAGRA	LAMBDA CIHALOTRIN 0,24% [GR] P/P	Potato
ES-01429	TRIKA LAMBDA 4	SIPCAM INAGRA	LAMBDA CIHALOTRIN 0,15% [GR] P/P	Potato
ES-01280	FUERZA	SHARDA (España)	TEFLUTRIN 0,5% [GR] P/P	Crops, NOT for potato
17502	LEBRON	ADAMA ESPAÑA	TEFLUTRIN 0,5% [GR] P/P	Crops, NOT for potato
25760	METEOR	DIACHEM	DELTAMETRIN 1,57% [SC] P/V	Crops, NOT for potato
ES-01151	SOILGUARD 1.5 GR	SHARDA (España)	TEFLUTRIN 1,5% [GR] P/P	Crops, NOT for potato

The loss recorded in the last five years due to wireworm in ware potato in Spain

Source: UDAPA S Coop. (One of the biggest ware potato trader in Spain, mainly Spanish and Southern French production

% Damaged Potato batches* in Spain (Peninsular) and France (Southern)

2018	5%
2019	7%
2020	7%
2021	12%
2022	13%
2023	16%

Dry autumns

Damaged potato batches threshold: an incidence > 7-8% tubers with more than 4 holes/tuber before washing and mechanical rejection of damaged tubers

The damaged batches* are not commercialized as ware potato, they are intended for industrial potatoes (processed)

NEIKER

MEMBER OF
BASQUE RESEARCH
& TECHNOLOGY ALLIANCE

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ETA AZPIEGITURA SAILA

DEPARTAMENTO DE DESARROLLO
ECONÓMICO E INFRAESTRUCTURAS

Country Updates: 1st EWRN Workshop

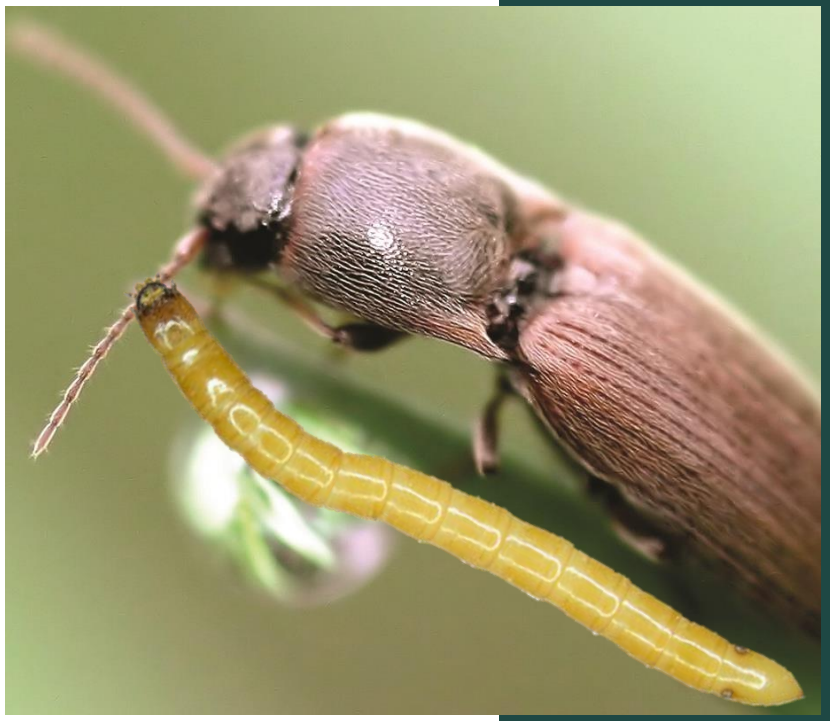
8

France by Ronan LC (INRAE-UMR)

RÉPUBLIQUE FRANÇAISE

Liberté
Égalité
Fraternité

Wireworm issues, research areas and knowledge gaps in France todate



Le Cointe Ronan[1], Larroudé Philippe[2], Thibord Jean-Baptiste[2], Cigna Jeremy[2], Ngala Bruno[3], Le Hingrat Yves[3], Plantegenest Manu[1] and Poggi Sylvain[1]

[1]INRAE – IGEPP – Team *Ecology and Genetics of Insects*
[2] *Arvalis Institut du Végétal*
[3] *Inov3PT*

ronan.le-cointe@inrae.fr

European Wireworm Research Network, 1st workshop – Oslo – 7 July 2024

Context in France : an increase in damage in recent years

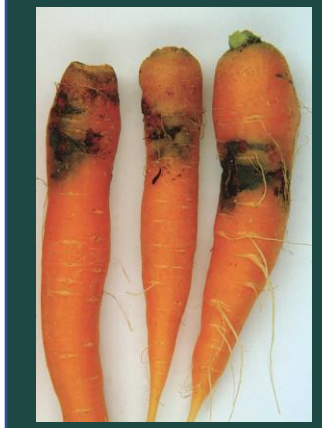
→ No more chemical pesticides reducing larval density

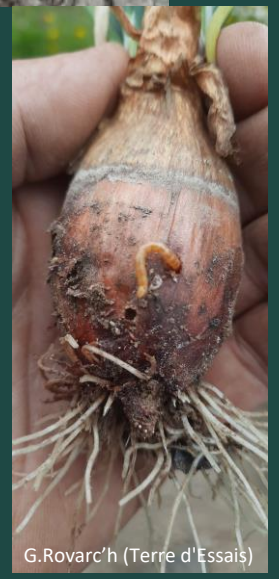
- Gradual withdrawal of pesticides since 20 years

- Permanent ban of ethoprophos in 2019

- Few authorised molecules left (lamba-cyhalothrine), Spinosad, *Beauveria bassiana*)

- **Major crops at risk of wireworm damage**: potatoes, maize, carrots, lettuce, bulbs





G.Rovarc'h (Terre d'Essais)

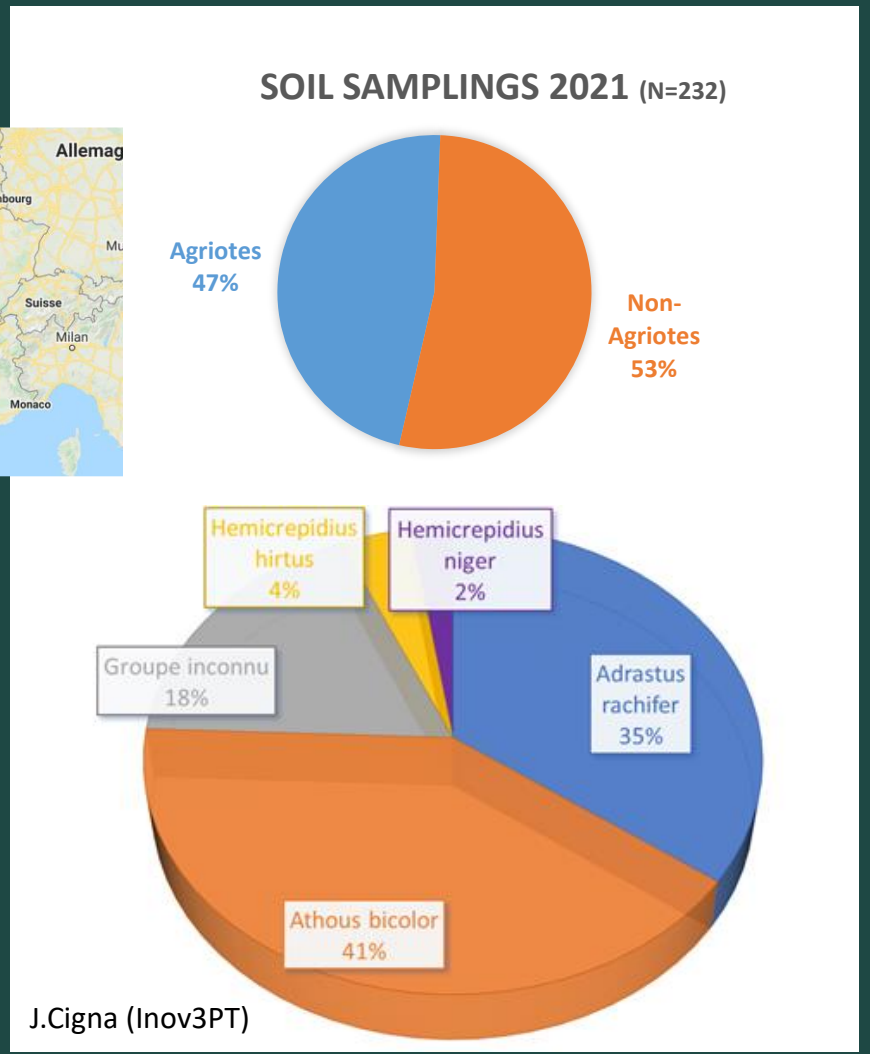
Le Cointe *et al.*, 2023. Innovations Agronomiques, 83, 78-90.

Many crops are regularly damaged by wireworms leading to both yield losses and a deterioration in product quality.

Context in France : species distribution

→ 2021 : survey including 232 plots previously cultivated with potatoes

- *Predominant species (other than Agriotes) :*
  - *Athous bicolor (41 %)*
  - Adrastus rachifer (35 %)
  - Athous campyloides (18 %)
  - Hemicrepidus (6 %)



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  - Hemicrepidus (6 %)

?? Role of non Agriotes

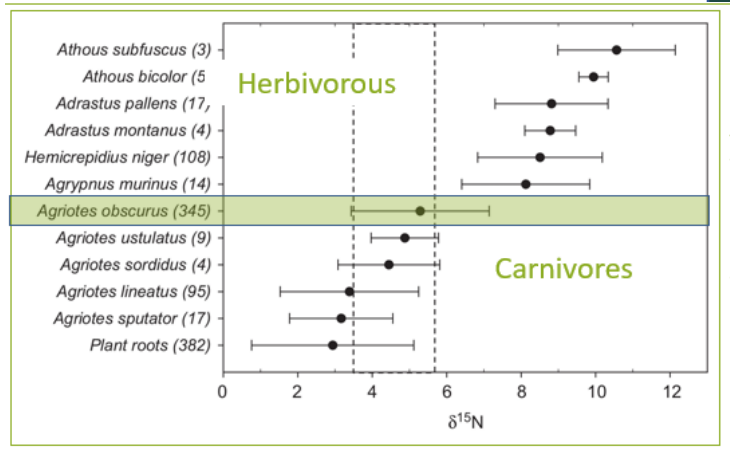
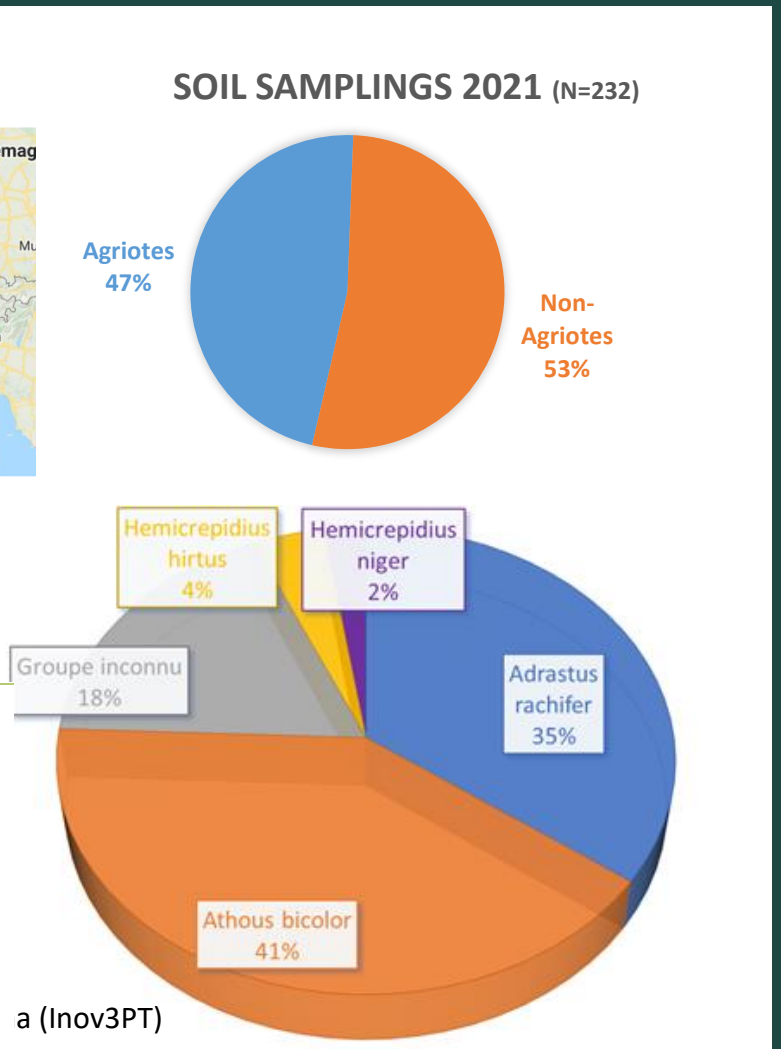


Fig. 4. Mean δ15N signatures of plant roots and elaterid larvae collected from Central European arable land. (Traugott, SBB, 2008)



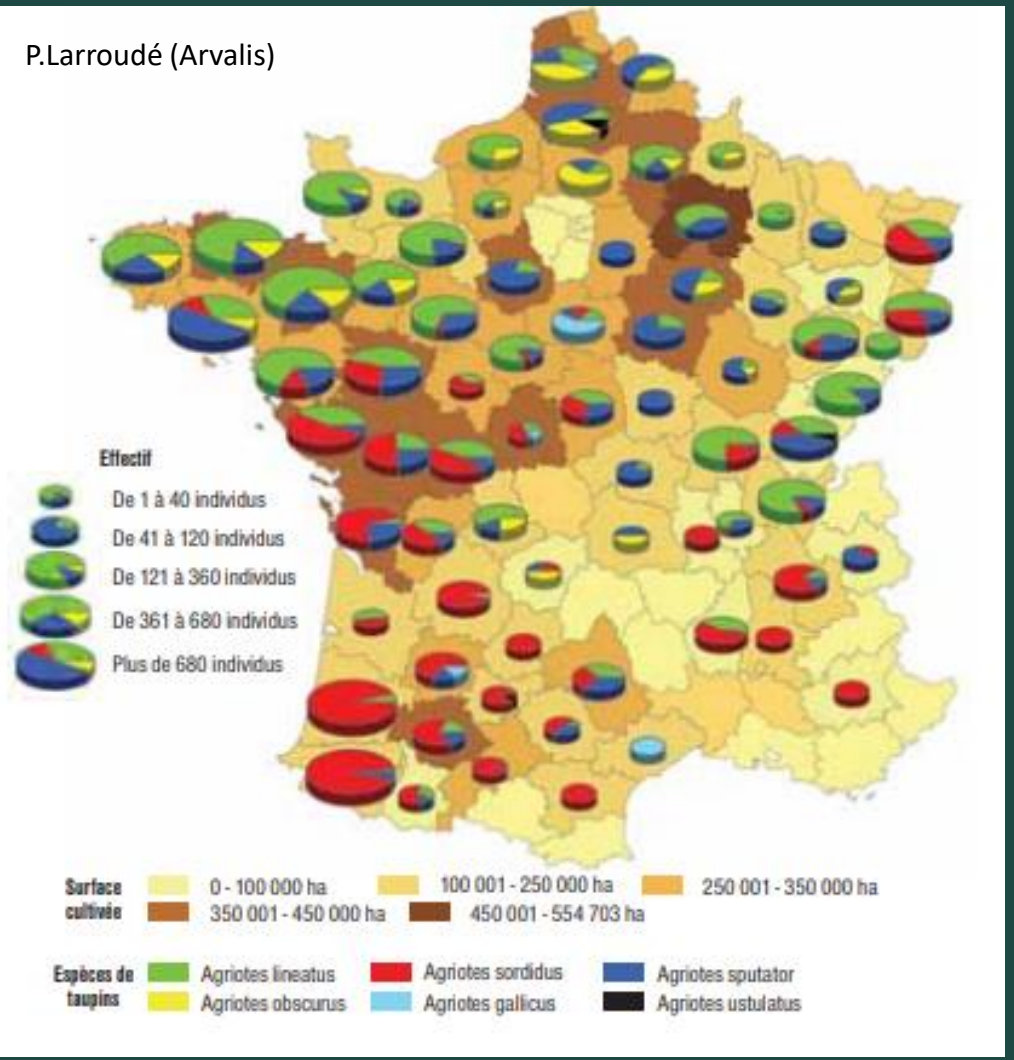
a (Inov3PT)

Context in France : species distribution

→ 2005 – 2014 : survey including 1200 maize fields

- *Predominant Agriotes species :*
  - *Agriotes lineatus (42,5 %)*
  - *Agriotes sordidus (29,5 %)*
  - *Agriotes sputator (20,4 %)*
  - *Agriotes obscurus (6,7 %)*

P.Larroudé (Arvalis)

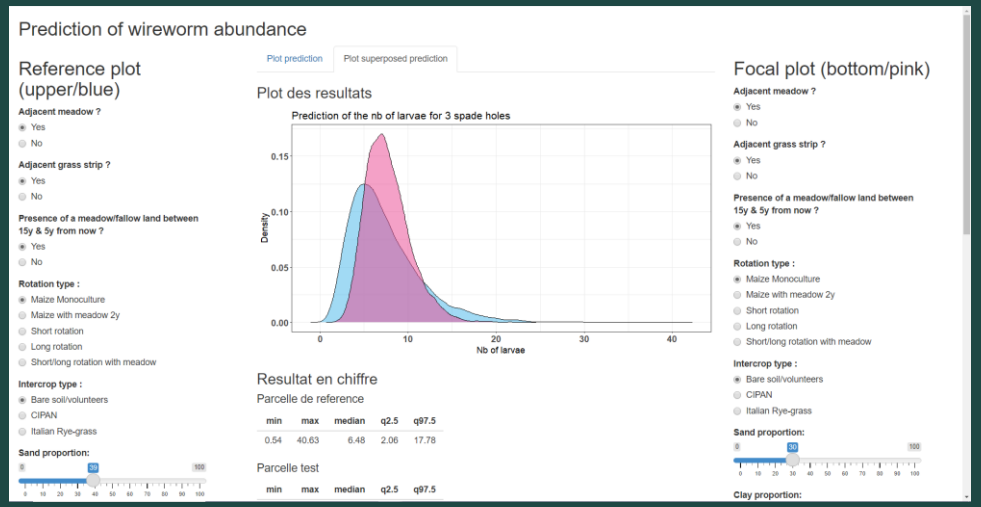


Larroudé *et al.*, 2015. Perspectives Agricoles, 427.

› Research priorities in France (1/3)

→ Developing tools for risk assessment

- First step : predicting wireworm abondance in plots



Roche J. et al., 2023. Smart Agricultural Technology,4.

?? Best way to assess larval density

Soil sampling
Baiting
Molecular tools …

Research priorities in France (1/3)

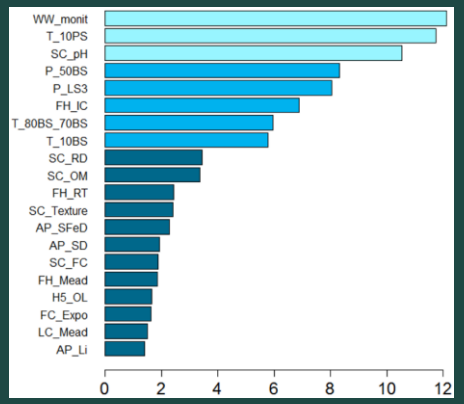
→ Developing tools for risk assessment

- Second step : understanding of the crop-specific processes that lead to damage

Dichotomy between crops for which the damage occurs at the beginning of the crop and those for which the damage occurs at the end of the crop

> Larval density

> Wheather conditions at sowing



Poggi S. et al., 2018. Journal of Pest Science.

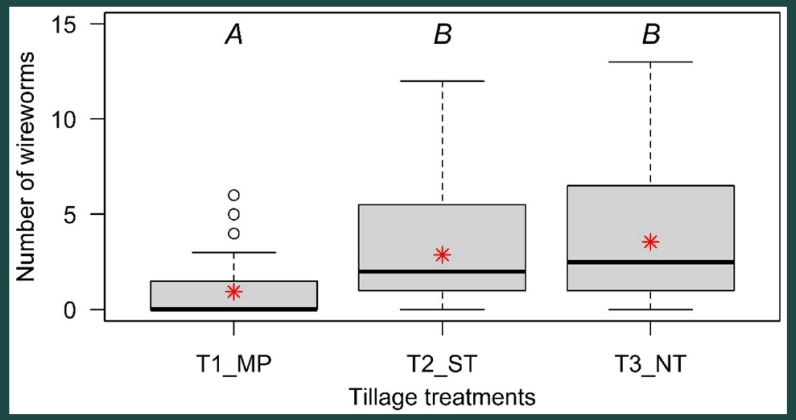
> In progress

> Length of period between haulm kill and harvest ?

Research priorities in France (2/3)

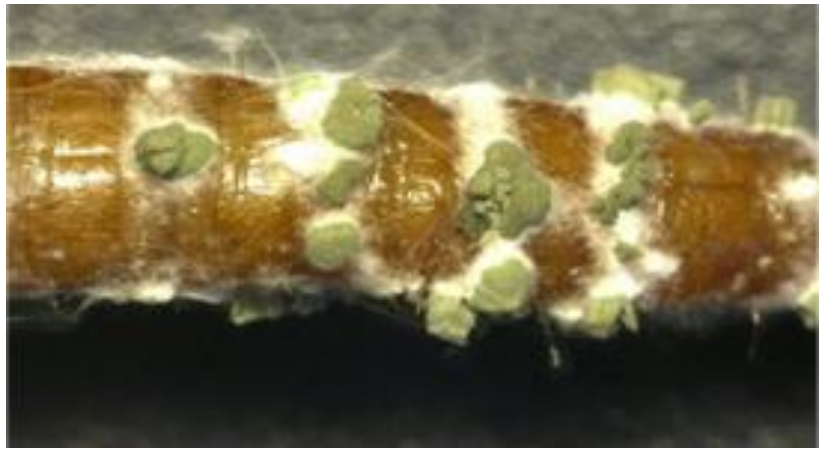
→ Reducing wireworm abundance

- *Effect of crop rotation*
- Effect of tilling >>>>>



Le Cointe R. et al., 2023. Arthropod-Plant Interactions.

- Fungi

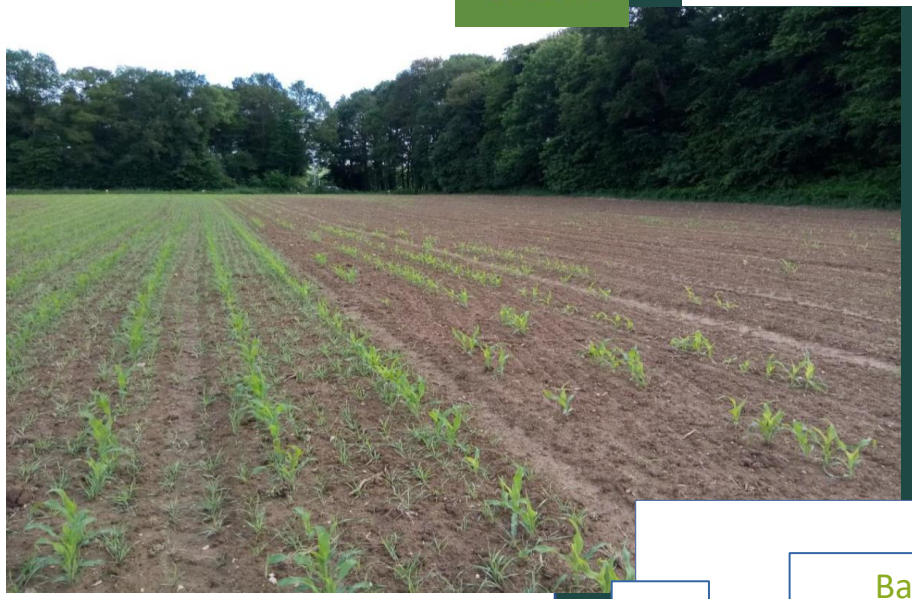


- Nematodes

?? Practices increasing EPFs or EPNs ??

› Research priorities in France (3/3)

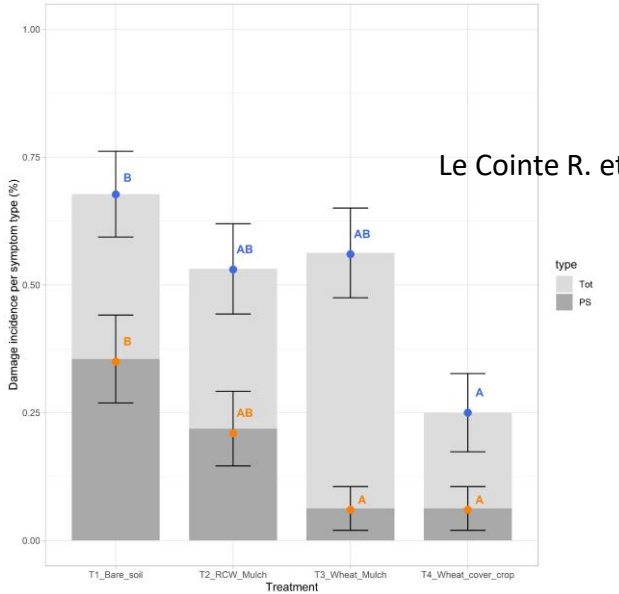
→ Crop Damage Management



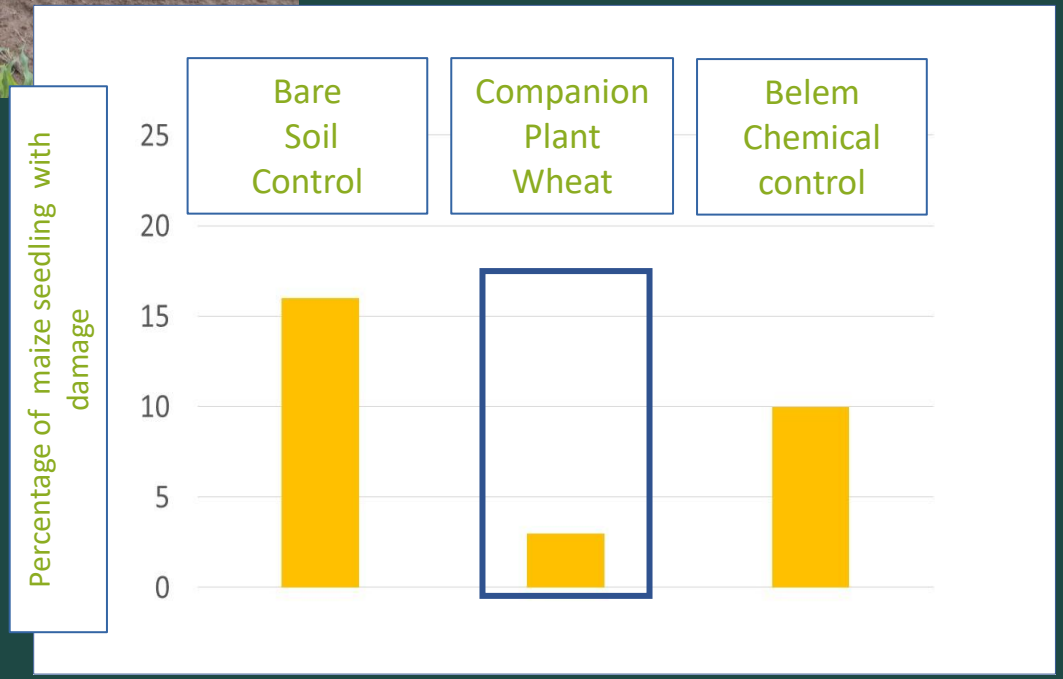
Thibord JB. *et al.*, 2017. Innovations Agronomiques, 55, 215-233.

- <u>Companion Plants:</u>

> Feeding Pests as an IPM Strategy



Le Cointe R. et al., 2023. Arthropod-Plant Interactions.

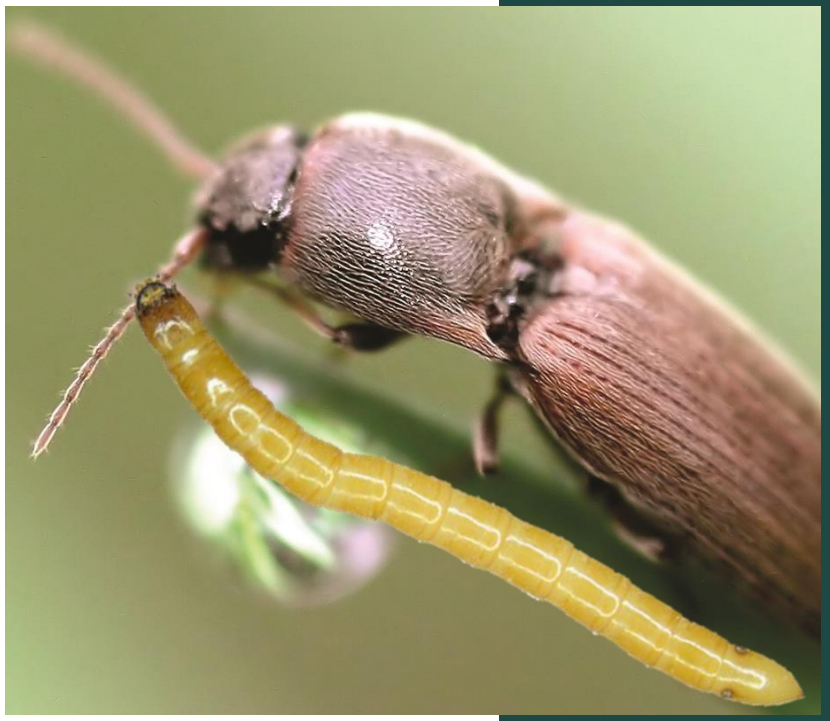


?? How to implement this strategy to other crops than maize ??

RÉPUBLIQUE FRANÇAISE

Liberté
Égalité
Fraternité

Thank you for your attention



ronan.le-cointe@inrae.fr

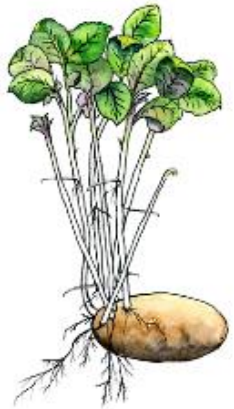
Country Updates: 1st EWRN Workshop

9

Sweden by Rolin A (PAR)

Wireworm in Sweden

Oslo 7 juli 2024

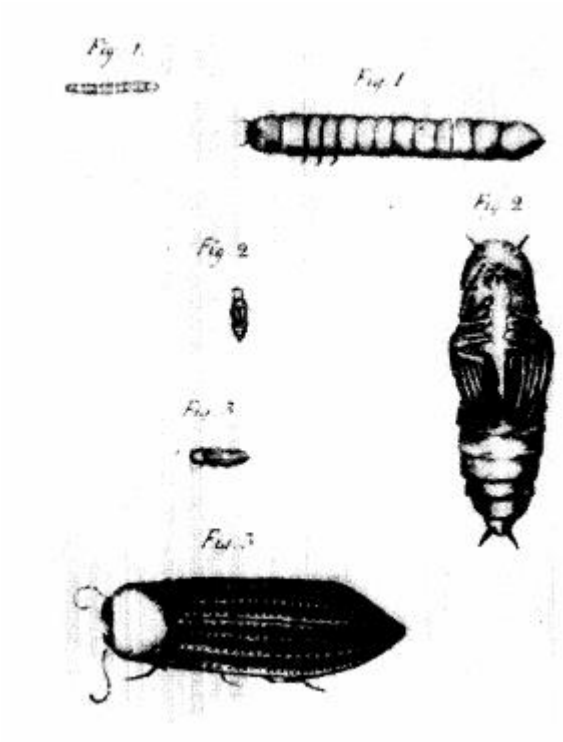


Potatiskonsult

Åsa Rölin

” My fortunes and my pleasure has been to discover the wireworms, to their nature, way of life and characteristics: the future is to invent happier means to exterminate and reduce them"”

(Carl Bierkander 1779)



Agriotes lineatus and A. obscurus are the main pests. Problems are increasing.
Less cultivation and stricter quality requirements are some reasons. No pesticides are allowed. Still need for solutions.

(Åsa Rölin 2024)

Crop rotation and tillage impact on occurrence of wireworm, 2006 -2009.

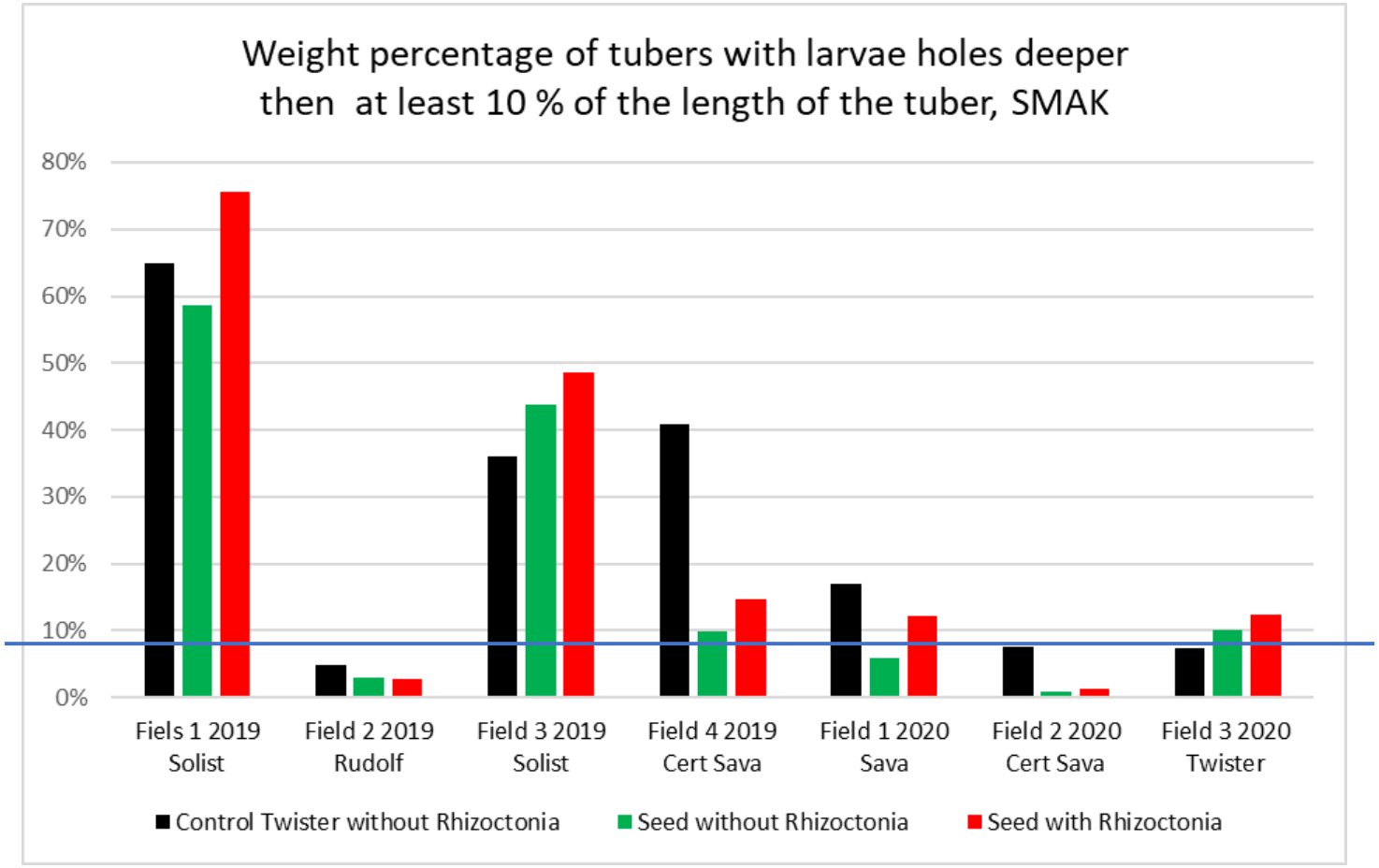
Different crop rotation and tillage were investigated.

Result:
A rotation with cereals and grass as intermediate crop significantly increased damaged caused by wireworms.

The result shows that there is a tendency for cultivation and crop rotation to reduce the number of larvae where fallow has been for a long time. The author cannot say whether crop rotation or tillage is better for reducing the number of larvae.

A Krijger., 2011. Stiftelsen lantbruksforskning H0842022, Final report 10 pages

Field trial with seeds with or without Rhizoctonia



Trials made by Åsa Rölin financed by Jordbruksverket

Catching Clickbeetles, 51 fields 2008-2013

Crop	average number of beetles	variation	Amount of fields
Faba bean	14	10-19	2
Oilreddish	28	5-49	4
Triticale	35	14-67	4
Potatoes	60	15-150	2
Oat	95	17-237	7
Winter wheat	195	56-420	3
Barley	227	17-535	16
Wild grass nature	566	380-822	6
Ley	663	131-1828	7

Investigation made by Åsa Rölin och Pia Björsell in Värmland

Country Updates: 1st EWRN Workshop

10 A

Germany by Manuela S (CIDSSCP)

SIMAGRIO-W

Decision support system to predict wireworm activity

Manuela Schieler, Lena Müller, Kathleen Kohrs, Jeanette Jung, Juliane Schmitt, Benno Kleinhenz, Paolo Racca

Central Institute for Decision Support Systems in Crop Protection, Germany

1st European Wireworm Workshop

07.07.2024, Oslo

Who are we? - Structure and Network of ZEPP

ZEPP

- Agreement of federal states in Germany
- **Development**, **validation** and **maintenance** of weather-based **models** and **decision support systems (DSS)** for important pests and diseases in Agriculture and Horticulture

Network of ZEPP

Crop protection services of federal states in Germany

ZEPP

Model developer
Scientific Institutes
e. g. Universities,
JKi

Other partners
isip wissen wie's wächst
Deutscher Wetterdienst
Wetter und Klima aus einer Hand
DWD
Software agencies etc.

isip
wissen wie's wächst

Informationsystem for Integrated Crop Production

- Registered association
- Realization and maintenance of hompage for consulting service

www.isip.de

Updates from Germany

- Sampling sites with high and low infestation rates
- Sugar beets: Secundary pests like rooks
- Potato
- Tendency to higher infestation but not area-wide

- Recent projects where ZEPP was/is involved:
  - SIMAGRIO (2009-2014)
  - ElatPro (2016-2019)
  - NIKIZ (2020-2023)
  - ValiProg (2019-2024)

Sugar beet site, rooks are searching for wireworms

Monitoring

Field samples

- 5 flowerpots per sample site
- Filled with vermiculite and germinated wheat seeds
- [illegible] per week
- [illegible]er site to

Voche 1)

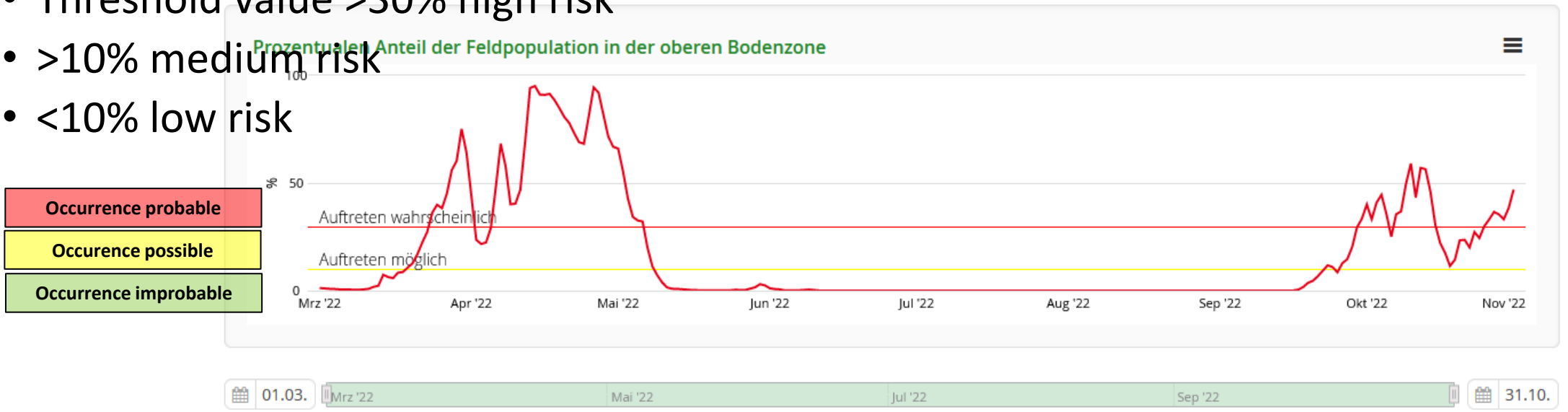
lle 1 (Woche 2)

Semi-field samples

- 2 flowerpots per cage
- Filled with vermiculite and germinated wheat seeds
- Sample

Decision Support System – SIMAGRIO-W

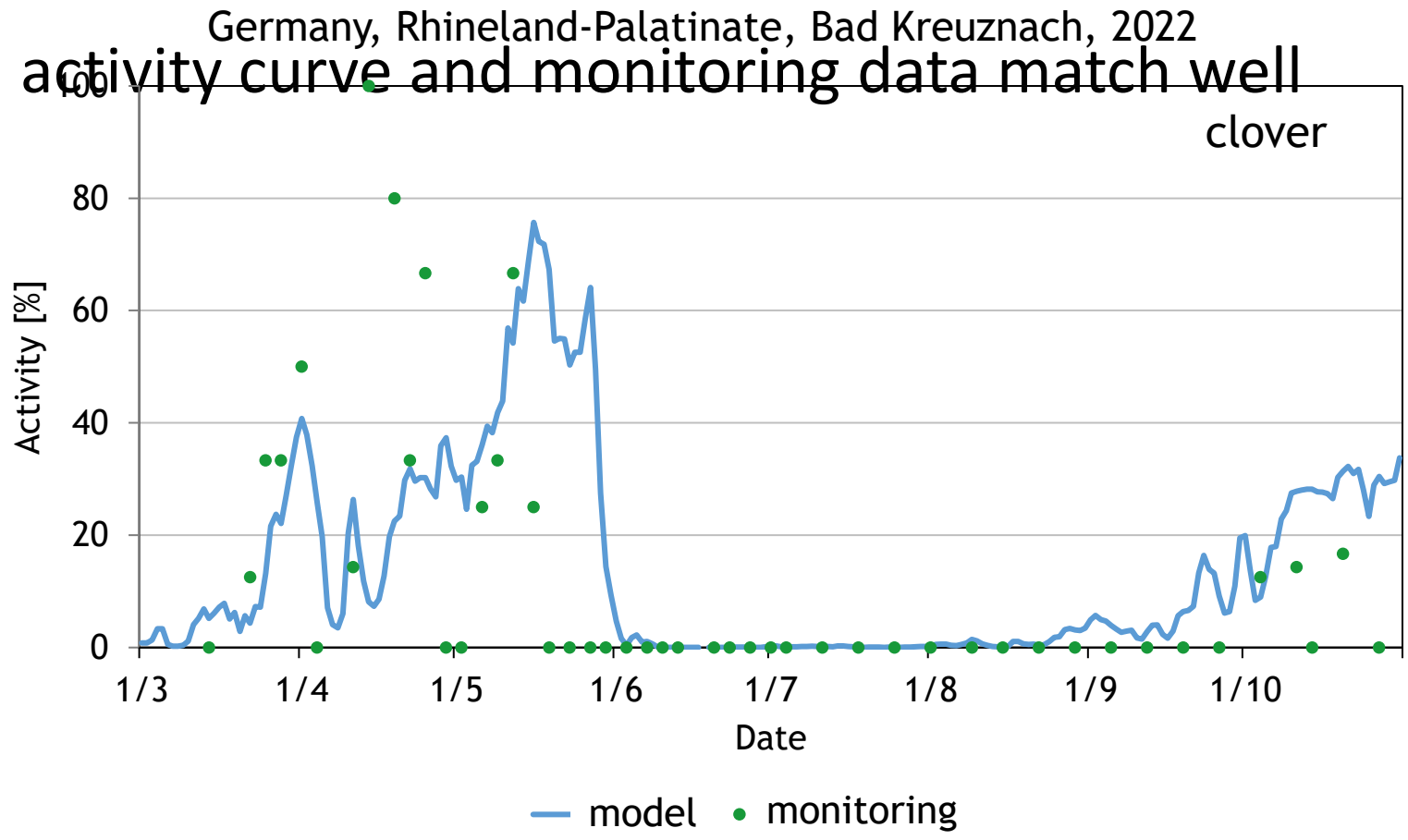
- Input: soil temperature, calculated soil moisture, crop, soil type
- Output:
  - wireworm activity in upper soil layer
  - Threshold value >30% high risk
  - >10% medium risk
  - <10% low risk



isip
wissen wie's wächst

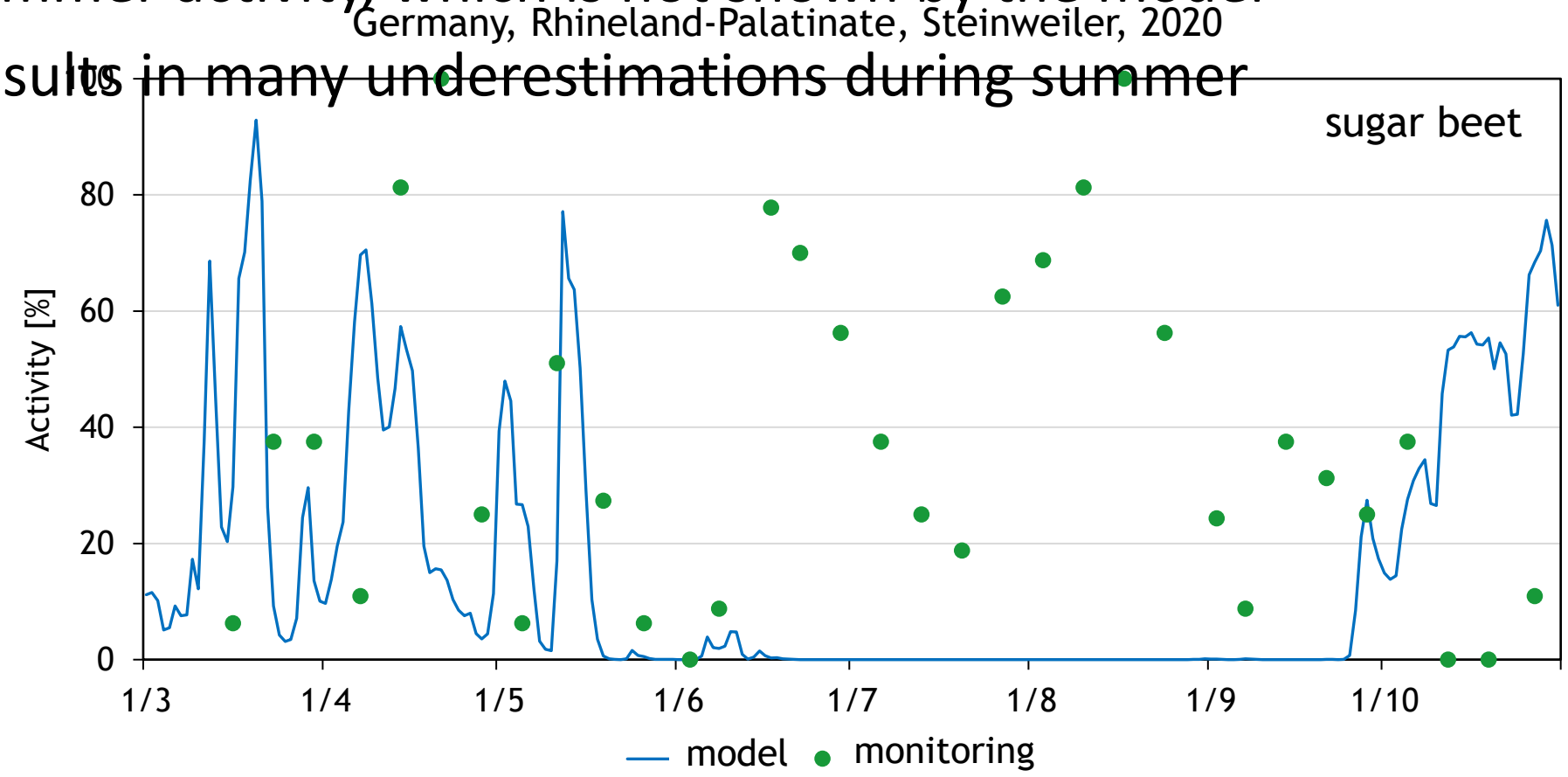
Semi-field sample site

- Model activity curve and monitoring data match well



Field sample site

- Summer activity, which is not shown by the model
- Results in many underestimations during summer



Conclusion




- Start of activity in spring is mostly correct
- Model usually has a spring and fall peak, latest monitoring data sometimes show activity in summer
- Checked the model with different temperature thresholds (soil temperature has a higher impact on model output than soil moisture), just little improvements
- Not enough monitoring data sets to improve model thoroughly
- Not sure if sampling method is good enough, sometimes crops might lure wireworms more than traps
- Wireworm activity season might get longer due to higher temperatures in fall and winter???

Thank you for listening!!

ElatPro
&

NIKIZ

Funded by:

Gefördert durch
Bundesministerium für Ernährung und Landwirtschaft
aufgrund eines Beschlusses des Deutschen Bundestages

Projektträger
Bundesanstalt für Landwirtschaft und Ernährung

Country Updates: 1st EWRN Workshop

10 Ƀ

Jörn Lehmhus (JKI)

Relevant Wireworm Species in Germany

Jörn Lehmhus

Institute for Plant Protection in Field Crops and Grassland, Messeweg 11-12, 38104 Braunschweig

Nationwide Click beetle + Wireworm-Monitoring 2010-2021

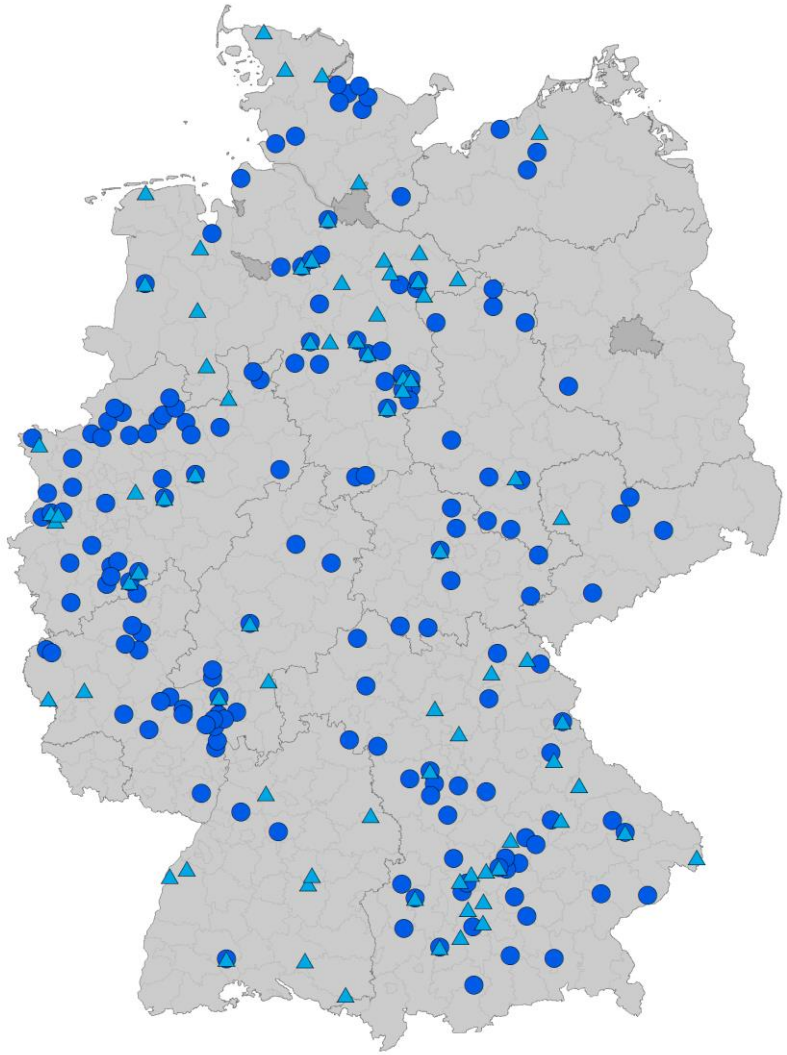
Material and Methods

- Pheromone traps (Yatlor traps) used to monitor click beetles of *Agriotes* species
- Bait traps for wireworms at some monitoring sites (bait: wheat grains soaked 24h in water)
- Cooperation with plant protection services of federal states, University of Göttingen and ZEPP, coordination by JKI
- Additionally high numbers of wireworm samples from farmers field sites with a history of wireworm damage were sent to JKI
- Wireworms and click beetles identified to species at JKI

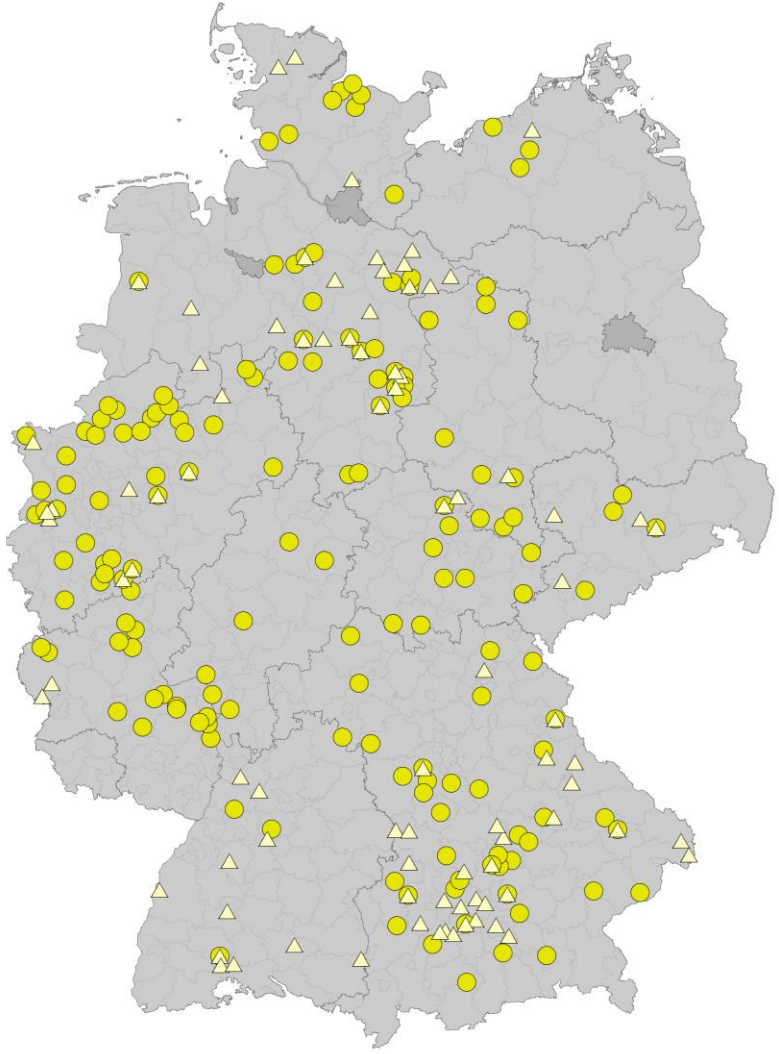
→ Maps of click beetle / wireworm occurrence on agricultural fields in Germany

Jörn Lehmhus, Institute for Plant Protection in Field Crops and Grassland, Messeweg 11-12, 38104 Braunschweig

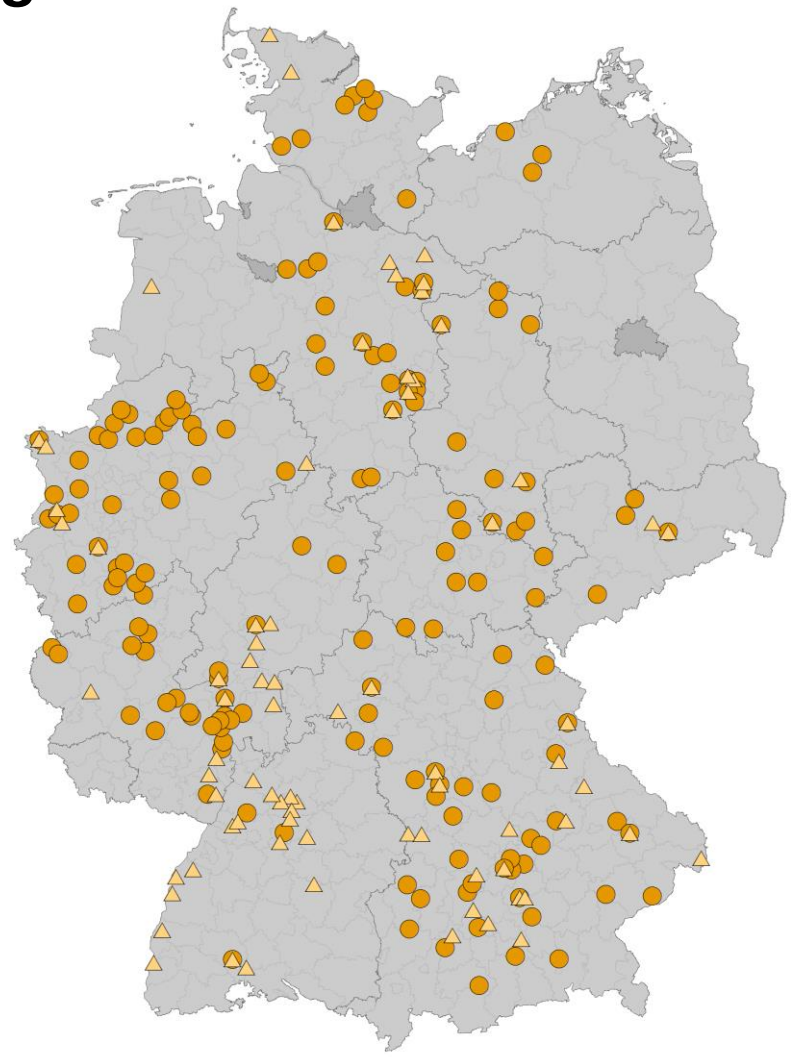
Nationwide Click beetle + Wireworm-Monitoring 2010-2021



Agriotes lineatus
Wireworms widespread in agricultural land



Agriotes obscurus
Wireworms widespread in agricultural land



Agriotes sputator
Wireworms widespread in agricultural land

△ Wireworms ○ Click beetles

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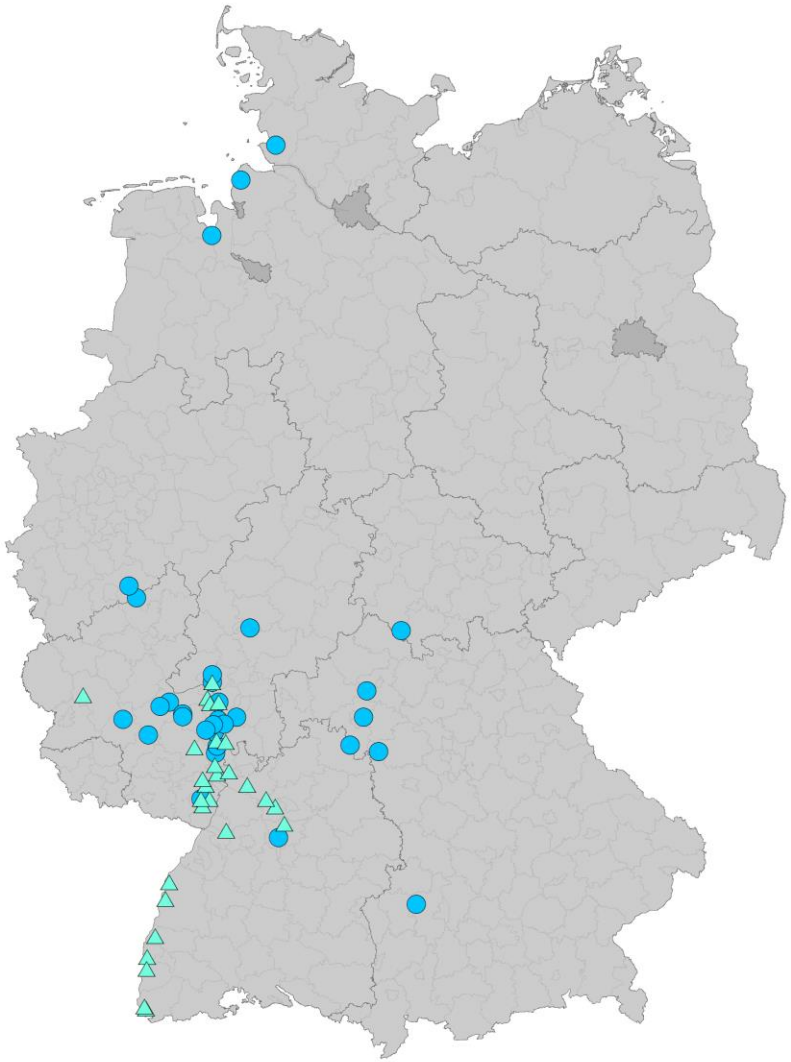
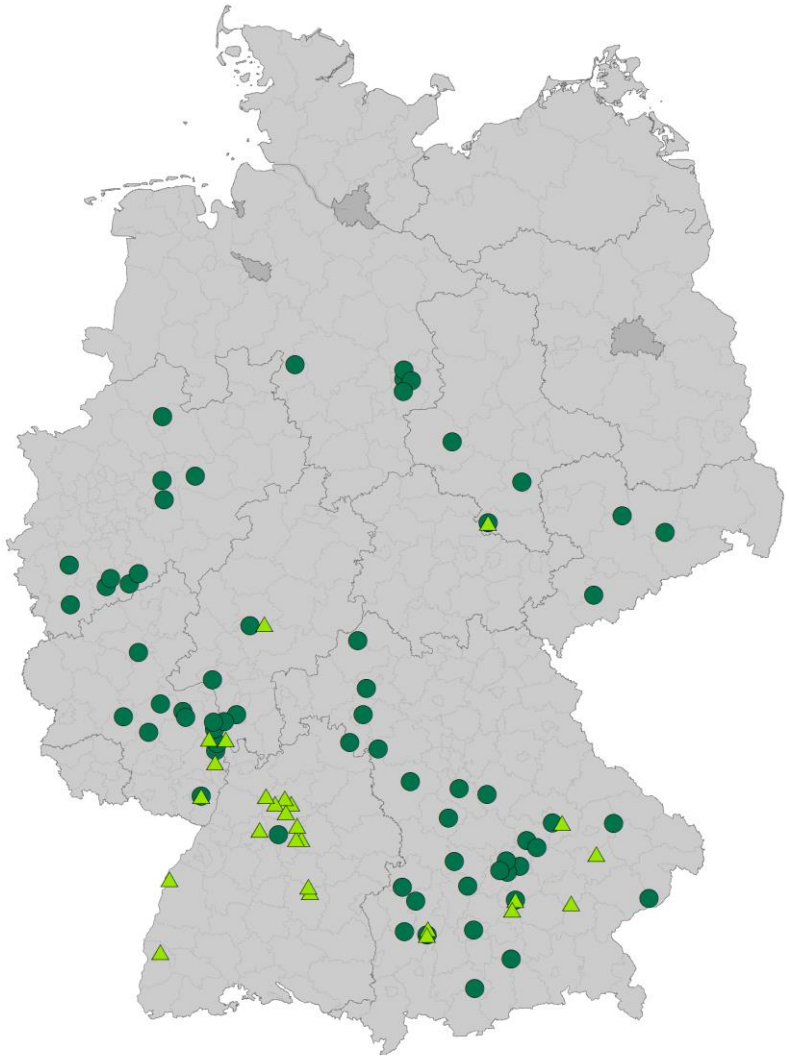
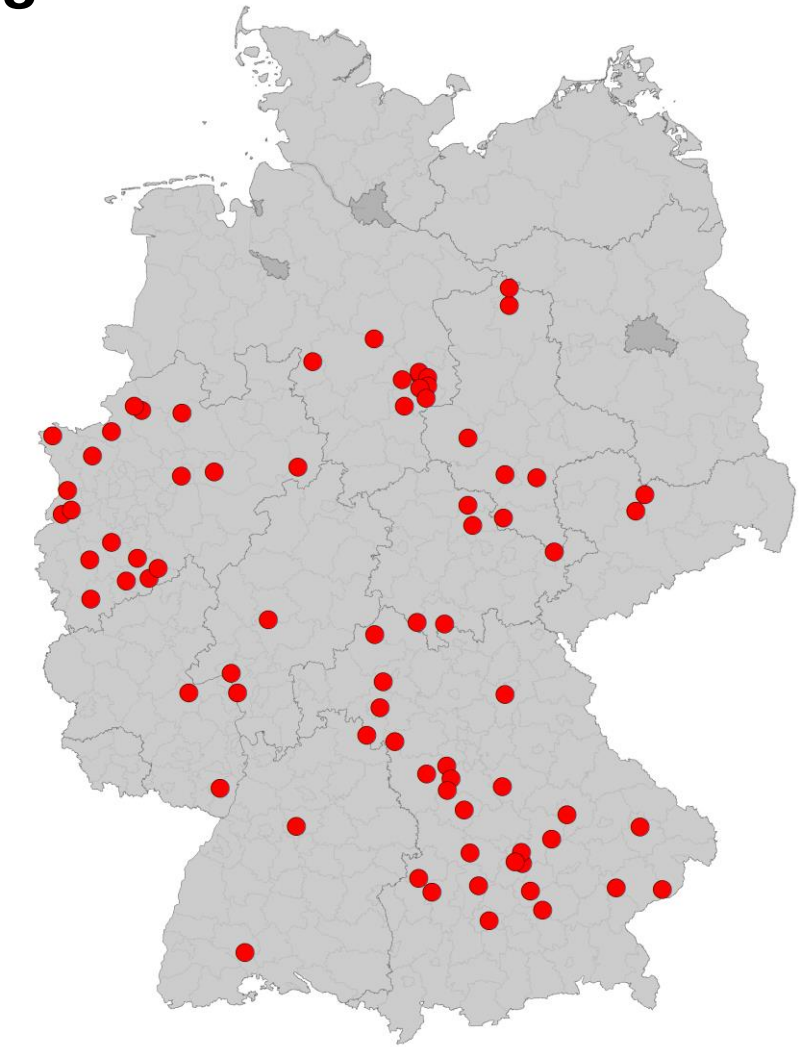
Nationwide Click beetle + Wireworm-Monitoring 2010-2021



Agriotes sordidus
Wireworms on agricultural land only in the Upper Rhine valley and adjacent regions



Agriotes ustulatus
Wireworms in agricultural land only in the southern half of Germany



Agriotes gallicus
No wireworms in agricultural land

△ Wireworms ○ Click Beetles

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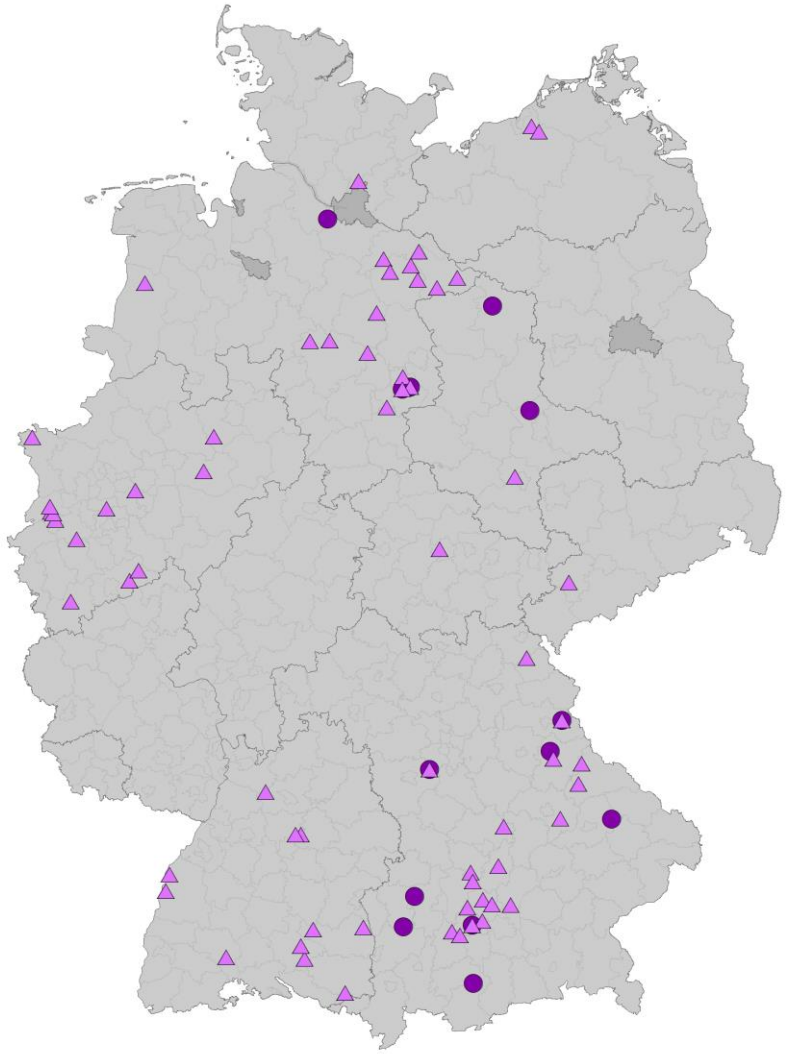
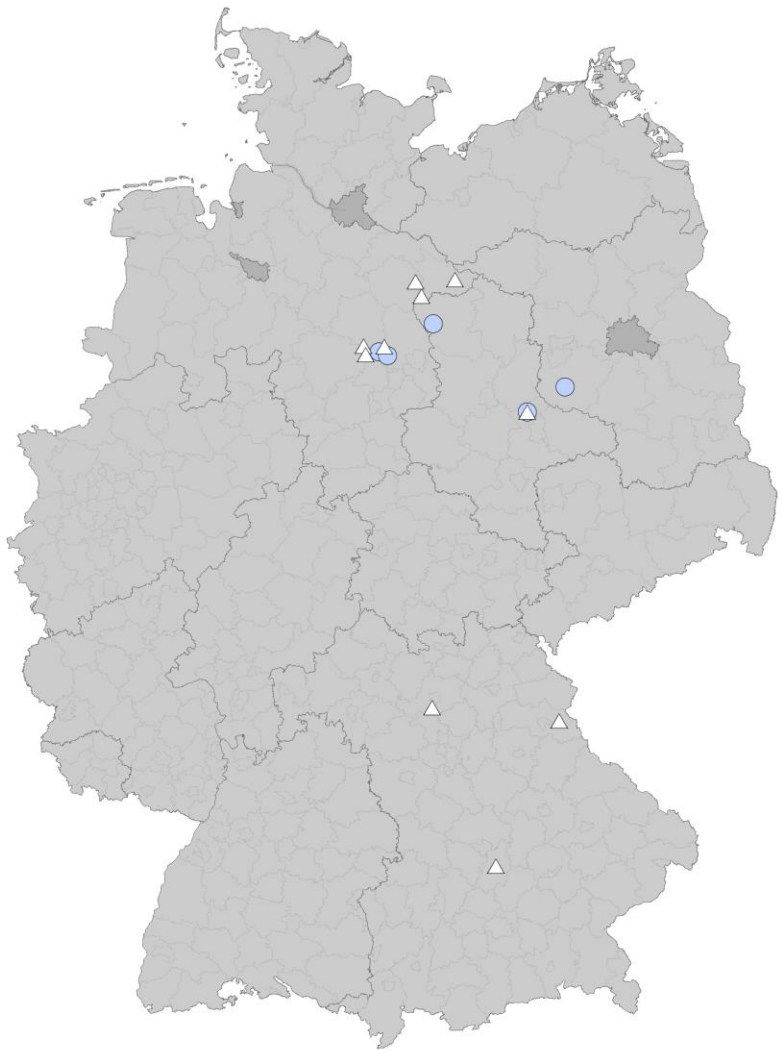
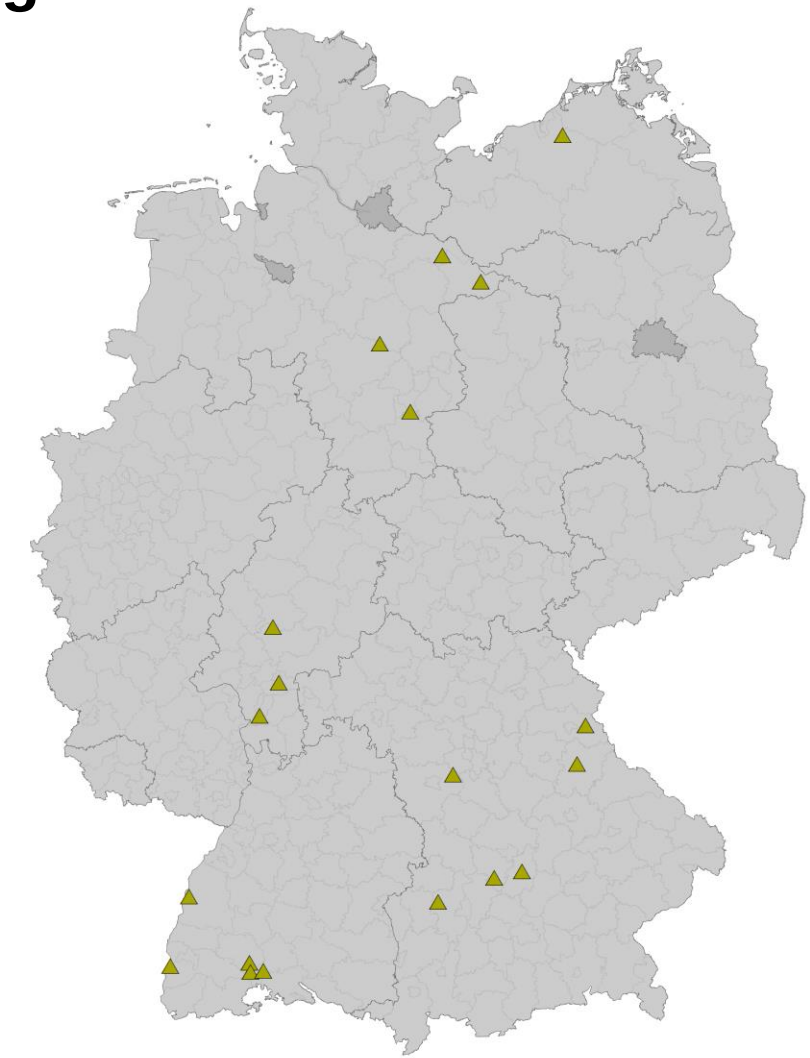
Nationwide Click beetle + Wireworm-Monitoring 2010-2021



Hemicrepidius niger
Wireworms widespread in agricultural land



Selatosomus aeneus
Wireworms only in agricultural sites with sandy soils, but can reach extreme densities



Agrypnus murinus
Wireworms rarely in agricultural land, but high abundance under grassland

△ Wireworms ○ Click beetles

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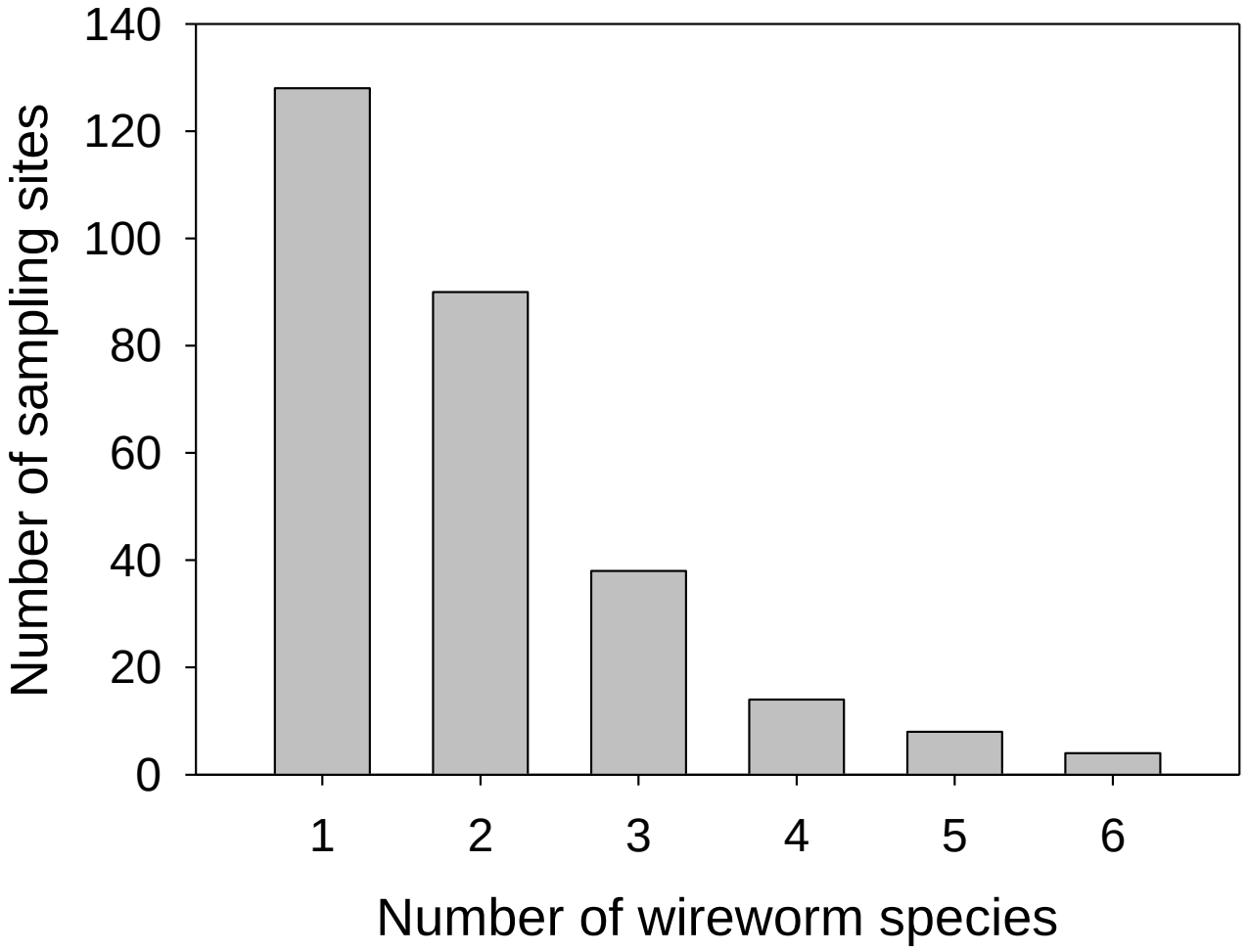
Wireworm sampling 2010-2021
Wireworm species at sampling sites



282 samples with at least 5 wireworms sent to JKI from farmer´s sites

- 45% of samples with only 1 species
- 32 % of samples with 2 species
- 23% of samples with 3-6 species

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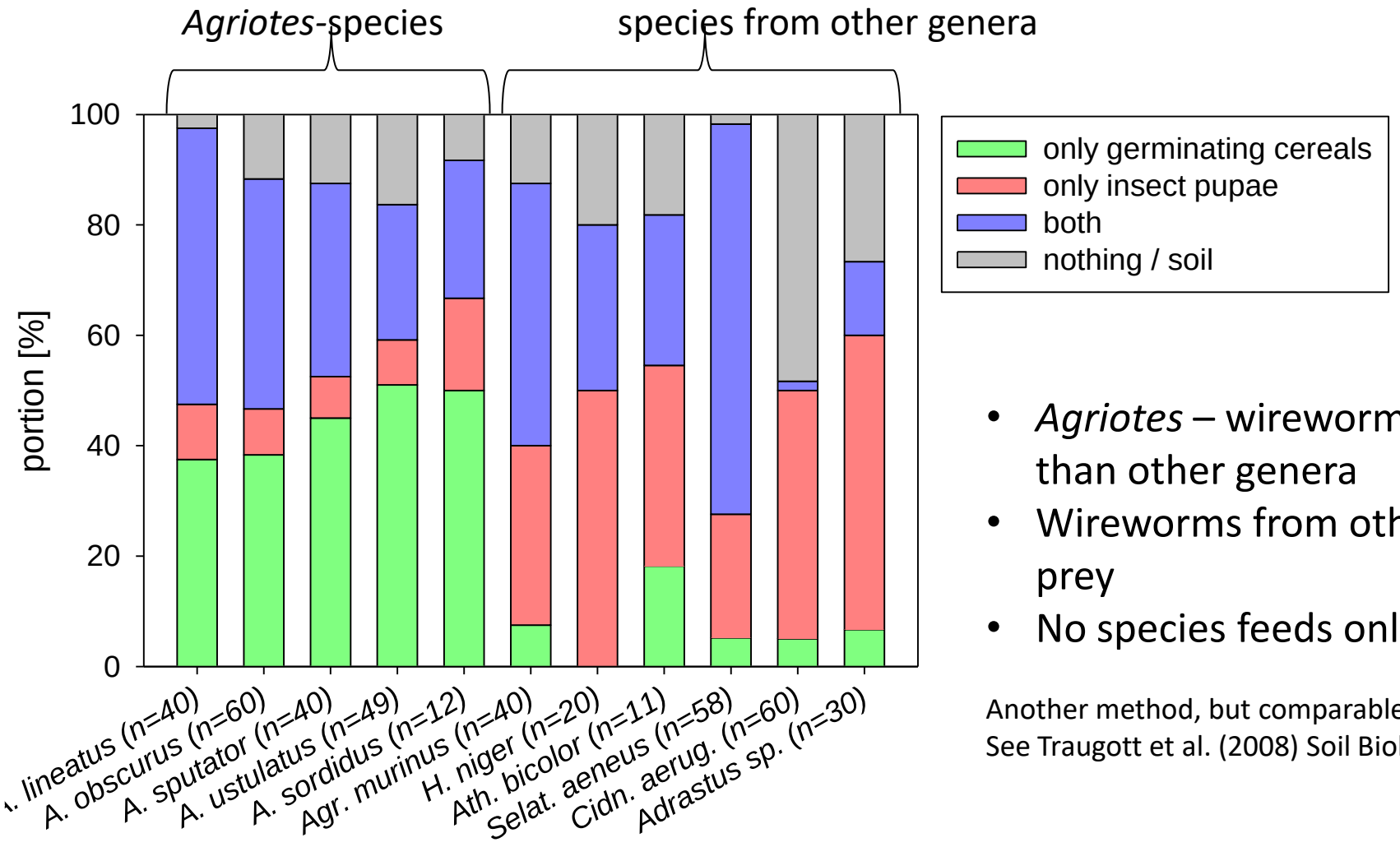
Biological traits: Wireworm feeding choice trials: Food preferences of different species



- *Agriotes* – wireworms take more plant matter than other genera
- Wireworms from other genera prefer animal prey
- No species feeds only on one type of food

Another method, but comparable results:
See Traugott et al. (2008) Soil Biology & Biochemistry 40, 342–349

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Nationwide Click beetle and Wireworm monitoring 2010-2021: Summary

- ***Agriotes lineatus, A. obscurus, A. sputator***
- ***Agriotes sordidus*** (only southwestern Germany), ***A. ustulatus*** (only southern Germany)
- *Hemicrepidius niger* (syn. *Athous niger*)
- *Selatosomus aeneus* (syn. *Corymbites aeneus)*; regionally on light, sandy soils, sometimes in extreme densities
- Locally damaging: *Athous haemorrhoidalis, Athous bicolor, Cidnopus aeruginosus*
- Rarely damaging, generally in occurring in low densities: *Melanotus* species, further *Athous* species, *Hemicrepidius hirtus, Agrypnus murinus,* further *Cidnopus* species
- At most sites only one or two wireworm species found
- *Non* –Agriotes species generally also less damaging due to preference for animal prey

Jörn Lehmhus, Institute for Plant Protection in Field Crops and Grassland, Messeweg 11-12, 38104 Braunschweig

Outlook

- Return of extremely effective chemical insecticides for wireworm control in Europe unlikely
- „Biological difficulties“ with wireworm control by entomopathogenic fungi can be reduced, but are unlikely to be fully overcome, combination of fungi strains might be a way to sort out species specific effects (project **AgriMet**, finished)
- New formulations for encapsulation? New methods: RNAi? (project **KoBRA** hopefully to start next year)
- Less susceptible potato varieties (project in early planning phase, preliminary results promising)
- Beside insecticidal control, other mitigation measures are necessary (e.g. soil cultivation, no harmful crops in crop rotation)

Only a combination of measures can be successful against this polyphagous, multi-species group of pests

Jörn Lehmhus, Institute for Plant Protection in Field Crops and Grassland, Messeweg 11-12, 38104 Braunschweig

Thank you
for your attention!

Many thanks to the very many colleagues from plant protection services, ZEPP, universities, companies, JKI and to all farmers, which have contributed to the **monitoring results**.

Jörn Lehmhus, Institute for Plant Protection in Field Crops and Grassland, Messeweg 11-12, 38104 Braunschweig