



IPM CONFERENCE 2024

Holistic IPM: Reducing pesticide use

BRUSSELS • MAY 14TH



Pest regulation through landscape diversity

*Sandrine Petit
Inrae*



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UNDER GRANT AGREEMENT N. 817617
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Fields are located in contrasting landscape contexts

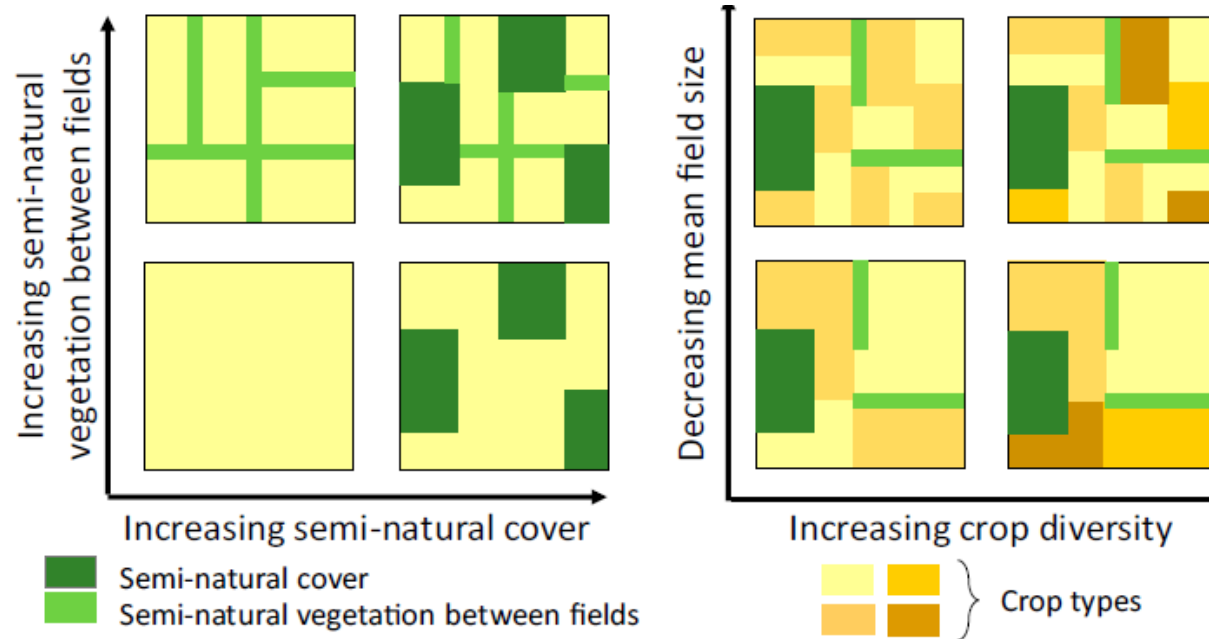
Simple landscape

Large fields
Low SNH cover
Low habitat diversity



Complex landscape

Small fields
High SNH cover
High habitat diversity



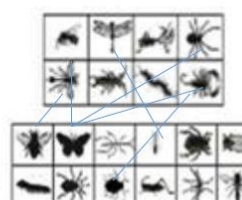
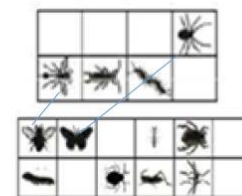
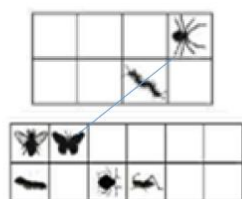
From Sirami et al. 2019, PNAS



Some ecological expectations on the effects of the landscape context of fields on natural pest control

Simple landscape

Large fields
Low SNH cover
Low habitat diversity



Complex landscape

Small fields
High SNH cover
High habitat diversity

Landscape complexity enhances natural pest control through natural enemies that regulate pests (**Top-down effect**)

NOT favorable to the natural enemies that regulate crop pests



Favorable to the natural enemies that regulate crop pest

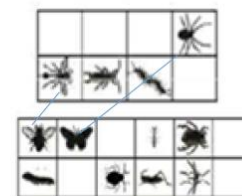
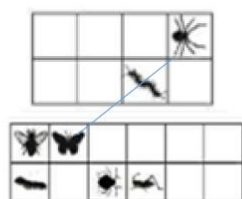




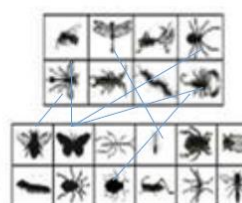
Some ecological expectations on the effects of the landscape context of fields on natural pest control

Some ecological expectations

Simple landscape: Large fields, Low SNH, Low habitat diversity



Complex landscape: Small fields, High SNH, High habitat diversity



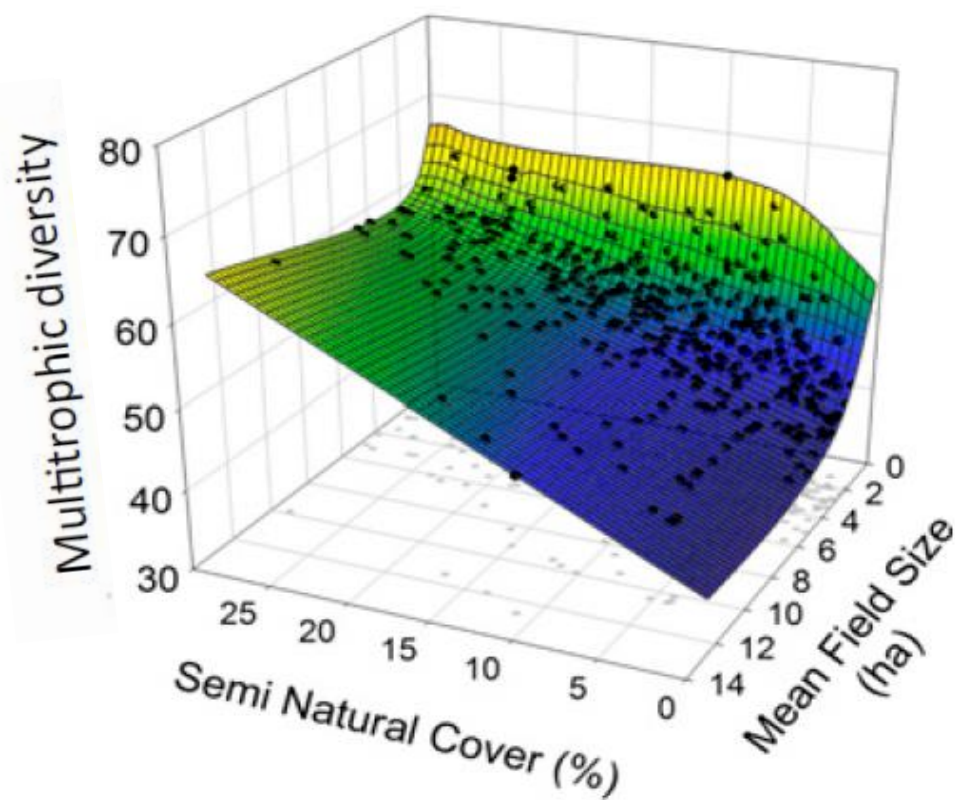
Landscape complexity directly regulate pests (**Bottom-up effect**)

- **Favorable** to the spread and growth of crop pests
- **NOT favorable** to the natural enemies that regulate crop pests
- **NOT favorable** to the spread and growth of crop pests
- **Favorable** to the natural enemies that regulate crop pests





Evidence of higher in-field biodiversity in complex landscapes



435 landscapes
plants, bees, butterflies, hoverflies, carabids, spiders, and birds.

PNAS

Sirami et al. 2019

www.pnas.org/cgi/doi/10.1073/pnas.1906419116

Increasing crop heterogeneity enhances multitrophic diversity across agricultural regions



Evidence that predators control pests

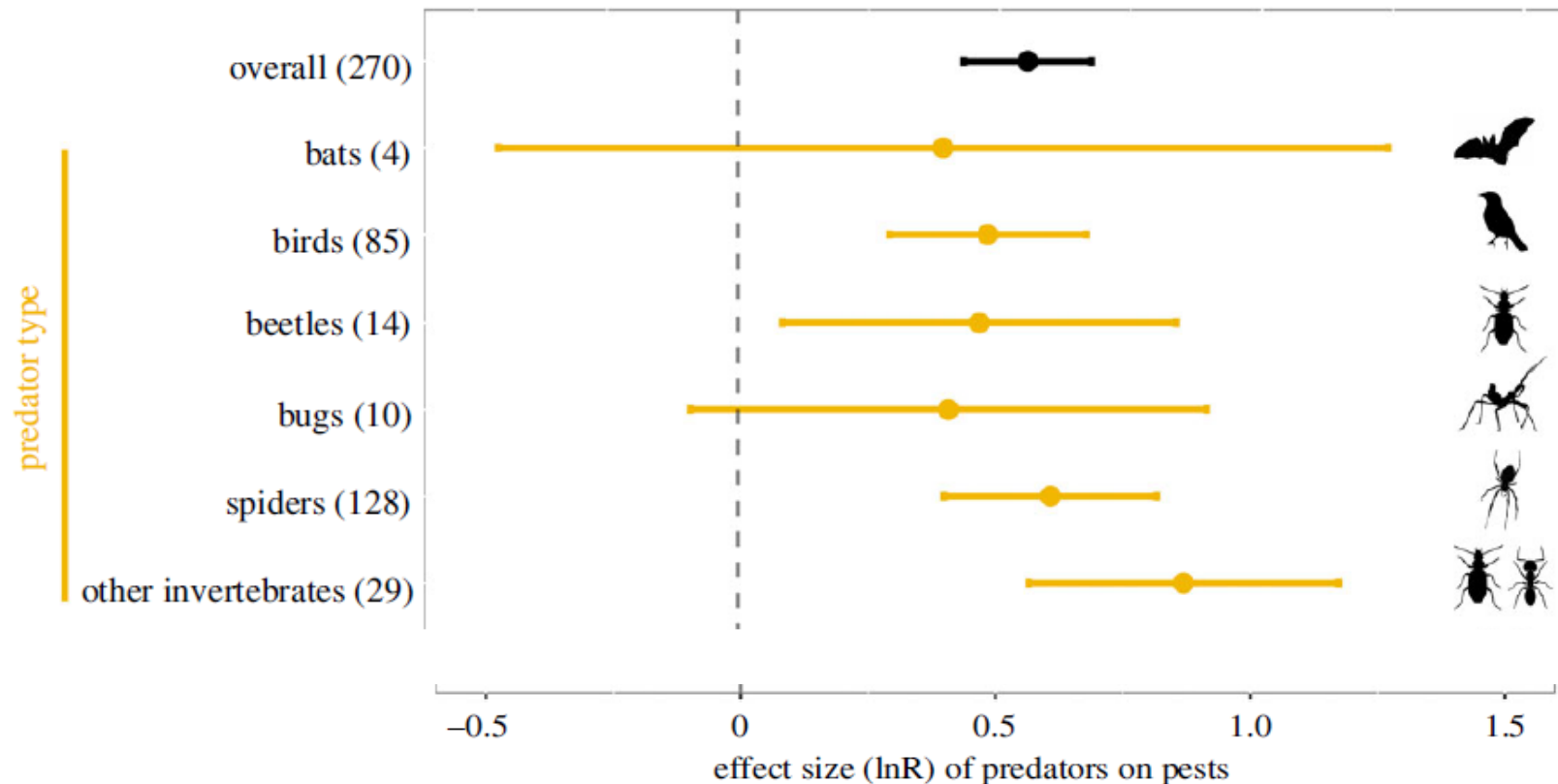


Gabriel X. Boldorini^{1,2}, Matthew A. Mccary³, Gustavo Q. Romero⁴, Kirby L. Mills⁵, Nathan J. Sanders⁵, Peter B. Reich^{6,7}, Radek Michalko⁸ and Thiago Gonçalves-Souza^{1,2,5,6}

<https://doi.org/10.1098/rspb.2023.2522>

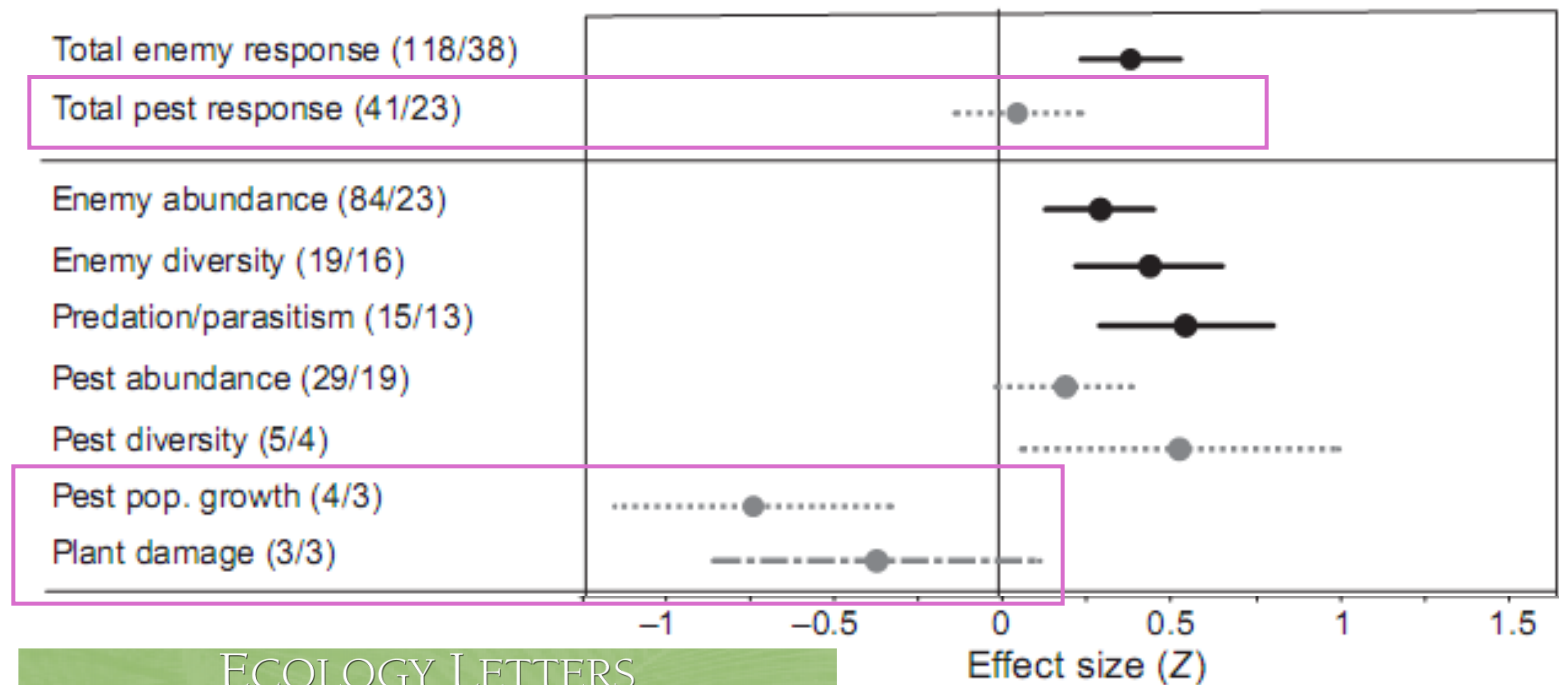
PROCEEDINGS B
royalsocietypublishing.org/journal/rspb

Predators control pests and increase yield across crop types and climates: a meta-analysis





Limited evidence of the effect on landscape complexity on pests



ECOLOGY LETTERS

Ecology Letters, (2011) 14: 922–932

doi: 10.1111/j.1461-0248.2011.01642.x

REVIEW AND
SYNTHESIS

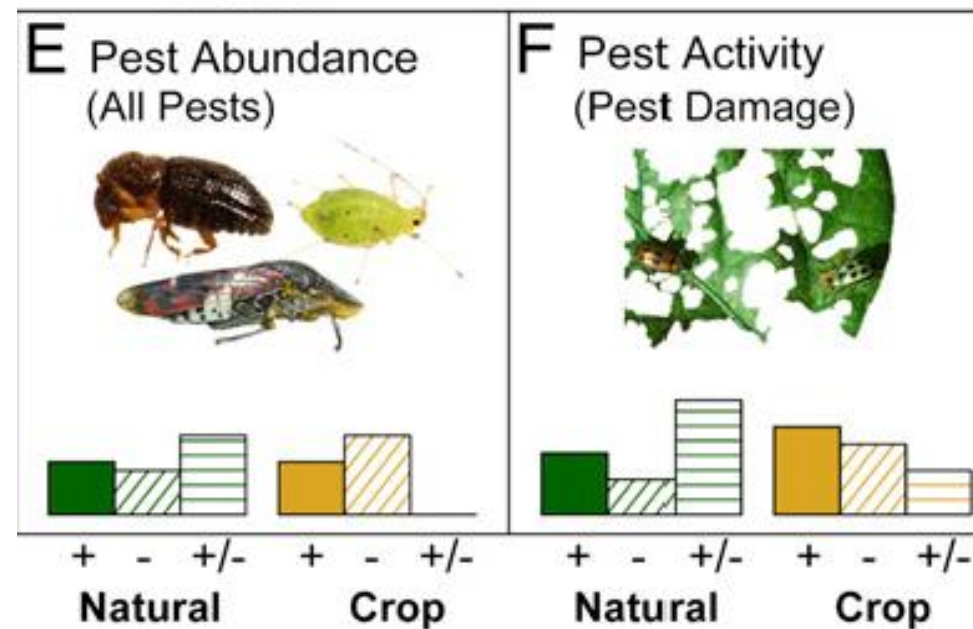
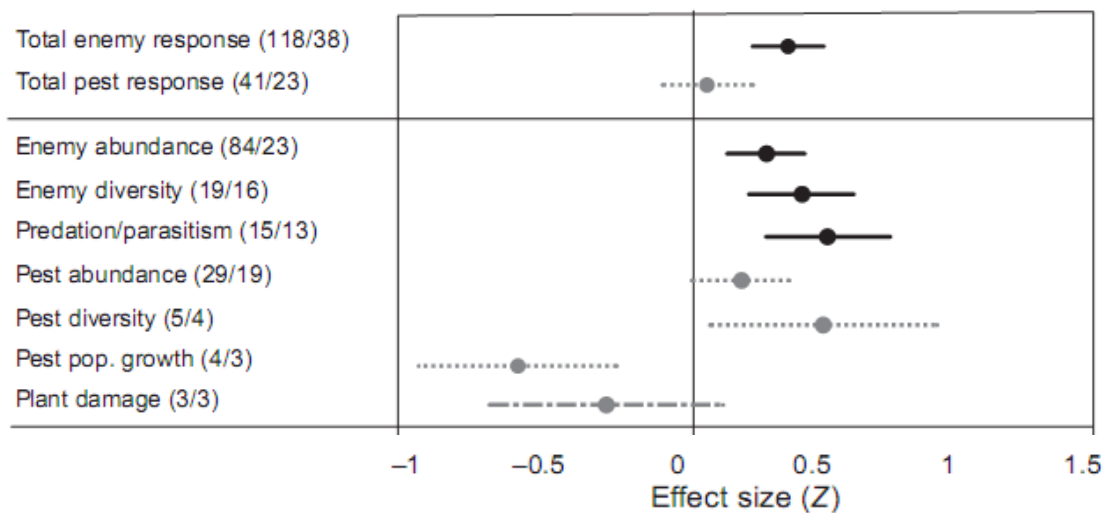
A meta-analysis of crop pest and natural enemy response to landscape complexity



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Limited evidence of the effect on landscape complexity on pests



PNAS Karp et al., 2018

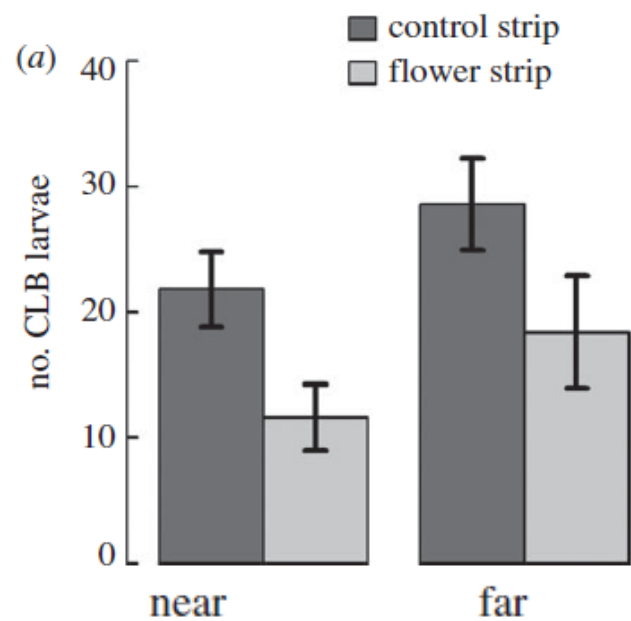
ECOLOGY LETTERS
 Ecology Letters, (2011) 14: 922-932 doi: 10.1111/j.1461-0248.2011.01642.x

REVIEW AND SYNTHESIS
 A meta-analysis of crop pest and natural enemy response to landscape complexity



Adding landscape elements to increase landscape diversity and boost natural pest control

Flower strips to control leaf beetle in wheat crops



-50% larvae
-60% crop damage



High effectiveness of tailored flower strips
in reducing pests and crop plant damage

PROCEEDINGS B

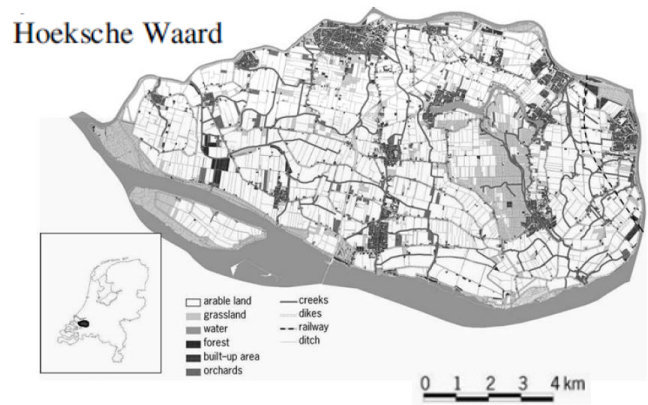
rspb.royalsocietypublishing.org

Matthias Tschumi^{1,2}, Matthias Albrecht¹, Martin H. Entling² and Katja Jacot¹

<http://dx.doi.org/10.1098/rspb.2015.1369>



Adding landscape elements to increase landscape diversity and boost natural pest control



Collective action
550 km of sown flower strips



Eggs & Larvae of lacewings and hoverflies



Aphids well below damage threshold



No insecticides targeting aphids since 2016



Eggs & Larvae of ladybirds



Colorado potato beetle well below damage threshold



After Paul C. J. van Rijn, IOBC WPRS Bulletin 2024

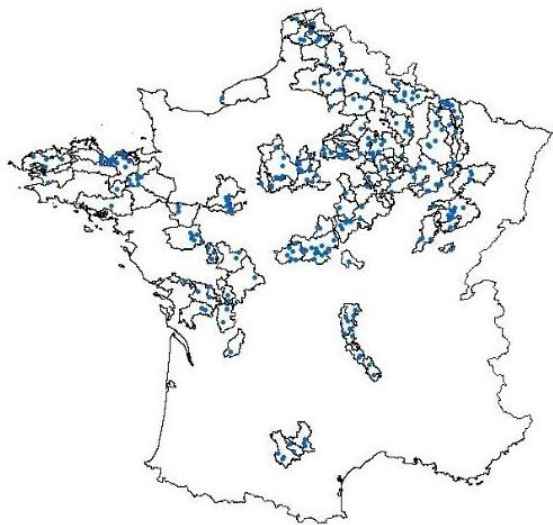


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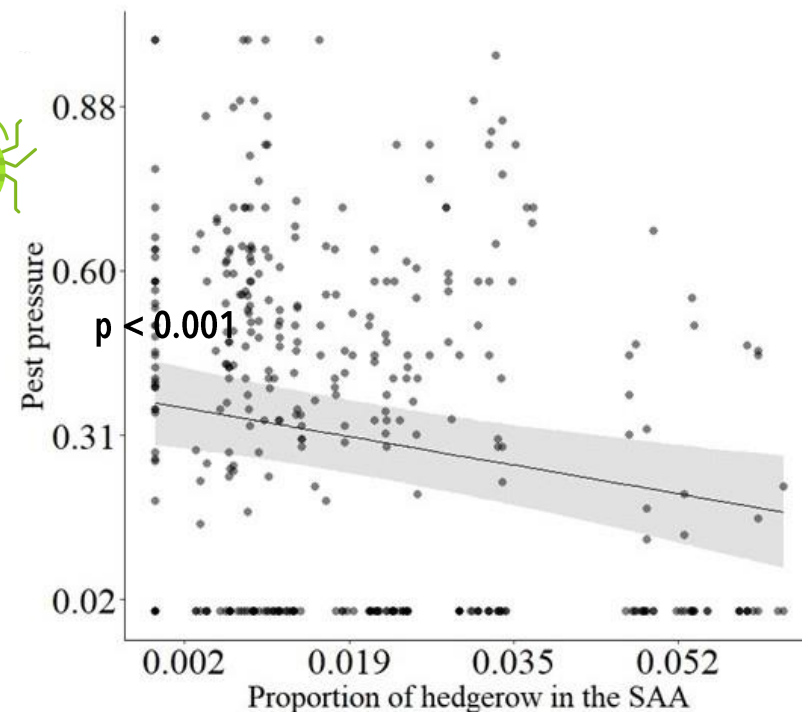


Example 1: wheat-based cropping systems across France

❖ Lower aphid pressure as hedgerow cover increases



557 farms in 93 SAA regions
Data from 2014 to 2019



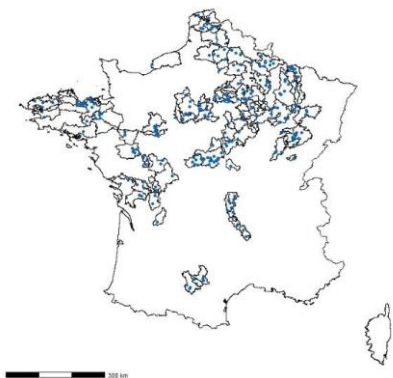
Reducing pest pressure and insecticide use by increasing hedgerows in the landscape

Emeric Courson^a, Benoit Ricci^{a,b}, Lucile Muneret^a, Sandrine Petit^{a,*}



Example 1: wheat-based cropping systems across France

❖ Lower insecticide use as hedgerows increase



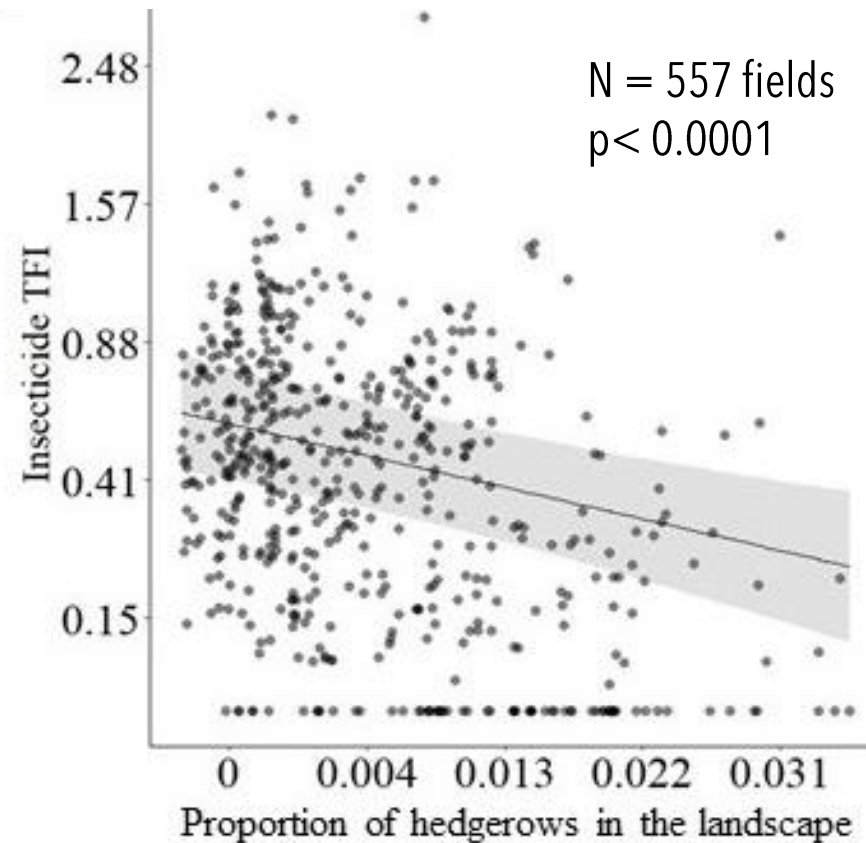
GLMM $R^2_m = 0.27$

Crop sequence ($p < 0.0001$)

Proportion hedgerows ($p < 0.0001$)

Pest pressure ($p = 0.049$)

Crop yield potential (*ns*)



Reducing pest pressure and insecticide use by increasing hedgerows in the landscape

Emeric Courson^a, Benoit Ricci^{a,b}, Lucile Muneret^a, Sandrine Petit^{a,*}



Example 2: Cotton fields in Australia

Small fields and % SNH > 20%

- > Delayed green mirid infestation
- > Delayed spraying
- > lower sprays per season

PNAS 2021 Vol. 118 No. 12 e2018100118

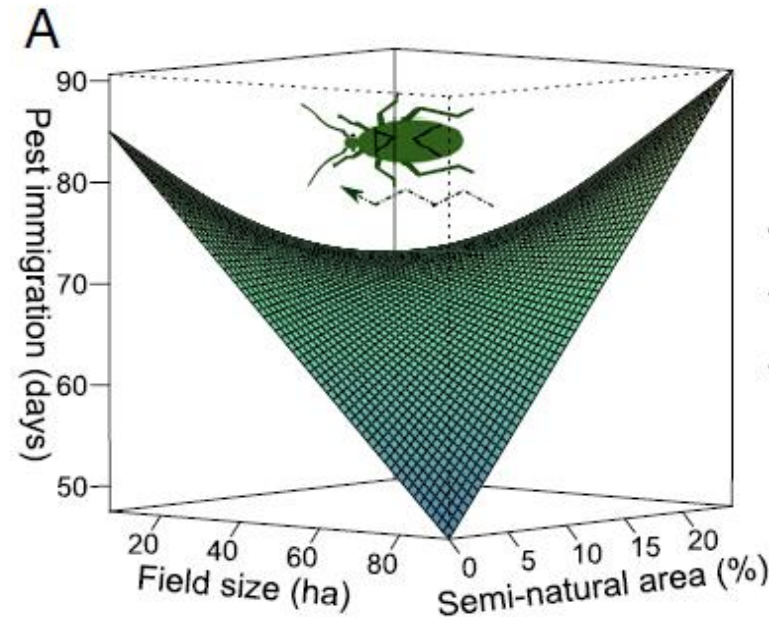
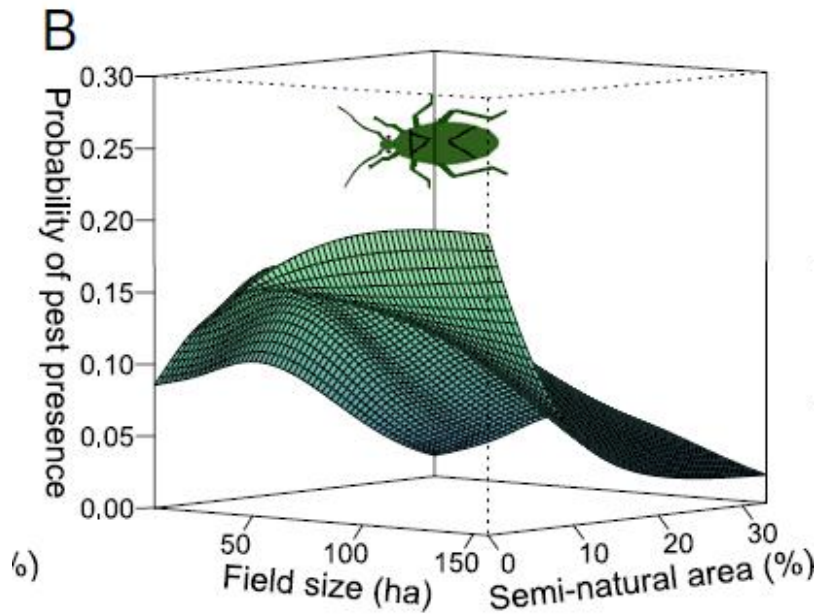
PNAS

Better outcomes for pest pressure, insecticide use, and yield in less intensive agricultural landscapes

Vesna Gagic^{a,b,1}, Matthew Holding^c, William N. Venables^d, Andrew D. Hulthen^e, and Nancy A. Schellhorn^{a,e}



373 cotton fields





Example 2: Cotton fields in Australia

Small fields

-> low pest level for longer after spraying

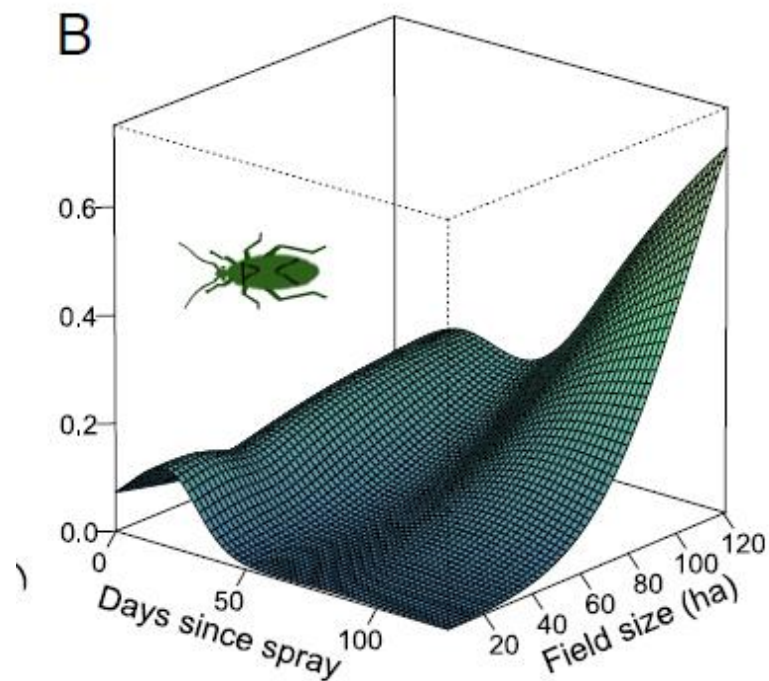
-> lower sprays per season

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Better outcomes for pest pressure, insecticide use, and yield in less intensive agricultural landscapes

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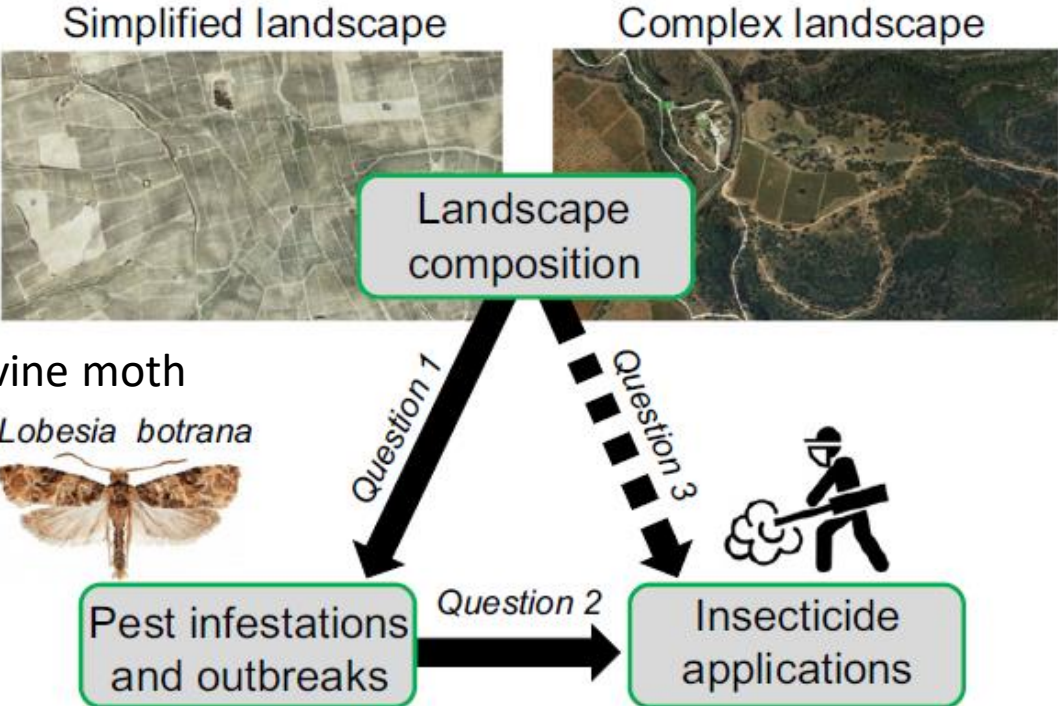


LETTER

Landscape simplification increases vineyard pest outbreaks and insecticide use

Example 3: Vineyards in southern Spain

Andalusia
475 farms
13 years





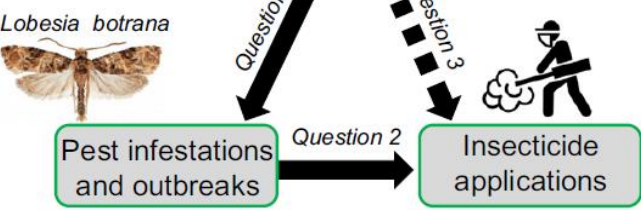
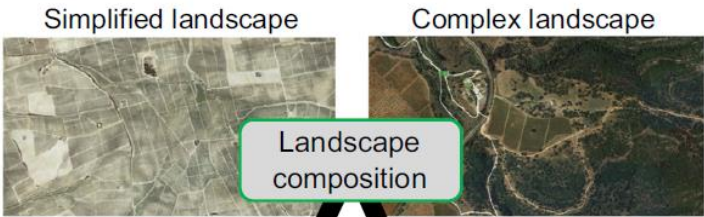
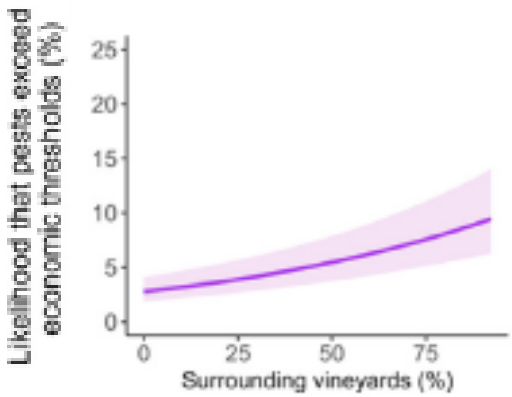
LETTER

Landscape simplification increases vineyard pest outbreaks and insecticide use

Example 3: Vineyards in southern Spain

Andalucia
475 farms
13 years

YES - % surrounding vineyard (+) and % shrubland (-)



YES - linear

YES - % surrounding vineyard (+) and % shrubland (-)





TAKE HOME MESSAGES

- ❖ There is strong and widespread evidence that the landscape context of crop fields impacts pest levels and their control by natural enemies but these effects are highly variable (organisms, local context, etc....)
- ❖ The landscape context of cropped fields can be modified by farmers in order to promote natural pest control (flower strips)
- ❖ Few studies have examined at large scales the cascading effects of landscape diversity on pest levels and in turn on pesticide use but existing studies have yielded convincing results



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THANK YOU!

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References

Courson, E.; Ricci, B., Muneret, L., Petit, S. 2024. Reducing pest pressure and insecticide use by increasing hedgerows in the landscape. *Science of the Total Environment* 96 170182

Gagic, V., Holding, M., Venables, W.N., Hulthen, A.D. and Schellhorn, N.A., 2021. Better outcomes for pest pressure, insecticide use, and yield in less intensive agricultural landscapes. *Proc. Natl. Acad. Sci. U. S. A* 118(12).

Paredes, D., Rosenheim, J.A., Chaplin-Kramer, R., Winter, S., Karp, D.S., 2021. Landscape simplification increases vineyard pest outbreaks and insecticide use. *Ecol. Lett.* 24, 73–83.