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Growth and reproduction responses of invasive and native populations of common ragweed (*Ambrosia artemisiifolia L.*) to defoliation

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INRA

Introduction

- Biological invasions are a threat for invaded ecosystems and even for human and animal health.

Pimentel *et al.* (2001), Agriculture, Ecosystems and Environment 1-20

Sakai *et al.* (2001), Annual Review Of Ecology Evolution And Systematics (32) 305-332

Ambrosia artemisiifolia - common ragweed - France

Rubus alceifolius – Reunion island

Eichhornia crassipes - water hyacinth - Mexico

- Understanding mechanisms behind biological invasion processes is one of the most fundamental challenges in invasion biology

Introduction

Role of biotic interactions and evolutionary consequences for introduced populations

Two major hypotheses:

- ***Enemy Release Hypothesis (ERH):*** loss of herbivores and pathogens following introduction of an exotic species in a new range – **decrease of natural enemy pressure**

Keane & Crawley (2002), Trends in Ecology and Evolution (17) 164-170

- ***Evolution of increased competitive ability (EICA)*****:** decrease in plant defence and resources reallocation to other plant functions like growth, competition or reproduction – **evolution toward an increase of plant vigour**

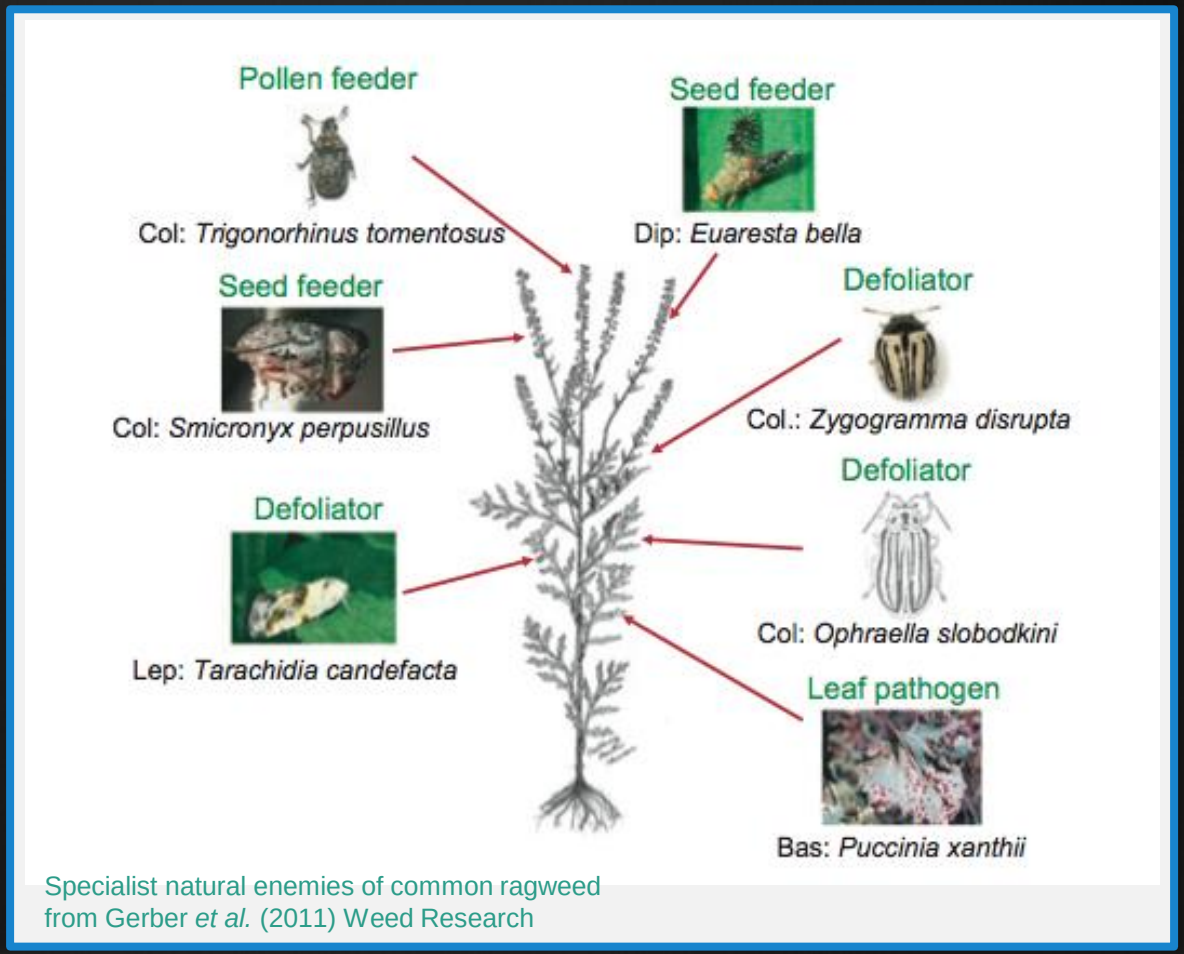
Blossey & Notzold (1995), Journal of Ecology (83) 887-889

Introduction

Biotic interactions (herbivore insects, pathogens)

In France, natural enemy pressure is far less important compared with the native range (North America) !

B. Genton, P. Kotanen, et al. (2005), Oecologia, 146(3):404–414.



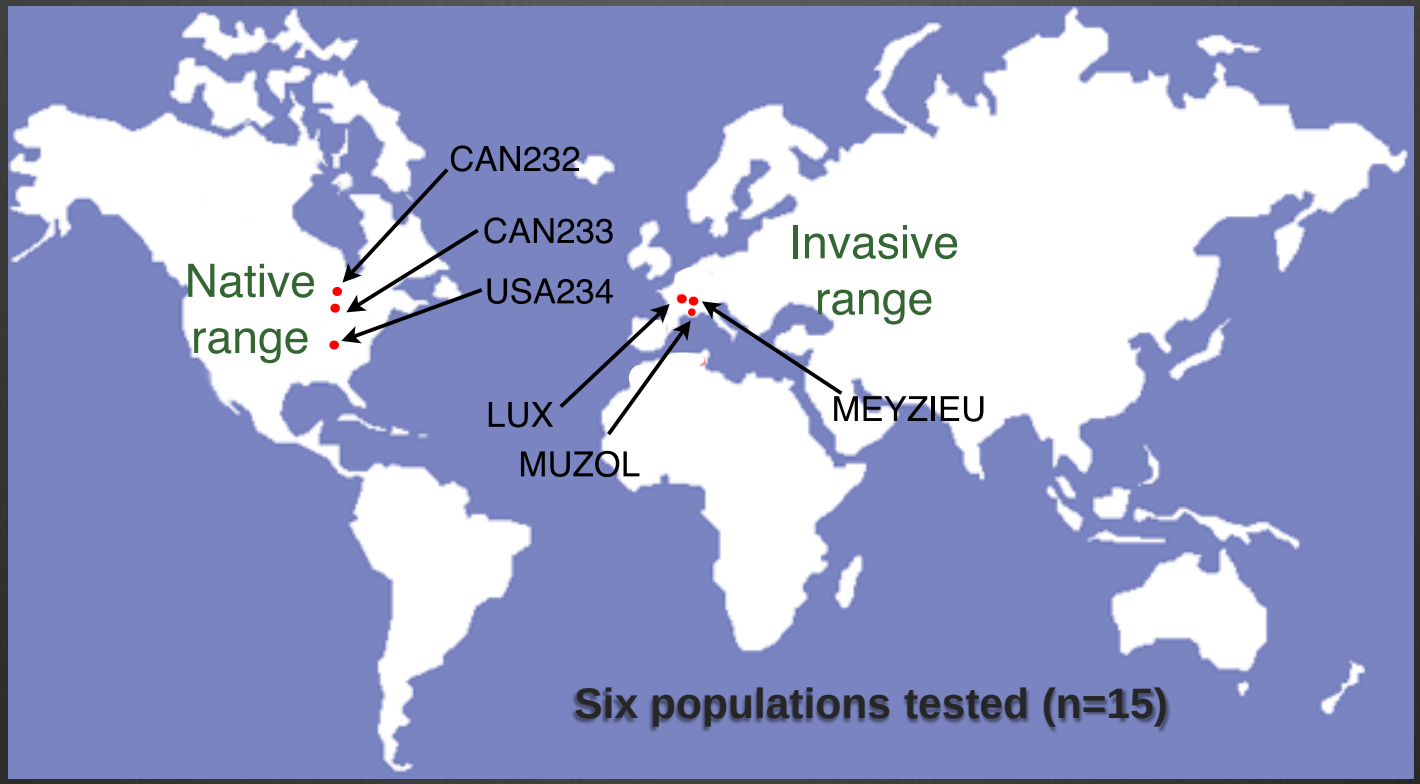
Specialist natural enemies of common ragweed from Gerber *et al.* (2011) Weed Research

Introduction

Scope of the study:

- Did the ability to tolerate herbivory evolve following the introduction of common ragweed in France?
- Did invasive populations of common ragweed achieve higher values of performance traits but are more sensitive to herbivory?

Material & Methods



3 North American populations: cover the natural range of the species

VS.

3 French populations: sampled in the Rhône valley one of the most invaded areas in France

Material & Methods

Simulated herbivory: to test the effect of insect herbivory in absence of an actual natural enemy

- To simulate the attack of *Zygogramma suturalis* a specialist herbivore of common ragweed already used in biological control program
- **Perforation** of the leaf limb leaving untouched the central vein
- Destruction of each leaf of the plant (except the youngest leaves at the top of the plant)

Material & Methods

Simulated herbivory treatments (damage levels):

Control	Medium defoliation	High defoliation
		
No perforation	50% of the leaf area removed	90% of the leaf area removed

Material & Methods

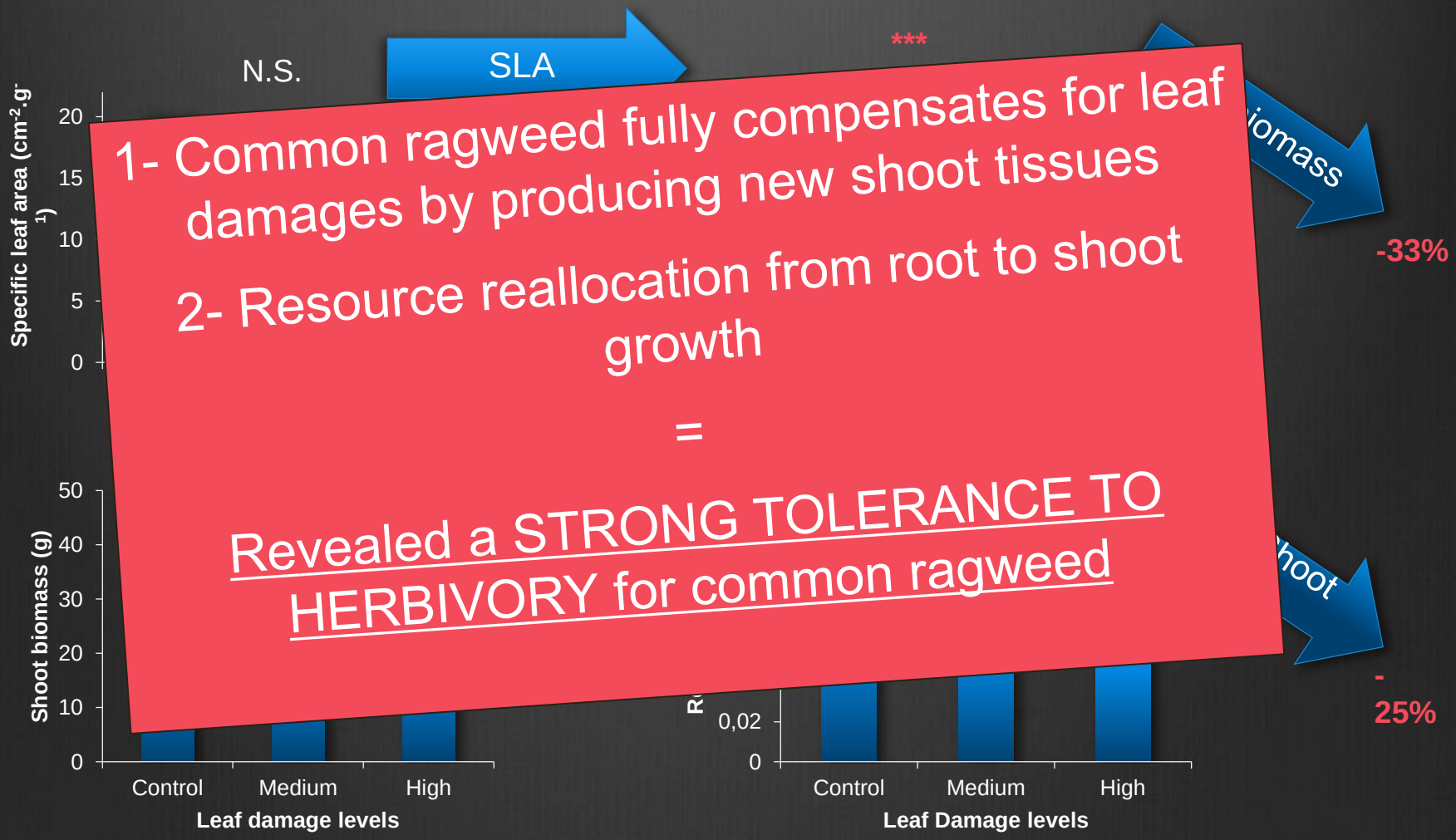
Measurement of the response of common ragweed to simulated herbivory:

- **Vegetative and reproductive traits** (Monty et Mahy, 2009)

Vegetative traits	Reproductive traits
Specific Leaf Area (SLA)	Number of days to male flowering
Shoot biomass	Reproductive success
Root biomass	Height at reproduction
Root:Shoot ratio	Number of seeds produced

Results & Discussion

1- Response of common ragweed to simulated herbivory



1- Common ragweed fully compensates for leaf damages by producing new shoot tissues

2- Resource reallocation from root to shoot growth

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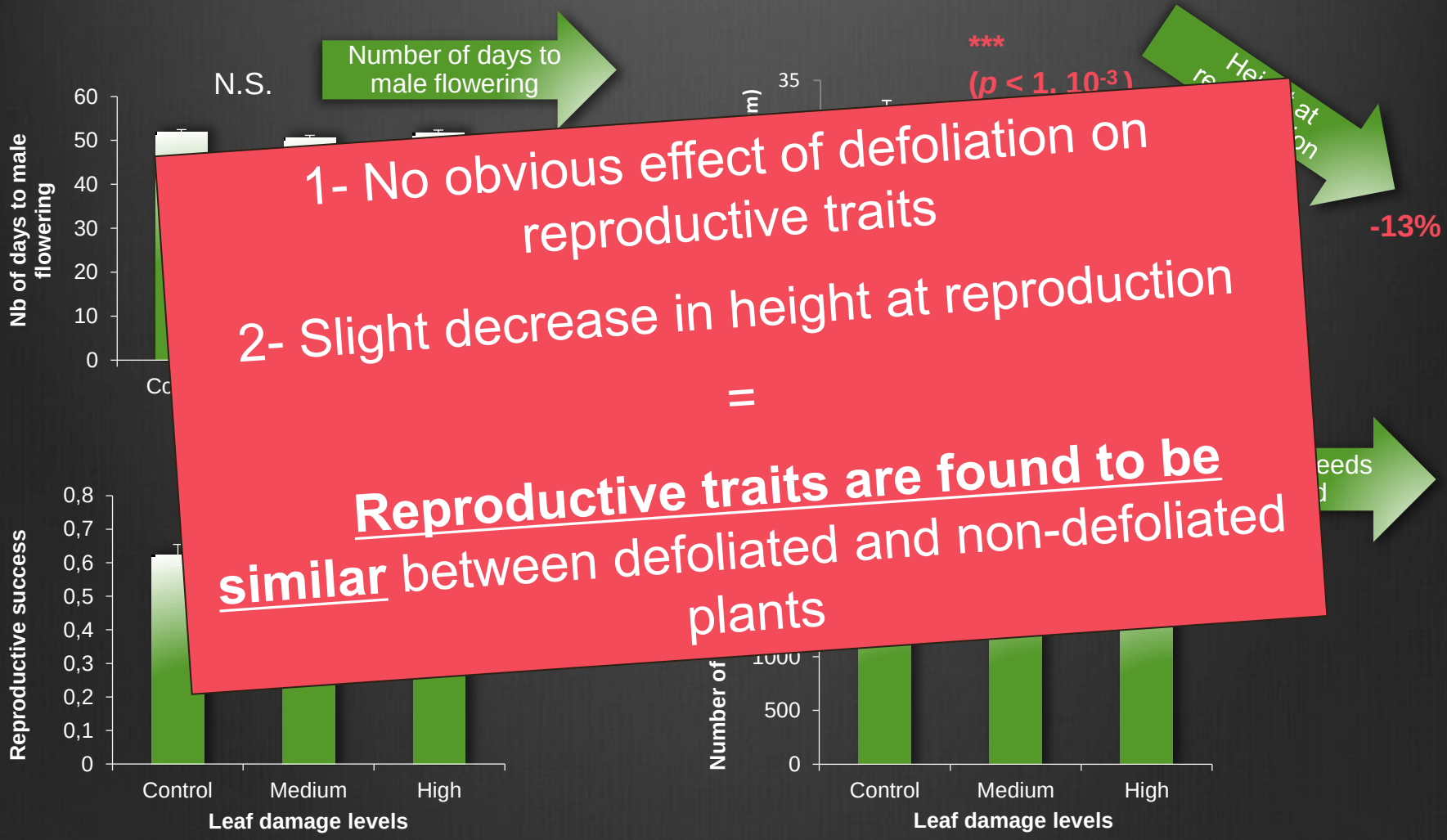
Revealed a STRONG TOLERANCE TO HERBIVORY for common ragweed

Results & Discussion

1- Response of common ragweed to simulated herbivory



1- No obvious effect of defoliation on reproductive traits

2- Slight decrease in height at reproduction

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Reproductive traits are found to be similar between defoliated and non-defoliated plants

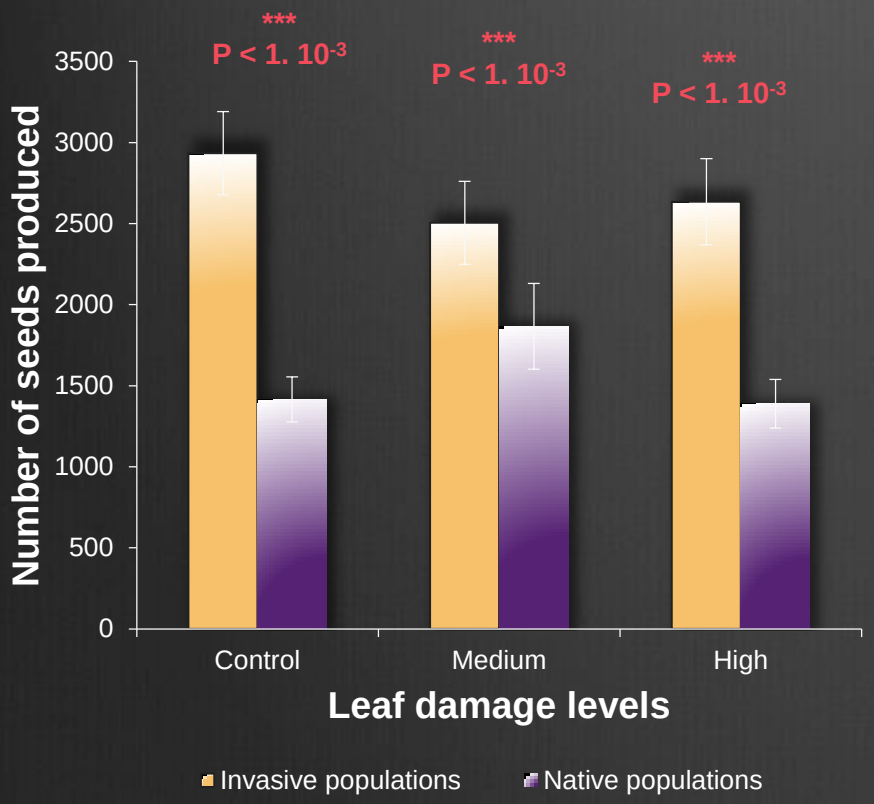
Results & Discussion

2- Comparison between native and invasive populations

Vegetative traits	Origin native vs. invasive	Reproductive traits	Origin native vs. invasive
Specific leaf Area (SLA)	N.S.	Number of days to male flowering	N.S.
Shoot biomass	N.S.	Reproductive success	N.S.
Root biomass	N.S.	Height at reproduction	N.S.
Root:Shoot ratio	N.S.	**Number of seeds produced**	***p* < 0.001 *****

Results & Discussion

2- Comparison between native and invasive populations



Invasive > Native

2691 seeds 1553 seeds

Higher seed production for invasive populations compared with native populations

Results & Discussion

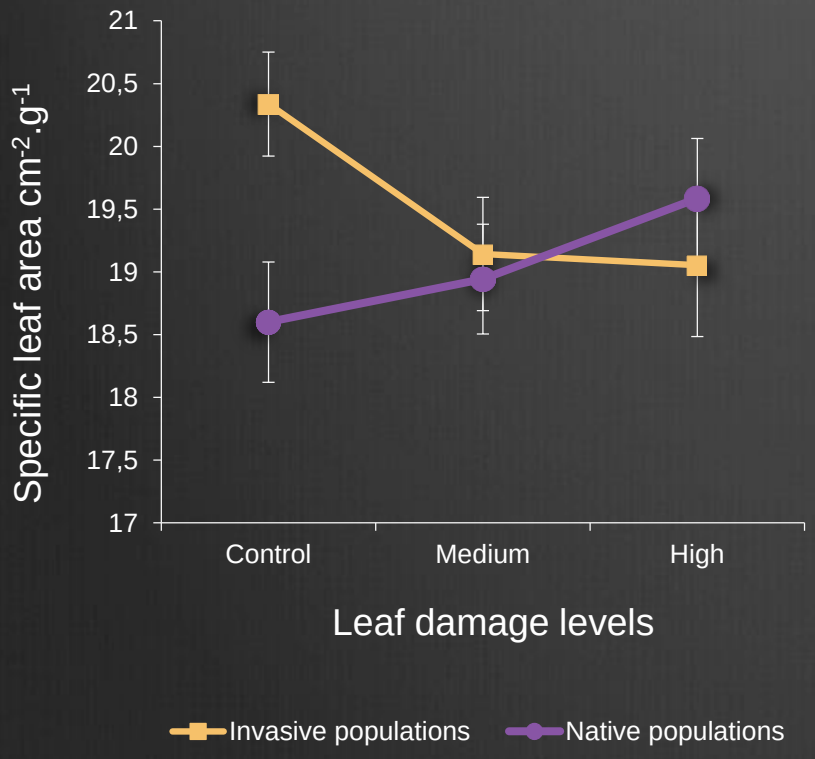
3- Evolution of the response to leaf herbivory following the introduction of the species in France

Vegetative traits	Interaction treatment x origin	Reproductive traits	Interaction treatment x origin
Specific leaf Area (SLA)	**** p = 0.05***	Number of days to male flowering	N.S.
Shoot biomass			N.S.
Root biomass			N.S.
Root:Shoot ratio	N.S.	Number of seeds produced	N.S.

Tolerance to herbivory is similar between invasive and native populations

Results & Discussion

3- Evolution of the response to leaf herbivory following the introduction of the species in France



For invasive populations:

- Higher SLA values in absence of defoliation
- But higher sensitivity to defoliation treatments

Consistent with EICA predictions

Conclusion

1- Tolerance to simulated herbivory:

- **Full compensation** of foliar damages induced by simulated herbivory
- **Plasticity in resource allocation** between root and shoot growth
- No obvious cost on plant fitness despite a strong alteration of the leaf area (90% of defoliation)

Conclusion

1- Tolerance to simulated herbivory:

2- Evolutionary changes following species introduction in France:

- No decrease in herbivory tolerance in invasive populations since introduction
- Increase in plant vigour in invasive populations with higher SLA values and higher seed production – consistent with EICA predictions

Perspectives

A. Artemisiifolia **management in the introduced range:**

Invasive populations caracteristics:

- Strong ability to tolerate defoliation
- High seed production
- Long-lived seedbank

Common ragweed: a harsh target for biological control programs

Recommendations:

- To perform large spectrum natural enemies survey
- To favour biocontrol agents attacking vascular and/or reproductive functions (ex : stem borer, pollen and seed feeders)
- To study positive interactions between above-ground and below-ground enemies to limit plant compensatory growth

Aknoledgements

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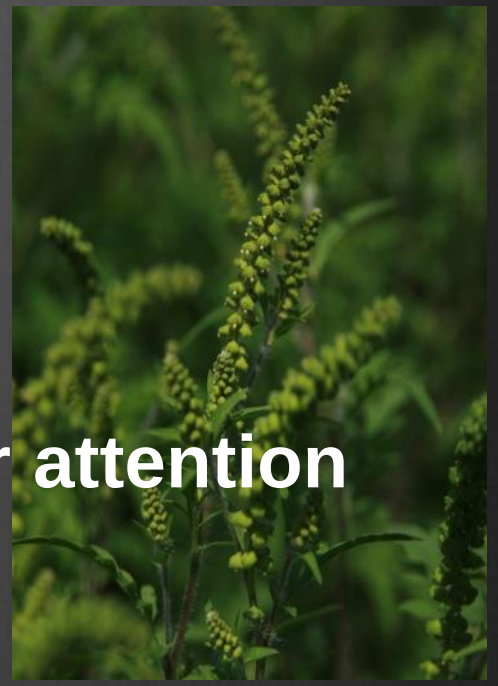
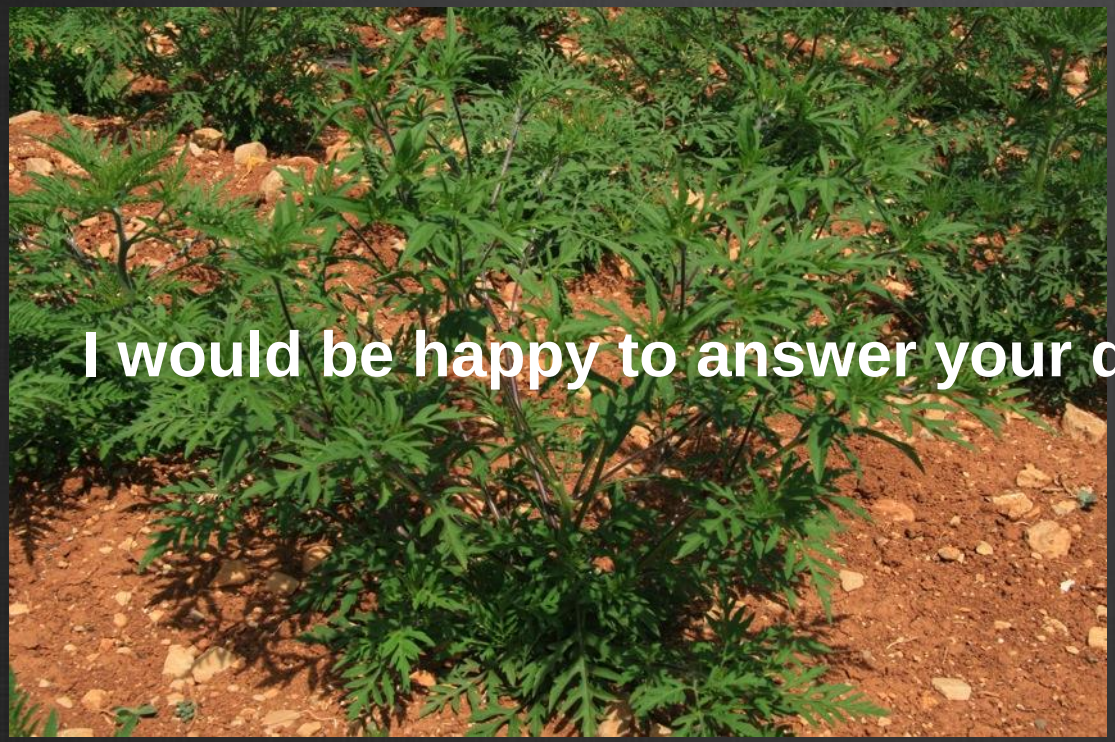


Thank you for your attention




I would be happy to answer your questions