Is *Ambrosia artemisiifolia* L. able to expand its invaded range northward in Western Europe?

COST Action FA1203 – SMARTER – Working group 3

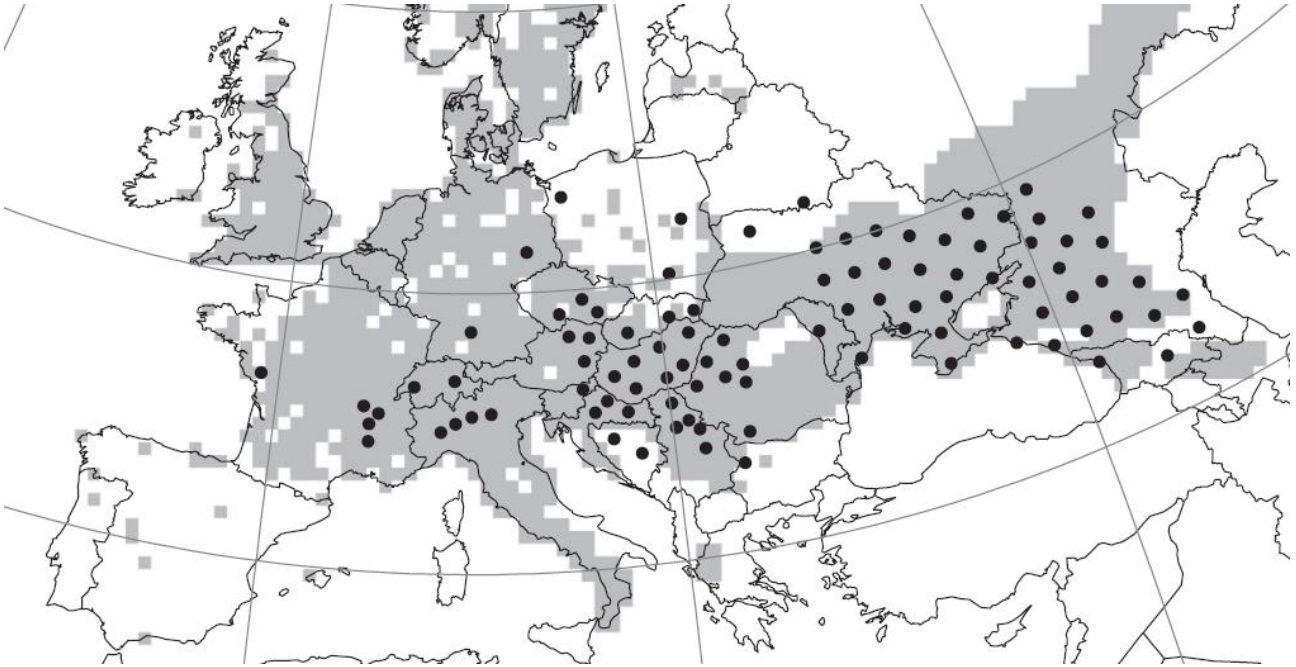
13TH of September 2016

By William ORTMANS

Gembloux Agro-Bio Tech
Université de Liège

INTRODUCTION

- Occurrences all over Europe

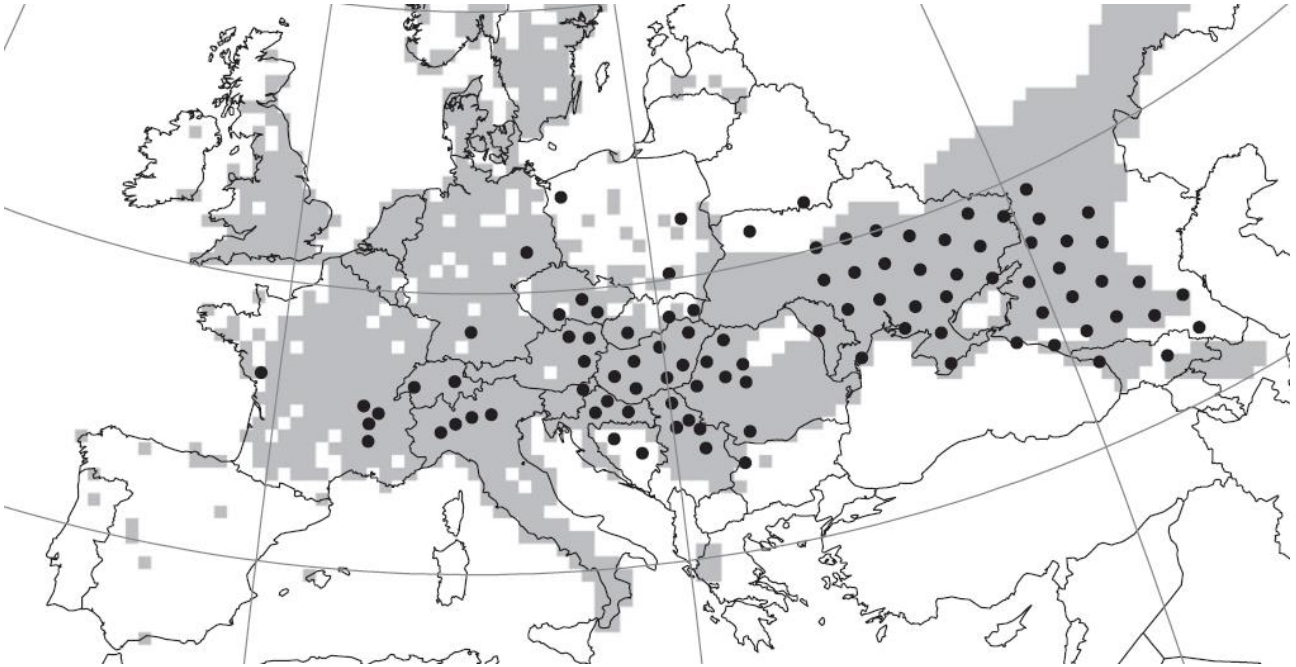


© Essl *et al.* (2015)

INTRODUCTION

- Occurrences all over Europe

...but is not invasive everywhere!

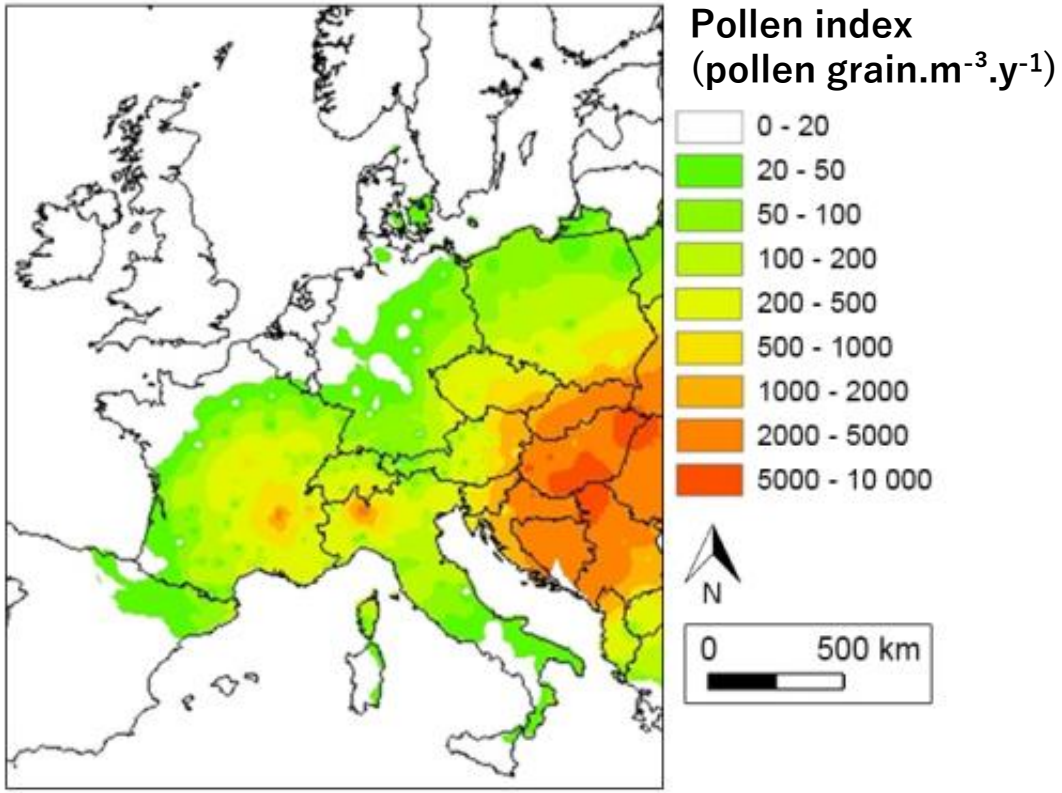


© Essl *et al.* (2015)

INTRODUCTION

- Occurrences all over Europe

...but is not invasive everywhere!

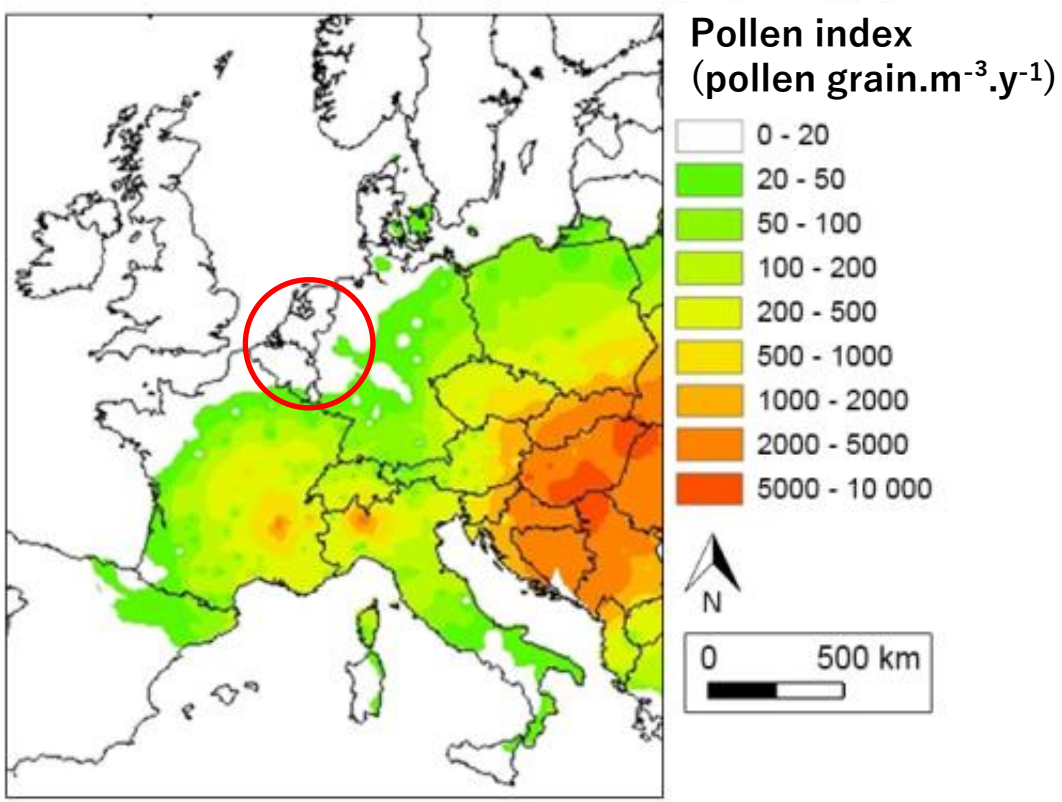


© Adapted from Smith *et al.* 2013

INTRODUCTION

- Occurrences all over Europe

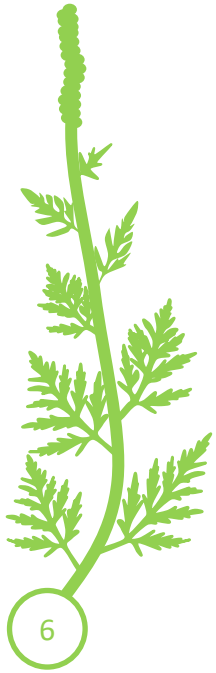
...but is not invasive everywhere!



© Adapted from Smith *et al.* 2013

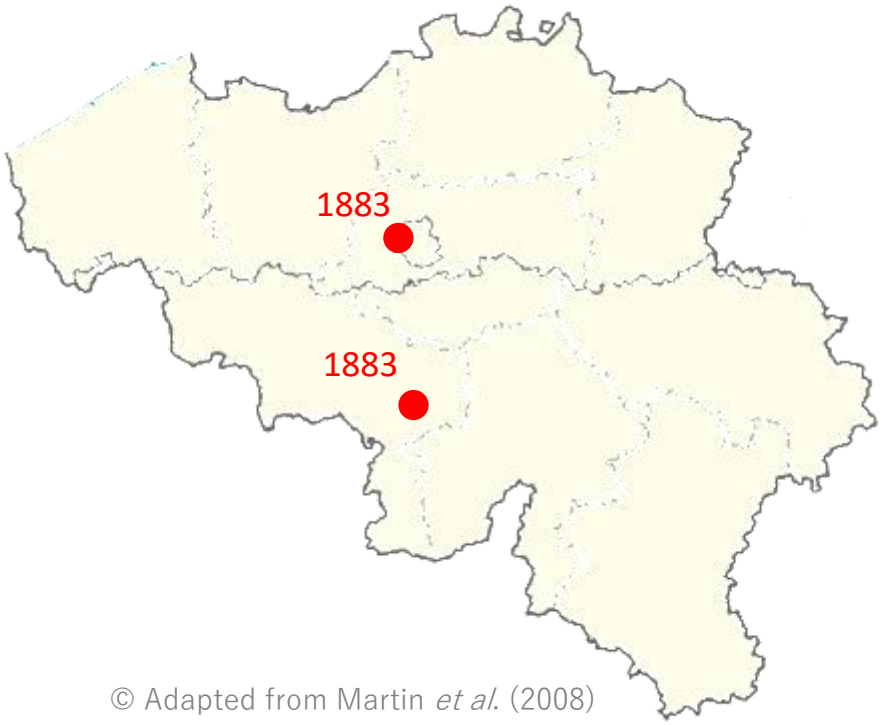
INTRODUCTION

- The situation in Belgium



INTRODUCTION

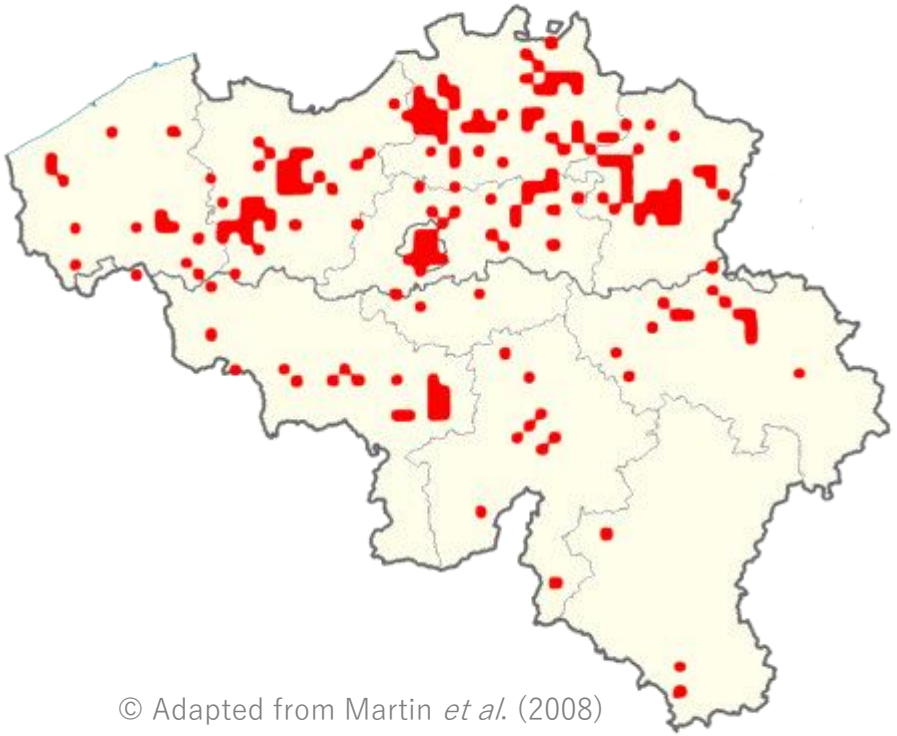
- The situation in Belgium
  - Presence of the species for a long time
    - First introduction before the 1900's



© Adapted from Martin *et al.* (2008)

INTRODUCTION

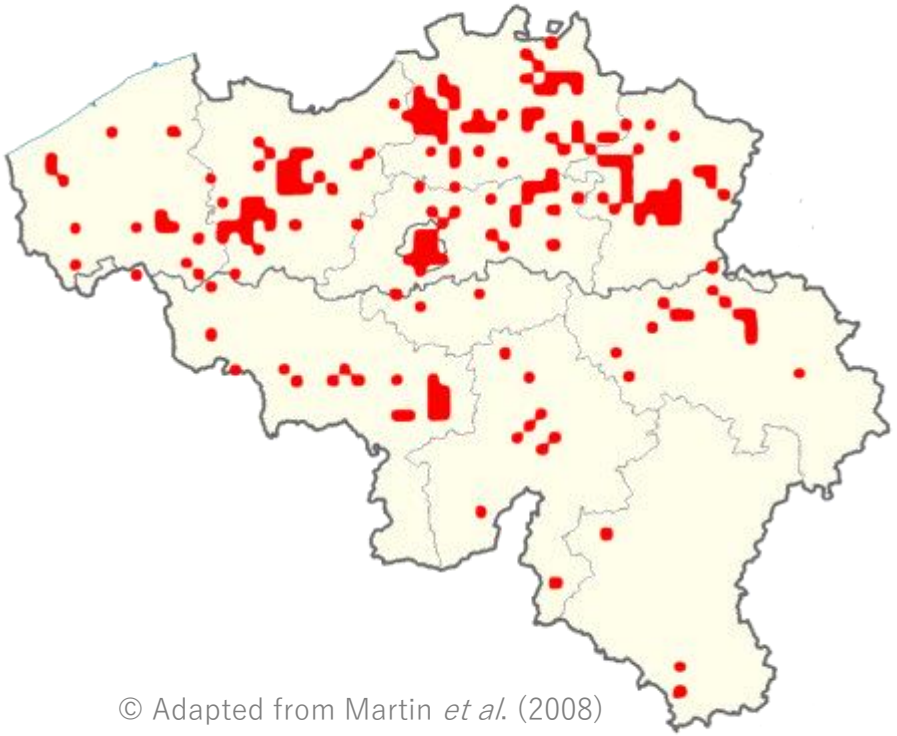
- The situation in Belgium
  - Presence of the species for a long time
    - First introduction before the 1900's
    - A strong propagule pressure



© Adapted from Martin *et al.* (2008)

INTRODUCTION

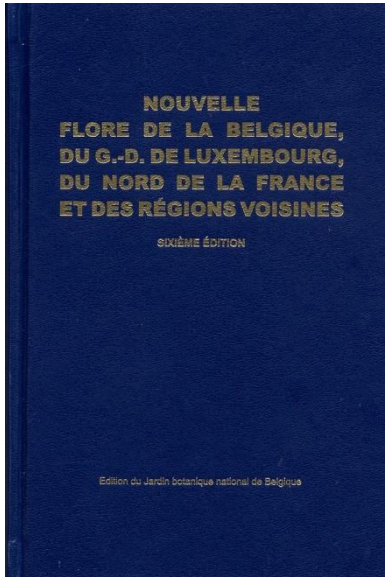
- The situation in Belgium
  - Presence of the species for a long time
    - First introduction before the 1900's
    - A strong propagule pressure
    - Occurrences disappear rapidly…



© Adapted from Martin *et al.* (2008)

INTRODUCTION

- The situation in Belgium
  - Presence of the species
    - First introduction before the 1900's
    - A strong propagule pressure
    - Occurrences disappear rapidly…

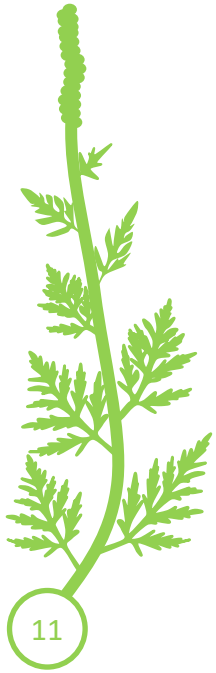


« The first autumnal frosts appear to kill the plants before the production of mature seeds… »

➔ Non-naturalized status

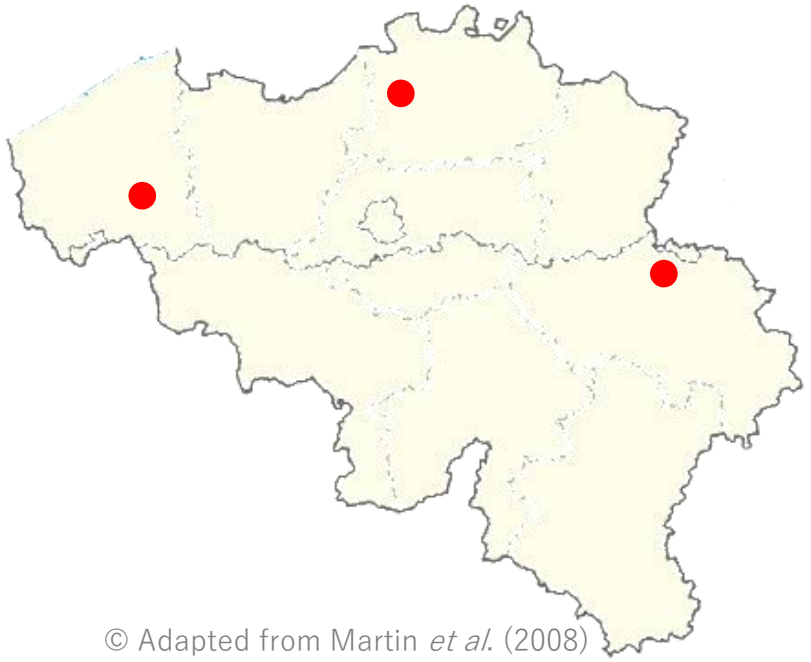
INTRODUCTION

- The situation in Belgium
  - An evolving situation?



INTRODUCTION

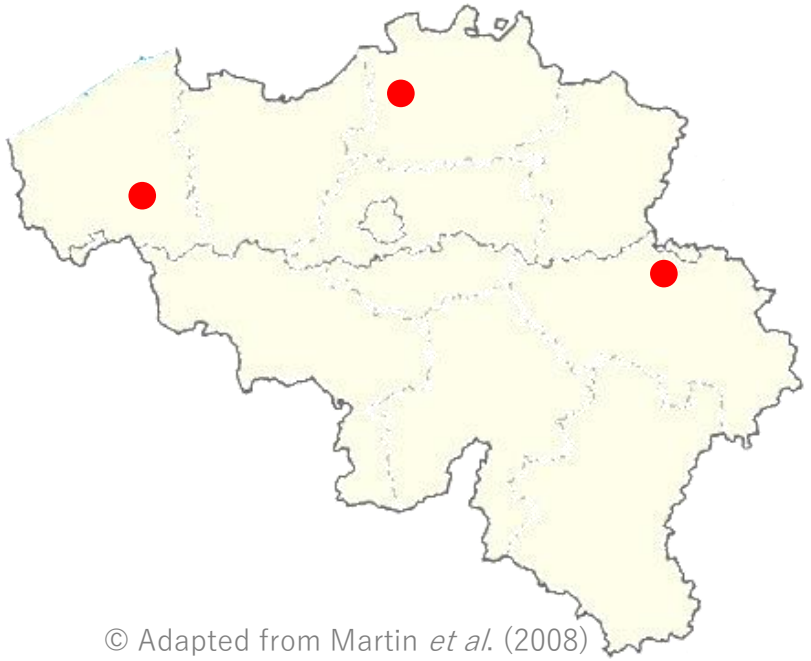
- The situation in Belgium
  - An evolving situation?
    - Some populations persist over time
      - Local naturalization?



© Adapted from Martin *et al.* (2008)

INTRODUCTION

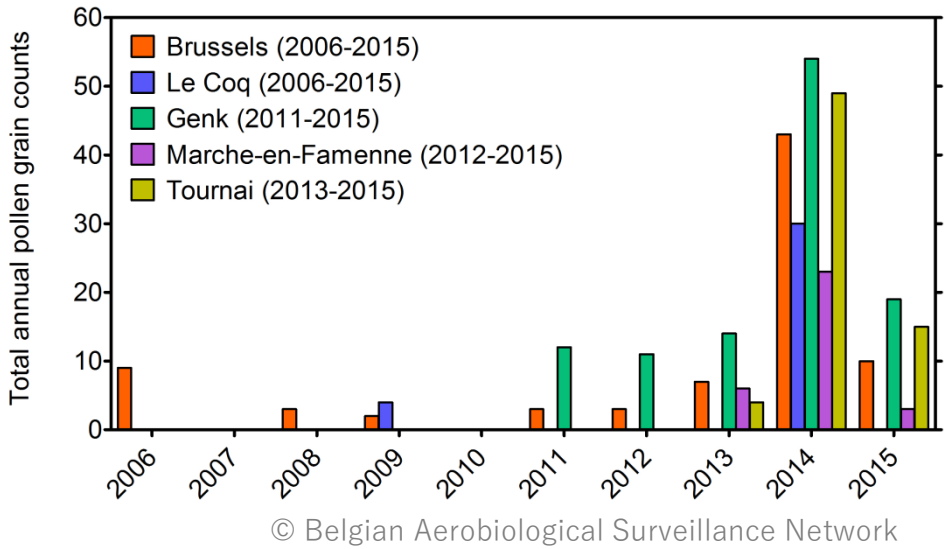
- The situation in Belgium
  - An evolving situation?
    - Some populations persist over time
      - Local naturalization?
      - Soil seed bank expression?



© Adapted from Martin *et al.* (2008)

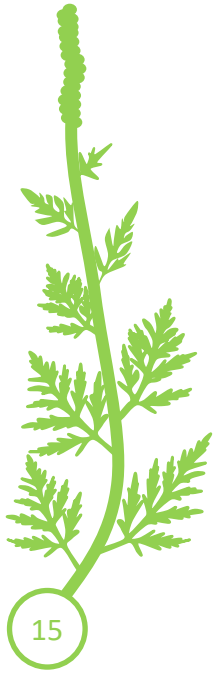
INTRODUCTION

- The situation in Belgium
  - An evolving situation?
    - Some populations persist over time
    - The pollen densities appear to increase



INTRODUCTION

- In this uncertain situation:
  - Is ragweed going to be a problem in Belgium?
  - Is ragweed in a naturalization phase?



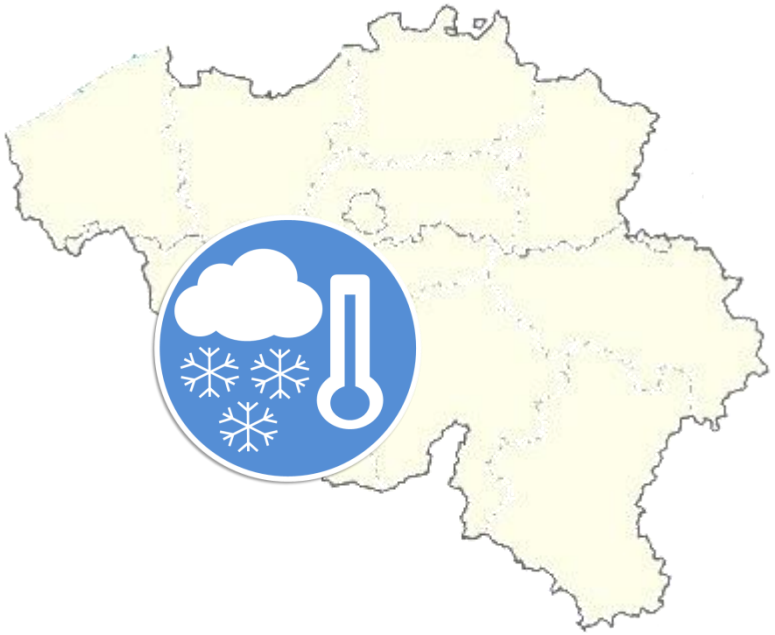
OBJECTIVES

Is there a limit to the naturalization of the species in Belgium?

OBJECTIVES

Is there a limit to the naturalization of the species in Belgium?

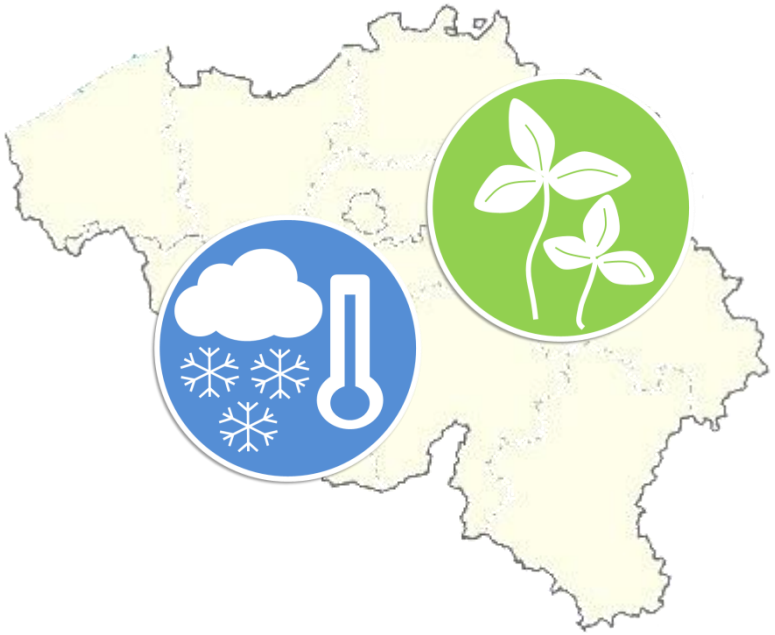
- What is the role of the local climate?



OBJECTIVES

Is there a limit to the naturalization of the species in Belgium?

- What is the role of the local climate?
- What is the role of interspecific competition?



Method

- Two complementary approaches:

Method

- Two complementary approaches:

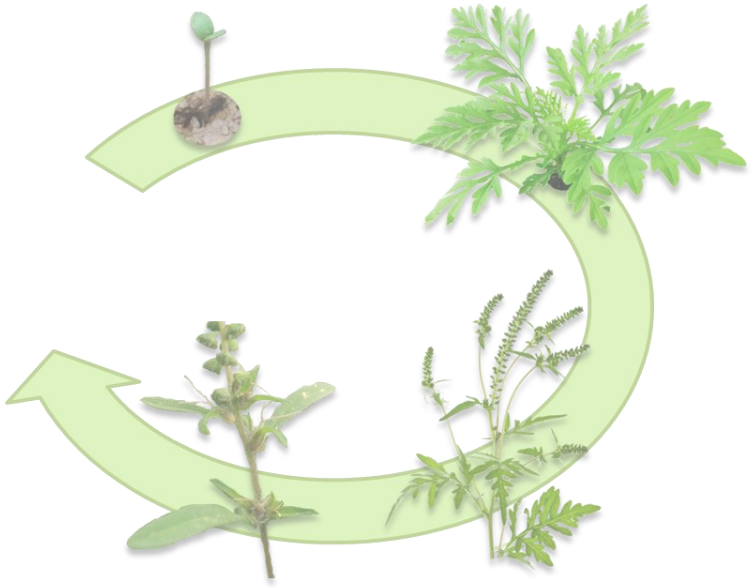
1) Field study
   - In-situ survey
   - Plant performance
   - Ruderal populations

Method

- Two complementary approaches:

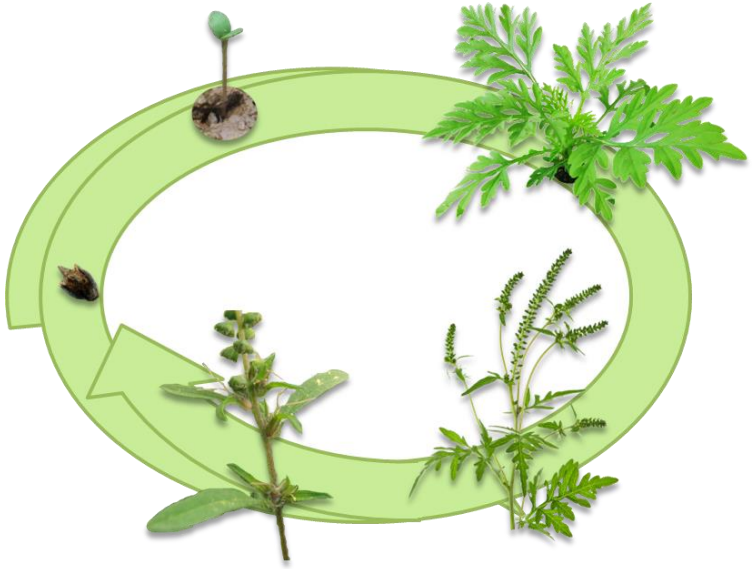
1) Field study

- In-situ survey
- Plant performance
- Ruderal populations



2) Experimental garden

- Controlled conditions
- Population dynamic
- Agricultural context



Method

- Short term scientific mission (STSM)

  INRA, Dijon, France (Bruno Chauvel's Team)

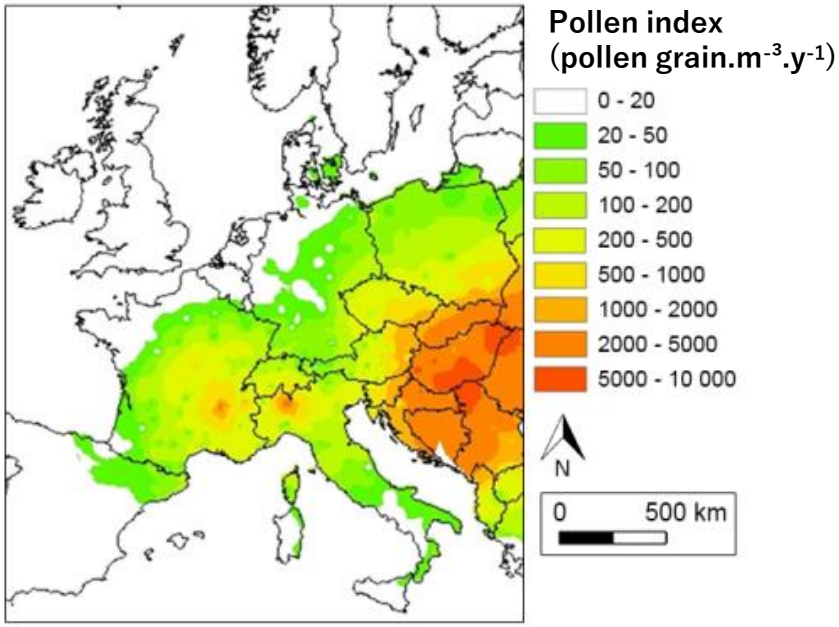
  – Population location
  – Laboratory use
  – Seed exchanges

Study n°1

Is there a plant performance reduction explaining the non-naturalization of the species in Belgium?

Study n°1 : Performance Variation

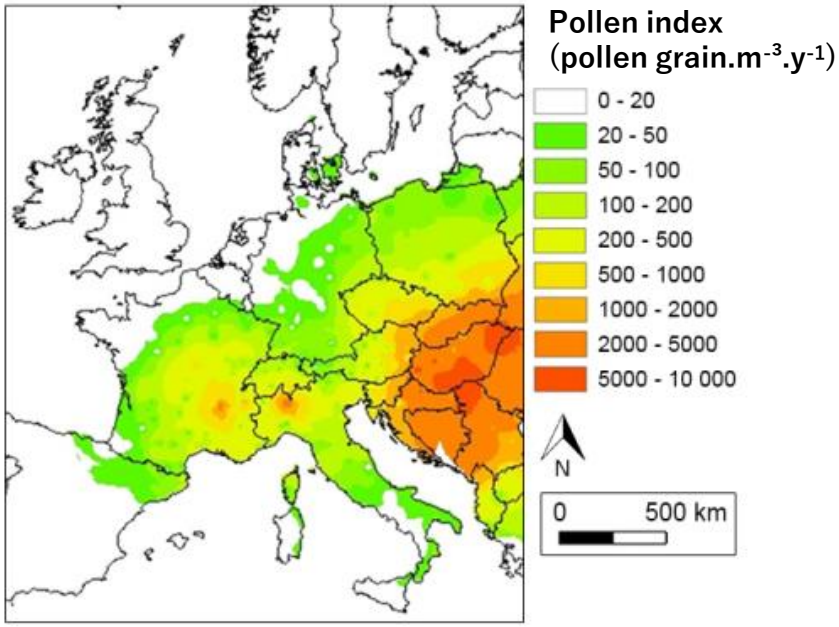
- Invasion levels definition



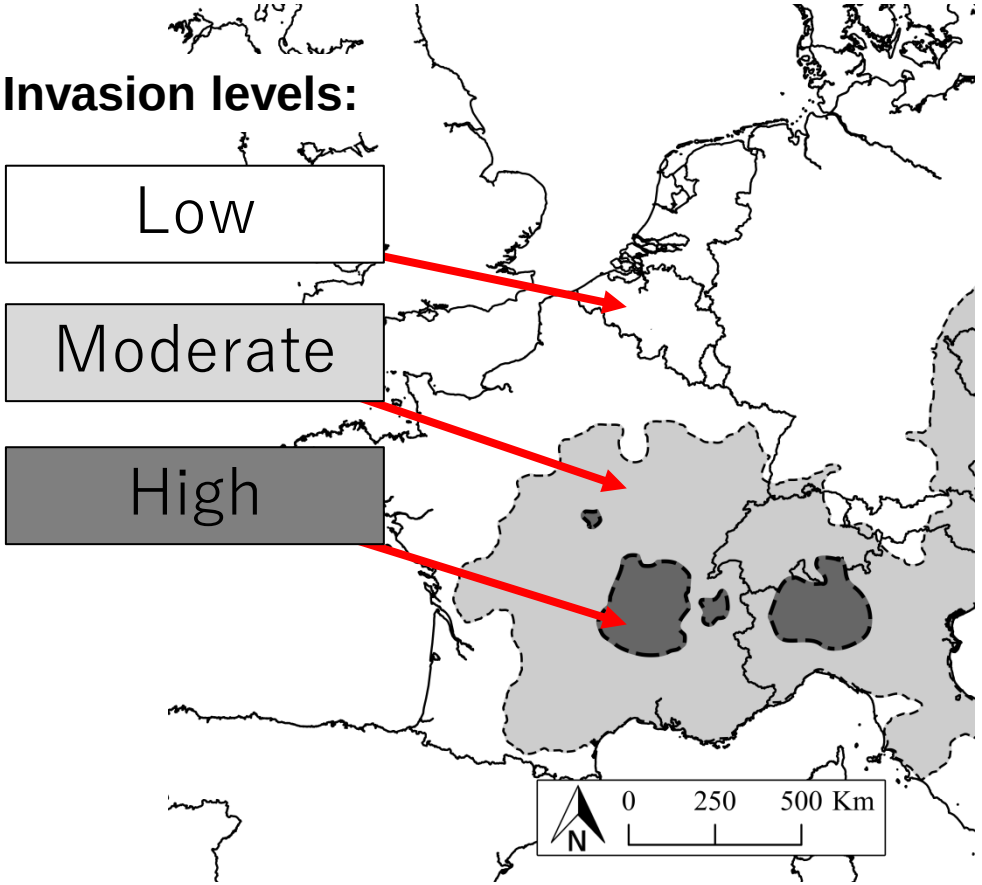
© Adapted from Smith *et al.* 2013

Study n°1 : Performance Variation

- Invasion levels definition



© Adapted from Smith *et al.* 2013



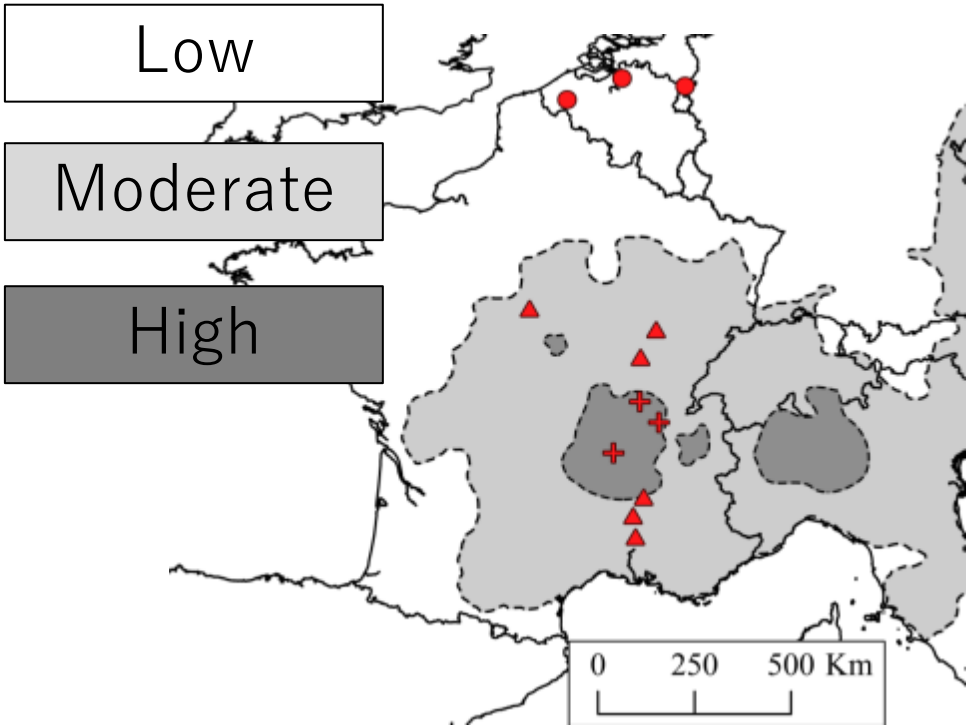
Study n°1 : Performance Variation

- Population selection

Merksem (BE)

Ramière (FR)

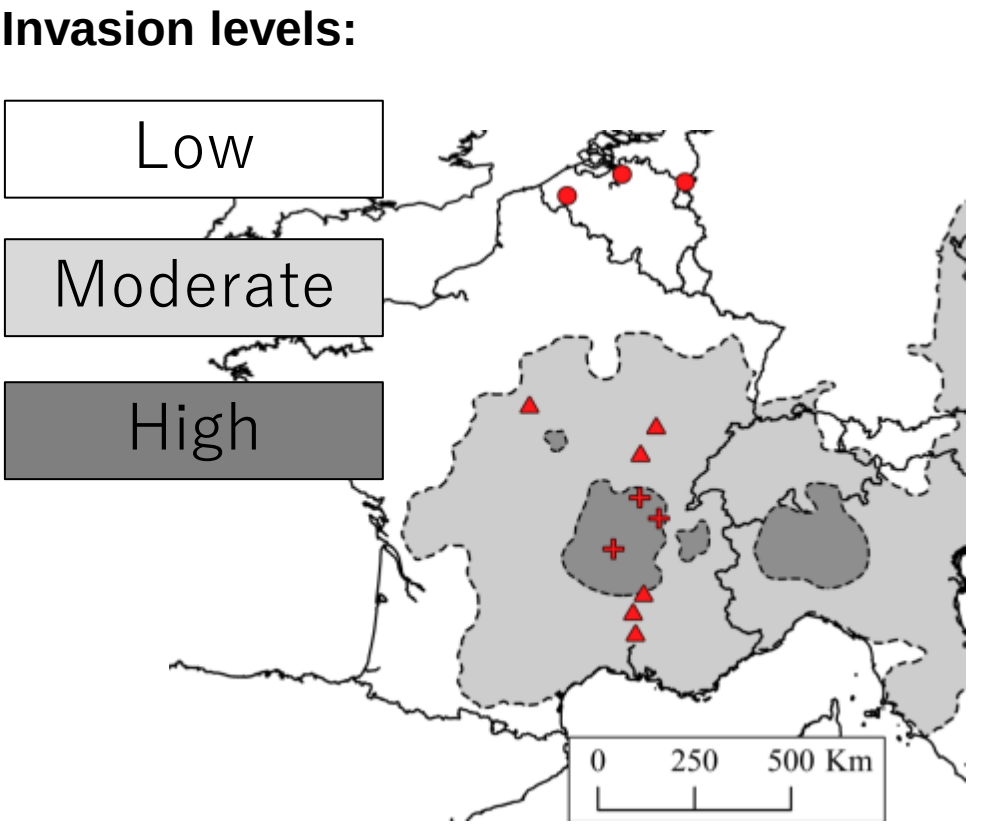
Invasion levels:



Study n°1 : Performance Variation

- Hypothesis

This situation of invasion is caused by reduced plant performance in the low level.

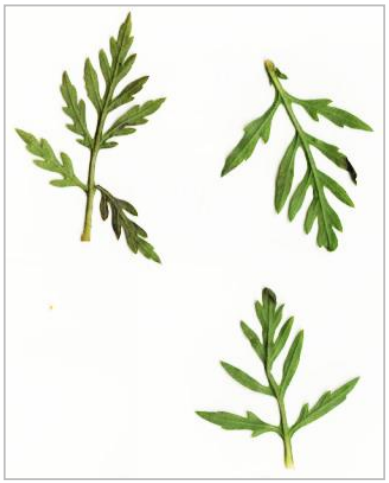


Study n°1 : Performance Variation

- Performance measurement on 25 plants

Summer

  - Specific leaf area (Stress)
  - Above ground biomass (Growth)

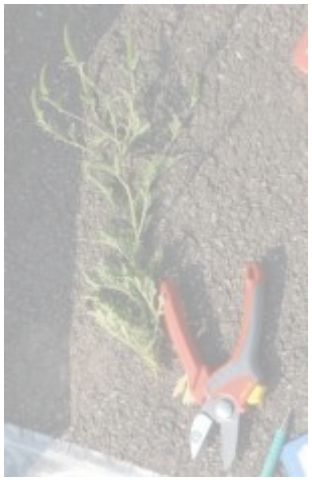


Study n°1 : Performance Variation

- Performance measurement on 25 plants

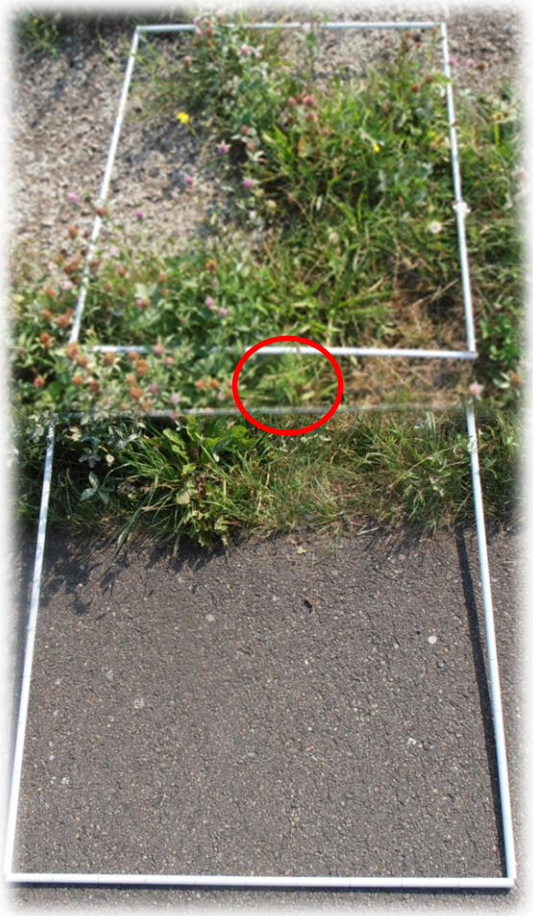
Summer
- Specific leaf area (Stress)
- Above ground biomass (Growth)

Autumn
- Seed number (Reproduction)
- Empty seed proportion (Pollen limitation)



Study n°1 : Performance Variation

- Interspecific competition (Summer)

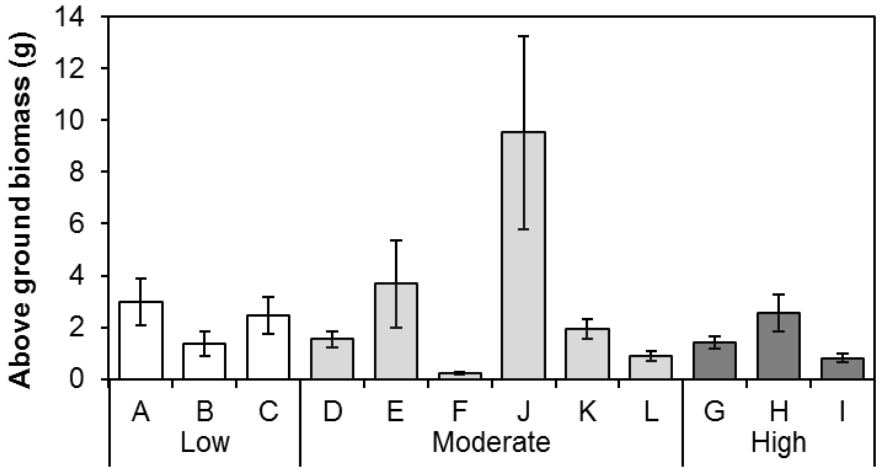


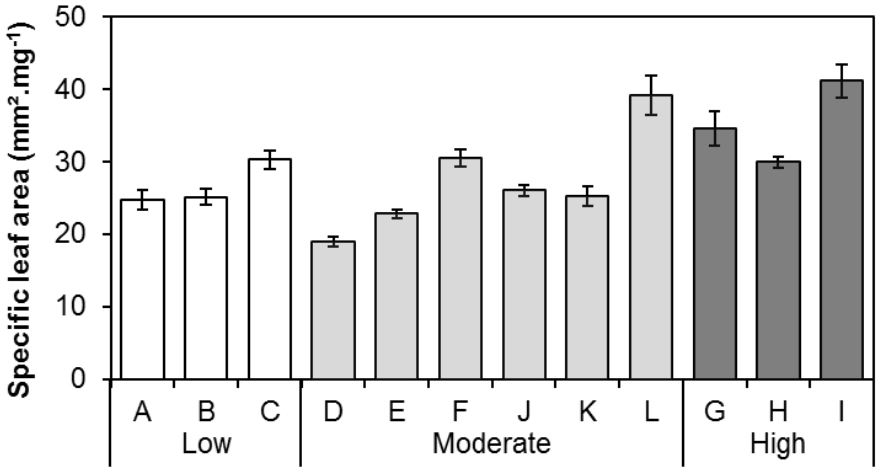
Study n°1 : Performance Variation

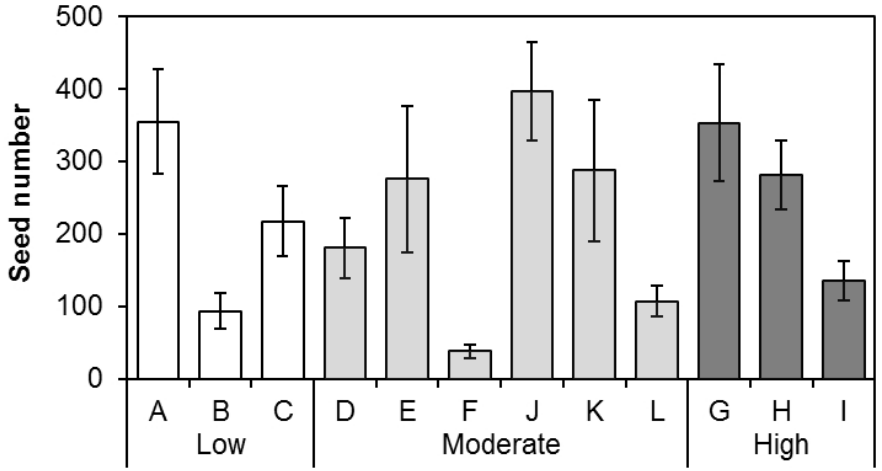
- Performance comparison
  - Histograms

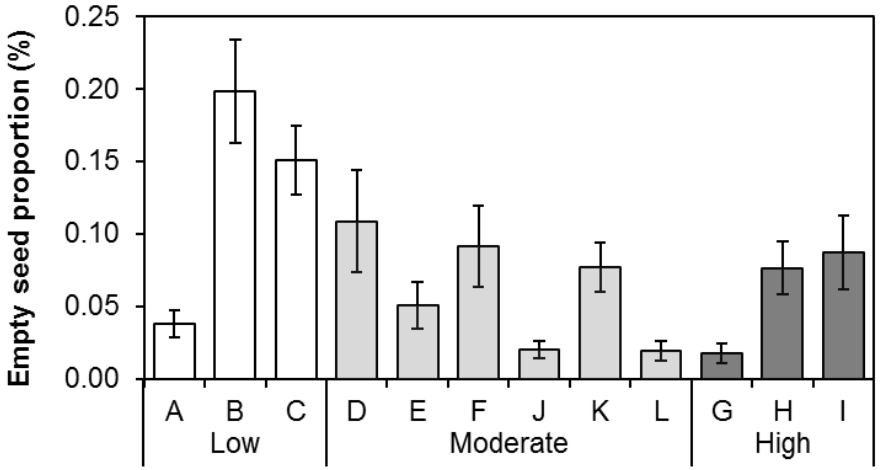
STUDY N°1 : PERFORMANCE VARIATION

- Performance comparison



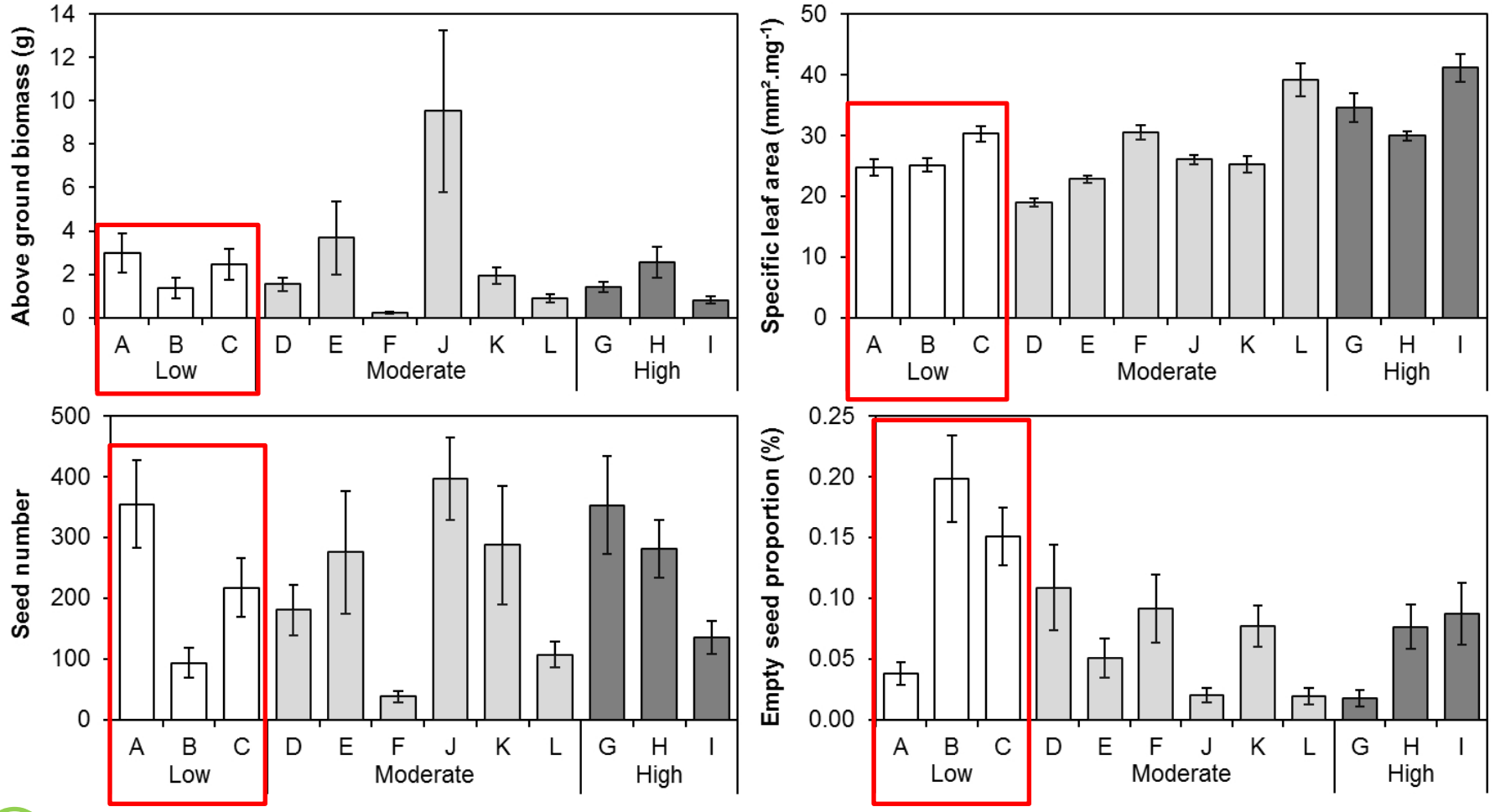






Study n°1 : Performance Variation

- Performance comparison



Study n°1 : Performance Variation

- Performance comparison

Summer (Ancova)

		Aboveground biomass		Specific leaf area	
Source of variation	**df**	**F**	**p**	**F**	**p**
Inter sp Comp	1	0.340	0.560	45.500	**<0,001**
Invasion Level	2	0.000	0.998	2.060	0.184
Population	9	6.120	**<0,001**	20.560	**<0,001**
Error	220	-	-	-	-

Autumn (Anova)

		Seed number		Empty seed proportion	
Source of variation	**df**	**F**	**p**	**F**	**p**
Invasion Level	2	0.270	0.768	2.180	0.169
Population	9	9.330	**<0,001**	6.060	**<0,001**
Error	288	-	-	-	-

Study n°1 : Performance Variation

- Performance comparison
  - Invasion level

Summer (Ancova)

		Aboveground biomass		Specific leaf area	
Source of variation	**df**	**F**	**p**	**F**	**p**
Inter sp Comp	1	0.340	0.560	45.500	**<0,001**
Invasion Level	2	0.000	0.998	2.060	0.184
Population	9	6.120	**<0,001**	20.560	**<0,001**
Error	220	-	-	-	-

Autumn (Anova)

		Seed number		Empty seed proportion	
Source of variation	**df**	**F**	**p**	**F**	**p**
Invasion Level	2	0.270	0.768	2.180	0.169
Population	9	9.330	**<0,001**	6.060	**<0,001**
Error	288	-	-	-	-

Study n°1 : Performance Variation

- Performance comparison
  - Interspecific competition

Summer (Ancova)

		Aboveground biomass		Specific leaf area	
Source of variation	**df**	**F**	**p**	**F**	**p**
Inter sp Comp	1	0.340	0.560	45.500	**<0,001**
Invasion Level	2	0.000	0.998	2.060	0.184
Population	9	6.120	**<0,001**	20.560	**<0,001**
Error	220	-	-	-	-

Autumn (Anova)

		Seed number		Empty seed proportion	
Source of variation	**df**	**F**	**p**	**F**	**p**
Invasion Level	2	0.270	0.768	2.180	0.169
Population	9	9.330	**<0,001**	6.060	**<0,001**
Error	288	-	-	-	-

Study n°1 : Performance Variation

- Performance comparison
  - Interspecific competition

Summer (Ancova)

Source of variation	df	Aboveground biomass F	Aboveground biomass p	Specific leaf area F	Specific leaf area p
Inter sp Comp	1	0.340	0.560	45.500	**<0,001**
Invasion Level	2	0.000	0.998	2.060	0.184
Population	9	6.120	**<0,001**	20.560	**<0,001**
Error	220	-	-	-	-

Autumn (Anova)

Source of variation	df	Seed number F	Seed number p	Empty seed proportion F	Empty seed proportion p
Invasion Level	2	0.270	0.768	2.180	0.169
Population	9	9.330	**<0,001**	6.060	**<0,001**
Error	288	-	-	-	-

Study n°1 : Performance Variation

- Performance comparison
  - Interspecific competition

Summer (Ancova)

Source of variation	df	Aboveground biomass F	Aboveground biomass p	Specific leaf area F	Specific leaf area p
Inter sp Comp	1	0.340	0.560	45.500	**<0,001**
Invasion Level	2	0.000	0.998	2.060	0.184
Population	9	6.120	**<0,001**	20.560	**<0,001**
Error	220	-	-	-	-

Autumn (Anova)

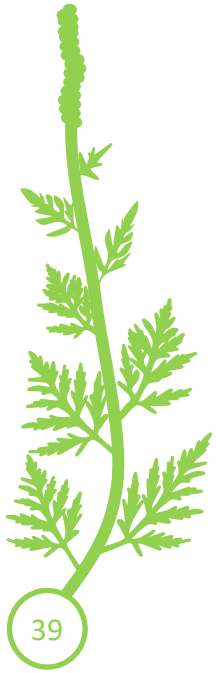
Source of variation	df	Seed number F	Seed number p	Empty seed proportion F	Empty seed proportion p
Invasion Level	2	0.270	0.768	2.180	0.169
Population	9	9.330	**<0,001**	6.060	**<0,001**
Error	288	-	-	-	-

Study n°1 : Performance Variation

- Conclusion

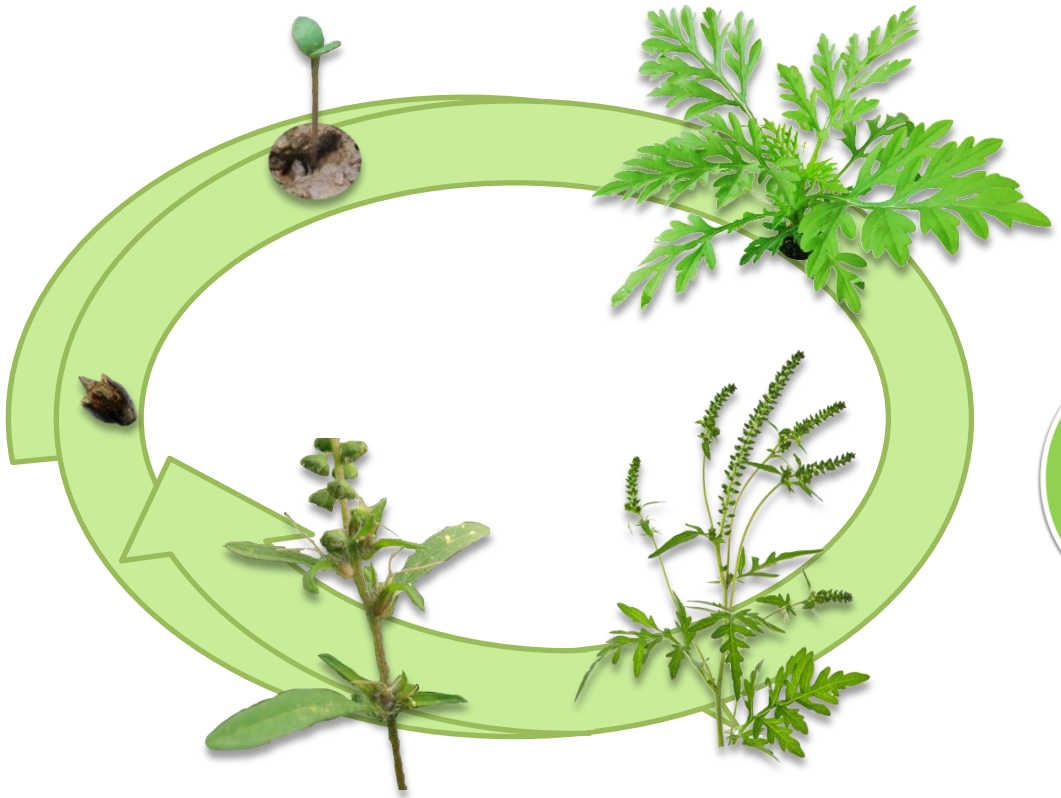
➔ Ragweed is not less performant in Belgium than in France

➔ The situation of invasion is not explained by a reduction of performance towards the North



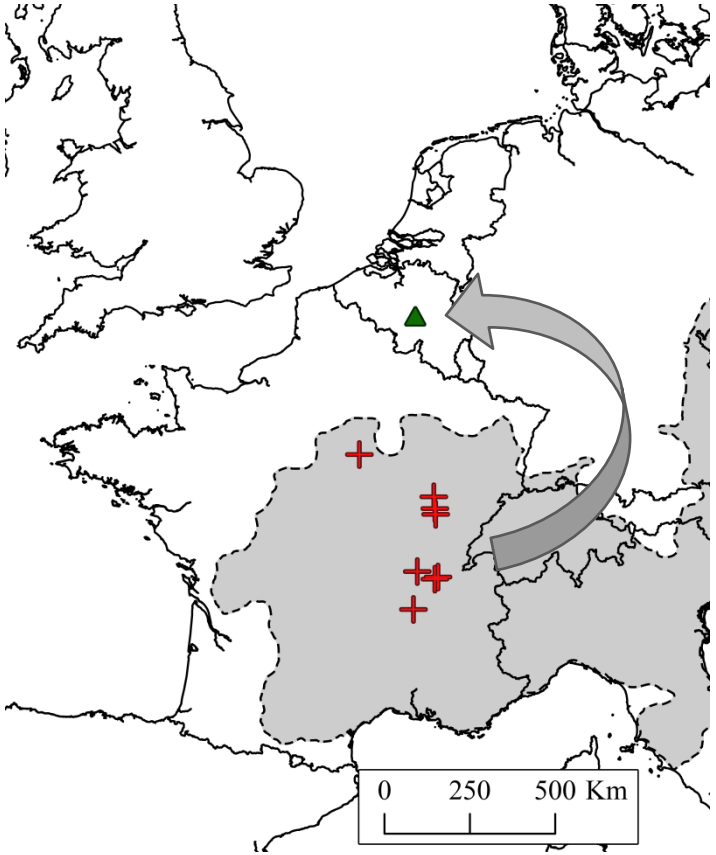
Study n°2

Is the species able to form invasive populations in an agricultural field of Belgium?



Study n°2 : Experimental Garden

- Population selection



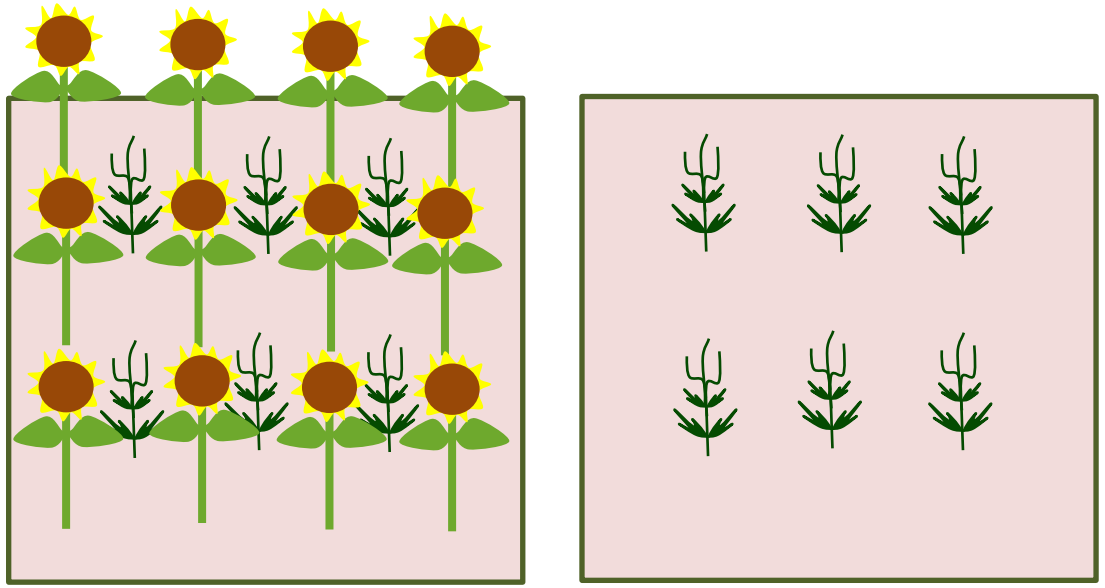
Study n°2 : Experimental Garden

- Experimental garden
  - Agricultural context (Gembloux)
  - 64 plots

Spring 2013

Study n°2 : Experimental Garden

- Sunflower competition
  - 6 ragweed by plot
  - With or without competition



32 placettes

32 placettes

Study n°2 : Experimental Garden

Summer 2013

Study n°2 : Experimental Garden

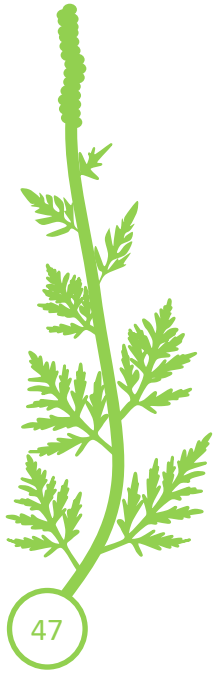
Spring 2014

Study n°2 : Experimental Garden

Summer 2014

Study n°2 : Experimental Garden

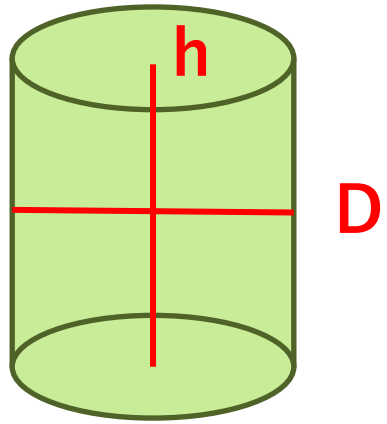
- Measurements
  - First growing season
    - Biovolume



Study n°2 : Experimental Garden

- Measurements
  - First growing season
    - Biovolume

$$V = \pi \times \left(\frac{D}{2}\right)^2 \times h$$



Study n°2 : Experimental Garden

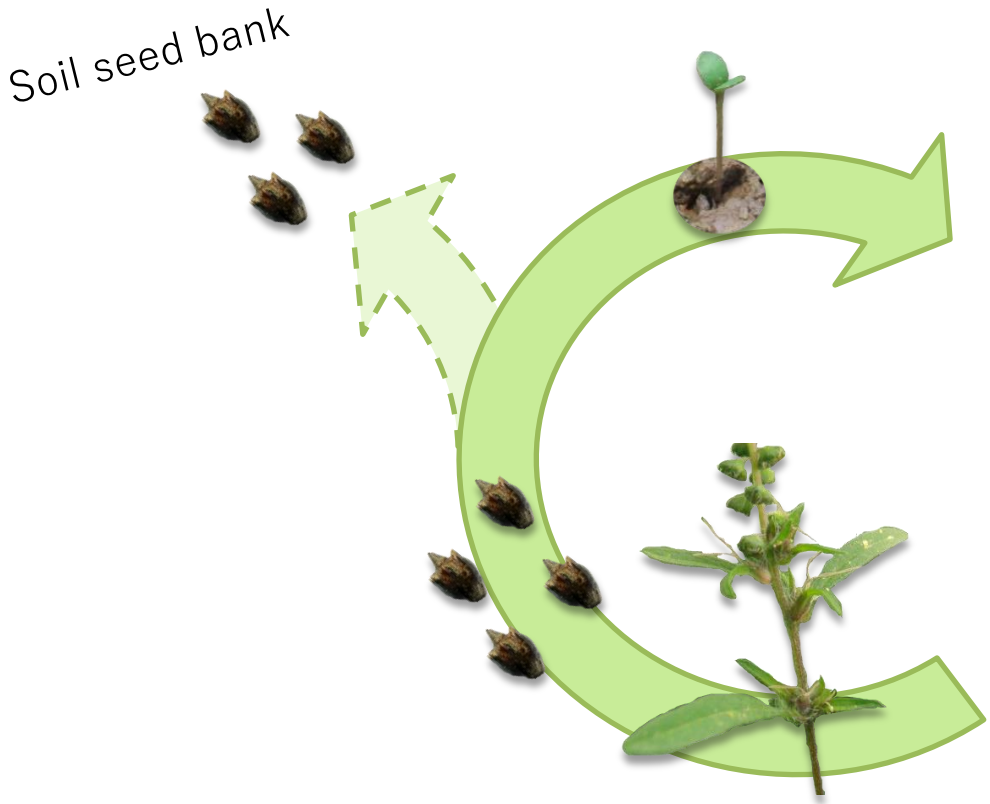
- Measurements
  - Second growing season
    - Offspring number

Study n°2 : Experimental Garden

- Measurements
  - Second growing season
    - Offspring number
    - Offspring aboveground biomass

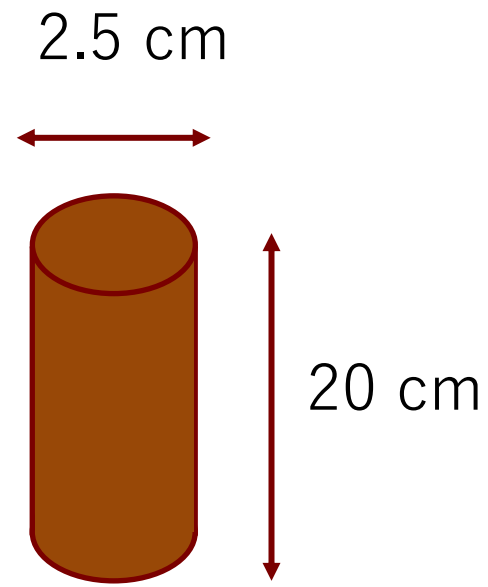
Study n°2 : Experimental Garden

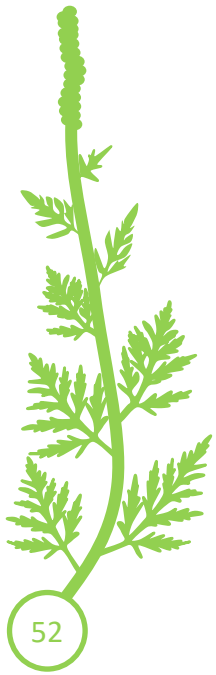
- Measurements
  - Second growing season
    - Residual soil seed bank



Study n°2 : Experimental Garden

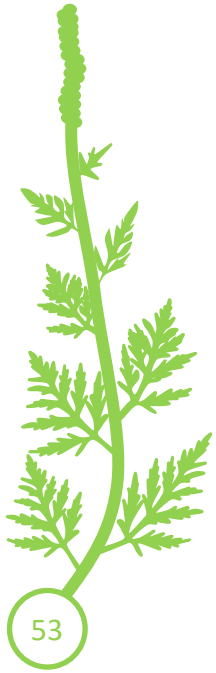
- Measurements
  - Second growing season
    - Residual soil seed bank
      - 20 soil cores / plot





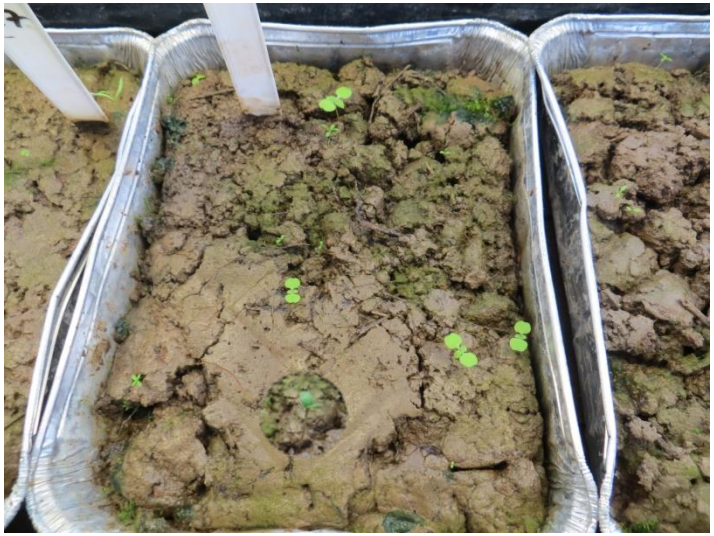
Study n°2 : Experimental Garden

- Measurements
  - Second growing season
    - Residual soil seed bank
      - 20 soil cores / plot
      - 4 weeks at 4 °C



Study n°2 : Experimental Garden

- Measurements
  - Second growing season
    - Residual soil seed bank
      - 20 soil cores / plot
      - 4 weeks at 4 °C
      - Germination in heated greenhouse



Study n°2 : Experimental Garden

- Measurements
  - Second growing season
    - Residual soil seed bank
      - 20 soil cores / plot
      - 4 weeks at 4 °C
      - Germination in heated greenhouse

Study n°2 : Experimental Garden

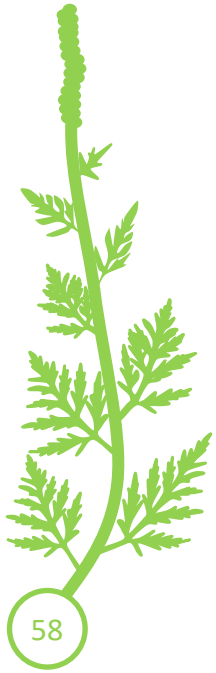
- Results
  - Residual soil seed bank (/m²) : 306 ± 51

Study n°2 : Experimental Garden

- Results
  - Residual soil seed bank (/m²) : 306 ± 51
  - Offspring (by « parent ») :
    - Seedlings only: 323 ± 24

Study n°2 : Experimental Garden

- Results
  - Residual soil seed bank (/m²) : 306 ± 51
  - Offspring (by « parent ») :
    - Seedlings only: 323 ± 24
    - Dormant seeds: 59 ± 10



Study n°2 : Experimental Garden

- Results
  - Residual soil seed bank (/m²) : 306 ± 51
  - Offspring (by « parent ») :
    - Seedlings only: 323 ± 24
    - Dormant seeds: 59 ± 10
    - Seedlings and dormant seeds : 382 ± 30

Study n°2 : Experimental Garden

- Results
  - Sunflower competition

Source of variation	*df*	Biovolume		Offspring number		Offspring biomass		Residual soil seed bank	
		F	p	F	p	F	p	F	p
Population	7	2.93	0.090	3.73	0.052	1.86	0.215	12.17	**0.002**
Competition	1	17.07	**0.004**	1.90	0.211	1.14	0.322	0.09	0.778
Pop.*Comp.	7	0.96	0.471	0.98	0.460	1.07	0.397	0.31	0.948
Error	48								

Study n°2 : Experimental Garden

- Results
  - Sunflower competition

Source of variation	*df*	Biovolume		Offspring number		Offspring biomass		Residual soil seed bank	
		F	p	F	p	F	p	F	p
Population	7	2.93	0.090	3.73	0.052	1.86	0.215	12.17	**0.002**
Competition	1	17.07	**0.004**	1.90	0.211	1.14	0.322	0.09	0.778
Pop.*Comp.	7	0.96	0.471	0.98	0.460	1.07	0.397	0.31	0.948
Error	48								

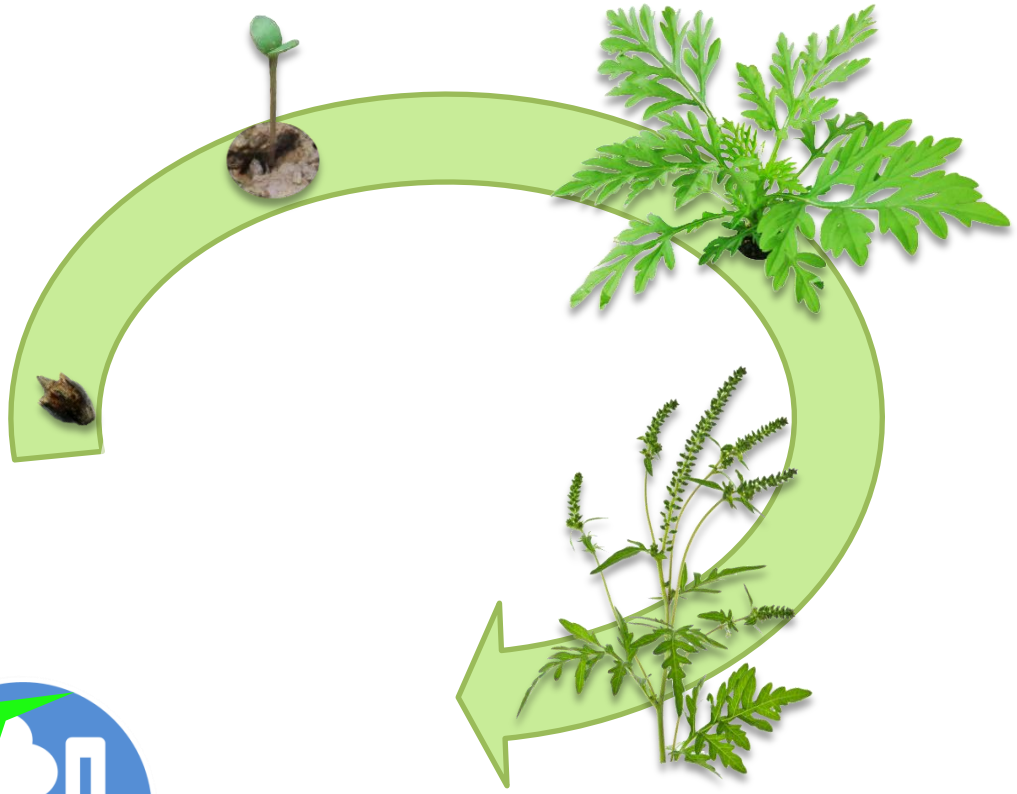
Study n°2 : Experimental Garden

- Results
  - Sunflower competition

Source of variation	*df*	Biovolume		Offspring number		Offspring biomass		Residual soil seed bank	
		F	p	F	p	F	p	F	p
Population	7	2.93	0.090	3.73	0.052	1.86	0.215	12.17	**0.002**
Competition	1	17.07	**0.004**	1.90	0.211	1.14	0.322	0.09	0.778
Pop.*Comp.	7	0.96	0.471	0.98	0.460	1.07	0.397	0.31	0.948
Error	48								

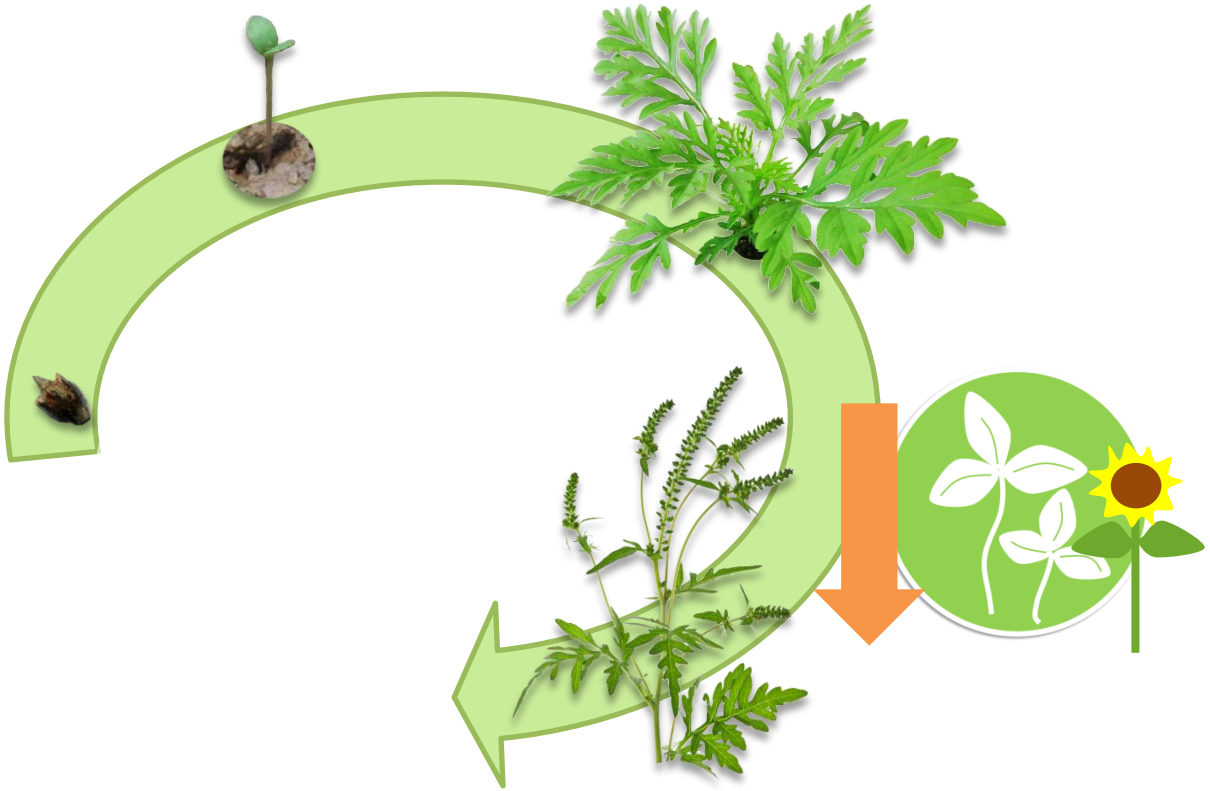
Study n°2 : Experimental Garden

- Results



Study n°2 : Experimental Garden

- Results

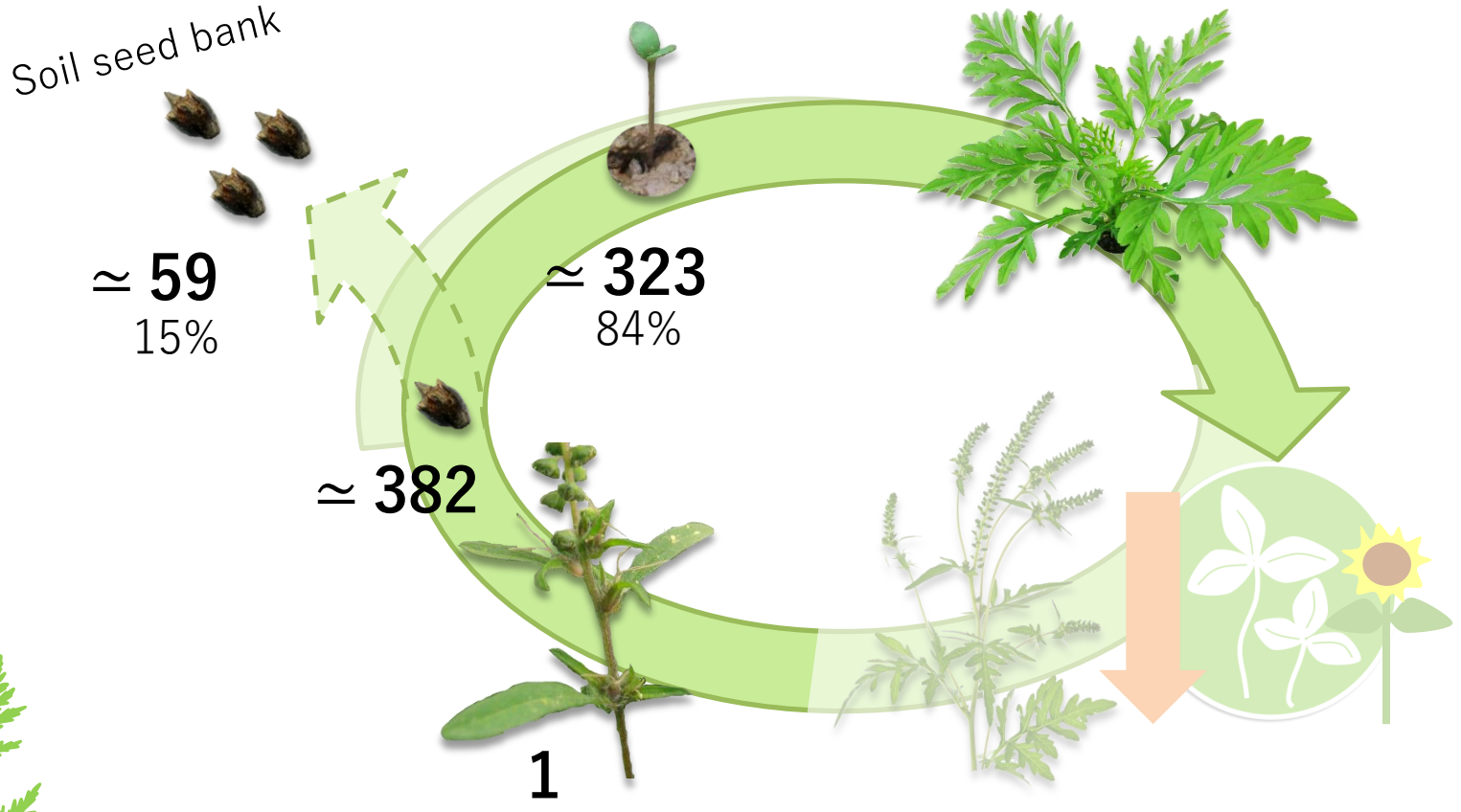


Study n°2 : Experimental Garden

- Results

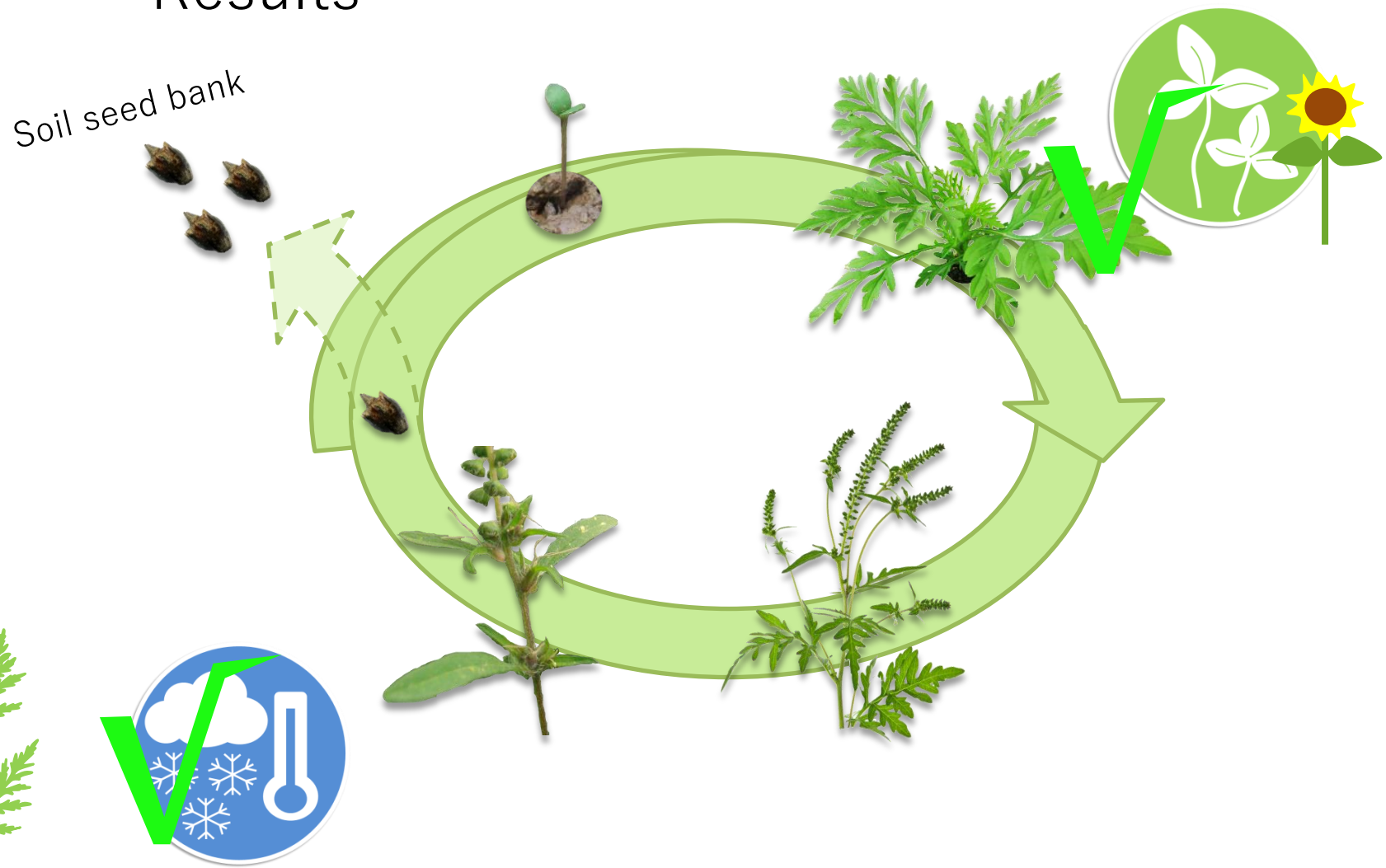
Study n°2 : Experimental Garden

- Results

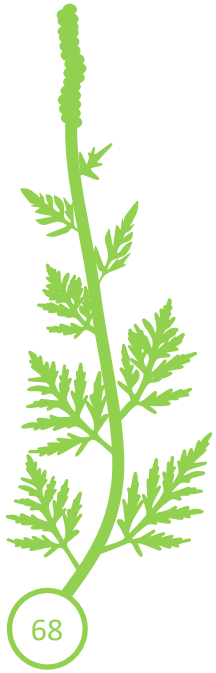


Study n°2 : Experimental Garden

- Results

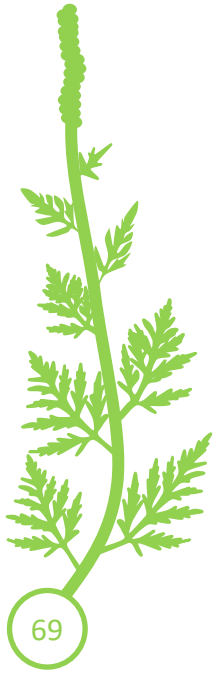


Conclusions



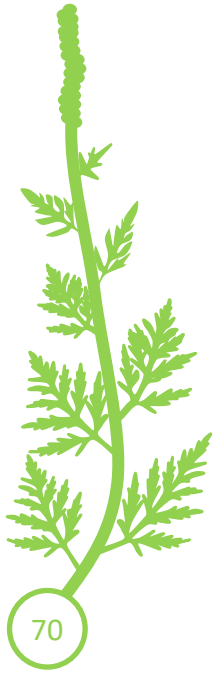
Conclusions

- Is there a limit to the naturalization of the species in Belgium?
  - No limit highlighted



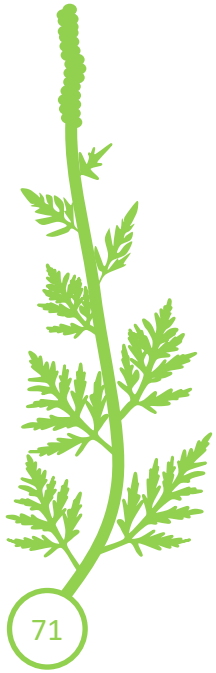
Conclusions

- Is there a limit to the naturalization of the species in Belgium?
  - No limit highlighted
  - The species appeared to be naturalized in Belgium



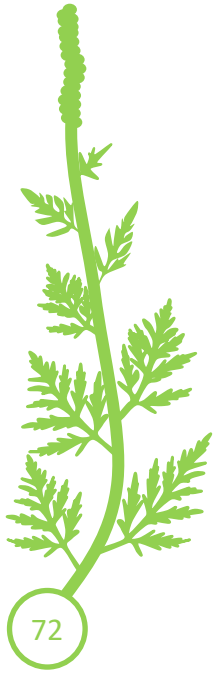
Conclusions

- Is there a limit to the naturalization of the species in Belgium?
  - No limit highlighted
  - The species appeared to be naturalized in Belgium
  - There is great potential of invasion in Belgium



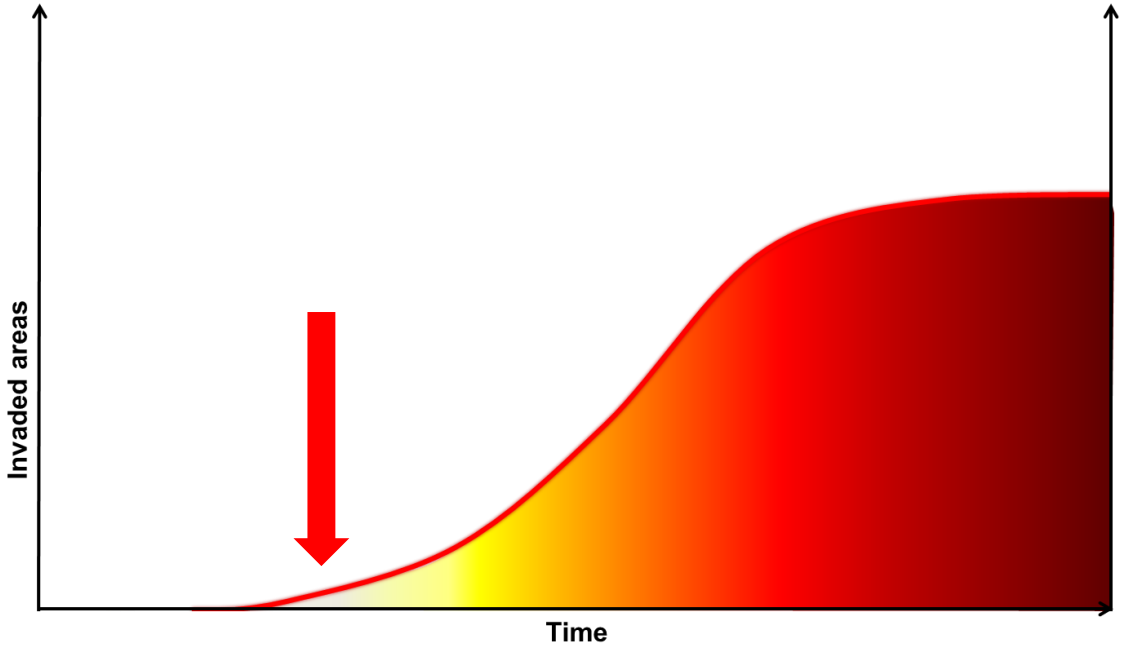
Conclusions

- Why the species does not seem to become invasive in Belgium?



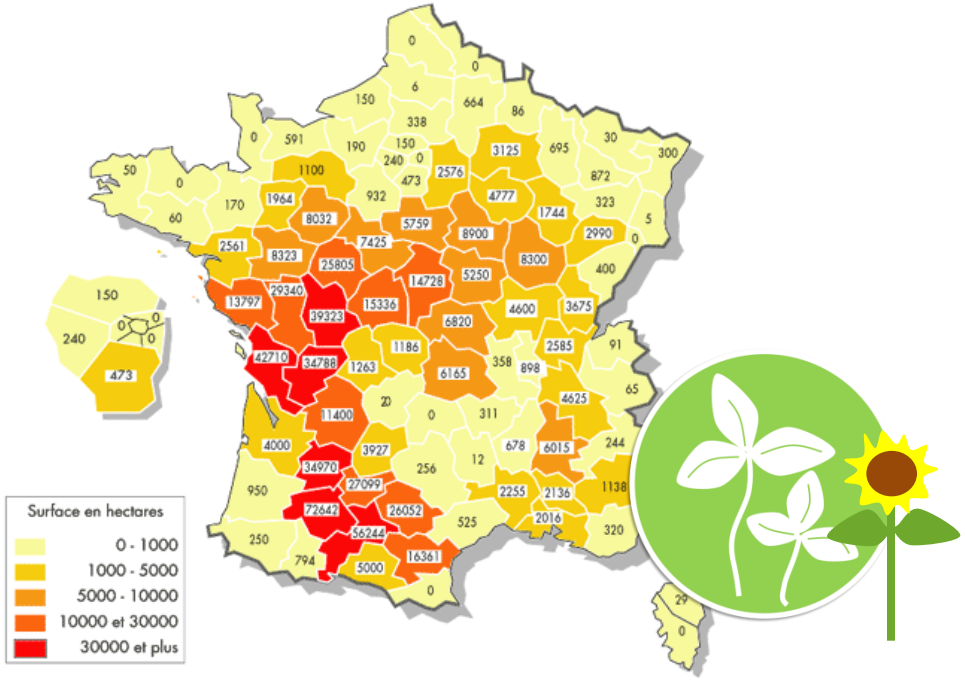
CONCLUSIONS

- Why the species does not seem to become invasive in Belgium?
  - Residence time



CONCLUSIONS

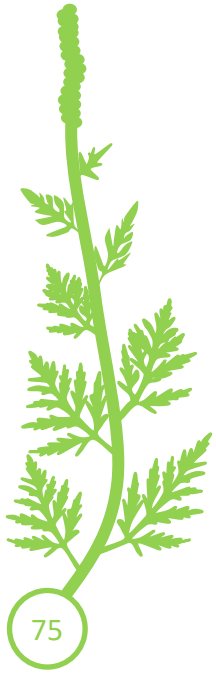
- Why the species does not seem to become invasive in Belgium?
  - Residence time
  - Difference of practices



Conclusions

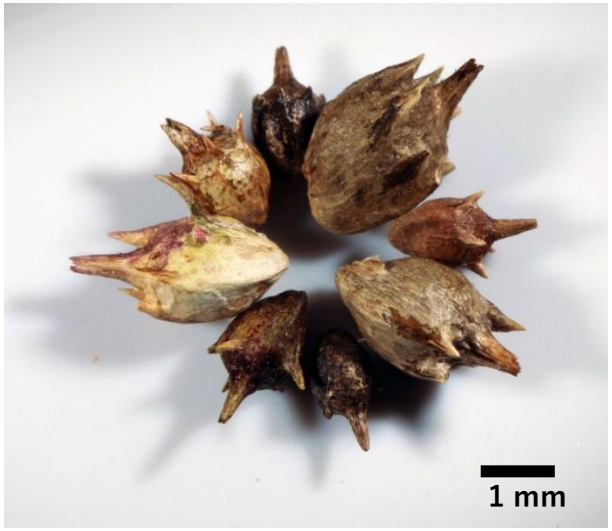
- Why the species does not seem to become invasive in Belgium?
  - Residence time
  - Difference of practices

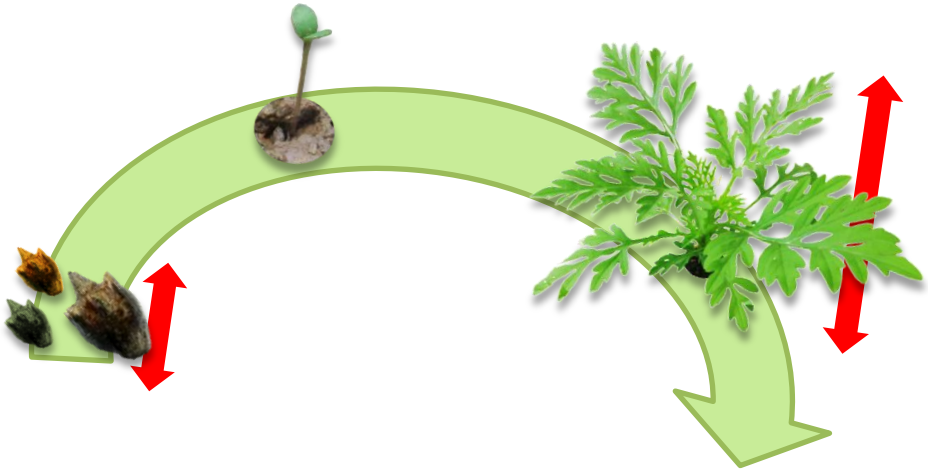
- Early detection is the key!



Study n°3 : Effect of seed traits

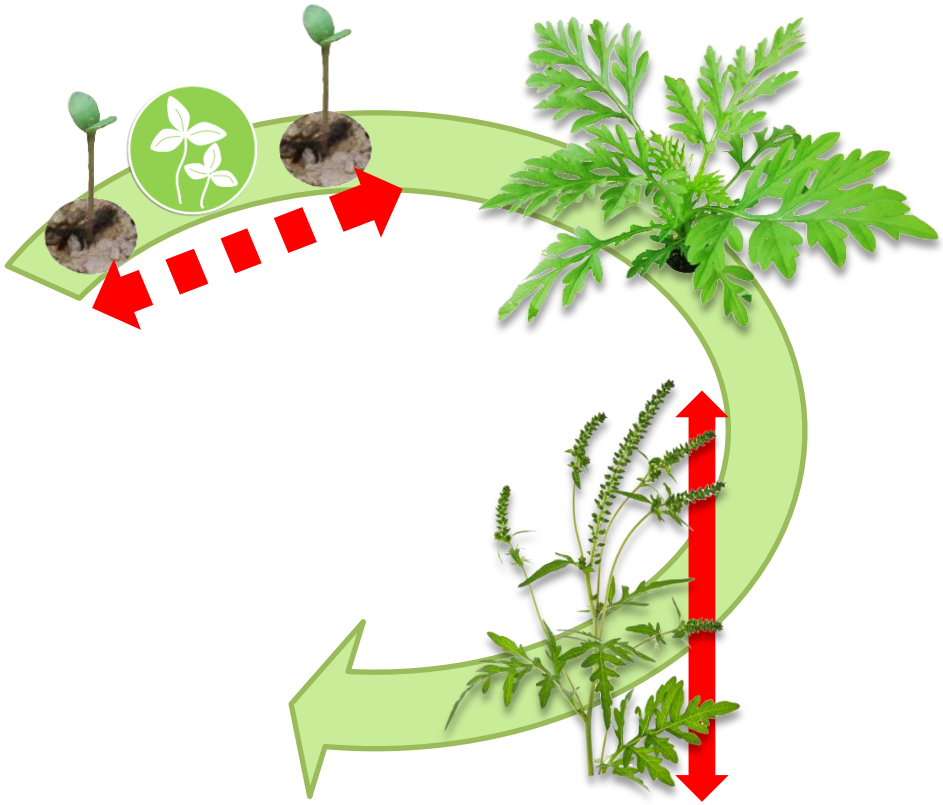
- Neobiota poster





Study n°4 : Priority effect

- Neobiota poster



Thank you for your attention