Importance of seeds in the process of common ragweed invasion

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Common ragweed

- Annual species
- Compositae
- Native from North America

Germination
Vegetative growth
Pollination
Seed production
Seed dispersion

- A spring-summer germinating weed
- A long cycle
- A late seed production
Common ragweed in Europe

- Plants present in many European countries
- Allergenic pollen also found in areas where the species is very rare or absent

http://www.polleninfo.org/
Introduction and spread in France

Before 1880
Before 1900
Before 1920
Before 1940
Before 1960
Before 1980
Before 2007

New areas in light green

Chauvel et al., 2006
Why such a success?
Why such a success?

Certainly because of an addition of various factors and among others:

- Enemy-release hypothesis?
  low level of natural regulation (even in native area)

- Empty ecological niche hypothesis
  river banks

- Climate change
  delay in the first days of frost

- Reduction of herbicide use
  strengthened environmental laws
Why such a success?

The characteristics of common ragweed biology:

- Wide ecological variation
  
  **Ragweed is present in different types of soils** (texture, structure) and can be present in different types of habitats (fields, roadsides, river banks)

- Stress tolerant
  
  water, salt, mowing, herbicides

- Competitive in open habitats
  
  between 20-cm to 2-m high according to habitats and available nutrients
Why such a success in comparison to ‘similar species’?

Example with two other annual weeds:

- **Amaranthus retroflexus**  
  *C4*  
  Auto-Allogamous  
  Spring - Summer  
  Invasive (16th century)

- **Chenopodium album**  
  *C3*  
  Auto-Allogamous  
  Spring - Summer  
  Native

- **Ambrosia artemisiifolia**  
  *C3*  
  Strictly Allogamous  
  Spring - Summer  
  Invasive (19th century)
Why such a success in comparison to ‘similar species’? – Role of seed stage?

Example with two other annual weeds:

Amaranthus retroflexus
Auto-Allogamous
Spring - Summer
Invasive
20 000 seeds/pl.
(500 to 30 000)
0,8-0,9 x 1,0-1,1 mm

Chenopodium album
Auto-Allogamous
Spring - Summer
Native
15 000 seeds/pl.
(500 to 20 000)
1,2-1,5 x 1,2-1,5 mm

Ambrosia artemisiifolia
Strictly Allogamous
Spring - Summer
Invasive
3000 seeds/pl.
(150 to 10 000)
1,5-2,0 x 2,0-3,5 mm
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1,5-2,0 x 2,0-3,5 mm

Strictly allogamous plant

- first flowers: mid-July male flowers
- mid-August: female flowers

Annual cycle
What are the steps involving the seed stages which can explain the ragweed success?

- Seed survival in soil
- Low seed regulation
- Seed dormancy
- Seed size
- Depth germination ability
- Seed-size variability

➢ But ragweed has **no natural seed-dispersal mechanism** needs a human dispersal vector to be spread
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1 - Survival duration

• **Seed survival in soil**: 6% of the seeds still able to germinate after 39 years in the soil (Toole & Brown, 1946)

• Majority of seeds able to survive **more than 5 years** (Stoller & Wax, 1974)

➢ **A real advantage for ragweed:**
  ▪ in cultivated areas (*survival longer than rotation duration*)
  ▪ in areas with perturbed soils (*river banks*)
  ▪ and what about the situation in areas with no soil perturbation (*roadsides*)?
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2 - Seed regulation in soil

On average 20.9% of ragweed seeds were consumed per week. Nevertheless, just a regulation that cannot control the species spread.

from Trichard et al., 2012
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3 - Seed dormancy

- Innate dormancy
- Enforced dormancy
- Induced dormancy

A real advantage in perturbed areas with high stress levels

from Bazzaz, 1979
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4 - Seed size

Weeds

Crops
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4a - Seed size - *spread*

<table>
<thead>
<tr>
<th>Mark</th>
<th>Total number of weed seeds per bag</th>
<th>Seeds of <em>Ambrosia artemisiifolia</em> L.</th>
<th>Mean number per bag</th>
<th>% with an embryo</th>
<th>Mean number of viable seed per kg of sunflower</th>
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<tr>
<td>Mark 2</td>
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<td>0.87</td>
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</tbody>
</table>
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5 - Depth germination ability

A significant part of the seed bank of ragweed is able to germinate under **4 cm**. (herbicide effect? Stale seed-bed practice?)
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Seed-size variability

- constitutes certainly a positive trait for:
  - the phase of **introduction** (different crops can be contaminated);
  - the phase of **colonization** tolerance to predation, soil environment, etc.;
  - the phase of **naturalization**: spread by different vectors (harvesters, rivers, bird seeds, soil transport, etc.) in the various habitats.
Why such a success?

Certainly difficult to prove the key role of the seed by simple experiments:

- multi-factorial causes
- not directly due to the seed itself, but indirect effects of cultural practices and environmental factors on the seed stage
- statistical control(s)?

Is it possible to demonstrate the role of seed more precisely?

**Idea**: investigate into the responses of the species in areas where it is not present to discover the limiting factors (Just environmental factors?)
Why such a success?

Other favourable reasons:

- Climate change
- Agriculture regulations
- Local reasons
- etc.

Challenges:

- To avoid mechanisms which favour the spread of the seeds
- To avoid development of herbicide resistant populations of ragweed

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Thank you for your attention