BRION Emilie - CHENEVERT Marie-Kate - MARTIN Lucie - PELLICOT Claire

Weed management

In agriculture, uncontrolled weeds result in a **yield reduction of 34%** worldwide [1]. Weeds compete with crops for vital ressources, some may also harbour parasites, be favorable for diseases or make harvesting operations more complicated and ultimately, reduce product quality. **Therefore, weed management is a major agronomic issue.**

Herbicide

Herbicides

Selectivity
- Non-selective
- Selective

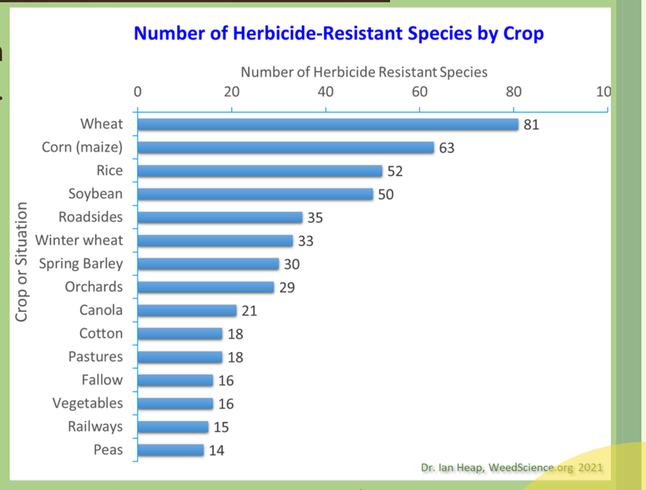
Time of application
- Pre-plant
- Pre-emergence
- Post-emergence

Mode of action
- Amino acid synthesis regulators
- photosynthetic inhibitors
- Cell membrane disruptors

Sites of actions
- Acetyle coenzyme A carboxylase (ACCase)
- Very-long-chain fatty acid synthesis (VLCFAS) inhibitors

Nowadays, there are many issues with resistance...

- In 2023, **523** weeds are resistant in 72 countries around the world (Heap).
  - It mainly concerns herbicides in the **ACCase** and **ALS families.**
  - **2** main mechanisms at play are : resistance by **target mutation** or resistance by **detoxification.**



4 highly controversial **active substances** are certain to be banned over the next 50 years in France. This represents **more than half of the herbicides on the market today.**

Crop rotation

Alternating winter and spring crops breaks the weed cycle. A long, diversified rotation avoids the selection of specialized flora and limits the emergence of resistance to plant protection products.

Integration of **cover crops:** fast coverage and high biomass to smother weed flora. ⟶ Broadcast sowing

Cover crops compete with weeds that emerge at the same time as them, but have little or no effect on weeds that emerge in the following crop

Permanent cover crops: Rotational grasslands have a dual effect in terms of herbicide reduction:
- They do not require weeding throughout their 3 to 5-year cycle.
- They reduce the seed bank for subsequent crops.
- Successive mowing (4 to 5 times a year) allows biomass to be removed before most of the weeds have set seed.

Shifting the sowing date: Delaying the sowing date (10 to 20 days) for winter and spring crops limits weed development and allows for an additional false sowing.

A 15-day delay can reduce Vulpine infestation by **more than 70%** [2]

However, this can be disastrous for crop establishment in harsh autumn conditions. It is therefore a lever to be used in the most difficult situations.

Mechanical control

Deep tillage
- **Equipment:** disc plough, chisel plough
- **Purpose:** overturning the soil
- **Effect:** This method buries weed seeds and seedlings which causes dormancy and blocks seed germination.

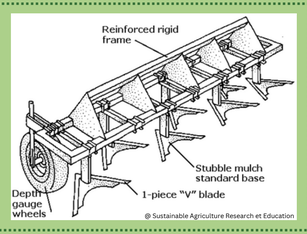
↘ Seed Stock

False sowing

In the same way as preparing a seedbed, false sowing consists of working the first centimeters of the soil during the weed germination period.

Optimal germination conditions for weed seeds
Destruction of weed seedlings before crop sowing

Stubble ploughing
- **Equipment:** sweep or blade plough (shallow depth)
- **Purpose:** uproot small weeds and cut larger ones
- **Effect:** In warm and dry conditions, weeds dry out in the sun.



Mowing field borders

Flowering weeds along field edges + Wind, passing animals or machinery ⟶ Additional weed seeds to cultivated plots

Solution: Mowing field edges before weeds mature (prevents seed production)

Innovations

Specialized harvesting system

Weed seeds can be intercepted, and destroyed : 75% of weed seeds end up in fine straw

↘ Renewal of the seed stock + Dissemination of weeds.

Specialized equipment

New technologies
- Drones + robots: monitor fields
- High-resolution satellite images

GPS-guided vehicle

Use of Bioherbicides
- New strains of microorganisms
- Improved nanoformulations

Genetic control

Developpement of genomic resources

Molecular approaches
Improve the choice of herbicides

GWAS: Improve herbicide tolerance, allow crops to outcompete weeds
Fababean in 2022 [3]

CRISPR/CAS9:
- **I**mprove the performance of the crops (herbicide tolerance, earlier vigor, allelopathic effect)
- **A**lter the development of weeds

Gene drives:
- **R**educe weed populations by inducing mutations that decrease their fitness
- **I**ncrease the susceptibility of the weed population

Conclusion

Weed management

An ongoing challenge

Herbicide application
- Weed resistance
- Quick and effective to use

Mechanical control
- Detrimental to soil structure and time consuming
- Main control method in organic farming

Crop rotation
- Not suitable for all cropping systems
- Sustainable

Innovation

Bioherbicide | Genome editing

New agricultural equipment

Rethinking the role of weeds in cropping systems...

Bibliography

- 1: Délye, C., Jasieniuk, M., & Corre, V. L.. (2013). Deciphering the evolution of herbicide resistance in weeds. Trends in Genetics, 29(11), 649-658. https://doi.org/10.1016/j.tig.2013.06.001
- 2: Chavassieux, D. & al.. (2023). Décaler la date de semis sur les parcelles à risque graminées : un levier indispensable.[On line] https://www.arvalis.fr/infos-techniques/decaler-sa-date-de-semis-sur-les-parcelles-risque-graminees-un-levier
- 3: Wong ACS, Massel K, Lam Y, Hintzsche J and Chauhan BS (2022). *Biotechnological Road Map for Innovative Weed Management. Front.* Plant Sci. 13:887723. doi: 10.3389/fpls.2022.887723
- 4: Agroscope. (2021). *Lutte intelligente contre les adventices.* [On line] https://www.agroscope.admin.ch/agroscope/fr/home/themes/economie-technique/smart-farming/lutte-intelligente-adventices.html
- 5: Chambres d'agriculture de l'Aude. (N.A.) *Leviers agronomiques pour la gestion des adventices.* [On line] https://aude.chambre-agriculture.fr/fileadmin/user_upload/Occitanie/064_Inst-Aude/documents_aude/polyculture/publications_polyculture/Fiches_alternatives/Leviers_agronomiques_adventices.pdf
- 6: Chambres d'agriculture de Normandie. (2023, March 15). *LES PRAIRIES TEMPORAIRES, UN LEVIER DE POIDS POUR LA GESTION DES ADVENTICES.* [On line] https://normandie.chambres-agriculture.fr/a-proximite/actualites-locales/detail-actualite/actualites/les-prairies-temporaires-un-levier-de-poids-pour-la-gestion-des-adventices/
- 7: Chambres d'agriculture Pays de la Loire. (2015, January). [On line] *Lutte préventive.* [On line] https://pays-de-la-loire.chambres-agriculture.fr/fileadmin/user_upload/National/FAL_commun/publications/Pays_de_la_Loire/2020/2020_guide_agricole_reductions_produits_phytosanitaires_1_3_Lutte_preventive_semis.pdf
- 8: Frontout, Y.. (2021, March 3). *Les couverts végétaux, levier efficace dans la gestion des adventices ?.*[On line] https://www.terre-net.fr/couverts-vegetaux/article/177485/les-couverts-vegetaux-levier-efficace-dans-la-gestion-des-adventices-
- 9: Ghatrehsamani, S. & al.. (2023). *Artificial Intelligence Tools and Techniques to Combat Herbicide Resistant Weeds—A review. Sustainability*, 15(3), 1843. https://doi.org/10.3390/su15031843
- 10: Kremer, R. J.. (2023). *Bioherbicide development and commercialization.* https://doi.org/10.1016/b978-0-323-95290-3.00016-9
- 11: Métais, P. & al.. (2018). *Gestion des adventices par l'agronomie et les agroéquipements : moyens mobilisables et perspectives.* [On line] https://ecophytopic.fr/sites/default/files/actualites_doc/Phloeme2018_T1_METAIS%20-%20Gestion%20des%20adventices%20par%20l%27agronomie%20et%20les%20agro%C3%A9quipements%20-%20moyens%20mobilisables%20et%20perspectives.pdf