Evolution of sunflower downy mildew in France

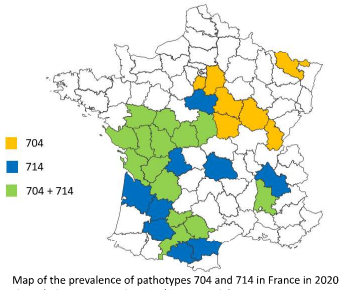
Penaud Annette[1], Perrot Sophie[2], Boniface Marie-Claude[3], Pauchet-Mattler Isabelle[4], Delos Marc[5] & Bret-Mestries Emmanuelle[1]

[1] Terres Inovia, 1 avenue Lucien Brétignières, 78850 Thiverval-Grignon, France
[2] GEVES, rue Georges Morel, 49071 Beaucouzé cedex, France
[3] INRAE-LIPME, Chemin de Borde Rouge – Auzeville, CS 52627, 31326 Castanet-Tolosan cedex, France
[4] UFS, 17 rue du Louvre, 75001 Paris, France
[5] DRAAF- SRAI, Cité Administrative- Bat E, Bd Armand Duportal, 31074 TOULOUSE cedex, France.

Since its first discovery in France in 1966, sunflower downy mildew, caused by *Plasmopara halstedii*, has become widely established in the country. Although no longer included in the list of quarantine pests since the end of 2019 but still regulated (now classified as NQRO, non-quarantine regulated organism), the monitoring of this biotrophic oomycete continues. It provides the basis for the development of integrated pest management recommendations for producers and for the orientation of breeding and research efforts.

- An annual field survey, in all production areas, before flowering, on a minimum of 500 plots
- An analysis by biological test of the pathotypes for any variety expected to be resistant to the 9 pathotypes officially recognized in France (100, 304, 307, 314, 334, 703, 704, 710 and 714) and attacked at more than 10% (GEVES laboratory)
- Differential host set of 9 lines defined by Tourvieille *et al*. (2000) + RHA340 (*Pl8*) and PSC8 (*Pl2*) recently added
- Symptoms scoring in 7 classes according to Mouzeyar *et al.* (1993)
- Until 2020, evaluation of the resistance to metalaxyl-M of each downy mildew isolate.

- Since 2000, 860 parcelles observed each year on average (from 566 to 1160)
- From 4 to 28% of infected fields, according to spring weather conditions
- Among the infected fields, 0 to 10% of fields showing more than 30% of dwarfed plants
- From 20 to 50 isolates analyzed each year, prevalence of pathotypes 704 and 714 detected for the first time in 2002 ---------->
- Resistance to metalaxyl-M (only fungicide authorized until 2021 and used on 85% of the sunflower crop each year): widespread, including recent isolates.



Map of the prevalence of pathotypes 704 and 714 in France in 2020 since their appearance in 2002 (Terres Inovia)

Departments where resistance overcoming was observed from 2018 to 2021 (more than 10% of dwarfed plants) : [number of cases; number of varieties concerned] (Terres Inovia)

- Resistance overcoming of expected resistant varieties (100, 304, 307, 314, 334, 703, 704, 710 & 714):
  - Since 2018, 77 cases on 28 varieties, mainly in the South-West <---
  - From 10% to 100% of dwarfed plants, 39% on average
  - Causes: short rotations, intensive use of resistant varieties, with only one *Pl* gene
  - Isolates of type 334, 704 and 714; some 714 isolates overcome *Pl8* (*cf.* Martin-Sanz *et al.*, 2020)
  - 3 types of 714 overcoming isolates identified by GEVES, suggesting **several concomitant overcoming events.**

→ Many countries are concerned, requiring expansion and adaptation of the differential host set (*e.g.*, Ban *et al*., 2021; Gilley *et al*., 2020; Iwebor *et al*., 2021; Sedlárová *et al*., 2016; Trojanová *et al*., 2018) and the harmonization of the bio-testing protocol (Trojanová *et al.*, 2017; Spring, 2019).

These reinforce the nedd to initiate or continue targeted research on different topics on both sunflower and *P. halstedii*:

- Mode of action of *Pl* genes and optimization of their exploitation
- Understanding the evolutionary mechanisms of the pathogen (virulence, fungicide resistance)
- Impacts of the simultaneous use of genetic and chemical protection
- Quantitative resistance
- Impact of climate change on downy mildew.

References

Bán, R., Kovács, A., Nisha, N., Pálinkás, Z., Zalai, M., Yousif, A.I.A., and K. Körösi. 2021.. J. Fungi 7:549 https://doi.org/10.3390/jof7070549.
Sedlárová, M., PospíchBán, R., Kovács, A., Nisha, N., Pálinkás, Z., Zalai, M., Yousif, A.I.A., and K. Körösi. 2021. J. Fungi 7:549 https://doi.org/10.3390/jof7070549.
Gilley, M.A., Gulya, T.J., Seiler, G.J., Underwood, W., Hulke, B.S., Misar, C.G., and S.G. Markell. 2020. Plant Disease 104:2823–2831 https://doi.org/10.1094/PDIS-10-19-2063-RE.
Iwebor, M., Antonova, T., Araslanova, N., Saukova, S., Pitinova, Y., Eliseeva, K., and A. Belorutskyi. 2021. Plant Protection Science 58:76-80 https://doi.org/10.17221/85/2021-PPS.
Martín-Sanz, A., Rueda, S., García-Carneros, A.B., and L. Molinero-Ruiz. 2020. Plant Dis :104:597.
Mouzeyar, S., Tourvieille, D., and F. Vear, 1993. J. Phytopathology 139:289-297.
Tourvieille de Labrouhe, D., Gulya, T. J., Masirevic, S., Penaud, A., Rashid, K.Y., and F. Virányi. 2000. In: Proc. 15th Int. Sunfl. Conf., Toulouse, France. Int. Sunfl. Assoc., Paris, France.
Trojanová, Z., Sedlářová, M., Gulya, T.J., and A. Lebeda. 2017. Plant Pathology 66:171-185 Doi:10.1111/ppa.12593.
Trojanová, Z.D., Sedlářová, M., Pospichalová, R., and A. Lebeda. 2018. Plant Pathology 67:113-144 DOI: 10.1111/ppa.12722.