

The benzamide fungicide, zoxamide, has been registered in Europe for the control of potato late blight since 2001. It is non-systemic and specifically active against Oomycetes, inhibiting β -tubulin assembly during mitosis. It was developed by Rohm & Haas, subsequently Dow AgroSciences, but is now owned by Gowan. FRAC considers zoxamide as having low to medium resistance risk. For potato blight control, zoxamide is marketed only in co-formulations with mancozeb (e.g. 'Electis', 'Aderio'). To support its European registration, Rohm & Haas initiated sensitivity testing of *Phytophthora infestans* isolates in 1997; this has been continued by Dow and Gowan up to the present. All testing has been carried out at Newforge, Belfast. Results from isolates collected 1997-2000 were reported by Cooke *et al.* (2002). Here results of tests on isolates 2003-2012 are reported.

Sample collection

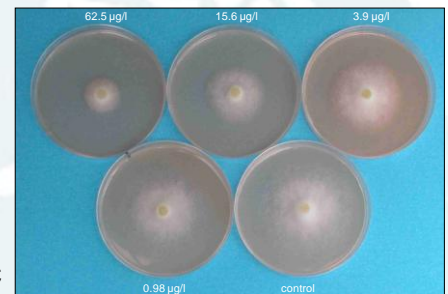
Samples of blighted potato foliage were collected from Dow/Gowan field trial sites across Europe and submitted to AFBI Newforge. Details of location, cultivar, trial protocol and disease severity were recorded. Where possible, samples were obtained from both zoxamide-treated plots and those receiving other fungicides or untreated. *P. infestans* was isolated onto antibiotic rye agar, obtaining up to three isolates per sample. Some additional characterised isolates collected from surveys in N. Ireland/Ireland were also included.

Sensitivity testing

Initially a protocol using zoxamide-sprayed potato leaf discs was adopted. However, this sometimes gave inconsistent or uniformly high values, which appeared to be associated with the physiological state of the leaf material (Cooke *et al.*, 2002). An *in vitro* poisoned agar test, based on a protocol developed by Dow AgroSciences, was subsequently adopted and has been used for all isolates since 2003.

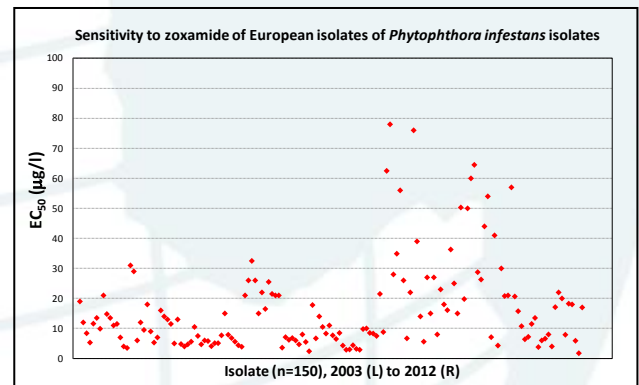
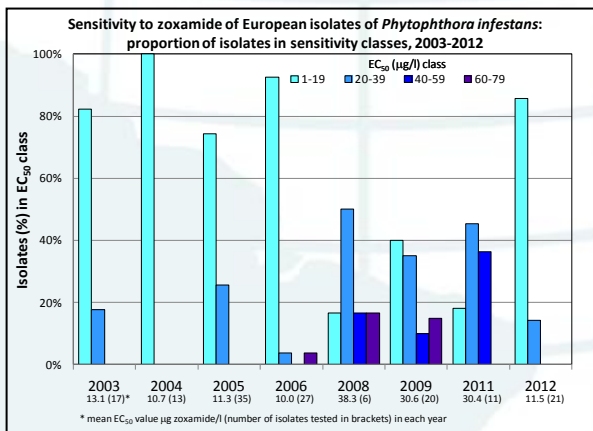
In vitro test

- Isolates tested on carrot agar
- Concentrations: 0.98 - 125 μg zoxamide/litre plus controls.
- 3 replicate plates per isolate per concentration
- Incubated 18-20°C
- Mycelial growth measured after 7-14 days
- Results expressed as EC₅₀ values (concentration inhibiting mycelial growth by 50%)



Results

- 150 isolates tested in total
- EC₅₀ values ranged from 1.8 – 78 $\mu\text{g}/\text{l}$
- Over 90% of isolates had EC₅₀ values <50 $\mu\text{g}/\text{l}$, all isolates were inhibited by 125 $\mu\text{g}/\text{l}$
- No consistent trend over years



- **Countries:** some differences
France (34 isolates) mean EC₅₀ 17.3 $\mu\text{g}/\text{l}$
Great Britain (68 isolates) mean EC₅₀ 13.5 $\mu\text{g}/\text{l}$
N. Ireland/Ireland (17 isolates) mean EC₅₀ 34.8 $\mu\text{g}/\text{l}$
- **Phenylamide resistance:**
S (39 isolates) mean EC₅₀ 20.3 $\mu\text{g}/\text{l}$
R (70 isolates) mean EC₅₀ 13.3 $\mu\text{g}/\text{l}$
- **Mating type**
A1 (92 isolates) mean EC₅₀ 17.3 $\mu\text{g}/\text{l}$
A2 (46 isolates) mean EC₅₀ 15.9 $\mu\text{g}/\text{l}$
- **Genotype:** limited information
13_A2 (6 isolates) mean EC₅₀ 29.4 $\mu\text{g}/\text{l}$
least sensitive isolate was an 8_A1
- **Field fungicide treatment**
Non-zoxamide-treated (77 isolates) EC₅₀ 18.0 $\mu\text{g}/\text{l}$
Zoxamide-treated (38 isolates) EC₅₀ 13.9 $\mu\text{g}/\text{l}$

Conclusions

There was a range of *in vitro* sensitivity to zoxamide in European populations of *P. infestans*, but all isolates had EC₅₀ values <100 $\mu\text{g}/\text{l}$ (<0.1 mg/l). Isolates from N. Ireland/Ireland and Wales tended to be the least sensitive, but there was no evidence of any consistent trend in sensitivity over years nor of any association with mating type, phenylamide resistance or treatment.

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Reference Cooke, LR, Carlisle, DJ, Wilson, DG, McCall, RD (2002). *PPO-Special Report No. 8*, 39-48.