

Windows of Selection :

How does selection pressure for insecticide resistance change in the months after spray and net deployments ?



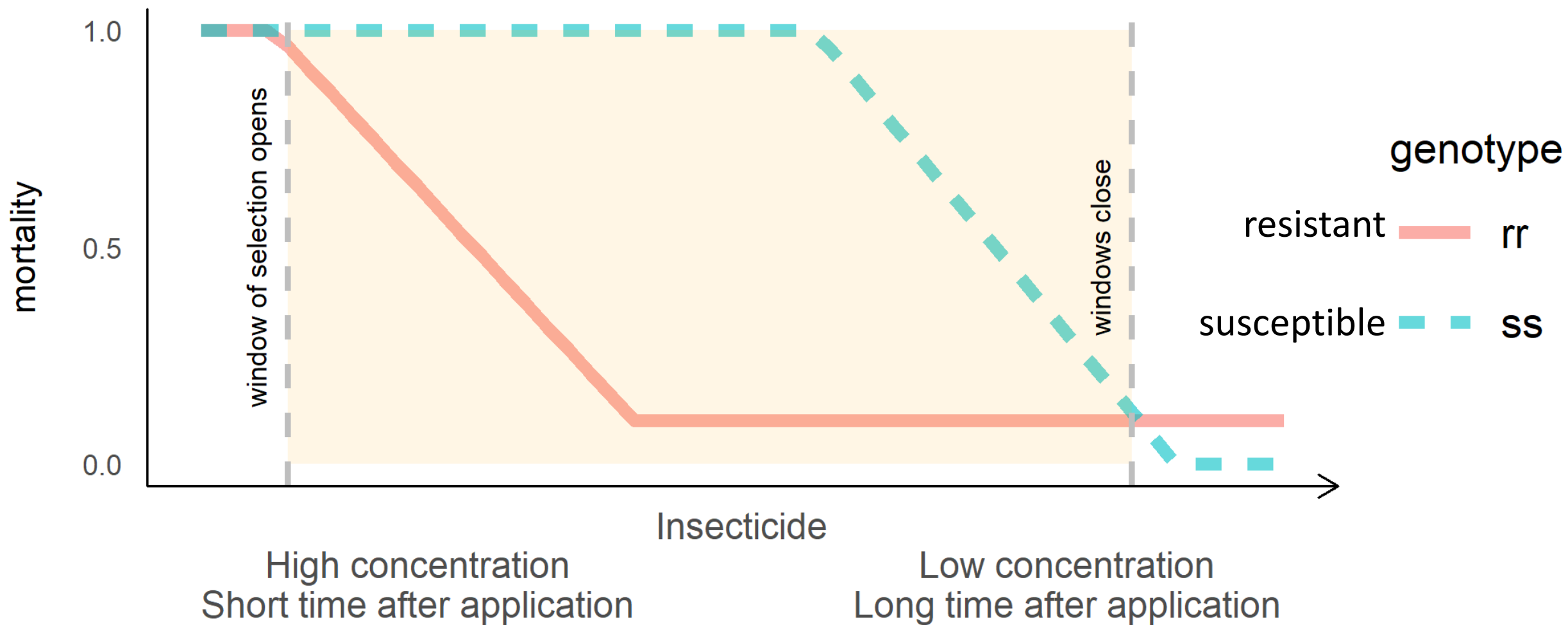
Andy South & Ian Hastings

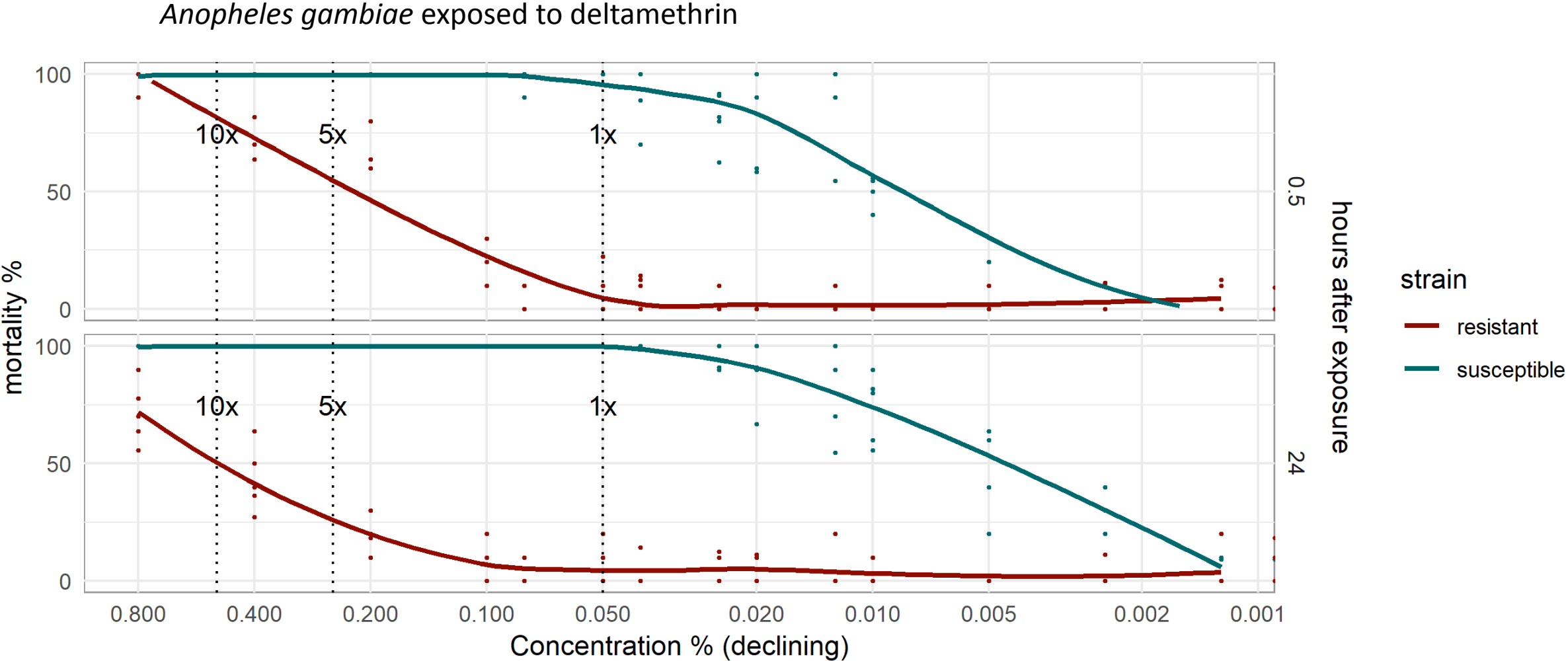
[@southmapr](#)

Vector Control Working Group, January 2019

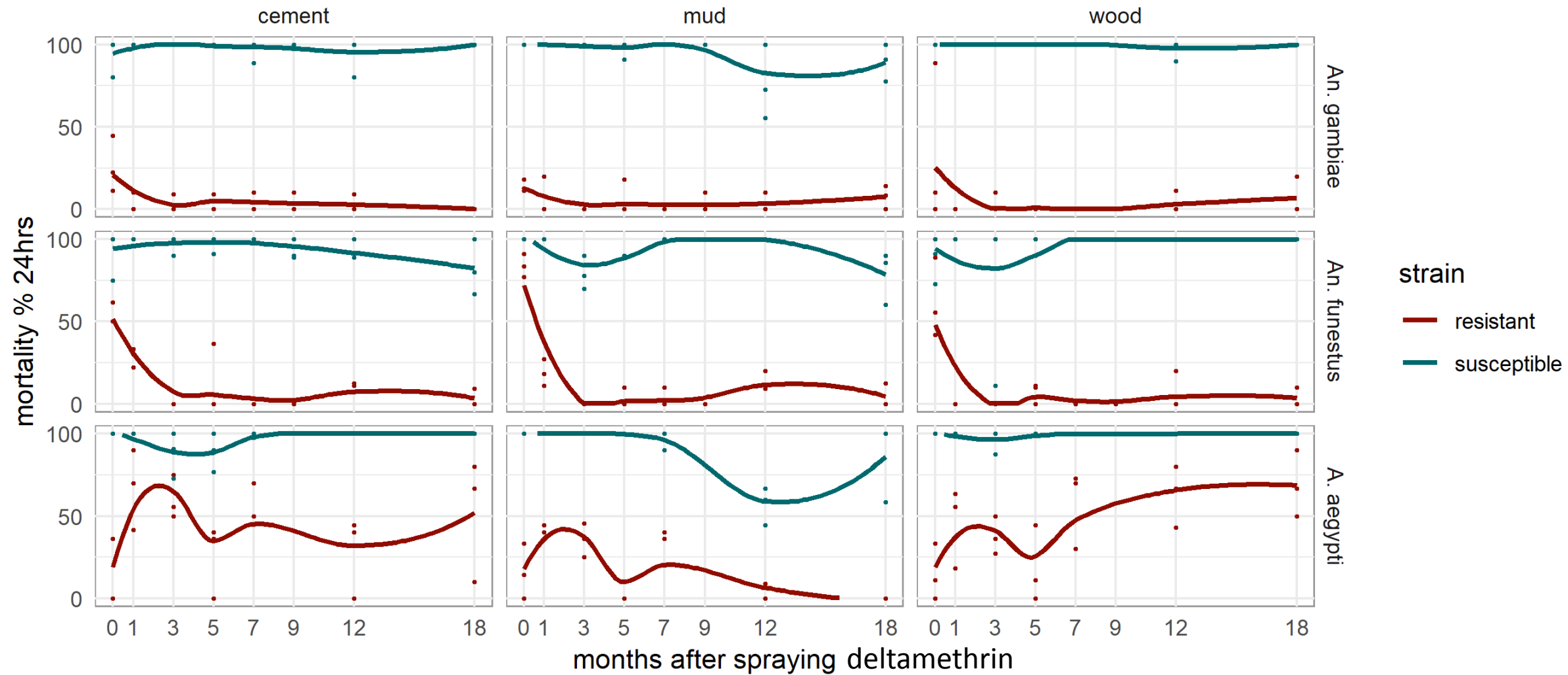


Window of selection

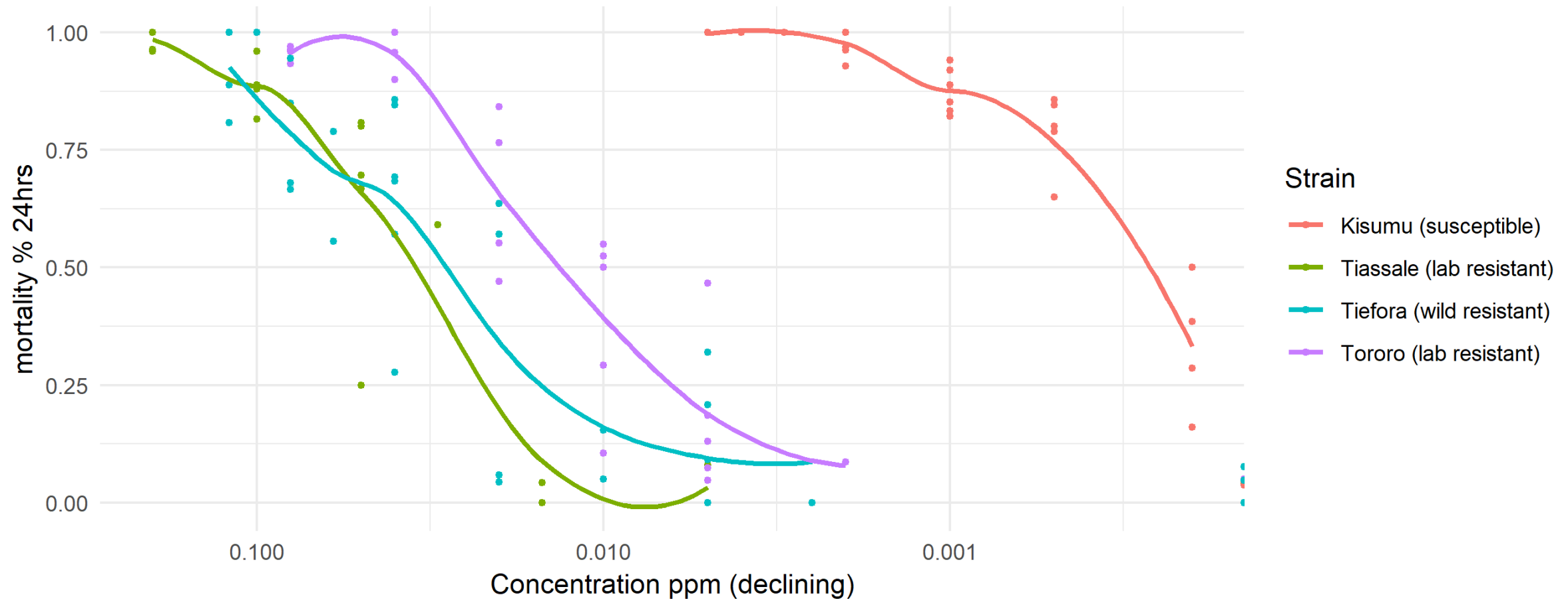




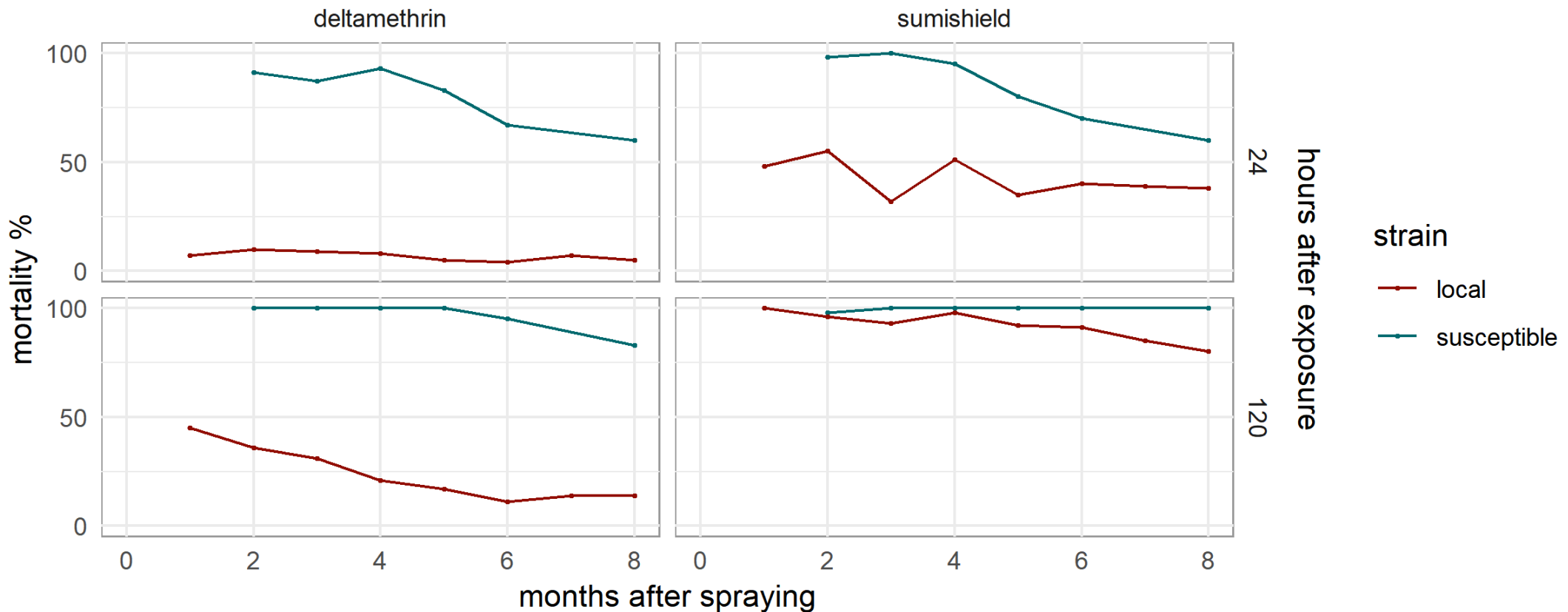
Laboratory experiments - time



Windows of selection examples from the Literature: *Anopheles gambiae* strains and permethrin concentrations

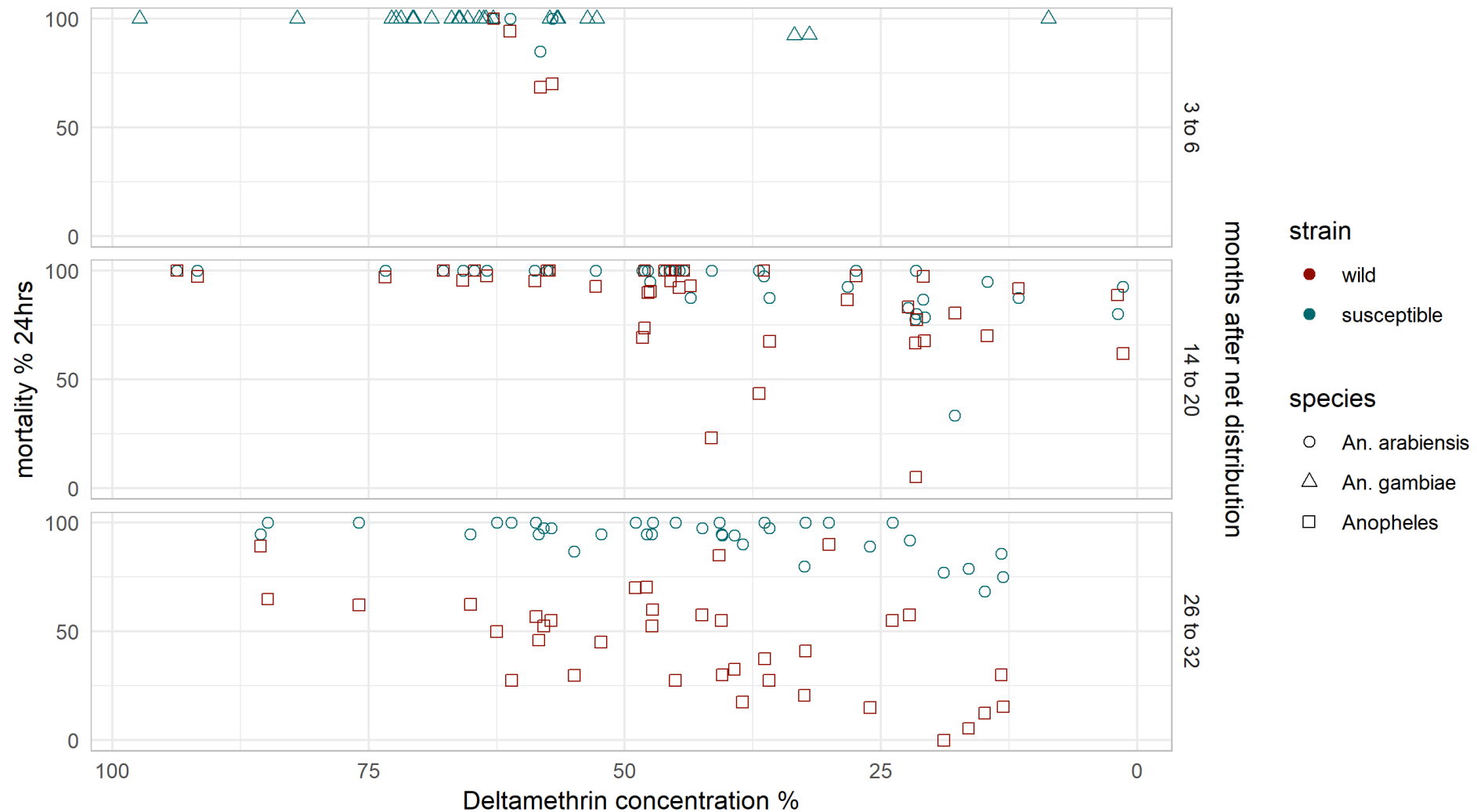


Windows of selection for free flying *Anopheles gambiae* in sprayed experimental hut trials



Agossa, F. R. et al. (2018) 'Efficacy of a novel mode of action of an indoor residual spraying product , SumiShield[®] 50WG against susceptible and resistant populations of *Anopheles gambiae* (s . l .) in Benin , West Africa', *Parasites & Vectors*.

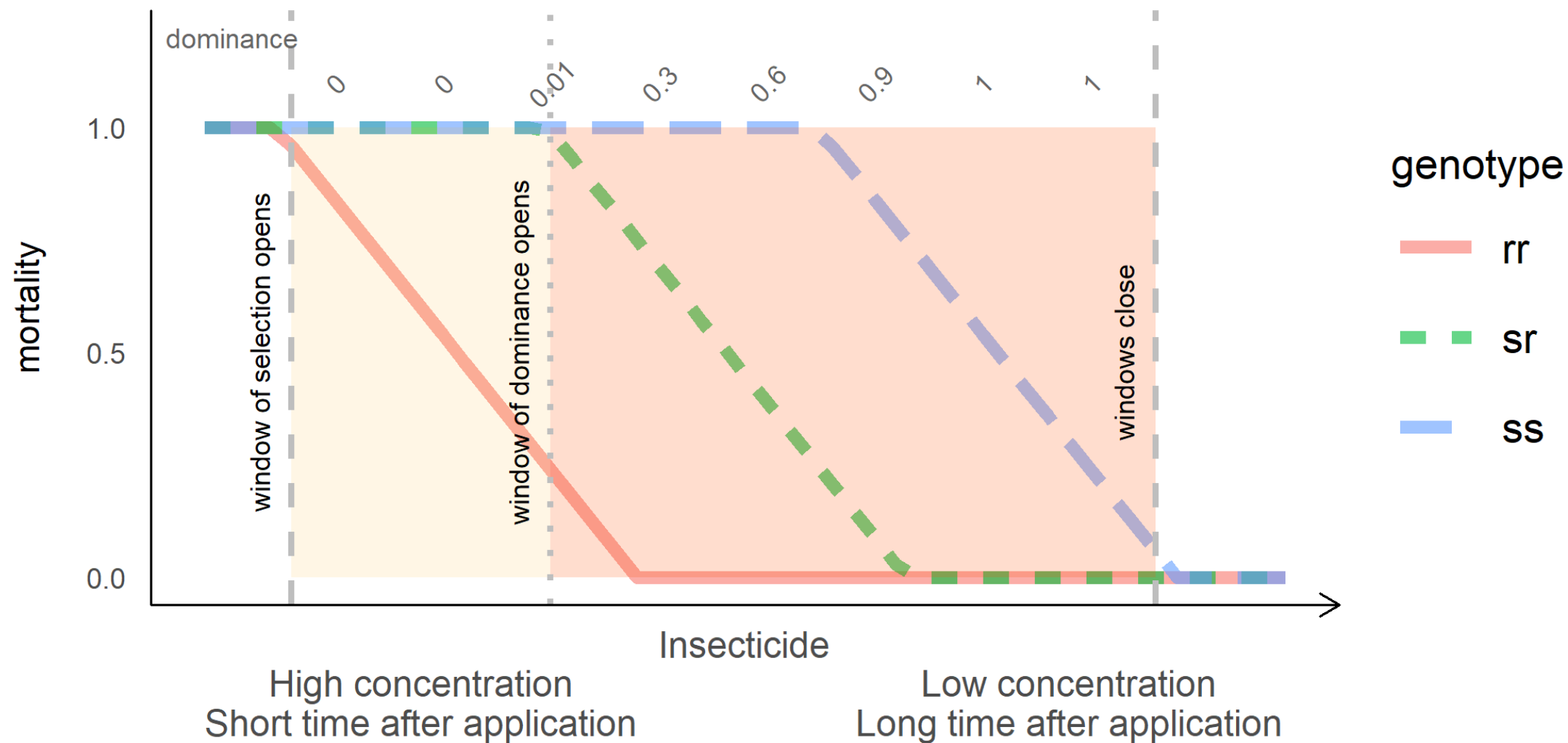
Window of selection for insecticide treated nets.



Window of dominance

- All earlier slides just considered 'resistant' versus 'susceptible' strains.
- Insects are diploid so may be RR, RS (heterozygous) or SS.

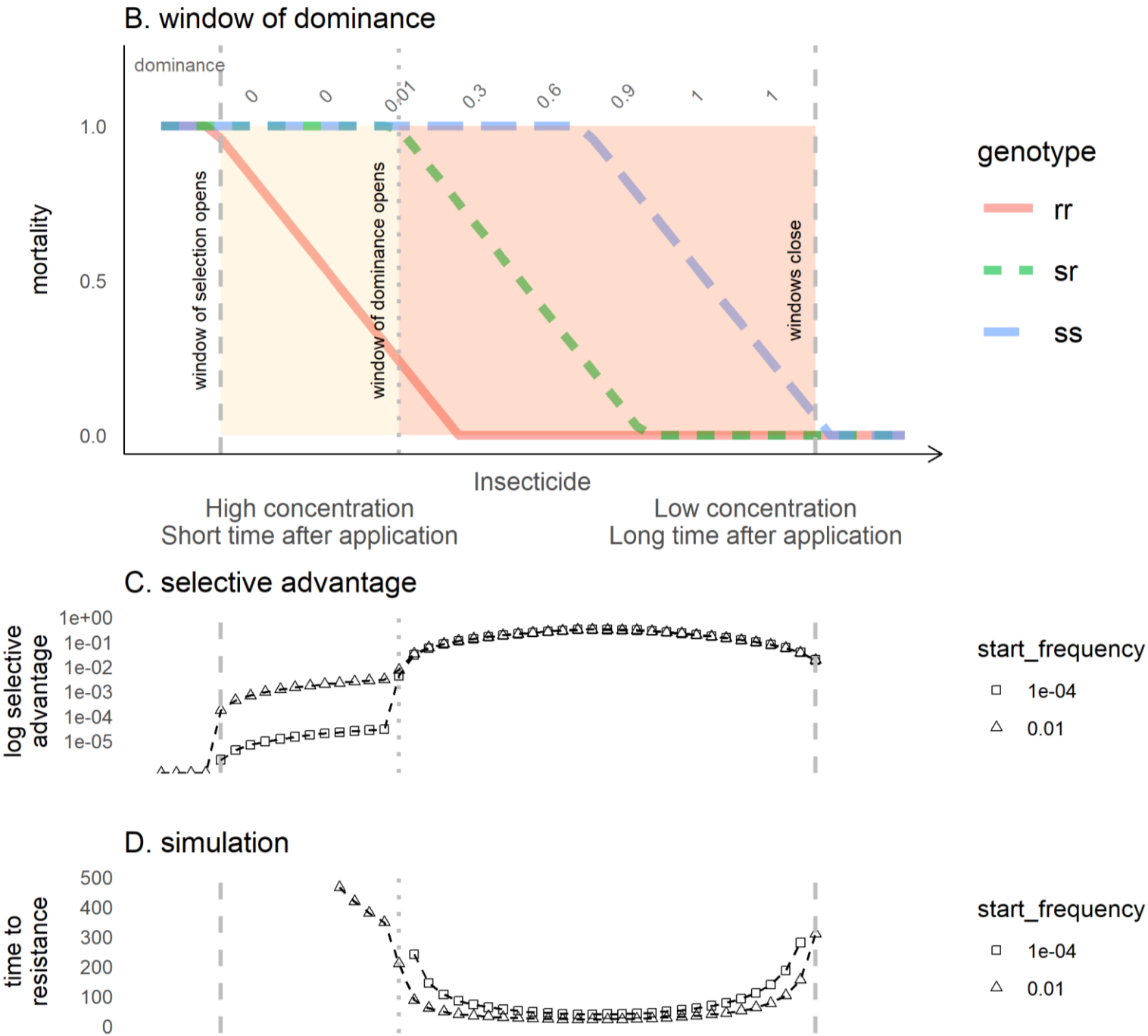
Window of dominance



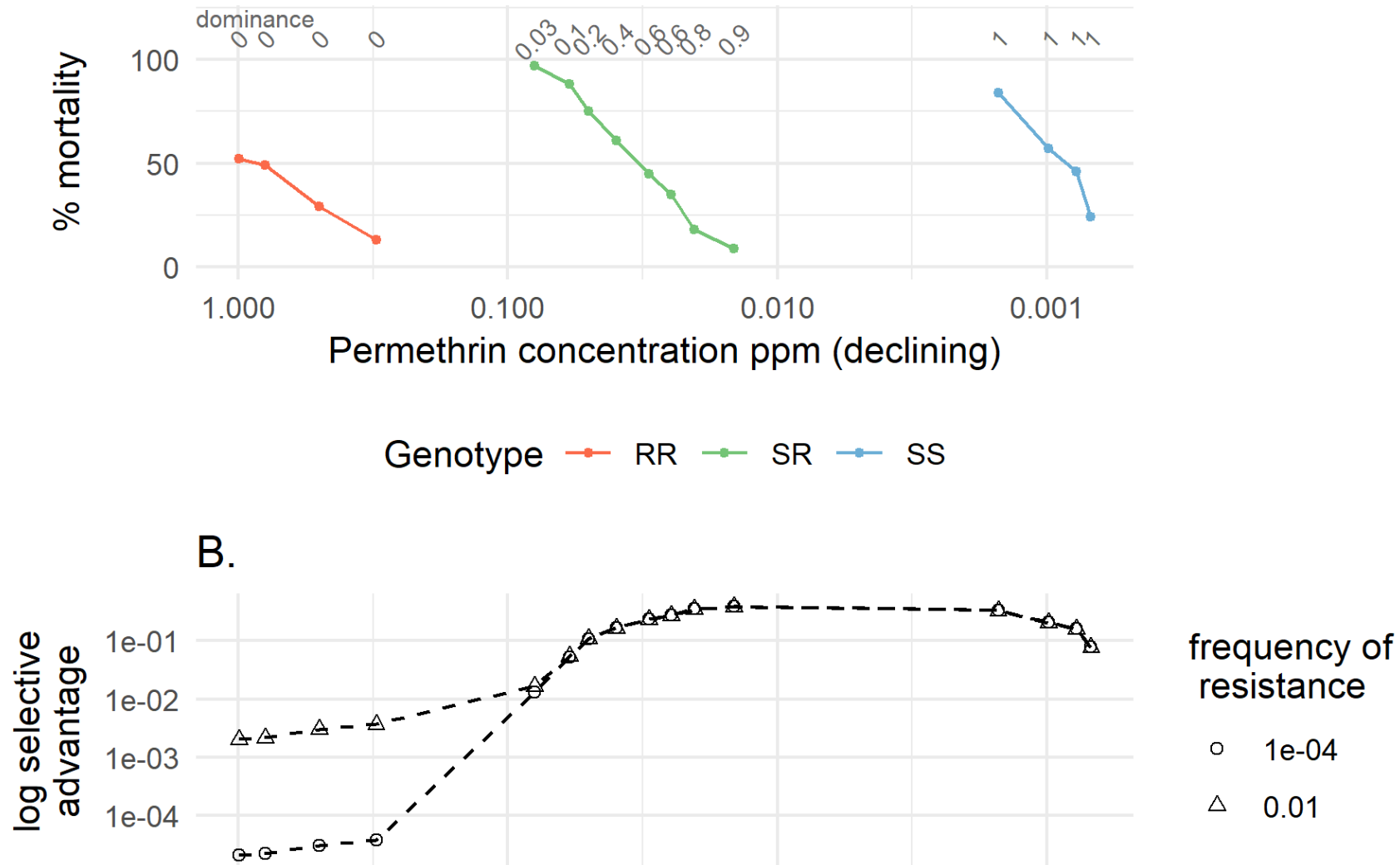
Evolution of resistance likely to be greatest within the window of dominance

selective advantage

estimated time-to-resistance



Window of dominance for *Culex quinquefasciatus* larvae exposed to permethrin.



Data from : Georghiou, G. P. and Taylor, C. E. (1986) 'Factors influencing the evolution of resistance', in *Pesticide Resistance. Strategies and Tactics for Management*. Washington D.C.: National Academy Press, pp. 157–169.

Potential lessons from 'high-dose standard' in transgenic crops

Killing heterozygotes is key.

Some success at limiting resistance evolution.

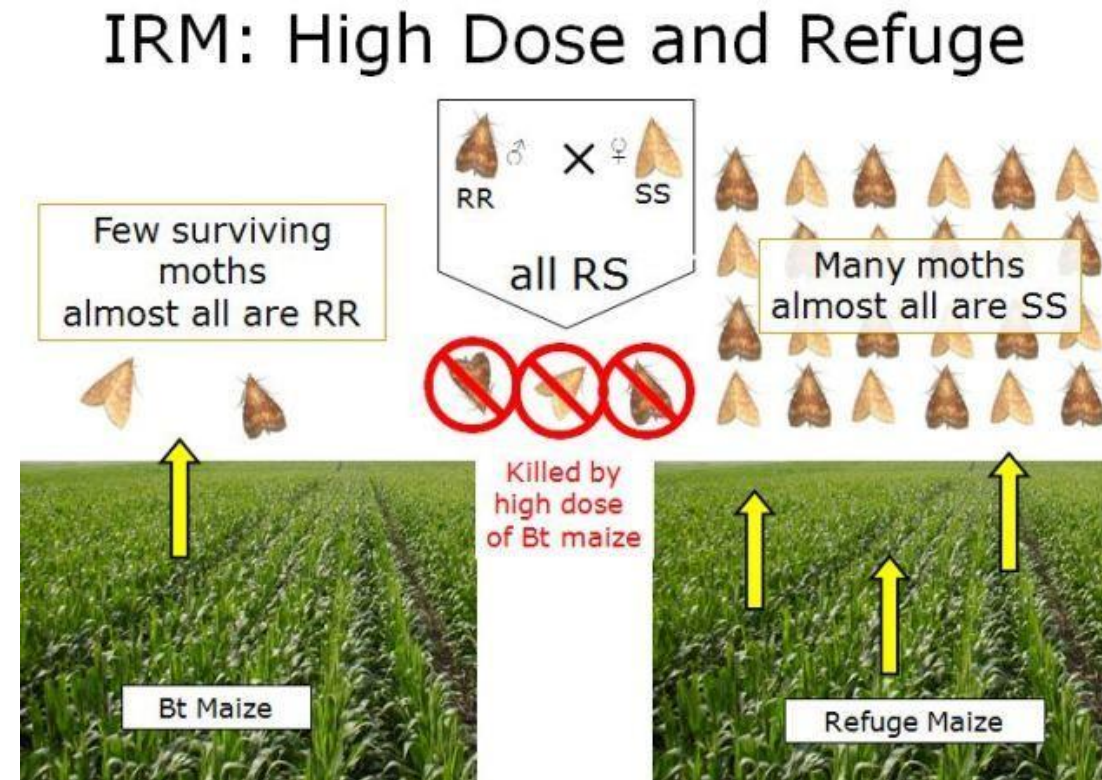
Definitions of 'high-dose' (US EPA) :

Theoretical : dominance < 0.05

Practical : mortality of susceptible insects $\geq 99.99\%$

“... if Bt plants do not kill all or nearly all susceptible insects, they probably will not kill nearly all insects that are heterozygous for resistance.”

Tabashnik, B. E. and Carrière, Y. (2017) 'Surge in insect resistance to transgenic crops and prospects for sustainability', *Nature Biotechnology*, 35(10), pp. 926–935.

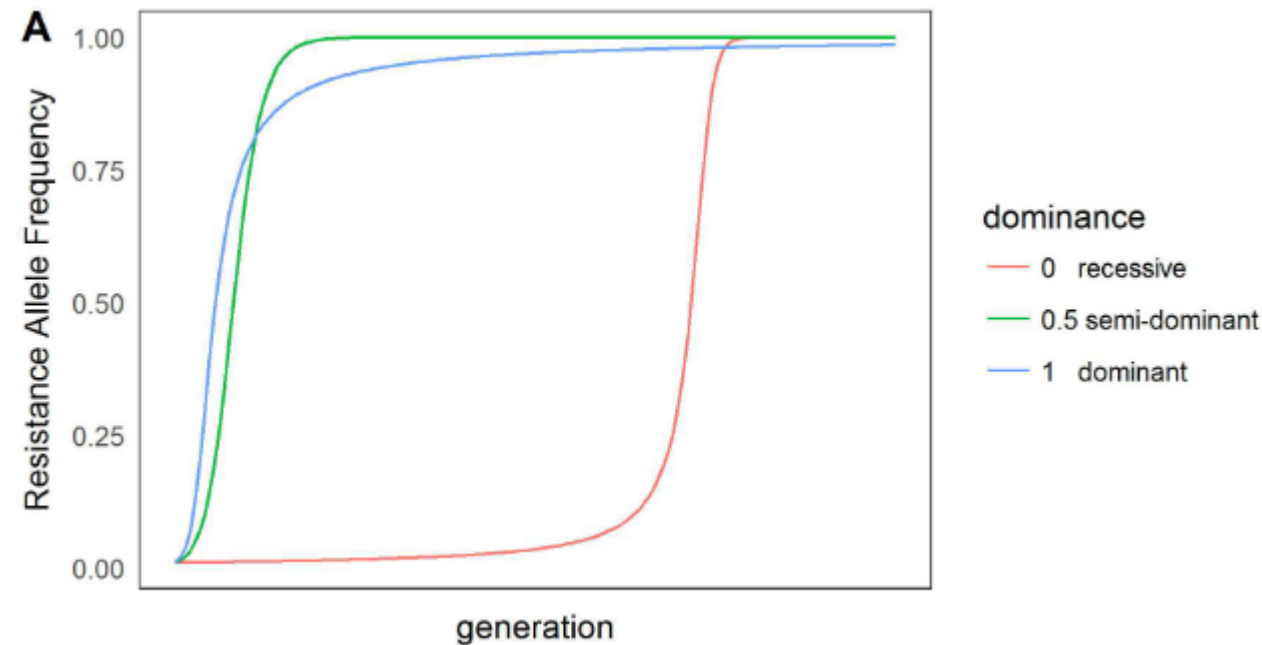
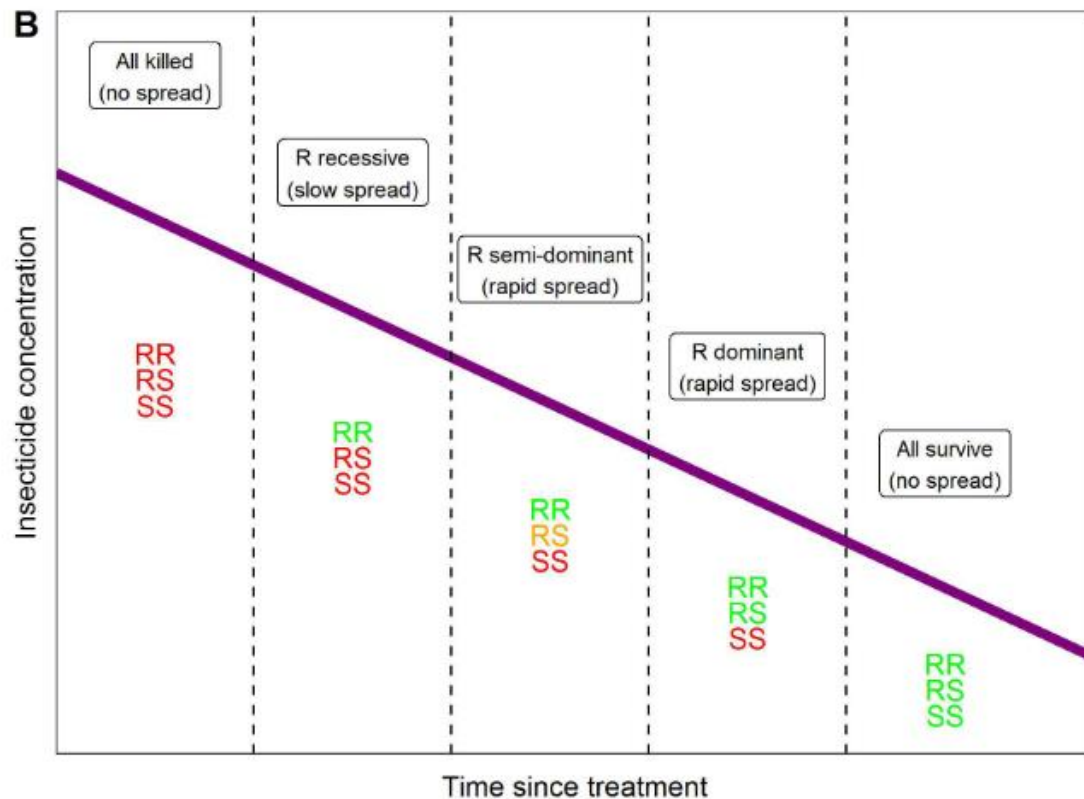


<https://www.nature.com/scitable/knowledge/library/use-and-impact-of-bt-maize-46975413>

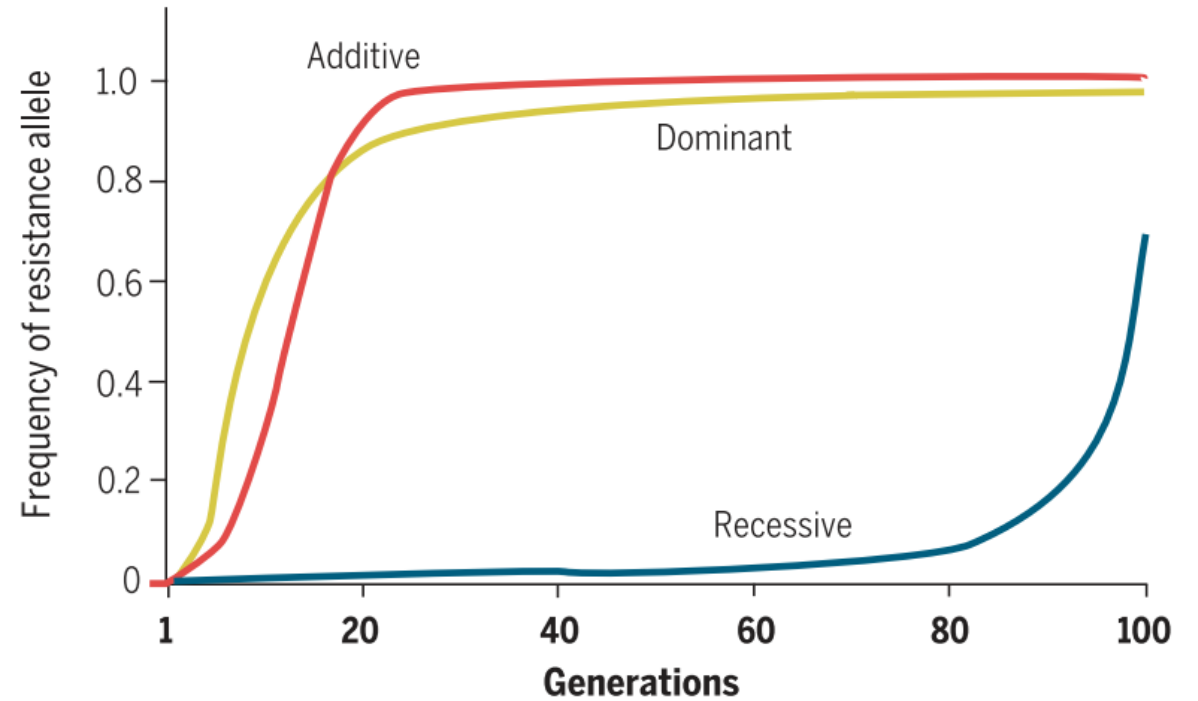
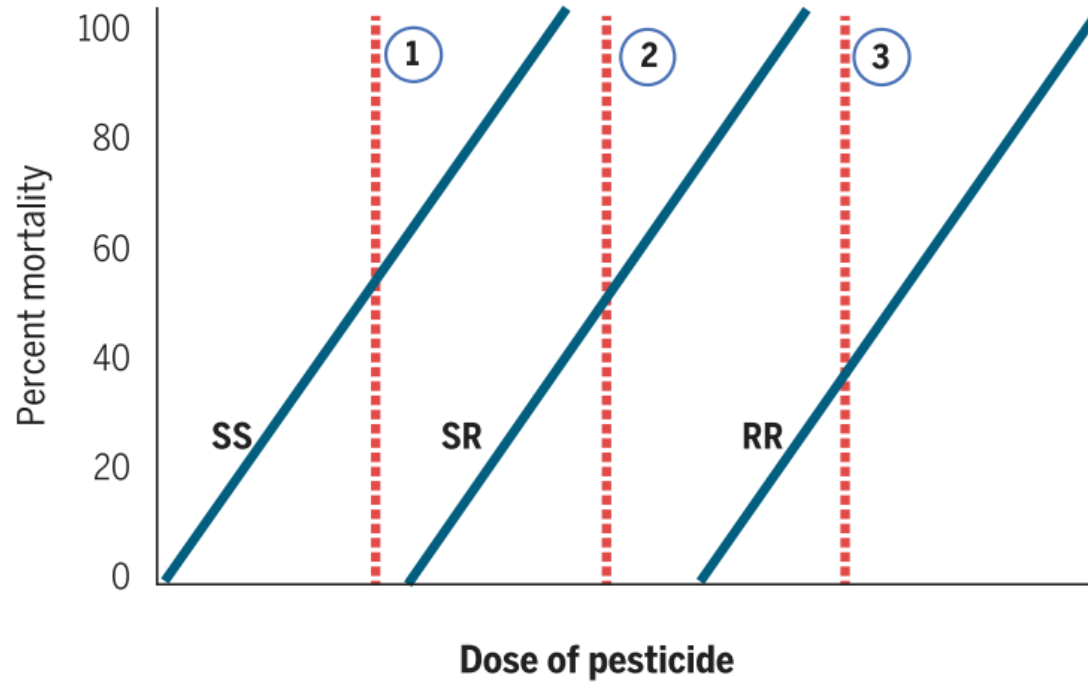
- Windows of selection are extensive in terms of concentration and time (months years)
- Evolution of insecticide resistance likely to be greatest within windows of dominance where mortality of $SR < SS$
- Measurement of changing mortalities of RR, SR, SS genotypes over time needed to answer questions like :

Will the evolution of resistance be minimised by

- a) using a higher concentration insecticide or
- b) replacing a lower concentration one more frequently ?



Levick B, South A, Hastings IM. A Two-Locus Model of the Evolution of Insecticide Resistance to Inform and Optimise Public Health Insecticide Deployment Strategies. *PLoS Comp Biol* 2017; 13(1): e1005327.



Gould F, Brown ZS, Kuzma J. Wicked evolution: Can we address the sociobiological dilemma of pesticide resistance? *Science* 2018; 360(6390): 728-32.