Prolonging the effective life of fungicides for the control of late blight on potato

Faye Ritchie, Neil Paveley, Philip Walker (ADAS), Ruairidh Bain (SRUC), Alison Lees, James Lynott (JHI)

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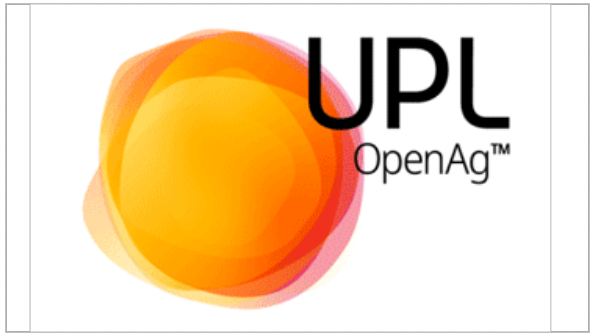
www.adas.uk

Project funding (2020 to 2022)



Sponsors and expert input

Project objectives

1. Determine appropriate strategies to slow resistance selection

   - alternation, mixtures, single and multisite fungicides in multi-spray programmes.

2. Produce a set of evidence-based guidelines outlining best practice and cost effectiveness for the industry.

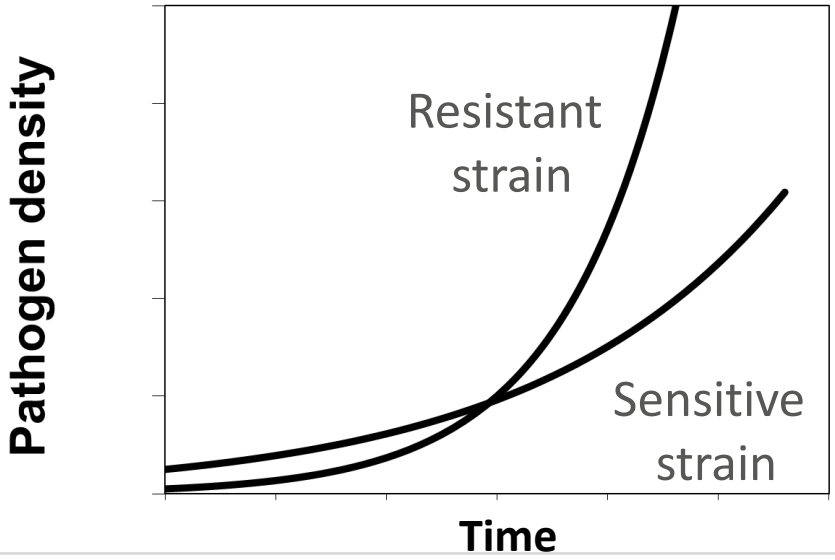
Three strategies for fungicide resistance management

Selection for fungicide insensitivity is reduced when:

Strategy 1: the per capita growth rate of both the sensitive and resistant strains are reduced.

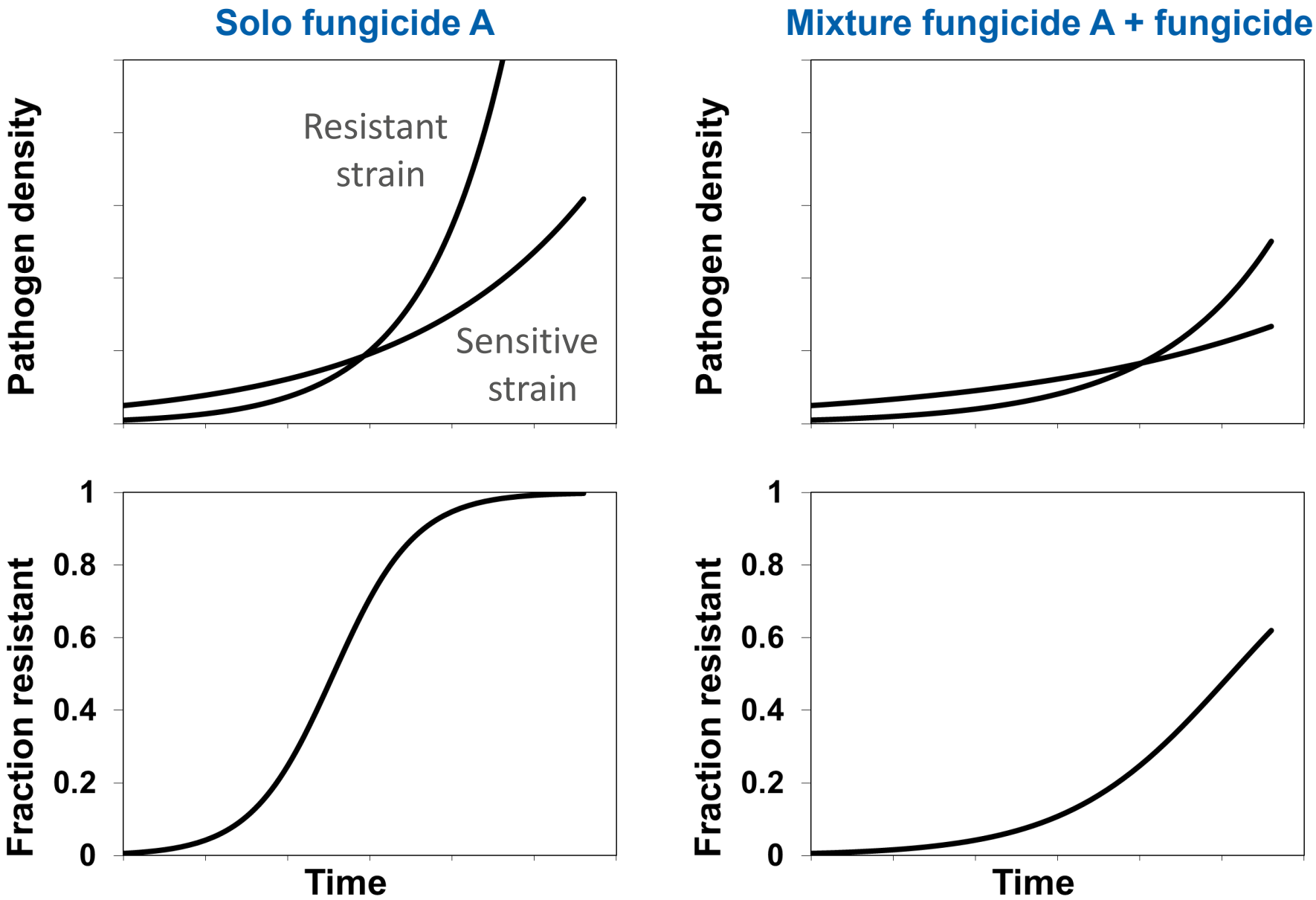
Strategy 2: the per capita increase of the resistant strain is reduced relative to the sensitive strain.

Strategy 3: the timespan over which selection (exposure time) is reduced.



Selection rate =
Difference in *per capita* rate of increase of resistant and sensitive strains

Milgroon & Fry, 1988; van den Bosch *et al*., 2014



van den Bosch *et al*. 2011 *Plant Pathology* 60, 597-606

Experimental evidence: Tactics to decrease selection for fungicide resistant strains

	Increase selection	No effect	Decrease selection
Increase dose	16	1	2
Increase spray number	6	0	0
Add mixture partner	1	6	46
Alternate (replace sprays)	1	2	9
Adjust timing	3	1	2

van den Bosch et al. 2014 Governing principles can guide resistance management tactics
Annual Review Phytopathology
**analysis included P. infestans, P. viticola, P. cubensis* and *P. aphanidermatum* (oomycetes)

Experimental system using 37_A2: select for fluazinam insensitivity

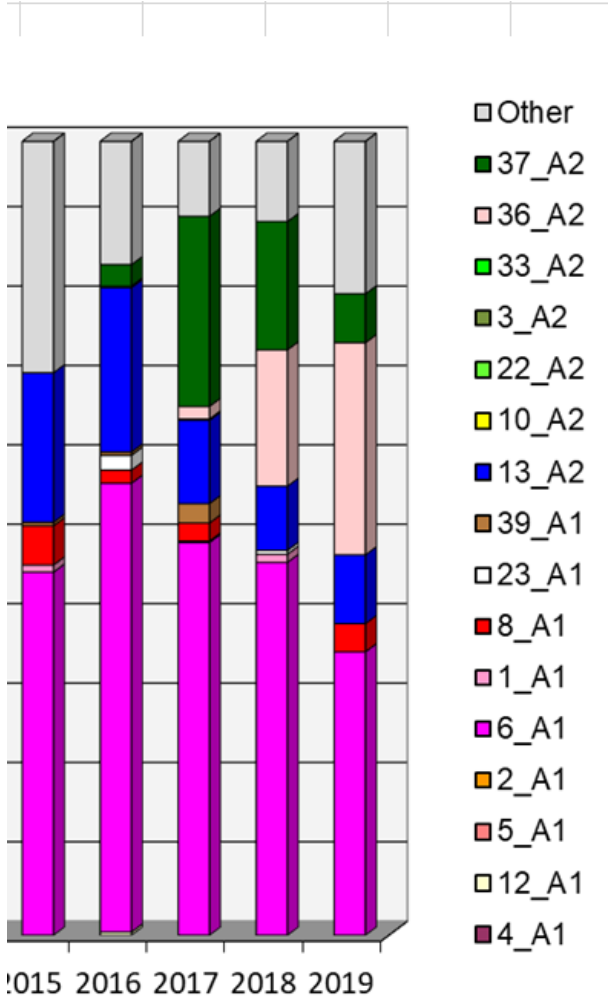
Currently in GB population

Still at a low frequency – use naturally occurring inoculum (inoculation as back up option)

37_A2 be used to track selection in the presence of fluazinam – proportion of strains within the population.

This is a test system for resistance management strategies – not to be used for recommendations

The efficacy of resistance management strategies can be tested in separate trials (based on the principles of resistance management)



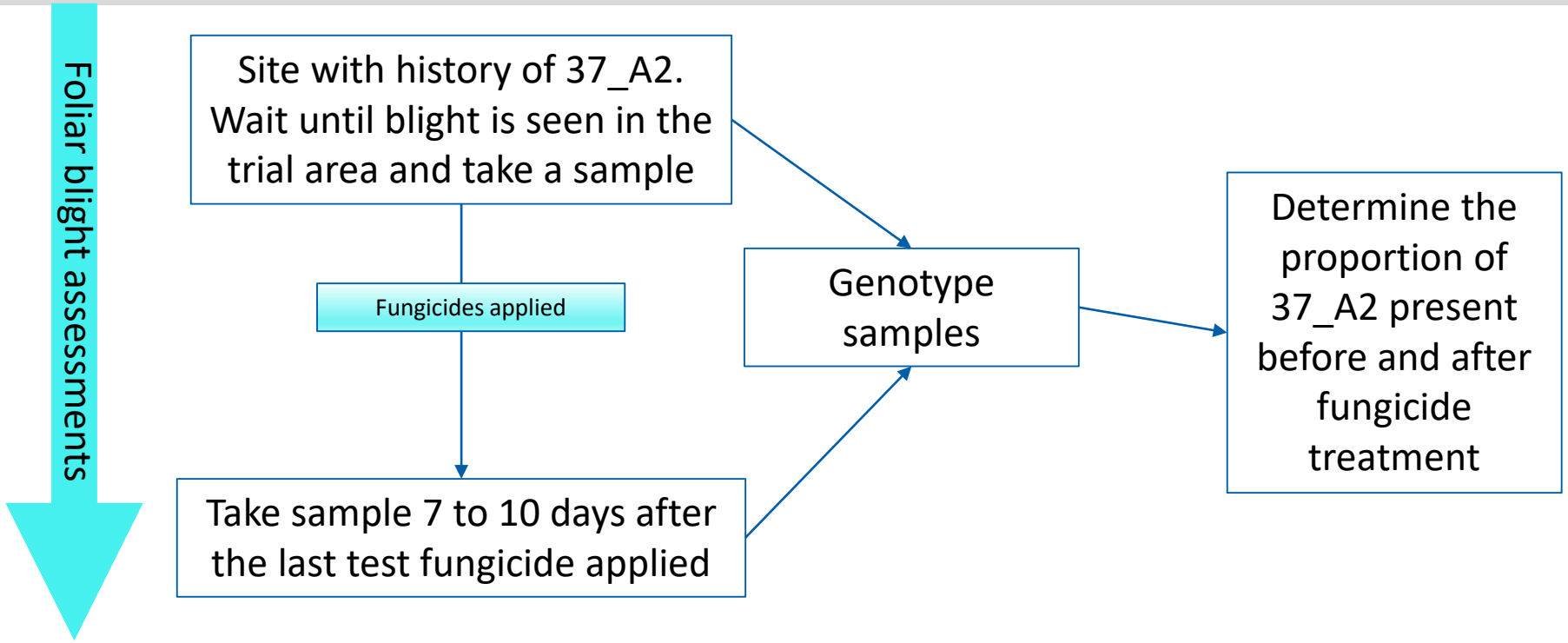
AHDB/JHI

Test treatments: Six sprays with spray interval of 7 days

***use is dependent on regulatory environment, strains present and potential risks to efficacy: check with product manufacturer when considering reduced rate applications and follow recommendations for product use

Trt	Spray order number*						
	4	5	6	7	8	9	Total dose (fluazinam)
Fluazinam solo	Shirlan 0.4 L/ha	Shirlan 0.4 L/ha	Shirlan 0.4 L/ha	Shirlan 0.4 L/ha	Shirlan 0.4 L/ha	Shirlan 0.4 L/ha	6.0
Multisite solo	mancozeb 2.0 kg/ha	mancozeb 2.0 kg/ha	mancozeb 2.0 kg/ha	mancozeb 2.0 kg/ha	mancozeb 2.0 kg/ha	mancozeb 2.0 kg/ha	0.0
Alternation	Revus 0.6 L/ha	Shirlan 0.4 L/ha	Revus 0.6 L/ha	Shirlan 0.4 L/ha	Revus 0.6 L/ha	Shirlan 0.4 L/ha	3.0
Alternation	Shirlan 0.4 L/ha	Revus 0.6 L/ha	Shirlan 0.4 L/ha	Revus 0.6 L/ha	Shirlan 0.4 L/ha	Revus 0.6 L/ha	3.0
Blocking	Shirlan 0.4 L/ha	Shirlan 0.4 L/ha	Shirlan 0.4 L/ha	Revus 0.6 L/ha	Revus 0.6 L/ha	Revus 0.6 L/ha	3.0
Blocking	Revus 0.6 L/ha	Revus 0.6 L/ha	Revus 0.6 L/ha	Shirlan 0.4 L/ha	Shirlan 0.4 L/ha	Shirlan 0.4 L/ha	3.0
Half dose mixture* **	Shirlan 0.2 L/ha + Revus 0.3 L/ha	Shirlan 0.2 L/ha + Revus 0.3 L/ha	Shirlan 0.2 L/ha + Revus 0.3 L/ha	Shirlan 0.2 L/ha + Revus 0.3 L/ha	Shirlan 0.2 L/ha + Revus 0.3 L/ha	Shirlan 0.2 L/ha + Revus 0.3 L/ha	1.5
Standard mixture (single site)	Shirlan 0.4 L/ha + Revus 0.6 L/ha	Shirlan 0.4 L/ha + Revus 0.6 L/ha	Shirlan 0.4 L/ha + Revus 0.6 L/ha	Shirlan 0.4 L/ha + Revus 0.6 L/ha	Shirlan 0.4 L/ha + Revus 0.6 L/ha	Shirlan 0.4 L/ha + Revus 0.6 L/ha	6.0
Standard mixture (multisite)	Shirlan 0.4 L/ha + mancozeb 2.0 kg/ha	Shirlan 0.4 L/ha + mancozeb 2.0 kg/ha	Shirlan 0.4 L/ha + mancozeb 2.0 kg/ha	Shirlan 0.4 L/ha + mancozeb 2.0 kg/ha	Shirlan 0.4 L/ha + mancozeb 2.0 kg/ha	Shirlan 0.4 L/ha + mancozeb 2.0 kg/ha	6.0

Experimental design: How best to implement resistance management strategies?



Site(s) with 37_A2 to be used
Experiment can be burned off once final samples are taken
Plan to inoculate if disease does not occur

Epidemic progress at the ADAS site - 2020

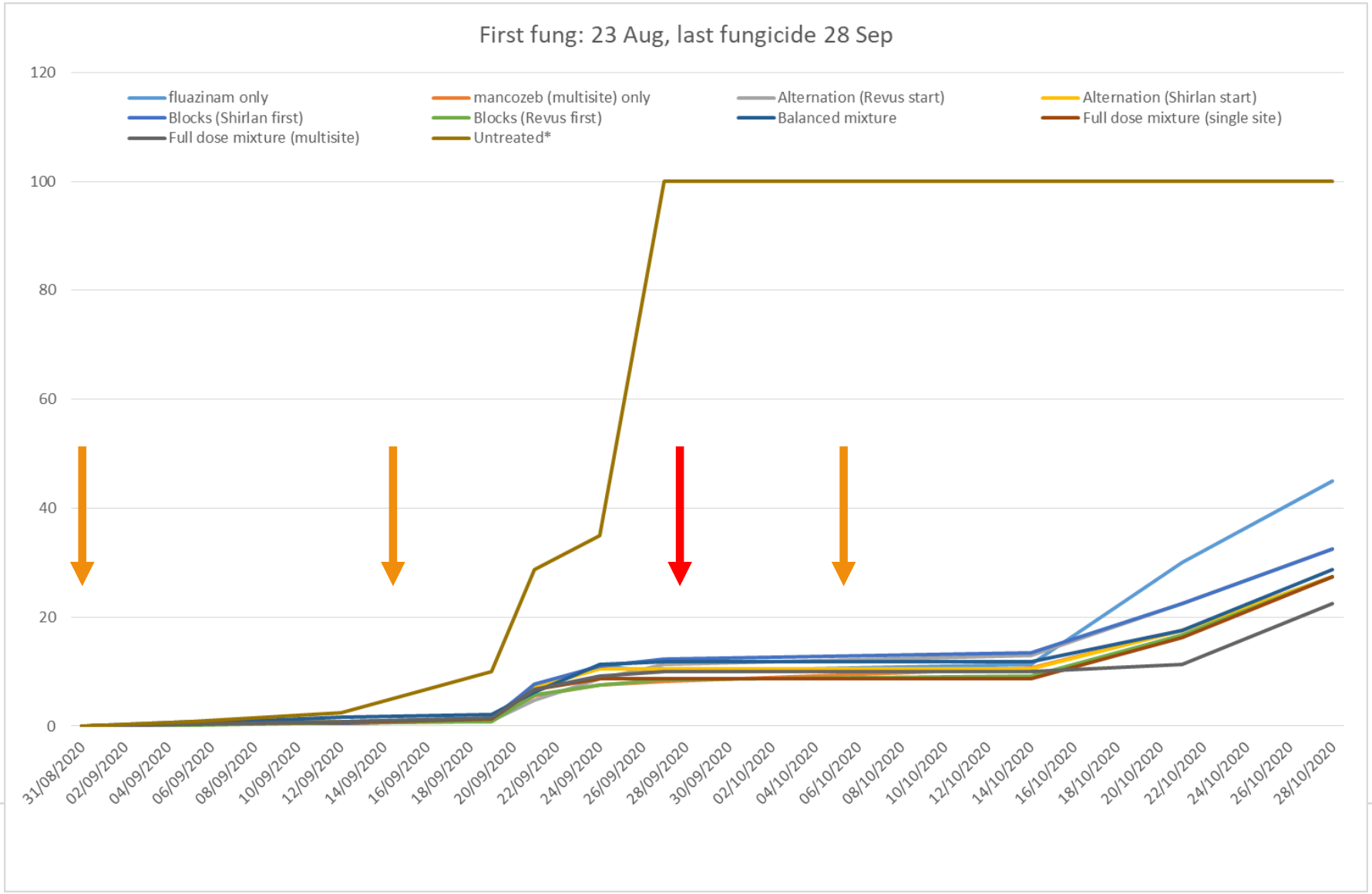
Blue: first fungicide

Red: final fungicide

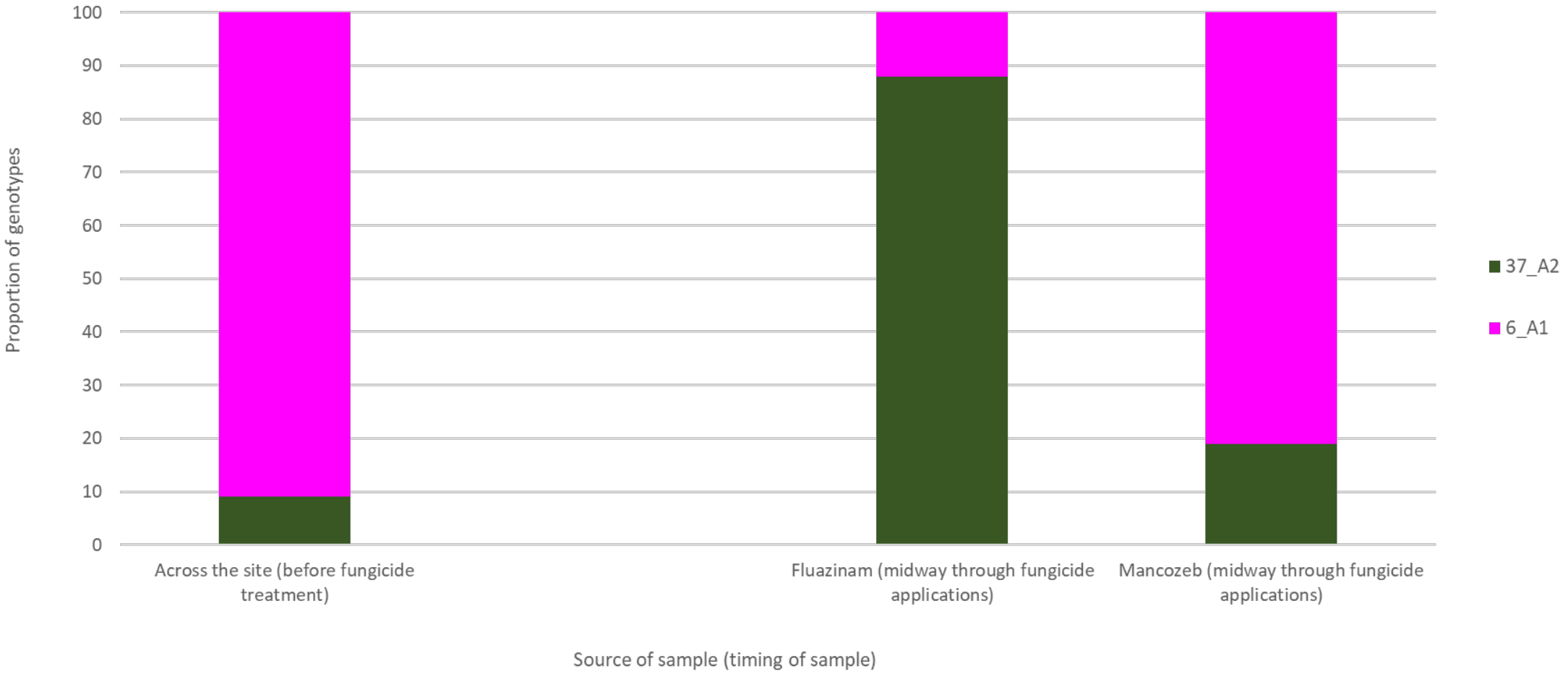
Orange: samples

Natural epidemic: No

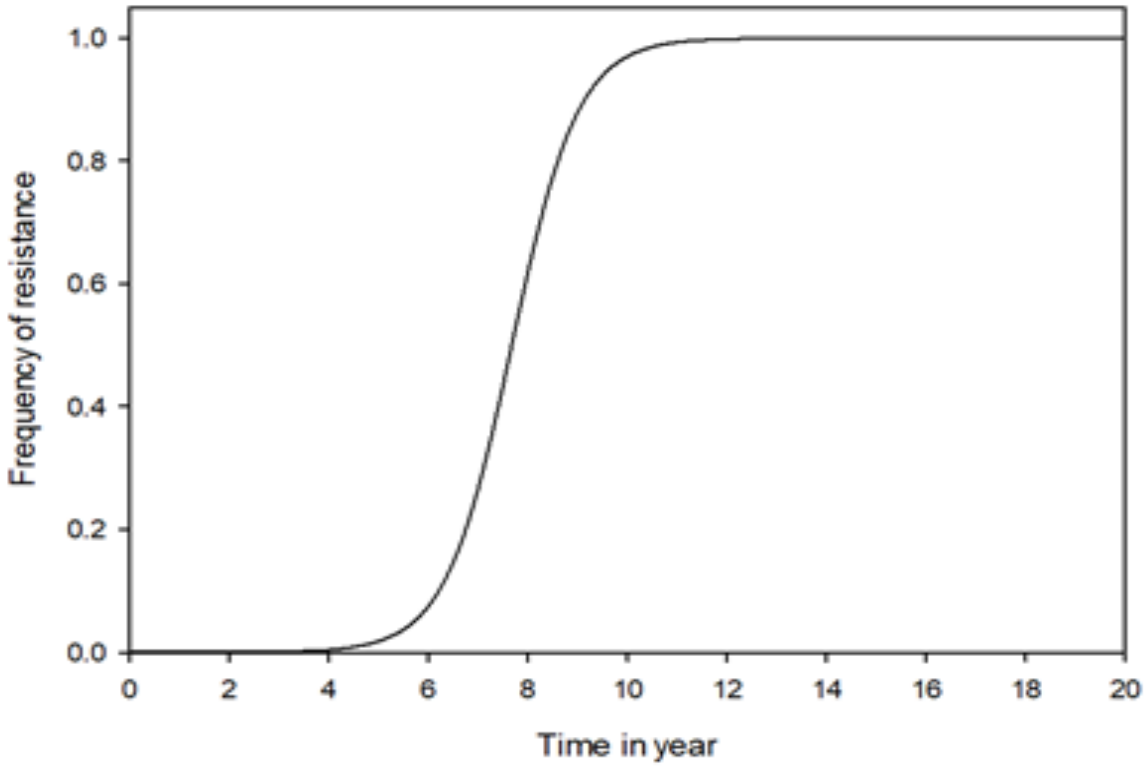
Inoculated with 6_A1 and 37_A2: 20 August



Change in the proportion of 37_A2 vs other strains: ADAS site



Selection coefficient calculation – increase per day

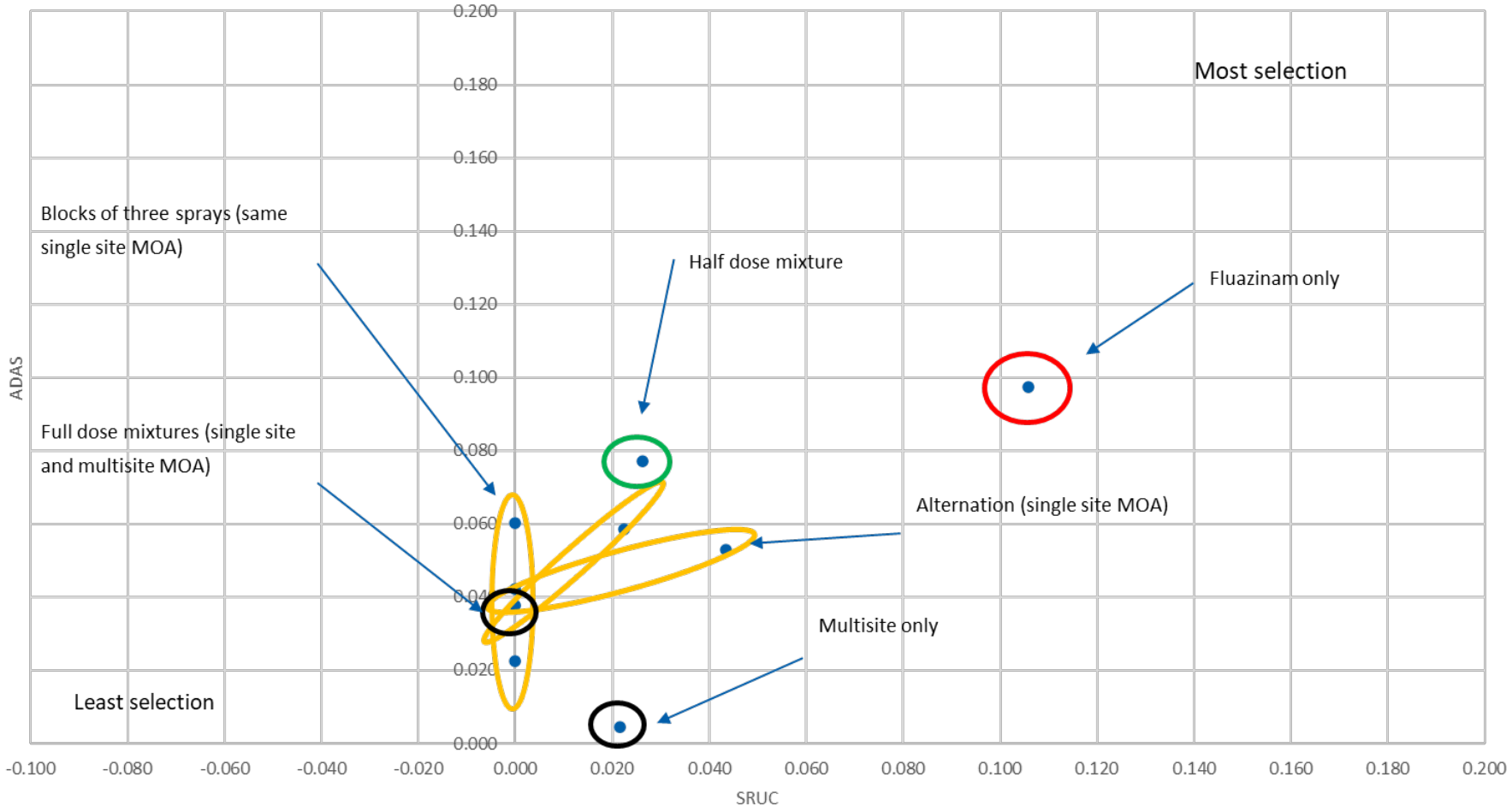


Proportion of 37_A2 at the first (o) second (*T*) sampling date

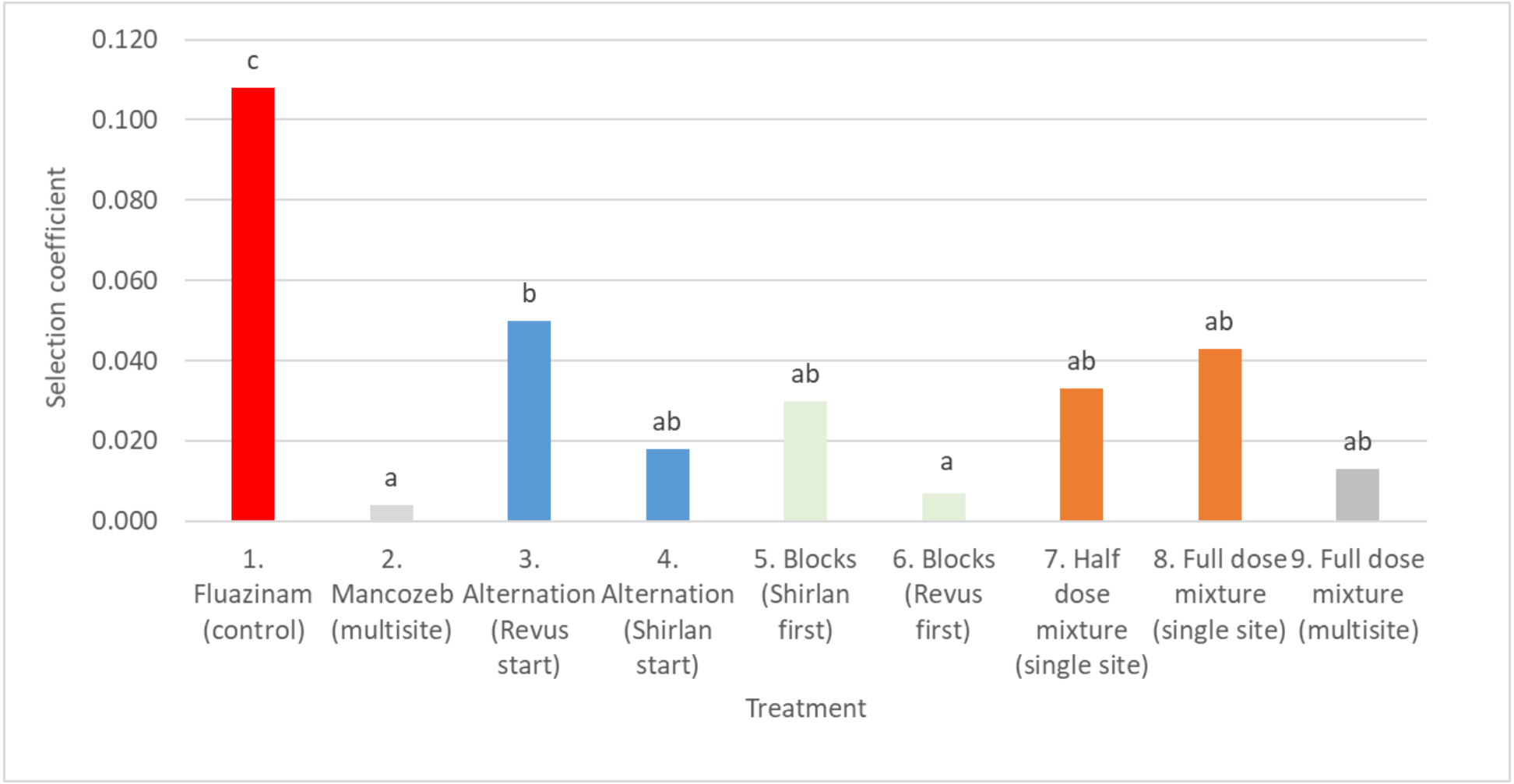
$$s = \frac{1}{T} \ln\left(\frac{q_T\,(1 - q_0)}{q_0\,(1 - q_T)}\right)$$

Number of days between the first and second sampling date

2020: Relative effects of different fungicide tactics on the selection coefficient for SRUC and ADAS sites

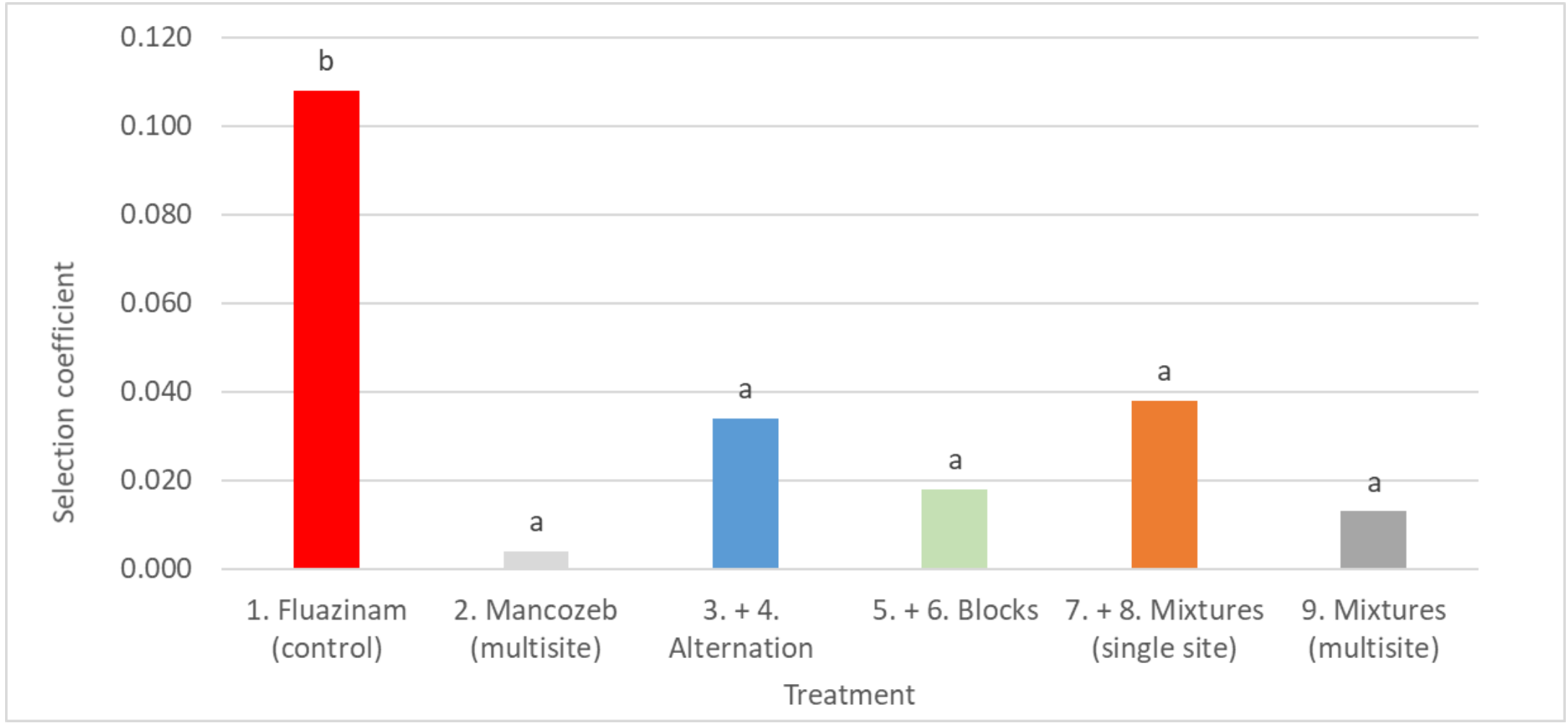


Cross site analysis: three sites and all resistance management tactics tested



Treatment*: P* = <0.001. Site.Treatment interaction *P*=0.072 (ns). Letters represent Duncan's multiple range test

Cross site analysis: three sites by type of resistance management tactic tested



Treatment*: P* = <0.003. Site.Treatment interaction *P*=0.084 (ns). Letters represent Duncan's multiple range test

Conclusions

- The experimental system was suitable to test different resistance management tactics where multiple fungicide applications are used.
- Repeated application of a single site mode of action selects for fungicide insensitive strains.
- All resistance management strategies tested decreased selection for fungicide insensitive strains.
- Next step: consult with industry on best practice and use this information to provide robust resistance management guidance for potato late blight.

Thank you

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- TBC, JHI
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