Department for Environment Food & Rural Affairs

ADAS





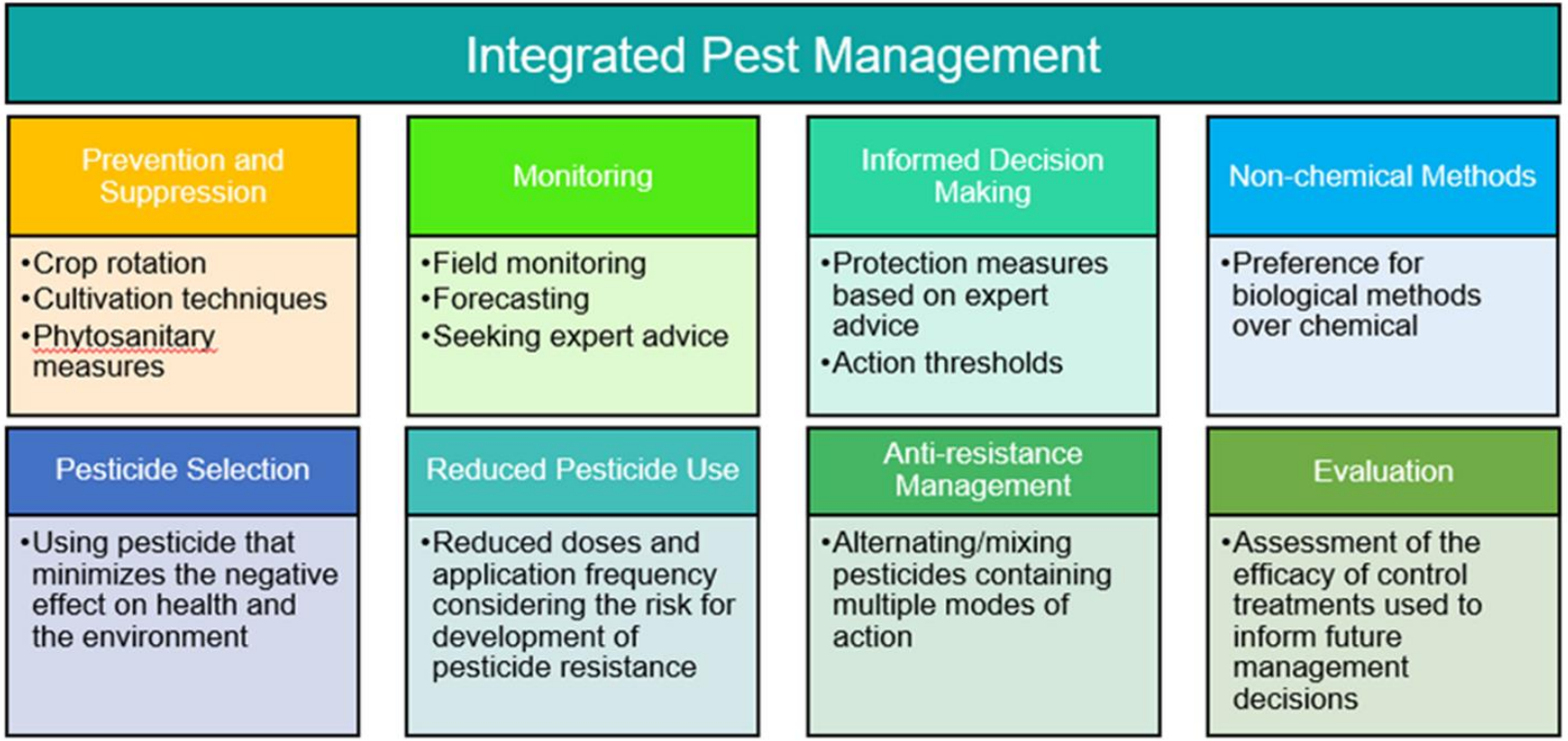
Integrated Pest Management: Science and Practice
Disease control in cereals

Neil Paveley and Frank van den Bosch

A video series funded by Defra and produced by ADAS

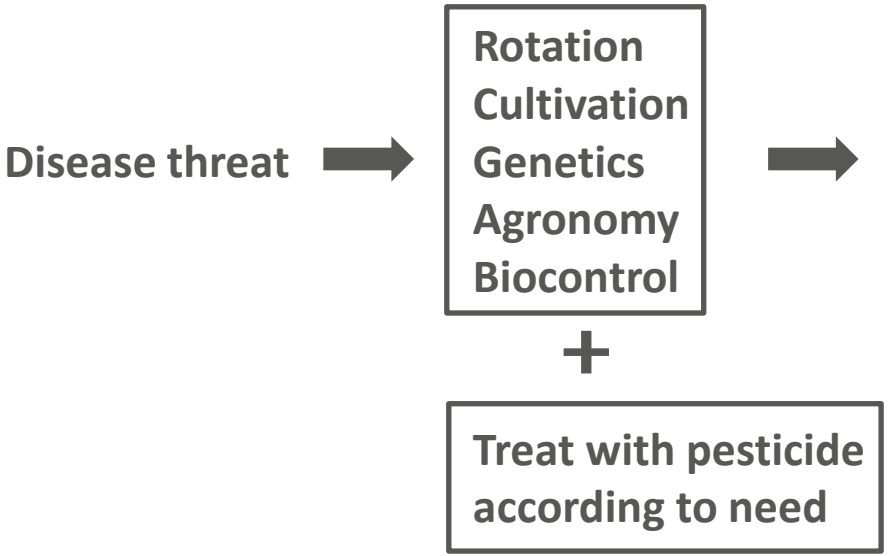
www.adas.co.uk

How to combine control methods in IPM?



Source: Sustainable Use Directive, Annex III

How to combine control methods in IPM?



Effective control

- Which control methods worked?
- Would less input have worked?
- Effects on other pests?

How to combine control methods in IPM?


December 2021

AHDB
CEREALS & OILSEEDS

www.ahdb.org.uk/ipm-review

Research Review No. 98

Enabling the uptake of integrated pest management (IPM) in UK arable rotations

(a review of the evidence)

Jonathan Blake[1], Sarah Cook[2], Kevin Godfrey[1], Lynn Tatnell[2],
Sacha White[2], Frances Pickering[1] and Paul Wright[1].

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573 evidence sources from global literature reviewed and interpreted for UK:

- 4 crops: wheat, barley, oilseed rape and potatoes
- 40 IPM control measures
- 80 weeds (grouped), pests and diseases
- 642 control measure by pest combinations which could be relevant for IPM

What is the IPM Tool for?

The tool provides specific guidance on the IPM control measures that are relevant to the crops you grow, and the particular pests, weeds and diseases that are a problem on your farm.

Using the Tool will also complete and record an IPM plan for your crops.

How do I use the IPM Tool?

For a short video showing how to use the tool, click here.

Video guidance on using the tool →

Introductory videos on IPM:
Arable here →
Grassland here →
Horticulture here →
Written guidance on IPM here:
Apple →
Brassicas →
Improved Grassland →
Maize →
Oilseed Rape →
Peas & Beans →
Potatoes →
Sugar Beet →
Wheat, Barley & Oats →
Weeds →

Who created the IPM Tool?

The tool was produced by crop protection and IPM specialists at ADAS and SRUC.

It links to guidance from AHDB and other independent sources, and development of the Tool was funded by Defra as part of a Test and Trial project.

Select Low-Risk Locations

Useful for: Yellow Rust

Use in current cropping season | Intend to use in future seasons | Not suitable for my farming system | No intention to implement

Add your notes

Last year selection | **Last year notes**

To see how many other users use this intervention:

Get benchmarking

Sowing date

Useful for: Ear blight | Septoria | Yellow Rust

Use in current cropping season | Intend to use in future seasons | Not suitable for my farming system | No intention to implement

Add your notes

Last year selection | **Last year notes**

To see how many other users use this intervention:

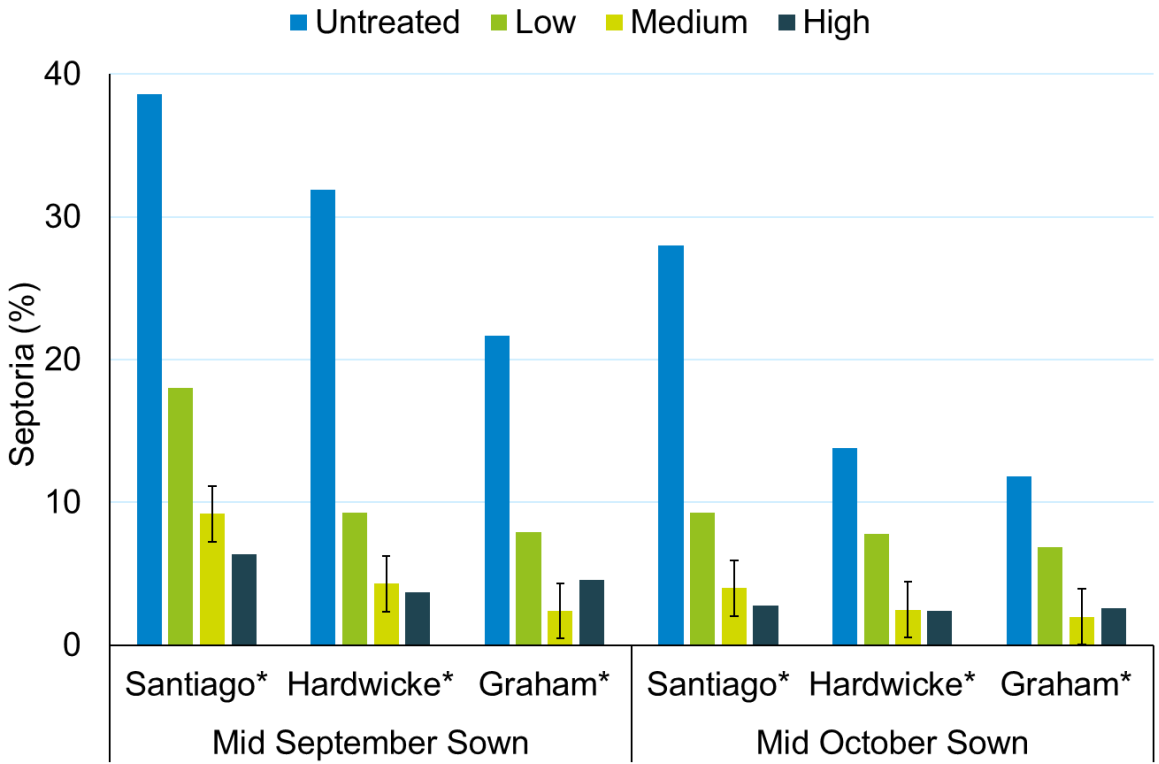
Get benchmarking

Varietal choice

Useful for: Brown Rust | Ear blight | Septoria | Yellow Rust

Use in current cropping season | Intend to use in future seasons | Not suitable for my farming system | No intention to implement

How to combine control methods in IPM?



Source: Morgan et al. (2021) AHDB Research Report PR634

Efficacy of integrating control methods – hypothetical example

Multiplicative Survival Model:

	Control method A 50% control		Control method B 50% control	
Survival fraction =	0.5	x	0.5	= 0.25

Combination of control methods gives 75% control

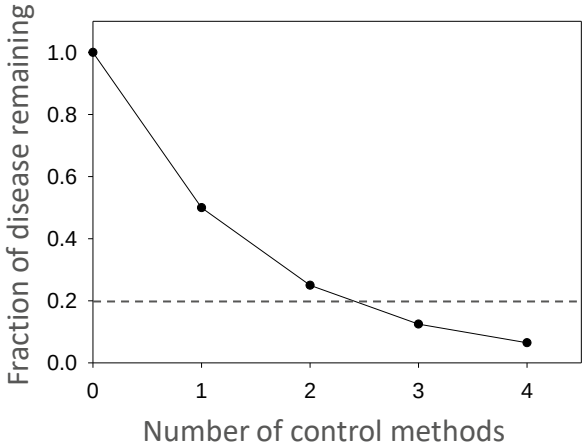
Model holds when there is independence of action

Source: Bliss (1939). The toxicity of poisons applied jointly. *Annals of Applied Biology*

Efficacy of integrating control methods – hypothetical example

Survival fraction (A) = 0.5 (50% control)

Number of control methods	Fraction remaining	
0	1	1
1	0.5	A
2	0.5x0.5=0.25	$AxA = A^2$
3	0.5x0.5x0.5=0.125	$AxAxA = A^3$
4	0.5x0.5x0.5x0.5=0.0625	$AxAxAxA = A^4$



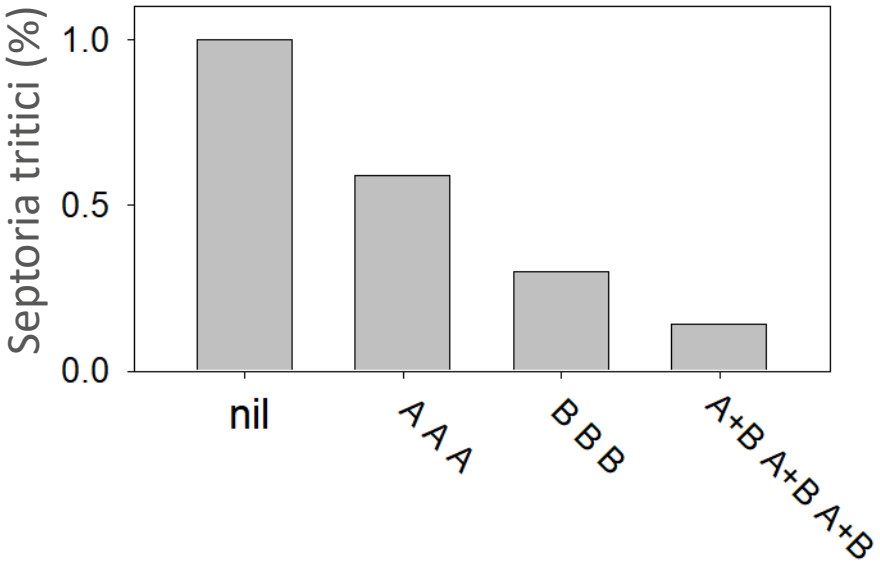
Efficacy of integrating control methods

Fungicide + Fungicide (Mixtures or Number of applications)

Disease resistance gene + Disease resistance gene (Pyramiding)

Disease resistant variety + Fungicide (Integration)

Efficacy of combining fungicides (mixtures)

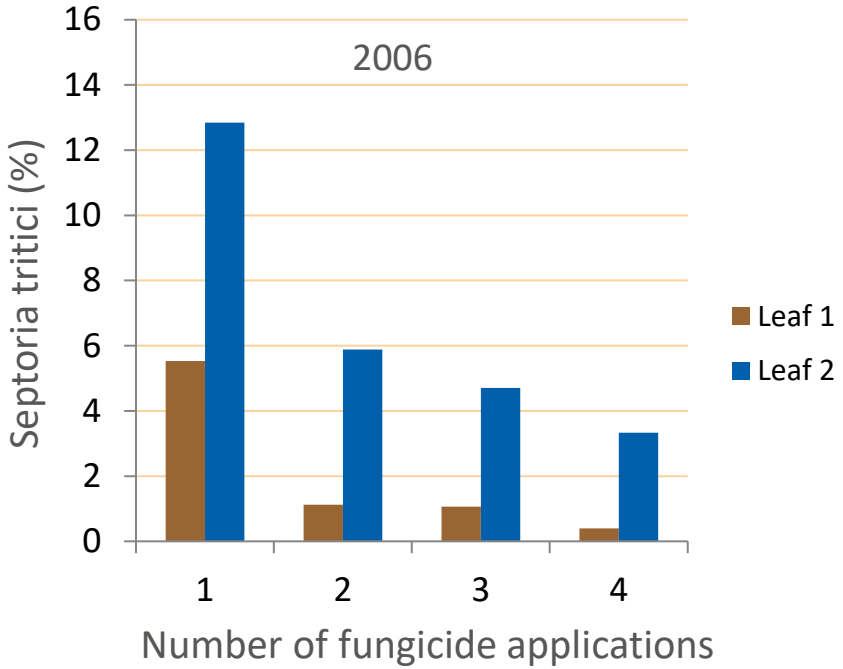


Treatment	severity	% control	Fraction remaining
Untreated	1.00		
A A A	0.59	41	0.59
B B B	0.30	70	0.30
3 x A+B	0.14	86	0.14

0.59 x 0.30 = 0.18

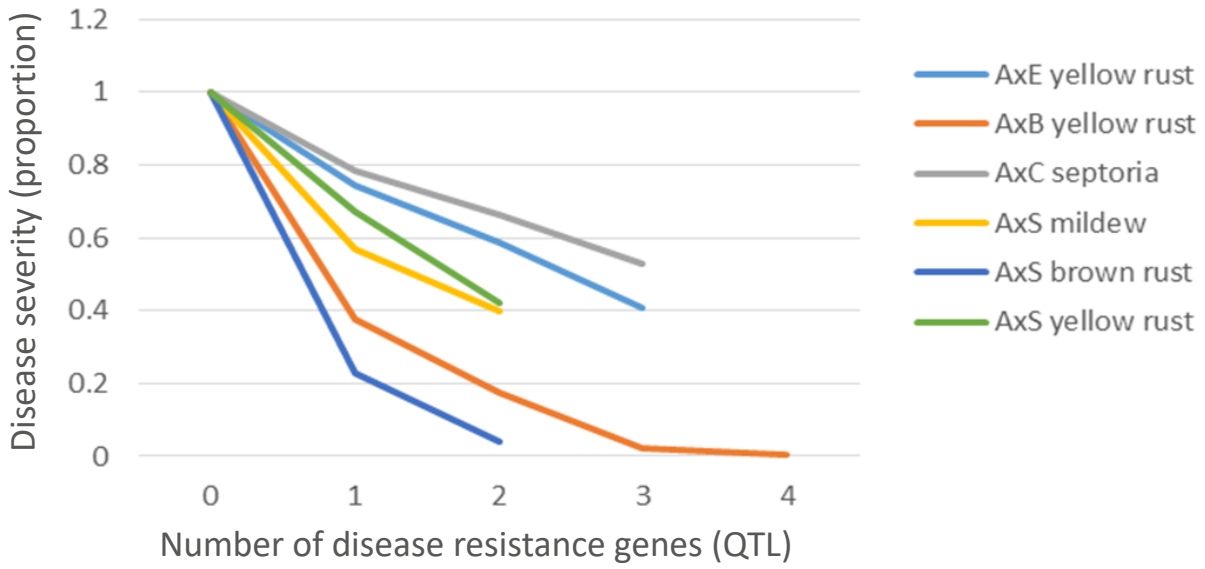
Source: Fraaije et al (2006). AHDB (HGCA) report 392

Efficacy of number of fungicide treatments



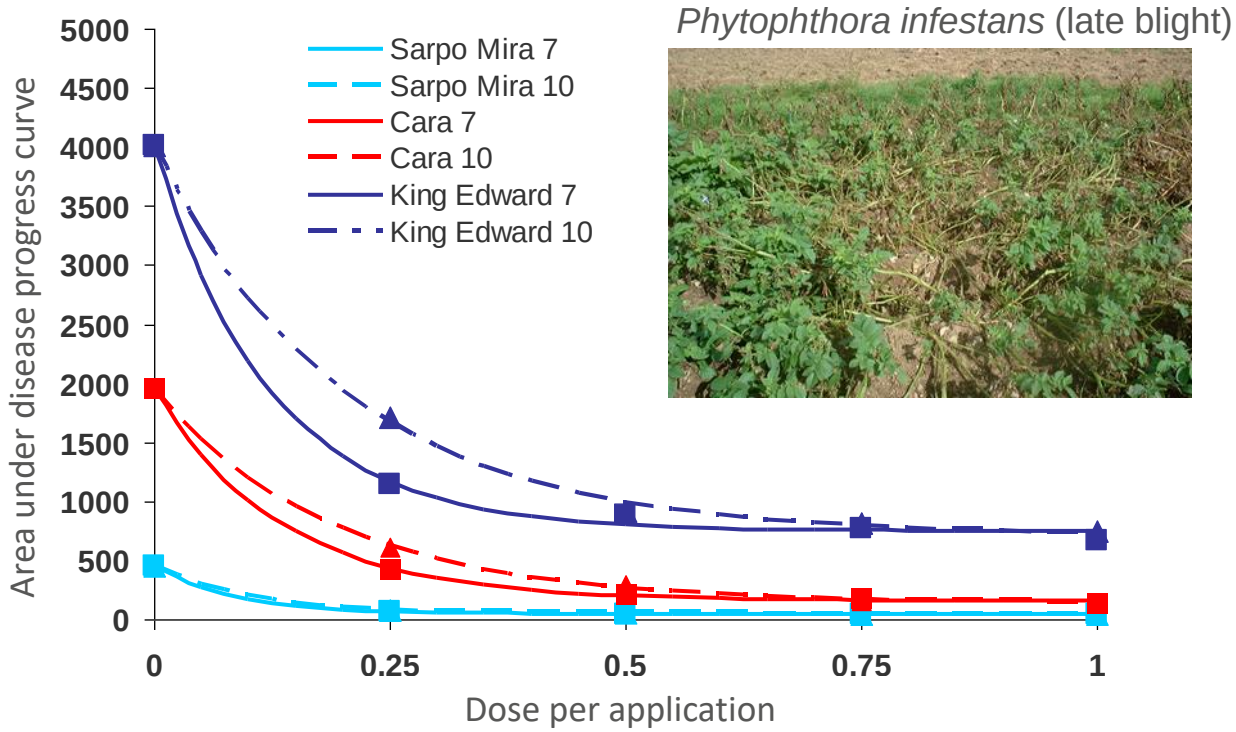
Source: Defra pest and disease survey (Fera). Paveley et al (2003) Plant Pathology

Efficacy of combining disease resistance genes



Source: Grimmer et al (2014) Plant Pathology

Efficacy of integrating variety resistance and fungicide



Phytophthora infestans (late blight)

Source: Ritchie et al (2018) Plant Pathology

Integrating control methods – hypothetical example

Efficacy of control methods*	Number of control methods for 80% control
20%	7
30%	5
40%	4
50%	3
60%	2
70%	2
80%	1

* Assuming all control methods of similar efficacy

Synergy or antagonism between control methods?

Two or more control methods are synergistic or antagonistic when their combined efficacy is greater than or less than expected

How to combine control methods in IPM?

- Identify control methods with proven efficacy
- If more control comes from one method, less control is needed from another
- Combined efficacy is predictable from efficacy of individual control methods
- Each additional control method has a diminishing return for efficacy, but a benefit for maintaining control in future

Pick the most effective methods and combine them

Further reading

IPM Planning Tool https://www.ipmtool.net/

Sustainable Use Directive, Annex III https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02009L0128-20190726

Bliss CI (1939). The toxicity of poisons applied jointly. Annals of Applied Biology 26: 585–615.

Paveley ND, Thomas JM, Vaughan TB, Havis ND and Jones DR (2003). Predicting effective doses for the joint action of two fungicide applications. Plant Pathology 52: 638-647

Grimmer MK, Boyd LA, Clarke SM and Paveley ND. 2014. Pyramiding of partial disease resistance genes has a predictable, but diminishing, benefit to efficacy Plant Pathology 64: 748–753

Ritchie F, Bain RA, Lees AK, Boor TRW and Paveley ND. 2018. Integrated control of potato late blight: predicting the combined efficacy of host resistance and fungicides. Plant Pathology 67: 1784–1791

van den Bosch, F, Blake J, Gosling, P, Helps, J and Paveley, N (2021) Identifying when it is financially beneficial to increase or decrease fungicide dose as resistance develops: a long-term evaluation from field experiments. Plant Pathology 69, 631-641.

Jørgensen LN, van den Bosch F, Oliver RP, Heick TM, Paveley ND (2017) Targeting fungicide inputs according to need. Annual Review of Phytopathology 55: 181-203.