Designing an Integrated Pest Management Strategy for Pollen beetles in Oilseed rape

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Pollen beetle pest status

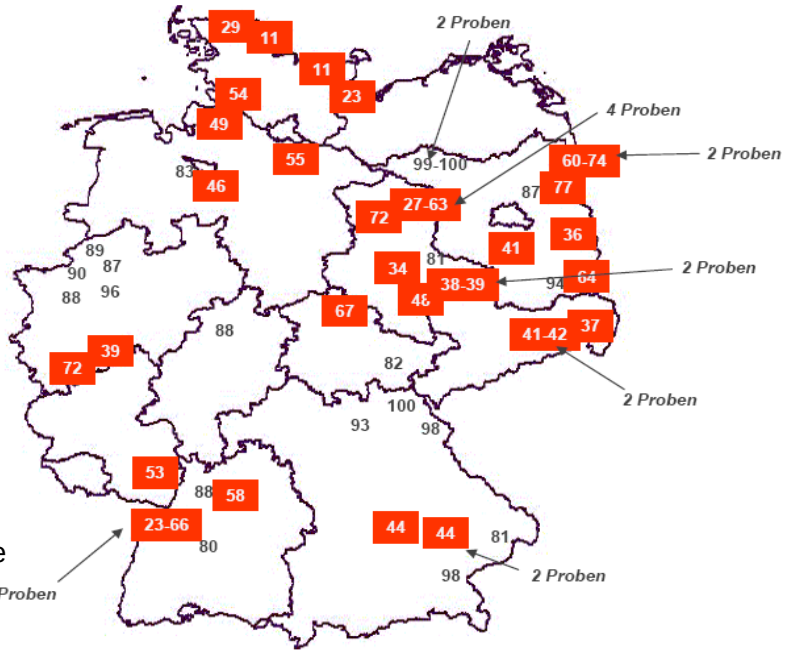
- Most abundant pest of OSR during bud-flowering stages
- Feeding damage causes bud abscission & yield loss
- **Damage susceptible stage = green-yellow bud**
- When the crop begins to flower, feeding occurs in open flowers and the crop can compensate for damage
- Controlled by insecticides

Pyrethroid resistance in pollen beetles

- Resistance to Pyrethroids 1st detected in France 1999
- Resistant populations spread quickly!
- Detected in Germany 2001 – monitoring started
- Resistance in Germany 2006 led to complete loss of 30,000ha (€22-25 M)
- **Now widespread across Europe**! **Need IPM to reduce selection for resistance**

2001

2006



Data: Bayer CropScience

Bayer CropScience

‘Development of an integrated pest management strategy for control of pollen beetles in winter oilseed rape’

LK09108 / HGCA RD-2007-3394

HSE Health and Safety Executive
Chemicals Regulation Directorate
Pesticides

defra Department for Environment Food and Rural Affairs

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syngenta

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AICC

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proPlant

vsn

SAATEN UNION

Development of an integrated pest management strategy for control of pollen beetles in winter oilseed rape – Project Aims:

ROTHAMSTED RESEARCH

Develop an IPM strategy for pollen beetles in OSR based on:

(i) Monitoring → development of a baited monitoring trap

(ii) Risk assessment → testing of proPlant phenological model to UK climate

proPlant

(iii) Crop management → validate trap cropping tactic & identify improved cultivars

(i) Developing a monitoring trap for pollen beetle IPM

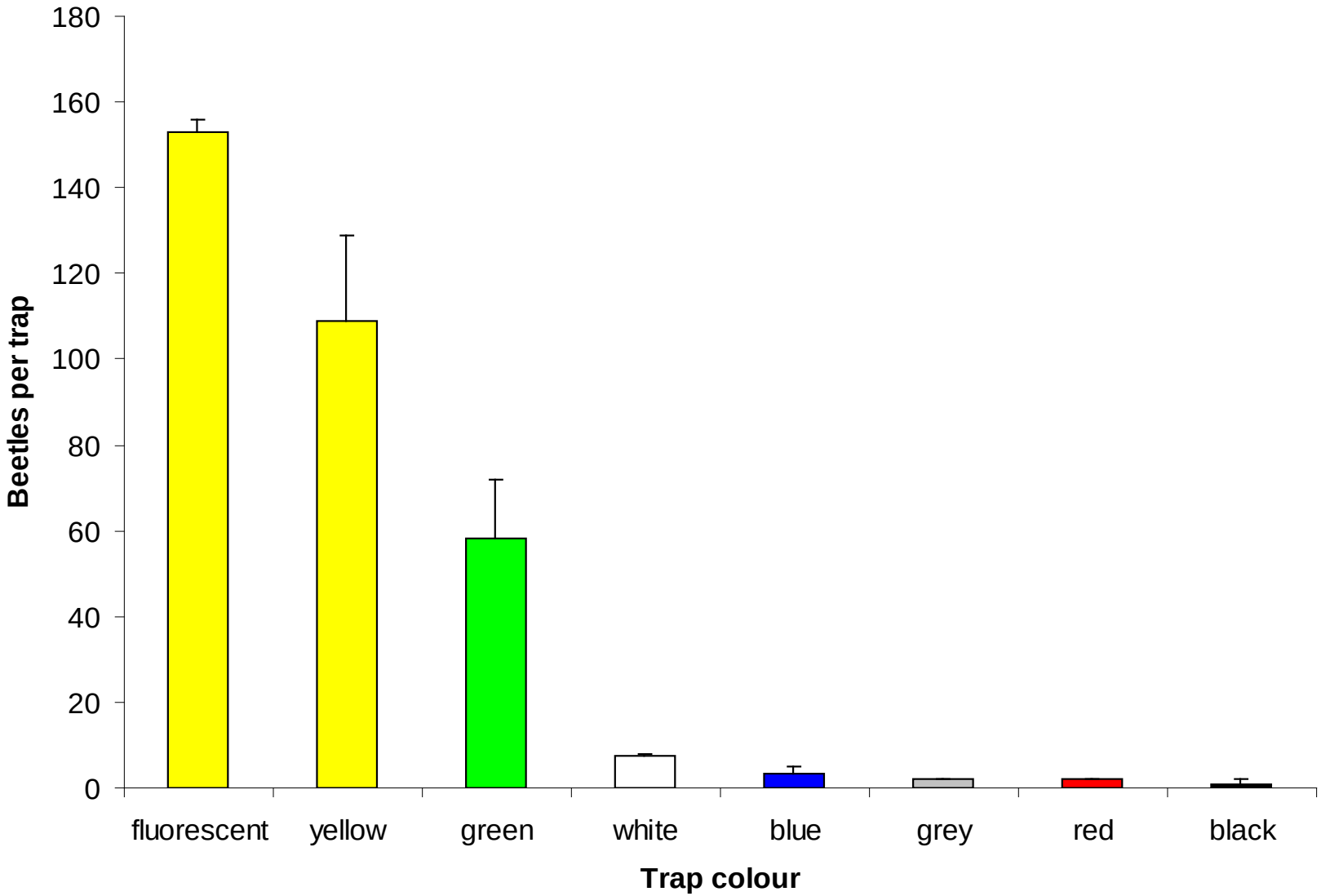
- A baited monitoring trap will help growers & advisers to more easily and more accurately identify when spray thresholds have been breached than by plant scouting methods

- Optimal trap colour & volatile bait investigated

Monitoring trap - colour

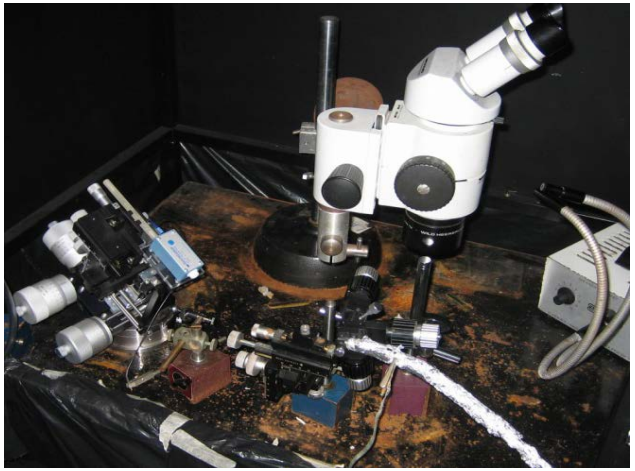
Dr Thomas F. Döring
Imperial College London

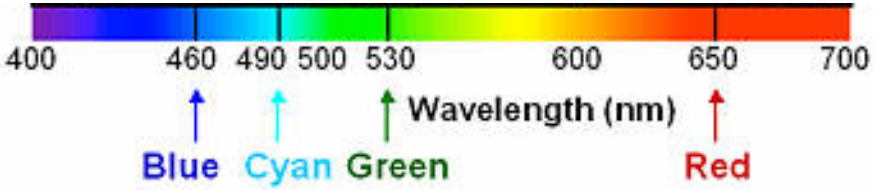
Monitoring trap – colour: Behaviour in the field



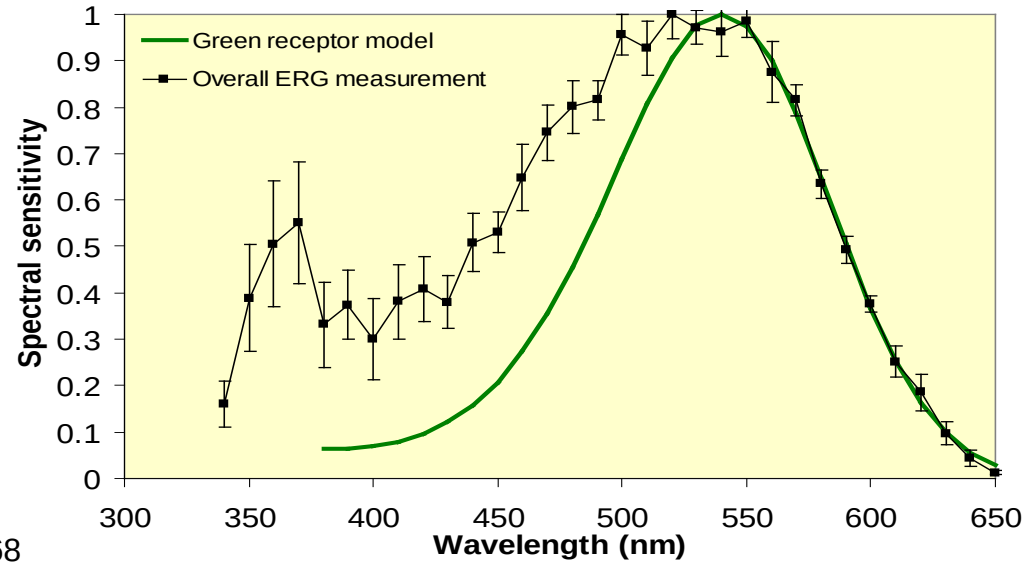
Identification of pollen beetle colour receptors

Electroretinoraphy: Measures voltage change of photoreceptors in response to monochromatic light stimulus



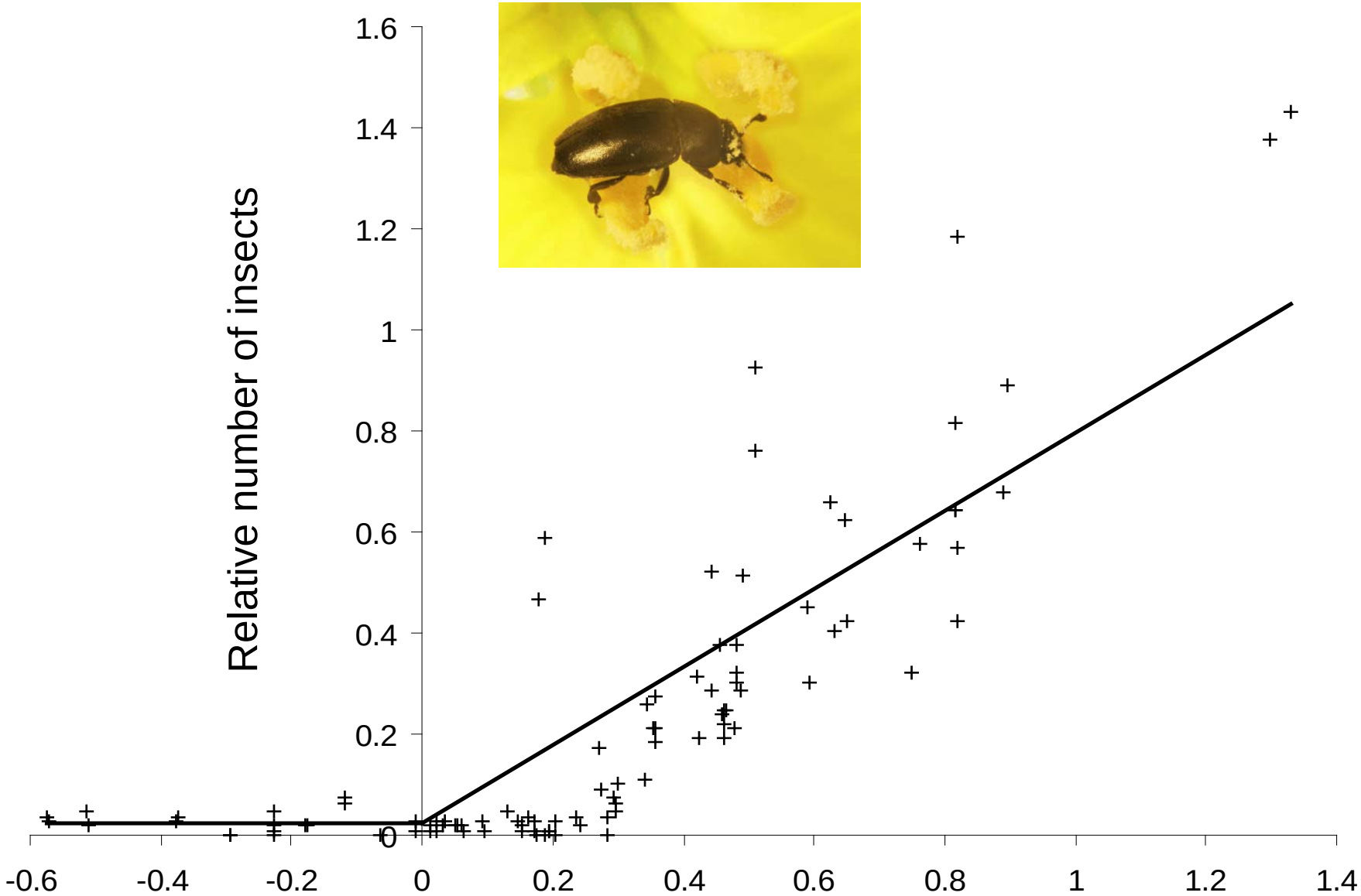


Spectral sensitivity: Maximum at ~540 nm (green); also blue and UV



Döring, Skellern, Watts & Cook (2012) Phys. Ent. 37:360-368

Model of pollen beetle colour choice behaviour

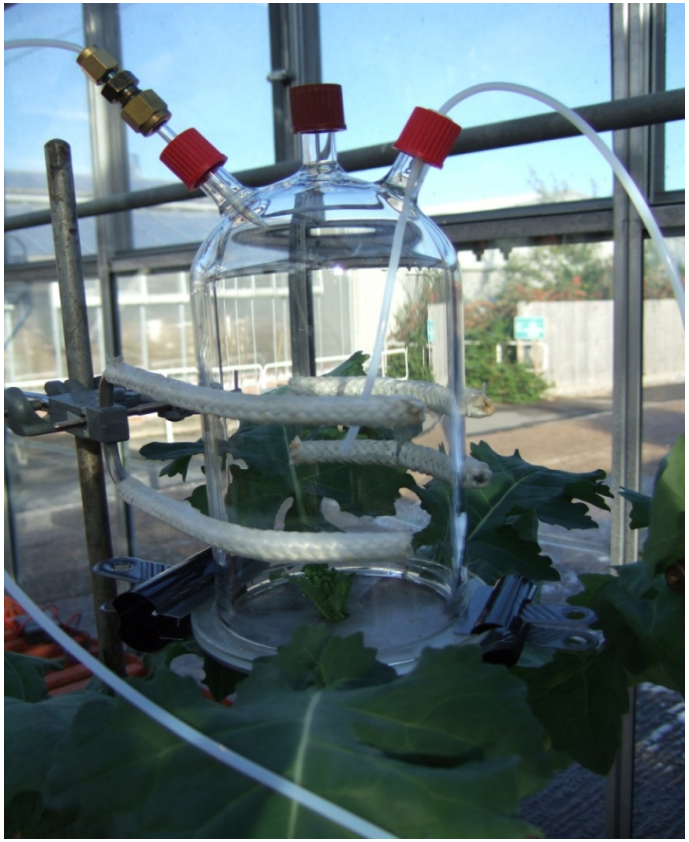


Green-blue-COM: **log (G) – log (B)**

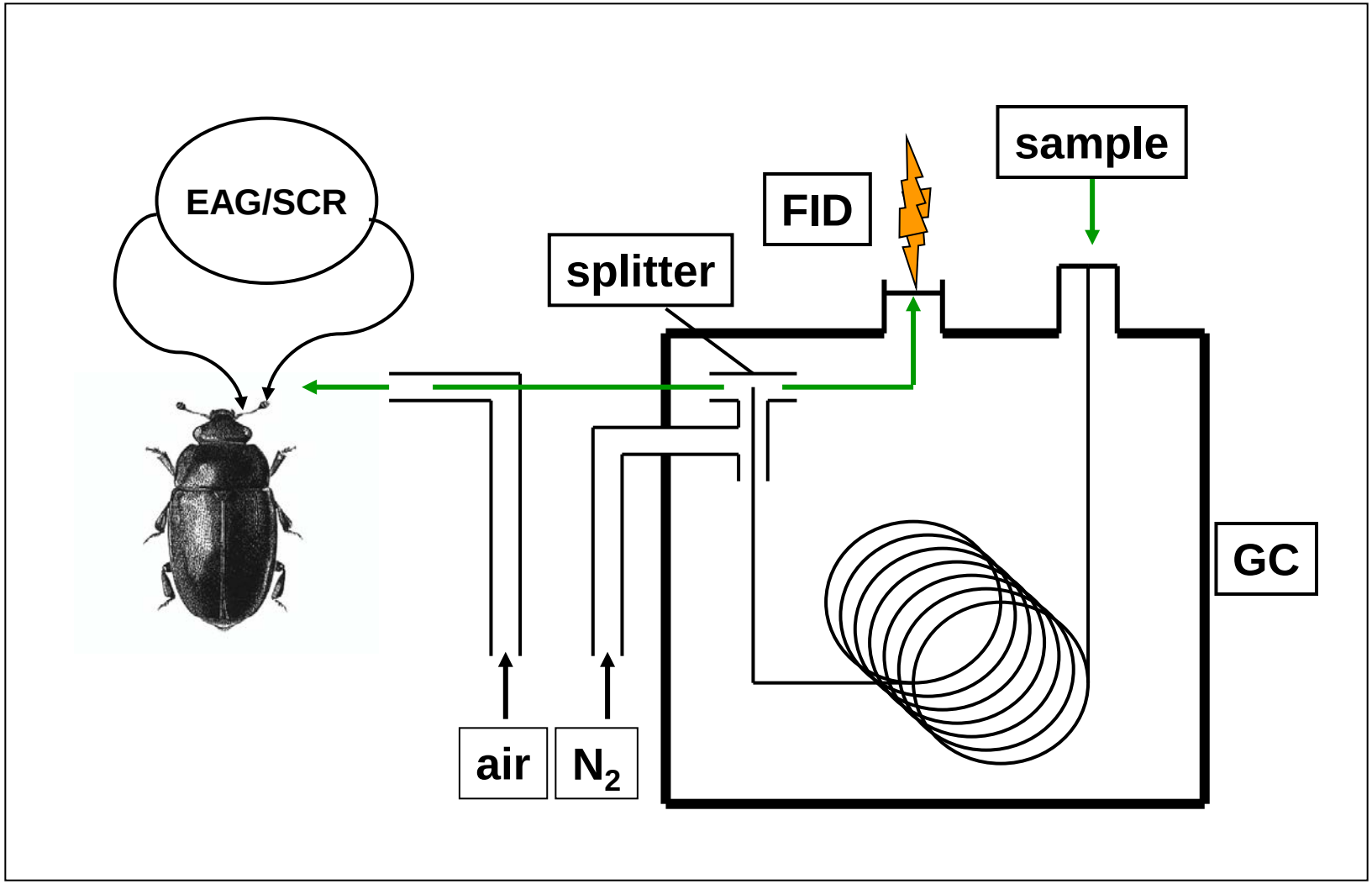
Döring, Skellern, Watts & Cook (2012) Phys Ent 37:360-368

Monitoring trap - Bait

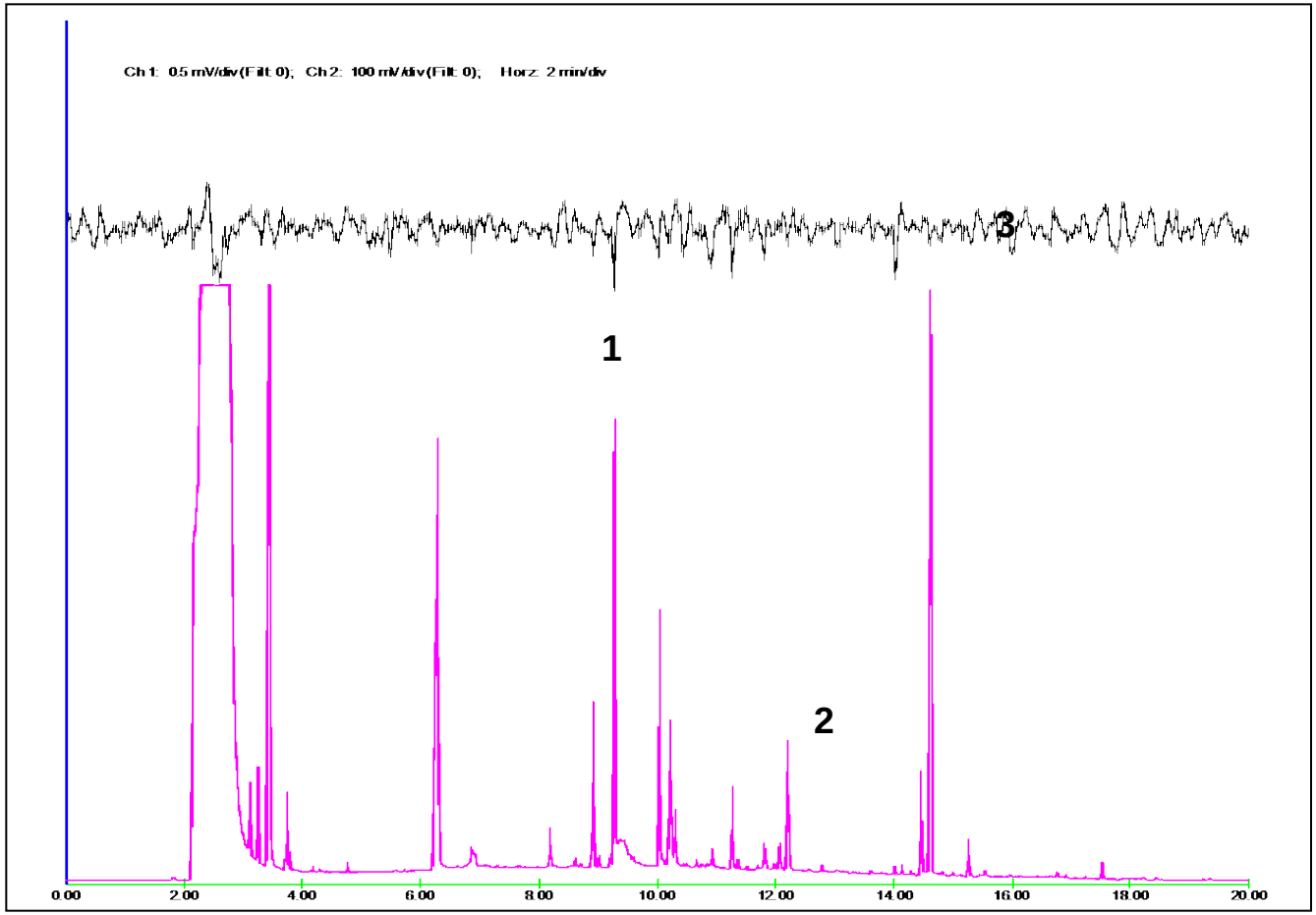
In the absence of pollen beetle sex / aggregation pheromones, we are developed a lure derived from OSR host plant volatiles



Coupled Gas-Chromatography-Electroantennography (GC-EAG)



Coupled GC-EAG of pollen beetle and oilseed rape flower volatiles



1 = phenylacetaldehyde, 2 = indole, 3 = (*E,E*)-α-farnesene

Results of replicated field trials 2008-2011

ROTHAMSTED RESEARCH

•15 volatile semiochemicals identified & tested

• Phenylacetaldehyde performed most consistently and was chosen for further development as the lure for the field trap

•Lure reduces total no. non-target insects caught

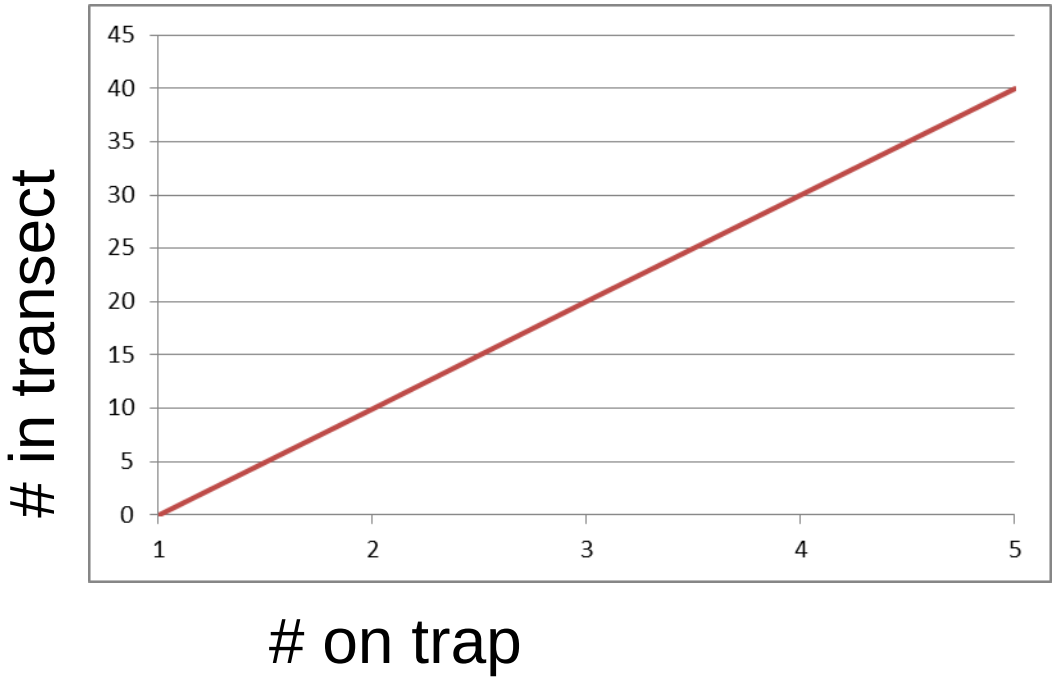
• IPS Ltd prototype commercial lure selected

•Oecos carrot fly sticky trap selected

•Available from Oecos 2013 www.oecos.co.uk

Monitoring trap – calibration

- Calibration of trap requires an understanding of the relationship between numbers of beetles caught on traps and numbers of beetles on the crop so that a given trap catch can relate to current (or new) threshold levels



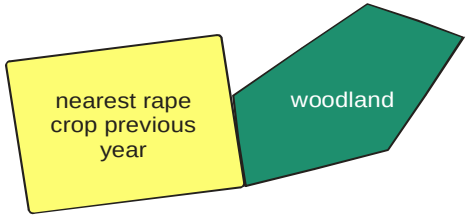
Trapping experiment

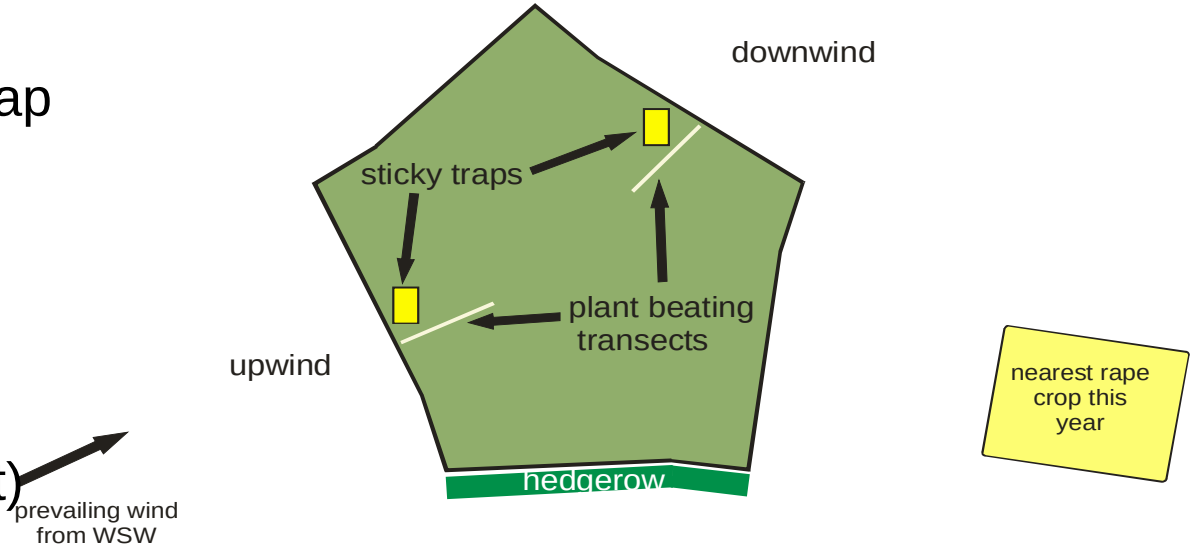
Sticky traps placed upwind and downwind in OSR crops

changed 1 or 2/week from green bud – early flowering (~6 weeks)

30m transect conducted at each trap site when traps changed to give mean no. beetles/plant from 10 plants

Sticky traps & transects → trap calibration analysis (& proPlant test)





Pollen beetle trapping experiments run across UK

17 sites 2008 (white)
27 sites 2009 (red)
57 sites 2010 (blue)
77 sites 2011 (yellow)
178 sites

Year	Total number of pollen beetles caught	Mean (±SE) number of beetles caught per trap
2008	3,142	8.12 (0.82)
2009	16,344	18.85 (1.74)
2010	60,301	29.46 (2.08)
2011	75,670	40.49 (2.49)

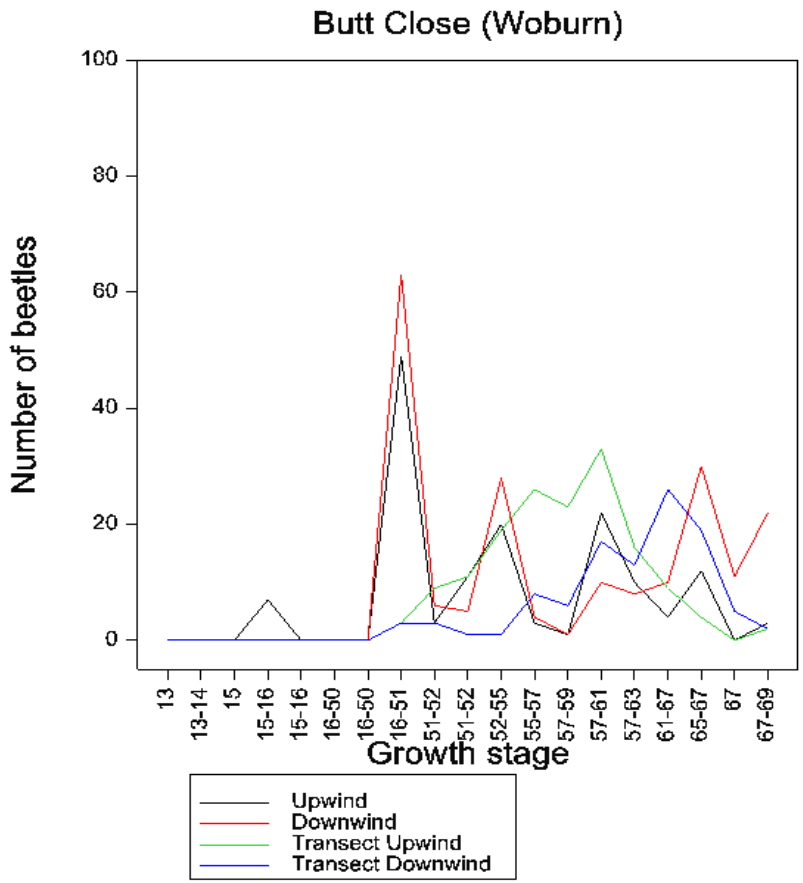
Monitoring trap – calibration

- Aim to correlate no. beetles on trap with no. in crop

- NO simple relationship was found

- So trap cannot be used to detect threshold breaches in the crop (yet)

- In any case the trap can provide good indication of local beetle movement !!!



(ii) Improved risk assessment for pollen beetle IPM
Test proPlant phenological model to UK conditions

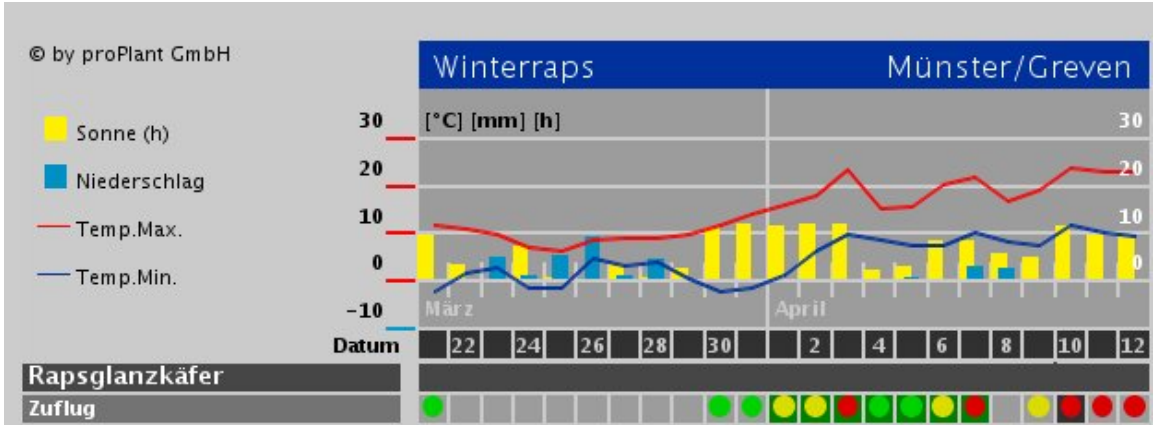
proPlant – DSS system used widely in Europe.

Its pollen beetle phenological model uses sunshine, rainfall, windspeed, and temperature data to predict immigration up to 3d in advance and could help improve monitoring and management decisions

Migration possible

Good conditions for migration

Optimum conditions for migration



Testing fit of proPlant phenological model to UK conditions

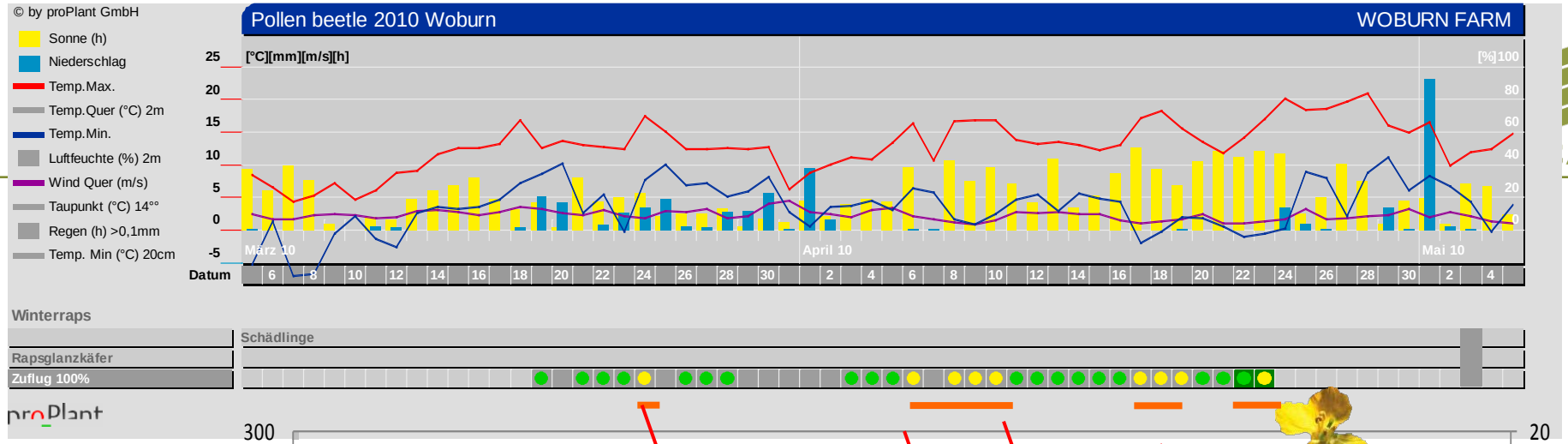
Compare the output of the proPlant model with the sticky trap data:

- start of migration

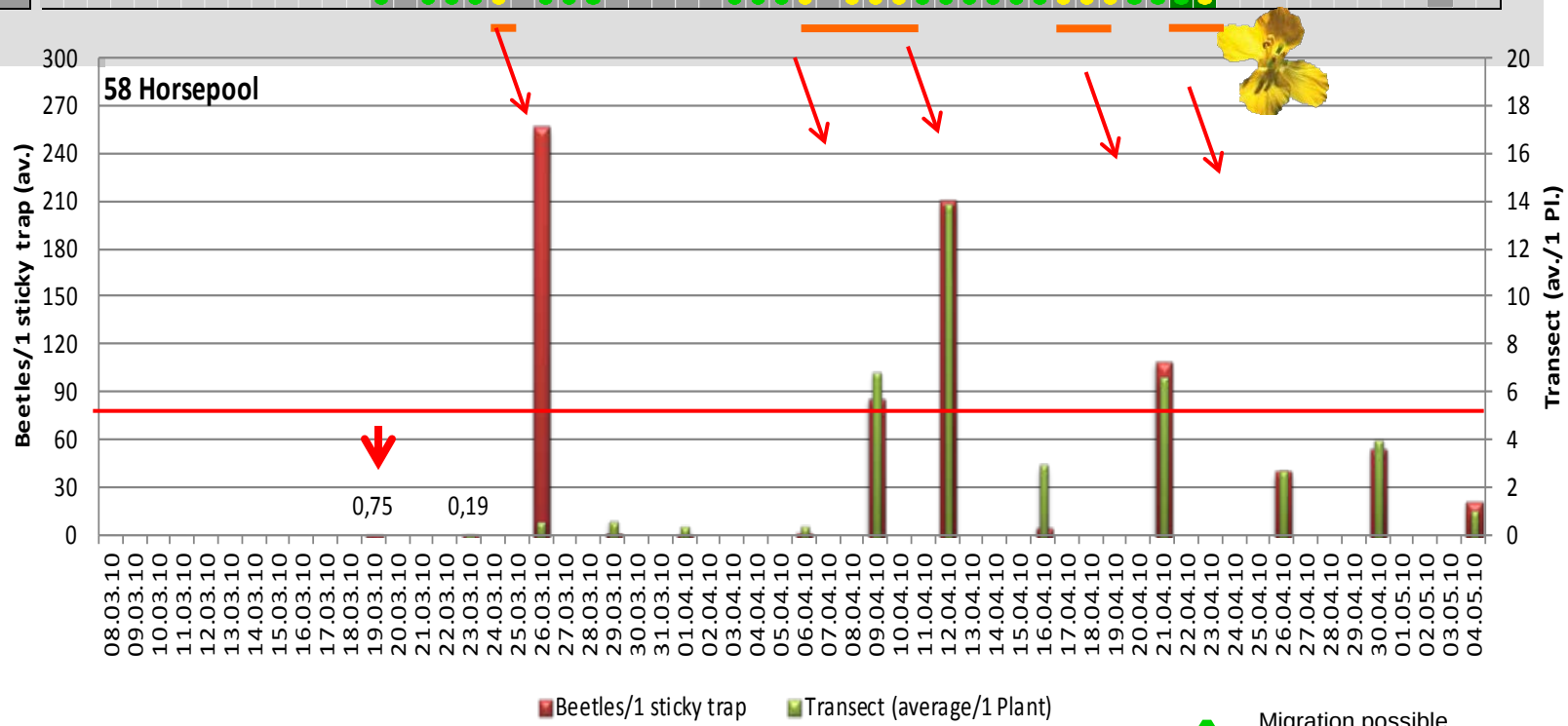
- peak(s) of migration

- % completion of migration

2010 data; Woburn farm



58 Horsepool
nr Woburn

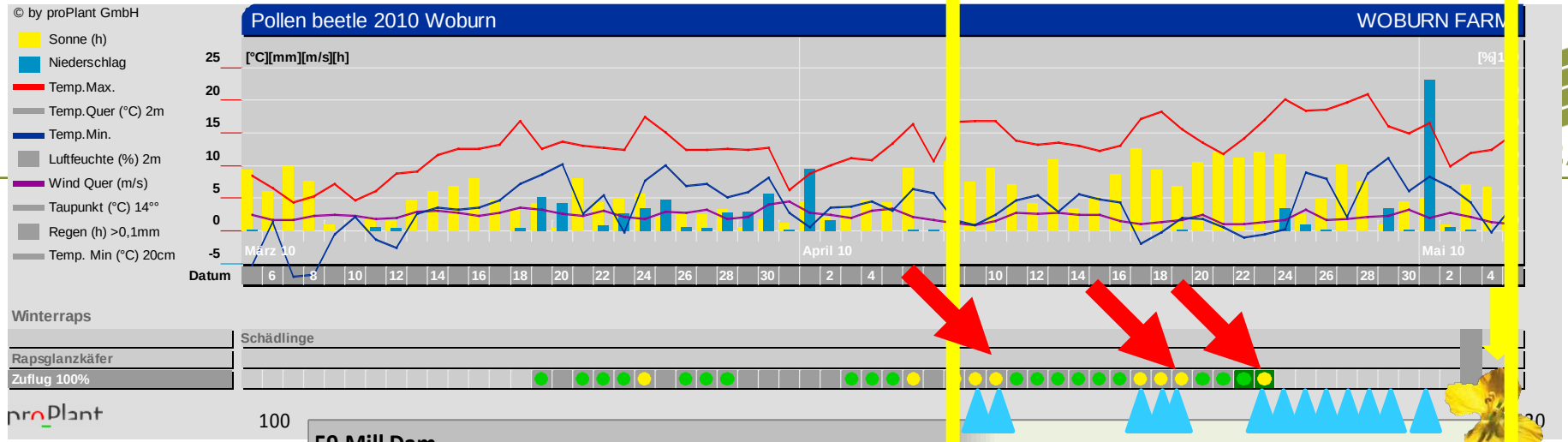


Migration possible

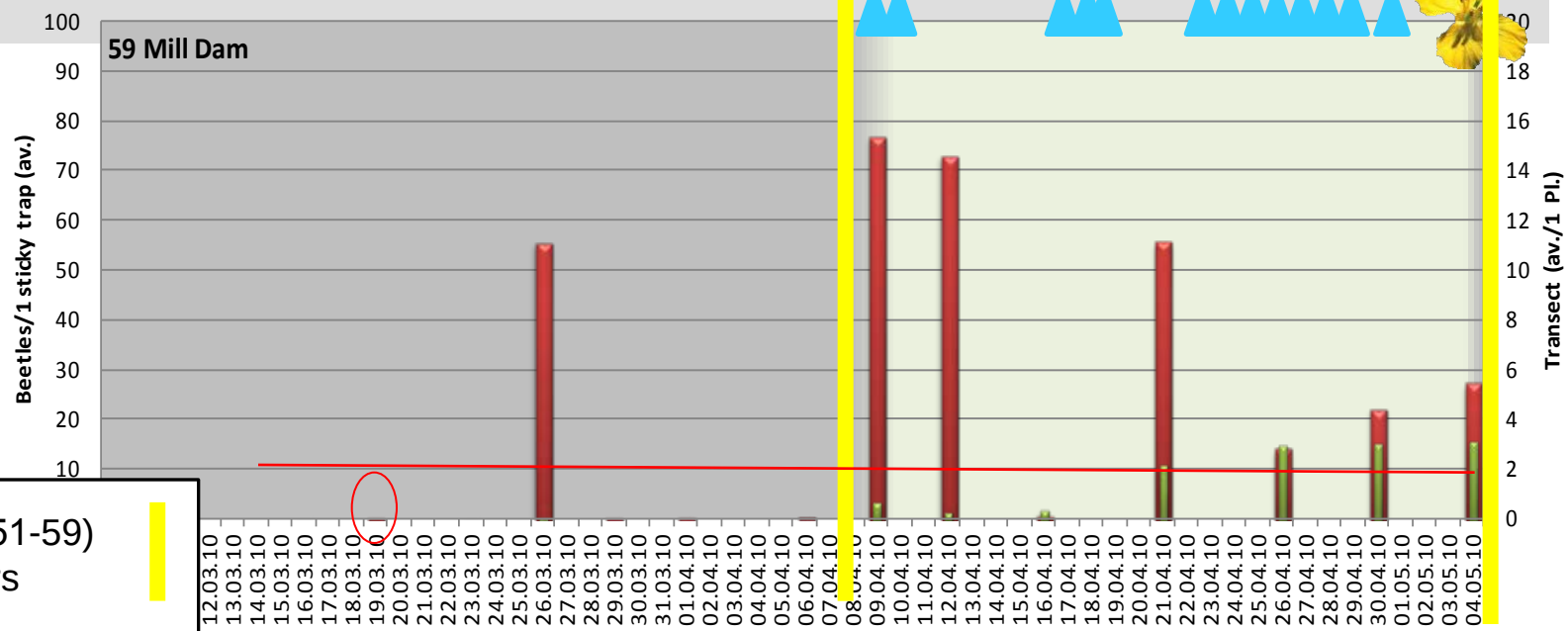
Good conditions for migration

Optimal conditions for migration

Predictive ability of proPlant may save insurance sprays?



59 Mill Dam
Woburn



Risk period (GS ≥ 51-59) between yellow bars

= Temp ≥ 15°C, Crop Monitor sample point

= Proplant sample point

No need to spray if threshold is near-breach and immigration is predicted to be 100%

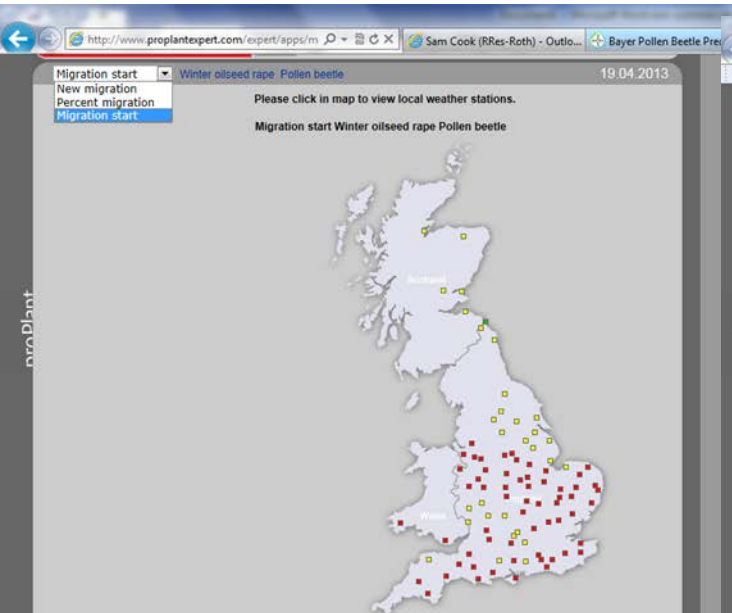
Gives confidence to hold off if threshold is near-breach but conditions are predicted poor for migration

Improved risk assessment for pollen beetle

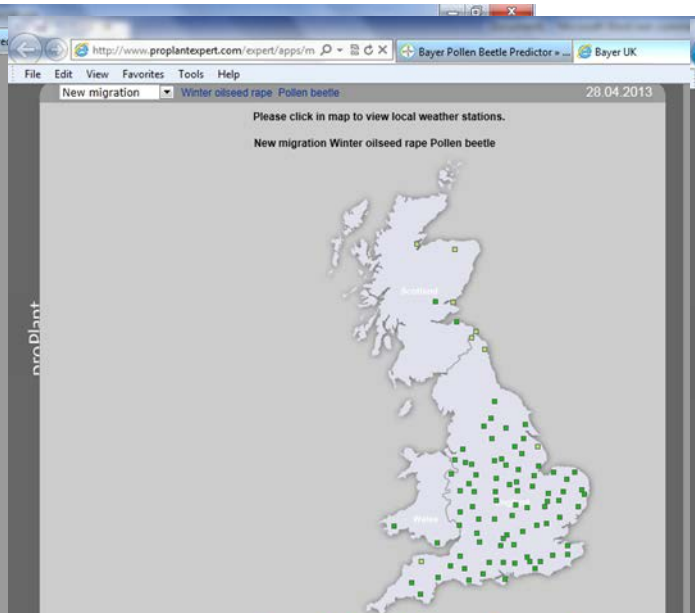
proPlant can accurately forecast start, peaks (risk periods) and end of immigration, **focussing monitoring effort to when it is most needed**

2012, 2013 ProPlant tool now provided free to UK growers via Bayer CropScience www.bayercropscience.co.uk/

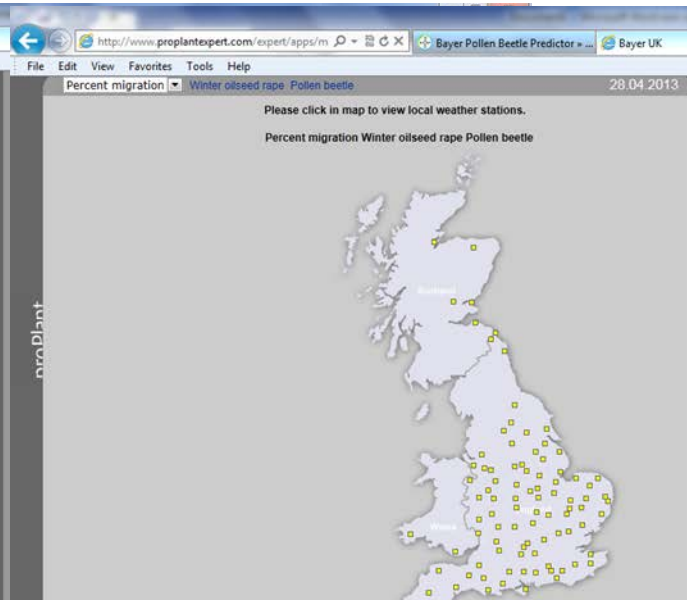
Immigration start



Immigration risk



% completion immigration



(iii) Crop Management

Validate trap cropping tactic

- Early flowering winter turnip rape (*Brassica rapa*) planted as a trap crop surrounding the main oilseed rape crop can reduce the population of beetles in the main crop to below spray threshold levels

- Cost:benefit not currently favourable for conventional growers

Future directions – breeding for improved pest tolerance

ROTHAMSTED RESEARCH

Approach:

- All major insect pests of OSR are crucifer specialists
- Pests locate and select host plants on basis of visual, olfactory, gustatory & tactile plant cues
- Pests show host plant preferences
- Understanding host location / selection behaviours and mechanisms of preferences can contribute to IPM tools for pests AND identify plant traits to inform breeding programmes for resistance (or a reduction in host-finding / selection)

Use of oilseed rape cv. with high proportions of indolyl and low proportions of alkenyl glucosinolates?

Alkenyl GS → 3-butenyl isothiocyanate

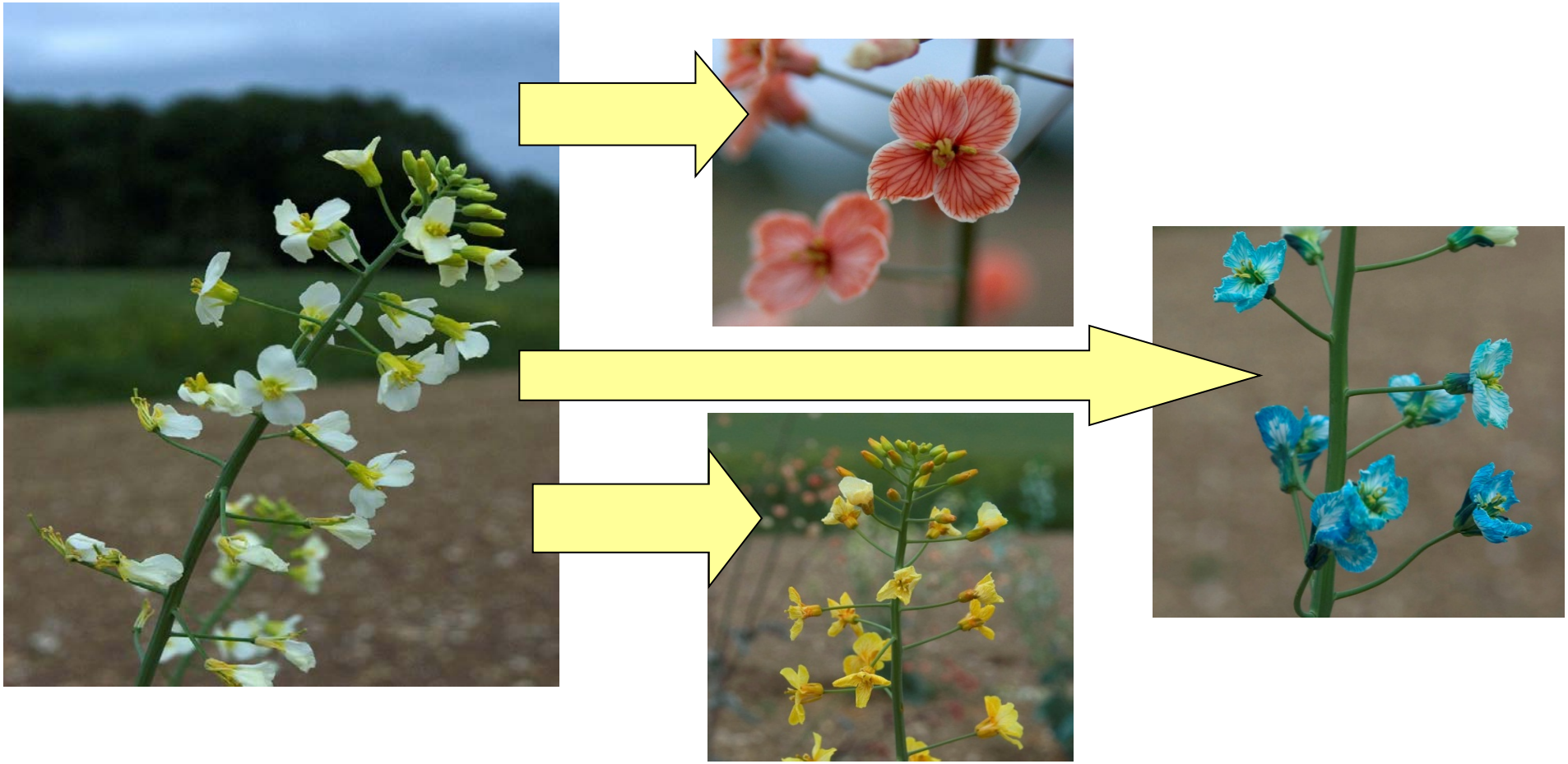
Indolyl GS do not catabolise to form stable ITC

Oilseed rape with low % alkenyl GS high% indolyl GS

Oilseed rape with high % alkenyl GS low % indolyl GS

Cook et al., 2006; *Ent. Exp. Appl. 119:221-9*

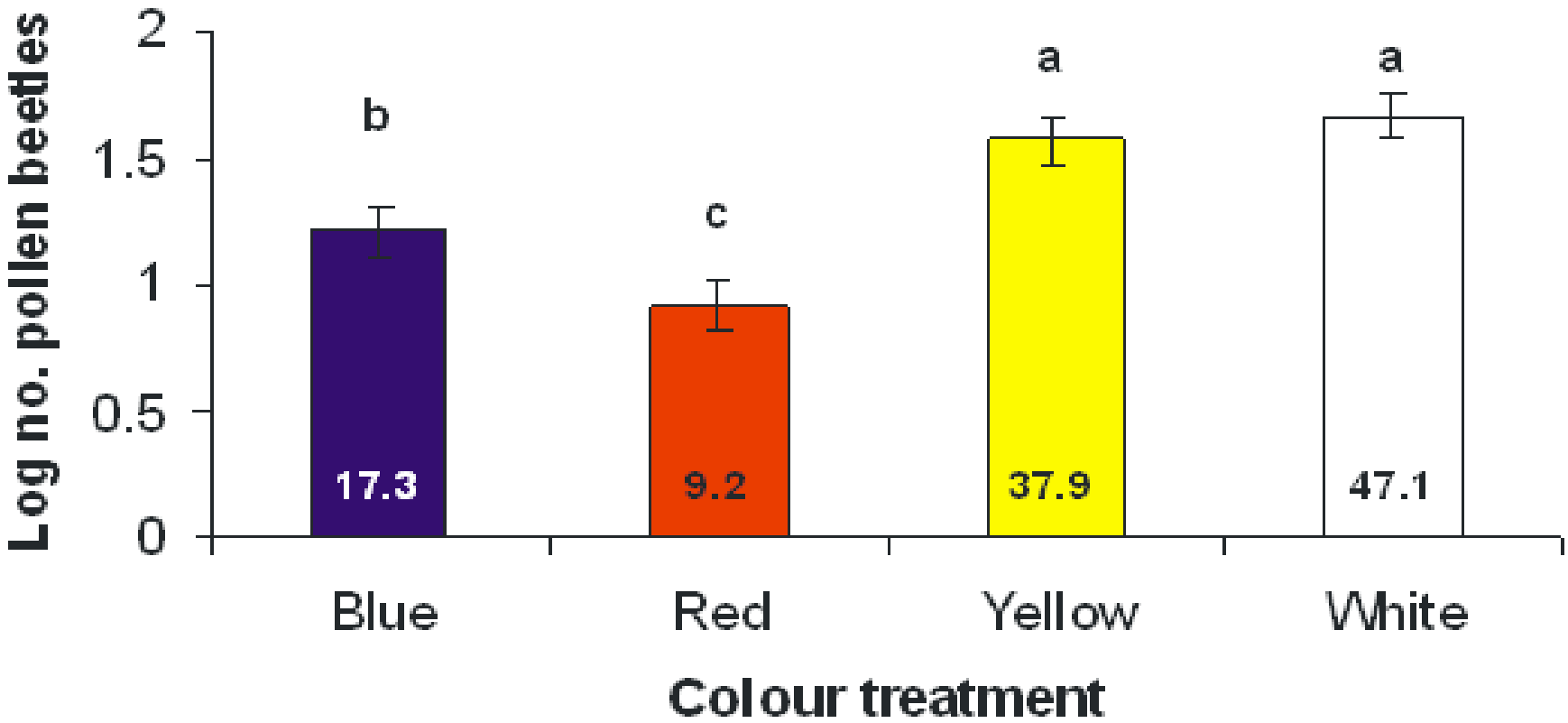
Red oilseed rape? Exploitation of colour preference in pollen beetle IPM



Potted plants of a white petalled oilseed rape line were dyed red, blue or yellow and colonization by pollen beetles observed in the field.

Cook, Skellern, Döring & Pickett (2013) Arthropod-Plant Interactions: *in press*

Colonization of plants by pollen beetles in field experiments



White and yellow treatments equally preferred over blue and red treatments

Cook, Skellern, Döring & Pickett (2013) Arthropod-Plant Interactions: *in press*

Acknowledgements

- John Pickett
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- Sue Welham
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- Janet Martin
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- Nigel Watts

ROTHAMSTED RESEARCH

defra Department for Environment Food and Rural Affairs

LINK COLLABORATIVE RESEARCH

HGCA

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- Michael Tait
- Jackie Davies
- Andreas Johnen

VSN International

Imperial College London

AICC

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