UK PACE Scheme

Pesticide dose Adjustment to the Crop Environment

Peter Walklate

Research sponsored by the UK Chemical Regulations Directorate

Introduction

- UK Regulators funded SRI & EMR to develop PACE (2001-2005)
  - Based on optimised dose adjustment
  - Rationale
    - Statutory Label Dose: “Maximum dose per hectare”
      - Became EU law in 2009 (Regulation 1107/2009)
      - Known to waste pesticide for orchard spraying
    - UK Grower Already making dose adjustments
    - Applied Dose = (Dose Adjustment ≤ 1) x (Statutory Label Dose)
  - This research needed a good model
    - Dose Adjustment = F (Canopy: Size and Density)
    - Canopy Size Dose Adjustment:

      AgChem Companies (1990’s) Favoured TRV
    - Canopy Density Dose Adjustment:
      - Sutton & Unrath, (1984) Plant Disease/Vol 68

Introduction

Factsheet 20/05
Tree fruit

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Orchard spraying: Opportunities to reduce rates

Peter Walklate, Silsoe Research Institute and Jerry Cross, East Malling Research

Do you want to:
- **Reduce pesticide residues on fruit?**
- **Reduce environmental and bystander contamination?**
- **Reduce operational costs by more efficient use of pesticide?**
- **Reduce aquatic buffer zones under a Local Environmental Risk Assessment for Pesticide (LERAP)?**

This factsheet provides a step-by-step guide to help you achieve these aims by determining the appropriate dose and making the right sprayer adjustments to suit different apple orchards at different stages of the season.

Background

Did you know that there can be a greater than five fold variation in average pesticide spray deposits in the tree canopy, due to the variability of tree size and canopy density? Current pesticide label dose recommendations stating the amount of product applied per hectare of ground area contribute to this problem. You may already have taken the opportunity to reduce the recommended dose of some products in particular orchards at certain stages. Many have already done so, based on successful practice and on ad hoc trials with different orchard/product combinations.

In some other countries, the 'tree row volume' method of dose adjustment has been adopted to improve dose optimisation. This method considers only the effects of different tree height, tree crown width and tree row width and ignores some important effects of foliar development and branching density at different growth stages. Pesticide Adjustment to the Crop Environment (PACE) is a dose adjustment system that additionally takes account of the increasing density of the canopy during the growing season. Research and grower trials have shown that there is the potential to apply pesticides from full-dose down to 1/4 full-dose during the pre-blossom growth stages depending on certain factors. Note that 1/4 full-dose applications reduce the risk of non-target contamination from drift by 75% and can be used to reduce the aquatic buffer zones according to the Defra LERAP guide for broadcast air-assisted sprayers.

1 Full dose high volume application produces a large plume

2 Spray drift has an environmental impact

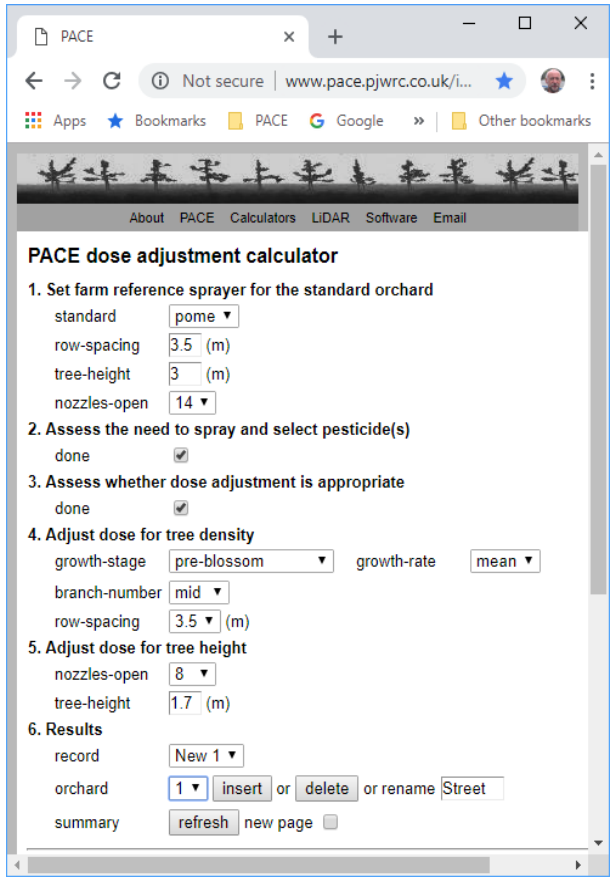
What should you do to optimise the dose?

Take these steps to optimise dose and reduce the variability of spray deposit:

1 Establish your standard orchard sprayer settings
2 Assess the need to spray
3 Select the pesticide(s) and assess whether dose reduction is appropriate
4 Reduce the dose for lower canopy density
5 Reduce the spray plume height for lower tree height.

- 1st PACE Scheme Roll-out (2005 – 2007)
  - HDC factsheet 20/05 to help growers use PACE
    - Worked examples of dose adjustment for different pesticides
  - Presentations made to major UK grower groups
  - Grower feed-back:
    - Simplify dose adjustment calculation
    - Because grower make mistakes
    - Complicate dose adjustment calculation
    - Dose scaling rules are not the same for all pesticide types

Introduction



- PACE calculator webpage (2008-2013)
  - http://www.pace.pjwrc.co.uk

- Include different scaling rules for different pesticides
  - Scab fungicides & products with pre-blossom dose
    - Alignment with LWA scaling
    - Canopy density is less important than canopy size
  - All other pesticides
    - Canopy density & size are both important
  - Walklate & Cross Crop Protection 54 (2013) 65-73

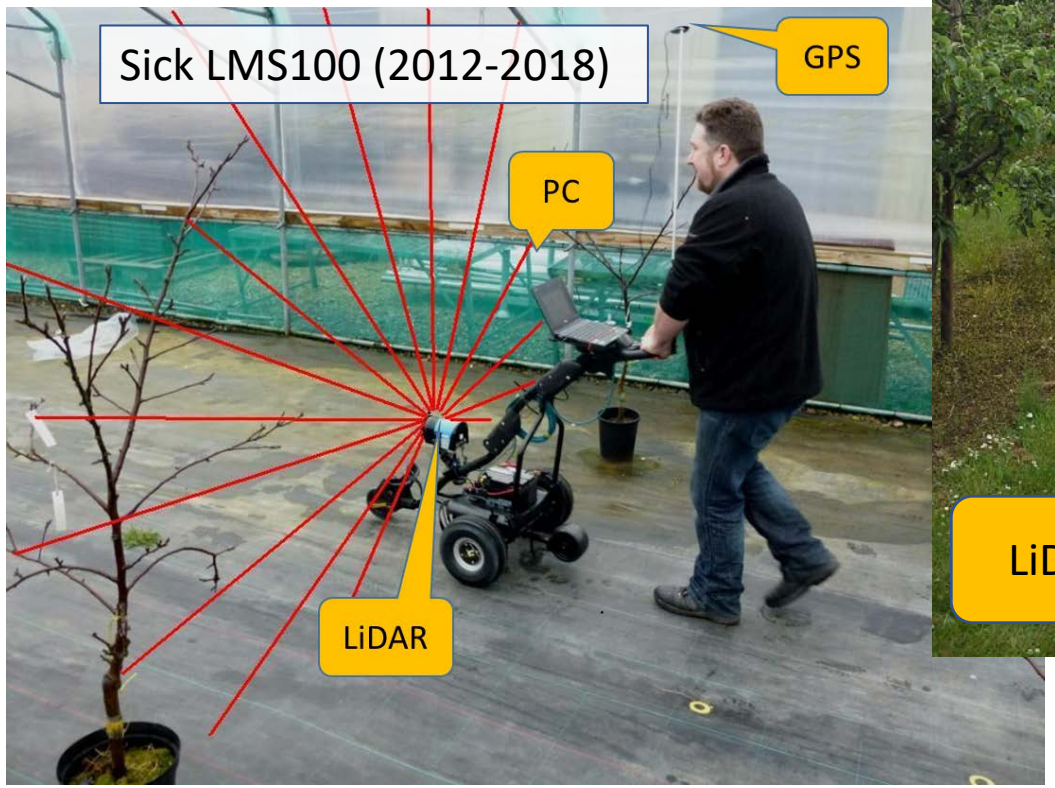
- Grower demo trials (2012 - 2013)
  - Using PACE webpage calculator

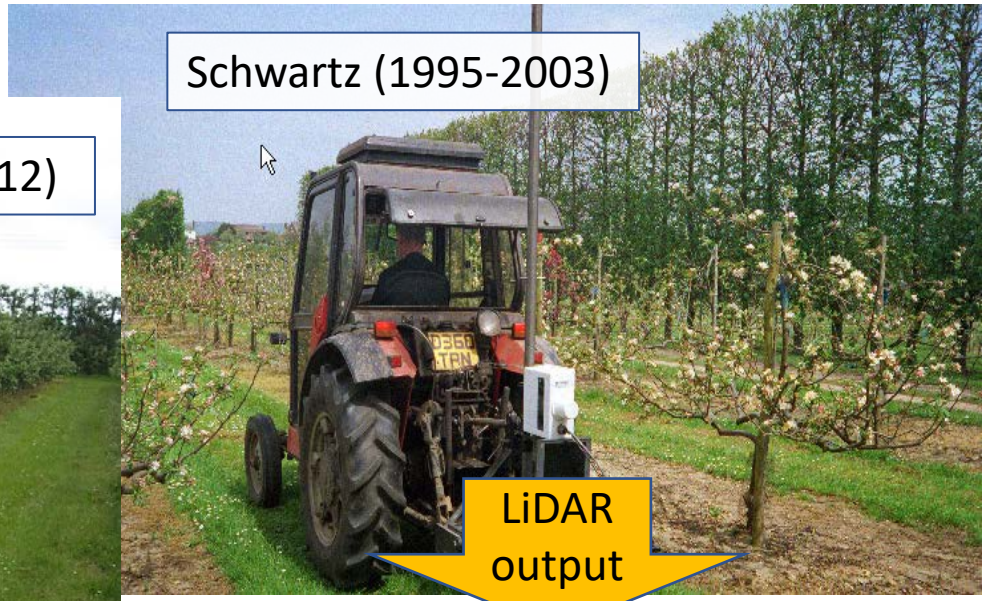
Why is dose adjustment needed?

Dose adjustment is needed to obtain uniform deposit across different structures

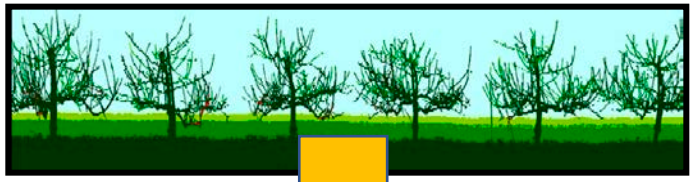
Traditional deposit measurements are a very time consuming and expensive way to determine dose adjustment

Possible alternative: LiDAR crop structure measurements



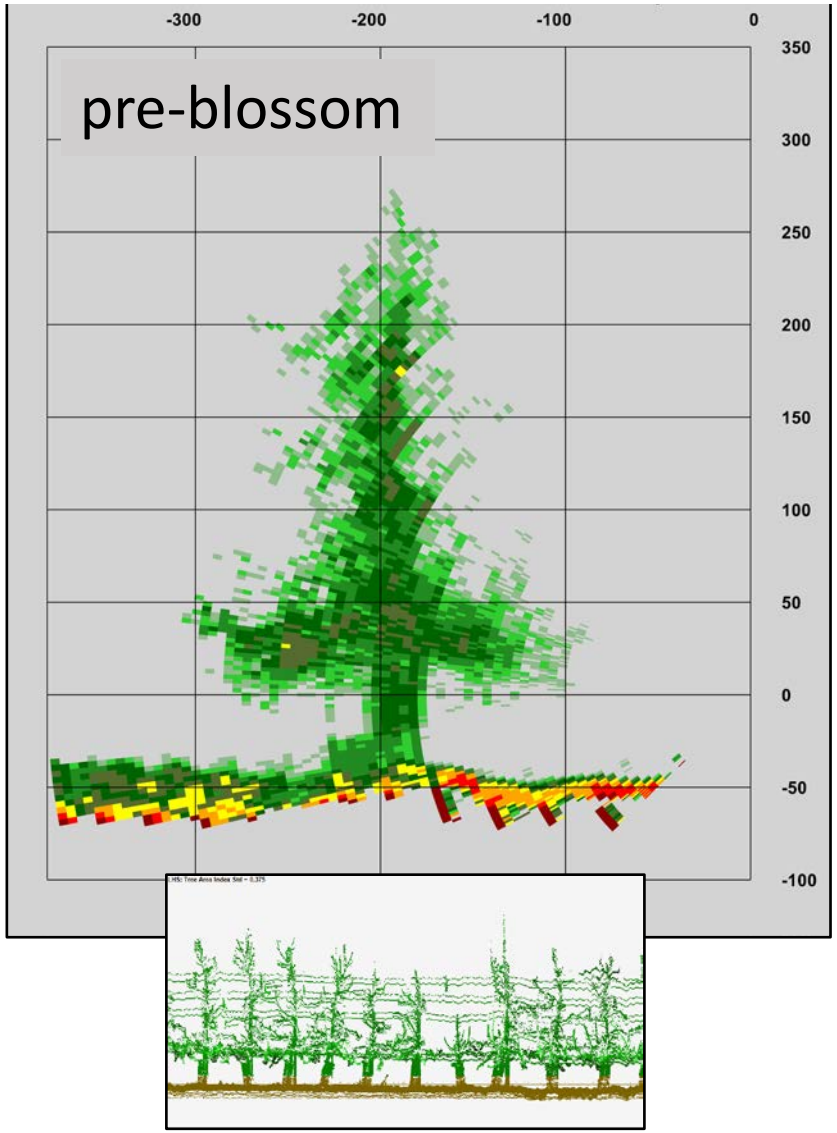


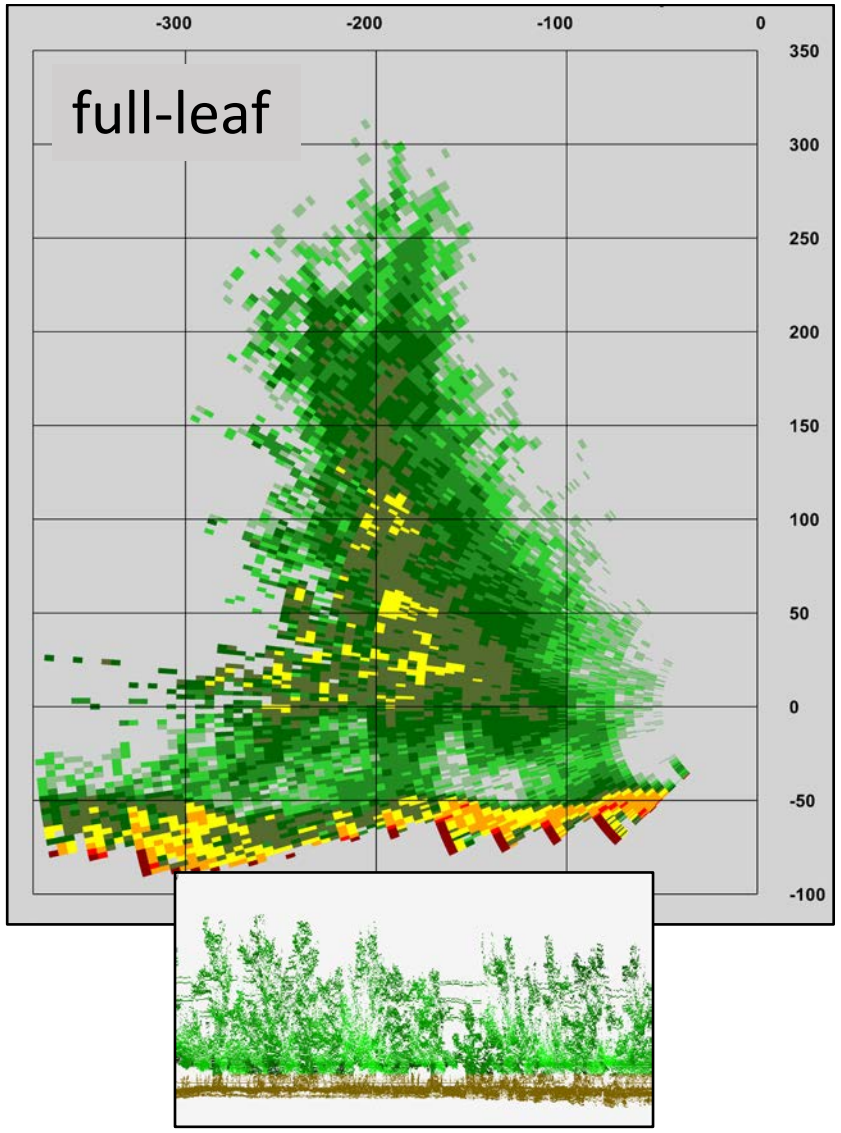
Range interception maps

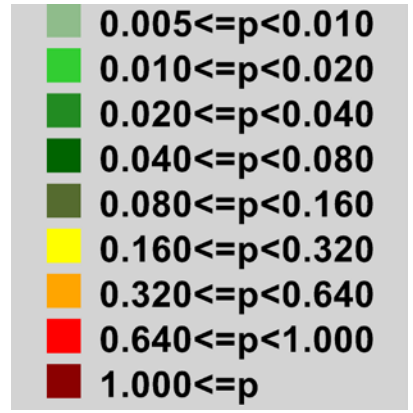


Crop structure parameters for dose adjustment models:
Ex. LWA, TRV, PACE

Range Interception Probability Distributions (PACE parameters: height, width, density, etc)



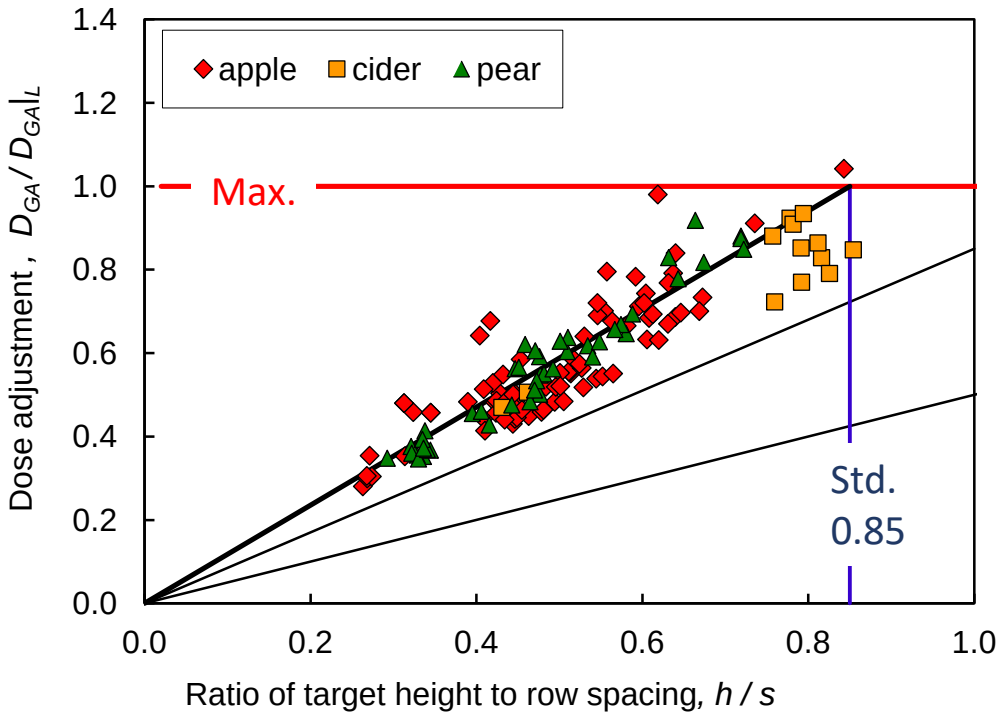




LiDAR-PACE dose adjustment model: UK orchards

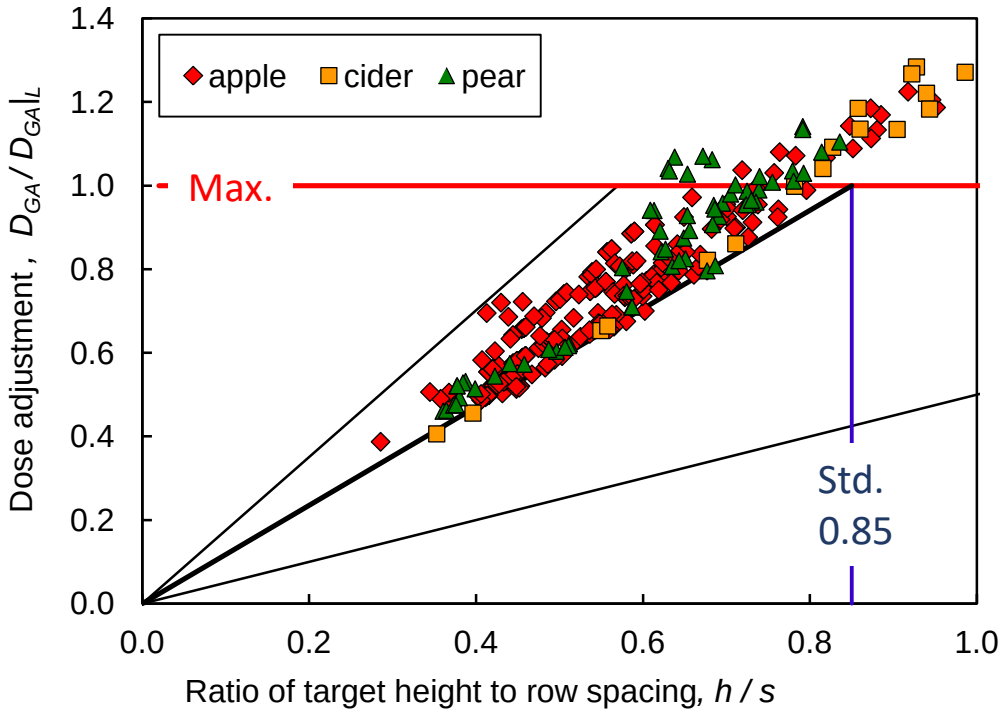
Scab fungicides

pre-blossom



PACE ➡ LWA

full-leaf



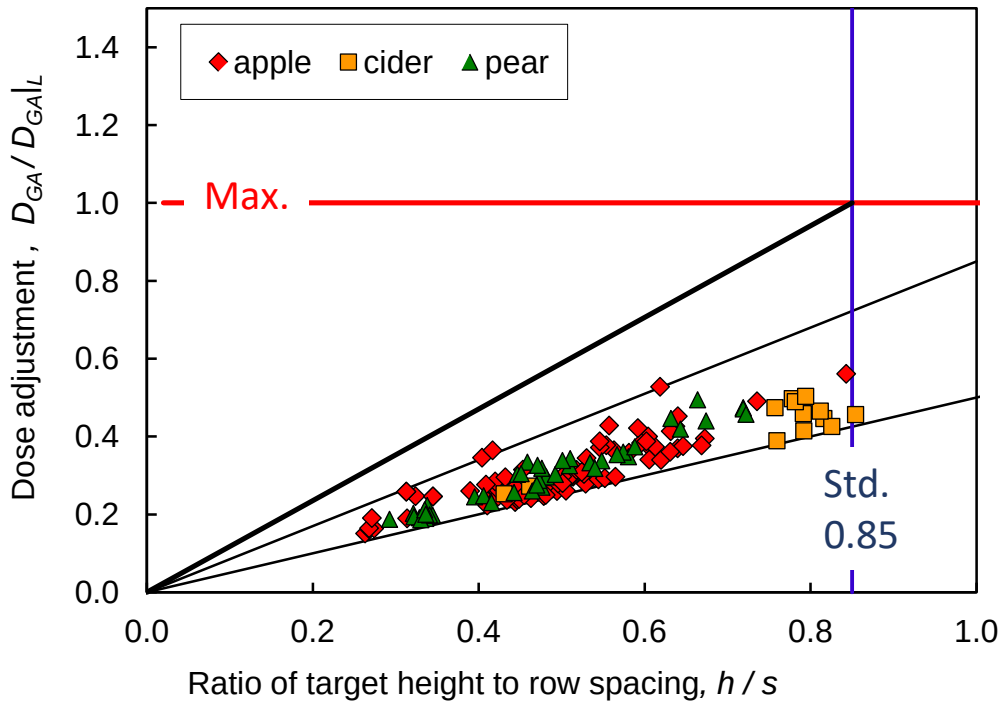
PACE ➡ LWA

LiDAR-PACE dose adjustment model: UK orchards

"All other products"

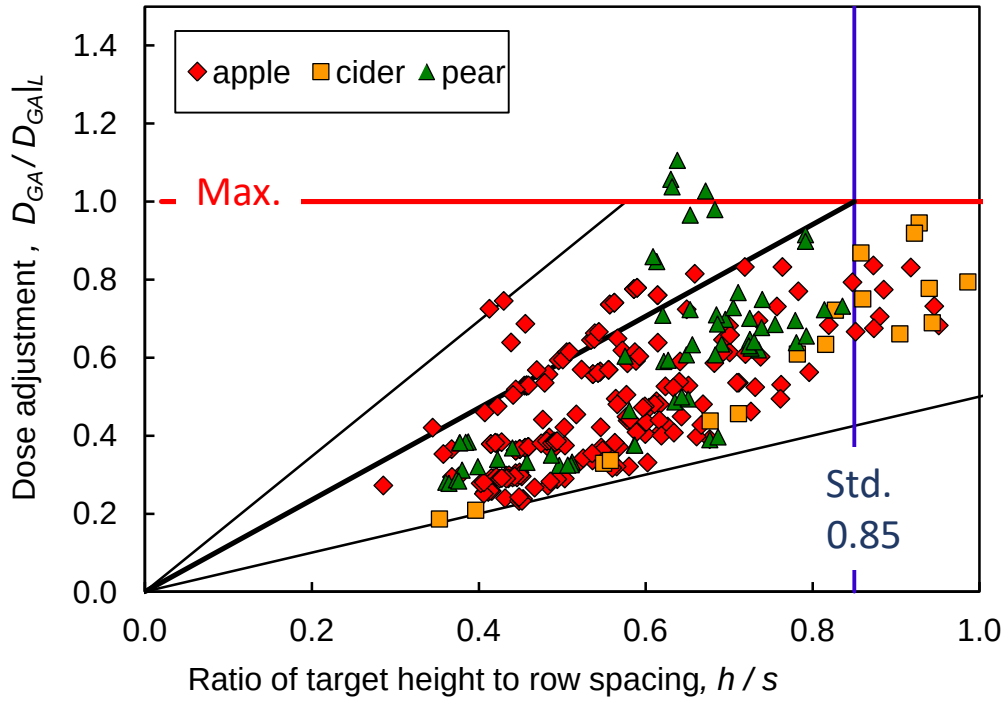
(These exclude scab fungicides & products with pre-blossom dose)

pre-blossom



PACE ➡ LWA

full-leaf



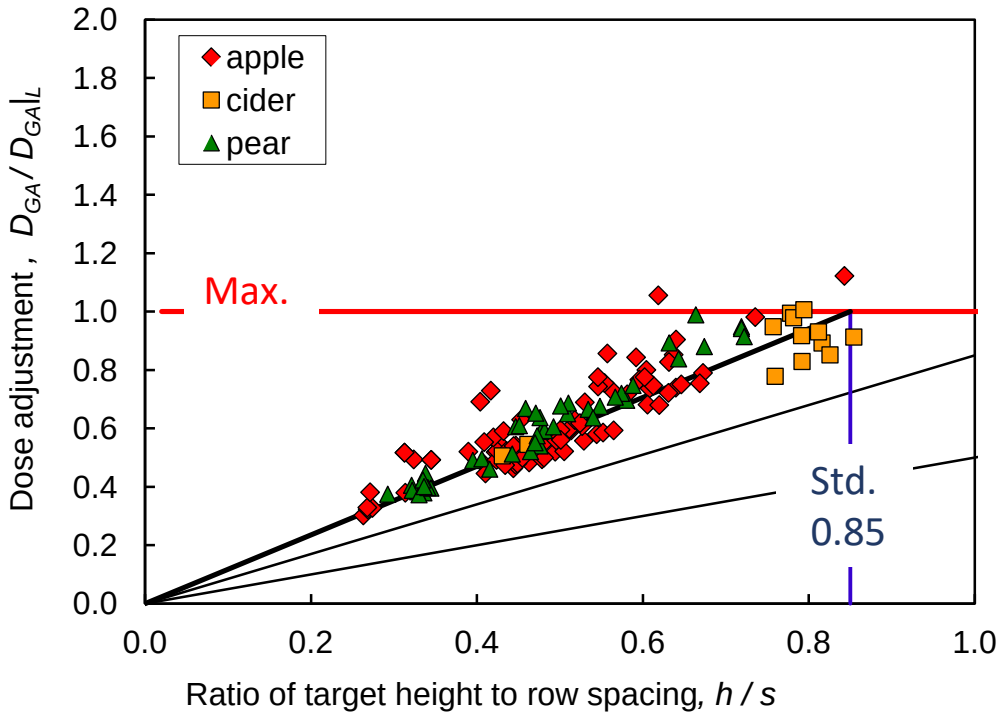
PACE > LWA

LiDAR-PACE dose adjustment model: UK orchards

"All other products"

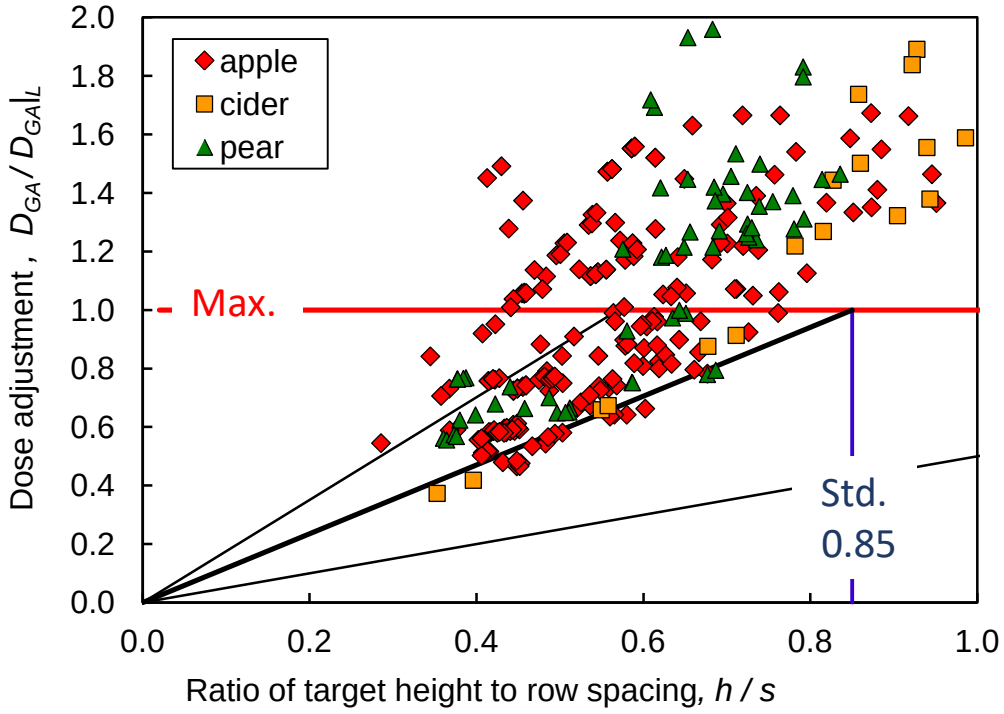
Scenario test product re registered (max. label dose is reduced by a factor of 2)

pre-blossom



PACE ➡ LWA

full-leaf



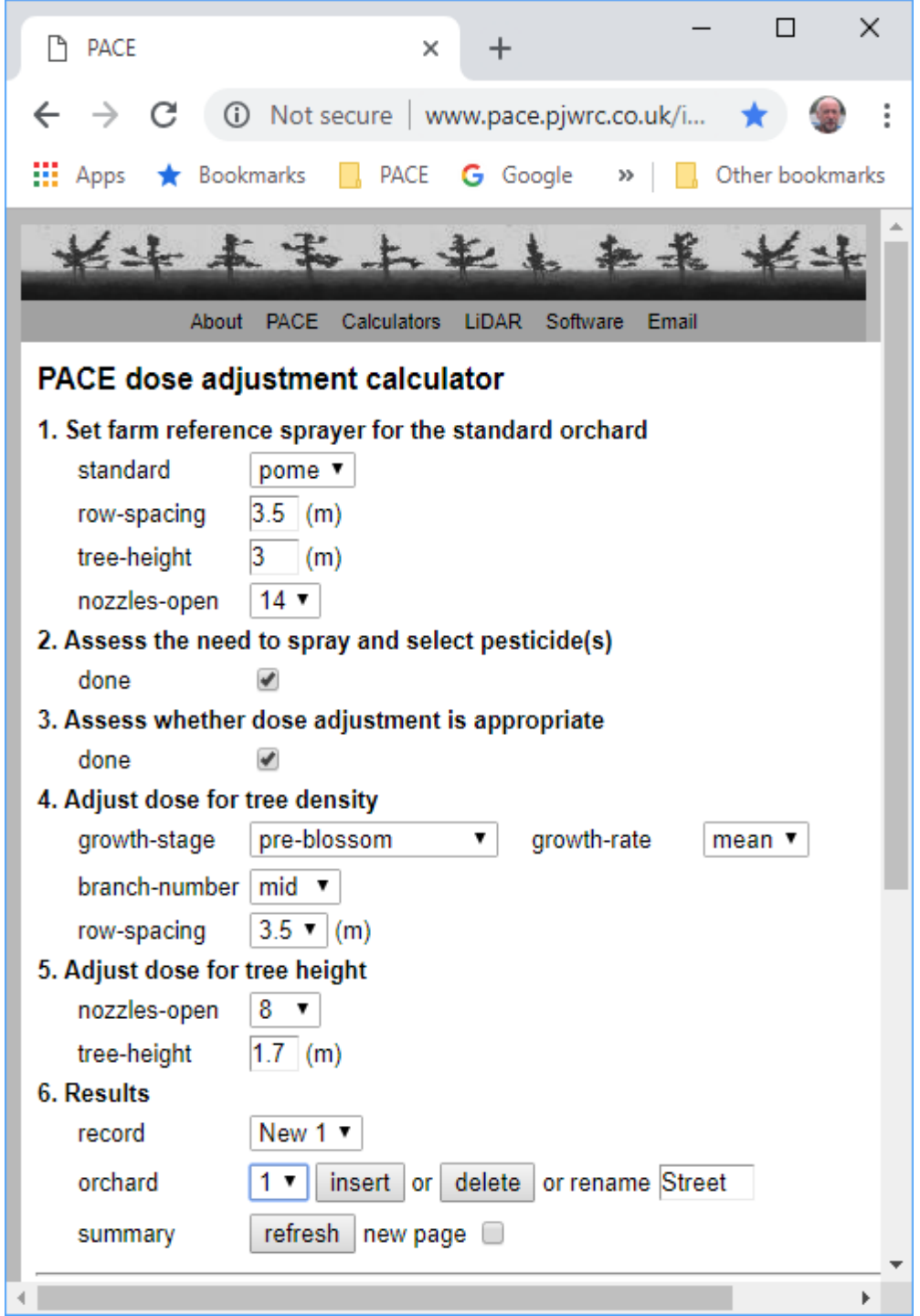
PACE > LWA

PACE Dose Adjustment Calculator

Dose adjustment calculator

1. Set reference sprayer (one off process)

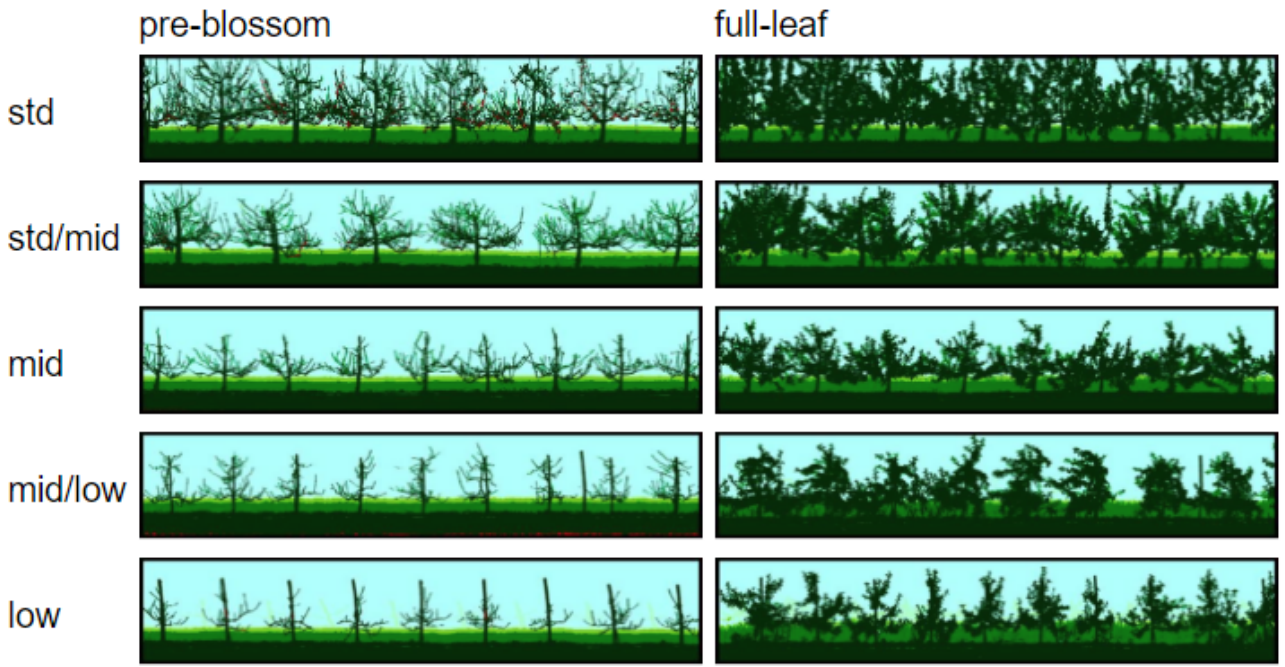
- Select the number of open nozzles for spraying the standard/ref orchard with a fully calibrated sprayer
  - Nozzles-open = 14

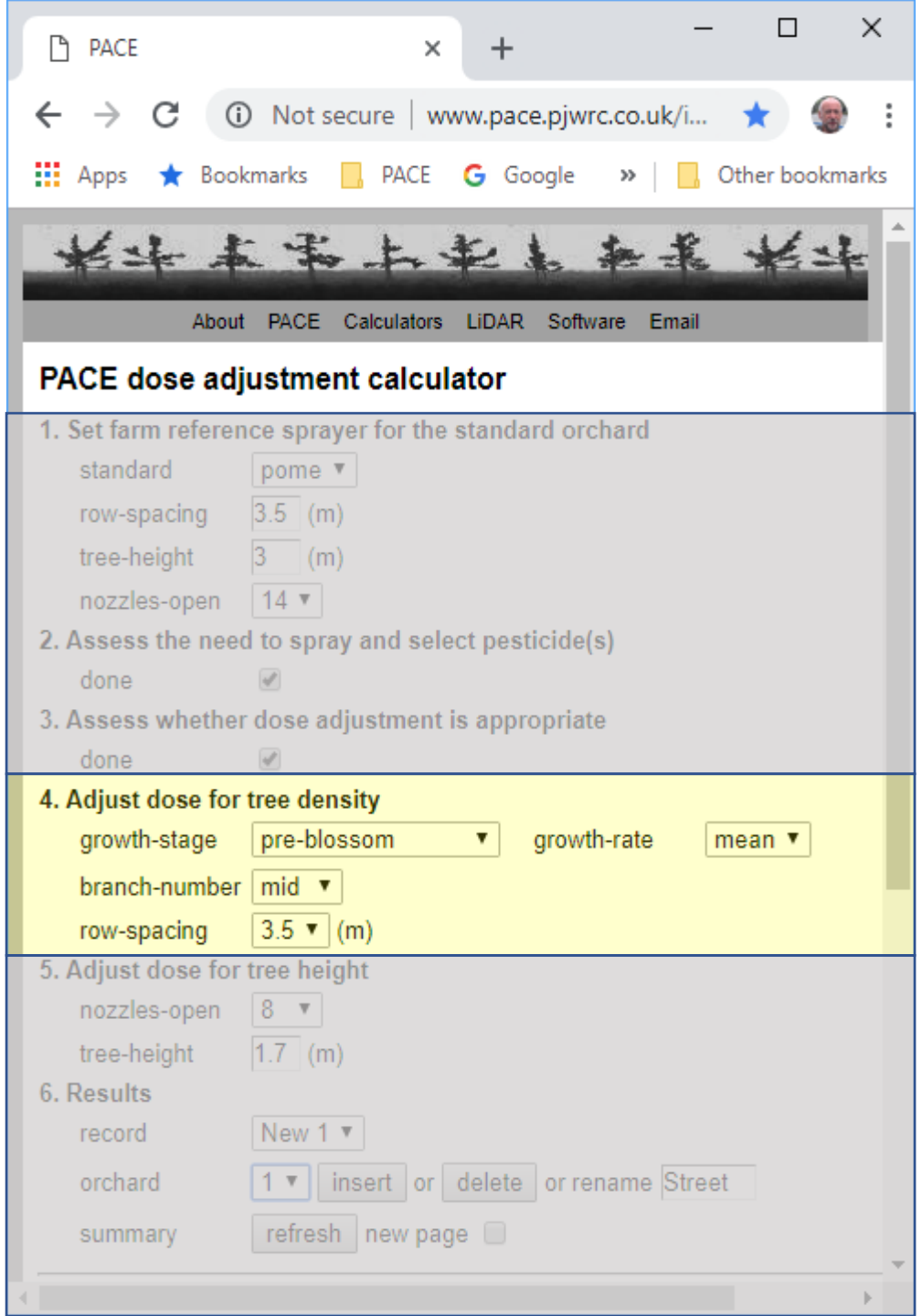


Dose adjustment calculator

4. Adjust dose for tree density

- Select growth-stage
- Select growth-rate model for predictive use
- Select branch-number (see chart below)
- Select row-spacing

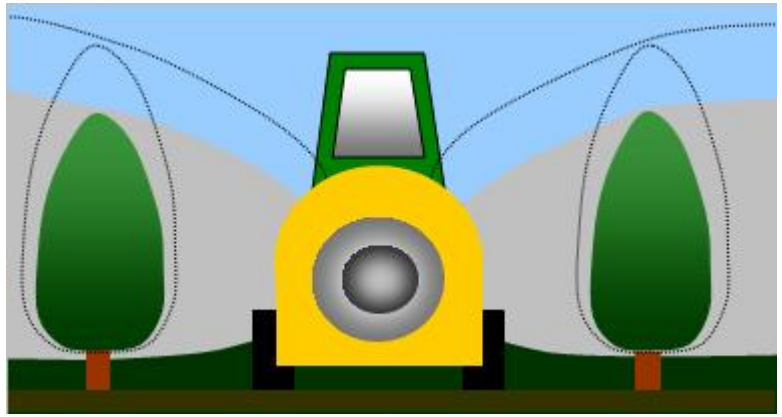


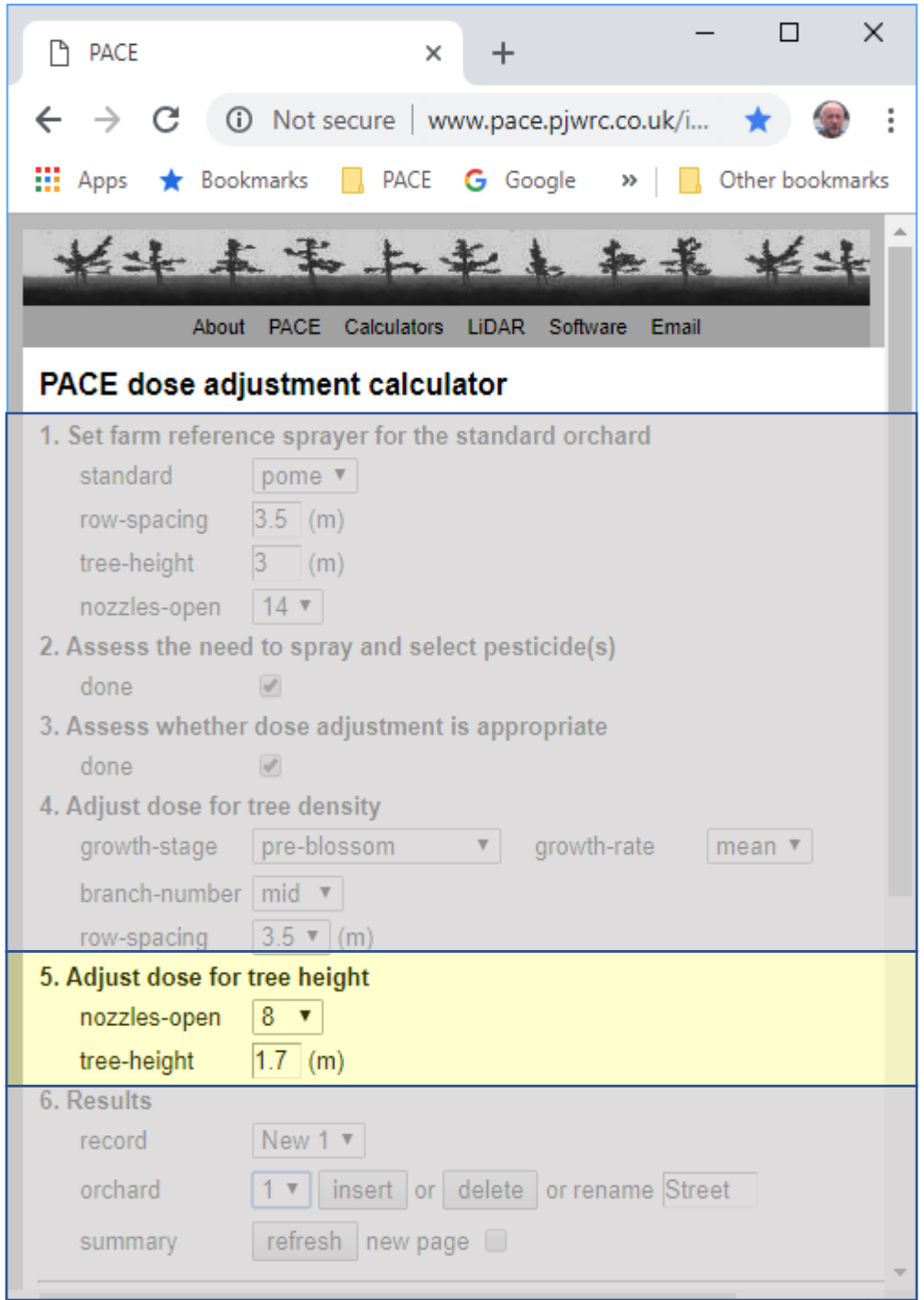


Dose adjustment calculator

5. Adjust dose for tree height

- Select number of open nozzles
  - appropriate for target tree height





Dose adjustment calculator

6. Results: Example with post-blossom predictions

pre-blossom assessment

post-blossom-early prediction or reassessment

full-leaf prediction or reassessment

PACE results summary record: New 4(10/10/2018)

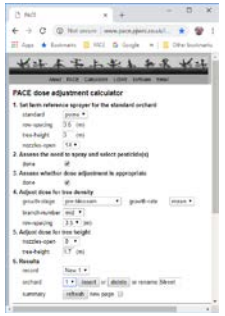
Trees of 3 (m) height are sprayed with 14 nozzles open

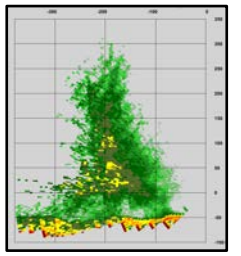
inputs									outputs	
growth-stage: pre-blossom										
id.	orchard	fruit	product	rate	branc	row-s	noz-o	tre-h	dose %	under %
1	Street	pome	pb dose	mean	mid	3.5	8	1.7	57	
2	Clover ley	pome	pb dose	mean	high	4.0	18	3.8	100	12*
1	Street	pome	scab f	mean	mid	3.5	8	1.7	57	
2	Clover ley	pome	scab f	mean	high	4.0	18	3.8	100	12*
1	Street	pome	others	mean	mid	3.5	8	1.7	32	
2	Clover ley	pome	others	mean	high	4.0	18	3.8	88	
growth-stage: post-blossom early										
id.	orchard	fruit	product	rate	branc	row-s	noz-o	tre-h	dose %	under %
1	Street	pome	scab f	mean	mid	3.5	8	1.7	57	
2	Clover ley	pome	scab f	mean	high	4.0	18	3.8	100	15*
1	Street	pome	others	mean	mid	3.5	8	1.7	37	
2	Clover ley	pome	others	mean	high	4.0	18	3.8	100	15*
growth-stage: full-leaf										
id.	orchard	fruit	product	rate	branc	row-s	noz-o	tre-h	dose %	under %
1	Street	pome	scab f	mean	mid	3.5	8	1.7	57	
2	Clover ley	pome	scab f	mean	high	4.0	18	3.8	100	43*
1	Street	pome	others	mean	mid	3.5	8	1.7	42	
2	Clover ley	pome	others	mean	high	4.0	18	3.8	100	43*
* Efficacy may be reduced.										

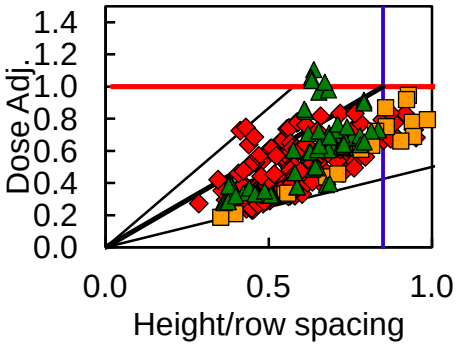
N.B. Further pruning may be required "Clover ley" orchard branch density set "high" gives significant under-dose at "full-leaf" with full label dose

Summary

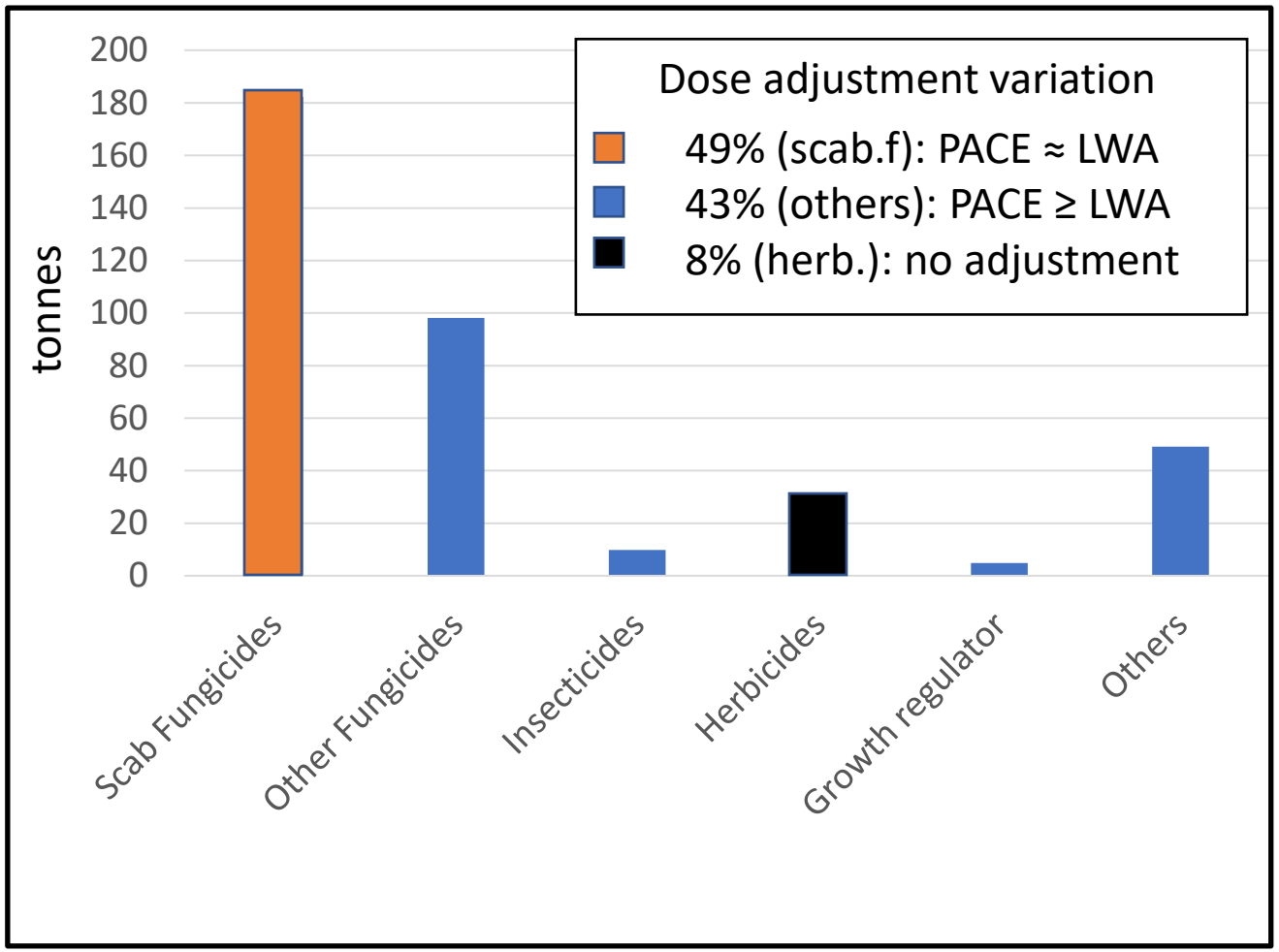
- I've described PACE developments
  - HDC leaflet
  - A more comprehensive approach
    - web-page supported system
- I've shown how LiDAR measurements can be used
  - To improve PACE
  - To quickly record & process orchard structure
  - To examine dose adjustment rules for different pesticides
  - To manage crop density
- Related research is still funded at EMR
  - For precision orchard spraying developments
- PACE funding from UK Regulators ended at EMR in 2013
  - The following issues are key







Issue 1: UK pesticide usage for orchard spraying

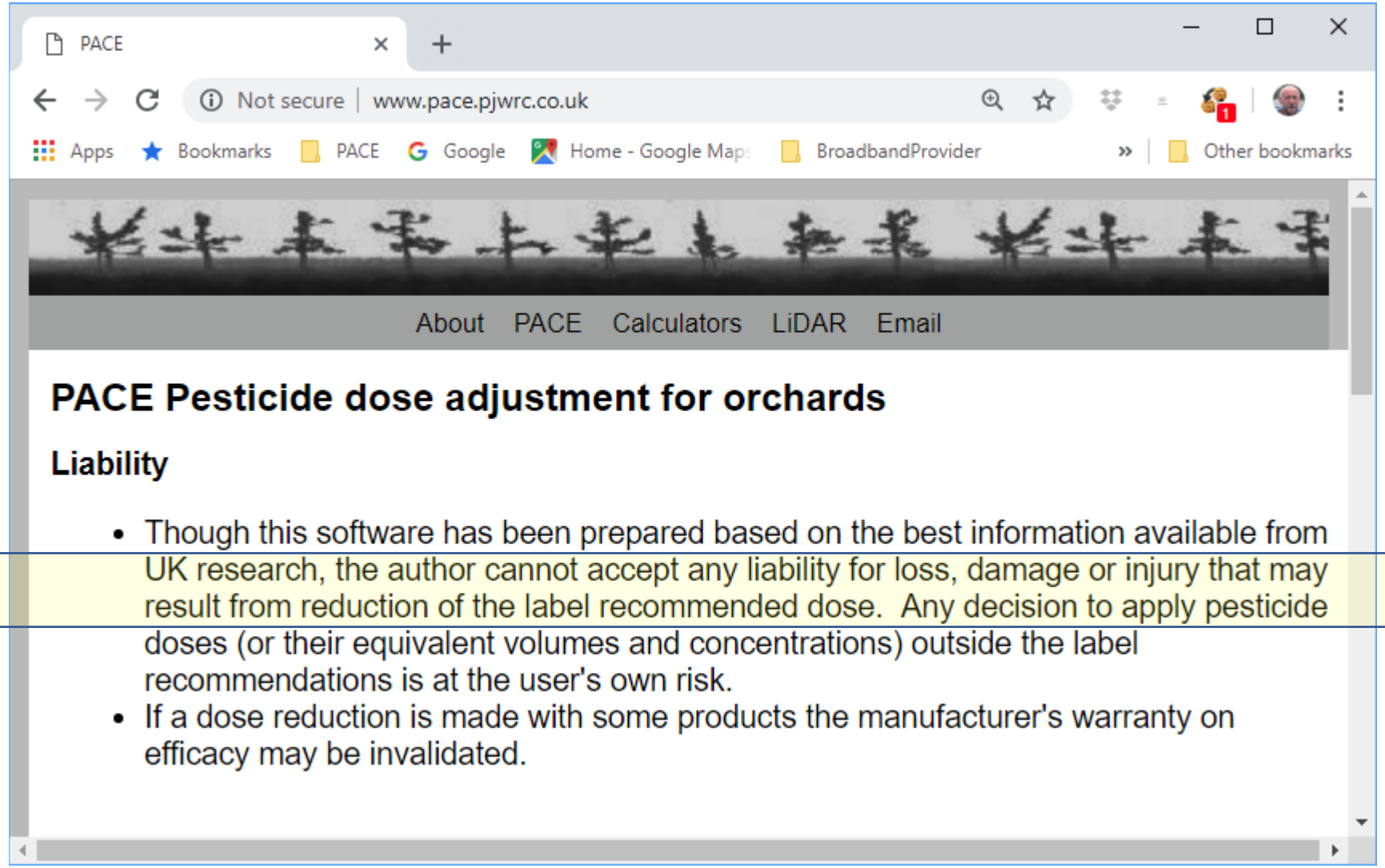


Fruit types

- 45% dessert & culinary apples
- 38% cider apples
- 8% pears
- 9% plums, cherries & nuts

Data source:
Pesticide usage survey report 273
Orchards in the UK 2016
FERA

Issue 2: Liability



The End
Many thanks for your attention

Key Publications: Early PACE developments

- Origin of spray deposit measurements
  - *Cross et al., Crop Protection (2001) 20: 13-30*
  - *Cross et al., Crop Protection (2001) 20: 333-343*
  - *Cross et al., Crop Protection (2003) 22: 381-394*
- Spray deposit modelling based LiDAR crop structure measurements
  - *Walklate et al., Biosystems Engineering (2002) 82 (3): 253-267*
  - *Walklate et al., Annals of Applied Biology (2003) 143: 11-23*
  - *Walklate P J & Cross J V. 2005. Horticultural Development Council Published Factsheet 20/05.*
  - *Walklate et al., Crop Protection (2006) 25: 1080-1086*

Key Publications: Additional PACE developments

- *Walklate P J, Cross J V, Pergher G. 2011. Support system for efficient dosage of orchard and vineyard spraying products. Computers and Electronics in Agriculture 75: 355-362.*
- *Walklate P J, Cross J V. 2012. An examination of Leaf-Wall-Area dose expression. Crop Protection 35: 132-134.*
- *Walklate P J, Cross J V. 2013. Regulated dose adjustment of commercial orchard spraying products. Crop Protection 54: 65-73.*
- *Walklate P J. 2013. Internet portal for links to all versions of the PACE dose adjustment calculator and associated web pages. http://www.pace.pjwrc.co.uk*
- *Cross J V, Walklate P J. 2015. PACE into fruit tree spraying practice. SuproFruit. Lindau.*