IPM in blackcurrant production

Jerry Cross, Adrian Harris, Michelle Fountain, NIAB EMR
David Hall, NRI

Plant Science into Practice

Integrated Pest Management (IPM)[1]

A definition[2]

IPM is a decision-based process involving coordinated use of multiple tactics (natural, genetic, cultural, biological, biotechnological methods etc) for optimising control of all classes of pests (insects, diseases, weeds etc) in an ecologically and economically sound manner

IPM is a vital cornerstone of sustainable food production

[1]Michelbacher & Bacon. 1952; [2]Compendium of IPM Definitions www.ipmnet.org/ipmdefinitions

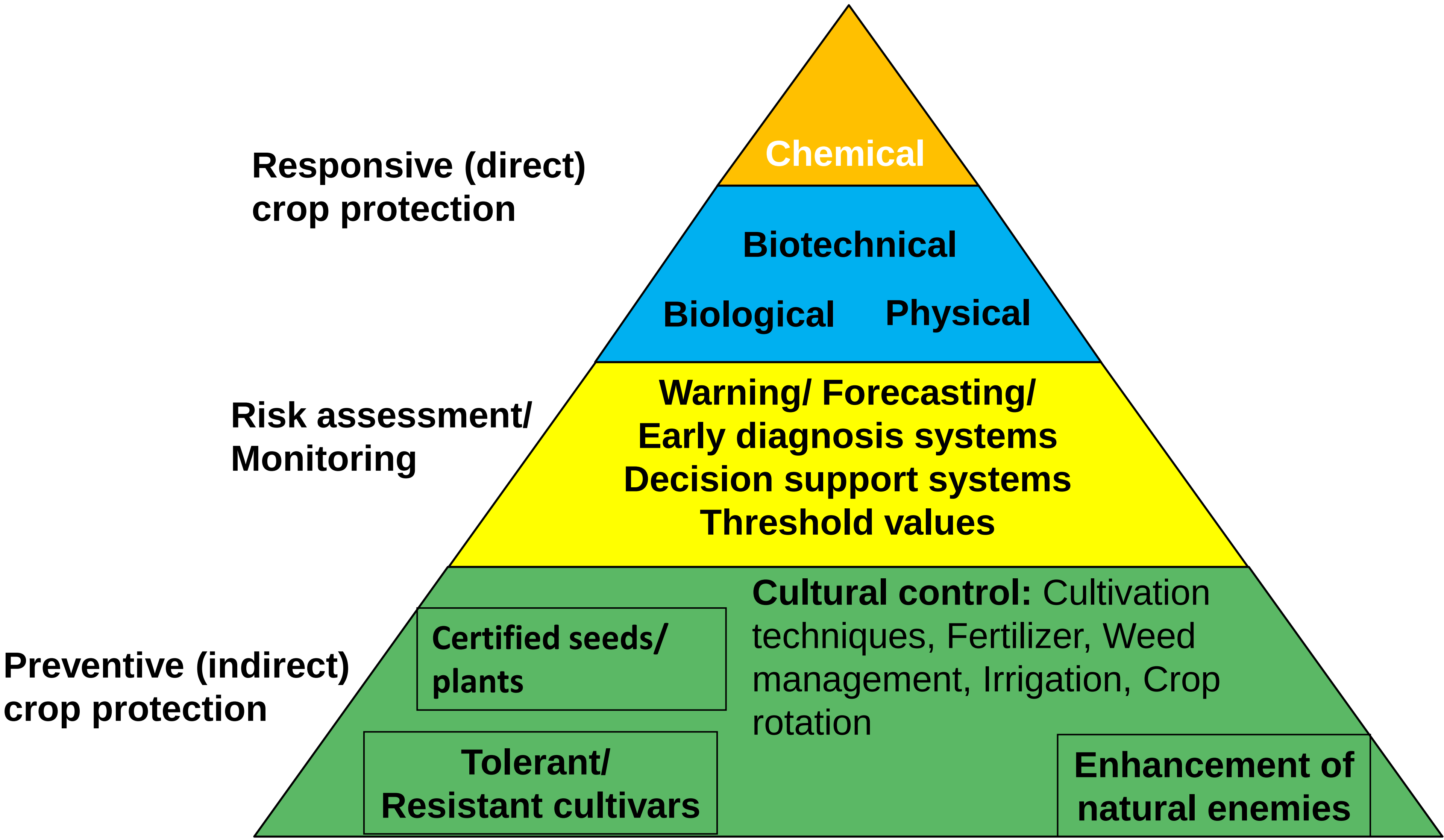
Definition of IPM in the Sustainable Use of Pesticide Directive (SUD)

«Integrated Pest Management» means careful consideration of all available plant protection methods and integration of appropriate measures that discourage the development of populations of harmful organisms and keep the use of plant protection products and other forms of intervention to levels that are economically and ecologically justified and minimise the risks to human health and the environment.

IPM emphasises the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms.

(EU Directive 2009/128/EC: Chapter 1, Art. 3, parag. 6)

The visualised IPM concept



Meissle et al. 2011.Pest Manag. Science,67

Key aspects of IPM

Decision-based process

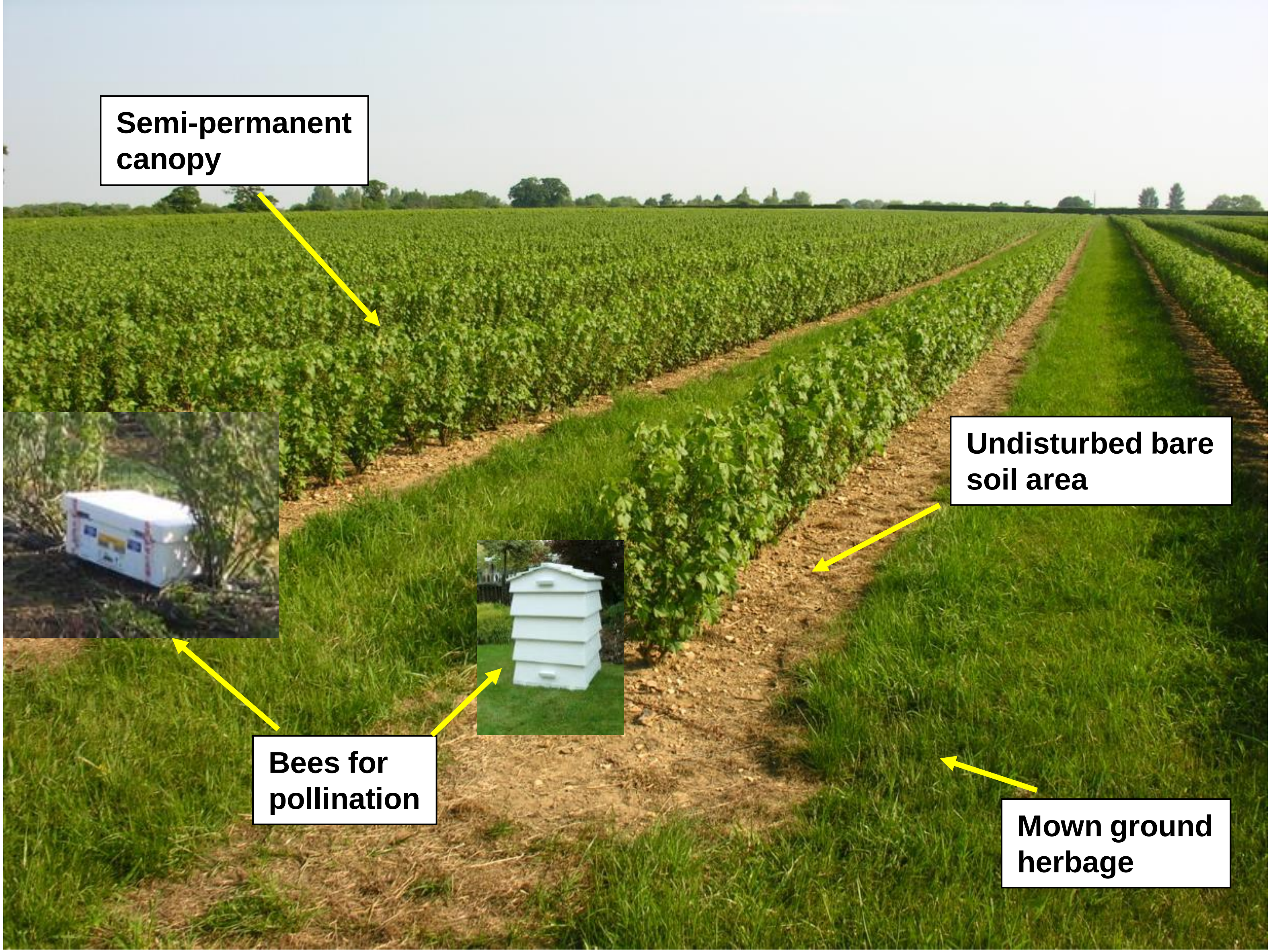
- **Monitoring of pest and antagonist populations and/or risks**
- **Economic, treatment or risk thresholds**

Multiple, compatible suppressive tactics

- **Priority given to natural, genetic, cultural, biological, biotechnological control methods**
- **Integrated, minimum use of safest selective pesticides**
- **Broad-spectrum, toxic/harmful, persistent pesticides avoided**

Ecologically and economically sound

Perennial fruit crops provide stable ecological habitats



Reliance on pesticide sprays in UK blackcurrant production

- ~7- 8 spray rounds in UK
- Frequent tank mixing
- ~6-7 fungicides/annum
- ~1-2 insecticides/annum
- Broadcast air assisted sprayers

The blackcurrant pest complex

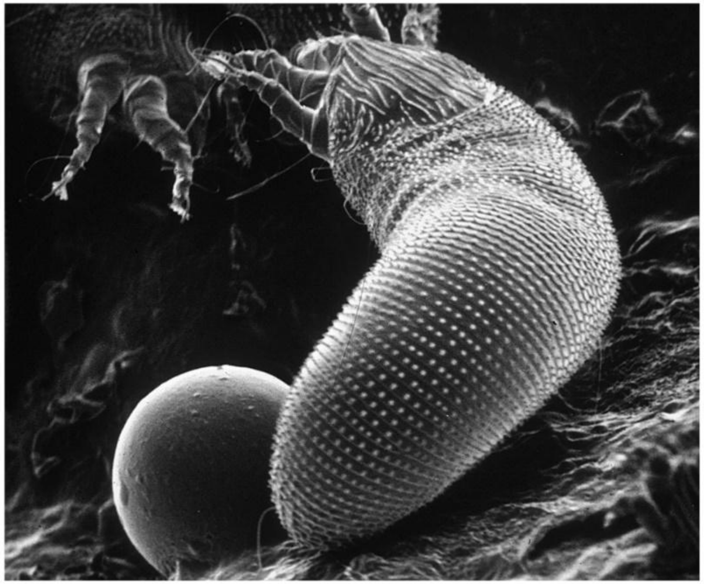
Communities of natural enemies

Resident generalist predators

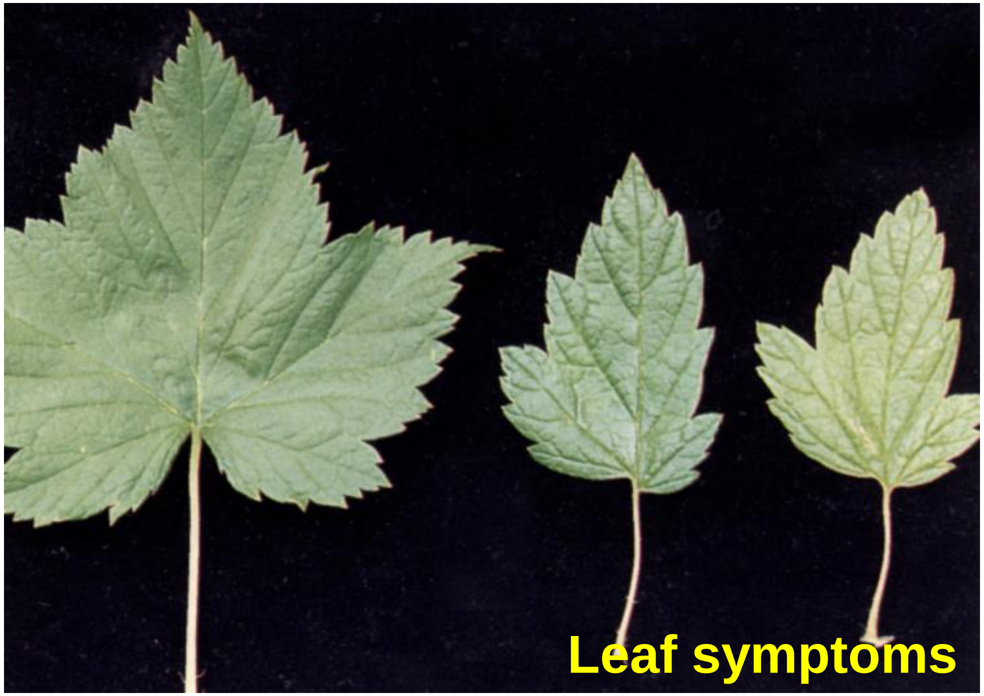
Highly mobile specialist predators

Species specific parasitoids

Blackcurrant gall mite

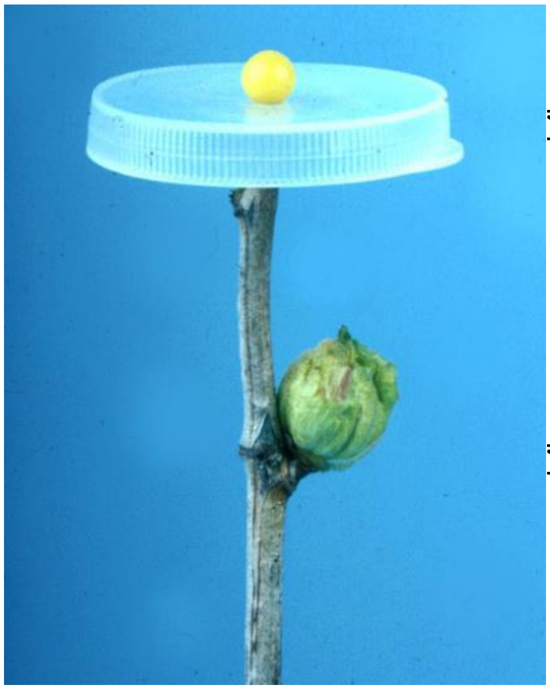


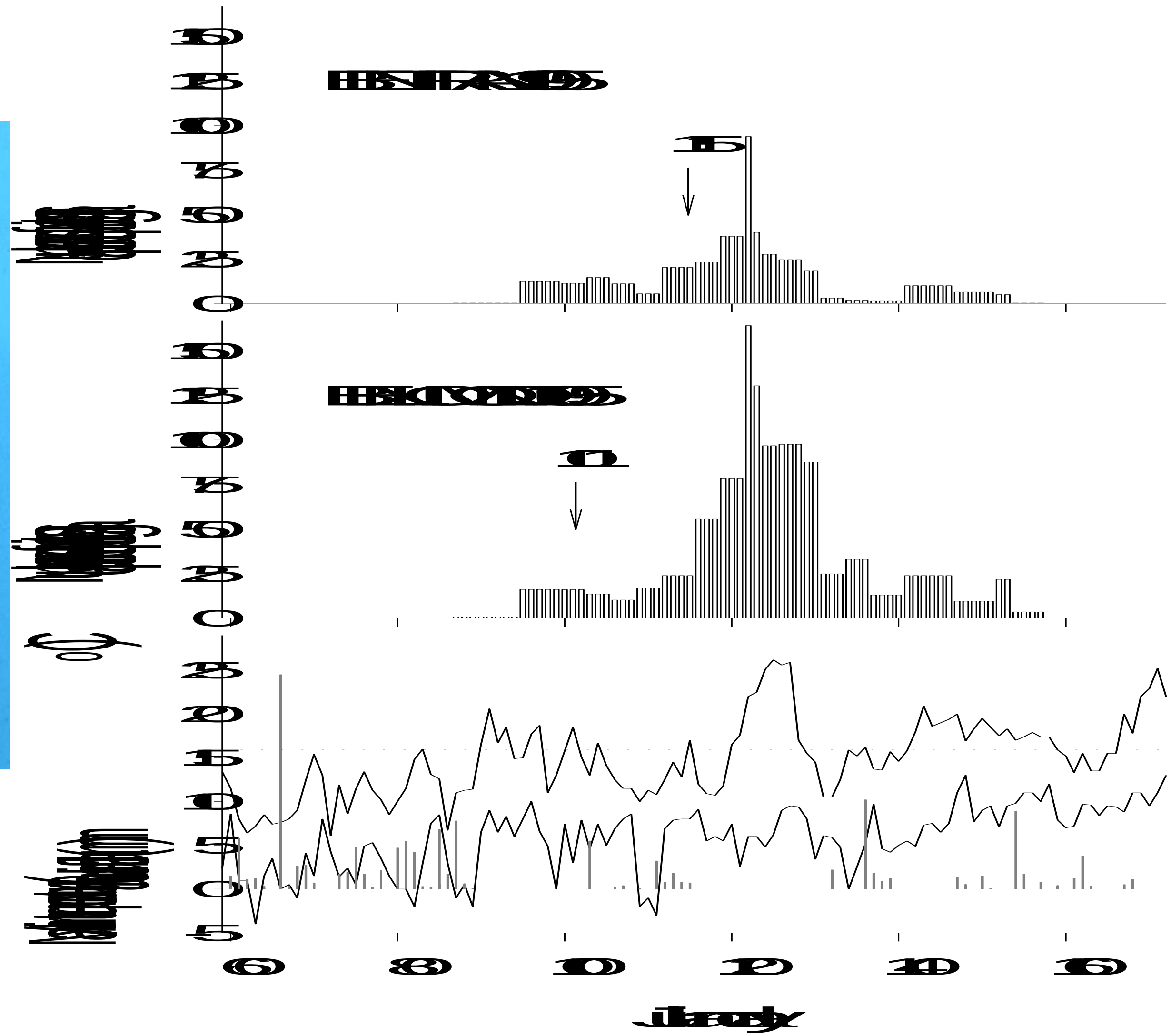
Reversion virus



- Causes sterility. Main limiting factor in life of blackcurrant plantations
- Finland , Lataval et al 1998 First mite transmitted nepovirus
- Transmission in 3 hr , but up to 5 years for bush to be fully reverted
- No vertical transmission
- Reverted bushes more susceptible to mite

Emergence monitoring



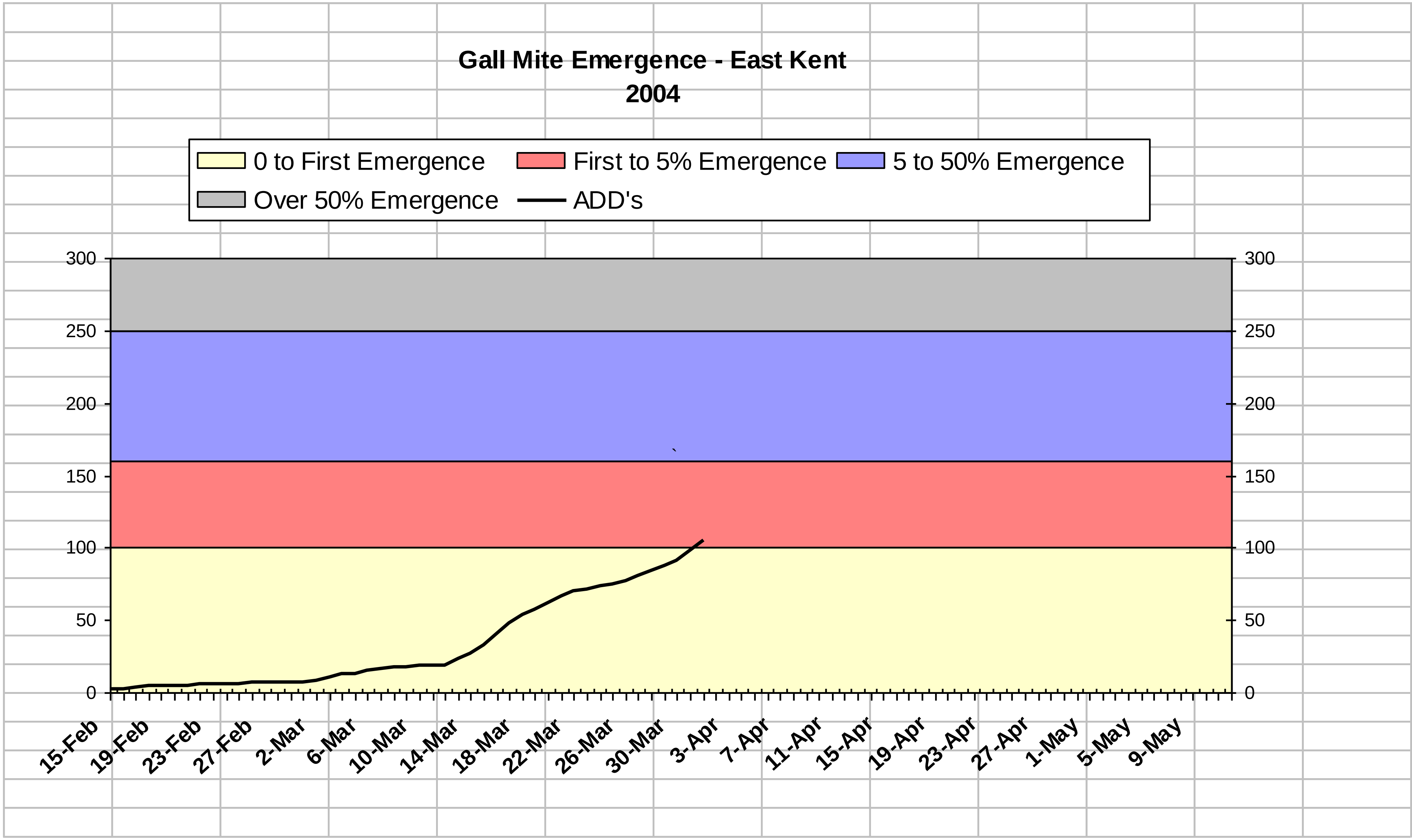


Day degree prediction of gall mite emergence

		Day ° > 4 °	Error (days)
Lomond	first	123	2.8
	5%	198	1.8
	50%	308	8.5
Tirran	first	121	3.3
	5%	200	0.8
	50%	323	5.8

Day degrees are accumulated from 15 February (Julian day 46)

Forecasting model



Gall mite migration

- Start of migration varies greatly from year to year
  17 March (76) -22 April (112)
- Not related to crop growth stage
- Preceded by gall swelling, terminated by senescence
- Delayed/interrupted by rainfall
- Start best predicted by day-degrees > 4 ^{o}C from 15 Feb
- Or first sunny day max temp > 16 ^{o}C after 1 March
- Lasts up to 80 days
- Strong diurnal rhythm
- Growth stage spray timing not the best approach

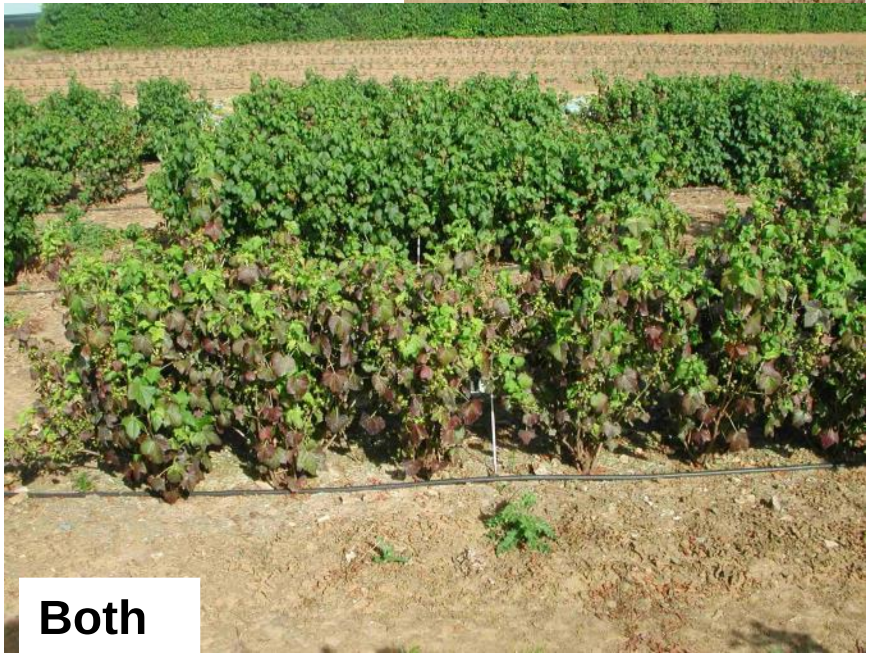
Gall mite acaricide trials in 90s and 00s

- A spray of sulphur at start of migration gives virtually complete control for 3-4 days, >95% control for >20 days
- Mites emerge from gall and fall from the stem walking over deposit
- No mortality of mites within galls
- Good spray cover is very important
- 2 sulphurs >1 sulphur+1 Masai >1 sulphur >>3 fenpropathrin >0
- Danger of sulphur phytotoxicity, especially after 1st grape visible, and especially in hot weather – variety dependent
- Different sulphur spray progs for different varieties
- Alternative acaricide needed to supplement early sulphur
  - spirotetramat promising (will only be able to use it post blossom): - Approval expected 2019

Ben Gairn

1st grape visible

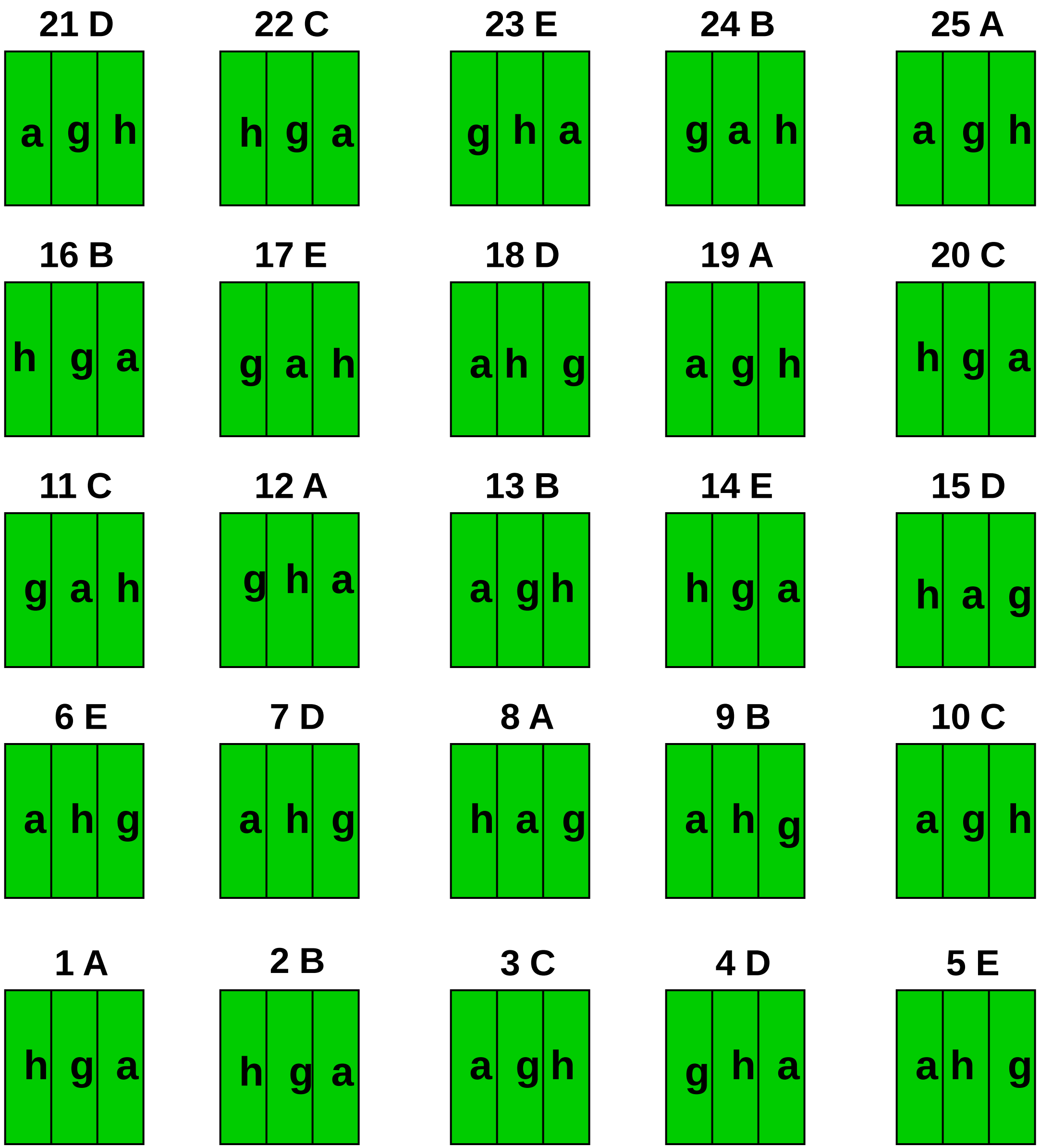
End of flower



Both

None

Blackcurrant IPM experiment at HRI-East Malling



Planted 1999

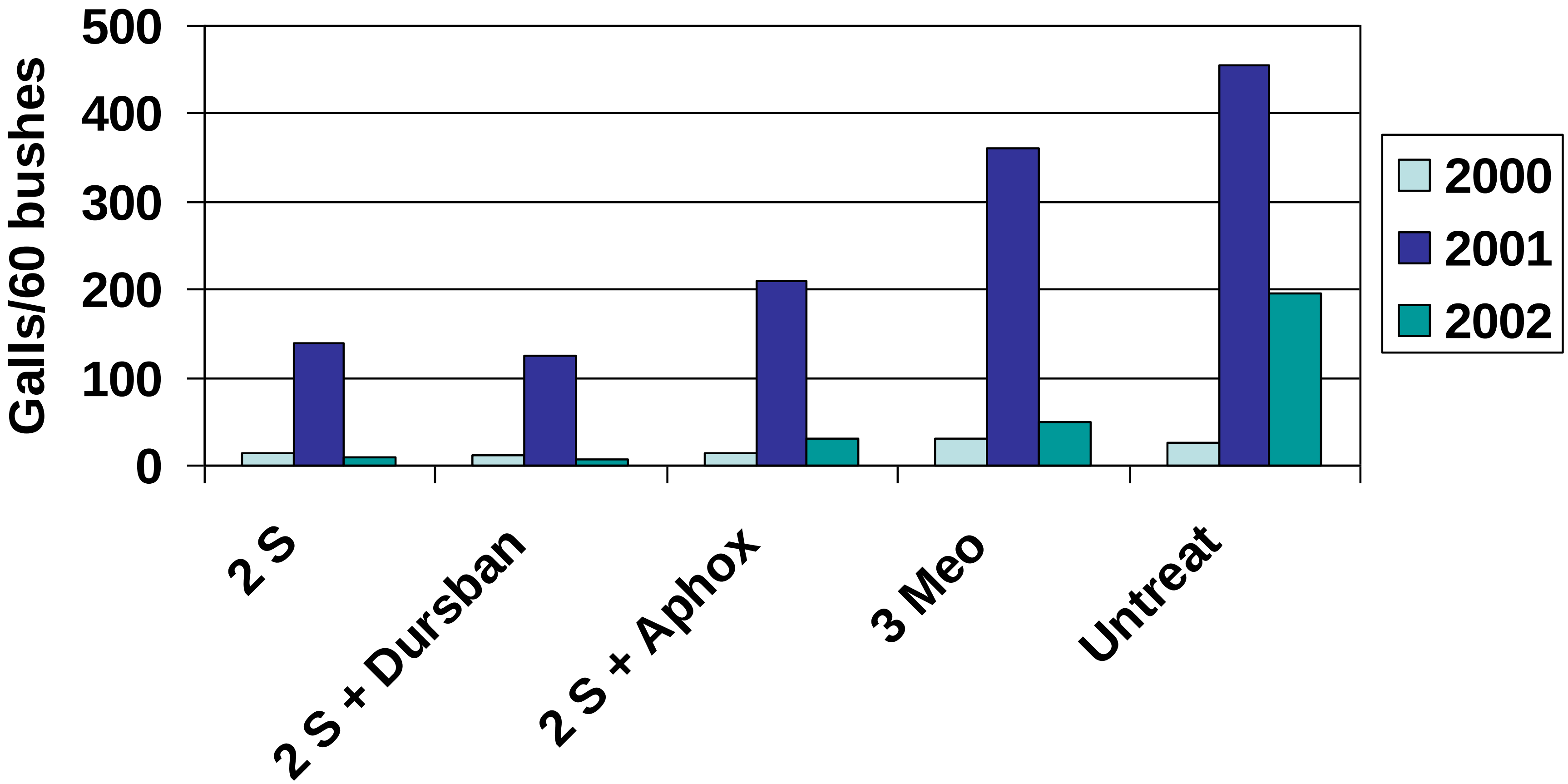
Varieties
a=Ben Alder
g=Ben Gairn
h=Ben Hope

Treatments 2000-02
A = 2 sulphur
B = 2 sulphur + Dursban
C = 2 sulphur + Aphox
D = 3 Meothrin
E = untreated

Treatments 2003-04
A = 1 sulphur
B = 2 sulphur
C = 1 sulphur, 1 Masai
D = 3 Meothrin
E = untreated

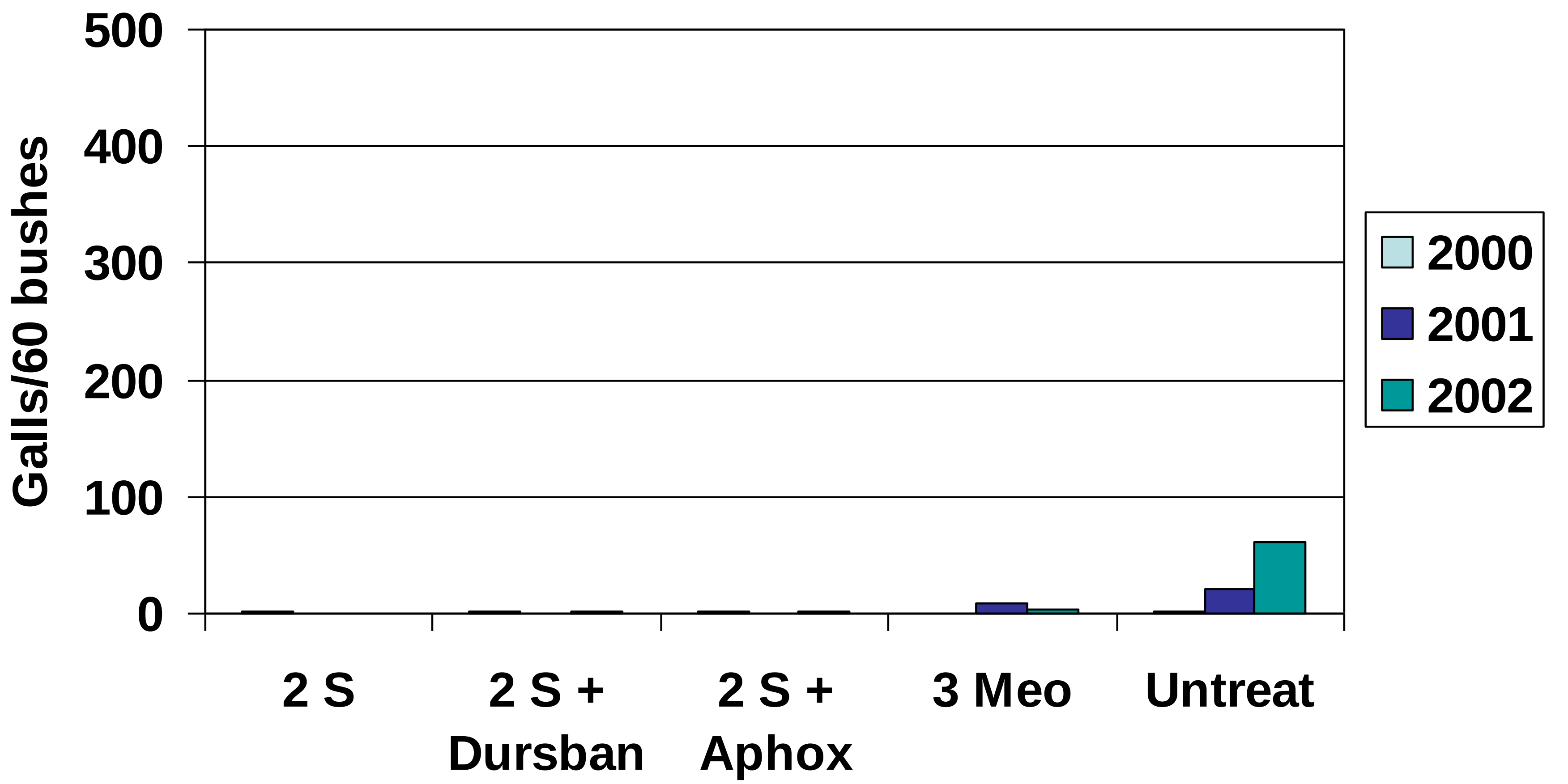
← N

Ben Alder



Galls/60 bushes
500
400
300
200
100
0
2 S
2 S + Dursban
2 S + Aphox
3 Meo
Untreat
2000
2001
2002

Ben Gairn


Galls/60 bushes
500
400
300
200
100
0
2 S
2 S + Dursban
2 S + Aphox
3 Meo
Untreat
2000
2001
2002

IPM experiment 2000-2002 Conclusions

- Relative susceptibility of varieties to gall mite

Alder : Gairn : Hope = 45 : 5.6 : 1

- Combined plant resistance with 2 early sulphurs gave high degree of gall mite control over first 3 years

Gairn = 99.5% control, Hope = 99.85% control

- Varietal resistance needs to be protected by acaricides
- Some evidence that Hope resistance is being overcome by resistance breaking strains – but Gairn remains robust
- New JHI varieties vary in their susceptibility to gall mite and reversion

IPM components – gall mite & reversion

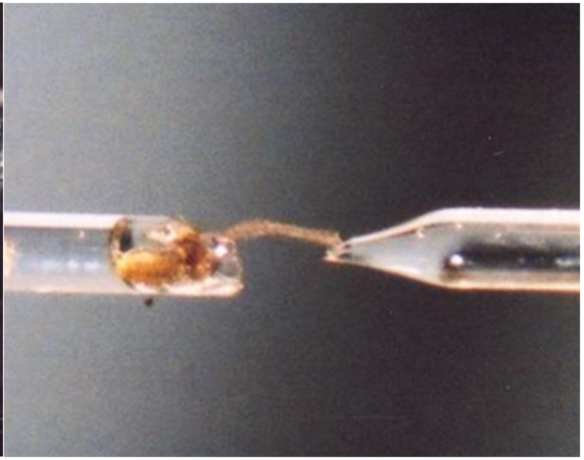
IPM component	Activity	Score
Decisions		
Monitoring	**Galls, reversion symptoms**	***
Thresholds	**Presence**	***
Tactics		
Resistant cvs	**Some**	**
Cultural controls	**Rogueing, isolation**	***
Biocontrol	**Predatory mites, EPFs**	
Selective pesticides	**Sulphur**	**
Broad spectrums avoided	**Thiodan, Meothrin gone**	***
Overall	**Multiple tactics**	***

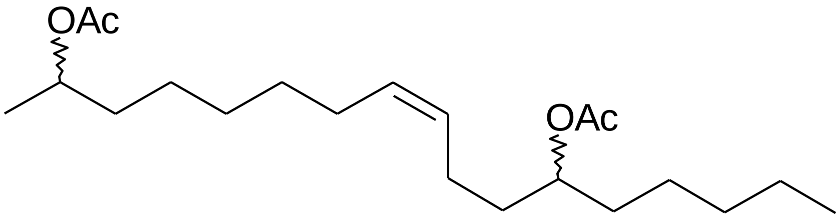
Need more gall mite and reversion resistant cvs

Need non-phytotoxic, selective acaricide for mite control after grape visible

Blackcurrant leaf midge

Blackcurrant leaf midge sex pheromone 2008

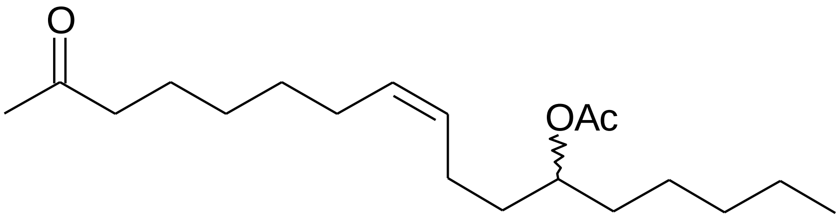




Major component

Di-acetate

4 stereo isomers



Minor component

Keto-acetate

2 stereo isomers

2 pg/female




A catch 10 midges per trap per week set as a nominal threshold for timing sprays

Crop damage

- Shoot growth stunted by 30-50%
- Shoots at base of bush attacked first
- Cut down crops seriously affected
- Unsightly, but no effect on yield in 8 established commercial crops over 3 years

Important leaf midge natural enemies

Anthocoris nemorum *Anthocoris nemoralis*

- **Natural enemies greatly reduced by broad-spectrum pesticides**
- **Make midge worse in long run**

Leaf midge insecticide trials in the 00s

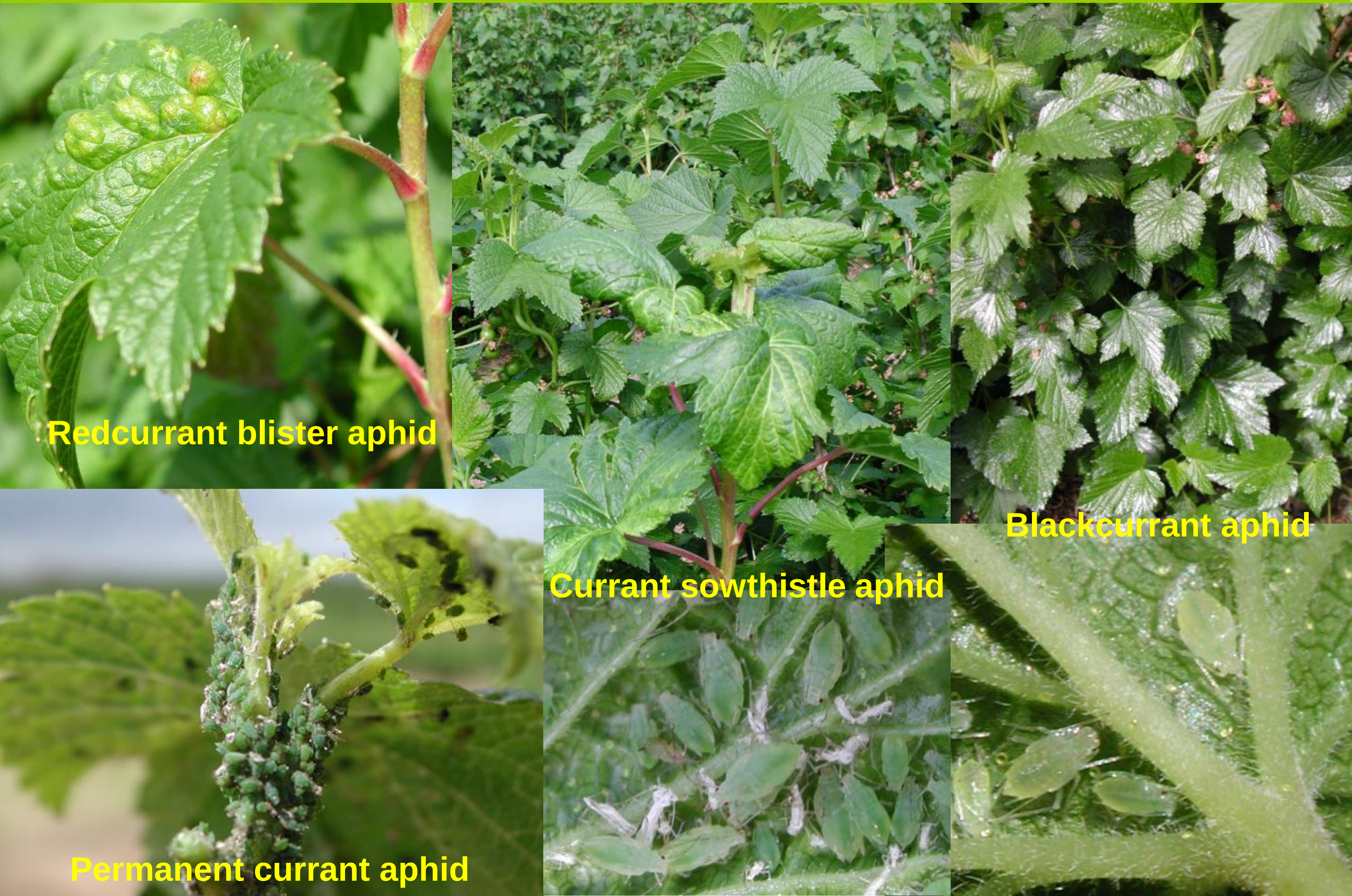
- Control of 1st generation reduces subsequent generations
- SPs variable in efficacy. Hallmark moderately effective
- Chlorpyrifos, Calypso only partially effective
- Broad spectrum SPs, OPs harmful to natural enemies
- Pheromone traps aid spray timing
- Spirotetramat controls larvae in galls and is selective

IPM components – leaf midge

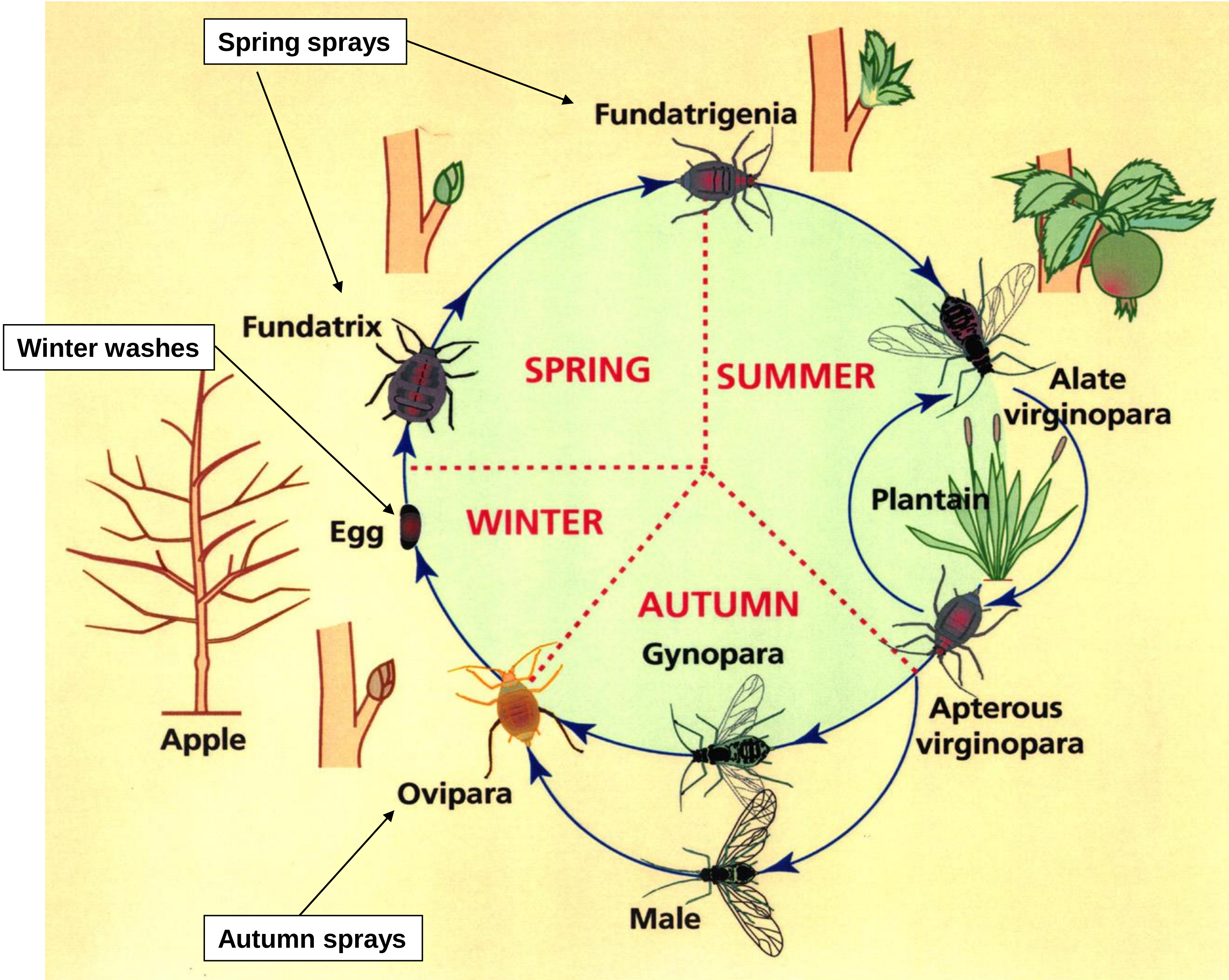
IPM component	Activity	Score
Decisions		
Monitoring	**Pheromone trap, galls**	***
Thresholds	**Nominal trap, crop damage**	***
Tactics		
Resistant cvs	**None**	
Cultural controls	**None (avoid flailing)**	
Biocontrol	**Anthocorids, *Platygaster***	*
Selective pesticides	**Spirotetramat in future**	**
Broad spectrums avoided	**Still using Hallmark**	
Overall	**Multiple tactics**	**

Is spraying for leaf midge reducing (e.g. with Hallmark) in established crops?
Natural enemies will increase
Approval of spirotetramat (Movento) awaited, use post blossom only

Aphid pests of blackcurrant



Aphid natural enemies


Spring sprays
Fundatrigenia
Fundatrix
Winter washes
SPRING
SUMMER
Alate virginopara
Plantain
Egg
WINTER
AUTUMN
Gynopara
Apterous virginopara
Apple
Ovipara
Male
Autumn sprays

Autumn spraying trials

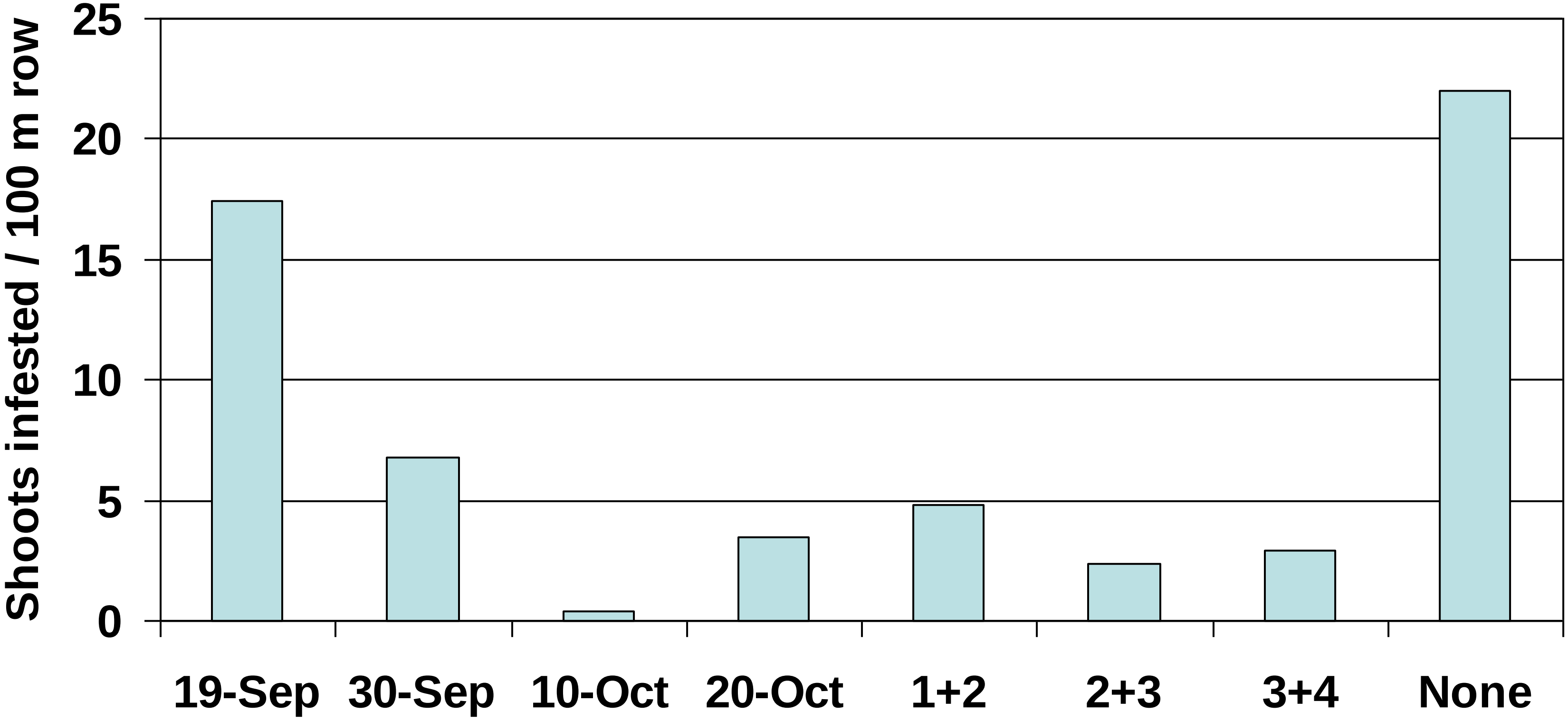
2003-04

Aphox (470 l/ha)
19 Sept
30 Sept
10 Oct
20 Oct
19 Sept + 30 Sept
30 Sept + 10 Oct
10 Oct + 20 Oct

2004-05

Product (540 l/ha)	Date
Aphox	30 Sept
Aphox	8 Oct
Calypso	30 Sept
Calypso	8 Oct
Plenum	30 Sept
Plenum	8 Oct
Untreated	-

Currant sowthistle aphid – 26 April 04



Autumn spraying trials - conclusions

- Efficacy of autumn control confirmed
- Single spray of aphicide in late Sept/early Oct gives good, though not complete, control of currant sowthistle aphid and blackcurrant aphid following spring
- Calypso best material, Plenum also highly effective, Aphox pretty good
- Sprays may still be needed in spring in bad years, especially on highly susceptible varieties like Gairn
- Reduced risk of residues and harmful effects on natural enemies

IPM components – aphids

IPM component	Activity	Score
Decisions		
Monitoring	Visual inspection	**
Thresholds	Understand damage threat	**
Tactics		
Resistant cvs	None	
Cultural controls	None	
Biocontrol	Generalist predators	**
Pesticide timing	Autumn spraying	***
Selective pesticides	Aphox lost, ~Calypso, Plenum	**
Broad spectrums avoided	Hallmark still used by some	
Overall	Multiple tactics	**

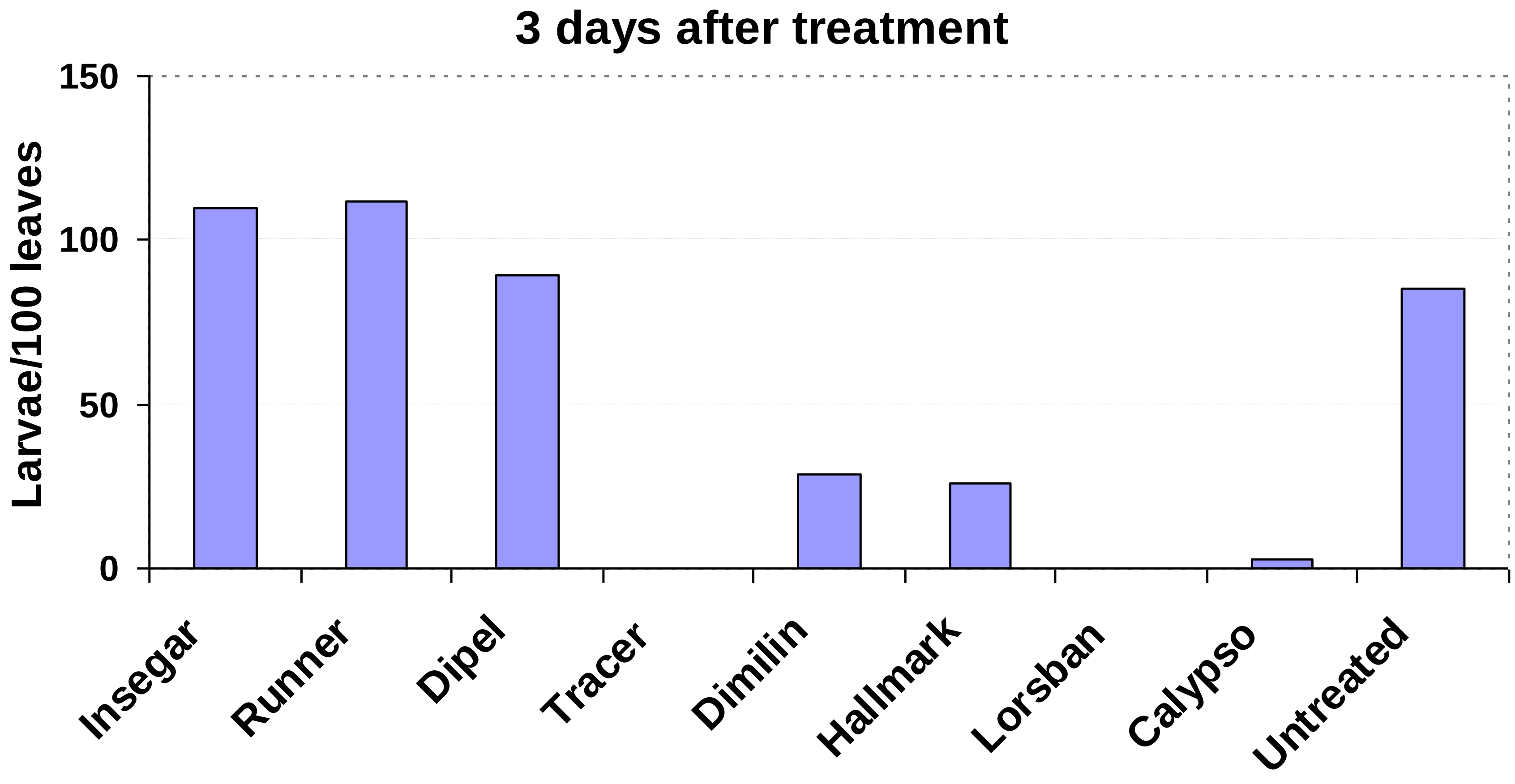
Blackcurrant sawfly (*Nematus olfaciens*)

Blackcurrant sawfly

- **Sporadic**
- **2 generations/annum**
- **1st May - June**
- **2nd July – August**
- **Eggs on undersides of leaves on veins**
- **? larvae**
- **Distributed in lower part of bush**
- **Rapid defoliation**
- **Contaminate harvested fruit**

Blackcurrant sawfly trial 2006

Hamrow farm, Whissonsett Ben Avon
Sprayed 9 June 2006 500 l/ha



Blackcurrant sawfly sex pheromone trap

Common European earwig

- Omnivorous
- Voracious nocturnal predator of many important pests – aphids, sawfly, woolly scale
- Is there large variation in earwig populations in blackcurrant as in apple?
- Bottle refuges to quantify populations
- Some pesticides are harmful to earwigs
  - Hallmark
  - Steward
  - Runner
  - Calypso
  - Tracer

IPM components – sawfly

IPM component	Activity	Score
Decisions		
Monitoring	Pheromone trap, pest, damage	***
Thresholds	Nominal	*
Tactics		
Resistant cvs	None	
Cultural controls	None	
Biocontrol/natural enemies	Earwigs	**
Selective pesticides	Tracer, Calypso	**
Broad spectrums avoided	Still using Hallmark	
Overall	Multiple tactics	**

Work on pheromone trap thresholds in progress

Spider mites

- Ben Gairn and Ben Vane only susceptible cvs
- Predatory mites not abundant on blackcurrant, but populations further reduced by pyrethroids
- Spider mite outbreaks occur rapidly on Gairn and Vane in hot weather
- Spray then required with selective acarcicide (e.g. tebufenpyrad (Masai)

Bronzed patches caused by two-spotted spider mite

Typh eating fruit tree red spider mite

Vine weevil

- Vine weevil rarely a problem with grassed alleys where predatory ground beetles abundant
- Ideal IPM solution

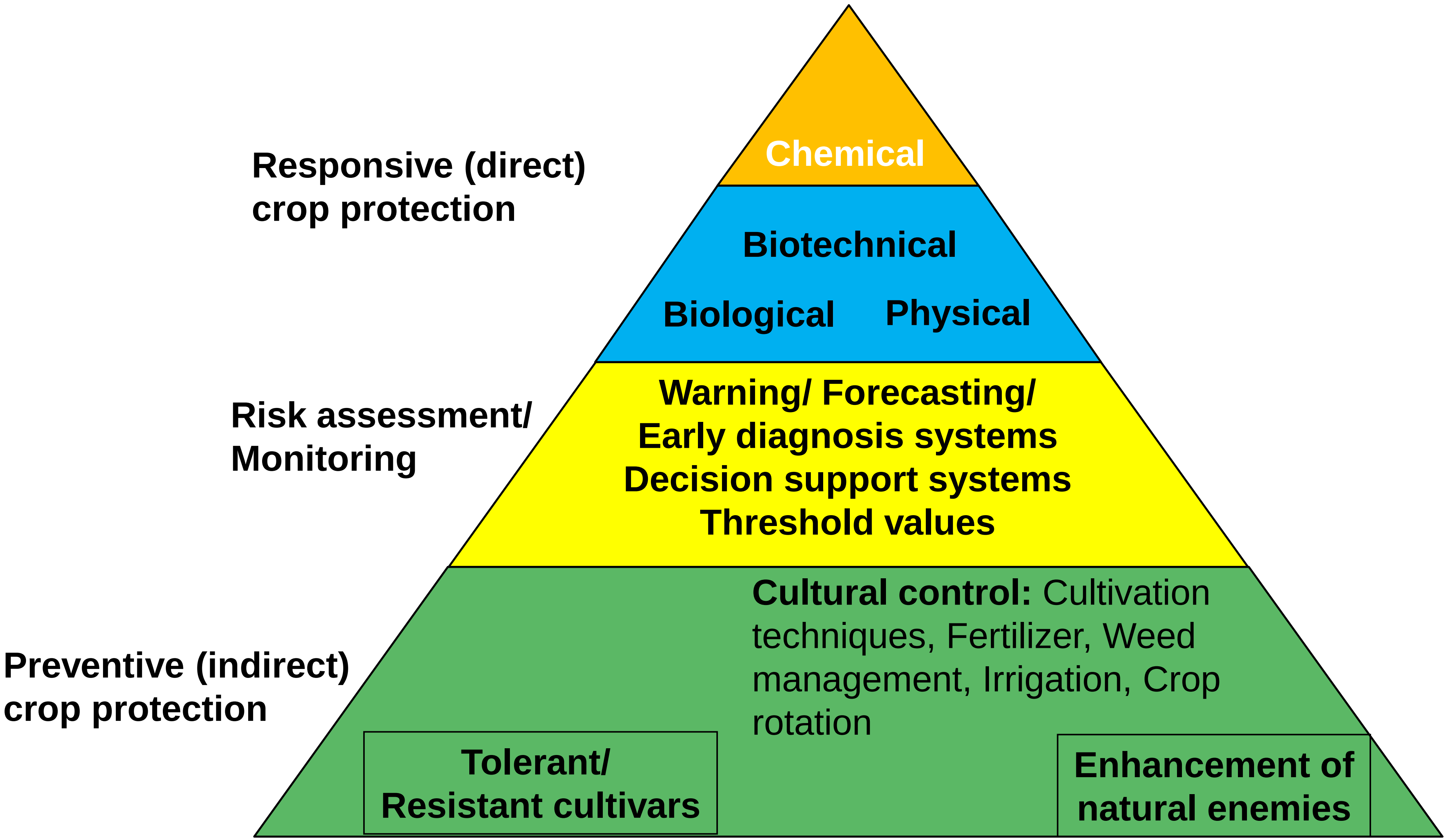
Common green capsid (*Lygocoris pabulinus*)

- **Likely to become more serious problem in future if broad-spectrum pesticide not available**
- **Pheromone trap developed by EMR/NRI could be used to direct autumn sprays**
- **Need selective insecticide**
  Plenum?



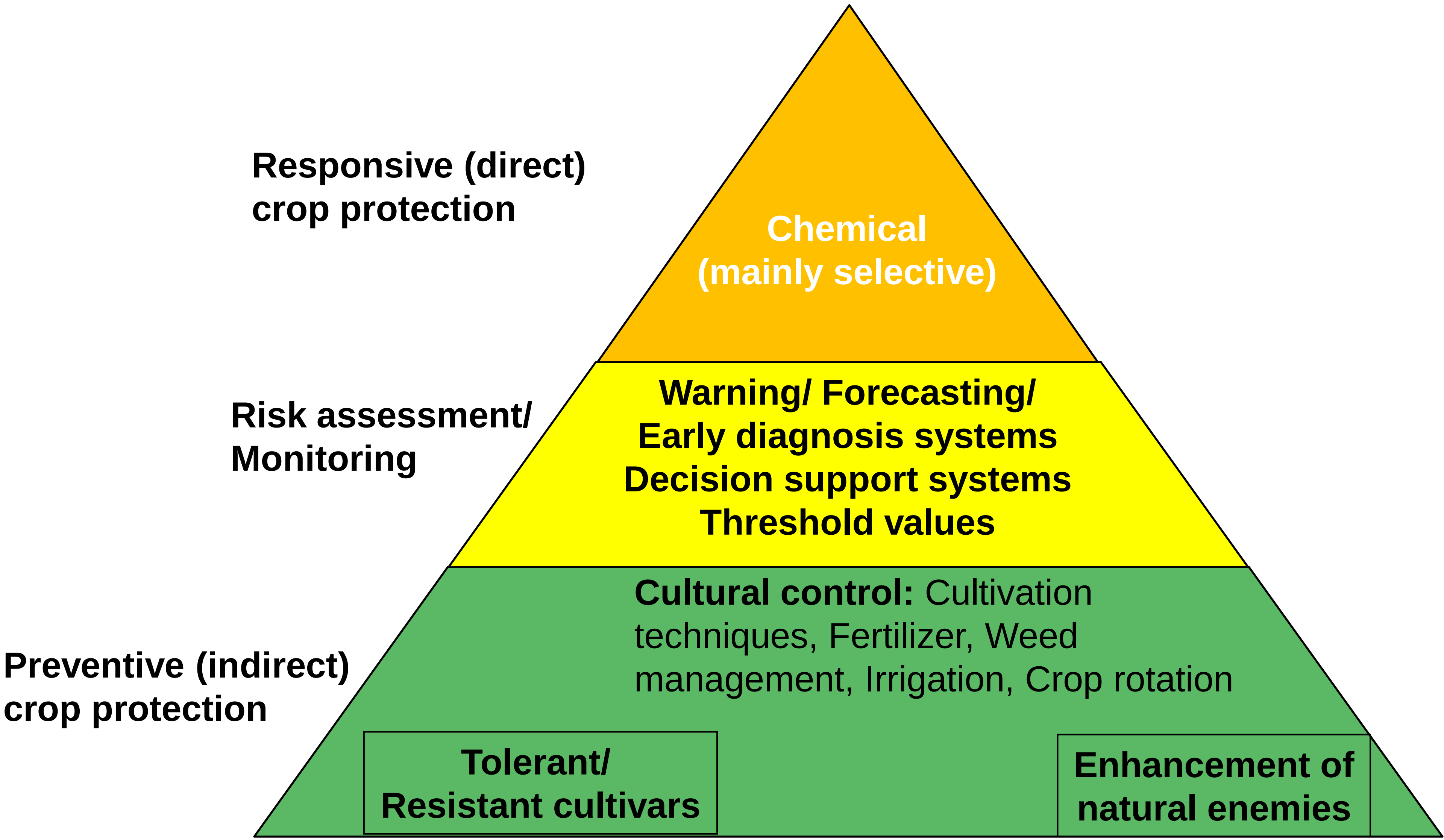
Routine spraying for several important blackcurrant diseases

The visualised IPM concept



Meissle et al. 2011.Pest Manag. Science,67

Blackcurrant IPM for pests



Meissle et al. 2011.Pest Manag. Science,67

Conclusions

- **Great progress made in developing IPM methods for blackcurrant pests. Less progress with diseases**
- **Several critical new risk assessment/monitoring methods including model for gall mite and pheromones for midge, sawfly and capsids**
- **Still reliant on pesticides, but using more selective materials which allow exploitation of natural enemies - generalist aphid and leaf midge predators and parasitoids, ground beetles**
- **Changing range of pesticide availability and use will have significant effects on the blackcurrant pest spectrum**
- **No biopesticides**
- **Some significant new challenges ahead – SWD, Capsids, woolly currant scale**

Future needs

- Pest and Disease resistant varieties that meet market requirements
- Better understanding of effects of pesticides on key natural enemies
- Conservation biocontrol methods
- New innovative cost-effective biological and biotechnological control methods

Thanks

Rob Saunders, James Wickham

UK blackcurrant growers

Agrochem companies, including Bayer CropScience

Chemical ecology group, NRI

Funders – Defra, AHDB, GSK, LRS