Aphids as virus vectors

Brian Fenton, Gaynor Malloch, Lesley Torrance, Jon Pickup, and Eric Anderson

Aphids as virus vectors

- There are many aphid species
- Those species that come into contact with the potato crop, and can acquire and transmit virus are vectors
- There are important differences in the way that different viruses are spread by different aphid species

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Methods of potato virus transmission

1. **Mechanical (PVA PVY) (non- persistent)**

2. **Circulative (PLRV) (persistent)**

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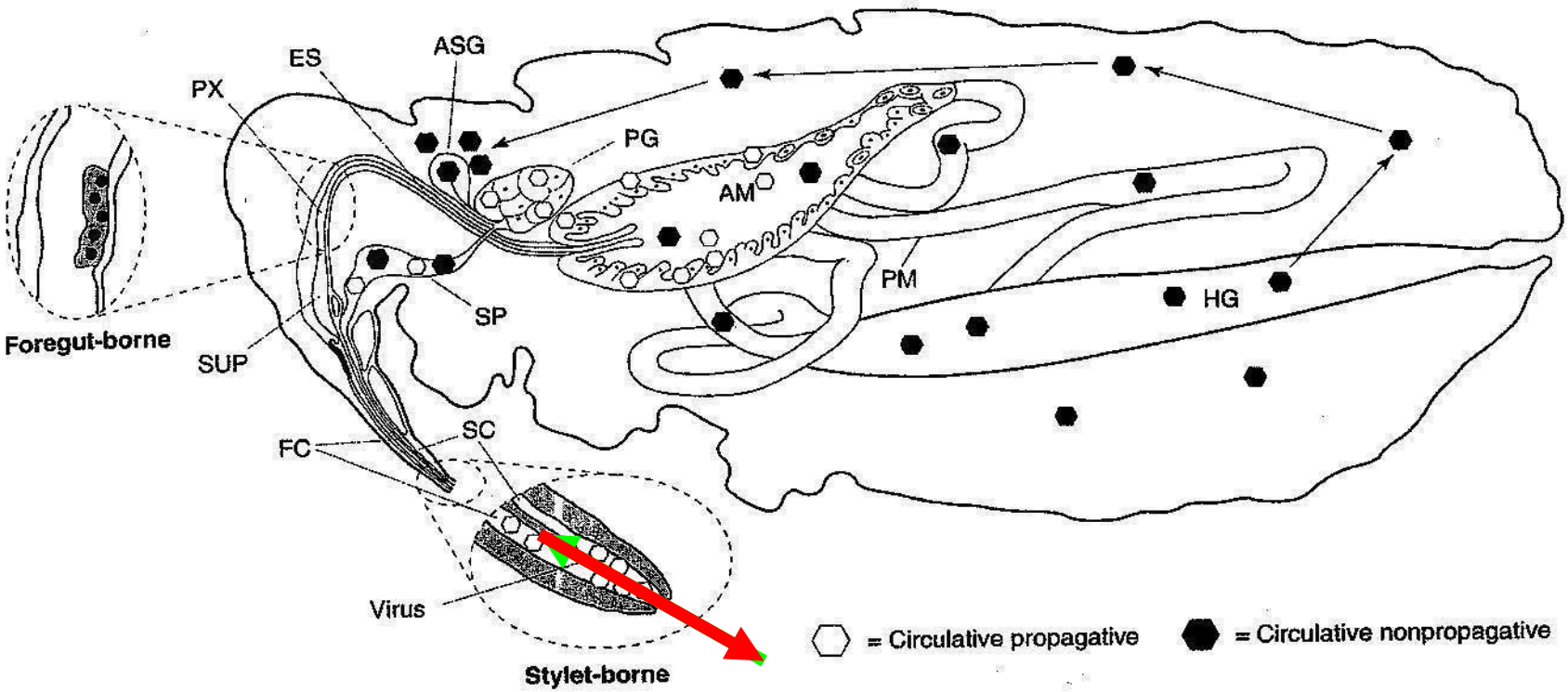
Mechanical transmission (e.g. PVY & PVA)



Acquisition short time – transmission short time

Aphids can lose virus

Many aphid species can vector

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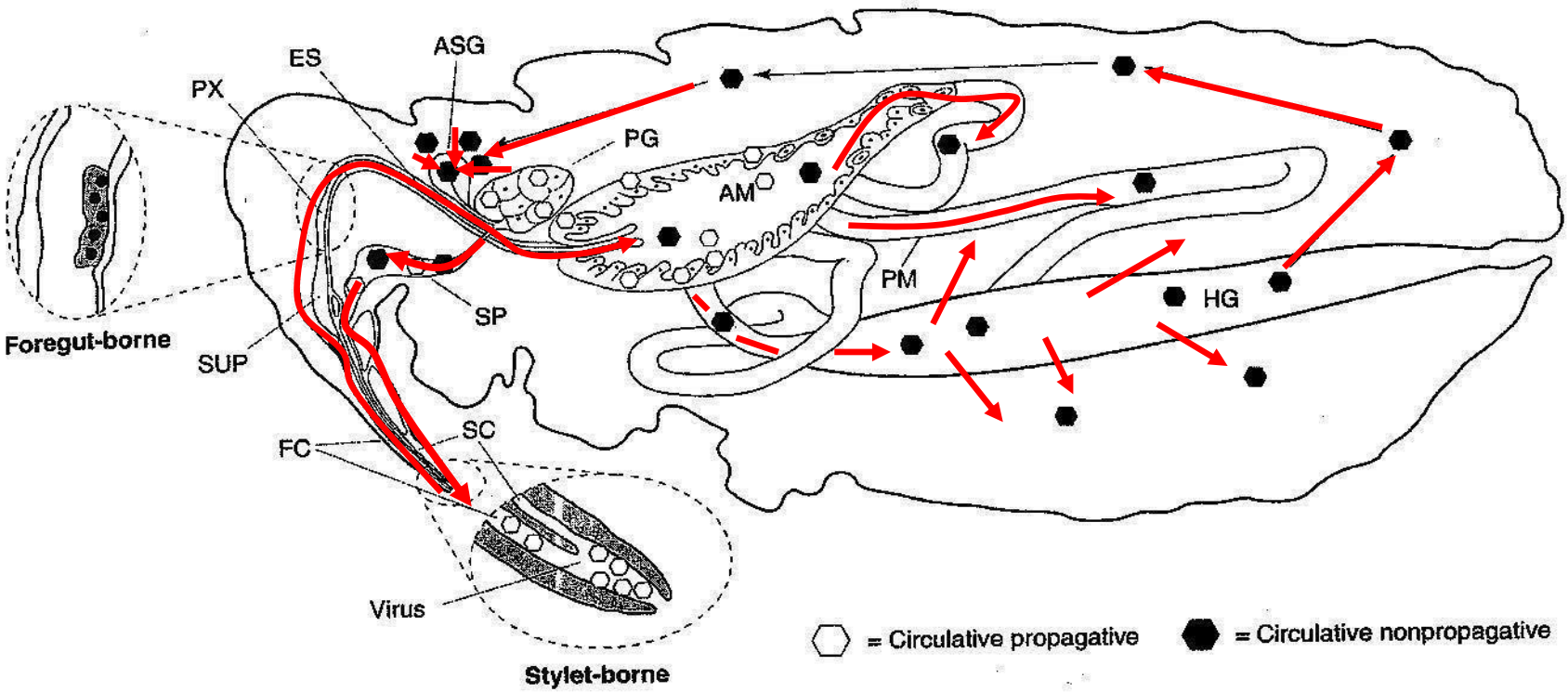
Circulative transmission (e.g. PLRV)



Acquisition short time – transmission long time

Aphid infected for life

Close association with peach potato aphid

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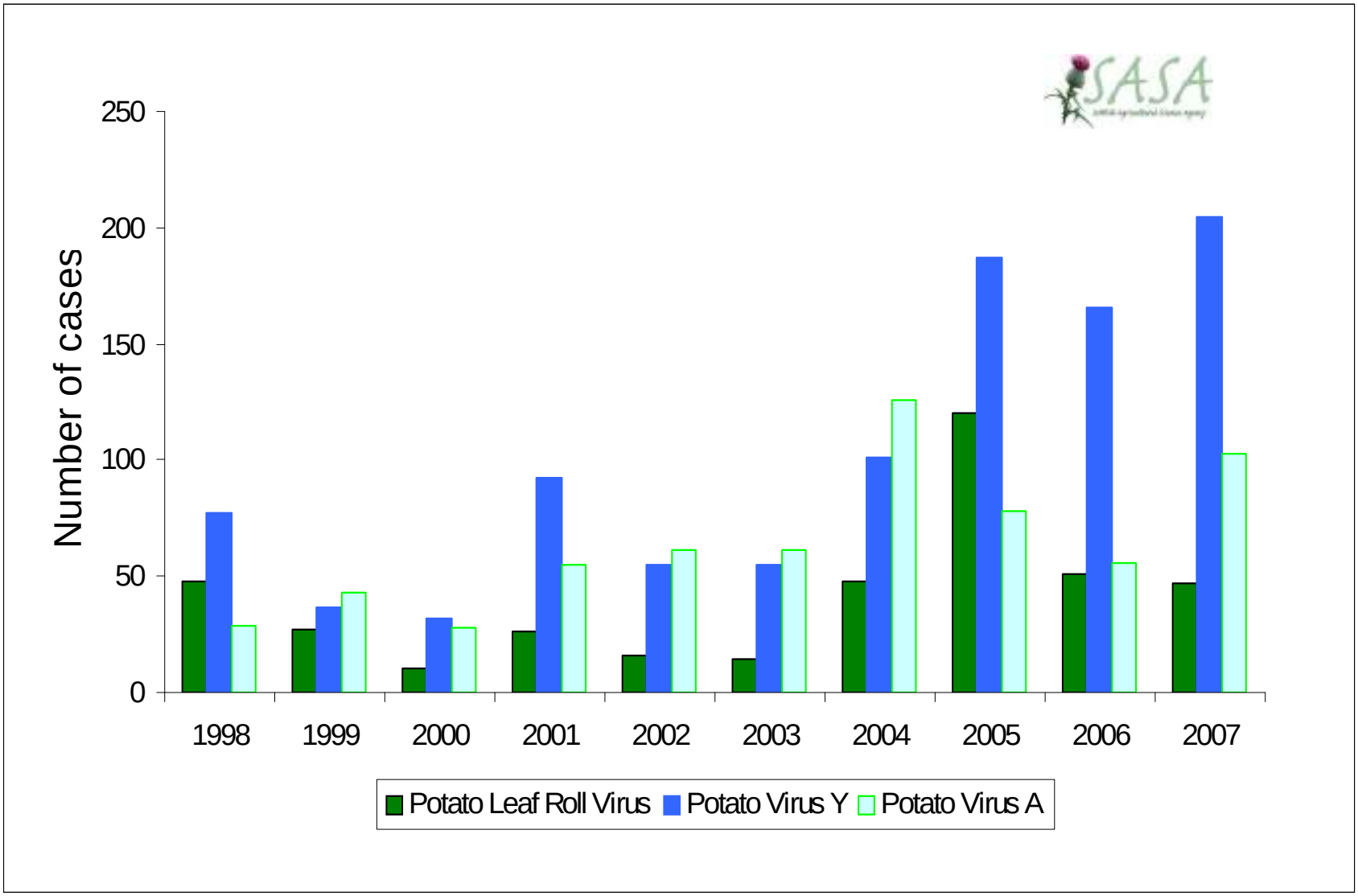
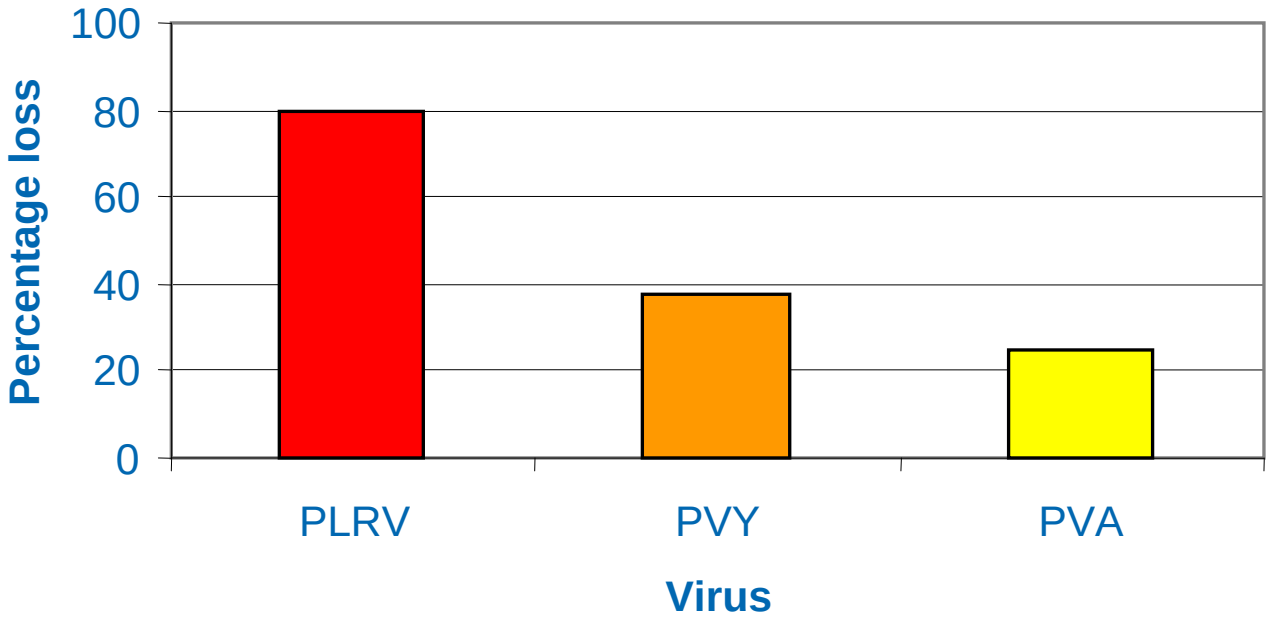
Virus incidence in the seed crop



Potential yield losses from infected seed



(Russet Norkotah)
Hamm and Hane 1999; Noite and McIntosh 2006

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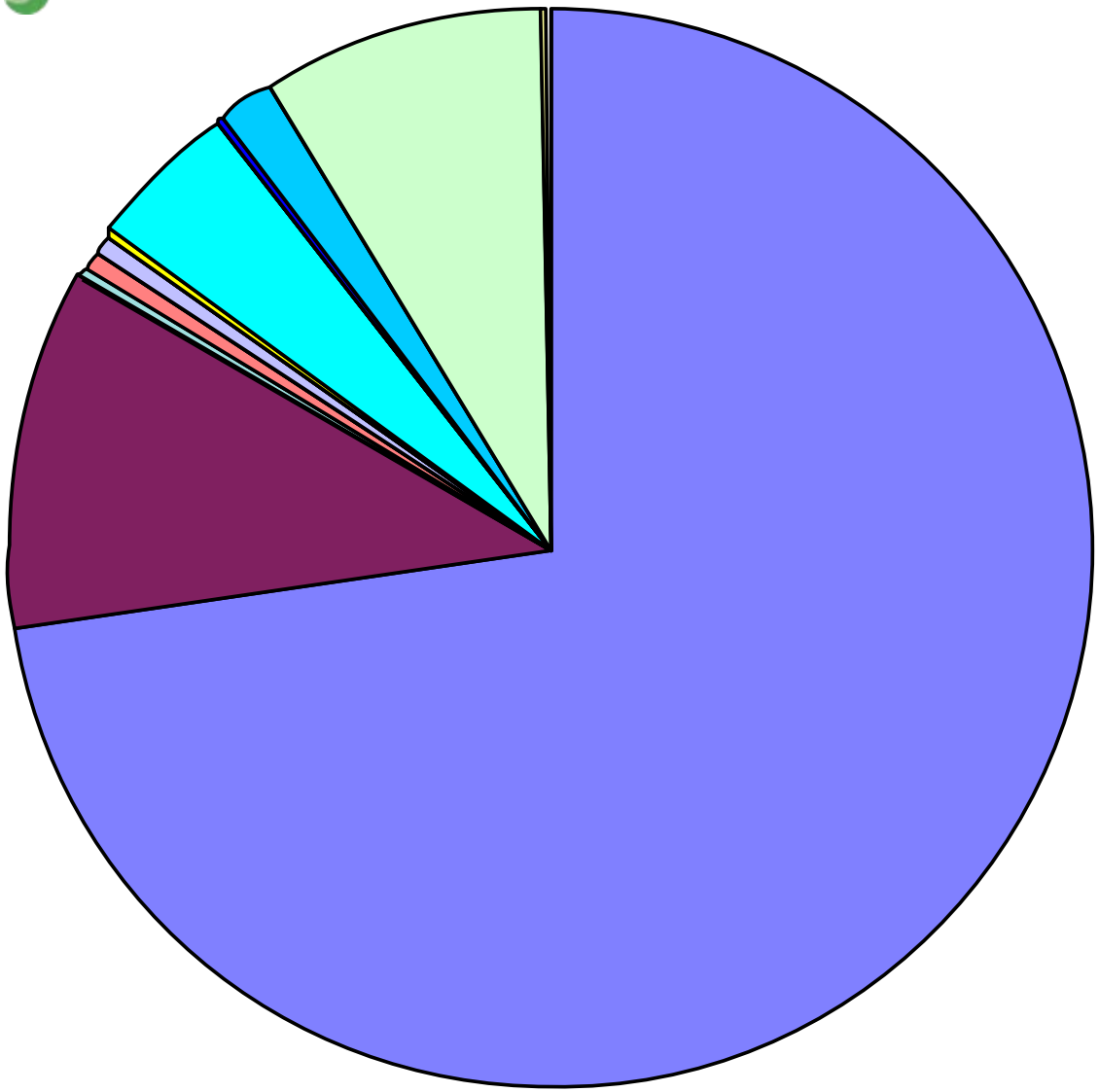
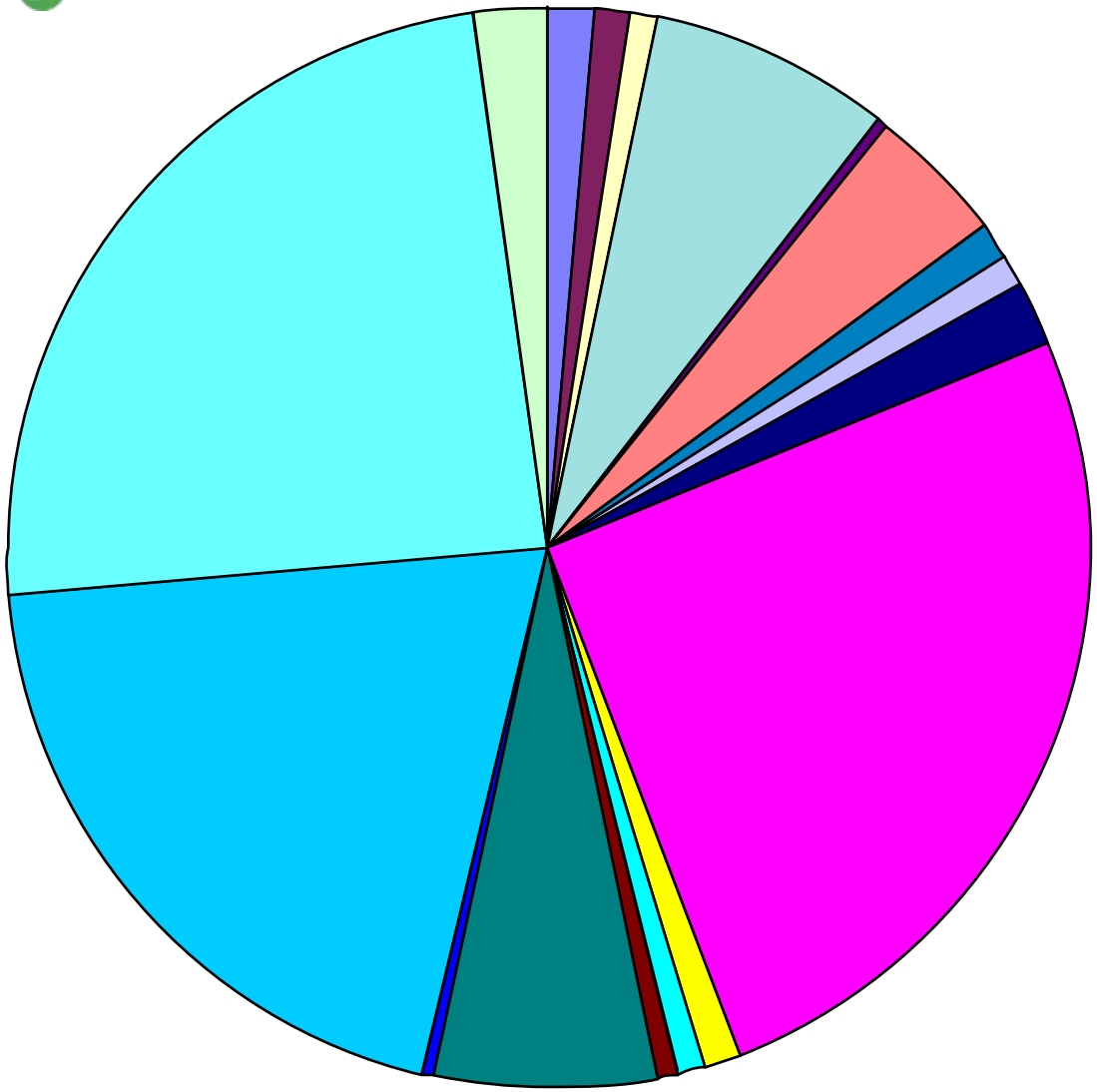
All vector species



Sycamore aphid

Spruce aphid

Vectors without the ‘big two’



- Acyrthosiphon pisum
- Aphis fabae (group)
- Aulacorthum solani
- Brachycaudus helichrysi
- Brevicoryne brassicae
- Cavariella aegopodii
- Hyalopterus pruni
- Hyperomyzus lactucae
- Macrosiphum euphorbiae
- Metopolophium dirhodum
- Myzus ascalonicus
- Myzus persicae
- Nasonovia ribisnigri
- Phorodon humuli
- Rhopalosiphum insertum
- Rhopalosiphum maidis
- Rhopalosiphum padi
- Sitobion avenae
- Sitobion fragariae

Which aphids are responsible for PVY and PVA virus transmission?

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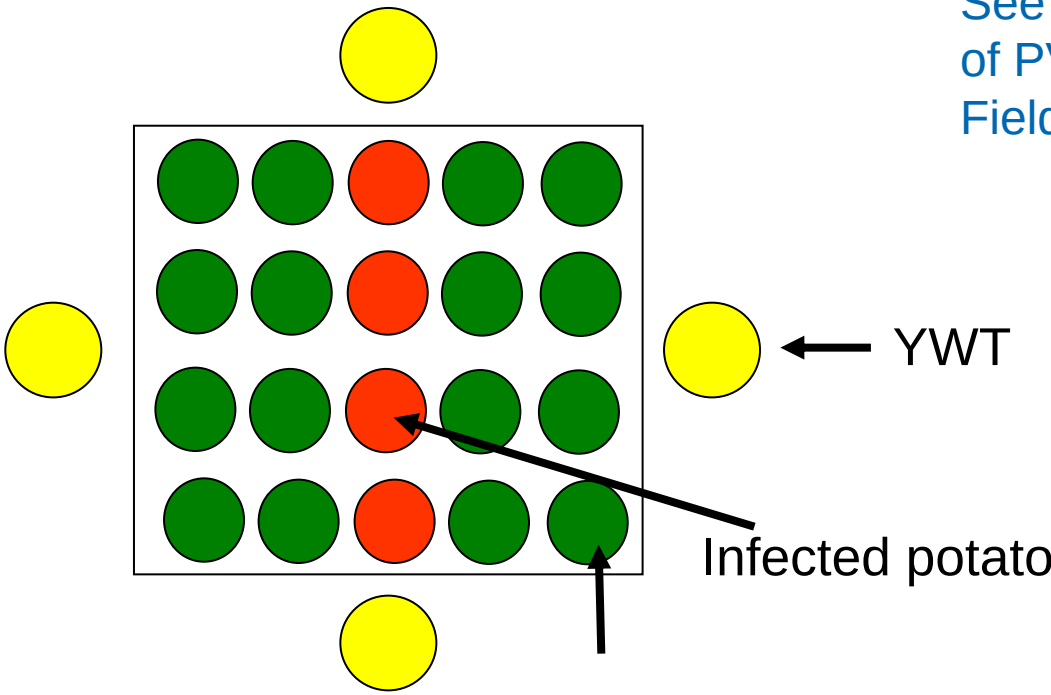
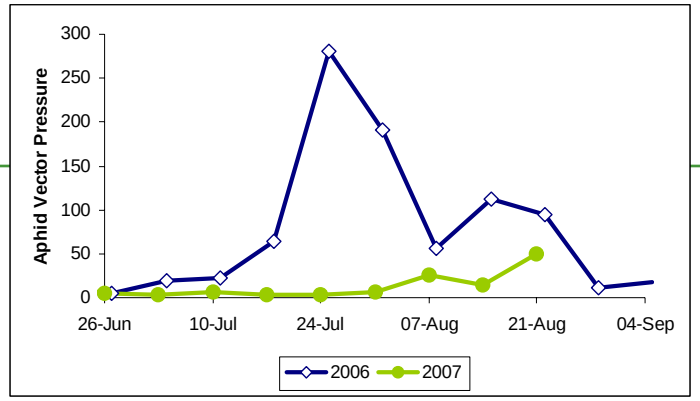
Field experiment carried out at SASA.



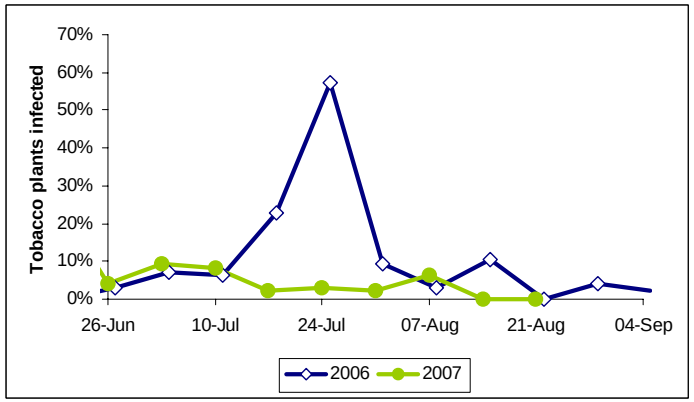
See Poster 'Aphid Transmission of PVA and PVY Under Scottish Field Conditions'

Plants and YWT changed and monitored weekly

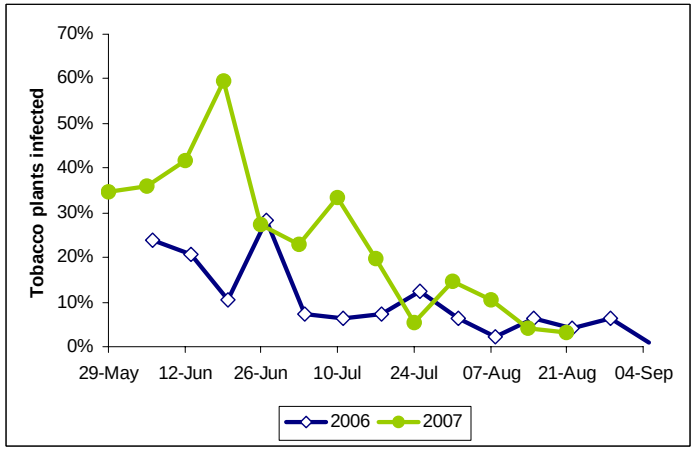
Aphids



PVY



PVA



Aphid activity correlates with PVY spread.

Peak aphid pressure was due to cereal aphids (rose grain aphid and grain aphid).

PVA transmission occurred early in the season.

It is unlikely that the species of aphids that vector PVY are similar to those that vector PVA

See Poster ‘Aphid Transmission of PVA and PVY Under Scottish Field Conditions’

Not enough is known about the vectoring of PVA and the repellent action of some insecticides.

As a result farmers are using regular and not targeted applications of insecticides.

The activity of aphid species that are not colonisers of potato is having an impact on virus incidence

We are currently monitoring aphid numbers around a potato crop in a field experiment at SCRI

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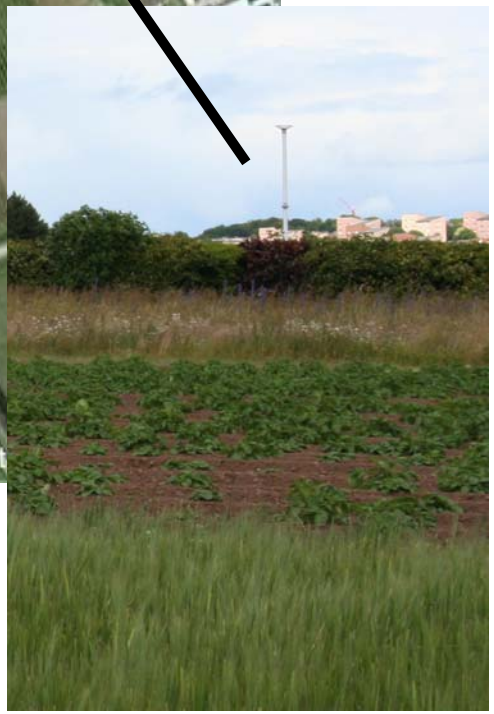
bterra Ltd & Bluesky, The GeoInformation Group, Map data ©2008 Tele At



Winged aphids migrate as the cereal crop matures

Can we detect aphids in cereal fields before they begin to probe the potato crop and transmit virus?

Could we use this as an early warning system for a more targeted insecticide spraying regime?

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PLRV and its main vector *Myzus persicae* the peach potato aphid

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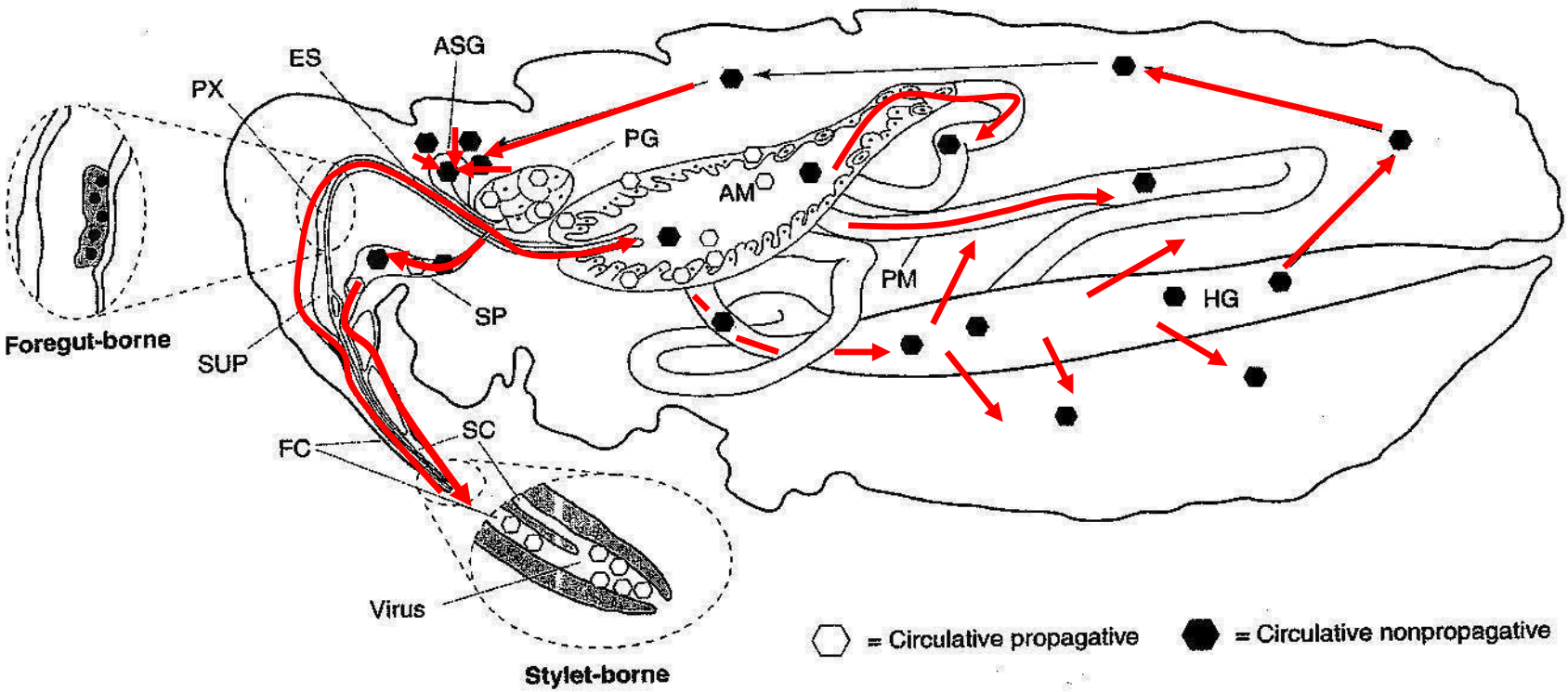
Circulative transmission (e.g. PLRV)



Acquisition short time – transmission long time

Aphid infected for life

Close association with peach potato aphid

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Virus control

PLRV has an association with its vector *M. persicae.*

It takes time for the aphid to acquire the virus

This makes PLRV easier to control than the mechanically transmitted viruses PVA and PVY

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Using DNA markers to detect aphid lineages or genotypes

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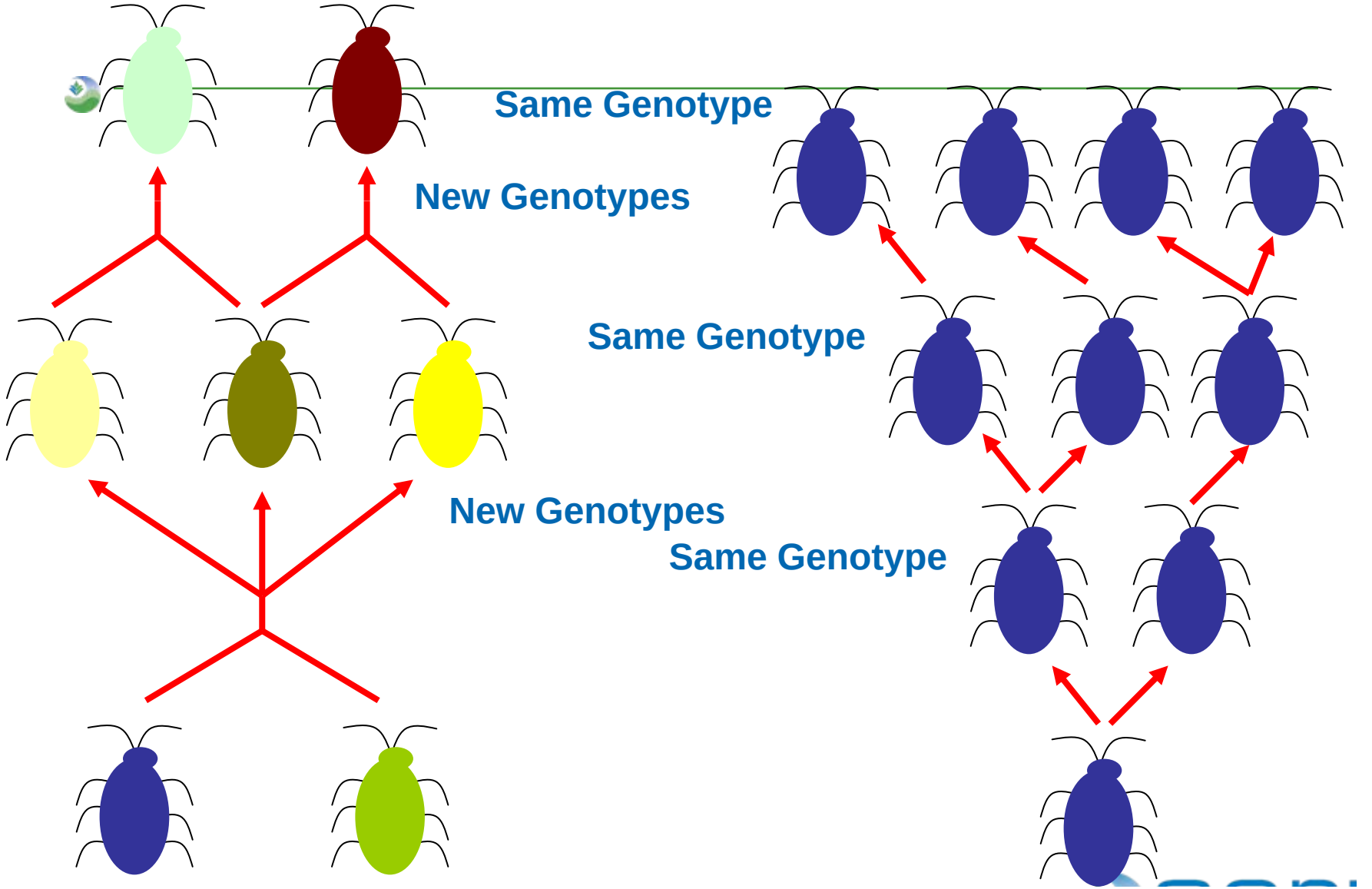
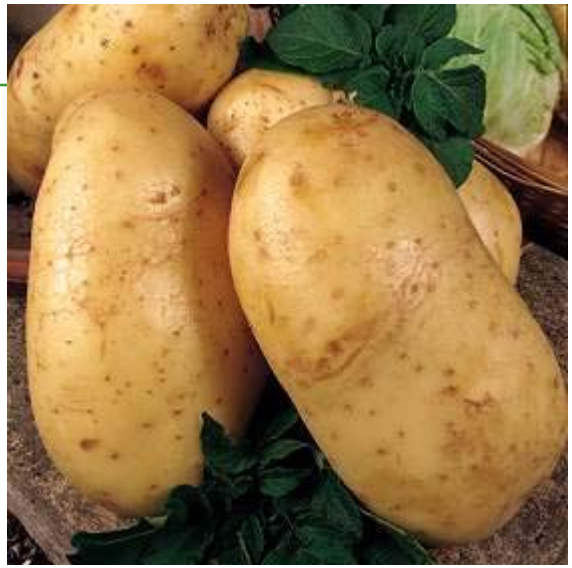
Sex and diversity



Desiree

Lady Balfour

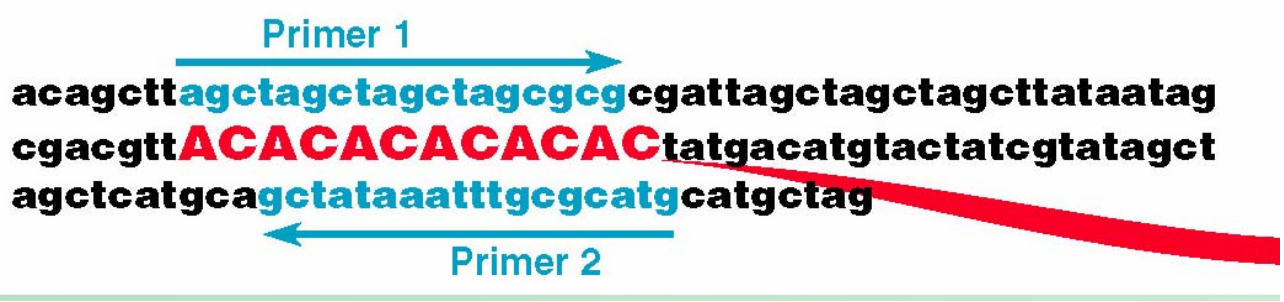


Pentland Dell

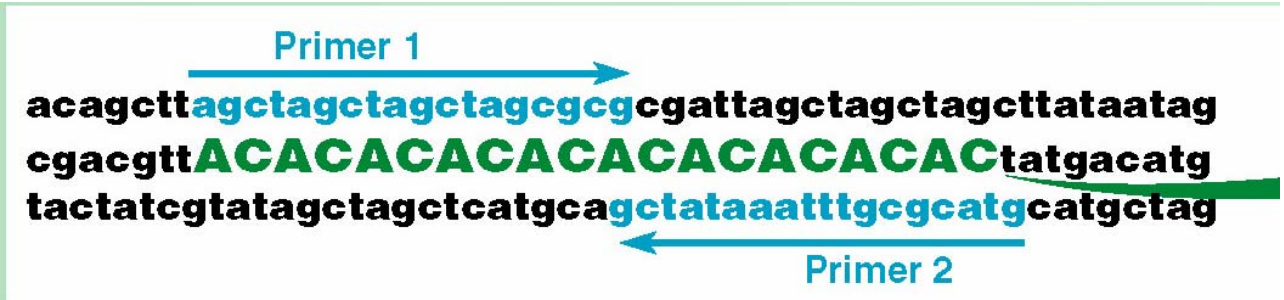
A single microsatellite....

Repetitive DNA amplified by PCR

Allele 1



Allele 2



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Genotype display

Clone	Locus 49		Locus 63		Locus 86	
	1	2	1	2	1	2
1	156	168	170	174	114	140
2	156	156	174	174	125	140

	M49		M63		M86		M35		M40		myz9		Region
Greece 64	114	146	157	166	99	113	182	188	133	133	207	226	N.Greece
Greece 46	114	146	157	166	99	107	184	184	133	133	208	224	Spain
Greece 69	114	170	157	172	99	103	182	182	133	133	220	226	N.Greece
2144F	114	170	166	174	113	113	182	182	120	133	207	226	Greece
Greece 80	120	170	174	174	103	126	200	200	114	135	201	205	Slovenia
4867A	120	170	174	176	103	126	200	200	114	135	201	205	Clone M
Greece 93	126	155	166	183	99	113	180	202	133	133	195	222	Japan
O4	129	166	181	181	99	126	188	200	120	120	201	218	Australia
WP16	130	170	151	170	95	141	188	188	129	133	189	216	Scotland
2518a	133	133	166	174	99	126	184	208	127	133	207	216	Turkey
1088Z	133	170	172	174	101	103	180	208	122	133	207	216	CE.Greece
Greece 161	133	168	172	172	99	141	182	198	133	133	195	207	CE.Greece
NZ64r	135	211	170	170	109	113	188	200	133	135	203	222	New Zealand
NZ73	135	211	170	170	109	113	188	200	133	135	203	222	New Zealand
2001-P1C	135	144	172	181	141	141	188	198	127	127	195	195	France
W5*1A	135	141	172	174	143	143	188	198	127	127	207	214	France
4824J	135	149	174	183	139	139	188	198	127	127	220	220	France(SCRI)
W2*9.1	135	149	174	183	139	139	188	198	120	127	220	220	France
Greece 120	135	149	174	183	139	139	188	198	120	127	220	220	N.Greece
Greece 20	137	176	157	183	101	107	188	200	133	133	195	203	Germany
Greece 32	137		157	183	101	107			133	133	201	203	Germany
4848A	137	144	157	170	99	103	180	198	114	125	203	220	England
Kettle red	137	144	157	170	99	103	180	198	114	125	203	220	Scotland
Greece 30	137	176	157	183	101	107	188	200	133	133	203	220	Germany
4847Z	137	186	157	181	119	139	188	200	122	133	212	220	Scotland
O50	137	159	159	187	126	134			120	133	207	222	Australia
O34	137	155	159	172	126	139			120	127	208	208	Australia
O58	137	149	161	179	134	134			133	133	207	214	Australia
CLS35	137	180	163	183	107	132	180	194	127	133	218	226	Scotland
Twphy1	137	180	163	183	107	132	180	194	127	133	218	226	Scotland
Greece 131	137	164	164	172	139	143	180	188	127	133	195	207	N.Greece
Greece 119	137	139	164	174	103	141	182	188	133	133	195	216	N.Greece
W3*10D	137	166	164	187	101	143	186	188	127	127	195	208	France

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Clones in Scotland = same genotype using SSRs

SSR	A		B		C		D		E		F		G		H	
Marker	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2
M35	196	196	196	200	186	196	186	196	198	202	186	196	178	192	180	196
M49	149	156	156	159	153	165	153	153	156	163	149	156	137	179	138	176
M63	174	184	169	204	169	172	174	204	167	172	184	204	165	186	167	169
M86	113	138	99	138	136	140	125	138	103	107	125	138	107	131	103	107

	I		J		K		L		M		N		O		P	
	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2
M35	186	196	186	186	186	198	186	198	198	198	178	178	182	182		
M49	153	203	153	165	138	186	138	156	121	169	138	143	176	211	170	201
M63	169	169	169	172	159	184	169	184	176	178	159	172	164	174	164	170
M86	125	140	115	140	119	138	138	140	103	125	99	103	99	101	103	107

More markers detect the same number of genotypes

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All Scottish MACE+ clones are associated with slightly different insecticide resistance mechanisms

	OrganoPs	Pyrethroids	Carbamates
Clone	Esterase	kdr	MACE
A	**R3**	**Yes**	**Yes**
B	**R1/R2**	**Yes**	**Yes**
H	**S/R1**	**Yes**	**Yes**
M	**R2**	**No**	**Yes**
N	**R1**	**No**	**Yes**
O	**S/R1**	**No**	**Yes**
P	**?**	**No**	**Yes**

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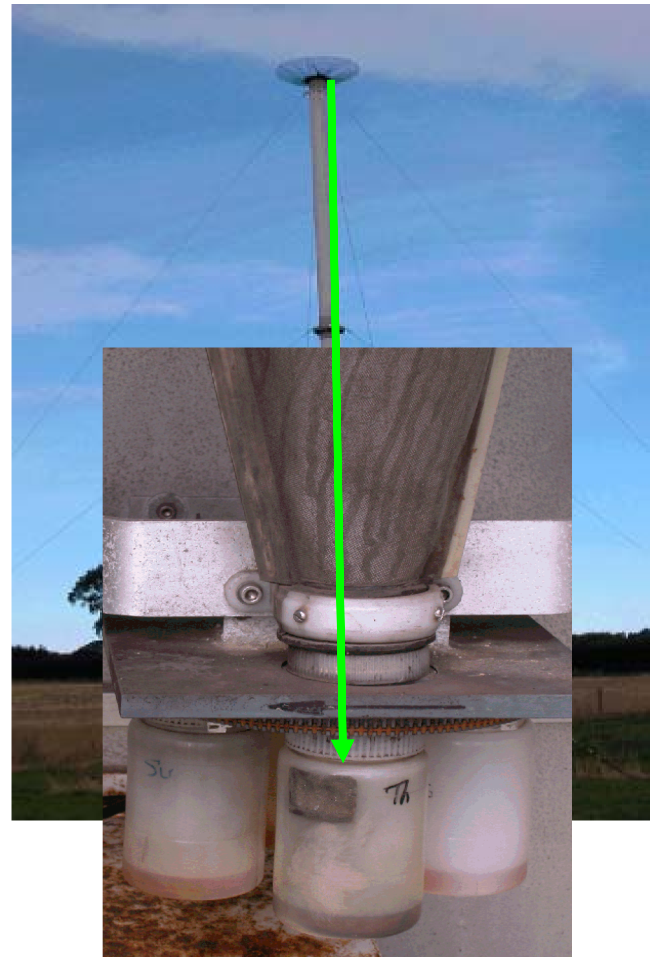
Monitoring involves - catching aphids and linking their flight activity to weather conditions



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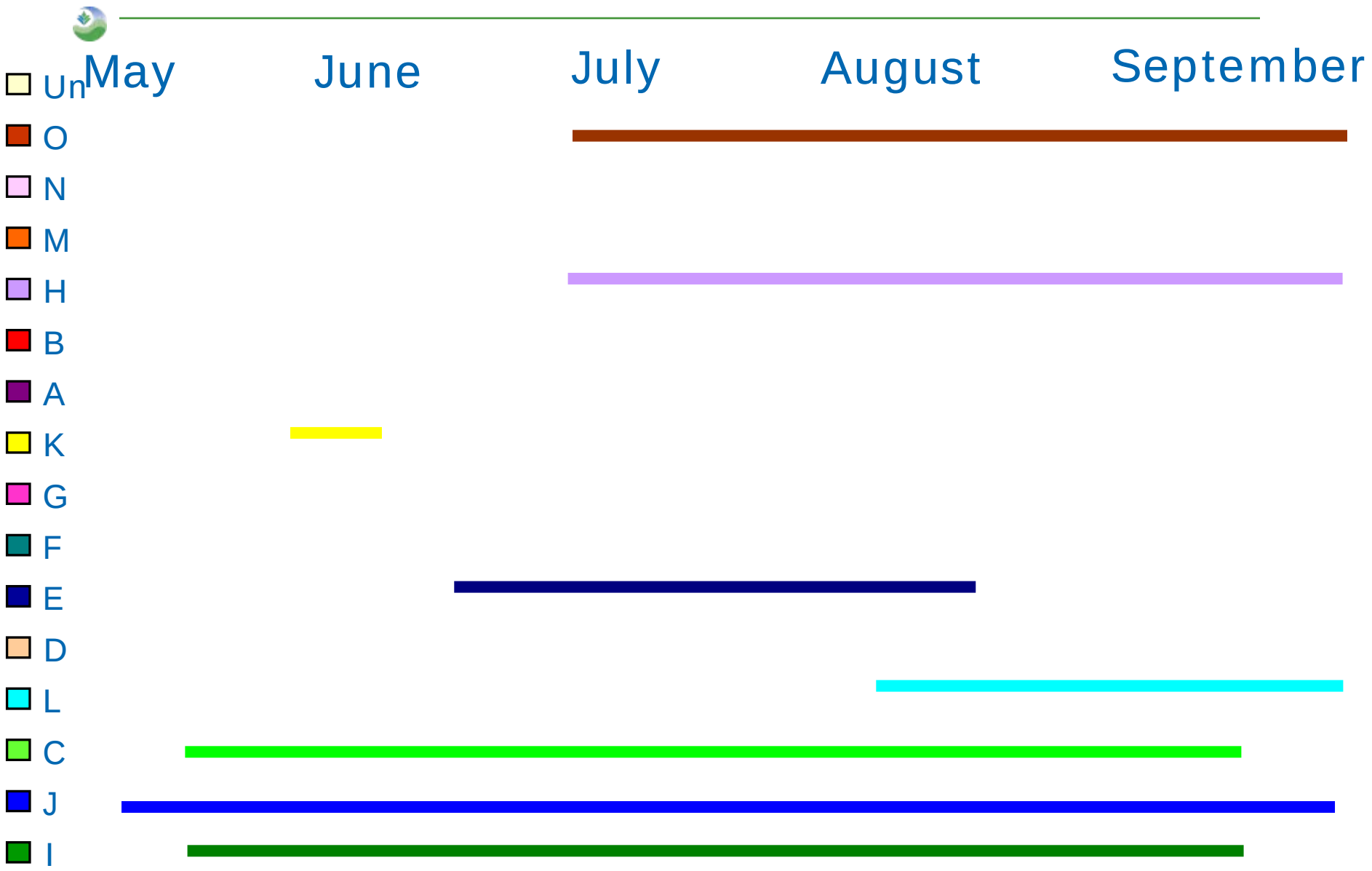
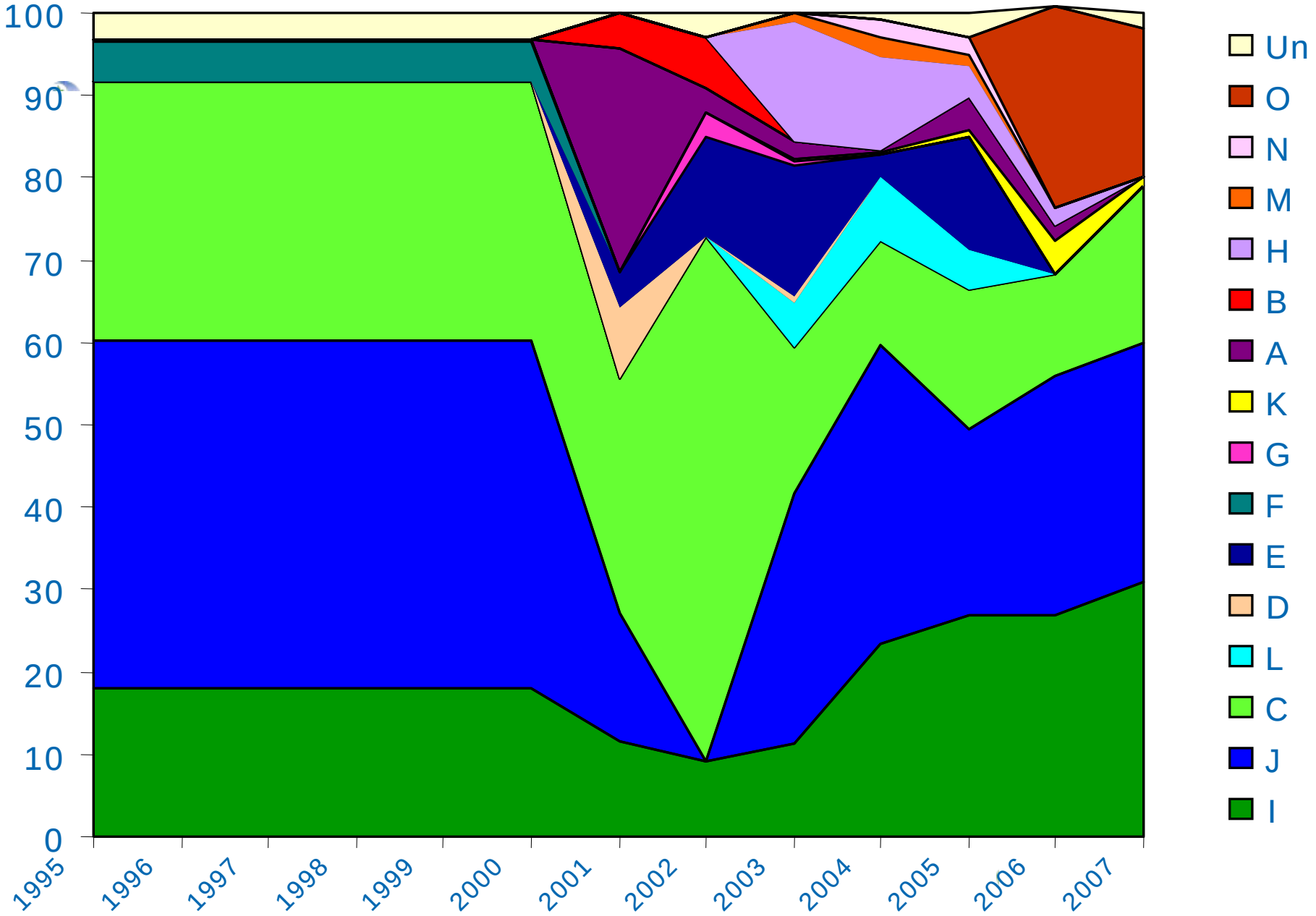
Suction trap locations
Elgin
Dundee
Gogar
Ayr
© 2007 Infoterra Ltd & Bluesky
Image NASA
Image © 2007 TerraMetrics
Google
Pointer 56°49'52.79" N 3°25'25.55" W elev 1672 ft
Streaming 100%
Eye alt 264.37 mi

Summary of ST typical seasonal results

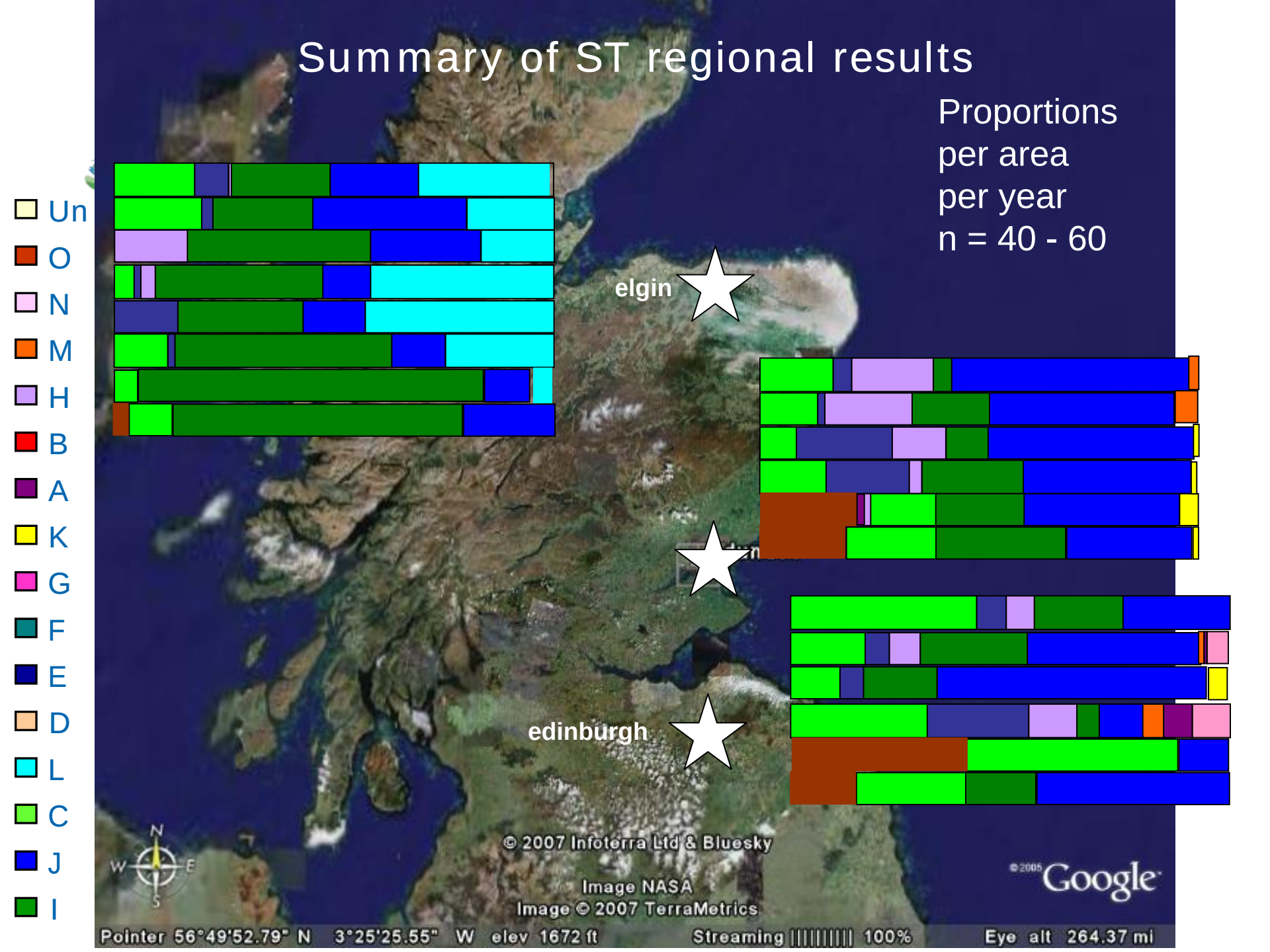


Summary of ST historical results



Summary of ST regional results

Proportions
per area
per year
n = 40 - 60



Insecticide resistant forms (type O) do appear to be becoming more adapted to long term survival in the UK

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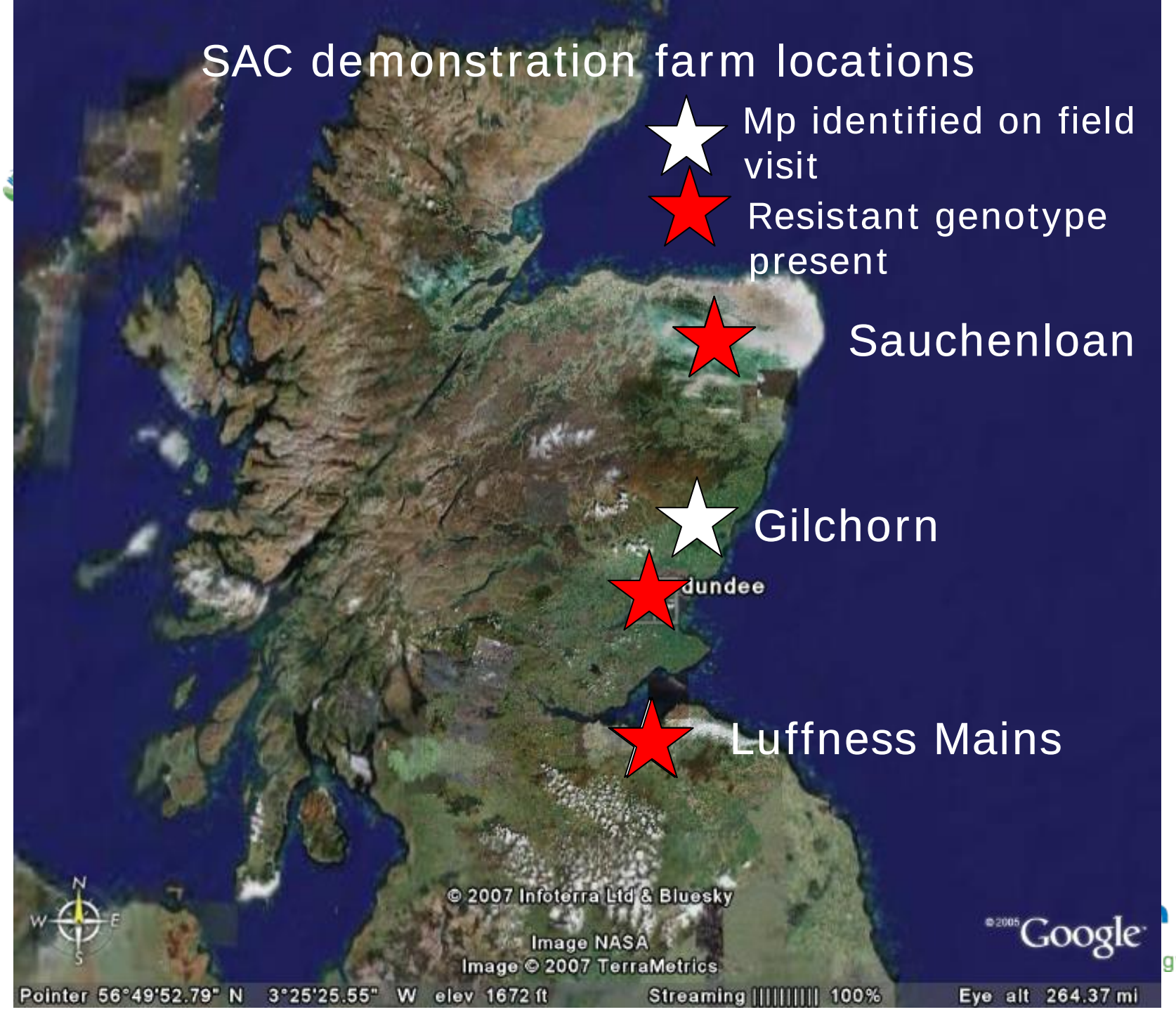
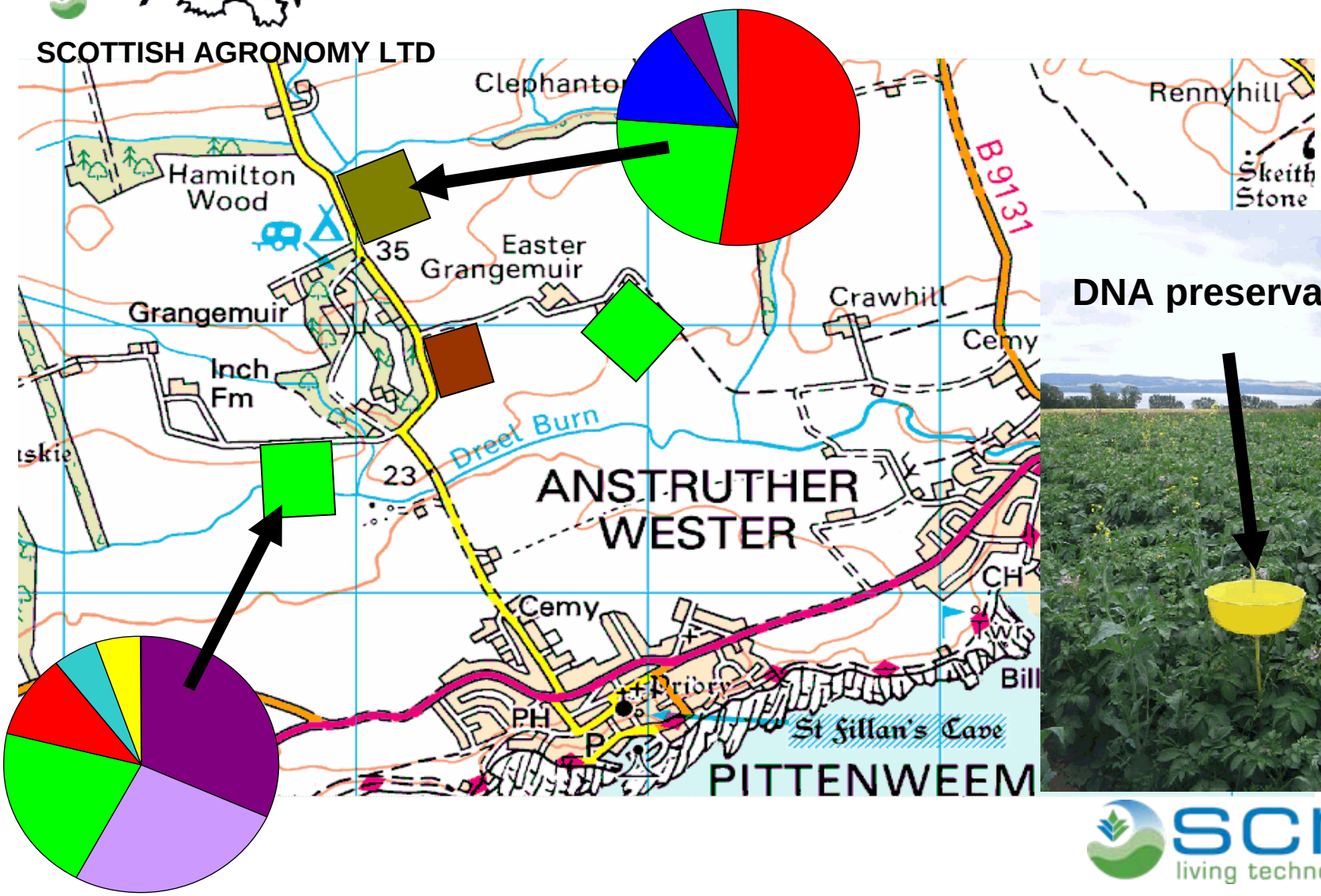

SAC demonstration farm locations
Mp identified on field visit
Resistant genotype present
Sauchenloan
Gilchorn
dundee
Luffness Mains
© 2007 Infoterra Ltd & Bluesky
Image NASA
Image © 2007 TerraMetrics
©2005 Google
Pointer 56°49'52.79" N 3°25'25.55" W elev 1672 ft
Streaming 100%
Eye alt 264.37 mi

Field Vector Studies
(in seed potato fields)

SCOTTISH AGRONOMY LTD



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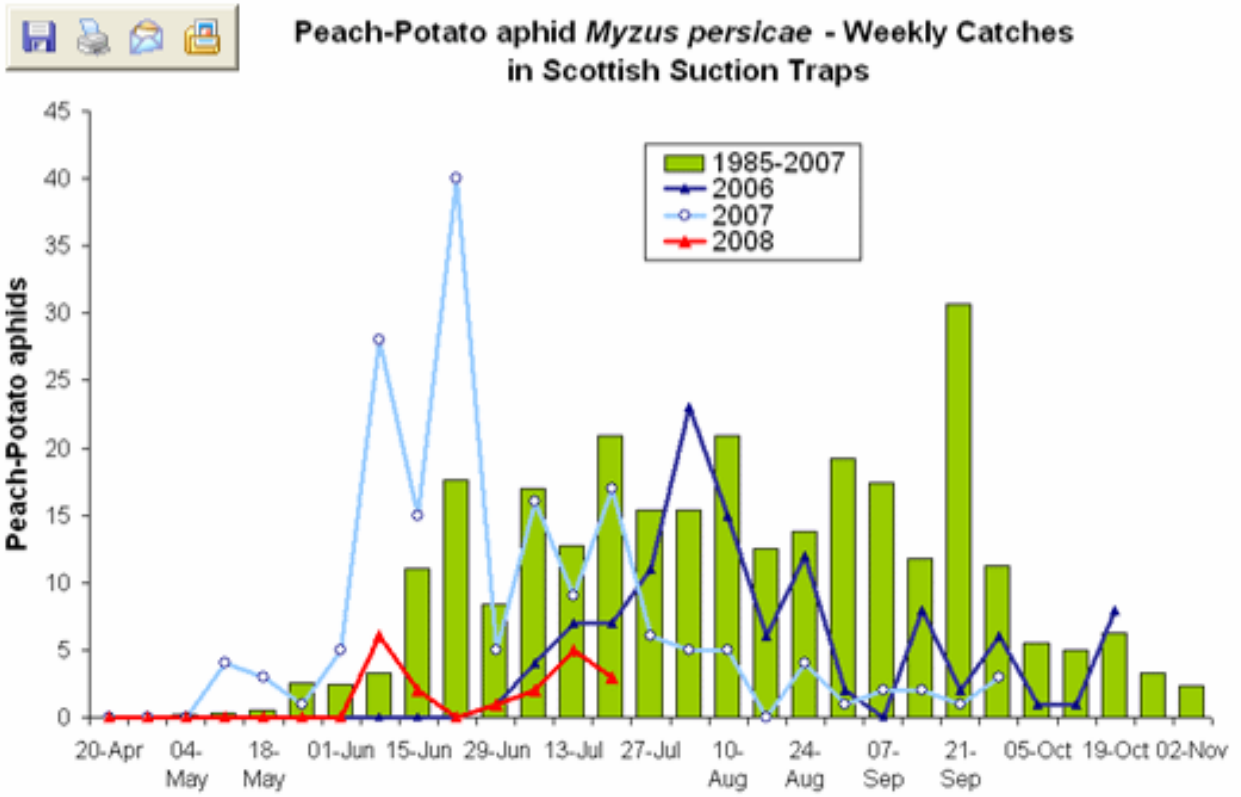
Virus Epidemiology 2008

Virus Prediction 2008

The first Peach-Potato aphid caught in the Scottish suction traps during June at Dundee. This is 2 days later than suggested by a prediction us and 13 days earlier than the average date.



Conclusions

We need to continue to monitor the spread and incidence of PLRV, PVY and PVA in order to develop better targeted control

Field experiments and ST data suggest that cereal aphids play an important role in the spread of PVY but their role in vectoring PVA is less clear

In Scotland there is a clonal turnover of insecticide resistant *M. persicae,* with new lineages appearing every year since 2001

Using ST data to monitor aphid numbers and predict aphid activity can help inform farmers about the level of aphid problems

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Acknowledgements

Louise Kasprowicz and Sheena Lamond (SCRI)

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Local Farmers

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