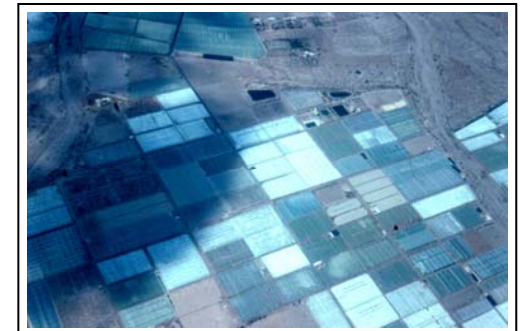


Some reflections on B and Q biotypes

Ian Denholm¹ and Ralf Nauen²

¹Rothamsted Research, Harpenden, UK

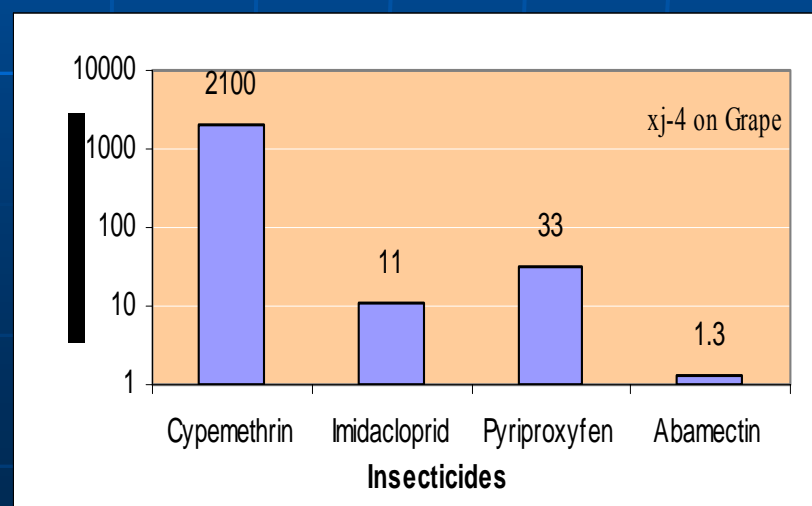
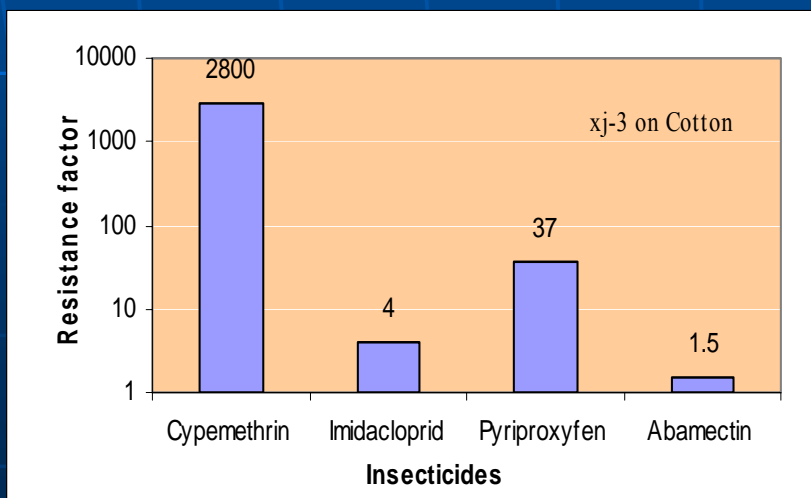
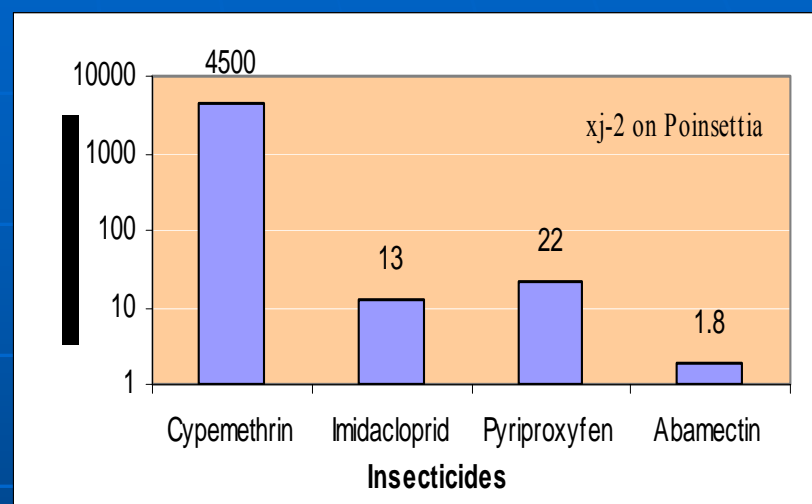
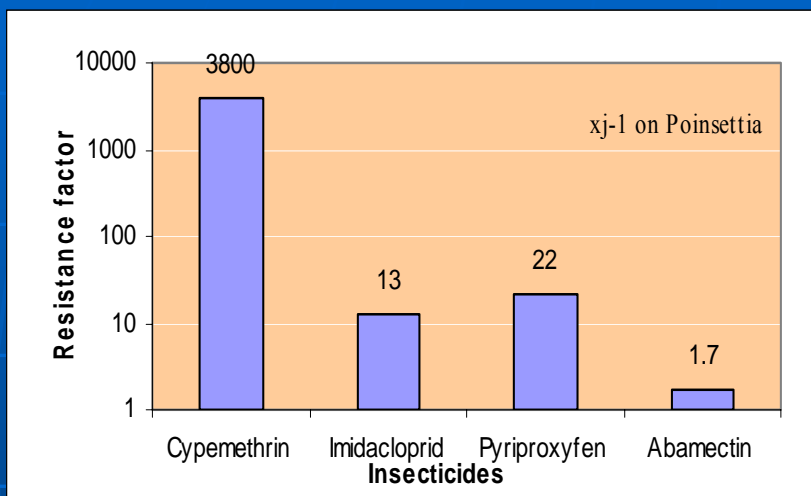
²Bayer CropScience, Monheim, Germany



Historical perspective: 1

- Mid 1980s to 1990s: Major geographical expansion in B-types
- B-types become predominant/supplant native biotypes due to wide host range, resistance to insecticides and/or other characteristics.
- B-types generally resistant to pyrethroids, but resistance to newer insecticide groups still patchy.

Resistance profiles of B-type strains of *B. tabaci* collected from Xinjiang, northwest China



Historical perspective: 1

- Mid 1980s to 1990s: Major geographical expansion in B-types
- B-types become predominant/supplant native biotypes due to wide host range, resistance to insecticides and/or other characteristics.
- B-types generally resistant to pyrethroids, but resistance to newer insecticide groups still patchy.
- However, some B-type populations are now strongly resistant to newer products (e.g. Guatemala).

Historical perspective: 2

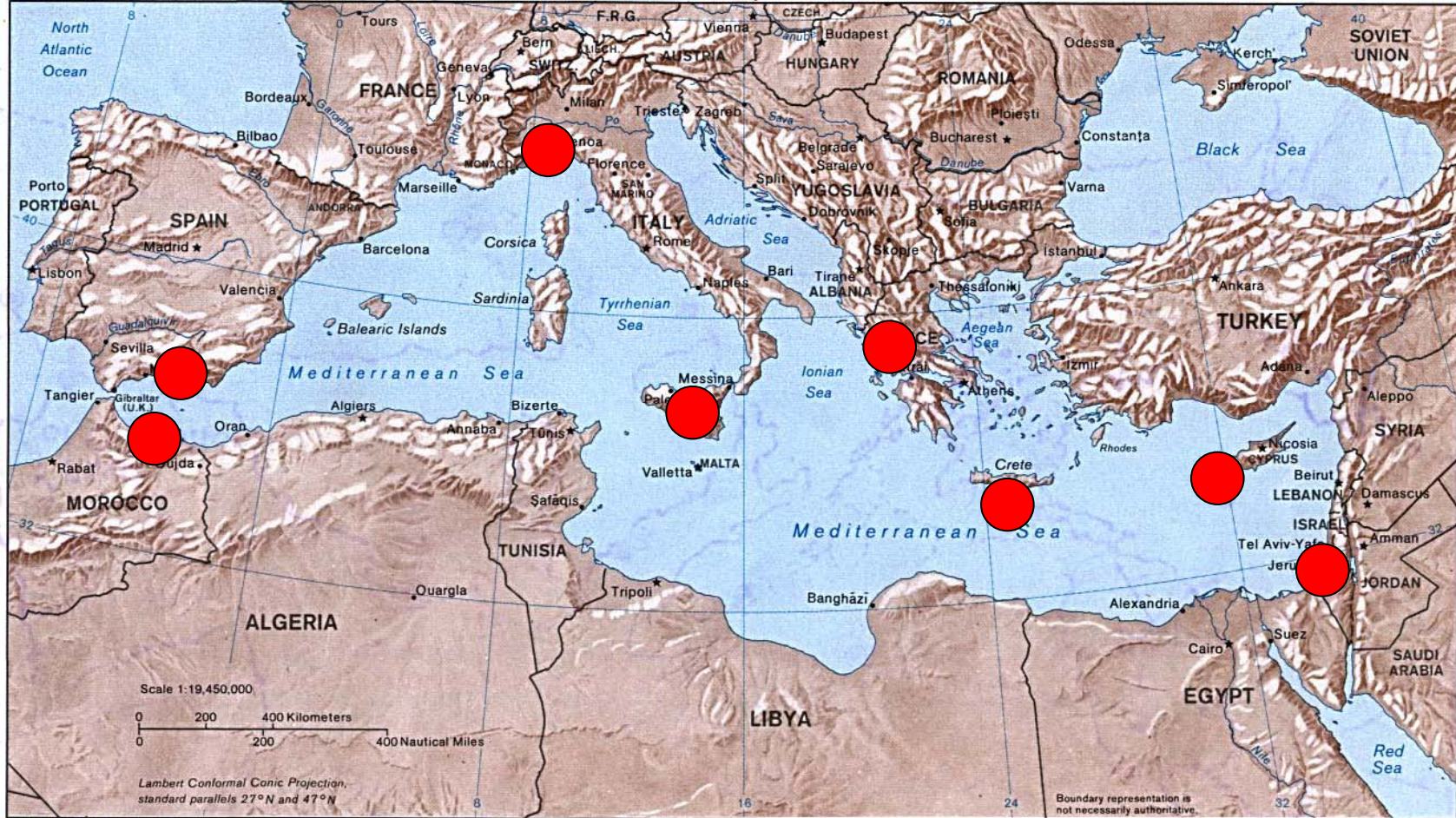
- Q-types formerly restricted to Mediterranean (?) where resistance to a broad range of insecticides (neonicotinoids, IGRs, pyrethroids) is now widespread

Spread of neonicotinoid resistance and Q-biotypes in the Mediterranean basin



Bemisia tabaci

The Mediterranean Basin



505327 (A00849) 11-82



Historical perspective: 2

- Q-types formerly restricted to Mediterranean (?) where resistance to a broad range of insecticides (neonicotinoids, IGRs, pyrethroids) is now widespread
- Q-types currently common over much of the Mediterranean, but not ubiquitous (B-types still occur).
- Q-types (plus multiple resistance) are now being transported on ornamentals to other parts of the world (e.g. USA, Japan, China, northern Europe)

...but care needed over claiming provenance!!

Dynamics of B- and Q-types appear to reflect interactions between resistance and other biological attributes

BUT

Concerns over Q-types relate primarily to its multi-resistance profile

(Invasions of multi-resistant B-types constitute an equally serious threat (would these be detected?))

Resistance in Q-types in Europe

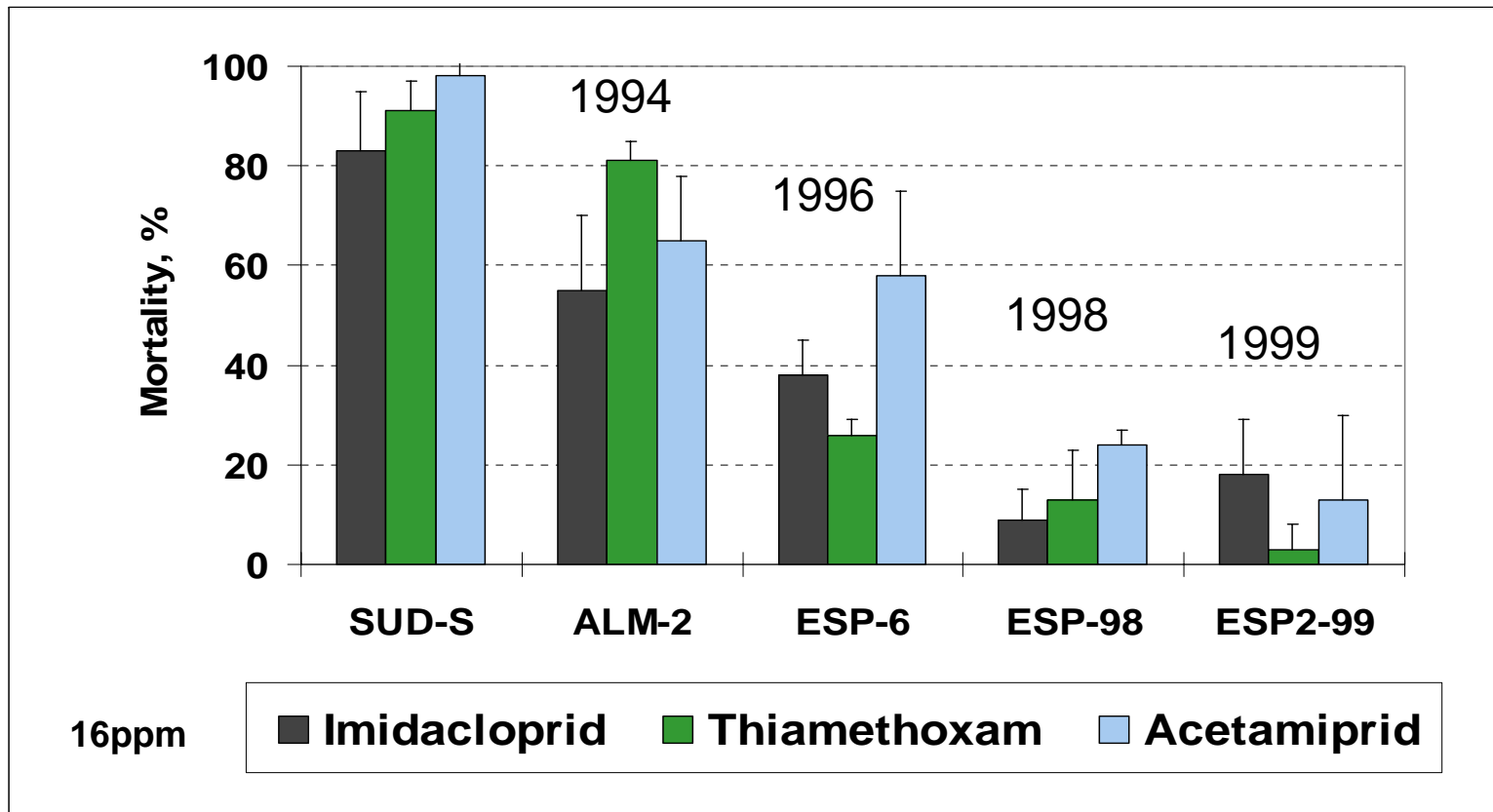
1. Neonicotinoids

- Now very potent in many regions

Resistance monitoring in Almeria, Spain



Almeria/Spain



Resistance in Q-types in Europe

1. Neonicotinoids

- Now very potent in many regions
- Broad-spectrum across group

Neonicotinoid resistance in *B. tabaci* from Almeria, Spain - 1999 and 2000

Resistance factor:

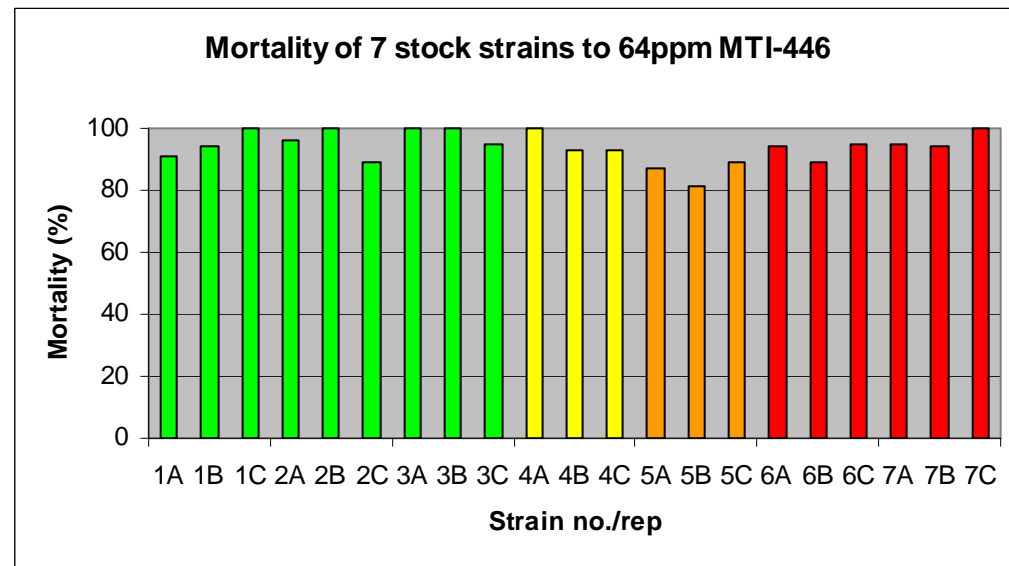
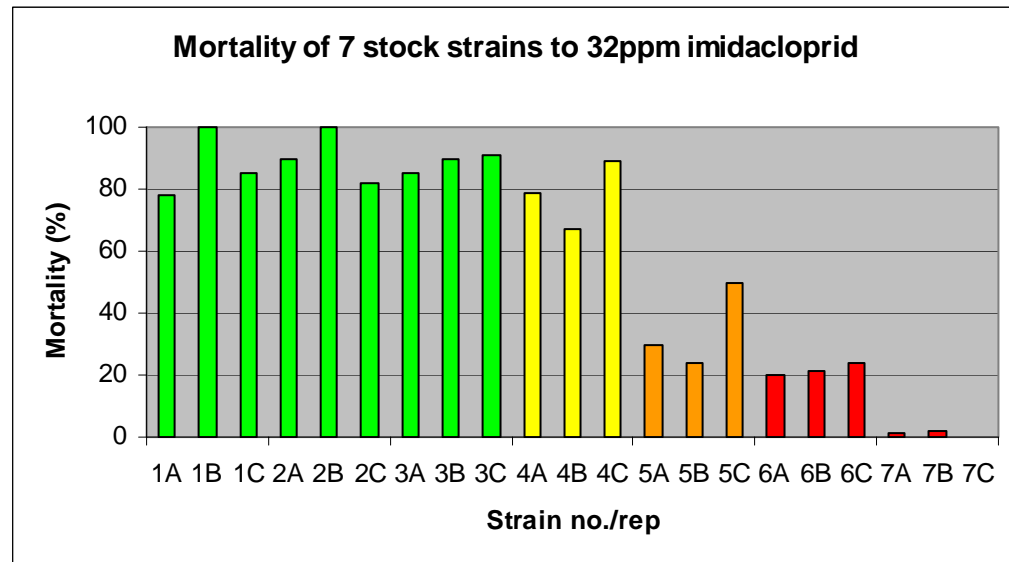
	Imidacloprid	Thiamethoxam	Acetamiprid
Sudan -S	1	1	1
Esp-1999	33	53	38
Esp-2000	>1000	301	142

- dramatic increase in resistance levels
- broad cross-resistance among neonicotinoids
- major impact on control efficacy

Source: Stumpf and Nauen (Bayer)

Discriminating dose bioassays

N o.	Strain name	Imid' status	resistance
1	EGYPT1	S	
2	PAK9	S	
3	GRB	S	
4	ALM1	LOW R	
5	ESP99	MED R	
6	AGUADULCE	HIGH R	
7	SPAIN-R	HIGH R	

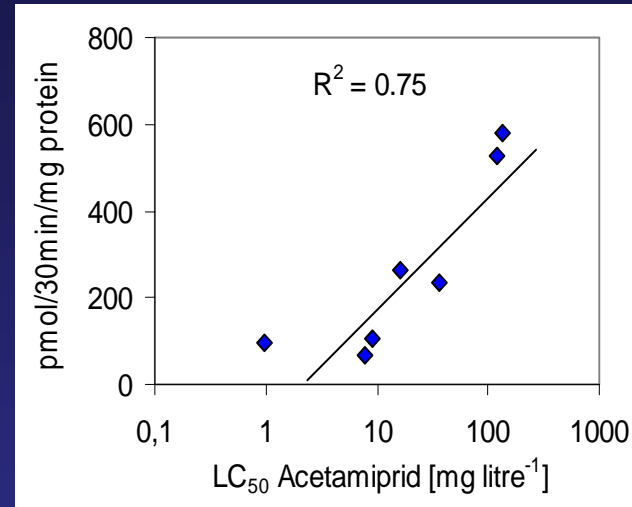
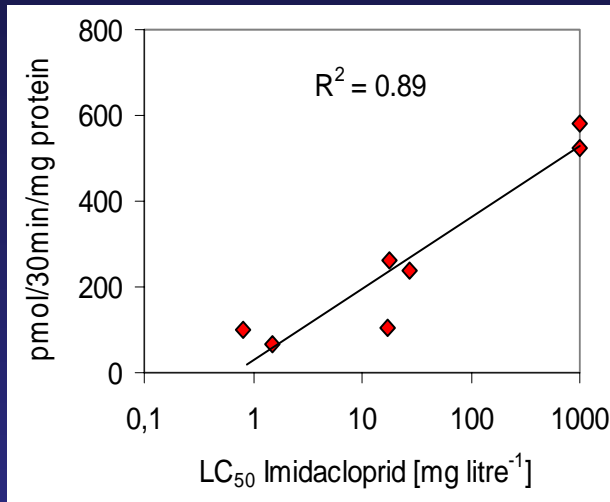


Resistance in Q-types in Europe

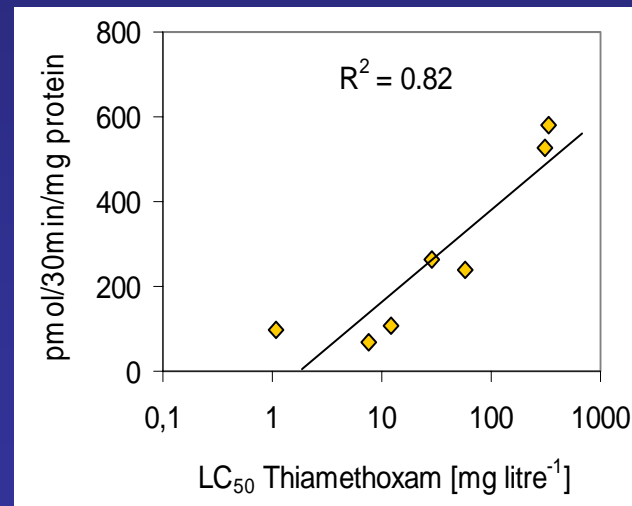
1. Neonicotinoids

- Now very potent in many regions
- Broad-spectrum across group
- Conferred (solely?) by enhanced monooxygenase activity

Neonicotinoid resistance in *B. tabaci*

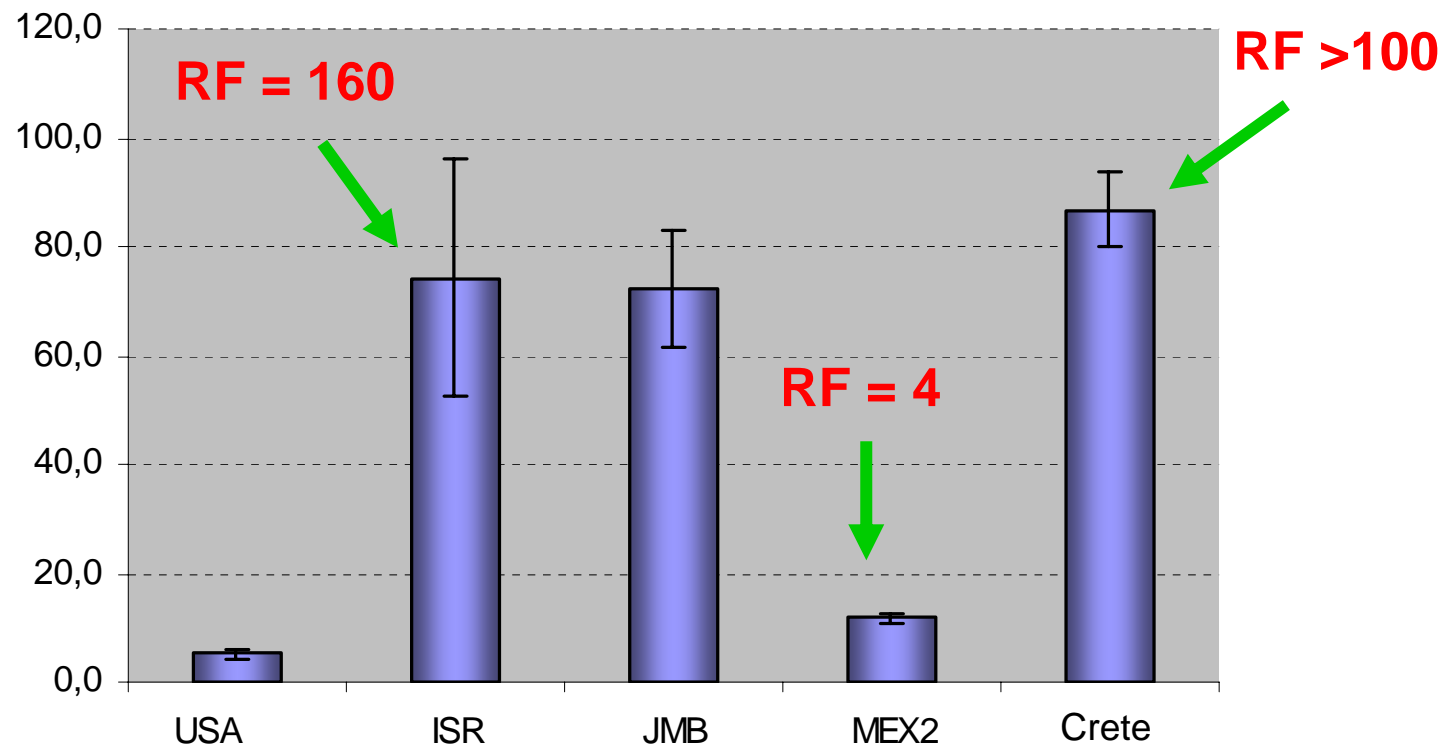


Resistance factors strongly correlated with cytochrome P450-dependent mono-oxygenase activity



Biochemistry of neonicotinoid resistance – molecular analysis of *B. tabaci* P450 genes identified *cyp6A14A* levels linked to neonicotinoid resistance*

Cyp6A 14A-Expression



*Data kindly provided by Dr. Juergen Benting (Bayer CropScience, Monheim, Germany)

Resistance in Q-types in Europe

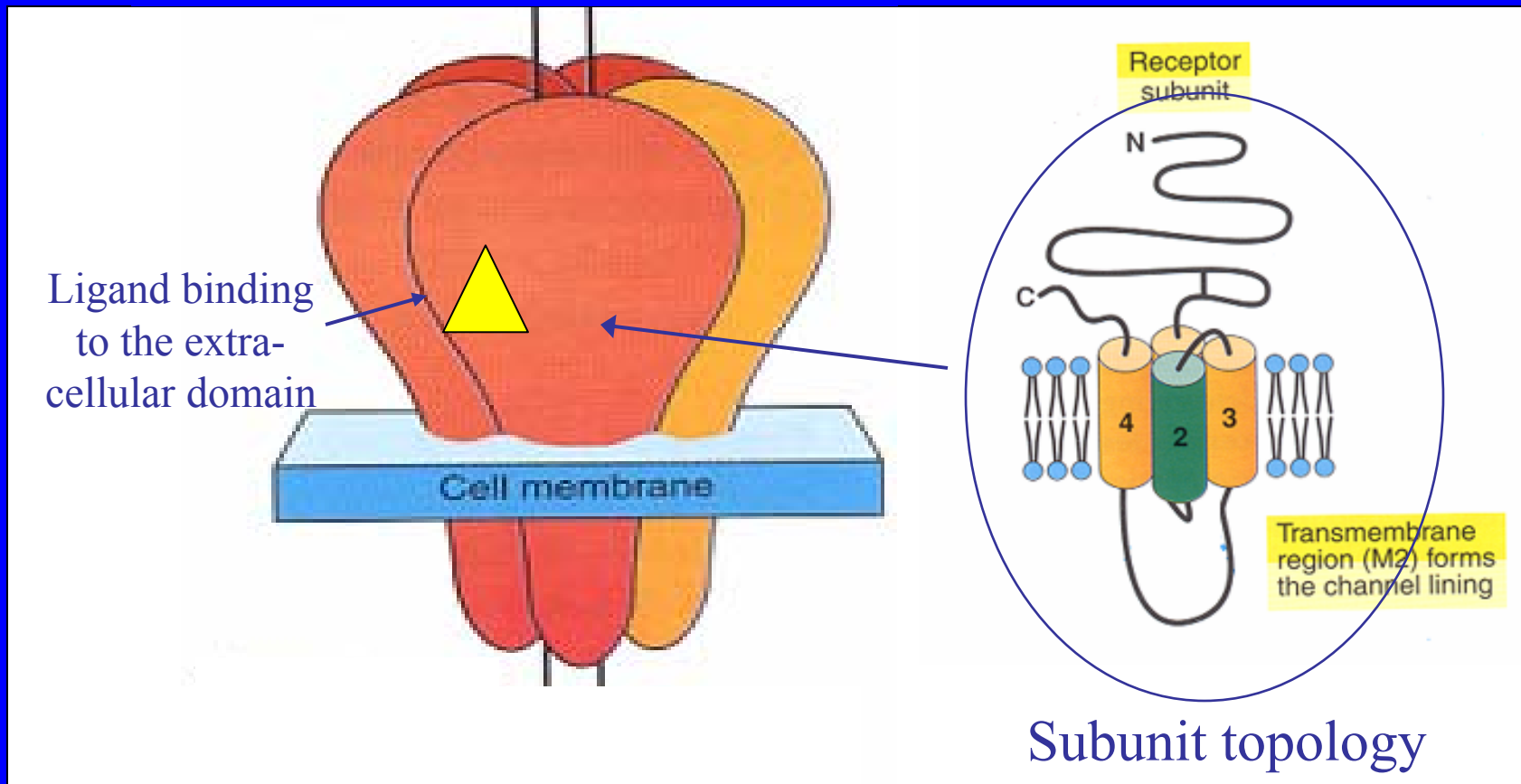
1. Neonicotinoids

- Now very potent in many regions
- Broad-spectrum across group
- Conferred (solely?) by enhanced monooxygenase activity
- Therefore cross-resistance to pymetrozine
- No target-site resistance (so far)



Brown planthopper, *Nilaparvata lugens*

Structure of the nicotinic acetylcholine receptor (nAChR)



- complex pentameric structure
- diversity of subunits implies a diversity of receptor structures?
- if so, is a single mutation in one subunit gene sufficient for resistance?

A tyrosine (Y) to serine (S) mutation in the N1alpha1 and N1alpha3 subunits confers broad-spectrum target-site insensitivity to neonicotinoids

```
1 GAT GGC AAC TAC GTG GTA ACG ACA AAG GCA GTA CTG CAT CAC ACG GGA AAG GTC GTA TGG
  D G N Y V V T T K A V L H H T G K V V W
61 AAA CCT CCA GCA ATC TAT AAG AGC TTT TGT GAG ATC GAC GTA CGA TAT TTC CCA TTC GAC +
  K P P A I Y K S F C E I D V R Y F P F D +
121 CAG CAG AAG TGT TTT ATG AAG TTT GGA TCC TGG ACA T ACC GAC GGC AAT CAT GTG GAC TTA
  Q Q K C F M K F G S W T Y/S D G N H V D L
181 CGT CAC ATG TCG CAG TCA CCA GAC TCG GAC ACG ATT GAC GTG GGC ATA GAC CTG CAG GAC +
  R H M S Q S P D S D T I D V G I D L Q D +
241 TAC TAC CTG TCG GTC GAG TGG GAC ATC ATG AGA GTA CCA GCC GTG CGC TAC GAG AAA TTC +
  Y Y L S V E W D I M R V P A V R Y E K F +
301 TAC TCA TGC TGC GAA GAG CC +
  Y S C C E E P +
```


Resistance in Q-types in Europe

2. Pyriproxyfen

- Highly potent, specific, monogenic
- Mechanism unknown

3. Buprofezin

- Little studied, assumed to be significant

3. Pyrethroids

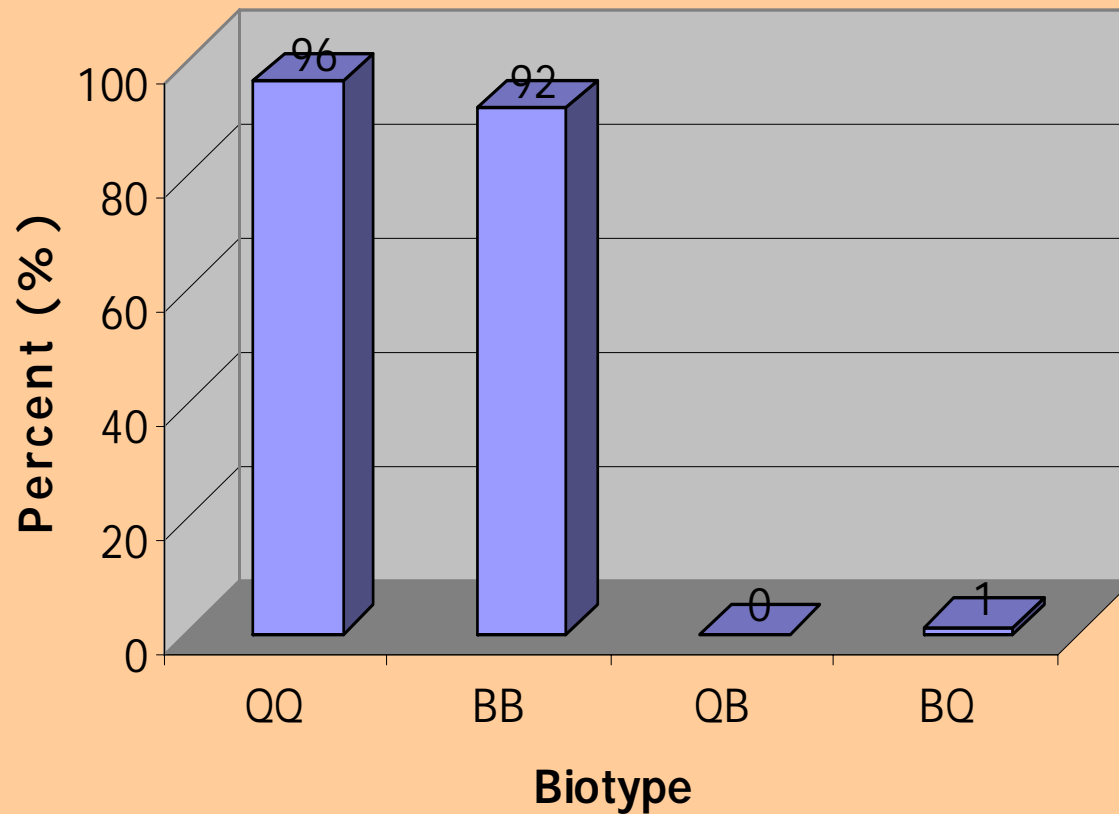
- Widespread, potent, combination of detoxification and target-site insensitivity (kdr)

No known resistance to spiromezifen, abamectin, (others?)

Biology of B- and Q-types

**Can resistance (and other) genes be transferred
between biotypes?**

Percentage of crosses producing female F₁ offspring



Pre-zygotic barriers

Pre-copulation: pairing

Intra- and inter- biotype crosses paired with similar success and within a similar time period



Copulation: mating

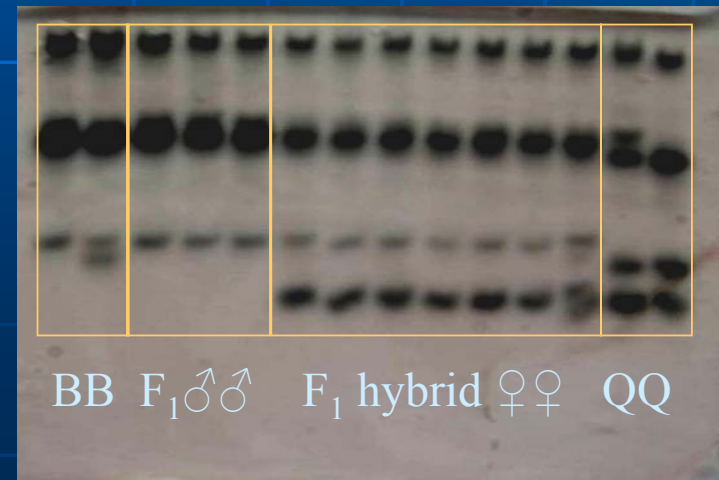
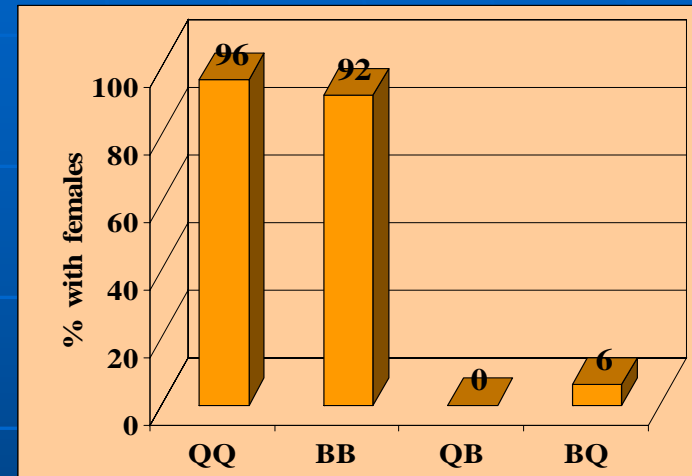
All intra-biotype pairs copulated within 4-30 minutes of pairing

All inter-biotype pairs failed to copulate within 3 hours (duration of exp.), apparently due to female rejection



Post-zygotic results

- Some inter-biotype crosses produced F_1 females
- Hybrid status confirmed
- All (100's) F_2 progeny failed to develop past the egg stage



Biology of B- and Q-types

**Can resistance (and other) genes be transferred
between biotypes?**

Pre- and post-zygotic reproductive barriers, so seems unlikely.....

..... but would be difficult to track if genes conferring 'B-ness' and 'Q-ness' get detached from biotype 'markers'

Biology of B- and Q-types

Competition between biotypes

Pascual and Callejas (2004), Nombela *et al.* (2002), Horowitz *et al.* (2005):

Evidence that B-types can out-compete Q-types when insecticides aren't used (or when 'unresisted' insecticides used?). Is this due to fitness drawbacks associated with resistance in Q-types, or a general handicap?

Rothamsted (unpublished data)

Outcome of using 'equally resisted' strains inconsistent.

Control of Q-types in Europe

- Use of less-resisted insecticides or mixtures (but *ad hoc* at times)
- More widespread application of IRM recommendations (cf. Israel and USA)
- Reduce use of insecticides
 - insect-proof netting, double doors, UV film etc.
 - mass release of biocontrol agents (do biotypes differ in vulnerability to BCA's?)