

Resistance of *Helicoverpa armigera* to Bt in China

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Presented by

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EC FPV project – Bt cotton in China 200-2004

Partners:

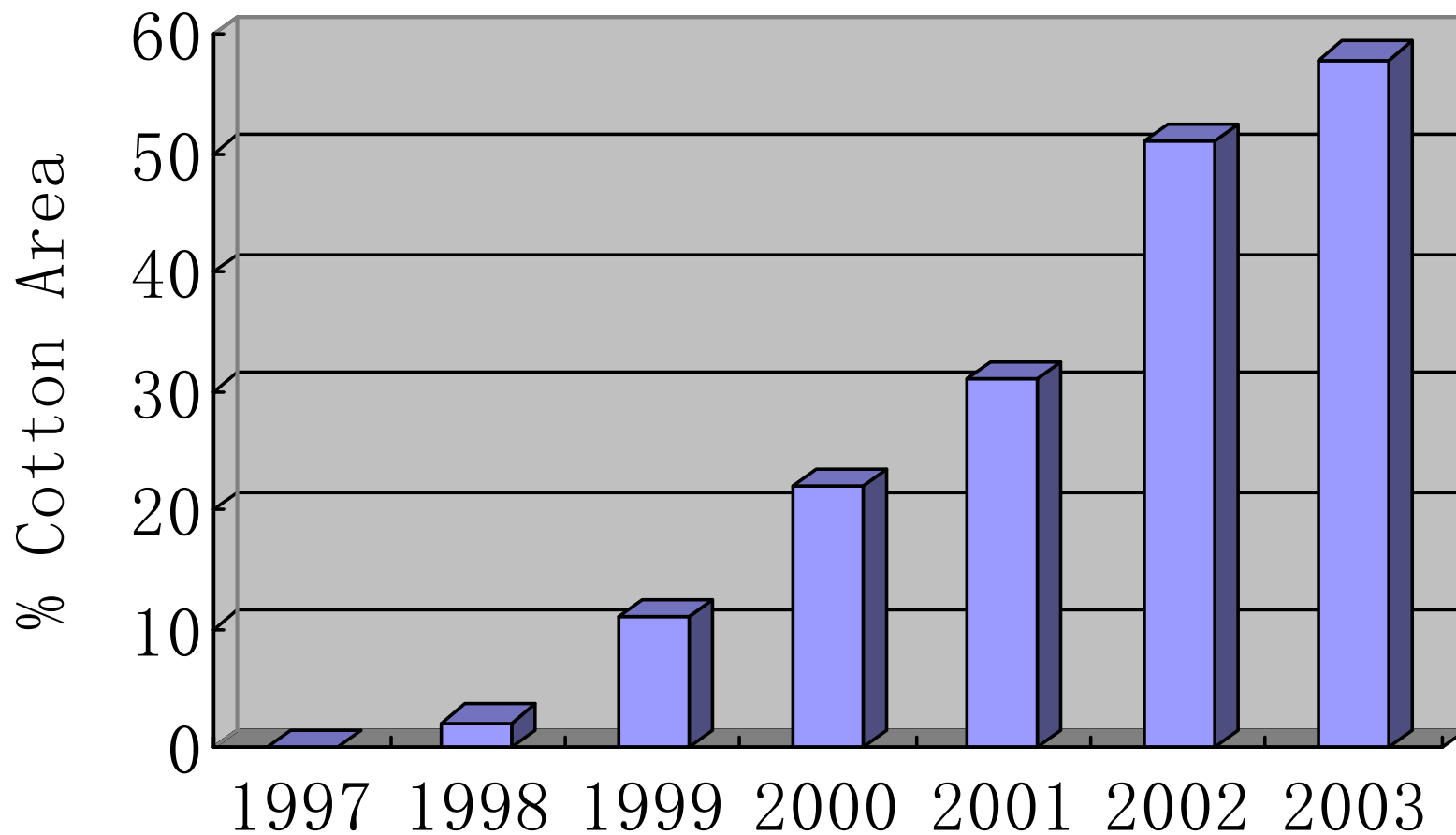
- Natural Resources Inst. UK – D.Russell
- Nanjing Agricultural Univ. China – Y.Wu
- CIRAD – J.M.Vassal
- Danish Institute for Agricultural Research – G.Lovei
- CABI – A Poswal
- NATESC – Yang Puyun

Status of cotton production and adoption of transgenic Bt cotton in China

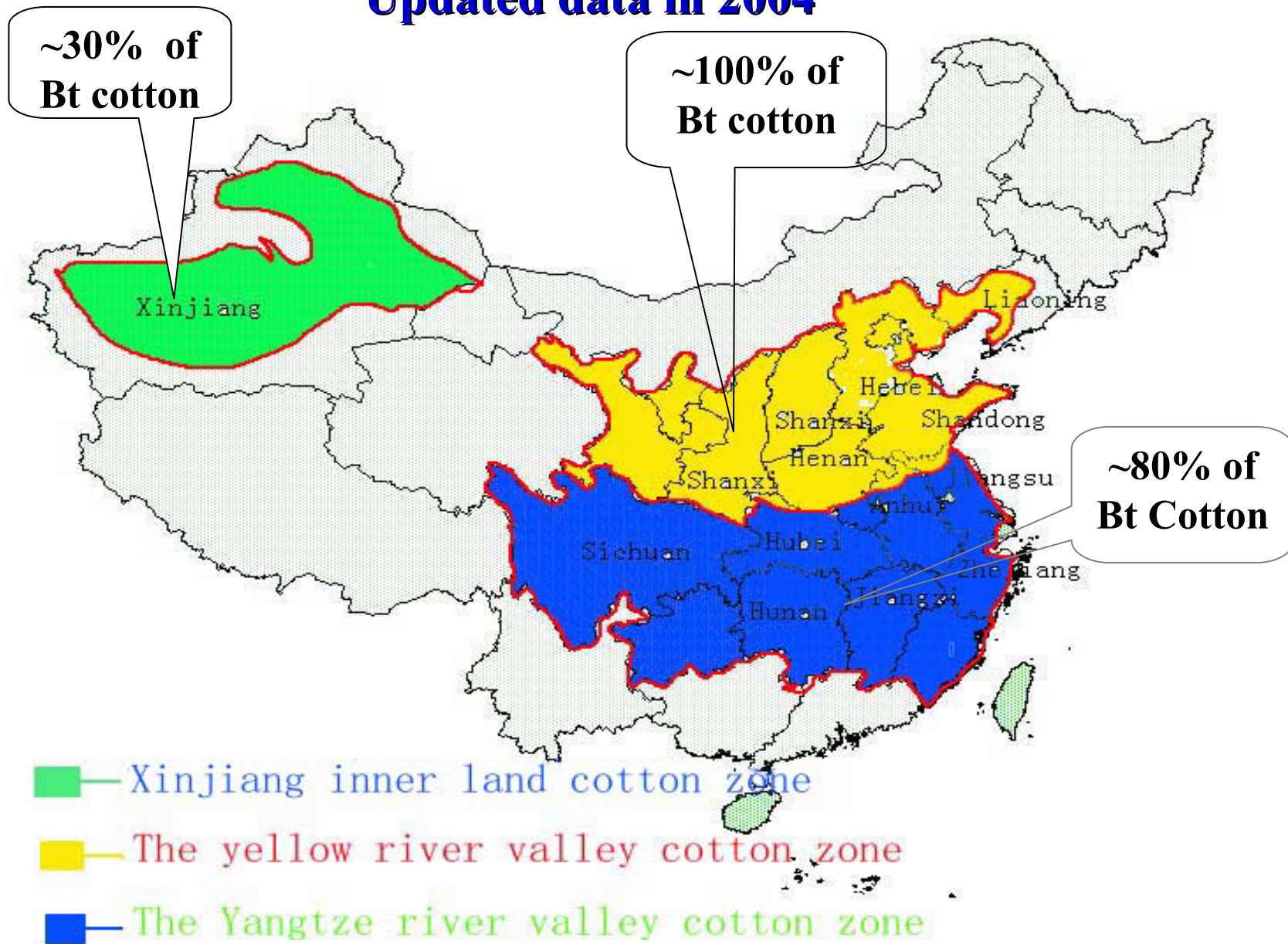
Total cotton area and lint yield of China from 1999 to 2002

| Year | Cotton area (million hectare) | Total lint yield (million tonne) |
|-------------|--|---|
| 2002 | 4.08 | 4.5 |
| 2001 | 4.76 | 5.32 |
| 2000 | 4.0 | 4.35 |
| 1999 | 3.7 | 3.83 |

Adoption of Bt cotton in China



Updated data in 2004



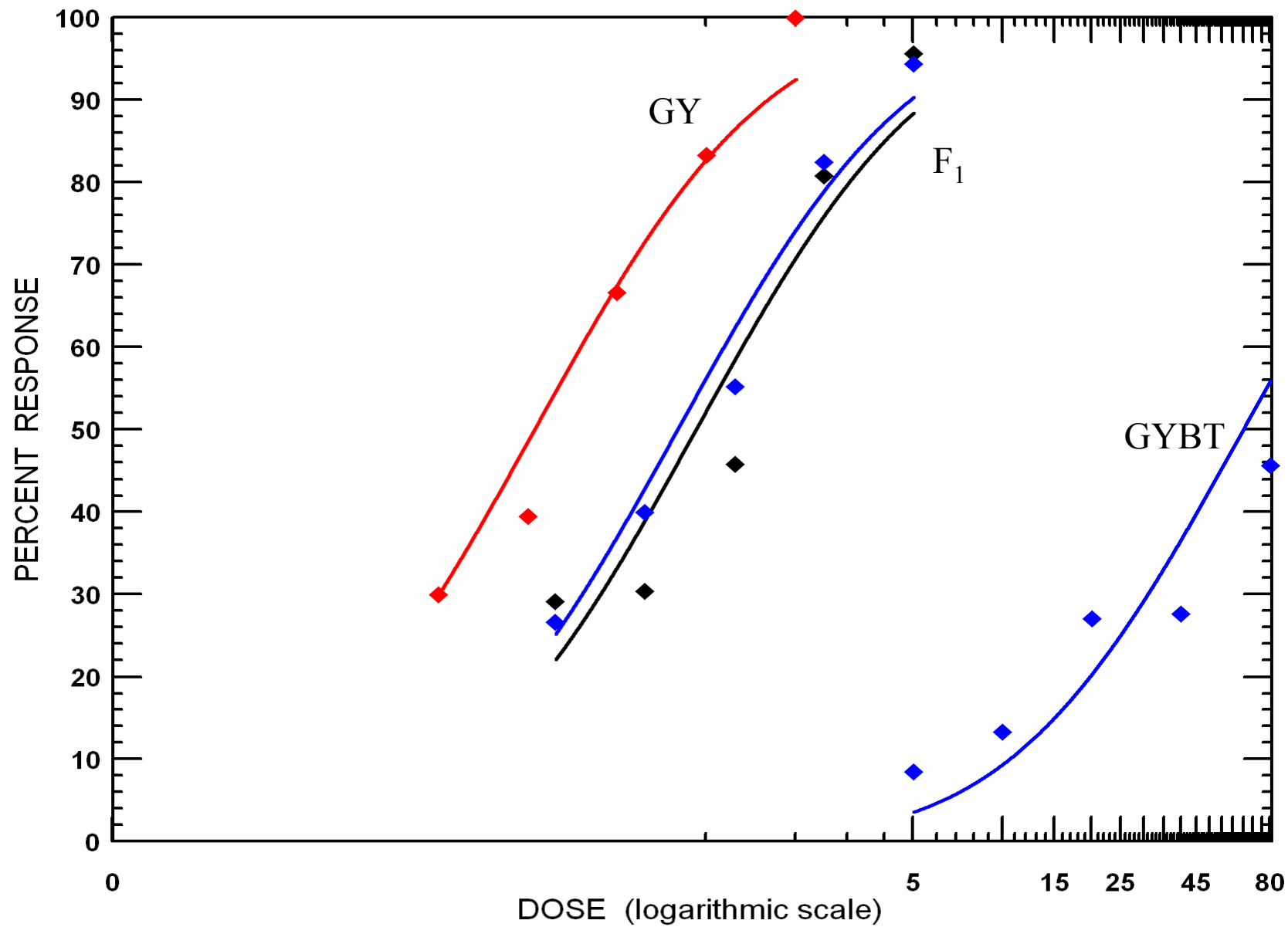
Objectives of our research on Bt resistance

- To assess the potential of Chinese *H. armigera* for resistance to *B. Thuringiensis*
- To develop efficient tools for the rapid detection of resistance as it develops
- To develop Bt transgenic cotton management options which reduce the risk of resistance development thereby maximising the useful lifetime of the technology.

**Cross resistance pattern of
Cry1Ac resistance in *H. armigera***

Cross resistance of the Cry1Ac-selected strain of *Helicoverpa armigera* (GYBT) compared with the control strain GY

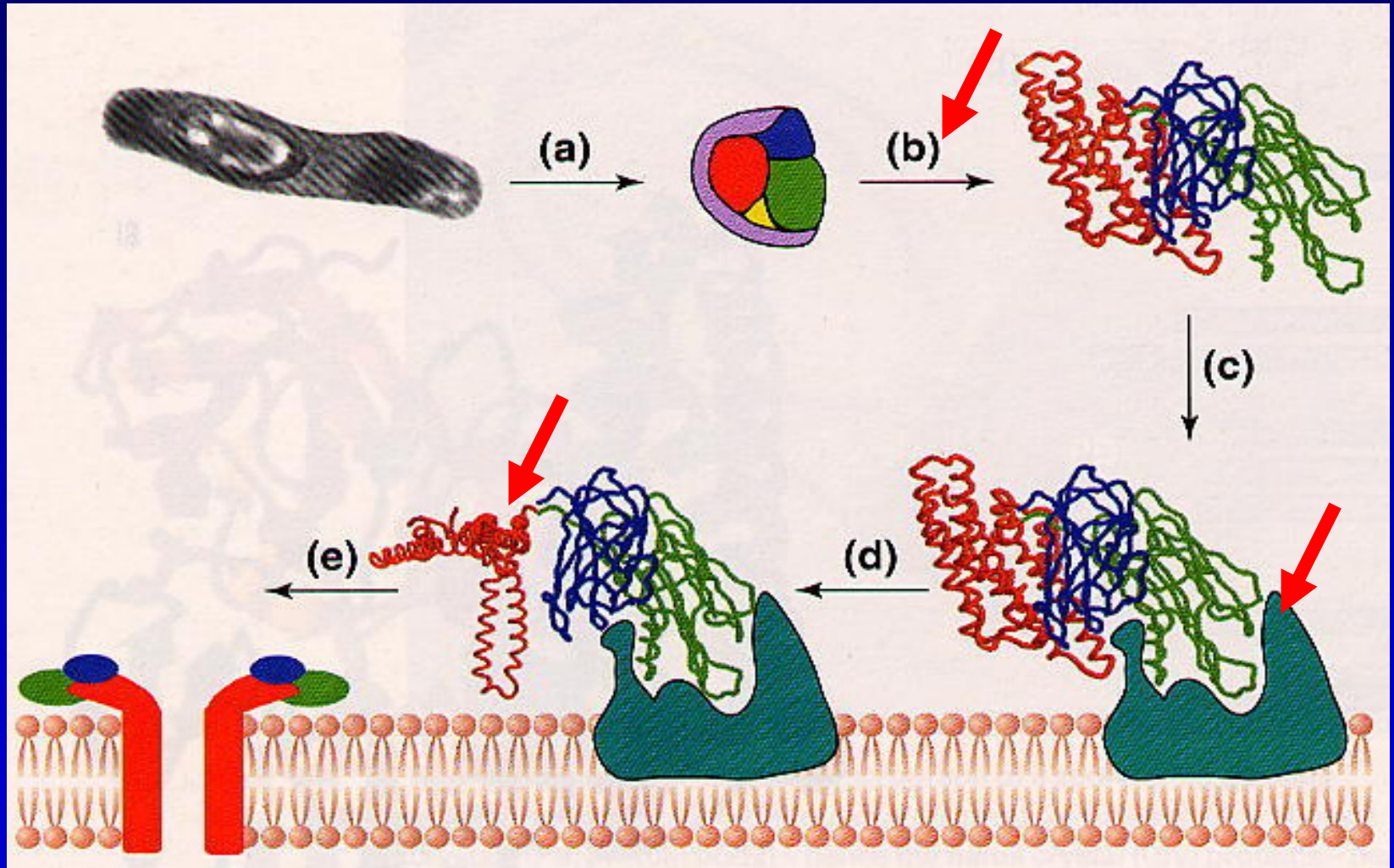
| Strain | Activated toxin | LC ₅₀ (μ g/cm ²) | 95%CL | Slope | RR |
|--------|-----------------|--|-------------|-------------|-----|
| GY | Cry1Aa | 1.44 | 0.80 – 2.38 | 1.17 ± 0.24 | 1 |
| | Cry1Ab | 3.23 | 2.15 – 5.28 | 1.42 ± 0.31 | 1 |
| | Cry1Ac | 0.1 | 0.08 – 0.12 | 1.60 ± 0.17 | 1 |
| | Cry2Aa | 1.02 | 0.57 – 1.67 | 1.21 ± 0.30 | 1 |
| | Btk HD-1 | 1247 | 984 – 1535 | 2.09 ± 0.25 | 1 |
| GYBT | Cry1Aa | 148 | 88.6 – 459 | 1.16 ± 0.32 | 103 |
| | Cry1Ab | >150 | | | >46 |
| | Cry1Ac | 56.4 | 31.4 – 217 | 1.0 ± 0.23 | 561 |
| | Cry2Aa | 1.41 | 0.97 – 2.01 | 1.61 ± 0.26 | 1.4 |
| | Btk HD-1 | 6205 | | 1.67 ± 0.23 | 5 |



Possible mechanisms?

Mode of action of Bt toxin

Bt毒素的作用机理

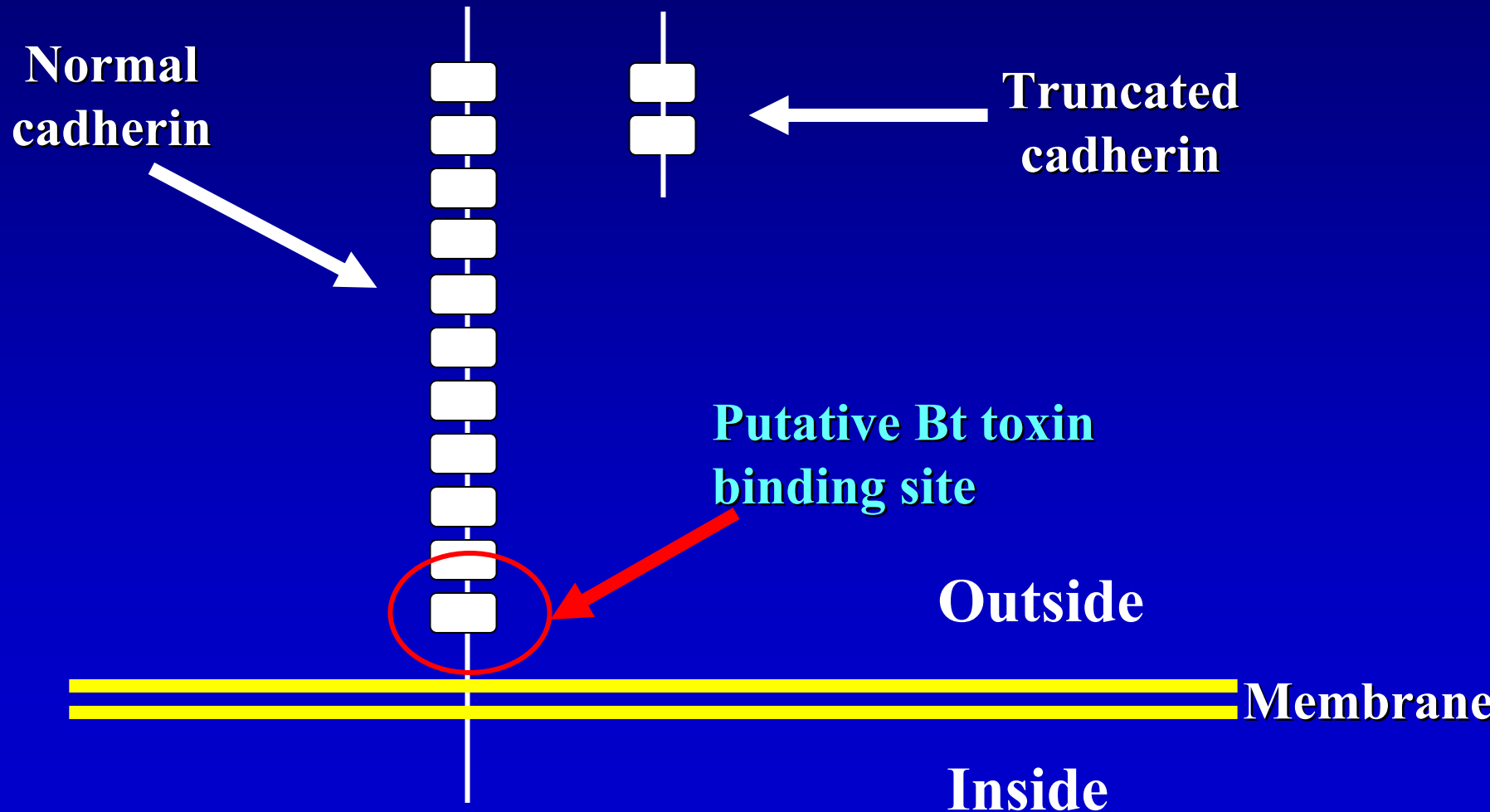


Two putative receptors:

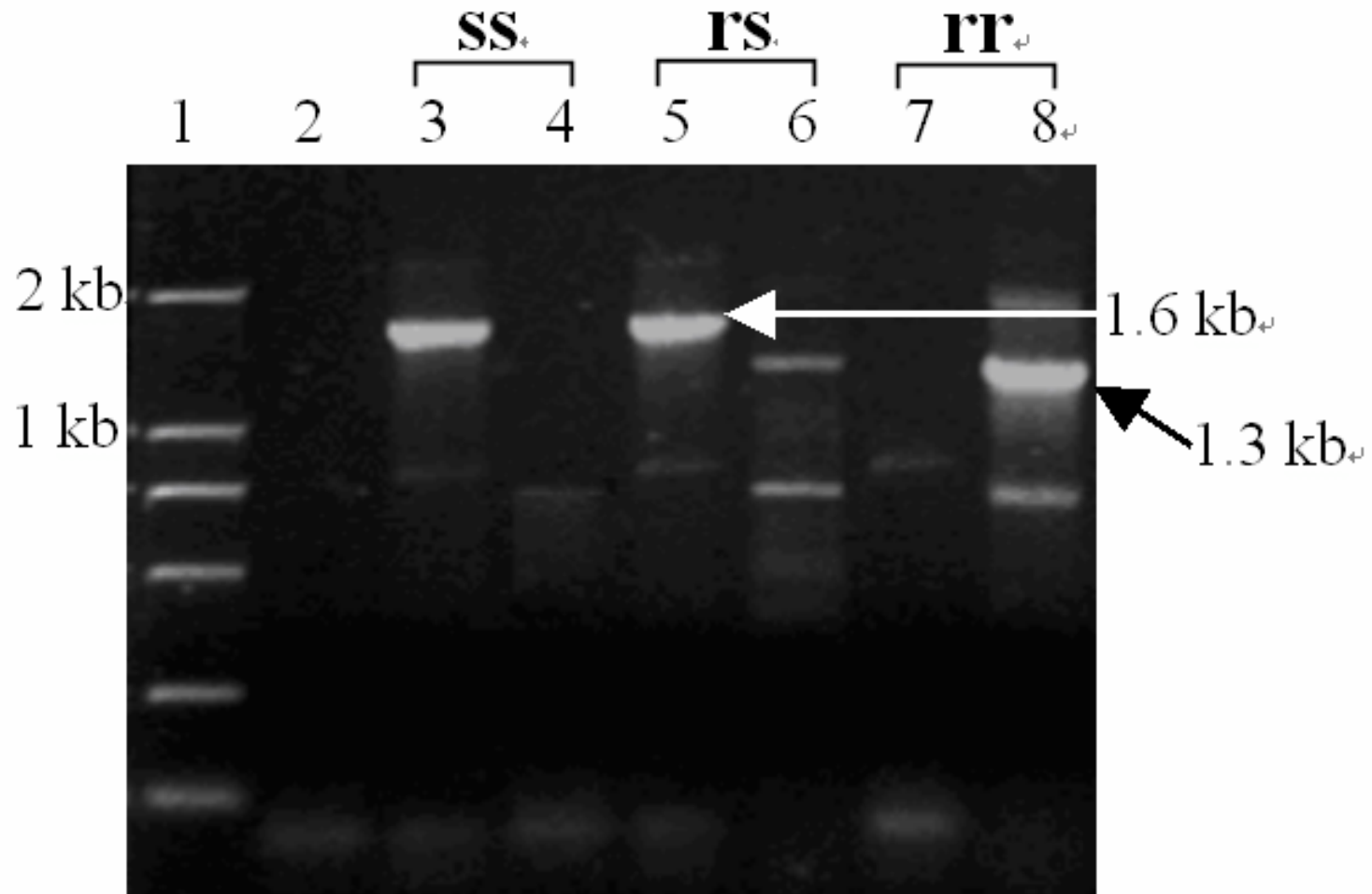
APNs

Cadherin

Cadherin disruption



Molecular diagnostics for Bt resistance gene (truncated cadherin)



Resistance frequency in the field in China (2004)

Cadherin mutation frequency:

**About 0.005
(5/1000)**

Resistance frequency in the field in China (2003)

Phenotype frequency:

About 0.001

(1/1000)

Genetic mapping of Bt resistance in *Helicoverpa armigera* with AFLP makers

Dr Yidong Wu, Nanjing Agricultural University (NAU), China

Dr Jean-Michel Vassal, CIRAD, France

Dr Monique Royer, CIRAD, France

Part A: Backcross analysis (Bioassay and genomic DNA extraction)

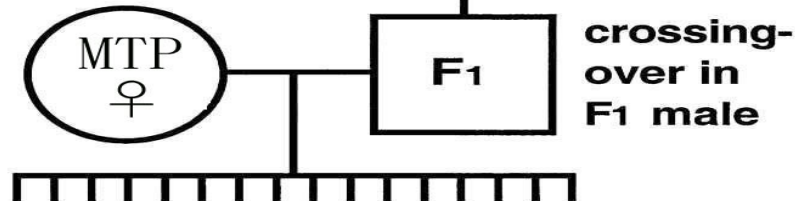
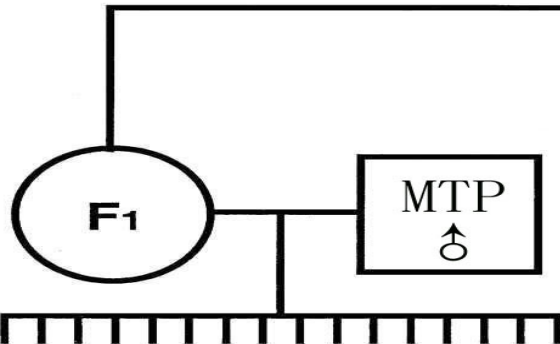
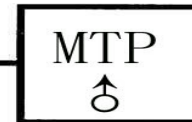
Susceptible strain of *Helicoverpa armigera*:
Montpellier strain

BT-resistant strain of *Helicoverpa armigera*:
BKBT strain

Bt resistance is inherited as one dominant autosomal gene.

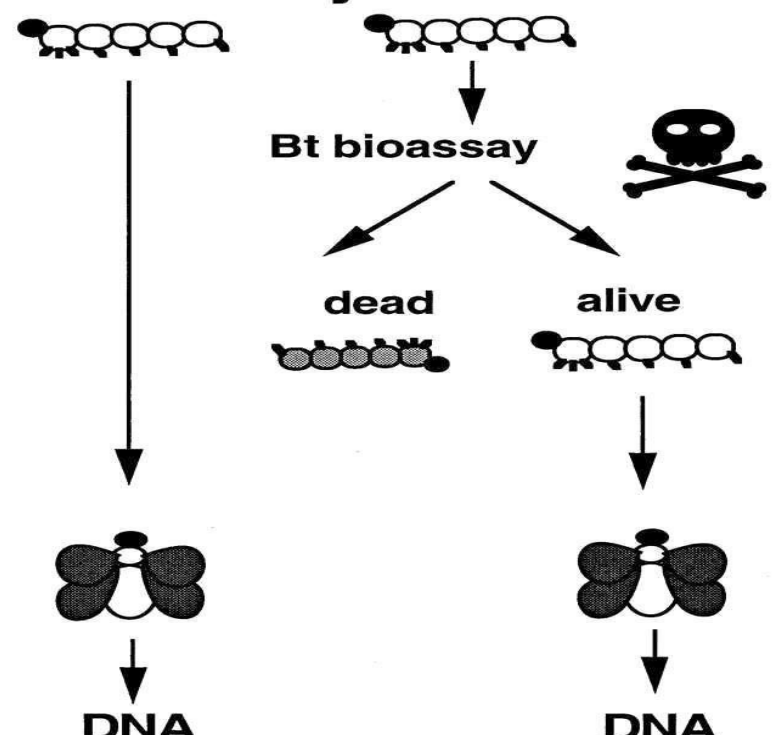
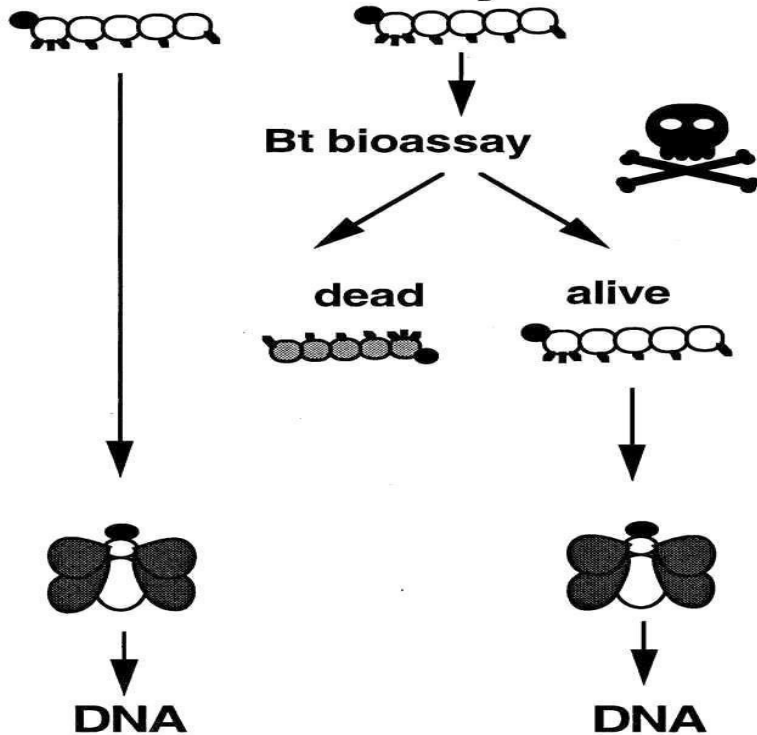
resistant

susceptible



Family BC1

Family BC2





LA LANGUEDOCIENNE

MTP ♂
x
MB2 ♀
BC10

MTP ♂
x
MB2 ♀
BC10

MB2 ♂
x
MTP ♀
BC10

P ♂
8 1/2
8 2 1/2

2002 6 8

81



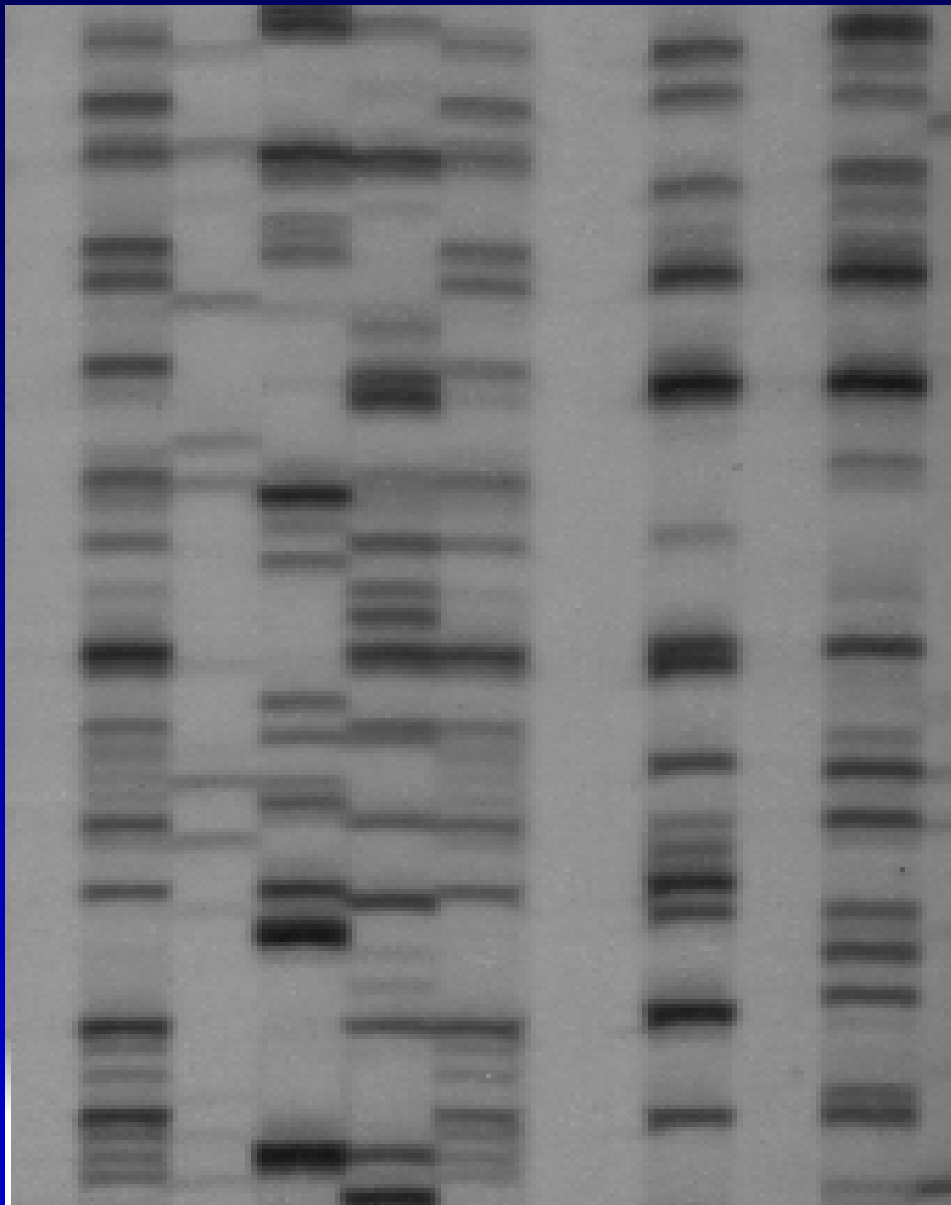
2002 6 24

Part B: AFLP makers linkage analysis

(i) Identification of linkage groups and tests of their contribution to Bt resistance

Family BC1: untreated adults, survival adults under DD of toxin

It is very important to get enough informative AFLP markers which are present in BKBT strain but absent in MTP strain.



AFLP analysis of genomic DNA from
Helicoverpa armigera

**(ii) Mapping Bt resistance gene
between two AFLP makers in one
specific linkage group**

Family BC2: untreated adults,
survival adults under DD of toxin

148 informative AFLP markers were identified.

5 markers are associated with Bt resistance

5 markers are in the same linkage group

Thank you!