Resistances to the tobacco cyst nematode complex in *Nicotianae*

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2006 CORESTA CONGRESS – Paris, 15-20 October

The tobacco cyst nematode complex

➔ **Host spectrum: Solanaceous plants**

- ✓ Tomato, egg-plant, tobacco, solanum sp.

➔ **Affects yield & leaf quality of tobacco**

➔ **Link with other diseases (*Fusarium* wilt)**

➔ **Build up of populations in soils**

- ✓ Short rotations of susceptible hosts

➔ **More difficult to detect than root-knot nematodes**

- ✓ Mature cysts (females) turn brown and detach from roots
- ✓ No deformation of roots
- ✓ Likely under-estimated problem

The tobacco cyst nematode complex

➔ *Globodera tabacum*

- ✓ *Globodera tabacum tabacum* GTT
  - USA: Connecticut, Massachusetts
  - Bulgaria, Italy, France…
- ✓ *Globodera tabacum solanacearum* GTS
  - USA: Virginia
  - Closely related populations in Mexico
- ✓ *Globodera tabacum virginiae* GTV
  - USA: Virginia

➔ Cyst nematodes probably present in many tobacco producing countries

- Spain, Argentina, etc…

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Material and methods

➔ Greenhouse test (INRA Rennes)

- ✓ 14 well characterized *Globodera* populations
  - 5 plants / population in 1000 cm3 pots
- ✓ Cysts in nylon bags → 10 J2 / g of soil.
- ✓ 120 days after planting, cysts extracted (Kurt elutriator) and counted.

➔ Field tests (Tabac Garonne Adour)

- ✓ 2004, 2005 & 2006: same farm, Virazeil, Lot-et-Garonne, Fr.
- ✓ Highly infested with GT but also some *Meloidogyne*
  - Likely GTT (French GT populations from adjacent localities identified as GTT, Marché 1997)
- ✓ Cyst count on roots (2') or notation
  - 6 to 15 plants / entry depending on trial.

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M&M, *Globodera* populations in greenhouse test

Population name	Location / code (country)	host	Identification **
Santa Ana	Santa Ana (ME)	wild *Solanum*	GM
Tlaxcala	Tlaxcala (ME)		
GM4 *	Huamanda (ME)		GTV
GM5 *	Huamanda (ME)		GM
GM3 *	(ME)		GTT
GV2 *	(USA)	tobacco	GTV
GV3 *	Crutchlow (USA)		GTV
GV1 *	(USA)		GTS
GS2 *	(USA)		
GS3 *	(USA)		
GS1 *	Watkins (USA)		
Connecticut *	(USA)		GTT
Aiguillon	Aiguillon (F)		
Agen	Agen (F)		

* Populations from L. I. Miller collection (University of Virginia, USA).
** GM: *Globodera "mexicana"*.

* Classified by Miller, Virginia University and modified (RAPD, AFLP) (Thiéry et al 1997, Marché et al. 2001)

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Results, greenhouse test (INRA Rennes)

Good correspondence host spectrum / classification from molecular data

Mean cyst number		Host						Non host			
Population	Group	*bigelovi*	*sylvestris*	*debneyi*	Samsun	Cocker 254	PBD6	*benthamiana*	*longiflora*	*repanda x sylvestris*	*repanda*
Santa Ana, Tlaxcala, GM5	GM	48	1	1	0	2	0	0	0	0	0
GM3, Connecticut	GTT (USA)	44	140	40	85	12	0	2	0	0	0
Aiguillon, Agen	GTT (Fr)	38	21	25	43	2	22	1	0	0	0
GM4, GV2, GV3	GTV	40	74	16	35	17	8	0	7	0	0
GS1, GS2, GS3, GV1	GTS	61	145	52	172	142	6	12	0	0	0

Resistance of *N. repanda* and *N. longiflora* effective against GTT and GTS from different origins,
GTT Fr: specific ability to multiply on PBD6 → ancient presence of GTT ?

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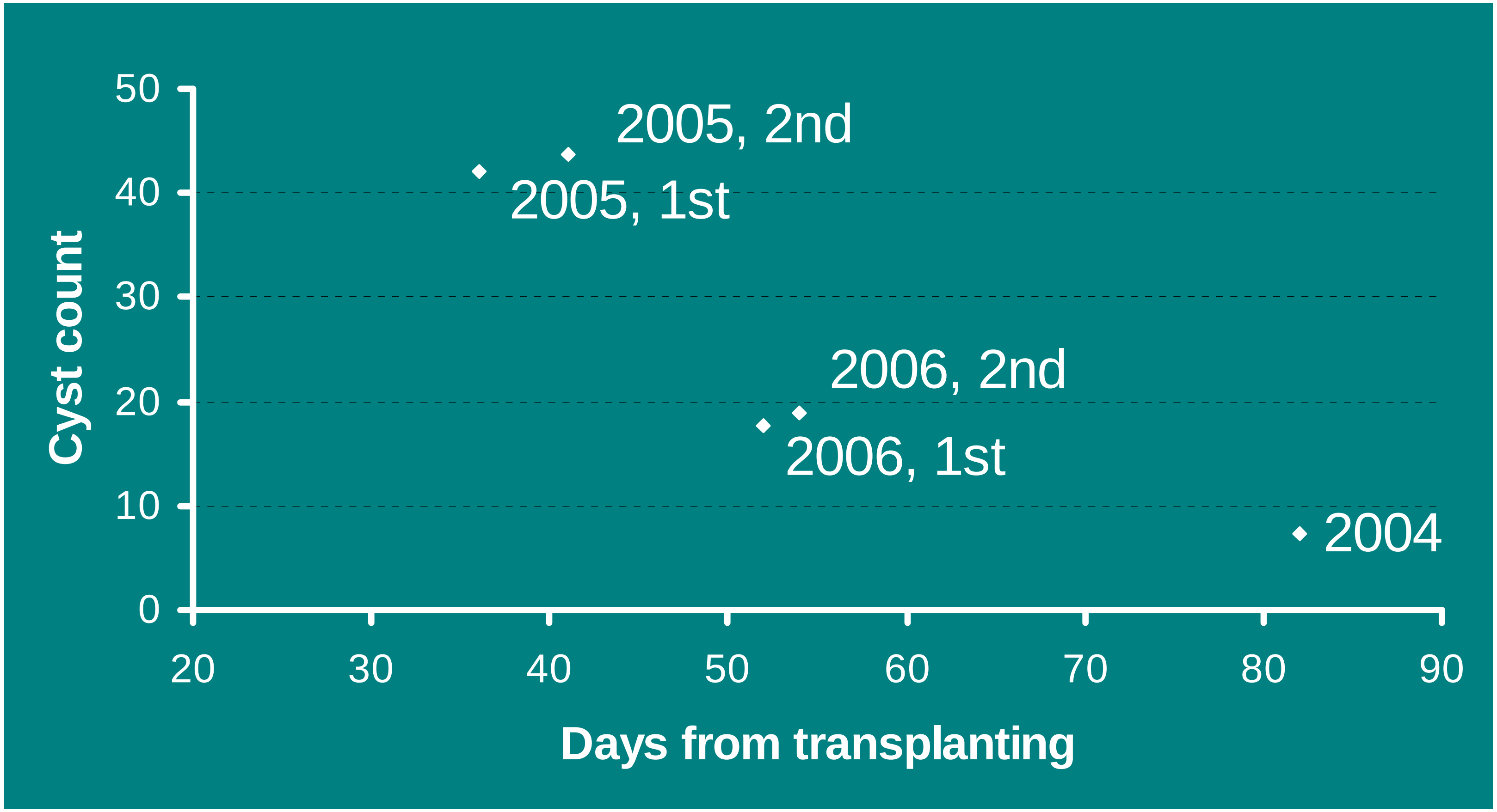
Results, field tests

➔ **Highest cyst counts 40 days after transplanting**



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Results, field tests, cultivar screening

2004

Cultivar		Mean count (9 plants)	NK group **
Coker 371	Ph	1,3	a
Burley 64	WF res	3,9	b
Burley 21	WF res	4,6	b
K 326		6,9	bc
Kutsaga 110	WF res	7,7	bc
TN 90	WF res	7,9	bc
NC 567		13,3	bc
K 394		12,7	c

** based on log. transformed data

Ph: from *N. plumbaginifolia* origin, res. to PPN race 0.
WF res: from *N. longiflora* origin, Wildfire res.

2006

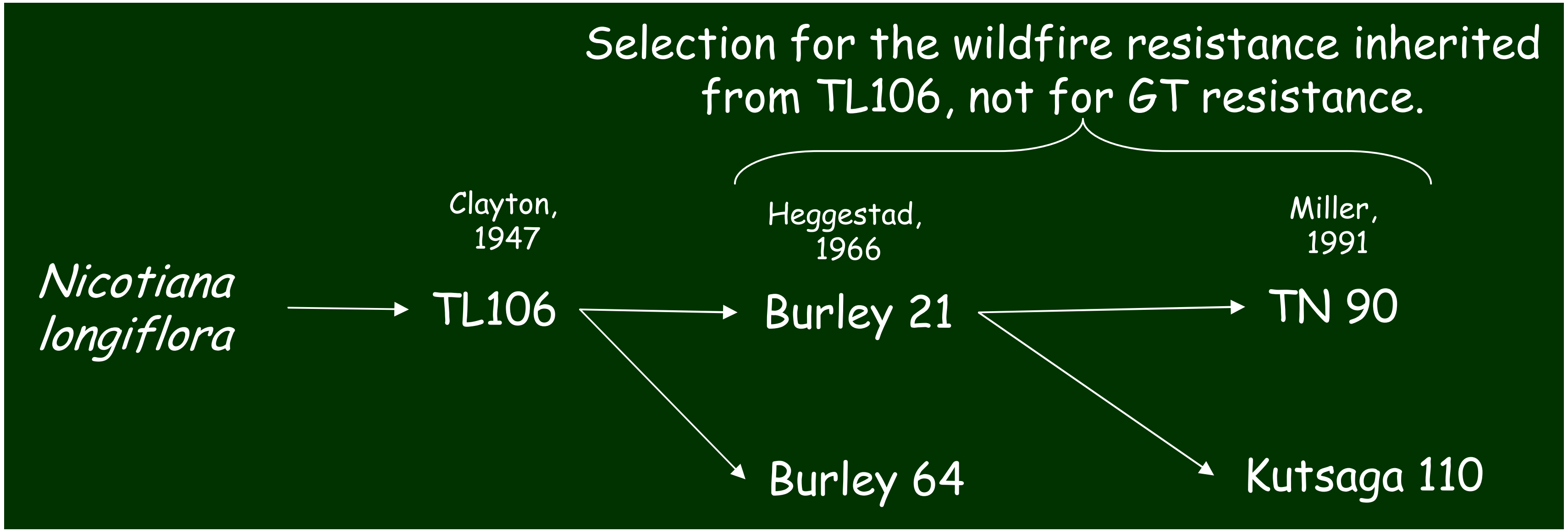
Cultivar		average class *	NK groups
TL 106	WF res	0	a
RGH 51	Ph	0,2	ab
NC 71	Ph	0,3	ab
KYR **		0,8	abc
Coker 254		1	bc
K394		1,3	c
PBD6		1,7	c
Hicks		2,5	d
TN 90	WF res	2,5	d
Bright Cospaia		2,7	d

* **0**: none, **1**: 1-3, **2**: 3-10, **3**: 11-30, **4**: 31-100, **5**: > 100 cysts. ** Breeding line.

➔ GTT resistance associated with the Ph gene ?

- ✓ Also observed in Virginia (USA) with GTS (Johnson C.S. 2001)

N. longiflora resistance factors in TL 106



GTS Virginia	R		R	(Hayes et al. 1997)	R
GT Virazeil	R	R	Some Res.		S

➔ **GT Virazeil: loss of *N. longiflora* resistance factors through breeding cycles from TL 106 to TN 90 and Kutsaga 110 ?**

✓ Factors not required for resistance to GTS, Virginia ?

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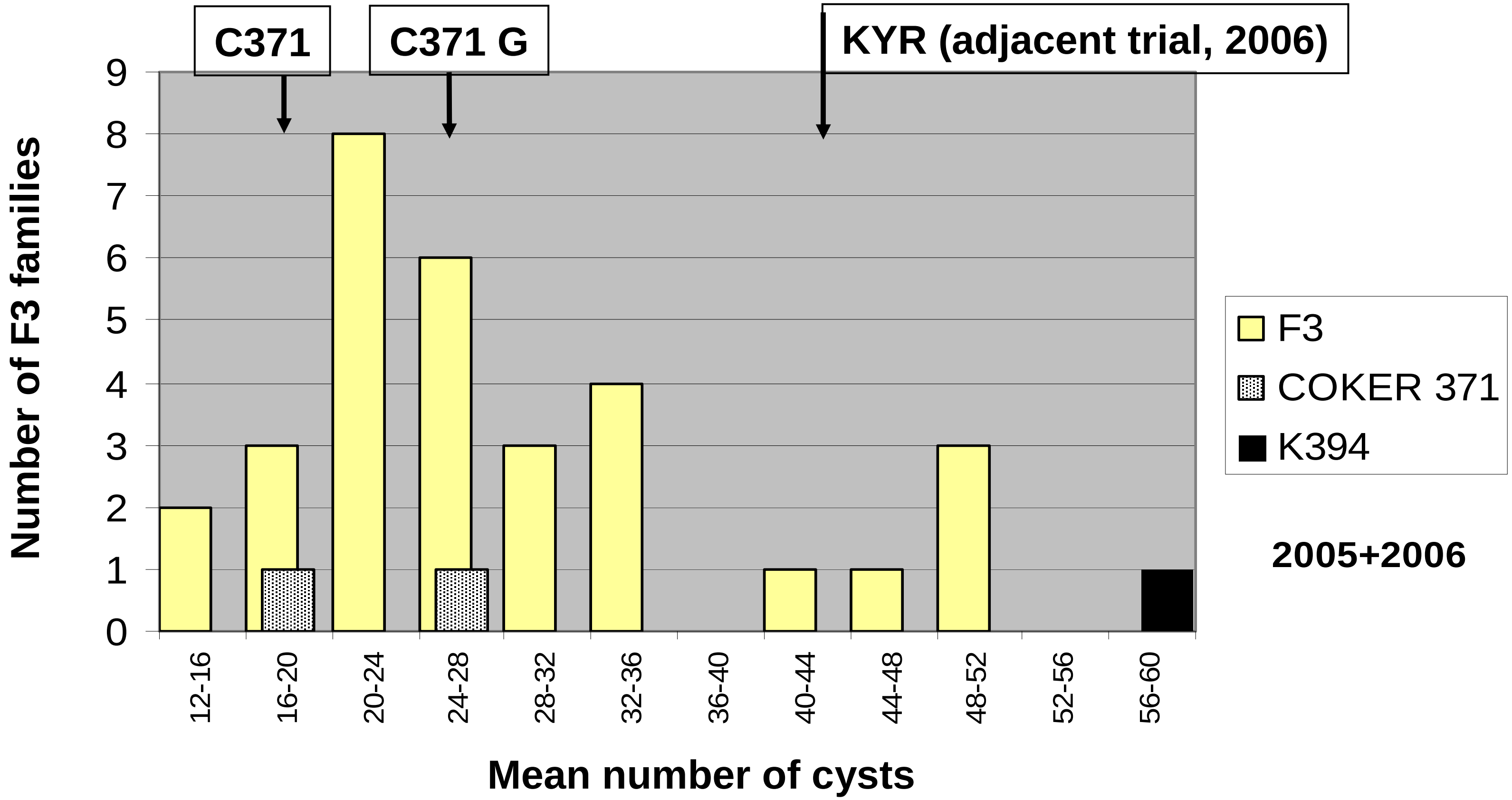
Inheritance of the resistance from Coker 371 Gold

➔ F3 families from Coker 371 Gold x KYR

✓ KYR: breeding line with K326 parentage.



Inheritance of the resistance from Coker 371 Gold

➔ F3 families from Coker 371 Gold x KYR

- ✓ The bimodal distribution fits with the hypothesis of one dominant gene from Coker 371 Gold conferring partial resistance to GT Virazeil.

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Conclusions

➔ *Nicotianae*

- ✓ Widest resistance spectrum: *N. repanda*
  - Dominant factors (*N. repanda x sylvestris*)
- ✓ *N. longiflora* res. to every GTS and GTT populations.
- ✓ *N. bigelovi* is a host for all GT and GM populations.

➔ *N. tabacum*.

- ✓ Introgressed resistance factors efficient against GT Virazeil
  - from *N. plumbaginifolia* (in Coker 371 Gold).

    Likely one dominant gene.

    Associated with Ph.
  - from *N. longiflora* (in TL 106).

    Loss of some of these factors through breeding cycles when selection for wildfire resistance ?