Roguing for management of Peanut bud necrosis virus in tomato

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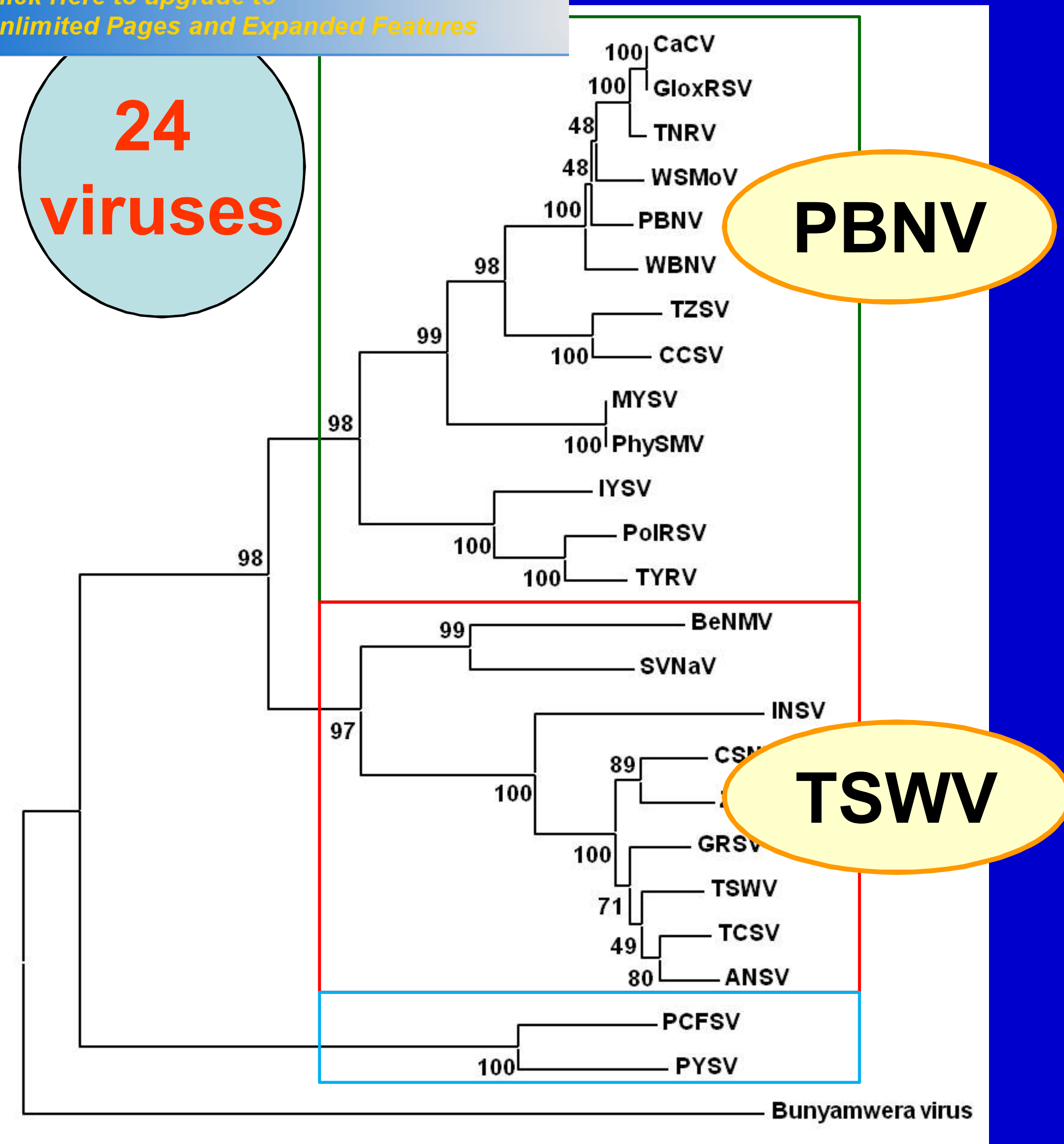
Tospoviruses

Type member: Tomato spotted wilt virus

Group of emerging plant viruses causing economically significant damage to a broad range of field crops, vegetables, ornamentals, fruits, e tc.

...en tospoviruses and thrips vector species

24 viruses



Phylogenetic tree - N protein

Majority in Eurasia
Primary vector:
Thrips sp.

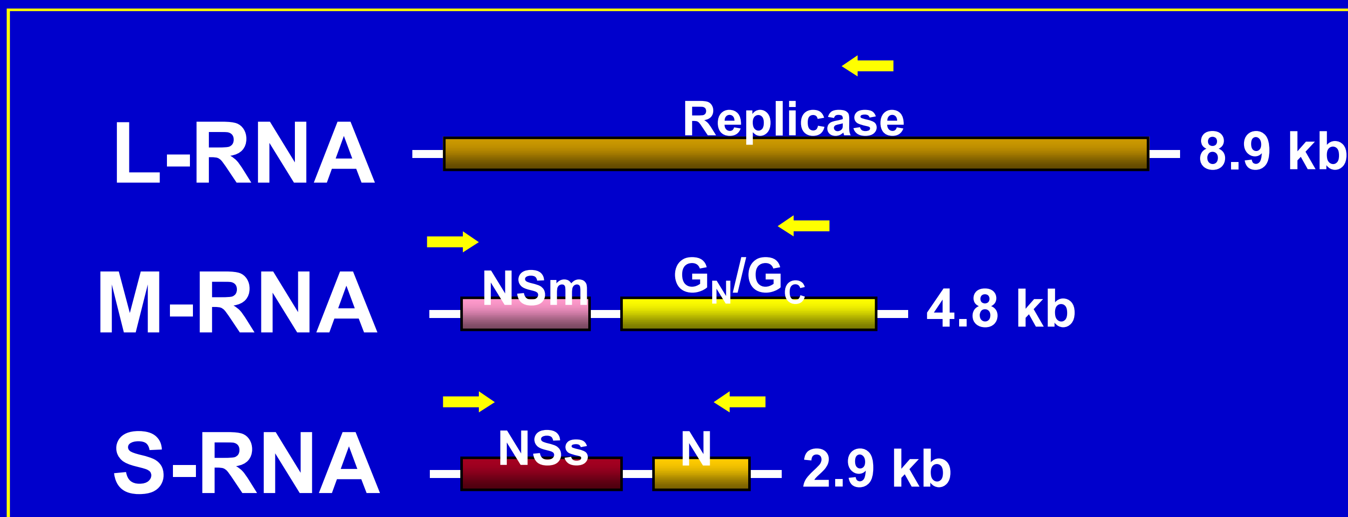
Majority in Americas
Primary vector:
Frankliniella sp.

In Asia
Primary vector:
Scritothrips sp.

es have a complex genome

Tri-partite genome: three genomic segments

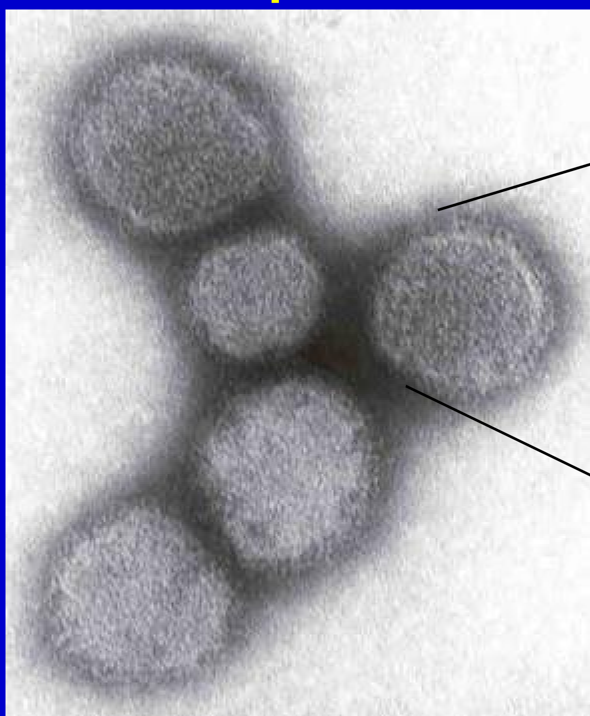
Organization



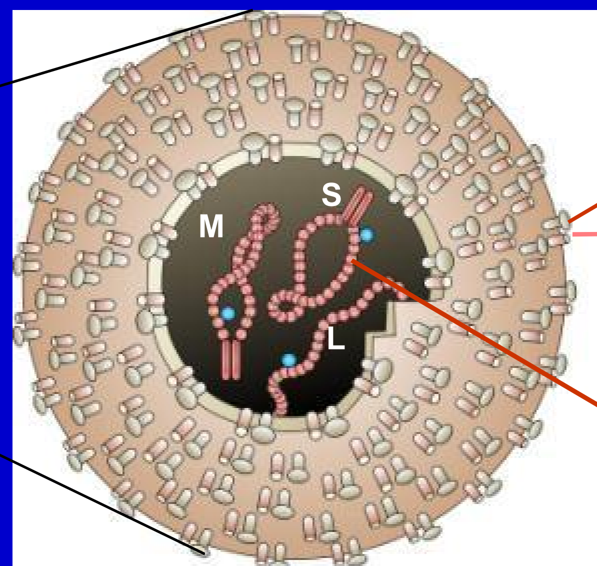
L-RNA = negative sense
M- & S- RNA = Ambisense

Tospoviruses

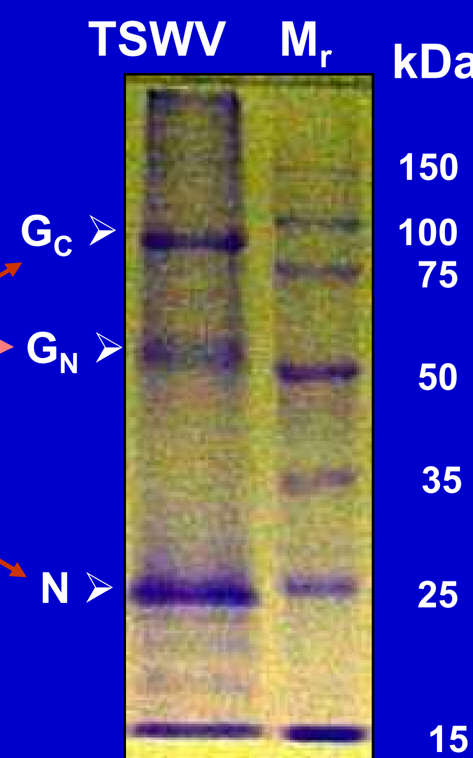
Electron micrograph of TSWV particles



Drawing of TSWV particle



SDS-PAGE of TSWV particle proteins



Pleomorphic particles = 80-120 nm size

opagative mode of transmission

Plants

T. palmi

Ability to multiply in two disparate hosts

Source: Zenkoko Noson, Kyoiku Kyoiku Co. Ltd., Japan

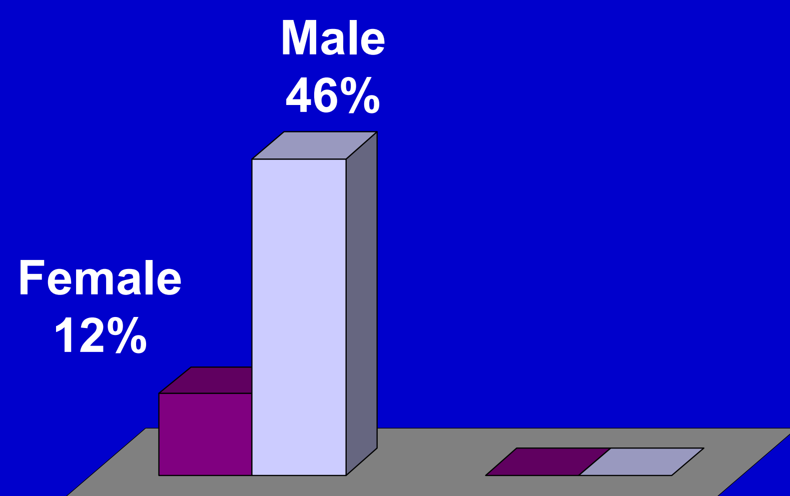
-specific differences in virus transmission

Western flower thrips

Male Female

Source: Ullman et al., 1997

Transmission efficiency



Males are efficient transmitters

Naidu et al., Plant Pathology 57: 190-200 2008

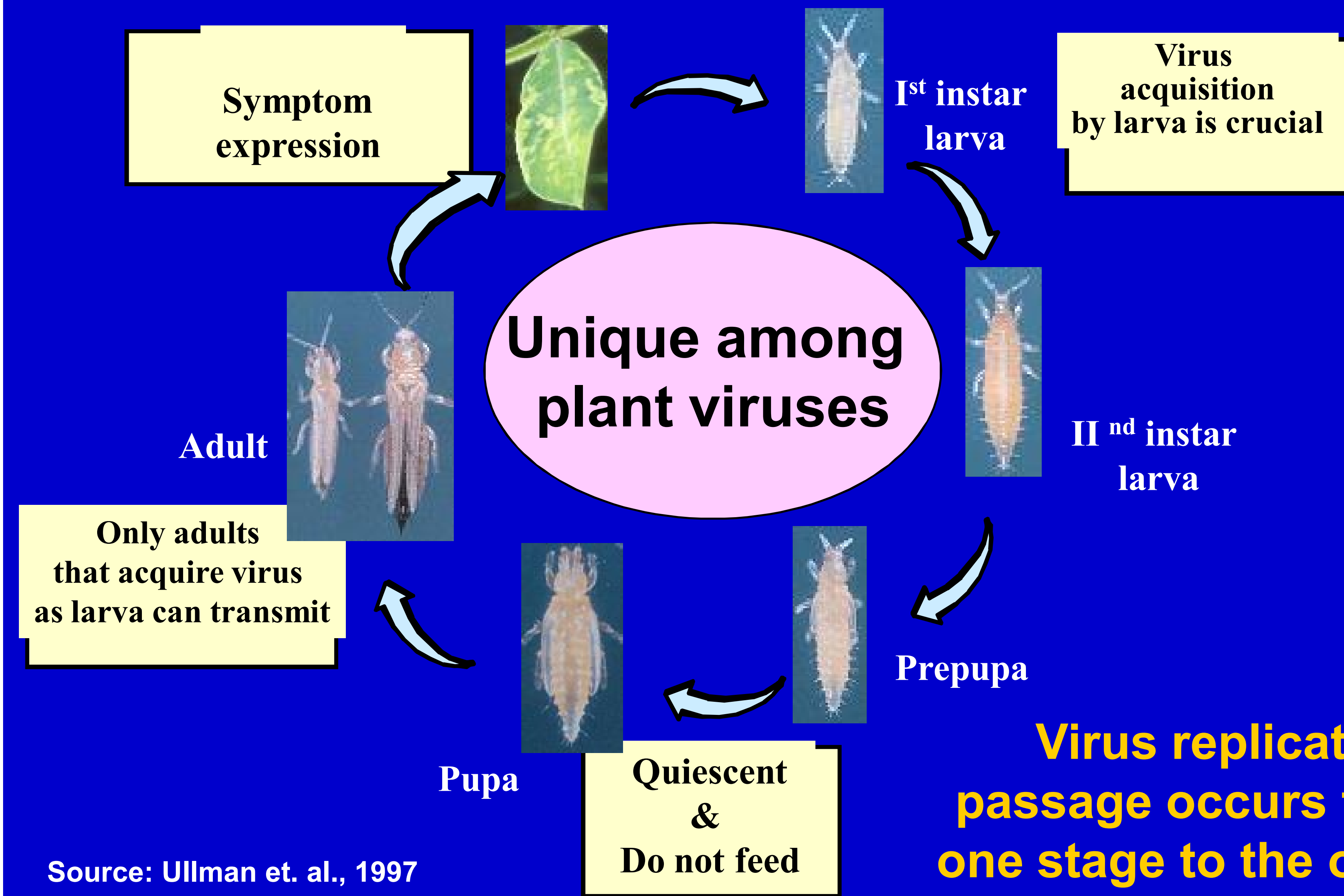
e stages of thrips

Egg Larva I Larva II Prepupa Pupa Adult♂ Adult♀

Source: Ullman et. al., 1997

ÅLarvae and adults: feeding stages
ÅPre-pupa and pupa: non-feeding stages
ÅLarva to adult = 15-25 days

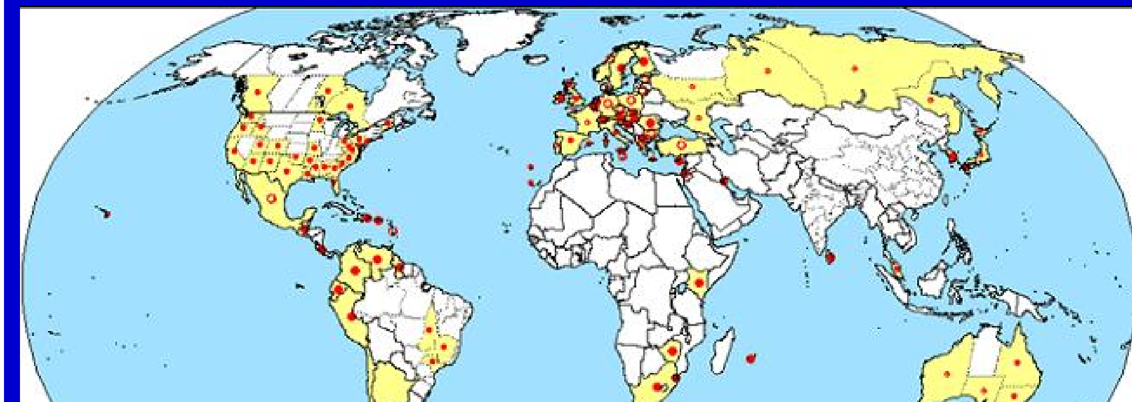
…ency between vector life-stage …ductive virus transmission



Virus replicates & passage occurs from one stage to the other

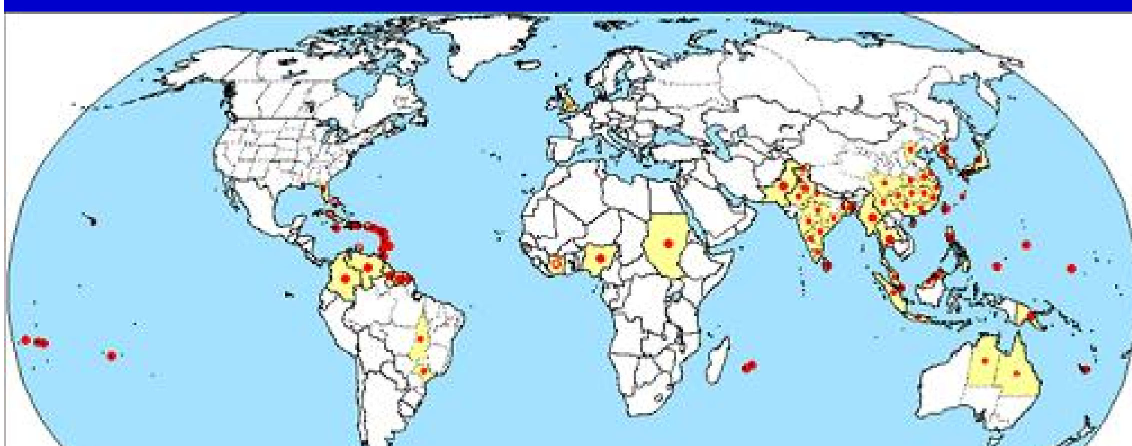
Source: Ullman et. al., 1997

…hemisphere spread of tospoviruses & thrips vectors



Western flower thrips (*Frankliniella occidentalis*)

- A native to the south-western USA
- Spread through global trade in ornamental greenhouse plants around the world from mid-1980s
- Spreading tospoviruses



Melon thrips (*Thrips palmi*)

- A native to Southeast Asia (Java and Sumatra)
- Expanded its geographic range in 1970s and 80s due to increased application of pesticides (and through trade and commerce)
- Spreading tospoviruses

Source: www.eppo.org

Natural host ranges of tospoviruses is generally broad

Tomato spotted wilt virus

Over 1,000 species of plants in 84 families are susceptible (Parrella et al. 2003)

tural host ranges of vegetable-infecting tospoviruses in India

Virus	Host range
PBNV	Very wide (several legumes, vegetables, weeds species)
CaCV	Tomato, pepper, peanut, and ??
WBNV	Cucurbits, and ??
IYSV	Onion, and ??

PBNV

First reported in peanut

Archives of Virology 141:85-98, 1996.
Journal of General Virology 77:2347-2352, 1996.
Archives of Virology 143:2381-2390, 1998.

PBNV

Symptoms

PBNV

Symptoms

Incorrect diagnosis of PBNV

PBNV
or
fungal infection?

Incorrect diagnosis of tospoviruses

PBNV or fungal infection?

PBNV
Symptoms

PBNV Symptoms

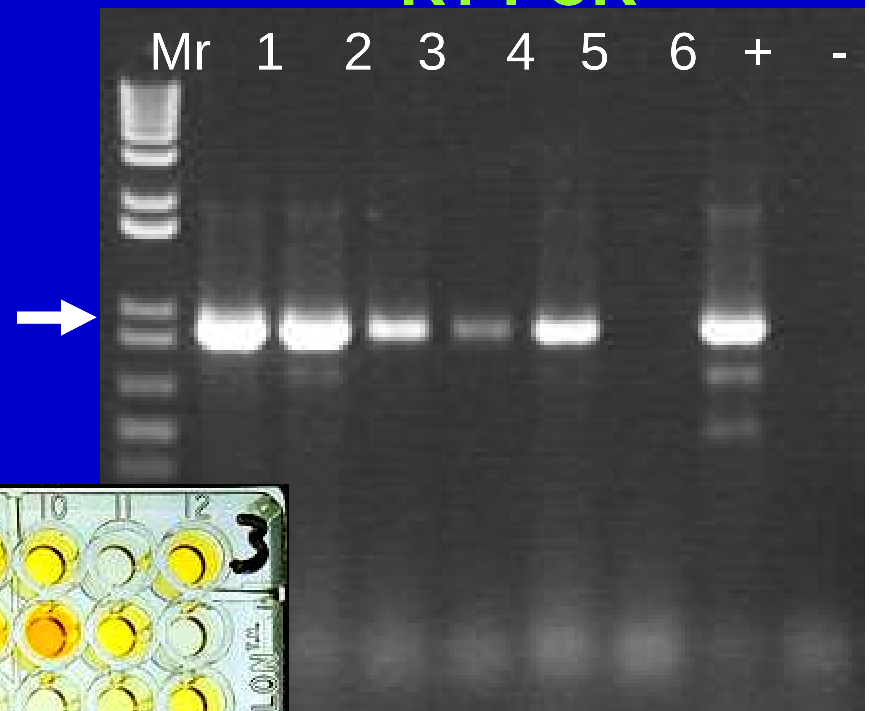
PBNV in India

Source: K.S. Ravi: Mahyco Research Center

te diagnosis is critical

Immunostrip

RT-PCR



ELISA

Does net house give protection?

Thrips palmi
the principal vector of PBNV

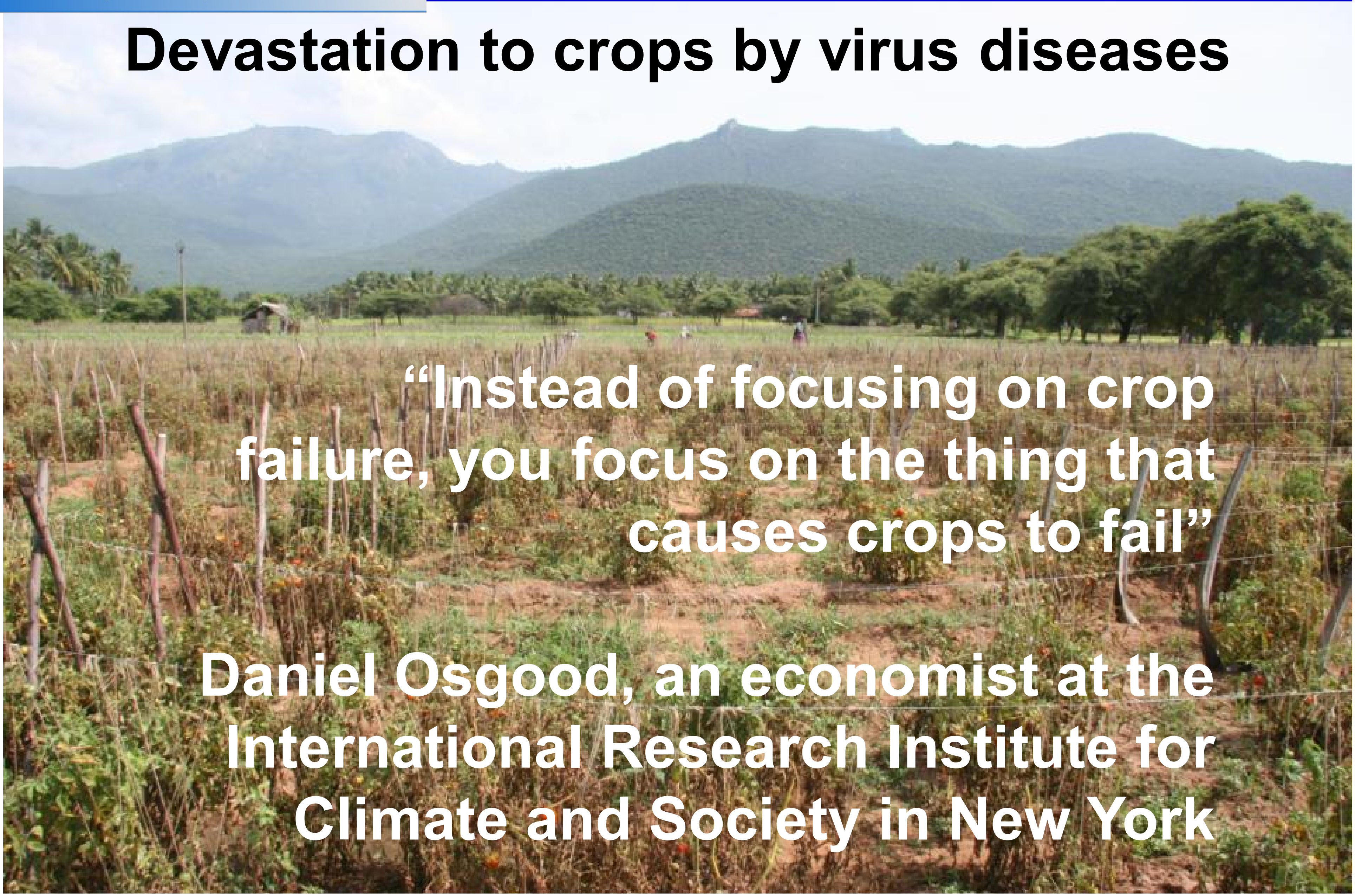
Thrips species	% Transmission
Thrips palmi	38
Frankliniella schultzei	2
Scritithrips dorsalis	0

Source: ICRISAT, India

Management of diseases caused by tospoviruses PBNV in tomato in India

the many consequences

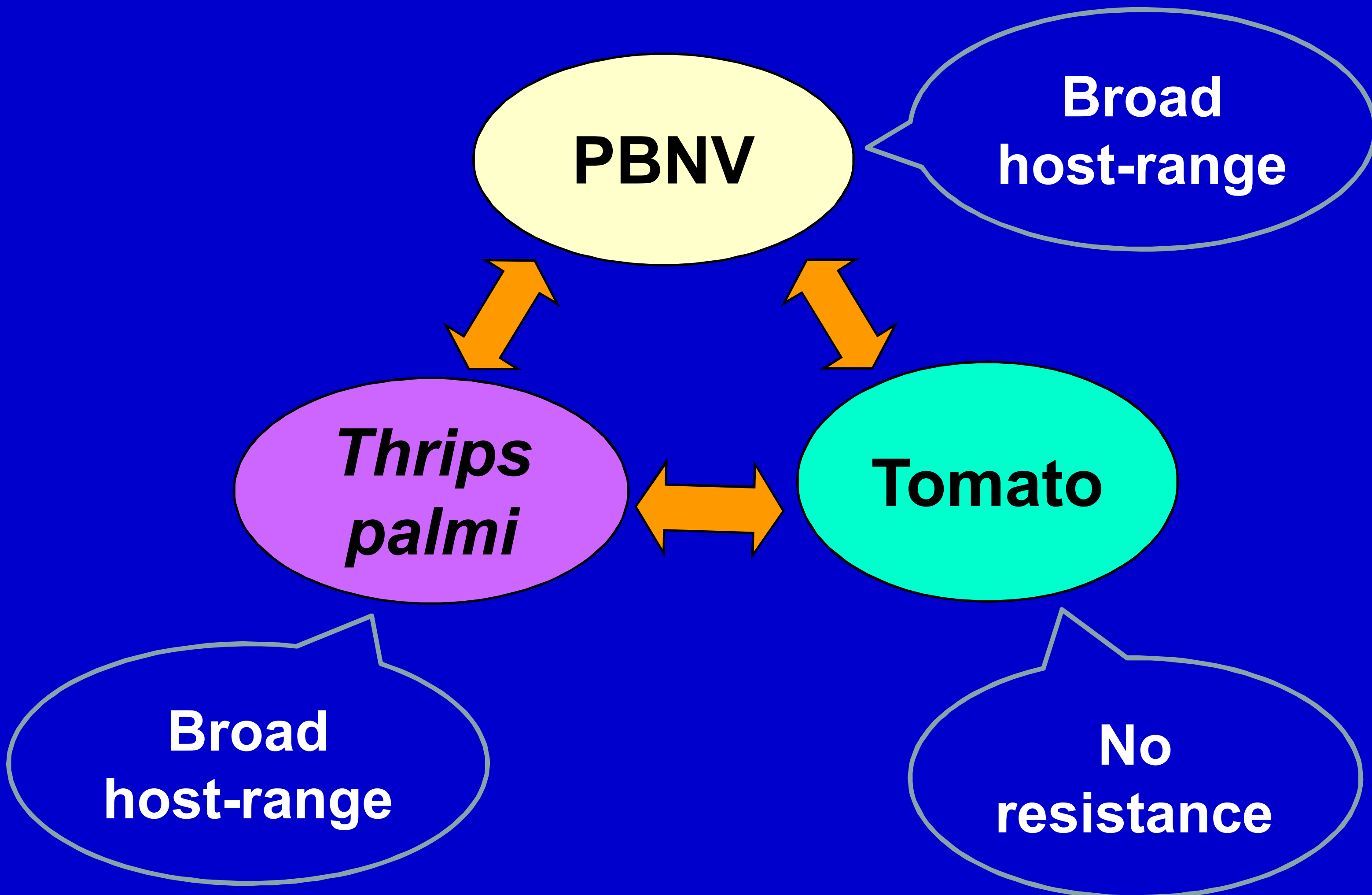
Devastation to crops by virus diseases



"Instead of focusing on crop failure, you focus on the thing that causes crops to fail"

Daniel Osgood, an economist at the International Research Institute for Climate and Society in New York

Bio-complexity of PBNV pathosystem



Options available for management of PBNV

- Vector control
- Host resistance
- Cultural practices
  - date of planting
  - crop density
  - crop rotation
  - host-free period

Challenges in thrips vector control

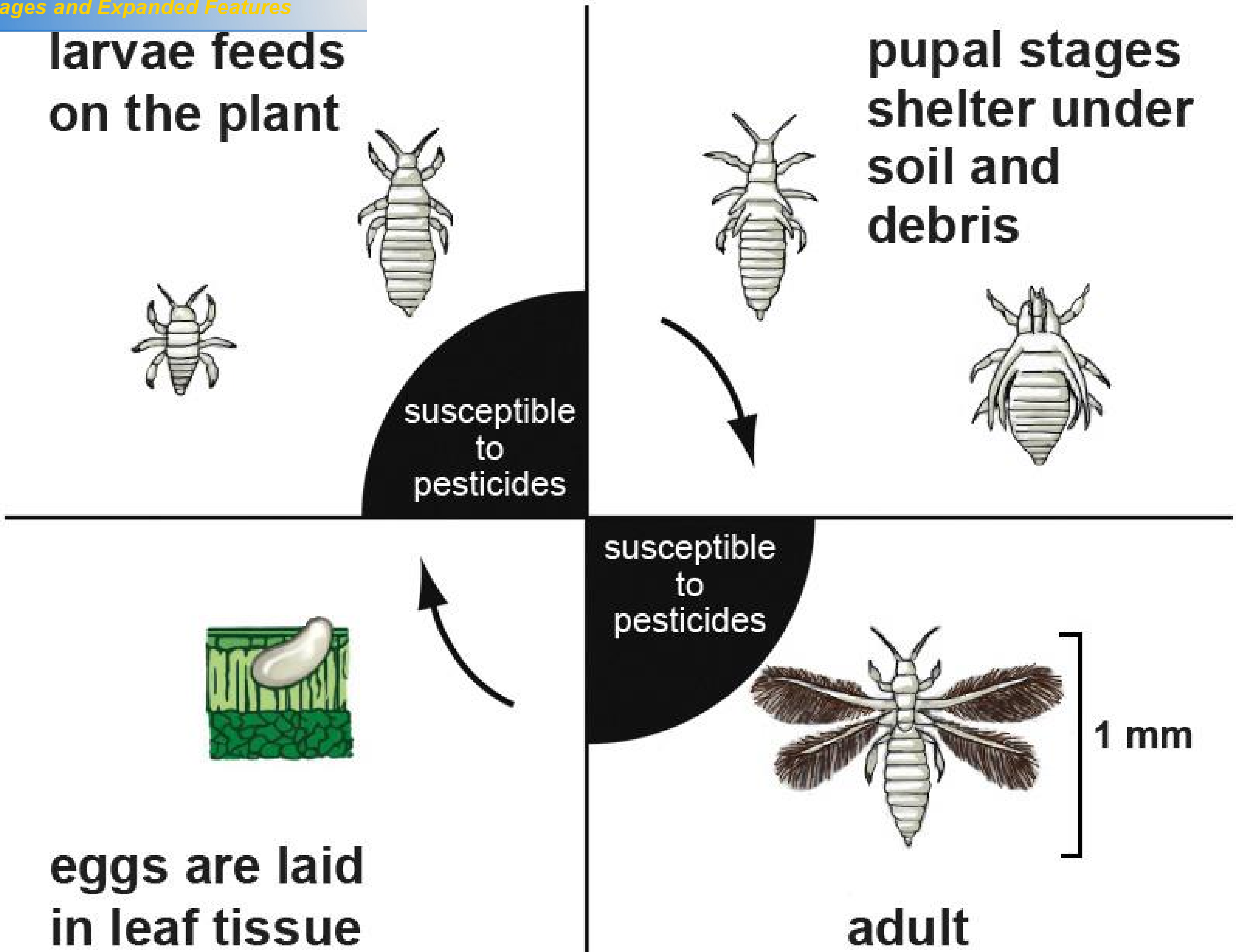
T. palmi

- polyphagous & survive in different habitats and climates
- can reproduce quickly and by many generations in a given season
- can 'overwinter' on a broad range of plant species

Use of pesticides to control thrips

Efforts to control vector thrips with insecticides have been mostly unsuccessful

...al control against thrips



Source: Western Flower Thrips Queensland Update - August 2005

T. palmi

Indiscriminate use of insecticides is leading to the development of resistance in thrips

Source of picture: Zenkoko Noson, Kyoiku Kyoiku Co. Ltd, Japan.

…minate use of insecticides …ds to development of resistance in thrips

e.g. Western flower thrips

- have evolved numerous metabolic detoxification pathways to metabolize many insecticides
- the major detoxification pathway appears to be through metabolism of toxicants by cytochrome P450 monooxygenases
- known to confer resistance and cross-resistance to pyrethroids, organophosphates, and carbamates

Espinosa et al. 2005

Pesticides are not the solution

How about host plant resistance ?

Resistance only against TSWV

- **Sw-5 resistance gene in tomato against TSWV**
- ***Tsw* resistance gene in *Capsicum* against TSWV**

Host plant resistance

- **No broad-spectrum resistance**

  e.g. CaCV overcame the *Sw-5* resistance gene in tomato

  e.g CaCV overcame TSWV resistance in *Capsicum chinense* accessions PI 152225, PI 159236 and AVRDC 00943

- **Resistance to ‘Asian’ tospoviruses not available**

  e.g. is there resistance to PBNV in tomato ?

ges in controlling PBNV

Cultural practices

- Multiple crops grown continuously throughout the year
- Imposing host-free period not possible
- Synchronizing planting date(s) not possible
- Maintaining optimum crop density not feasible
- Reservoir hosts survive throughout the year

Can transgenic resistance solve the problem?

Management of PBNV

- No "silver bullet" approach
- No "one-size-fits-all" measures

Management of PBNV
an integrated approach

ÅKnowledge about the virus & vector
ÅDiagnostic tools
ÅEcology and epidemiology
ÅThrips vector control
ÅAltering cropping patterns
ÅCultural and biological measures
ÅDeploying tolerant/resistant cultivars
ÅCapacity building

BNV via infected transplants ?

…ato seedlings in net houses …urce of virus inoculum?

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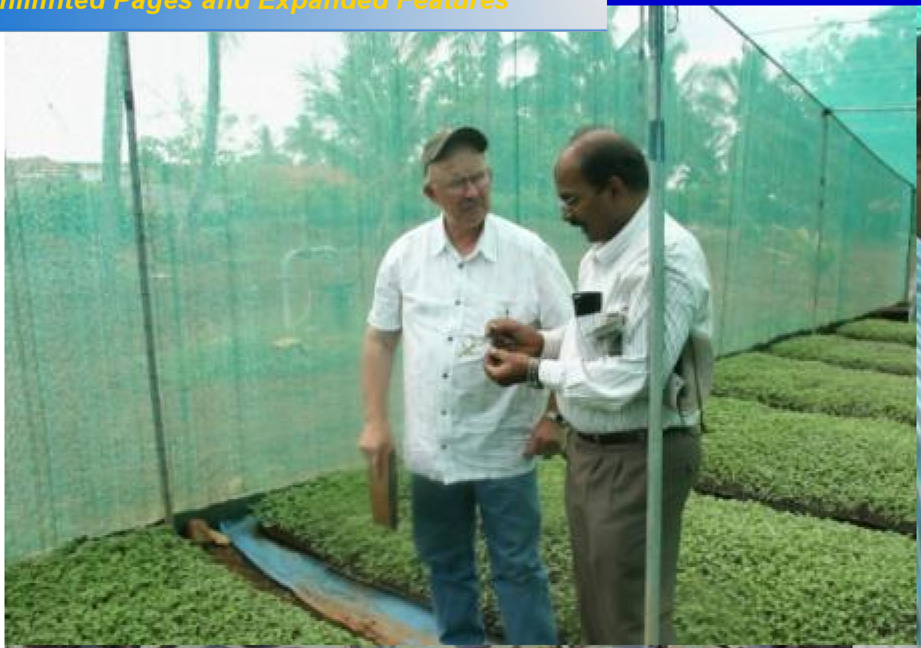
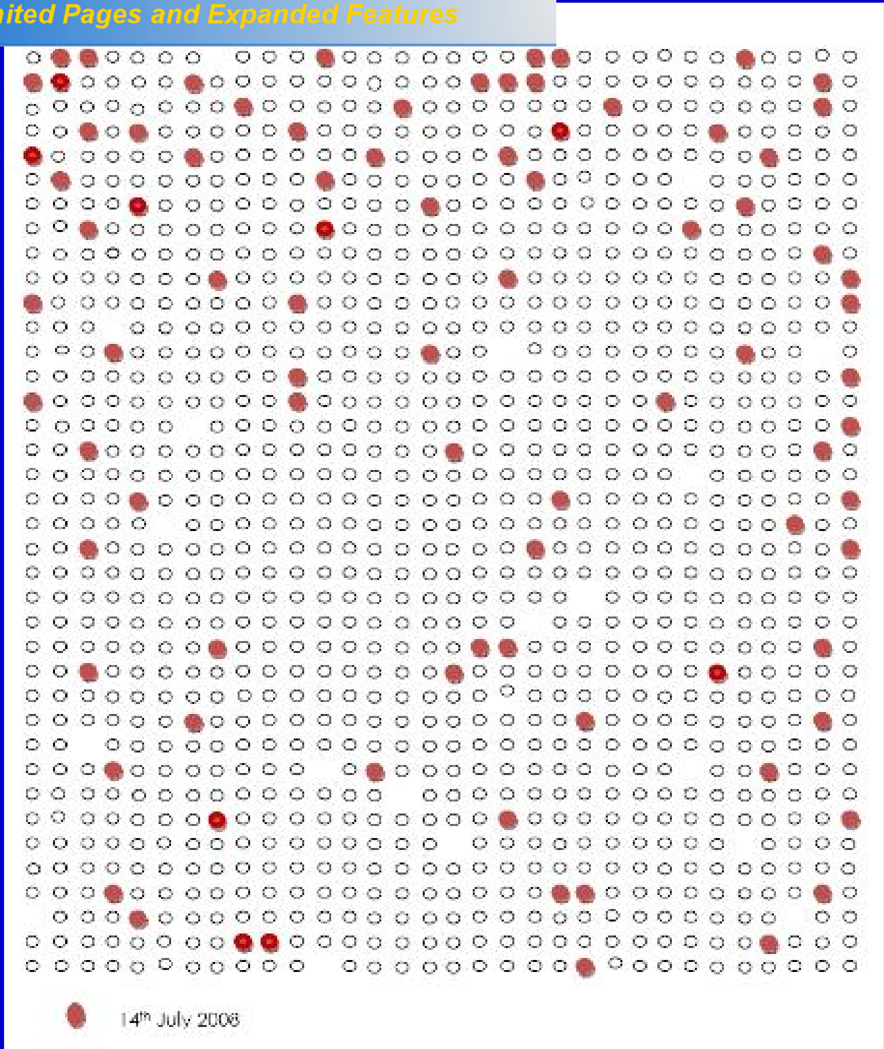
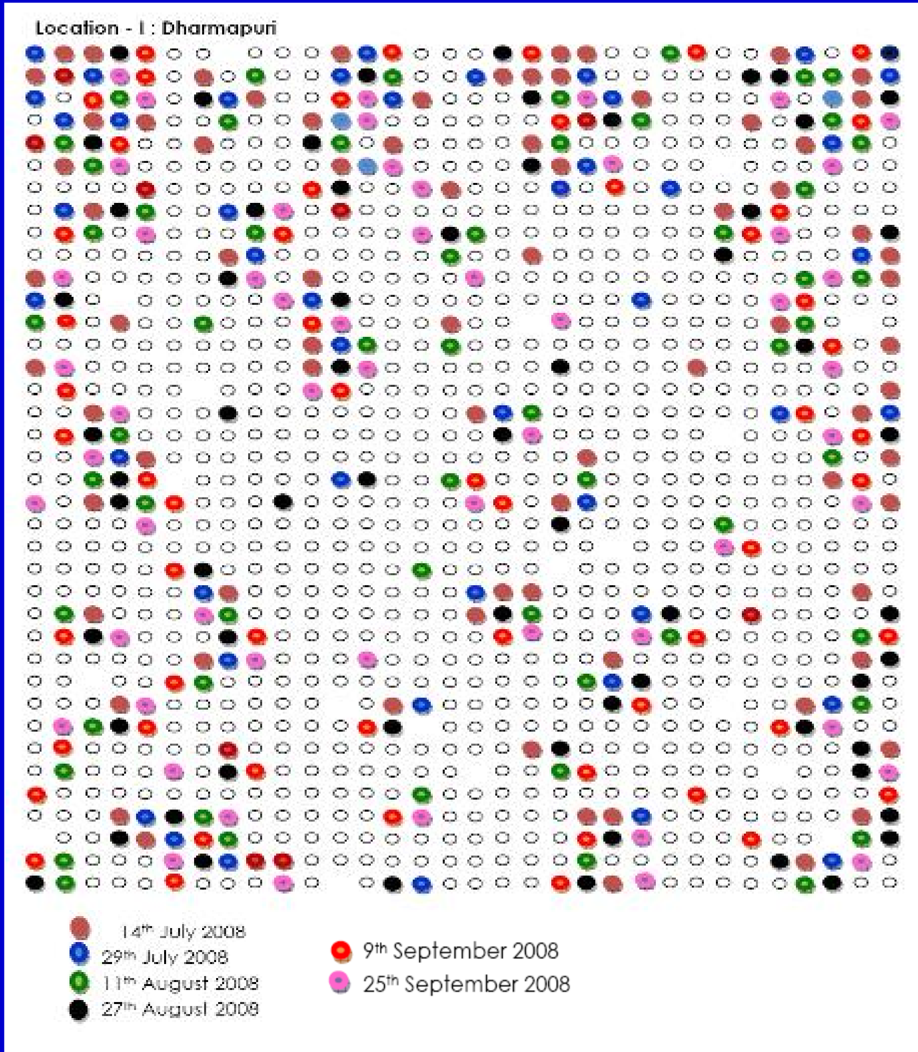
seedlings in net houses



o seedlings in net houses a source of virus inoculum?

PBNV via infected transplants

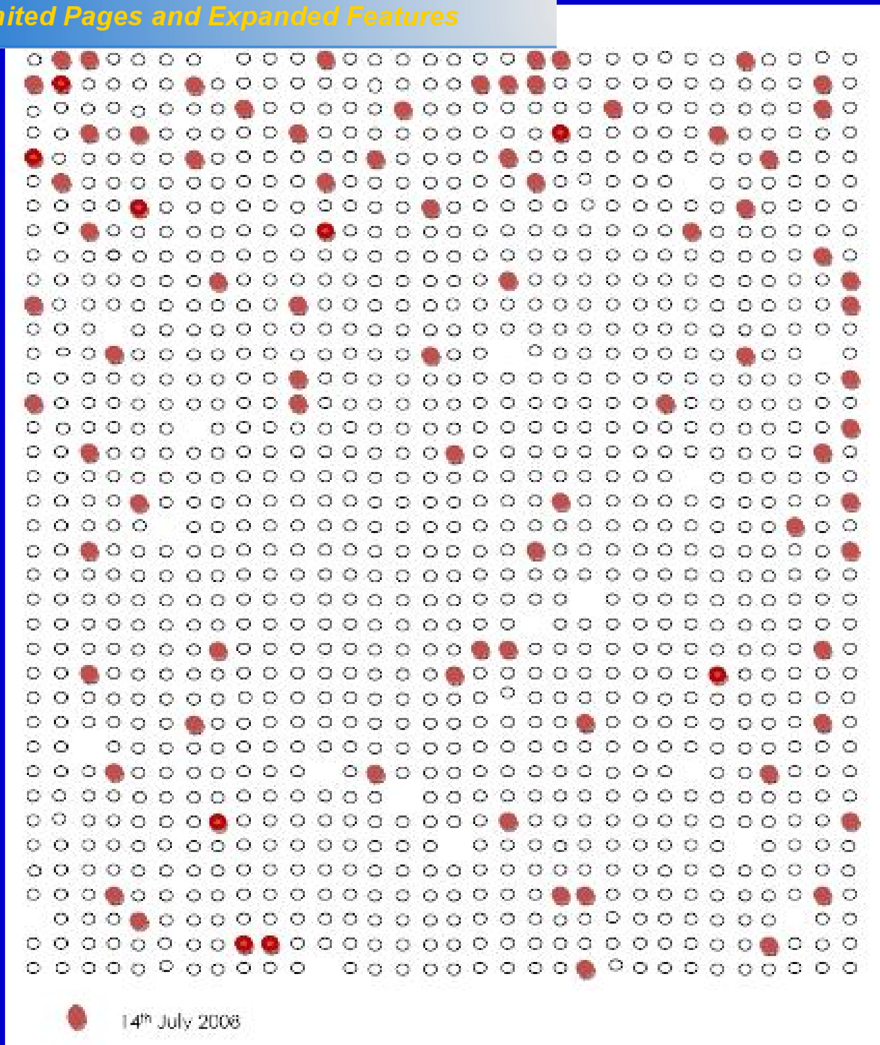


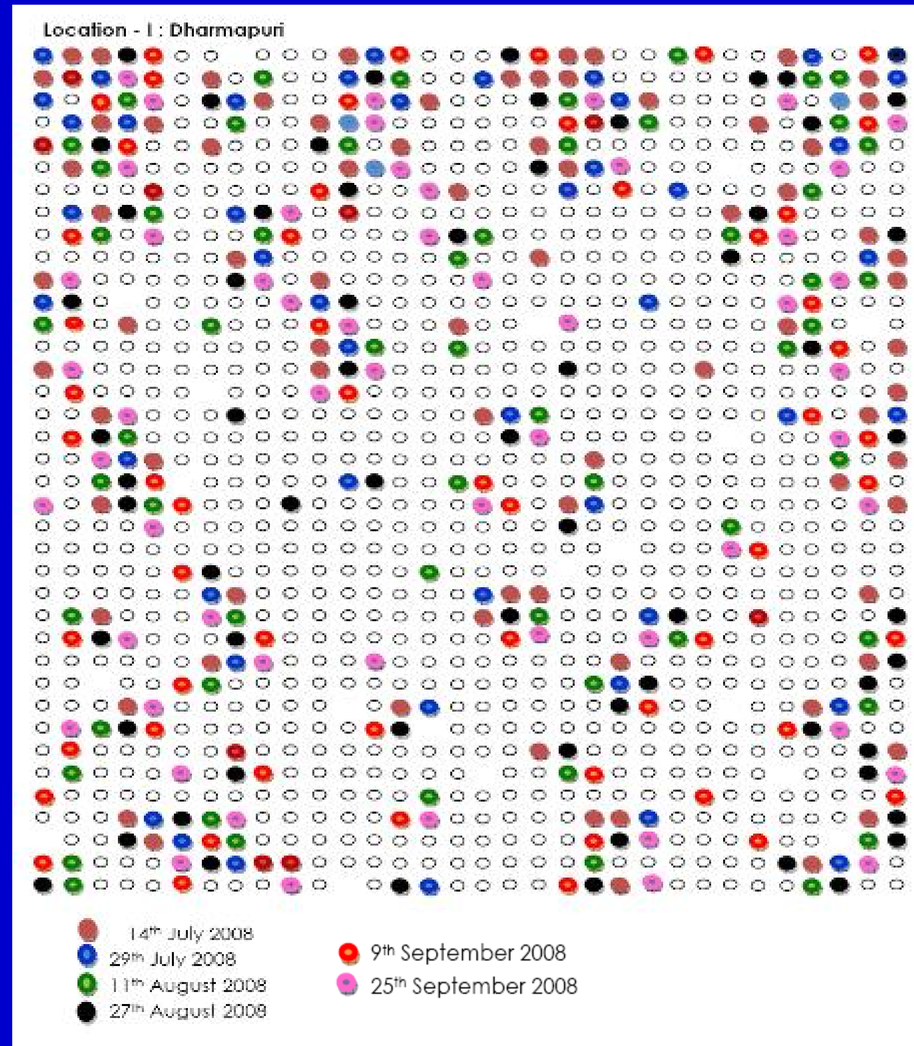


14th July 2008 (7.1%) → 25th Sept 2008 (29.9%)

Aggregation/clustering of infected plants

PBNV via infected transplants





fected transplants - carry virus & thrips eggs/larvae

Infected transplants - as a source of virus inoculum

as a management tool ?

g as a management tactic

No roguing

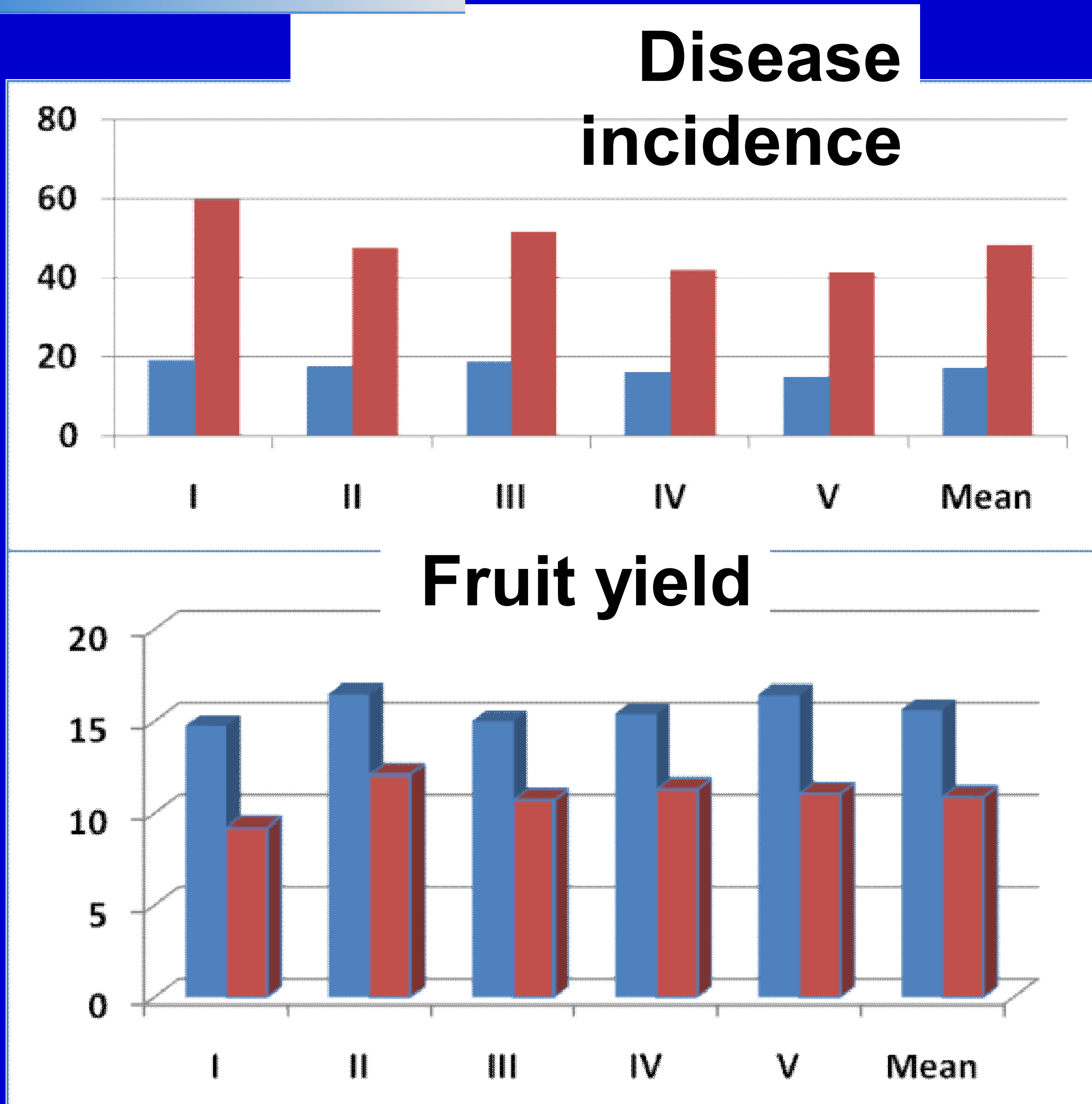
Transplant all seedlings (no removal of symptomatic seedlings)

Roguing

Remove symptomatic seedlings before transplanting

Remove symptomatic plants within 45 days post-transplanting

as a management tactic



%

Tons/h

Location

No roguing

Roguing

Tomato cvs/hybrids

I = US 618

II = Laxmi /5005

III = S 44

IV = Laxmi /5005

V = Vaishnavi

Roguing

Benefit - cost ratio

Cumulative yield of tomato fruits:

With roguing: 16.45 tons/ha

With no roguing: 11.1 tons/ha (32.5% decrease)

Income: using a low market price of Rs. 4/kg

With roguing = Rs. 65,800/ha

Without roguing = Rs. 44,400/ha

Revenue gained with roguing= Rs. 21,400/ha

Additional savings from no pesticide sprays

s a management tactic for management of PBNV being adopted by farmers

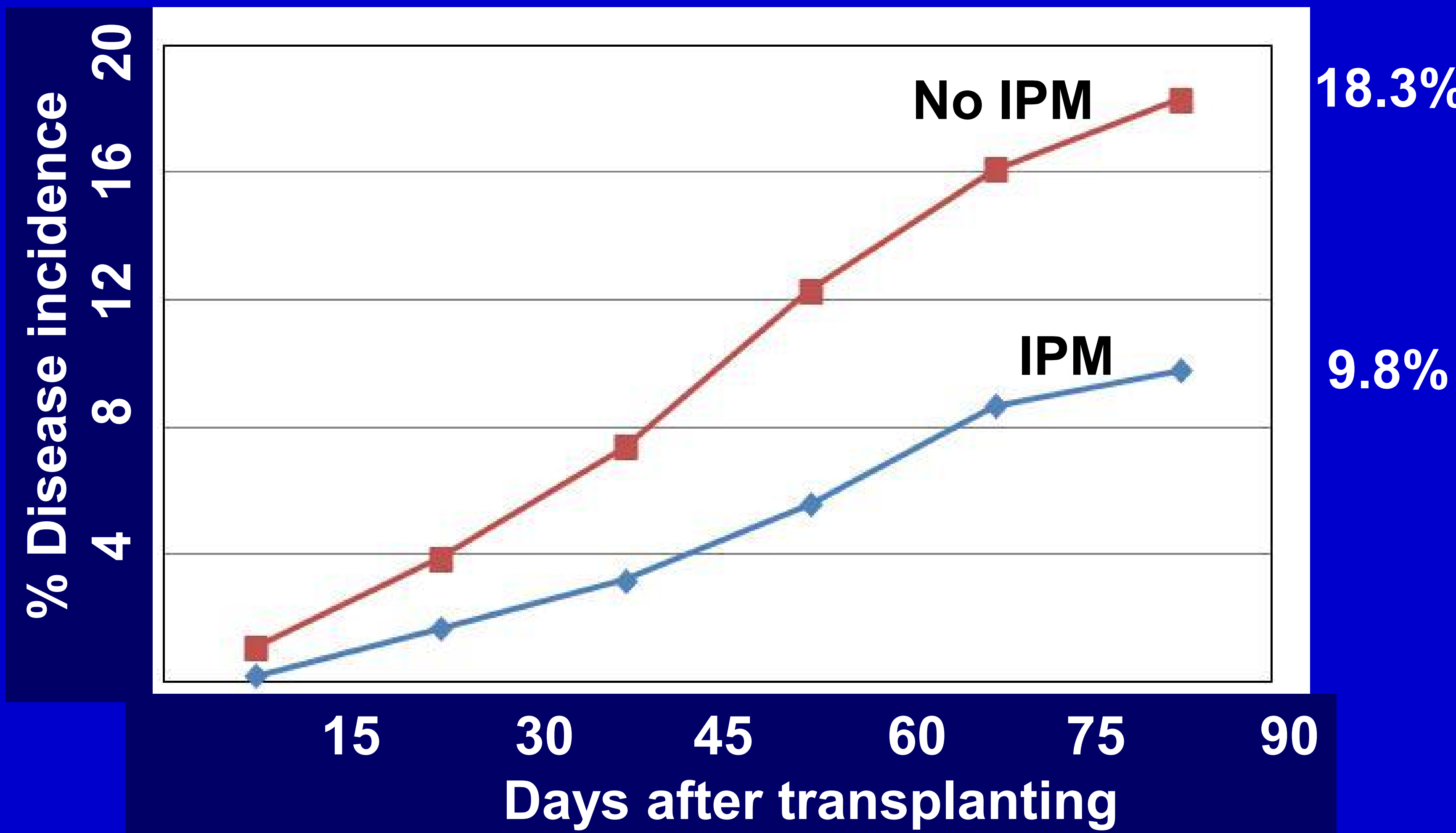
ÅRemove symptomatic seedlings before transplanting
ÅRemove symptomatic plants in the field up to 45 days post-transplanting
ÅReplant clean plants up to 45 days

M packages for PBNV management

- **Seed treatment with *Pseudomonas fluorescens* @ 10g/kg and *Trichoderma viride* @4g/kg of seeds.**
- **Soil application of neem cake @ 250kg/ha.**
- **Soil application of *P. fluorescens* @ 2.5kg/ha.**
- **Selection of healthy seedlings for transplanting.**
- **‘Roguing’ virus infected plants up to 45 days post-transplanting.**
- **Installation of yellow sticky traps.**
- **Spraying neem formulations / neem seed kernel extract (need-based).**

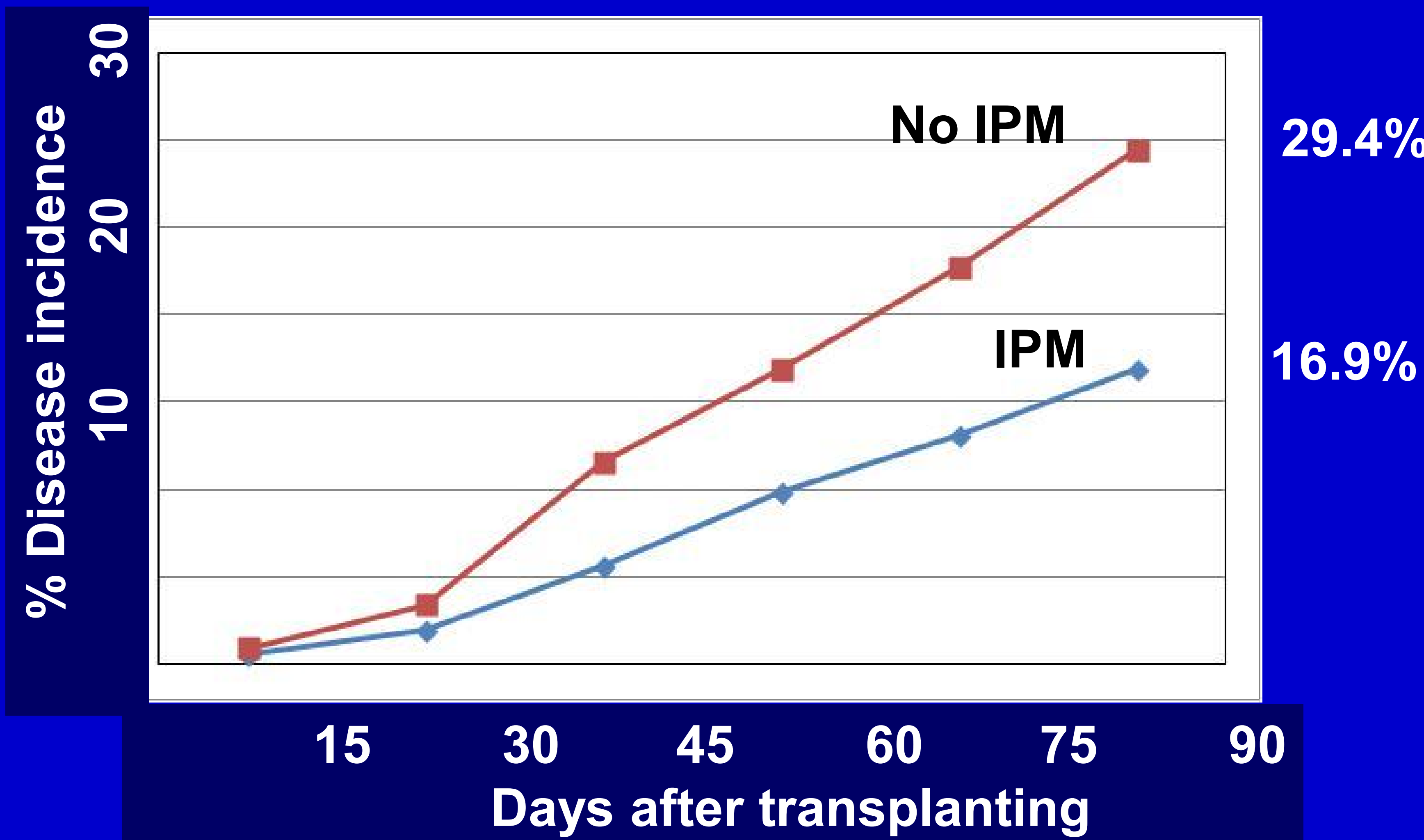
M packages for PBNV management

Tomato Hybrid: Ruchi
Location: Dharmapuri, India



M packages for PBNV management

Tomato Hybrid: Lakshmi
Location: Coimbatore, India



IPM packages for PBNV management

Cumulative fruit yield

	IPM Practice	No IPM Practice
Location 1:	27.5 t/ha	19.1 t/ha
Location 2:	24.4 t/ha	16.9 t/ha

wledge dissemination

Working with farmers for dissemination of technology
&
facilitate technology adoption

Conclusions

A single tactic (roguing) can be effective in reducing the source of inoculum.

Different components of IPM can have additive effect in reducing/suppressing disease incidence.

IPM strategies are being used for simultaneously managing different vector-borne virus diseases (e.g. thrips- and whitefly-transmitted viruses).

IPM strategies could be an effective strategy for managing vector-borne virus diseases due to climate variability in subsistence agriculture.

Thanks to:

USAID
FROM THE AMERICAN PEOPLE

IPM CRSP

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World Class. Face to Face.

Host Country Collaborator

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Coimbatore, India