Virus (Vector) Management – then and now

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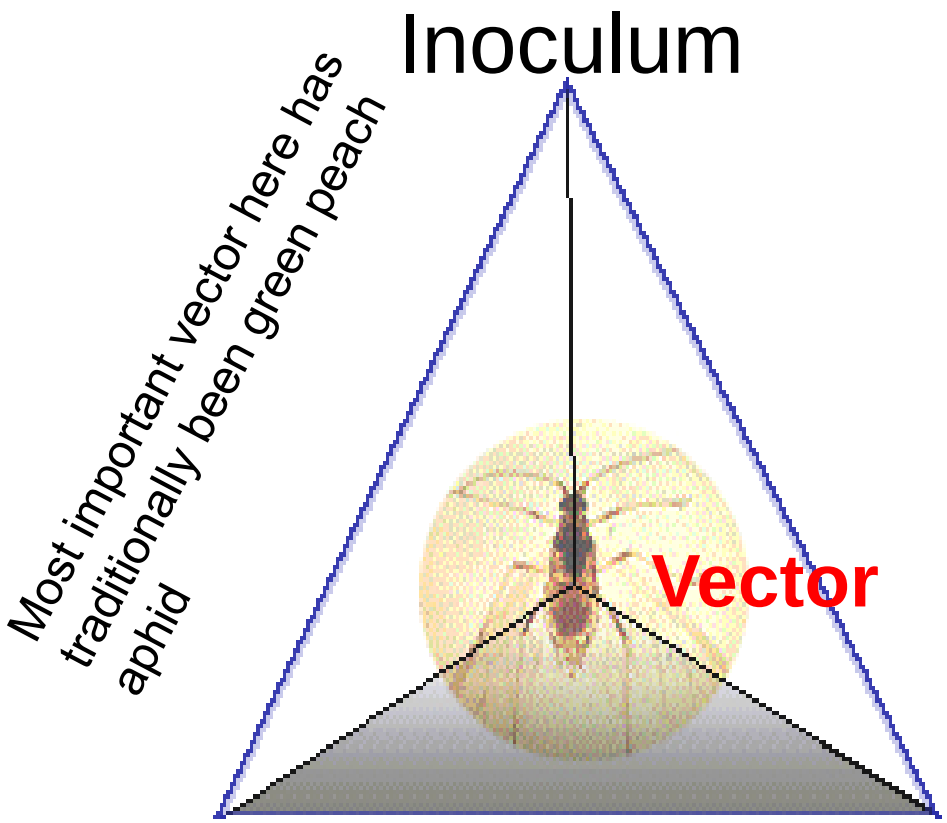
Virus disease of potato

- Potato Leaf Roll Virus (PLRV)
- Potato Virus Y (PVY)
- Major mechanism for transmitting both is aphid vectors

Disease Tetrahedron



Aphids probe plants to determine if they're suitable hosts, so upon landing, they sink their mouthparts

This action transfers any non-persistent, non-circulative virus to the plant, infecting it. Aphids pick up virus in same manner.

Standard solutions then…

- Starting with clean seed
- Visual identification & rogueing of infected plants within season
- Decreasing inoculum in the system via seed certification, etc
- Vector control

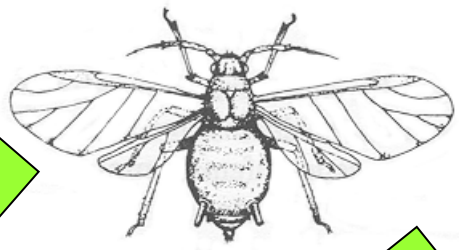
Vector Control

Reasons vector control desirable

1. Cultivars have varying resistance to PVY, but maybe not what you grow
   - Resistance being bred into other cultivars but 'in development'
2. No rescue treatment for PVY virus
3. Levels of vector control possible now
   - Still needs research, some issues to iron out…

Aphid Life Cycle

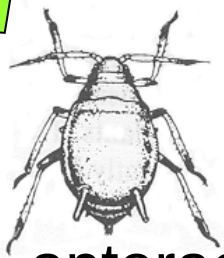
Fundatrix (Stem Mother)



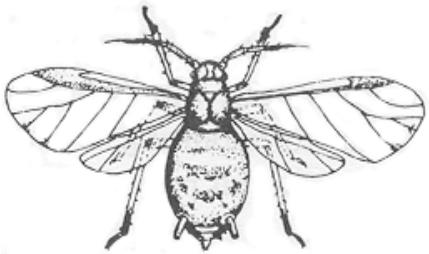
SPRING MIGRANTS

Morphs on Secondary (Summer) Host

SUMMER MORPH



apterae

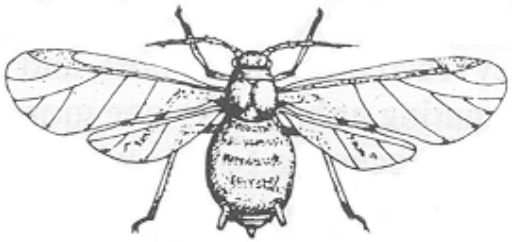


alatae

Populations build and move amongst summer hosts

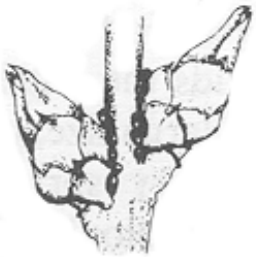
Androparae - MALE

FALL MIGRANTS (SEXUALS)



Gynoparae

Oviparae



Eggs laid near buds

Drawings from Minks and Harrewijn 1987; Higley & Boethal 1994

Aphid life history

- Winged aphids – job is to disperse
  - from overwintering hosts to summer hosts
  - amongst summer hosts in response to crowding (declining host quality)
    - Land on potential plant, taste it to determine if it's a suitable host, deposits 1 or 2 daughters and leaves to next plant
    - Use most energy for travel
  - Back to overwintering hosts in fall
- Wingless aphids – job is to build colony
  - Have many more offspring than winged aphids
  - Live daughters, no males, 'born pregnant', don't move much plant to plant

PLRV

- Persistent virus
  - Takes hours for aphid to acquire virus from infected plant. Then must cross the gut, make it to the salivary glands, etc (“latency period” = days), but aphid remains infective for life
  - Takes hours for infective aphid to transmit virus to clean plant
    - Tends to be wingless, resident aphids involved in transmitting PLRV
    - Can be controlled with insecticides
  - So, not as much of a problem in recent years

PVY (also our current problem)

- Non-persistent virus
  - Aphid acquires virus in seconds
  - Can then transmit in seconds
  - Some species may remain infectious but most clean mouthparts on the first uninfected plant but can quickly re-acquire from another infected plant
  - Because transmission time is so short, can't be adequately controlled with insecticides
  - Vectored principally by winged aphids moving plant to plant

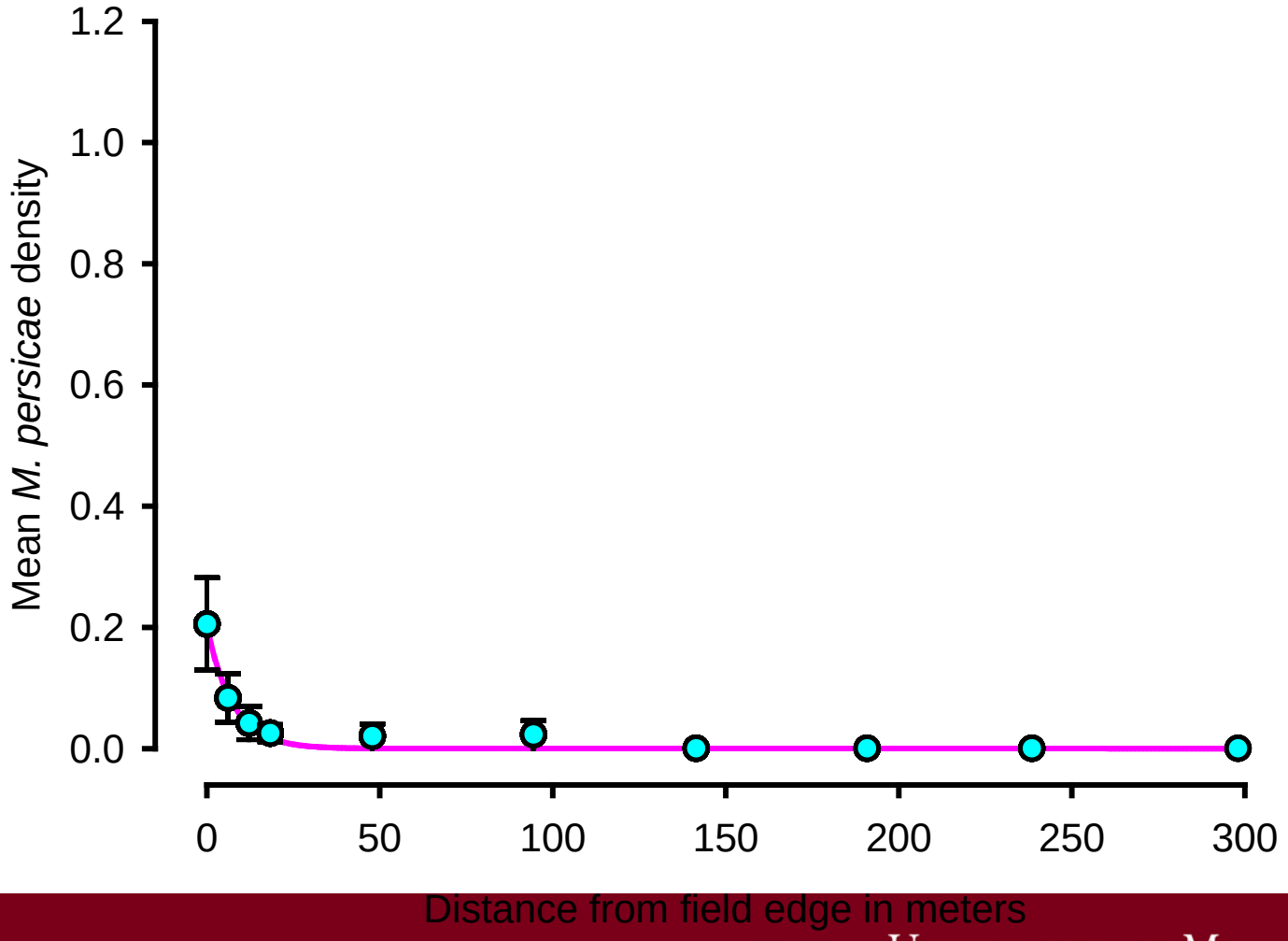
Traditional femmes fatale…

- Green peach aphid – most efficient vector of both PLRV & PVY
  - Can pick up and vector both more easily and efficiently than other aphid vectors
- Cereal aphids (bird cherry oat aphid, corleaf aphid, English grain aphid), potato aphid, sunflower aphid, melon(cotton) aphid are also vectors

!!!

Spatial distribution of M. persicae

Mean density of *M. persicae* at fixed distances from the field edge in a 32 ha potato field of cv.1879 & 1533



Border crops

The attraction of canopy and adjacent bare soil has been used in an effective control tactic. Planting non-PVY host plants (small grains such as rye, or soybeans) as border crops around small seed lots serves 2 purposes:

- Eliminates comparative difference between bare soil and green canopy
- Provides a ‘clean’ plant on which aphids that are arriving infective can clean off virus from their mouthparts

Border crop

- Easy to implement
- Expanded to include any open area in the field (alleys, variety separation,etc)

From: peipotato.org

From: A. Charkowski,
U.W. Madison:
Downloaded from: http://ofrf.org

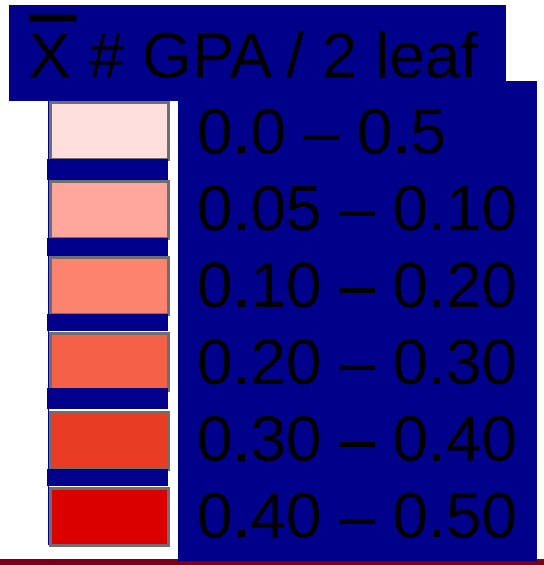
Crop oils – refined mineral oils

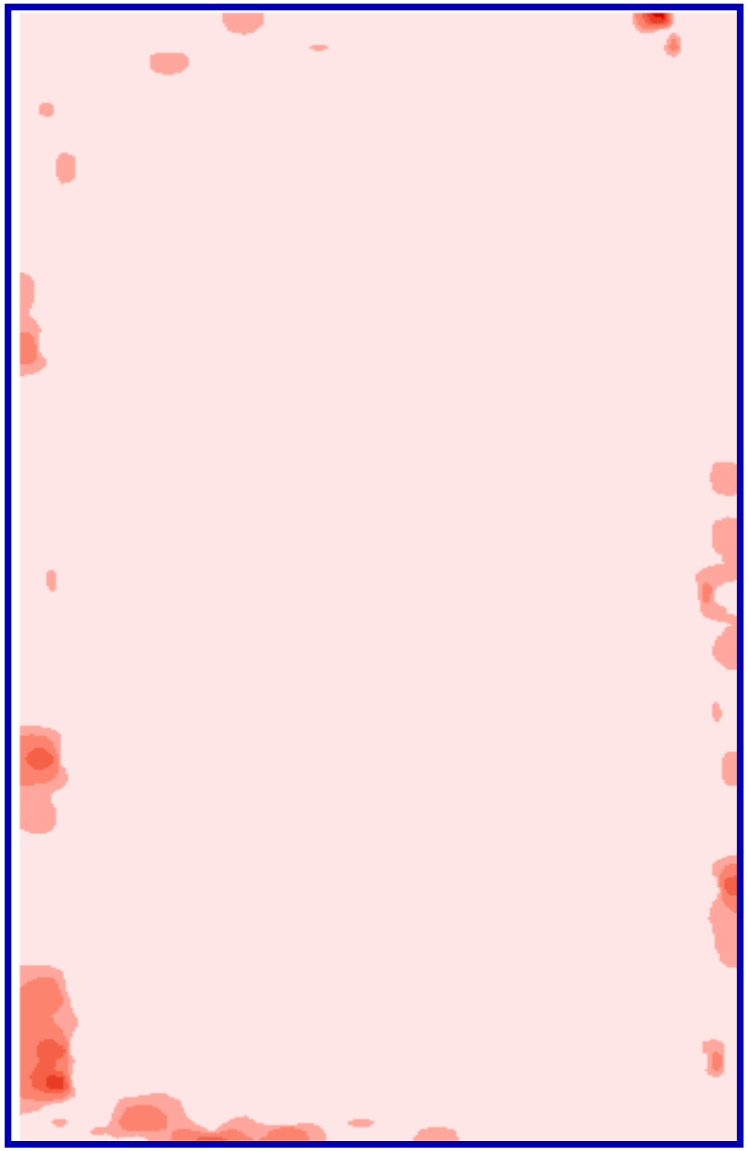
- E.g. Aphoil, JMS Stylet Oil, etc.
- Mineral oils reduce PVY transmission efficiency by 73% in trials
- Oil treatment of the source plant or both the source and test plant proved even more effective in reducing virus transmission efficiency.
  - Maybe inhibitory amount of oil particles are carried over on aphid mouthparts during subsequent feeding events
- Exact mode of action unknown but appears to be a complex contact-based action.
  - Complete & uniform coverage of the leaf surface with oil is essential with 5-7 day re-application to cover new growth (so timing is necessary)
  - Aphoil 2%-4% v/v, JMS Stylet Oil 0.75%-1.5% v/v in 30-60g/ac

Colonization of fields by Green Peach Aphid

Aggregate of mean # GPA August 7-21

2001

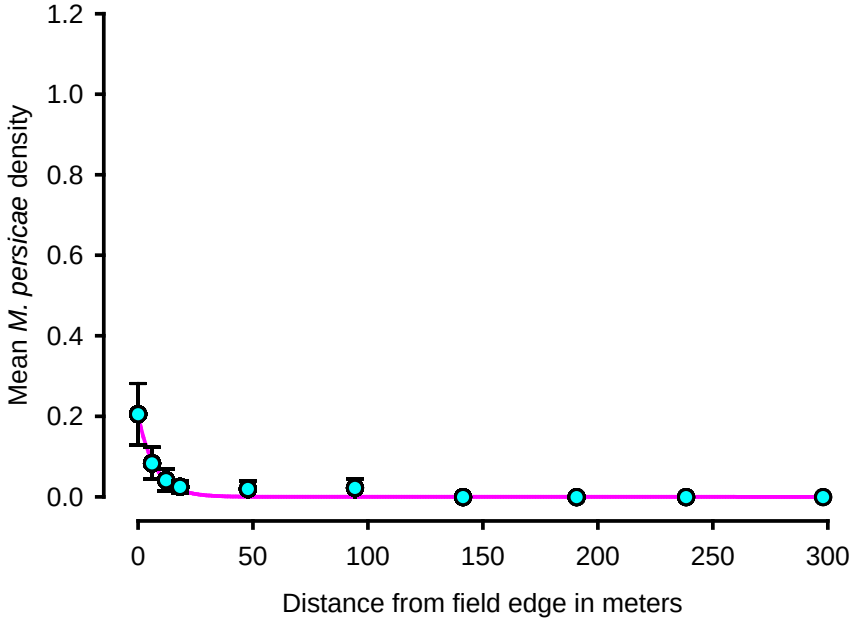




Aphid colonization

- Green peach aphid and other vectors tend to first colonize the field edge (next to bare soil) and settle for 7-10 days prior to dispersing across the field
- Provides opportunity for targeted border applications to control aphid vectors
  - Practice used by a number of seed producers
- Does SBA colonize edge?
  - Maybe, but also goes into field rapidly
  - Potato not a suitable host, but will probe and leave without depositing nymphs

Mean density of *M. persicae* at fixed distances from the field edge in a 32 ha potato field of cv.1879 & 1533



Tactics developed over past 20 yrs…

- Steps to lower inoculum
- Vector control
  - Timed insecticide / threshold applications for PLRV
  - Border crops
  - Crop oils
  - Targeted application

Then the world changed…

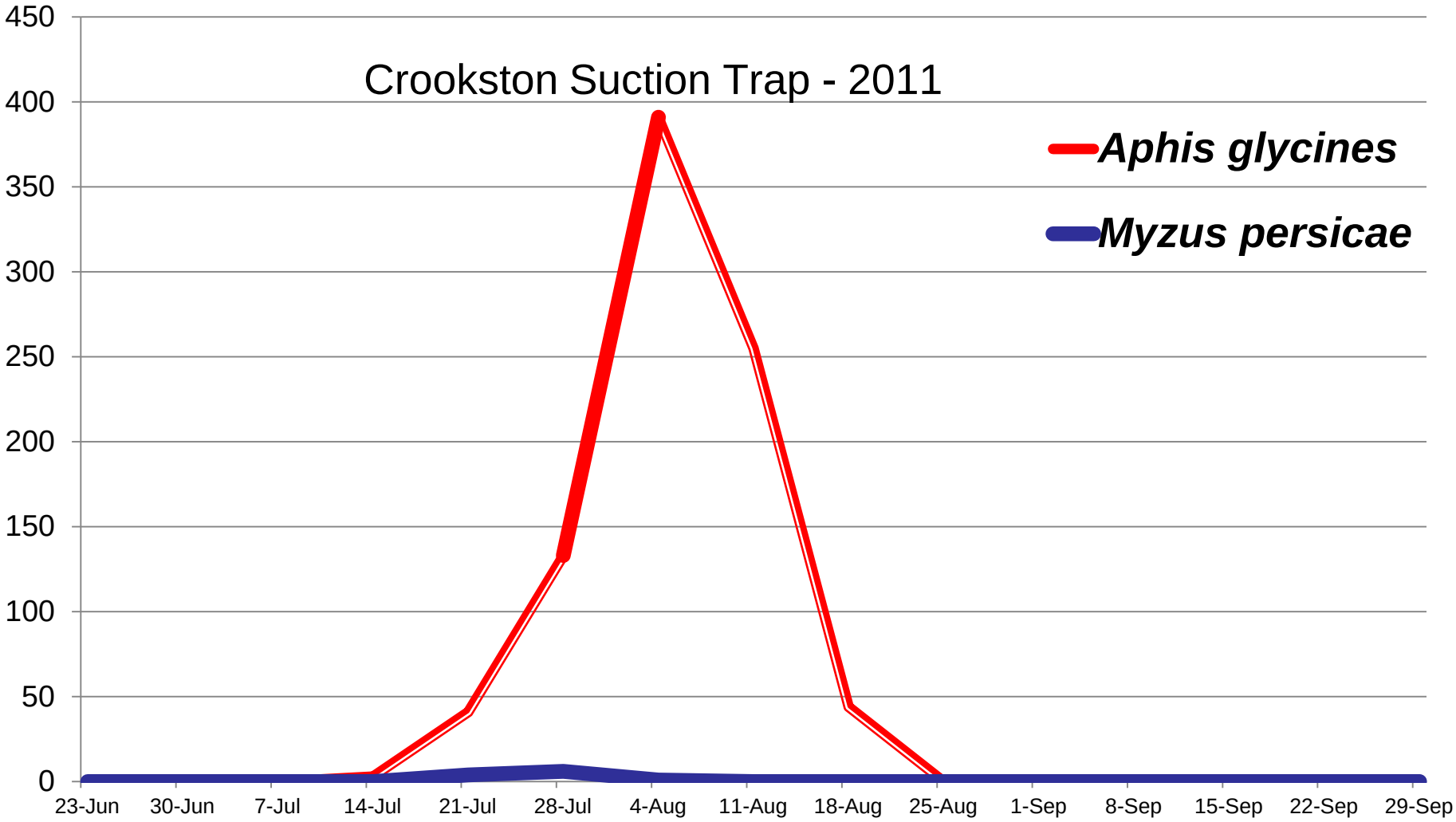
- Adoption of potato varieties asymptomatic for PVY and shift to asymptomatic PVY strains (e.g. PVY^{NO}); both can increase local level of inoculum without warning
  - No visual symptoms - impacted summer scouting!
- Replacement of the ordinary strain of PVY by necrotic strains and introduction of strains that combine genes from both ordinary and necrotic strains
  - **PVY^{N}, PVY^{NTN},**
  - Potato Tuber Necrotic Ringspot Disease (PTNRD) now impacting commercial potatoes, so PVY now a potential problem for commercial production…
- A new vector species of aphid changing the epidemiology

Soybean Aphid

- A new insect pest of soybeans 1st recorded in MN in 2000
- Populations develop through summer
- Readily disperses
- Can overwinter here…

Soybean aphid in spuds

- Soybean aphid (SBA) has been shown to be effective in transmitting Potato Virus Y (PVY)
- Some evidence we're seeing this insect become a problem in other crops
  - Presence of PVY and field certification failure in years with low populations of traditional vectors (green peach aphids, cereal aphids, potato aphid, etc)
  - BUT, those years had high SBA numbers


Crookston Suction Trap - 2011
Aphis glycines
Myzus persicae
450
400
350
300
250
200
150
100
50
0
23-Jun
30-Jun
7-Jul
14-Jul
21-Jul
28-Jul
4-Aug
11-Aug
18-Aug
25-Aug
1-Sep
8-Sep
15-Sep
22-Sep
29-Sep

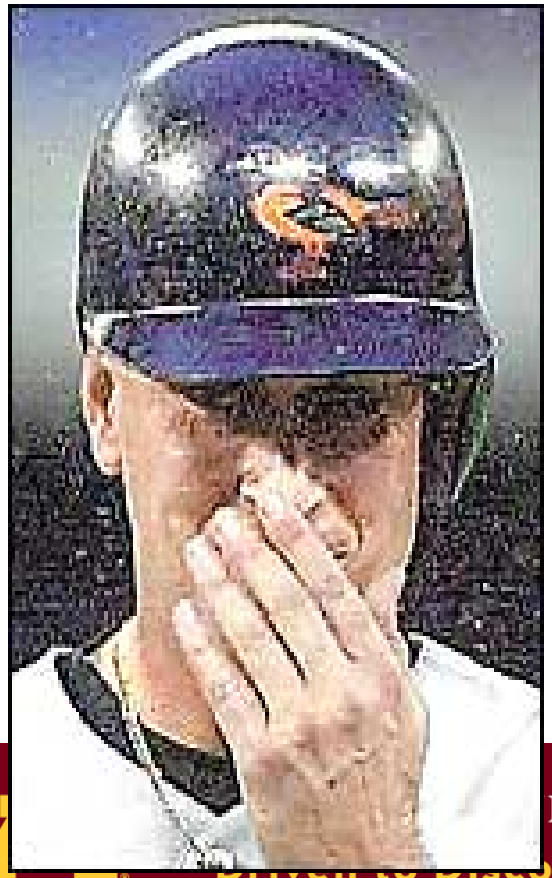
Aphid scouting

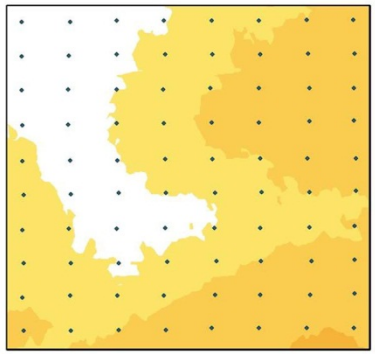
- Typically was focused on field edge
  - Catch 1st colonizers
  - Still recommended
    - ***Traditional vectors still a problem!!***
- SBA transient in potato fields
  - Maybe aphid you don't see more troublesome than the one you do see!
  - What SBA lacks as effective vector it more than makes up in numbers!
    - PVY transmission efficiency of SBA low but aphid numbers very high!

Production of Alatae (Winged Aphids)

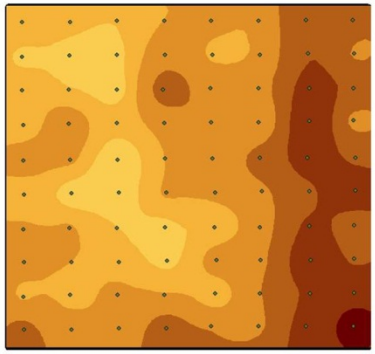
- Alate aphid formed in response to food quality / crowding
- Also 3 environmentally cued dispersal events (dev. Of winged forms)
  - Spring dispersal to soybean
  - SDE (Sturgis Dispersal Event – Bruce Potter) late July/early Aug dispersal, often long distance
  - Fall dispersal back to buckthorn.
- Winged aphids always give birth to non-winged aphids
  - Only grand-daughters of alates can be winged

Soybean Aphids Descend on Toron
August 2-3, 2001

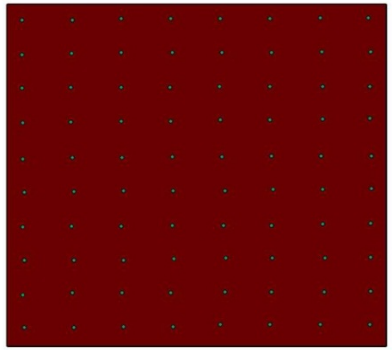




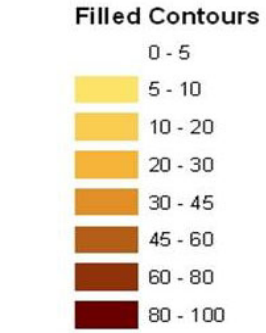
July 12



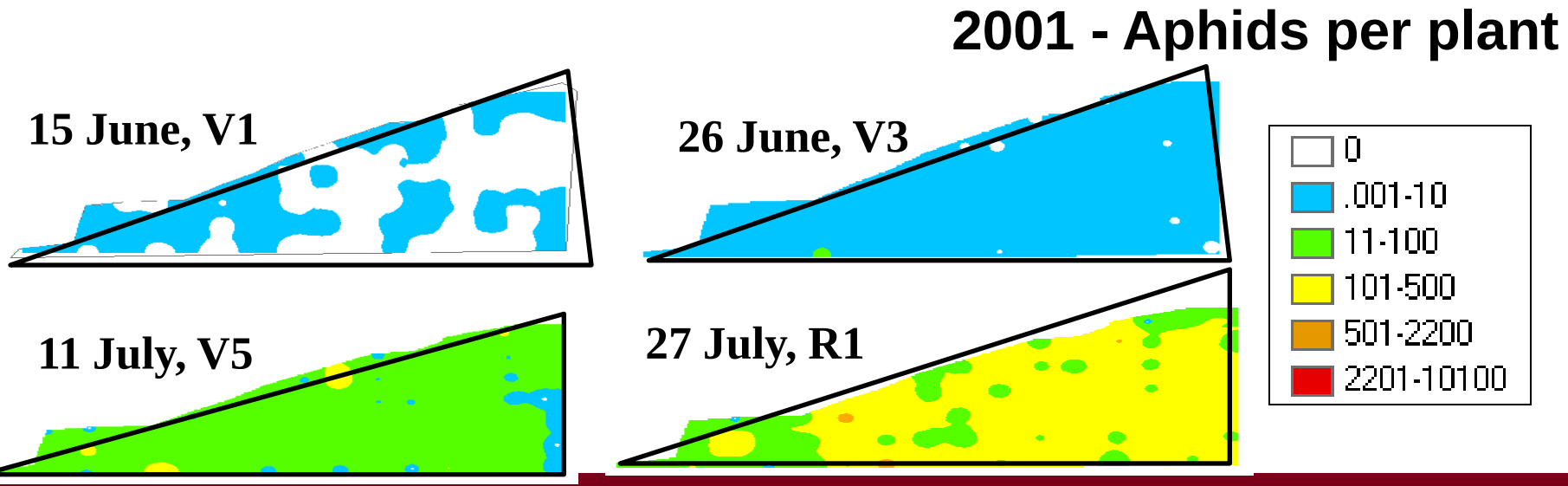
July 19



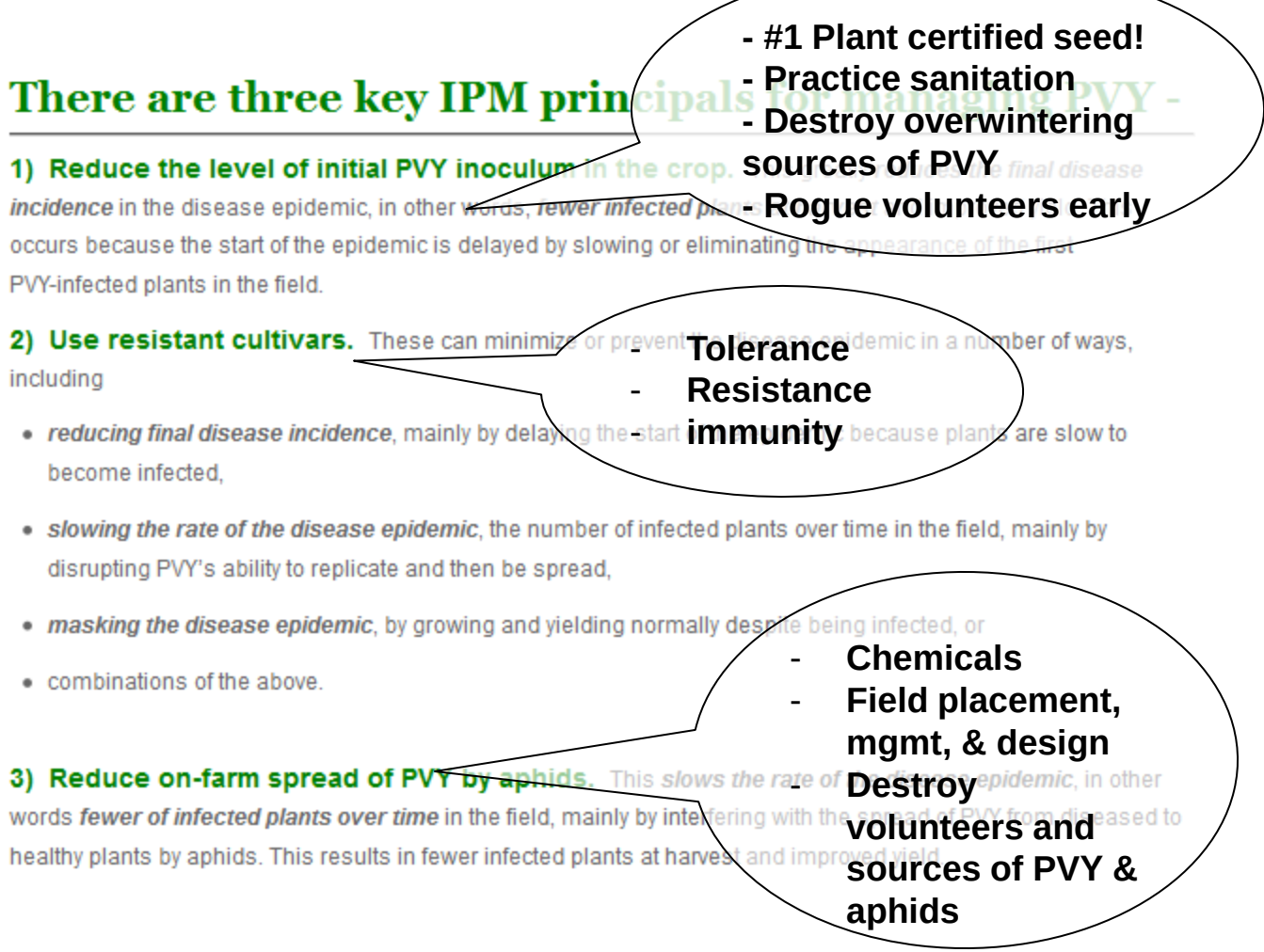
July 26



Colonization of Soybean Fields



What's old is new again – a lot of the same techniques still have merit…



- From potatovirus.com – a federally funded effort to stem the nationwide PVY epidemic

What works, what might not…

- Crop borders but it's important to remember these don't help with within field movement of existing inoculum
- Crop oils – time application prior to arrival of aphids (or first colonizers *at very latest*!)
- Border treatments (originally only recommended for PLRV) are probably less effective with lots of soybean aphid in the mix, SBA spends so little time at the edge

Newer: anti-feedant insecticides

- E.g. Fulfill (Pymetrozine, Syngenta Crop Protection, Greensboro, NC) and Beleaf® (Flonicamid, FMC Corp. Philadelphia PA) – both are pyridines
  - Have anti-feedant properties
    - Once exposed, insect stops feeding & probing
    - Prevents distribution of non-persistent virus within field but unlikely to stop aphids from transmitting on their first probe
    - Translaminar and remains in plant (7d intervals for re-application)
- Still must know when aphids colonizing fields
  - Monitoring of not only potato fields but knowledge of what local soybean aphid populations are doing