Management of insect vectored diseases

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Presentation Outline

- Fundamentals of pathogen spread by insects (definitions)
  - association with insects (circulative, propagative)
  - transmission types (non-persistent, semi-persistent, persistent)
  - patterns of spread (primary vs secondary)
  - insect movement and colonization

- Managing the problem (approach)
  - varietal selection
  - sanitation and inoculum source reduction
  - precise timing of crop protectants

Photo credit. Gerald Holmes

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Insect – Vectored, Plant Disease Ecology

Spread of Plant Pathogens by Insects Involves Interactions of

Plant

Pathogen

Insect Vector

Environment

- weather
- cultural practices
- farming operations
- agroecosystem

→ Plant Disease


whiteflies


thrips


aphids


leafhoppers

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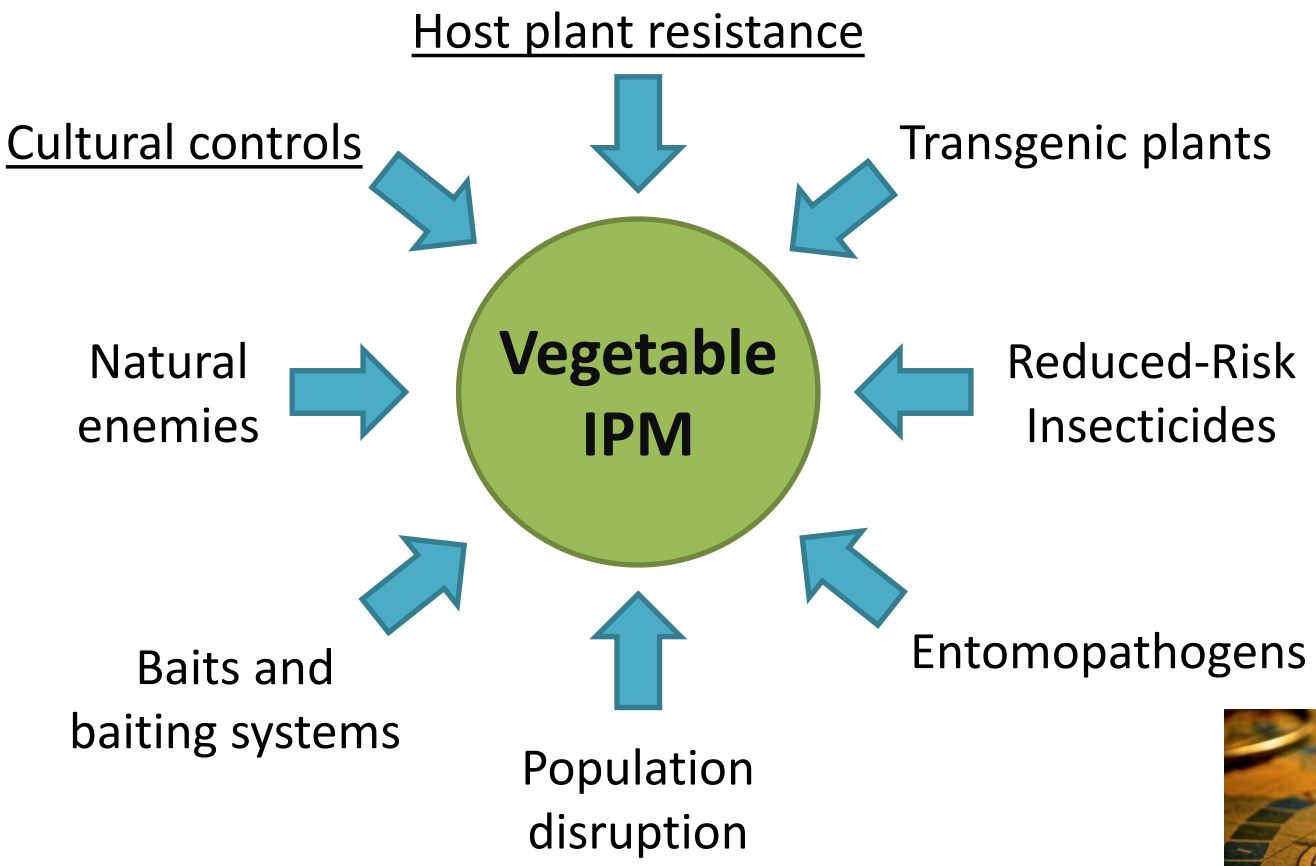
Pest management tactics for vegetable insects

Integration of available tools to manage pest damage in the most economically, socially, and environmentally sound way



Several non-persistently transmitted viruses

- Cucumber mosaic virus (CMV) – Bromoviridae (Cucumovirus)
- Watermelon mosaic virus (WMV-1) – Potyviridae (Potyvirus)
- Papaya ringspot virus (PRSV-W) – Potyviridae (Potyvirus)

  - Symptoms similar across many viruses
  - Time of infection important
  - Aphid vectors
  - Mixed infections

- Squash mosaic virus (SqMV) – Secoviridae (Comovirus)

  - Beetle transmitted (striped / spotted cucumber beetle)

CMV – Cucumber mosaic virus

Photo credit. Gerald Holmes

Watermelon mosaic virus - WMV

Papaya ringspot virus – PRSV-W

Papaya ringspot virus

Squash mosaic virus - SqMV

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Bacterial wilt – *Erwinia tracheiphila*

Striped cucumber beetle

Aster yellows– Candidatus *asteris phytoplasma*

Aster leafhopper

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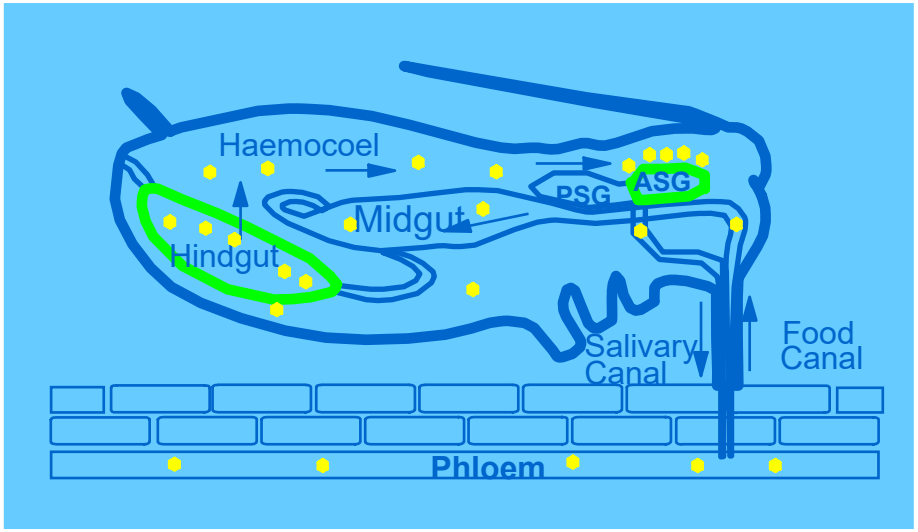
Types of Pathogen Interactions with Insects

Circulative (PLRV, AYp, TSWV)

Systemic movement within insect body



Propagative

Pathogen replication within insect body (transovariol)

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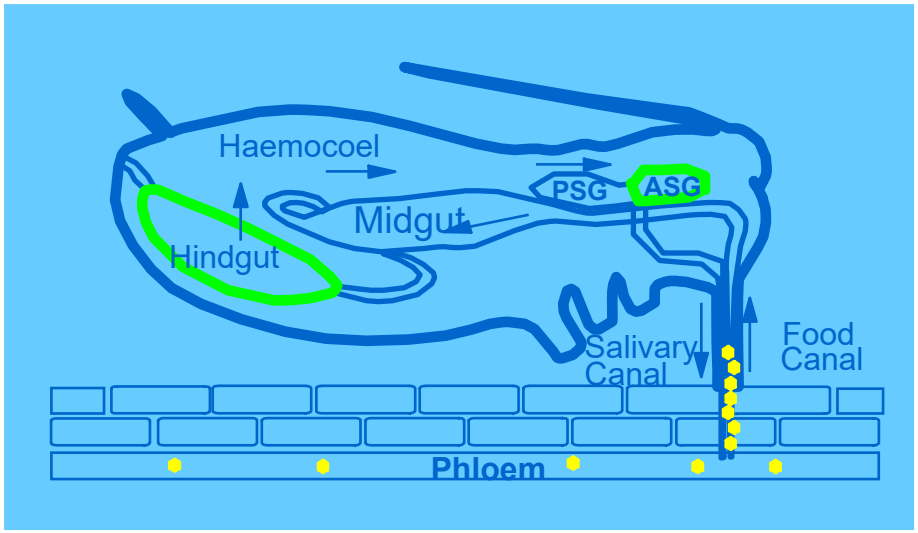
Types of Pathogen Interactions with Insects

Non-circulative (PVY, CMV, AMV)

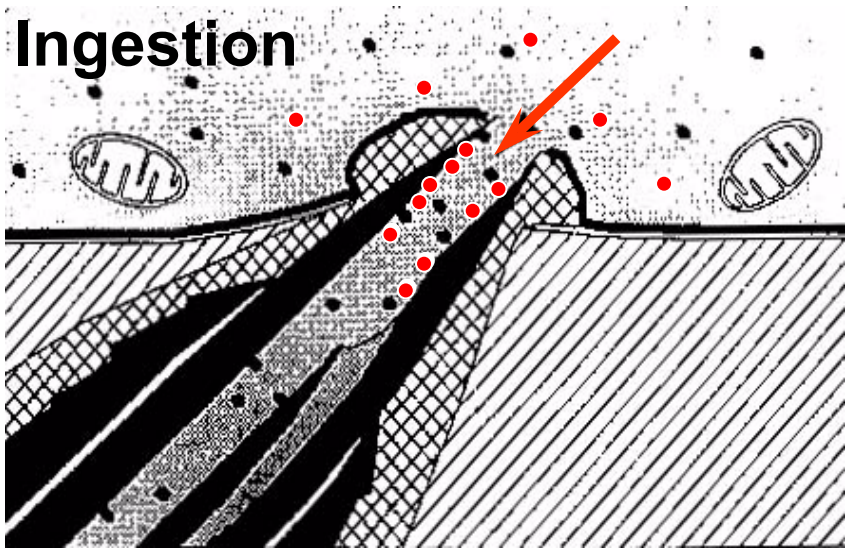
often referred to as “stylet-borne”

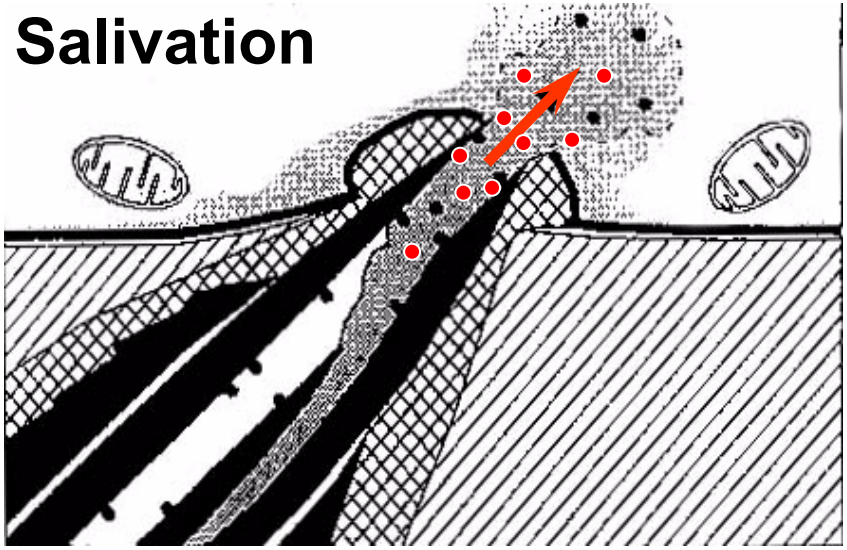


Non-Circulative Pathogen Movement in Insects

Food Ingestion - pathogen particles attach to maxillary lumen

Egestion - pathogen particles released with saliva





Types of Pathogen Transmission by Insects

Non-persistent

often referred to as “stylet-borne”

Persistent

Variations include circulative, propagative, transovariol

Semi-persistent

Categories of Vector Residence

Transient vectors

- do not colonize the crop to which they spread virus
- most important for non-persistent viruses
- relatively unimportant for persistent viruses


Rhopalosiphum padi

Resident vectors

- colonize the crop to which they spread virus
- can be important for all types of transmission
- most important for persistent viruses


Myzus persicae

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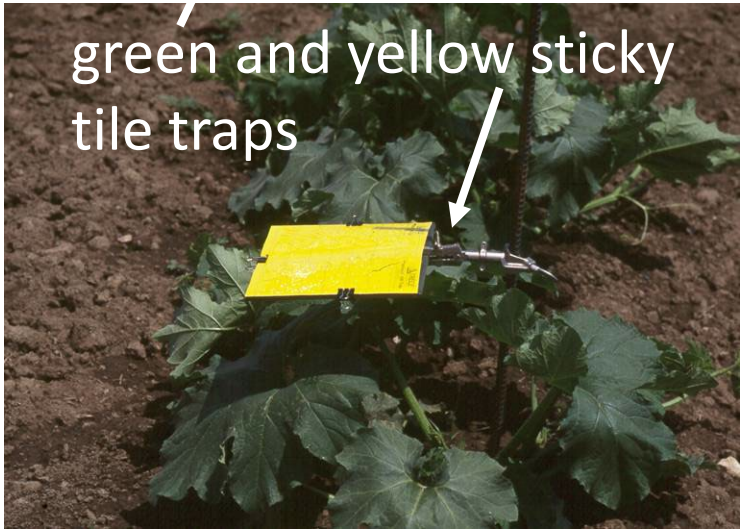
Traps for Determining Transient Vectors



- Resident vectors are evaluated through visual inspection and associated offspring

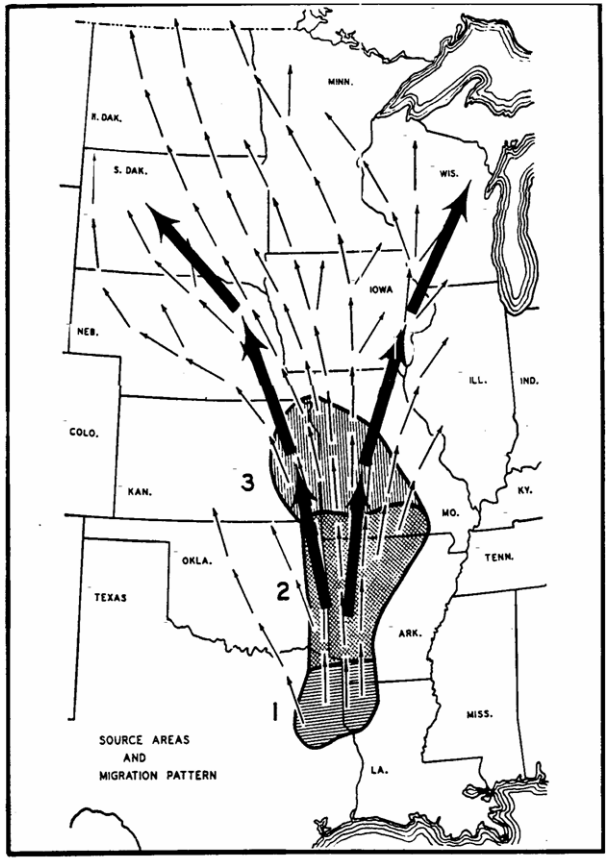
Categories of Insect Dispersal

Trivial flights (aphids, cucumber beetles)

- random movement among selected hosts
- important for secondary spread
- important for non-persistent viruses

Insect migration (aster leafhopper)

- long distance obligatory flights
- can be important for all types of transmission



Host selection and alightment by aphids

- Migrating aphids ready to land are attracted to yellow/green and repelled by UV

- Landing on plants is usually edge-distributed, but generally random

- Suitability of plant determined by briefly probing the plant with mouth parts, or stylets (tasting)

  - Small proportion of aphids remain on 1st suitable host plant encountered

  - Subsequent flights of aphids that leave a suitable plant are relatively short 'trivial'

Reflective Mulch for Aphid/Virus Management

Theory:

Repels winged aphids

(reflected UV)

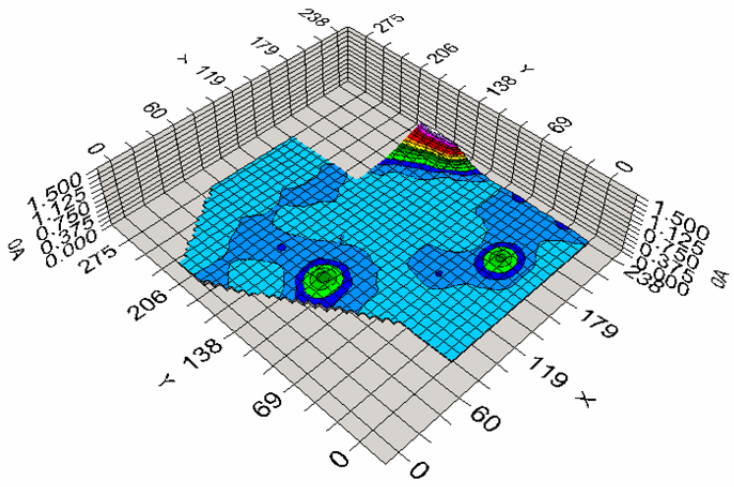
Delays aphid colonization

Delays virus infection

Categories of Pathogen Spread

- **Primary spread:**

  - Initial spread of pathogen into a field from sources outside field



- **Secondary spread:**

  - Spread of pathogen within a field from sources of virus within the same field

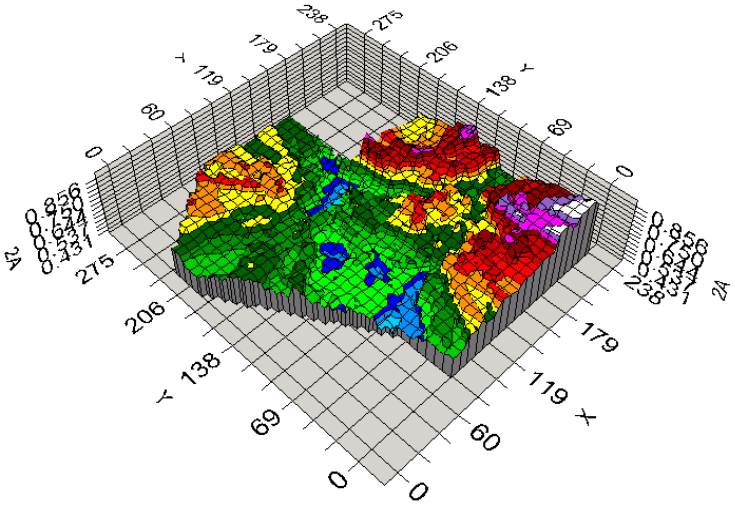


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Photo credit. Gerald Holmes

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Key Determinants of Virus Spread

- Amount of virus inoculum in area (initial inoculum)
- Location of virus inoculum relative to crop (outside/inside)
- Susceptibility of crop to virus infection (cultivar variation)
- Vectors
  - number of species (relative abundance in landscape)
  - transmission efficiency of vectors
  - abundance of individuals
  - activity of vector
    - level and timing
- Environmental conditions (wind, RH, temp)

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General Approaches to Management of Aphid-borne Plant Viruses

- Host manipulation (isolation in space and time), host tolerance (planting dates, variety selection)
- Reducing virus sources (inoculum id and reduction)
- Manipulating (controlling) vectors (alightment, landing, plant apparency)
- Blocking virus transfer between aphid & plant (oils, insecticides, transgenics)

Resistance to virus and bacterial infection

Cornell Disease Resistant Cultivars

Pumpkin Variety	Cucumber Mosaic Virus	Cucumber Vein Yellowing Virus	Papaya Ringspot Virus (WMV-1)	Watermelon Mosaic Virus (Strain 2)	Zucchini Yellow Mosaic Virus	
	CMV	CVYV	PRSV	WMV	ZYMV	Seed Company
Casperita F1 (white mini)				X		HO, HS, JO, SI, SW
Corvette F1				X	X	HO
Harvest Moon					X	C
Jamboree F1	X		X			HO
Magician F1					X	C, HS, RS, SW
Moonstone					X	C
Munchkin (mini)				X	X	HS
Newton F1				X		HO
Poco Blanco (mini)				X		C
Rembrandt F1				X		HO
Silver Moon F1 (white)					X	HO, HS, SI
Speckled Hound F1					X	HS, SI, SW
Speckled Pup F1					X	HS
Zeus F1					X	HS, RS, SW

http://vegetablemdonline.ppath.cornell.edu/Tables/TableList.htm

Johnny's Selected Seeds
An employee-owned company

Rupp

HARRIS SEEDS EST 1879

GURNEY'S SEED & NURSERY CO.

BURPEE

TERRITORIAL SEED COMPANY

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Insect – Sampling and thresholds (foliar)

Sampling

- Yellow sticky cards
- Plant counts
- Colonization times critical

Action thresholds

- 1 beetle/plant for melons, cucumbers, and young pumpkins
- 5 beetles/plant for watermelon, squash, and older pumpkins

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Reducing sources of inoculum

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Sanitation – weed management and exclusion

Cultural

- Eliminate weeds, weedy edges (non-crop sanitation)
- Crop rotation
- Early season row cover

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Aphid lifecycles

- Two-host species (3 host species)
- Polyphagous

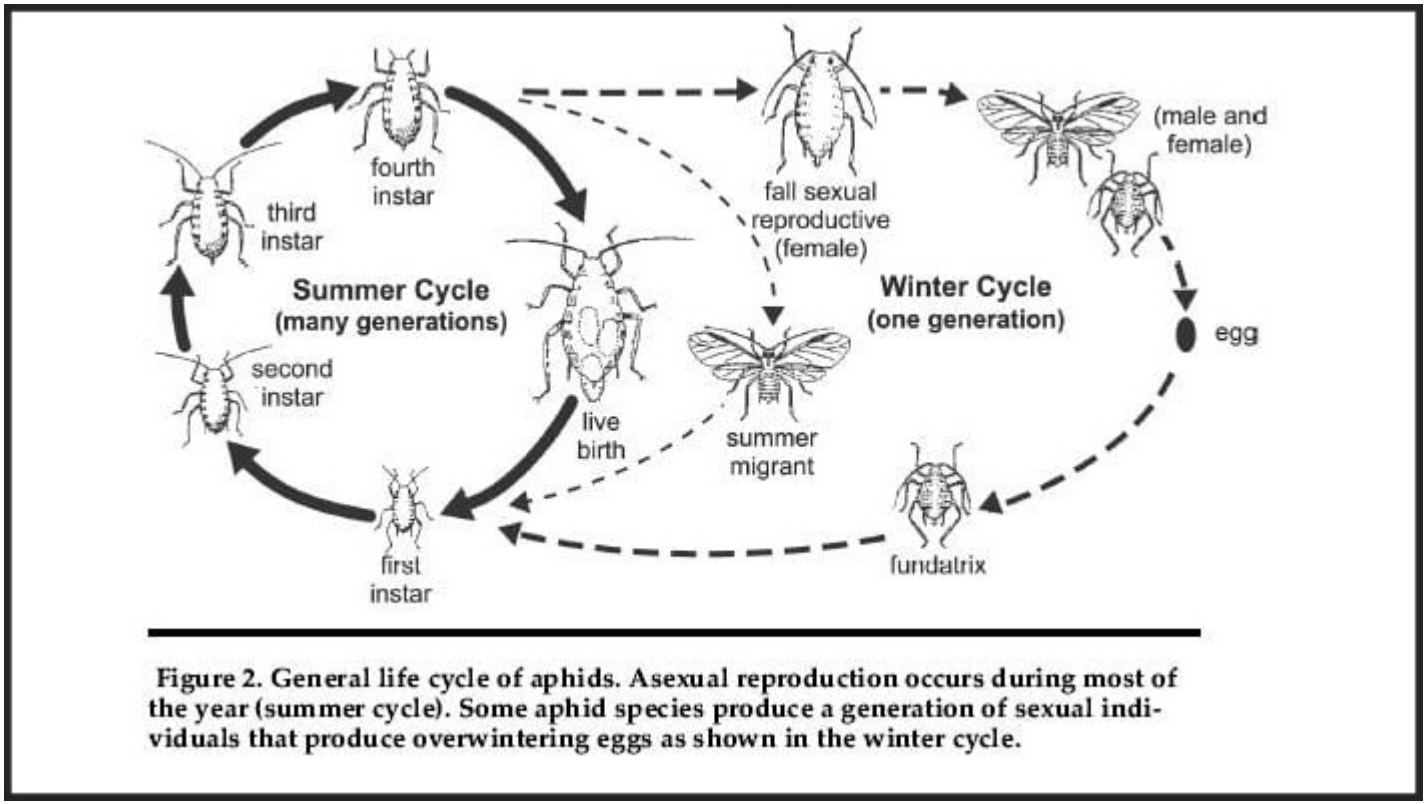

Figure 2. General life cycle of aphids. Asexual reproduction occurs during most of the year (summer cycle). Some aphid species produce a generation of sexual individuals that produce overwintering eggs as shown in the winter cycle.

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Aphid generation time(s) and arrival

- Parthenogenic populations (asexual reproduction)

- Temperature dependent generation times
  - *Aphis craccivora* (4.7 days) cowpea pahid
  - *Aphis gossypii* (5.0 days) melon aphid
  - *Rhopalosiphum padi* (5.1 days) bird cherry-oat aphid
  - *Rhopalosiphum maidis* (5.0 days) corn leaf aphid
  - *Aphis nasturtii* (7.8 days) buckthorn aphid
  - *Myzus persicae* (9.1 days) green peach aphid
  - Macrosiphum euphorbiae (10.3 days) potato aphid

- Arrival in crop by winged aphids (alatae)

- Colonization in crop typified by non-winged aphids (apterous)

- Initial populations found around edges
  - Pivot (road)
  - Irrigation stands (tracks)
  - Field edges
  - Wind breaks (eddy effects)

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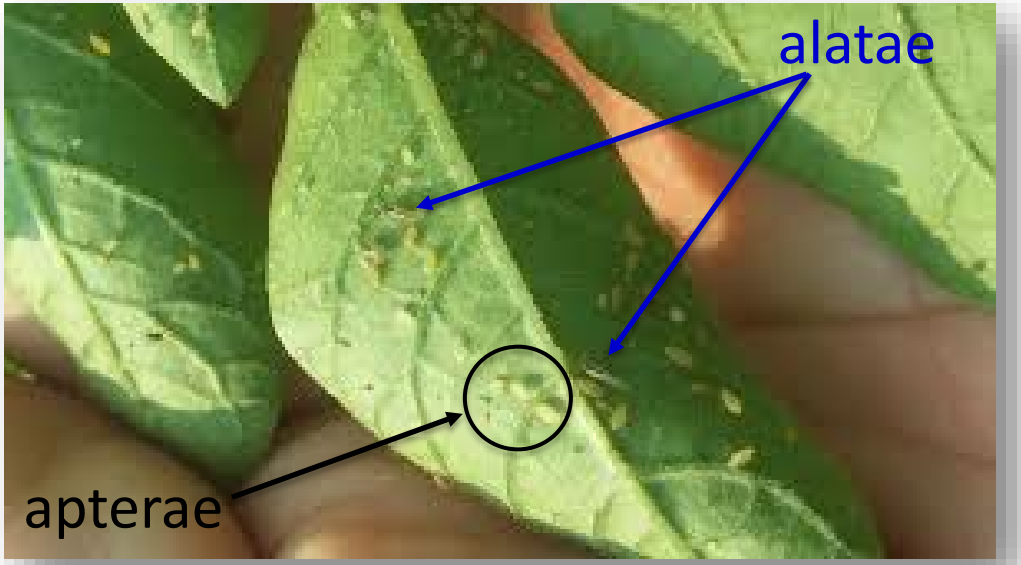
Scouting to identify colonizing aphids



- Scout 10-12 sites per field
- Turn over 25 whole leaves per site
- Turn leaves from mid- to lower canopy positions
- Thresholds:
  - '0' alatae (winged)
    - Avg 5 apterae (wingless) per leaf (action threshold)
    - > 15% of leaves infested (4/25)

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2020 Applied Research Highlights

2023 Applied Research Highlights

2023 Applied Research Highlights

https://vegento.russell.wisc.edu/field-trials/

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New, recent or existing registrations

- **PQZ** (pyrifluquinazon, Nichino America) – brassicas, cucurbits, potato, leafy: aphids only (Group 9B)
- **Sefina/Versys** (afidopyropen, BASF) – brassicas, leafy, potato: aphids only (Group 9D)
- **Sivanto HL** (flupyradifurone, Bayer Crop Sci) – beans, peas, sweet corn, brassicas, potato: aphids, PLH (Group 4D)(soil and foliar)
- **PFR-97** (*Isaria fumosorosea* Apopka Strain 97, Certis USA) – aphids only; (Group UNK, biologic)
- **Transform WG** (sulfoxaflor, Corteva) – aphids and PLH
  beans, peas, sweet corn, brassicas, carrot, onion, potato: aphids, PLH (Group 4C)

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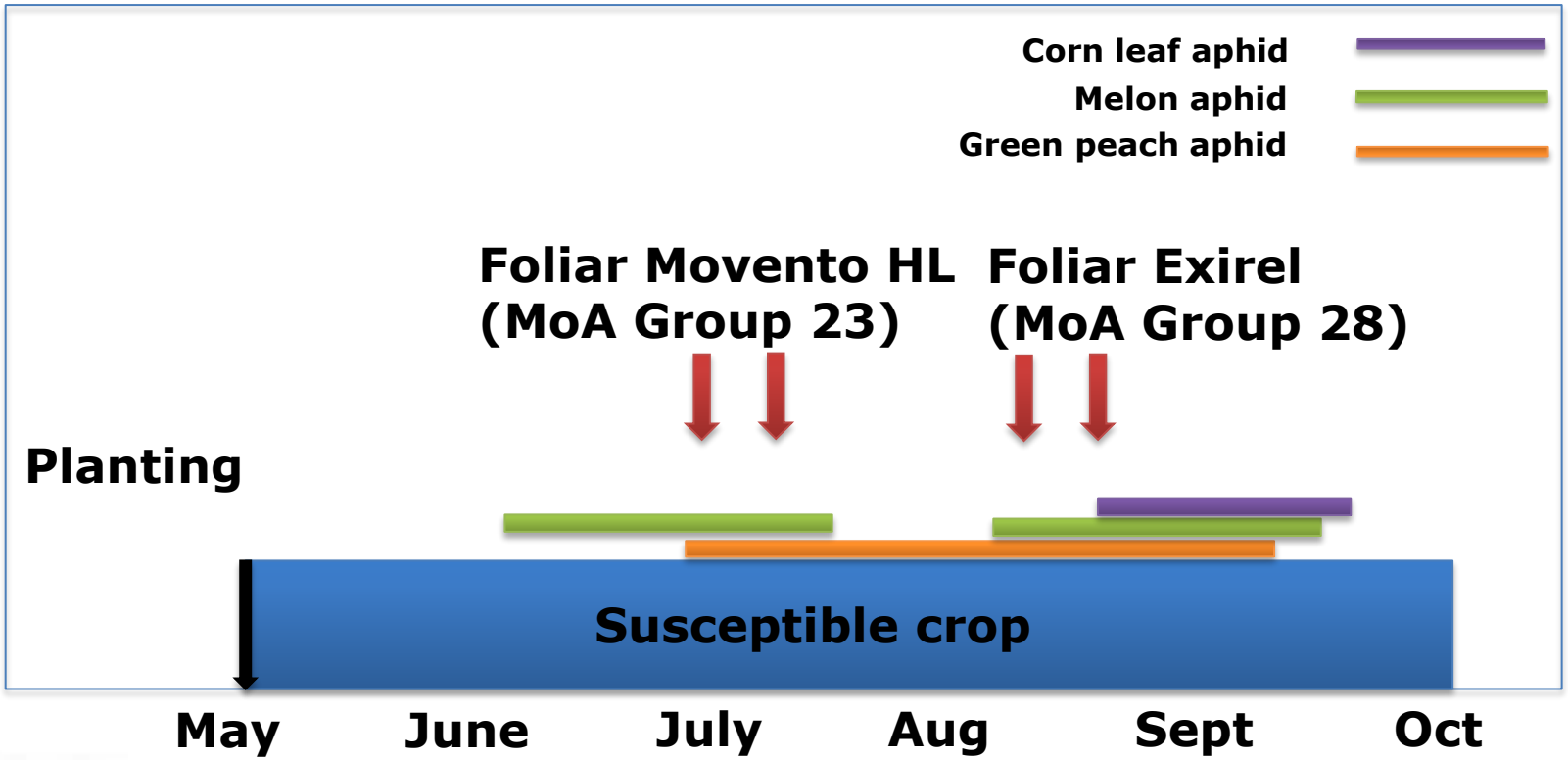
Managing Aphids: Multi-tactic Approach

- Colonizing aphids and mass flights (late June – early July)
- Choice of product should consider other pests



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Management considerations

- **Populations can build quickly under warm and dry conditions**
- **Synthetic pyrethroids can ‘flare’ colonizing aphid populations**
- **Application coverage is critical to target colonizing species in mid- to low canopy**
- **Reduced-risk or soft chemistry can conserve beneficial insects that parasitize aphids**

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Virus Management Summary

- Approaches to limit aphid/beetle/leafhopper landing / alightment
- Selection of cultivars with stated resistance to virus infection
- Sanitation of weedy hosts supporting both the vector (aphids/leafhoppers) and the virus (weedy inoculum)
- Improved understanding of the timing of disease spread and relationship to regional, primary insect vectors – *A. glycines, R. padi, etc…*
- Appropriate timing or applications of mineral oil, insecticides or feeding deterrents.

Acknowledgements and Questions

http://labs.russell.wisc.edu/vegento/

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