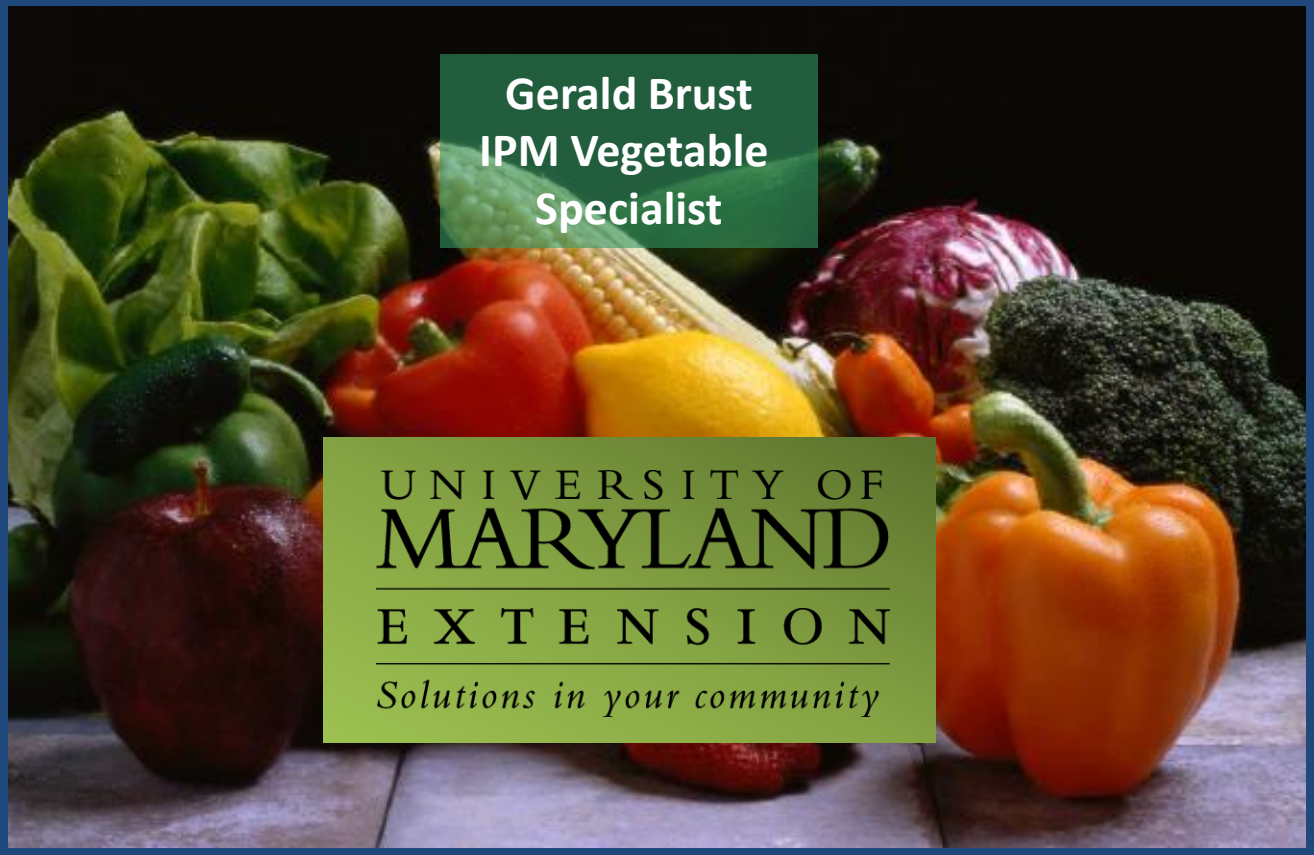
Virus transmission by striped cucumber beetle in pumpkins



What will be discussed

1. Field problems of early season virus infections
2. Aphid and beetle studies
3. Aphid transmission of viruses
4. Beetle transmission of viruses
5. Recommendations

1. Field problems of early season virus infections

Growers in the mid-Atlantic have been complaining about early season (late June early July) virus infections of their cucurbit crops, most notably pumpkins, squash and cucumbers and much less in watermelon and cantaloupe.

By far most of these early season infections occurred in pumpkins.
Some growers claimed that the seed must be infected as
the virus infection took place so quickly and without any aphids ‘being seen’

Plants infected by a virus have their new growth become deformed as this is where the virus is concentrated. This infection often produces a mottled appearance of the new growth that is at times strap-like or distorted. The biggest problem is once infected the fruit (pumpkin, melon, cucumber) will not develop normally and fruit pollinated after virus infection will not develop at all. A plant can be infected days or weeks before any symptoms appear.

Deformed fruit caused by virus infection

- Some pumpkin fields had 35-45% virus infection by late June, their yields were reduced by 50% or more

- Fields were either ‘hit hard’ with virus or were not hit at all

- Most infections were from watermelon mosaic WMV (80%) or an undetermined Potyvirus (20%)

- Early season aphids were thought responsible

- Growers and a crop consultant (Bob Rouse) felt something else responsible

In general, the spread of Potyviruses in the field occurs when aphid activity is high and is usually very rapid and localized

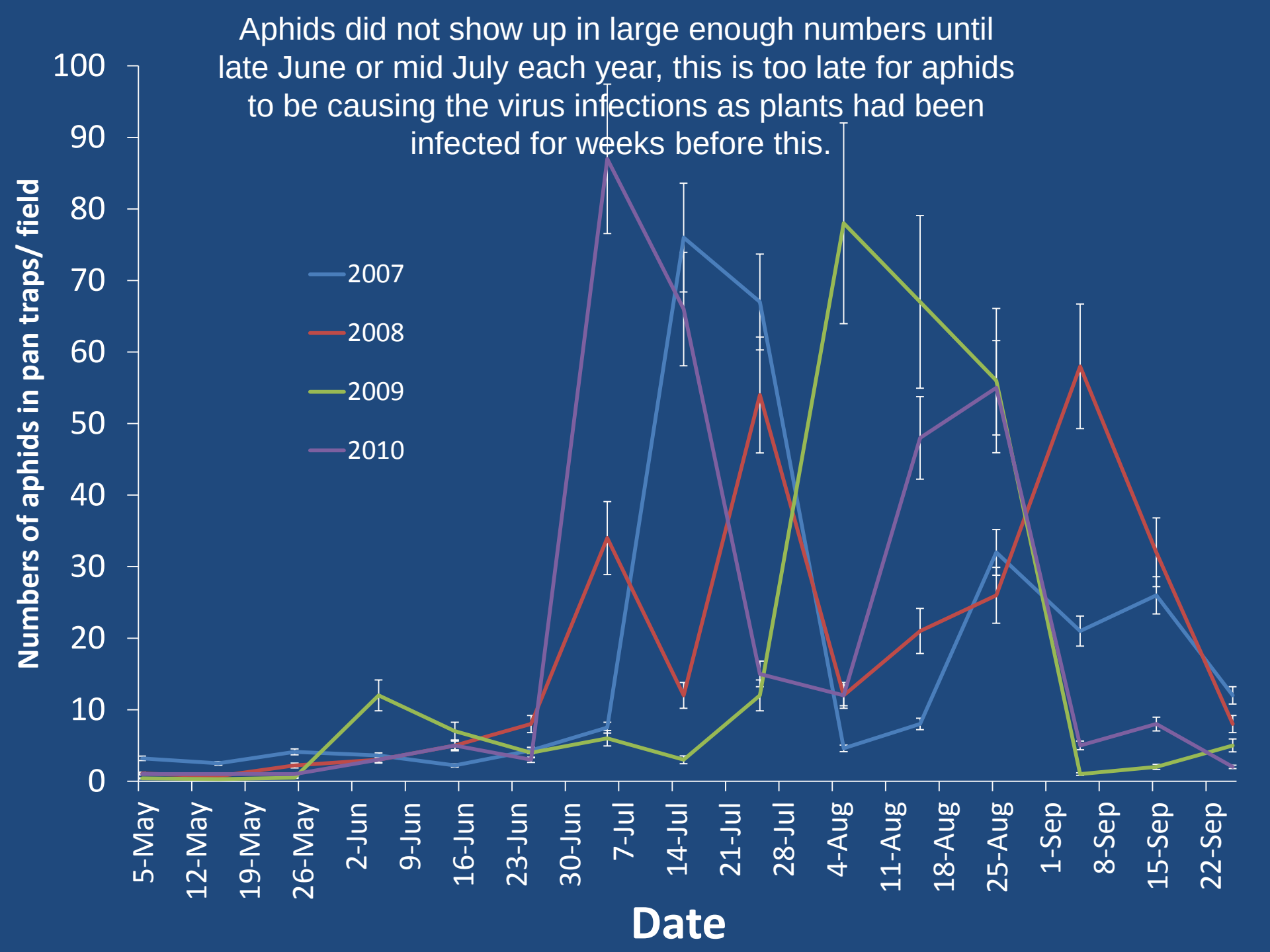
What is known about virus vectors

Viruses	Virus Vector
• Papaya Ringspot	Aphids
• Watermelon Mosaic	Aphids
• Zucchini Yellow Mosaic	Aphids
• Squash Mosaic	Aphids, Cucumber beetles
• Cucumber Mosaic	Aphids, Cucumber beetles

Since the most common virus found was Watermelon mosaic virus (WMV), it was presumed that aphids had to be the vectors, but……..

2. Aphid and Beetle studies

Yellow water-pan traps and at times yellow sticky traps were used to monitor aphid flights into pumpkin fields in 5 locations in Maryland from 2007-2010. Number and species of aphids were recorded for each pumpkin field (20) in the survey.


Aphids did not show up in large enough numbers until late June or mid July each year, this is too late for aphids to be causing the virus infections as plants had been infected for weeks before this.
Numbers of aphids in pan traps/ field
100
90
80
70
60
50
40
30
20
10
0
2007
2008
2009
2010
5-May
12-May
19-May
26-May
2-Jun
9-Jun
16-Jun
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
Date

What about striped cucumber beetles, that show up very early in the pumpkin season as well as in other cucurbits?

Greenhouse feeding trials were conducted looking at striped cucumber beetles that had been captured in early season virus infected pumpkin fields.

Pumpkins fed upon by these beetles became infected only with watermelon mosaic virus

3. Aphid transmission of viruses:

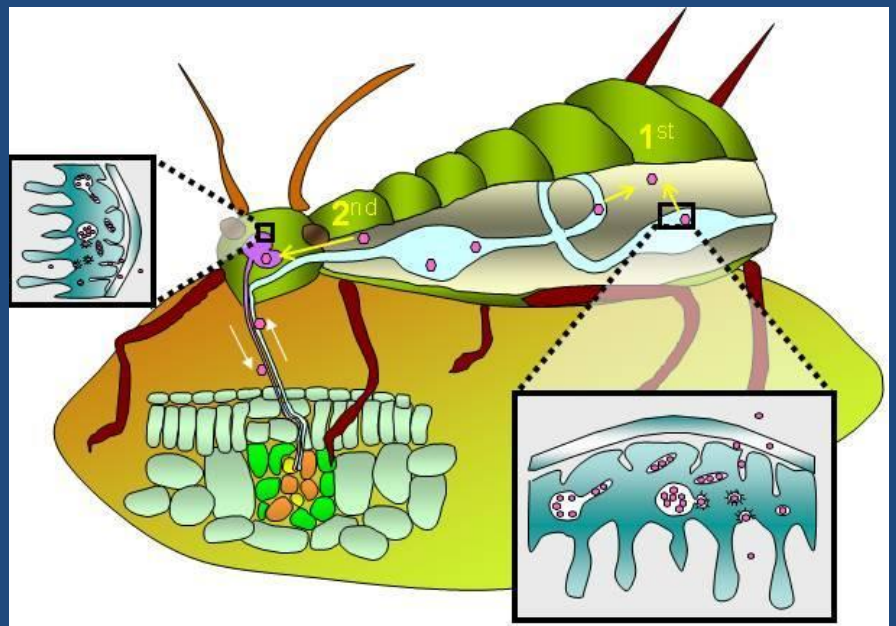
To understand what is going on in the field, we need to look at how aphids transmit viruses and then how this compares with beetles.

Aphids use a very slender flexible needle-like mouth-part called a stylet (black wiggly line) that they push into the plant and tap the phloem tube where they abstract large amounts of sap. They also inject saliva into the plant containing among other things viruses.

Mechanisms of Virus Transmission

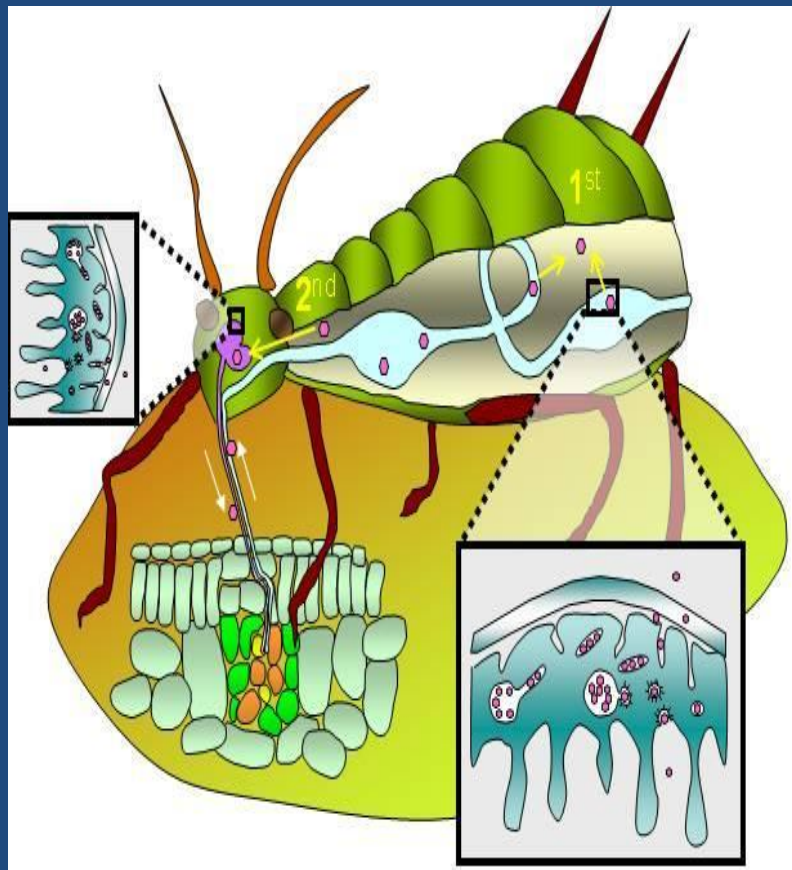
Non-Persistent Stylet Borne transmission: very short latent period - transmissible within minutes

- Virus acquired in “Test Probes” of 20 to 30 secs
- Virus transmitted in “Test Probes” of 20 to 30 secs
- Virus retained by aphid for ≤ 1 hour



Semi-Persistent

- Requires longer acquisition time, up to several minutes of feeding
- Short latent period—transmissible within a couple of hours
- Aphid retains the ability to transmit virus for several hours up to several days—loses ability to transmit virus after a molt



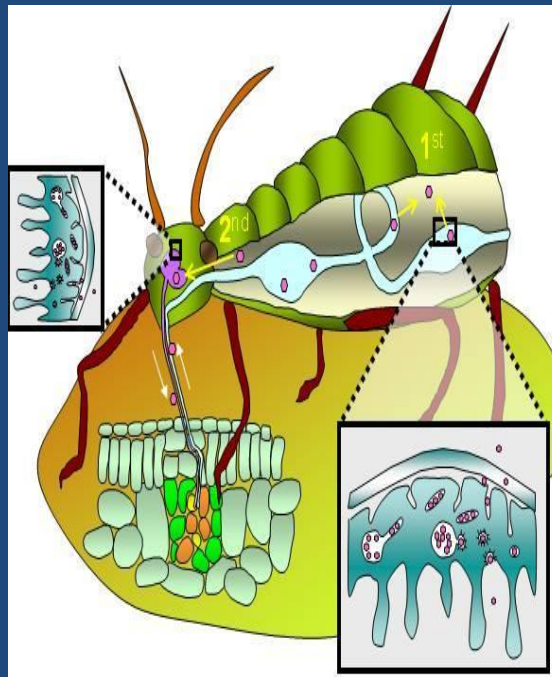
Persistent

- Requires longer period of feeding to acquire virus—several hours
- Latent period— a few hours to a few days
- Aphid can transmit virus for weeks

Propagative and Circulative:

- Propagative viruses are able to replicate in both plant and insect

- Circulative cannot



Persistent

(propagative)

- Aphid remains infective during its entire life because the virus is found inside the cells of the aphid.
- Aphid's offspring before they are born are infected and capable of transmitting the virus to new plant cells.
- Virus can reproduce in two hosts (animal-aphid and plant) with vastly different genetics, and each host is necessary for the viral infection to complete its cycle.
- Virus cannot move on its own from one plant to another.

4. Beetle transmission of viruses

Beetles retain many viruses such as squash mosaic virus, cowpea mosaic virus, watermelon mosaic virus, cucumber mosaic virus, and tobacco mosaic virus, but they will “not” transmit watermelon mosaic virus or tobacco mosaic virus

(J.P. Fulton, R.C. Gergerich and H.A. Scott)

The curious case of virus transmission by beetles

- Plant viruses appear in hemolymph of beetles within minutes of feeding on an infected host (one bite out of plant is potentially enough)

- Many stable viruses that beetles carry are not transmitted (TMV)

- Once in hemolymph, viruses can be detected in beetle's regurgitant

- Reflexive bleeding and feces both contain active viruses

- Only by feeding on a plant can beetles transmit any viruses

- Beetles can transmit viruses for a few or many days

- Beetles can transmit virus with one bite or it might take days of feeding

- Virus retention can last much longer if beetle goes into quiescence or hibernation

- Very little if any latent period

- Some beetles can stop transmitting a virus for a few days and then start-up again

The beetle’s regurgitant (saliva) prevents the transmission of most of the viruses that the beetle carries, but does not prevent the transmission of the “beetle-transmissible viruses”


Striped cucumber beetles feed and defecate in the same area of the leaf. The feces can contain bacteria that cause bacterial wilt, but these open feeding wounds are also where viruses that the beetle carries can enter the plant.
Robert Durgy
UCONN

When beetles feed they transmit the virus or viruses in their body into the plant in their regurgitant

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Viruses then try to ‘move’ into the plant via the feeding damage

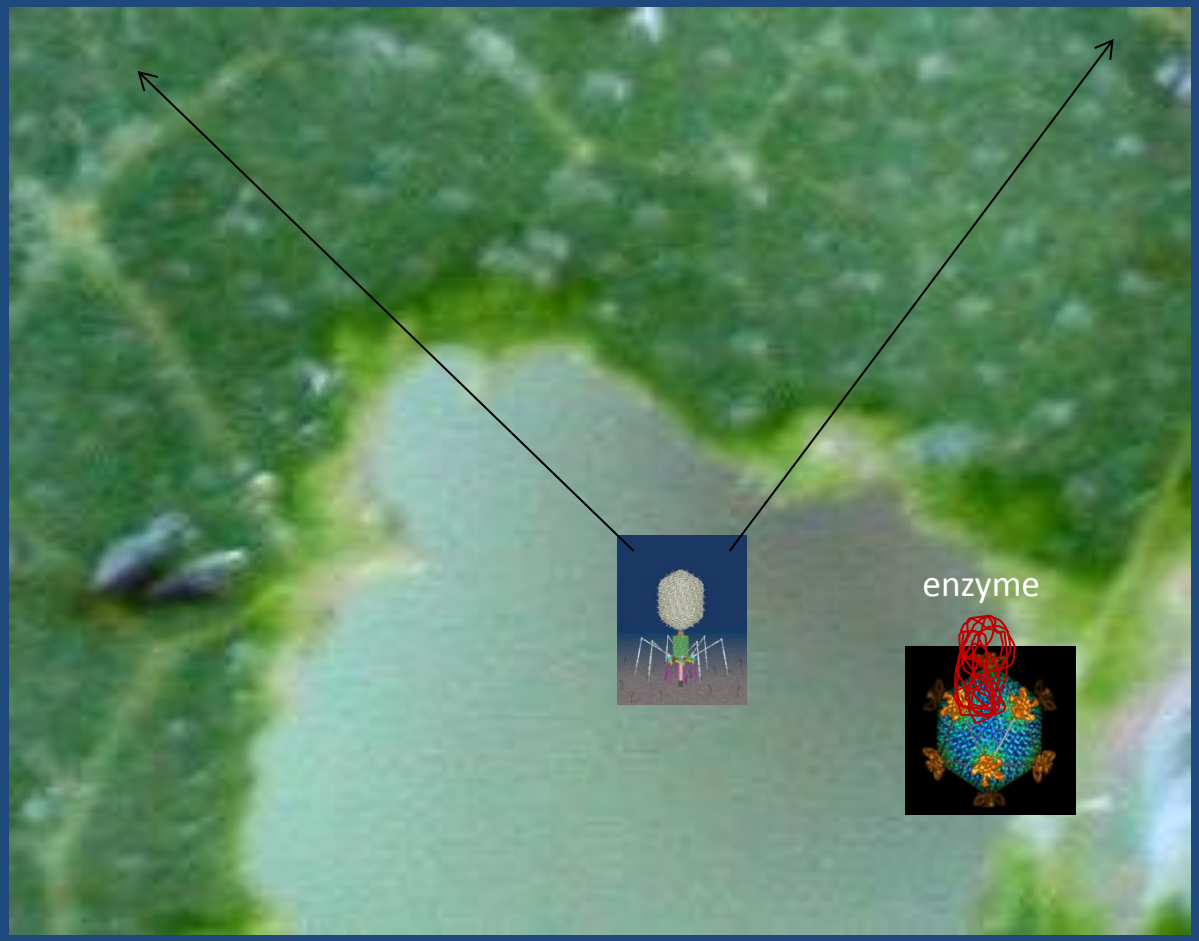
However before the viruses can do this they encounter an enzyme from the beetle that can inactivate the virus

Enzyme in beetles saliva, regurgitant, inactivates some viruses

However, some viruses when they encounter the enzyme……

Are not inactivated by the enzyme

This allows certain viruses (known as “beetle transmissible viruses”) to then move into the plant and infect its cells. Watermelon mosaic virus is one of these “beetle transmissible viruses”



The potyviruses found in early field infections were all:

Watermelon Mosaic Virus

All Potyviruses are found in wild and volunteer cucurbits.

Watermelon mosaic virus also occurs in weeds such as goosefoot, lambsquarters, various legumes, and other related plants.

The virus is transmitted by many species of aphids, and now we know, striped cucumber beetles too.

Lambsquarters found in or near many of the problem fields

Greenhouse studies were conducted looking at the transmissibility of WMV from pumpkin plant to pumpkin plant and from weed to pumpkin plant by striped cucumber beetles

Striped cucumber beetles can transmit WMV from lambsquarter infected plants to pumpkin plants at a very high success rate of 45%.

The beetles can transmit WMV better from a lambsquarter plant to a pumpkin plant than from a pumpkin plant to another pumpkin plant

45% from weed, 25% from cucurbit

Striped cucumber beetles that were captured virus free from virus-infected fields can transmit WMV better in cage trials than beetles captured from non-virus infected fields

33% from infected field
18% from non-infected

Recommendations

Need to know if striped cucumber beetles are virus vectors in your field or not before season starts—DO NOT start intense control program for beetles unless you are sure they are virus vectors

Do not use pyrethroids all the time to control beetles, or else you will have aphid outbreaks later in the season

Use different classes of chemistries: imidacloprid – Admire, endosulfan -Thionex (2012), acetamiprid – Assail, dinotefuran – Scorpion, clothianidin – Belay, Pyrethroids

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Using pyrethroids early and often will cause aphid and possibly mite outbreaks in your pumpkins

Beetles like to feed at the base of cucurbit plants - like pumpkin. Concentrate sprays at the base of the plants.

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Questions

UNIVERSITY OF MARYLAND EXTENSION

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jbrust@umd.edu

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