High Plains wheat mosaic virus: biology, management, and seed transmission

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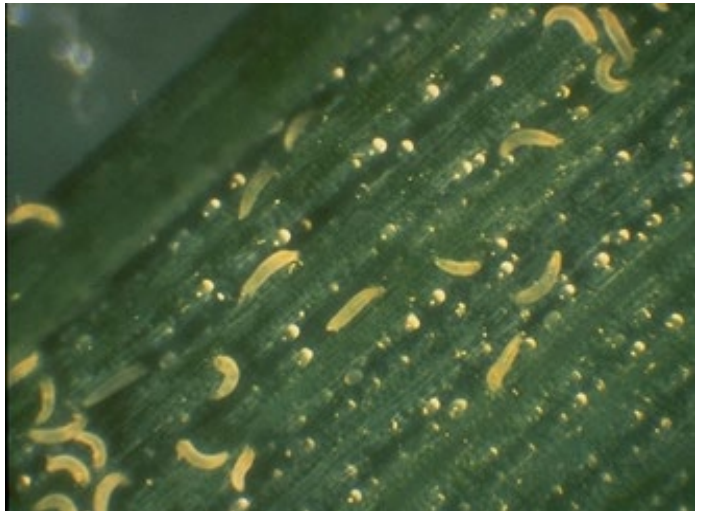
High plains wheat mosaic virus (HPWMoV)
a.k.a High Plains virus (HPV), wheat mosaic virus (WMoV)

- First discovered in High Plains region of the US in the 1990s
- But now widespread in the corn growing regions of the U.S.
- Infects corn, wheat, barley, oats, rye, and some weedy grasses
- Transmitted by the wheat curl mite (*Aceria tosichella*)
- Renewed interest due to the recent phytosanitary restrictions and concerns over seed transmission



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Seed Health Testing

And challenges with diagnostics

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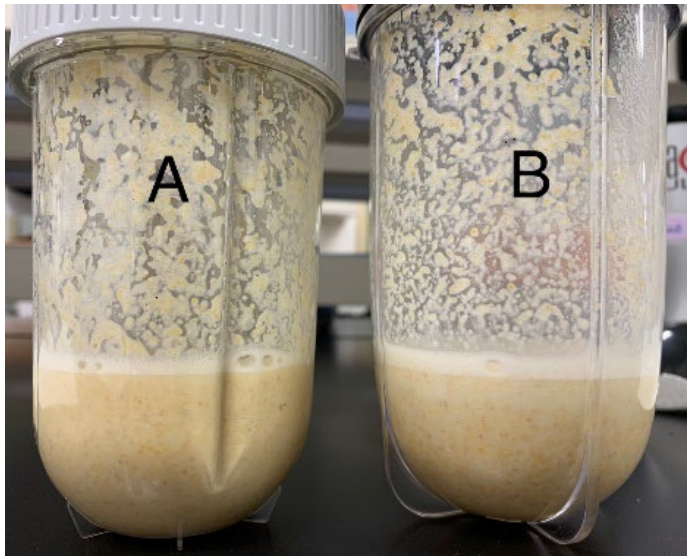
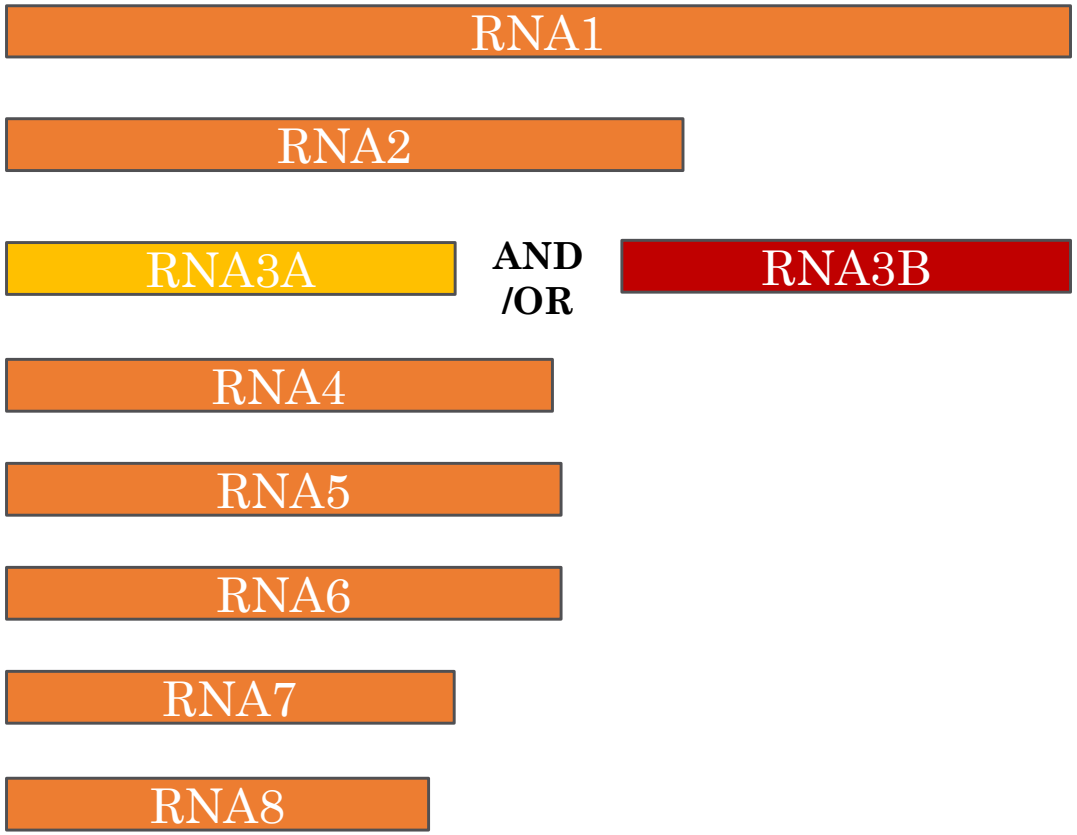
Seed Health Testing

- Direct testing of seed tissues for a pathogen, usually using RT-PCR or ELISA
- There are many challenges compared to testing other tissues, including challenges in disrupting seed tissues, lower pathogen titer, etc.
- RT-PCR is more sensitive than ELISA but it all depends on how well the primers recognize the virus genome



Genomic Diversity of HPWMoV



- The virus has 8 genome segments which makes it hard to sequence
- There are two versions of RNA3
- The first genome sequence was not determined until 2016
- The main primer set used for diagnostics, from LeBas *et al.* 2005, predates the first genome sequence
- Other diagnostic primer sets based on the LeBas sequence also target RNA3

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Status of the HPWMoV Test

- There is no official seed health test per the National Seed Health System
- Test development is underway by joint group between Iowa State University Seed Science Center and the Bayer Vegetables diagnostic lab
  - Have developed wet and dry grinding methods
  - Currently setting up a comparative test and further refining the grinding method
- Development of additional primers sets with targets other than RNA3 are underway…

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Virus Isolate Collections

Collected in 2022

So far in 2023

These isolates are an excellent tool to design primers and validate the seed health test

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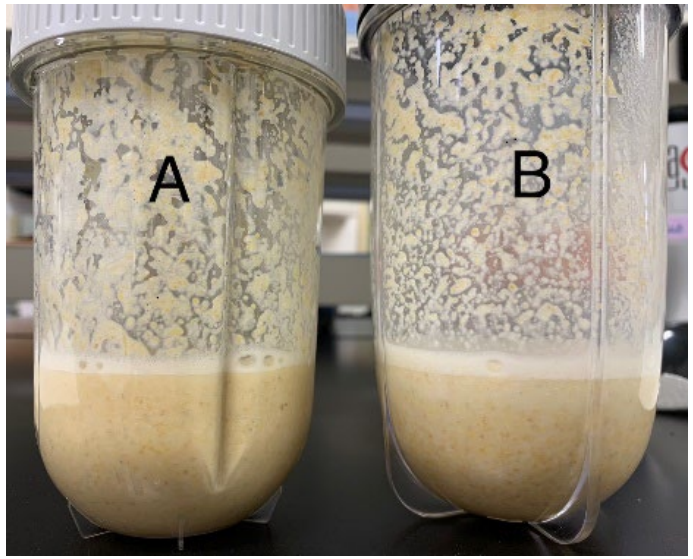
- There are many challenges compared to testing other tissues, including challenges in disrupting seed tissues, lower pathogen titer, etc.
- RT-PCR is more sensitive than ELISA but it all depends on how well the primers recognize the virus genome
- These tests cannot distinguish between viable vs. inviable virus



- **What is the relevance of a seed health test as far as seed transmission?**

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Seed Transmission

Key questions and ongoing research efforts

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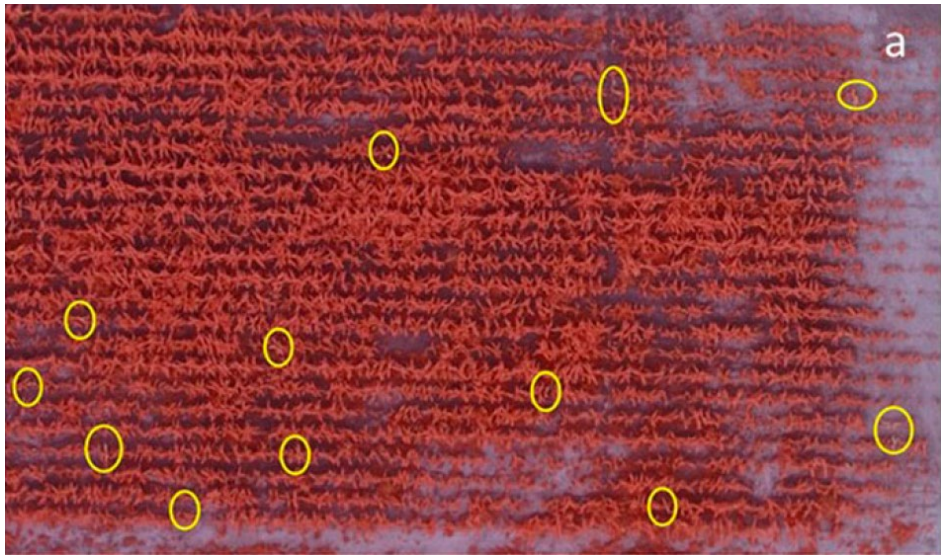
Evidence for Seed Transmission

- An initial study showed the transmission rate is incredibly low (<0.01%, Forster et al. 2001).
- A recent study claims 40% yield loss and as high as 3% seed transmission in one isolated field in Utah (Nischwitz 2020)
- Anecdotally, random virus distribution in the field is indicative of seed-borne rather than vector-borne transmission



What is the true rate of seed transmission?

How to assess seed transmission?

Grow-out Tests – plant hundreds/thousands of seeds and test the resulting seedlings

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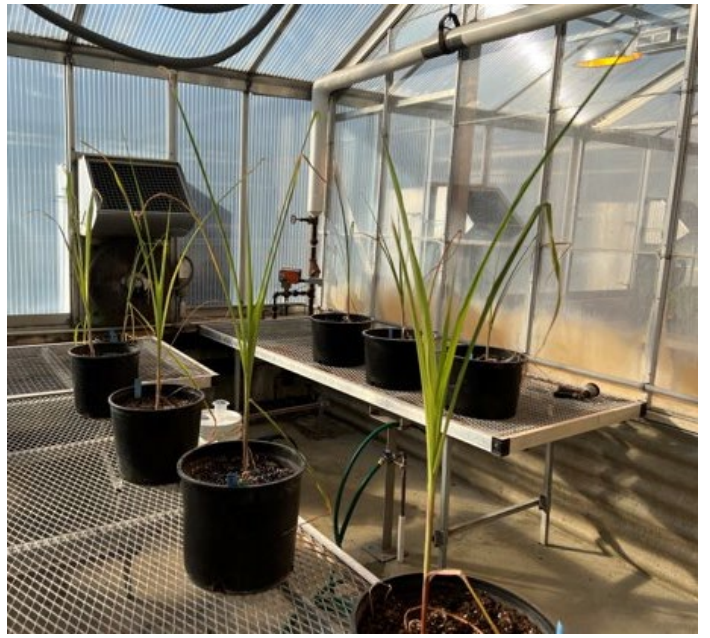
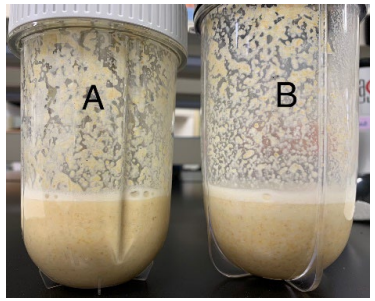
How to assess seed transmission?

1. **Inoculate corn plants and allow infected plants to grow to seed**
   - Plant growth stage at inoculation
   - Host genotype/cultivar
   - Virus isolate
2. **Collect the seeds and perform seed health testing**
3. **Grow-out the seed and test the resulting seedlings**
   - How many seeds is enough?





Management

Challenges and opportunities

Potential Management Strategies

- **Host resistance**
  - Does virus resistance reduce or eliminate seed transmission?
- **Vector management**
  - Very challenging to manage the vector
  - But timing of infection may be important

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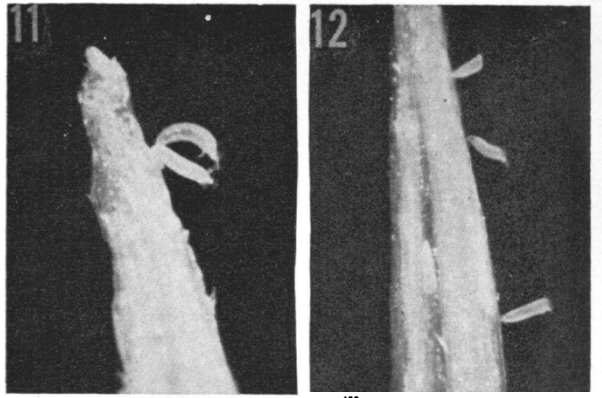
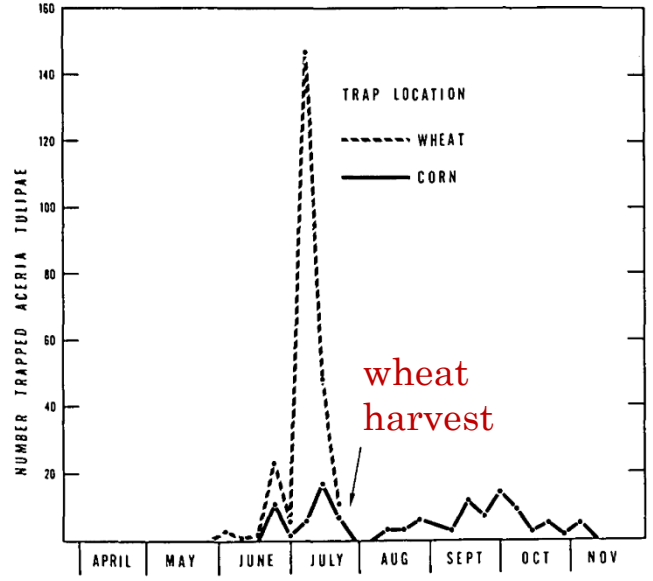
Wheat curl mites actively facilitate their dispersal through behavior

- Mites colonize the leaf whorl – they are down in the base of the leaf sheaths where they are protected from wind, pesticides, and detection
- When ready to disperse, they:
  - move to the leaf tips
  - stand perpendicular to the leaf or form chains/towers to be picked up by the wind
- Mite dispersal is driven by host plant senescence/drying or extreme overcrowding
- Mite dispersal is highest during wheat maturation and harvest



mites standing perpendicular to the leaf or forming chains



from Nault & Steyer 1969

Potential Management Strategies

- **Host resistance**
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- **Vector management**
  - Very challenging to manage the vector
  - But timing of infection may be important
- **Seed drying/treatments**
  - For another maize virus, drying of seed to 15% moisture content eliminated seed transmission (Bernardo et al. 2023)

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