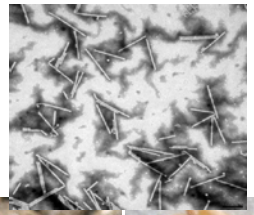
Cucumber green mottle mosaic virus

Keep an “Open Mind” and Question Your Observations

Disease Cycle

2. CGMMV cross-contaminated via mechanical transmission – people/equipment, debris and soil

1. Bees and other insects potentially disperse CGMMV in the field



CGMMV-contaminated seed

3. Weeds around fields can be hosts/reservoirs for CGMMV

direct sown / transplants

Cucumber Green Mottle Mosaic Virus (CGMMV)

- Very stable and easily transmissible by mechanically and by plant debris in soil.
- Distribution: Worldwide - thought to originate in Asia
- Other Cucurbit Tobamoviruses (ZGMMV, KGMMV) distribution– Korea, ??
- Seed transmission has been reported most frequently in cucumber. Although Watermelon appears to be on the increase (Australia, CA,USA).

CGMMV Host Range

- Cucumber
  Melon
  Watermelon
  Bitter gourd
  Gherkin

  CGMMV outbreak in Fresno area 2017

  - Bottle gourd ; Opo round
  - Squash
    (pumpkin type; C moschata-C. maxima)
  - Korean melon
  - Japanese cucumber
  - Chinese bitter melon

Weeds identified as Potential Hosts to CGMMV

Family	Scientific name	Common name
Apiaceae	*Heracleum moellendorffii*	Eosuri
Boraginaceae	*Heliotropium europaeum*	Common heliotrope
Lamiaceae	*Moluccella laevis*	Bells of Ireland
Solanaceae	*Solanum nigrum*	Black nightshade
	Withania somnifera	Indian ginseng
Amaranthaceae	*Amaranthus blitoides*	Prostrate amaranth
	Amaranthus graecizans	Mediterranean amaranth
	Amaranthus muricatus	Rough-fruit amaranth
	Amaranthus retroflexus	Redroot amaranth
	Amaranthus viridis	Green amaranth
Chenopodiaceae	*Chenopodium album*	Lambsquarter
Portulaceae	*Portulaca oleracea*	Pigweed
Cucurbitaceae	*Citrullus colocynthis*	Bitter apple
	Ecballium elaterium	Squirting cucumber
	Mukia maderaspatana	Headache bryony vine
Euphorbiaceae	*Chrozophora tinctoria*	Turnsole

Common Weeds Found in CA
Might they be a host?

- *Conyza canadensis* (formerly *Erigeron canadensis* L.; common horseweed).

- *Convolvulus arvensis* (field bindweed)

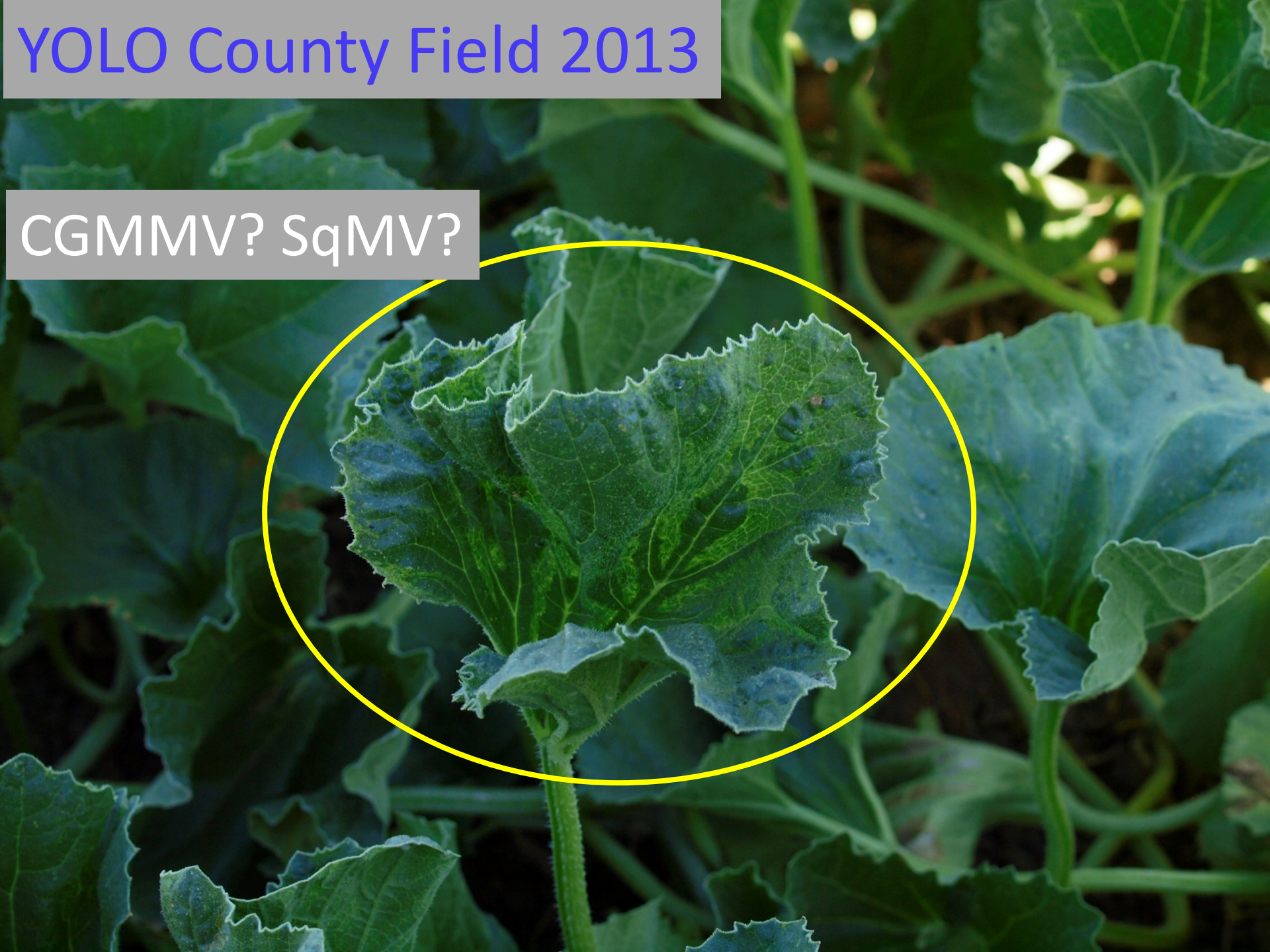
- *Xanthium strumarium* (common cocklebur)

- *Malva parviflora* (little mallow; cheese weed)

Potential Area of RISK?

YOLO County Field 2013

CGMMV? SqMV?



Foliar symptoms vary among cucurbit hosts

Difficult to distinguish from other cucurbit viruses

Mosaic
Mottle Mosaic
Severe mottle mosaic
Blistering
Necrosis
Deformed fruit (cucumber)
Spongy flesh (watermelon)
Irregular ripening (watermelon)
Leaf rolling
Wilting
Yellowing??

Melon seedling infected with CGMMV

Note mosaic and fringe–like appearance

NO Distinct CGMMV symptoms

2017 Fresno County field detect.

CGMMV, a “NEW” unidentified tobamovirus (in progress), and POTY’s detected

Pumpkin (*Cucurbita maxima*) and Watermelon CGMMV Infected Fields (AU)

In AU, mixed infections with Potyviruses(ZYMV,WMV) is common.

2014 Watermelon Outbreak in California

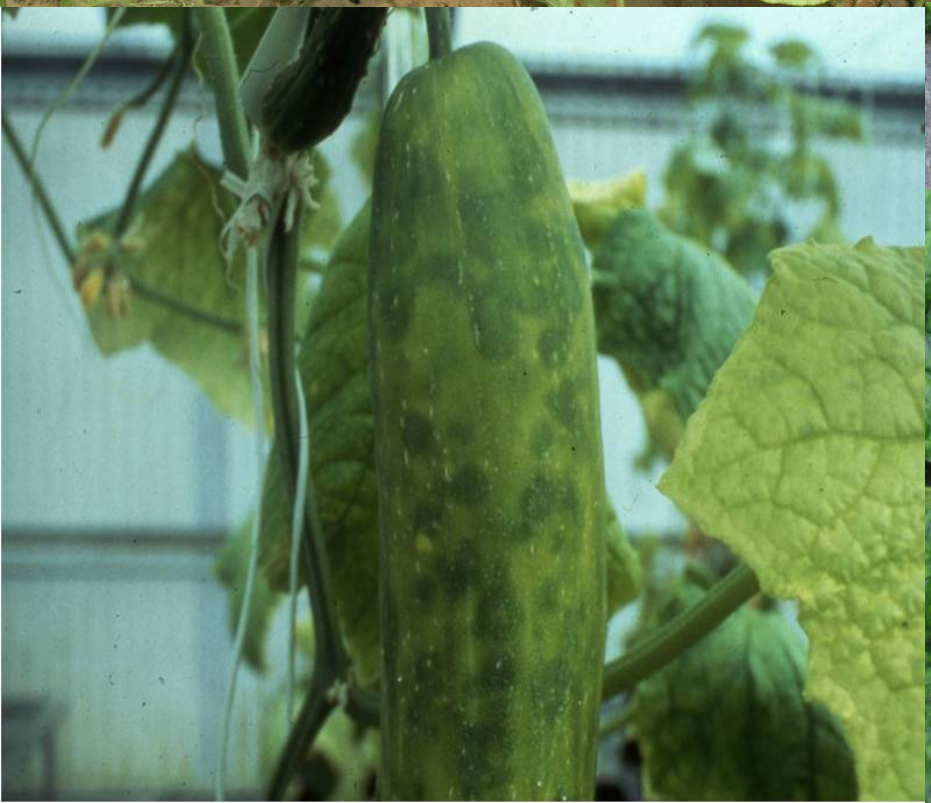




Paddy melon
Pumpkin (*Cucurbita maxima*; Kabocha squash)

CGMMV Fruit Symptoms

- Bloody red flesh
- Greening of mature fruit
- Distortion of fruit
- Pedicel scarring
- Mottling
- Mosaic



Uneven Ripening with a Necrotic Pedicel (IL)

CGMMV infected fruit
“Blood RED” Flesh (AU)

Symptomology comments from Australian Researchers

- CGMMV symptomology appears it can change depending on age of plants and with temperature.
- They have seen beautiful symptoms one day and the very next day they disappeared.
- Older the plants, the more difficult to see symptoms.
- CGMMV much more evident in younger plants. This will impact timing of inspections At the beginning of flowering – just post flowering.
- Watermelon Fruit is relatively asymptomatic apart from browning on the peduncle until you cut it open (uneven ripening, blood red flesh).

Associating Symptoms to a Virus can Lead to Improper Diagnosis or NO DIAGNOSIS!!

- We tend to define symptoms on an individual plant/virus combination.
- Relying solely on what you think in the field may bring us to a wrong and undesired conclusion.
- Viruses can develop different symptoms on different varieties of the same crop.
- SYNERGISTIC EFFECT - A mild virus may become more aggressive and devastative when mix infection occurs with a different virus.
- LAB Diagnostics is critical – CGMMV can look like several other Cucurbit viruses

Symptom Summary

Factors which can influence Symptomology

- Environment (temperature, lighting)
- Strain of Virus
- Host (specie, variety)
- Time of infection (crop stage)
- Insect vector (infection via flower?)
- Tissue type (leaf, fruit)
- Growth stage (seedling-adult)
- Growing conditions (crop management)

Virus Movement

- **SEED – Request seed health certificate from seed supplier**
- **Mechanically** –CGMMV (Tobamoviruses) –HIGHLY Contagious
- **Irrigation** –re-circulated nutrient solution, river water, surface water.
- **Pollen** - has been shown to be involved experimentally.
- **Crop debris**
- **Contaminated substrate / soil**

VIRUS Movement

- Grafting
- **Birds**
- Bio-control / pollinator insects
- Honeybee's – bees have been shown to transmit CGMMV passively. Also live CGMMV found in the honeycomb.

  Prior to this find the industry was only concerned about hives not coming from a common species (watermelon-watermelon). Purity concerns.

  How to manage – will need to work with bee keepers to develop a plan. Develop a better understanding of hive movement to cucurbit fields.

- Chewing insects in the open field? Experimentally Red pumpkin beetle (*Raphidopalpa foveicollis*) look like probable suspect.

  Diabrotica spp. - Could these spp. be candidates?

CGMMV Infection

- Expression can occur 7-14 days after infection protected culture.

- Light intensity effects expression of tobamoviruses
  - Low light favors expression
  - High light appears to mask expression (observed with Solanum tobamo's).

- High Temperature tend to enhance fruit symptoms

Control /Management of Tobamoviruses

- Clean Seed –ensure seed was properly tested by an approved method prior to planting. Request a seed testing certificate from your supplier.

- Transplant house /Nursery –
  - Ensure material targeted for your fields or productions are isolated or placed with seed which was also tested and Negative for CGMMV.
  - Industry should work with transplant growers.

- Familiarize yourself with virus symptoms when you inspect productions.

  CHALLENGING due to lack of expression. Expression is clearer under lower light conditions and under protected culture conditions. Could infection be occurring at flowering?

- Crop rotation - 3-5yrs for standard cucurbit production;
  5-7 for a seed borne disease infected field or complete avoidance if possible.

Control /Management of Tobamoviruses cont……

- Weed control program including weed surveys to develop a better understanding of CGMMV/Weeds in CA or wherever CGMMV has been detected.
- Australia has seen a CGMMV outbreak resulting from poor weed control.
- Implement a complete hygiene program (sowing seed in nursery - production house – workers –field – harvest).
  Australia growers are implementing BIOSECURITY programs

Gaiters can be a good option to walk cucurbit fields

CGMMV - Proposed Disinfectants

	Bacteria	Virus
Disinfectant	**Bacterial fruit Blotch** (Ac)	**Tobacco Mosaic** (TMV)
KleenGrow (0.3%)	+++	2%
Simple Green d Pro 5 (0.5%)	+++	2%
Physan 20 (syn. Maril 100 (India; 0.13%)	+++	2%
Lysol (25%)	+++	50%
Ethyl Alcohol* (70%, 75%)	+++	-
Isopropyl Alcohol* (70%, 75%)	+++	-
Virocid (0.25%)	+++	1%
Virkon S (0.5%)	+++	2%
SaniDate (0.4%)	+++	2%
Virex II 256 (0.4%)	+++	2%
Non-Fat Dry Milk (3.5% Protein 20% wt/vol.)	+++	10% protein 20% wt/vol.
Bleach/Clorox (sodium hypochlorite)	+++	10%/ 0.8%a.i. 60 sec. / 15min

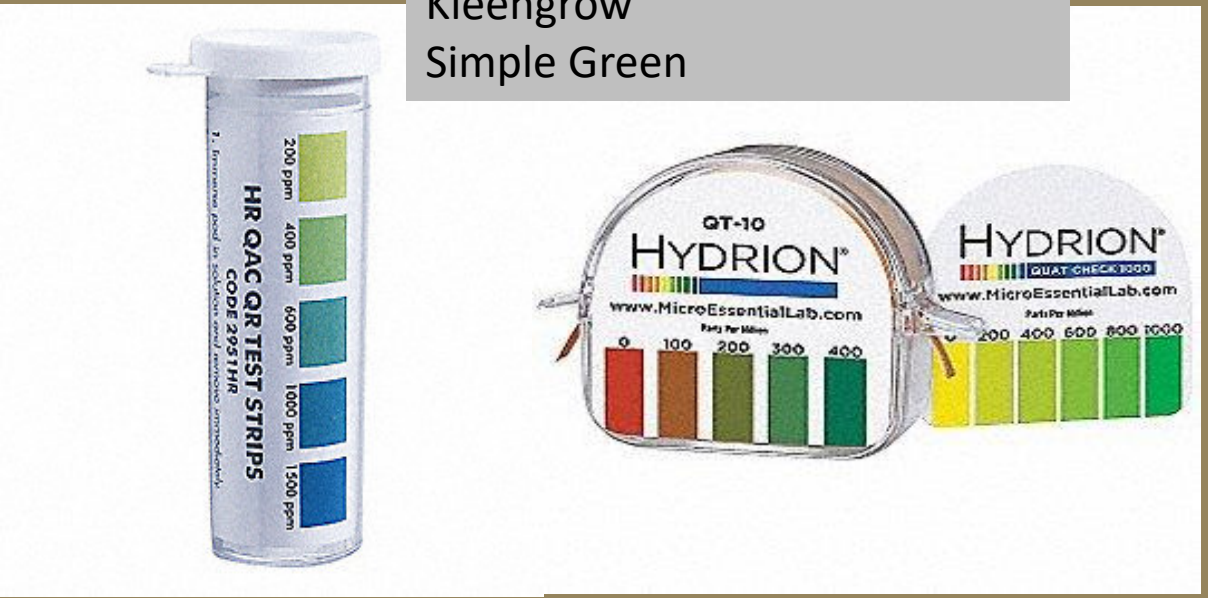
Are you monitoring your disinfectant ?

Why test your disinfectants:

1 - Ensure your prepared solution is at the targeted concentration
2 - Allow you to determine how frequently you need to change your solution
3 - Check activity in foot dips (organic matter exposure)
4 - Calibrate dosing equipment
5 - Environmental conditions change and can impact your solutions.

Specific product kits

Generic Quaternary Test Kits
Kleengrow
Simple Green

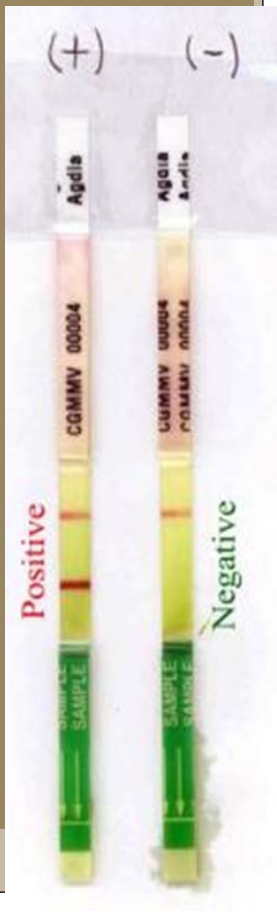


SUBMIT Suspect samples to a reputable diagnostic laboratory

1. CGMMV, BFB, MNSV and SqMV, Potyvirus ImmunoStrips exist – great 1st Step for diagnostics. Never use these test kits as final diagnostic. Need lab confirmation.

2. Work with your seed company field representative.
   Request a visit by a seed company pathologist or contact your county commissioners office who will work with CDFA on sample collection.

3. Recommend that both a seed company and CDFA lab receive samples (ensure the same sample is shared between the two labs).



Submitting a Sample

- If you suspect a virus or a disease in your field
  - Call the seed companies field representative.
  - Isolate/mark off the infected area of the crop until diagnostic results are known because CGMMV can be easily moved mechanically

Sampling Preparation

- Photograph samples prior to collecting them
- Submit samples that have a range of symptoms, from light to severe, representative of the field symptoms.
- Do not send dead plants.
- Submit whole plants with roots / remove soil.
- If whole plants are not possible send damaged/infected parts of plants.
- Do not package plant material in plastic bags over the summer months.
- Refrigerate or keep sample(s) cool before they can be delivered to the seed company field rep. or reputable lab (i.e. CDFA) Avoid ice pack in contact with tissue
- SUBMIT SAMPLES -

Finding a Suspect Plant in a Field

Mark Suspected plant
Identify each plant with a unique sample #
Submit sample to lab
Subsequent actions will depend on lab results

Managing Field after Detect

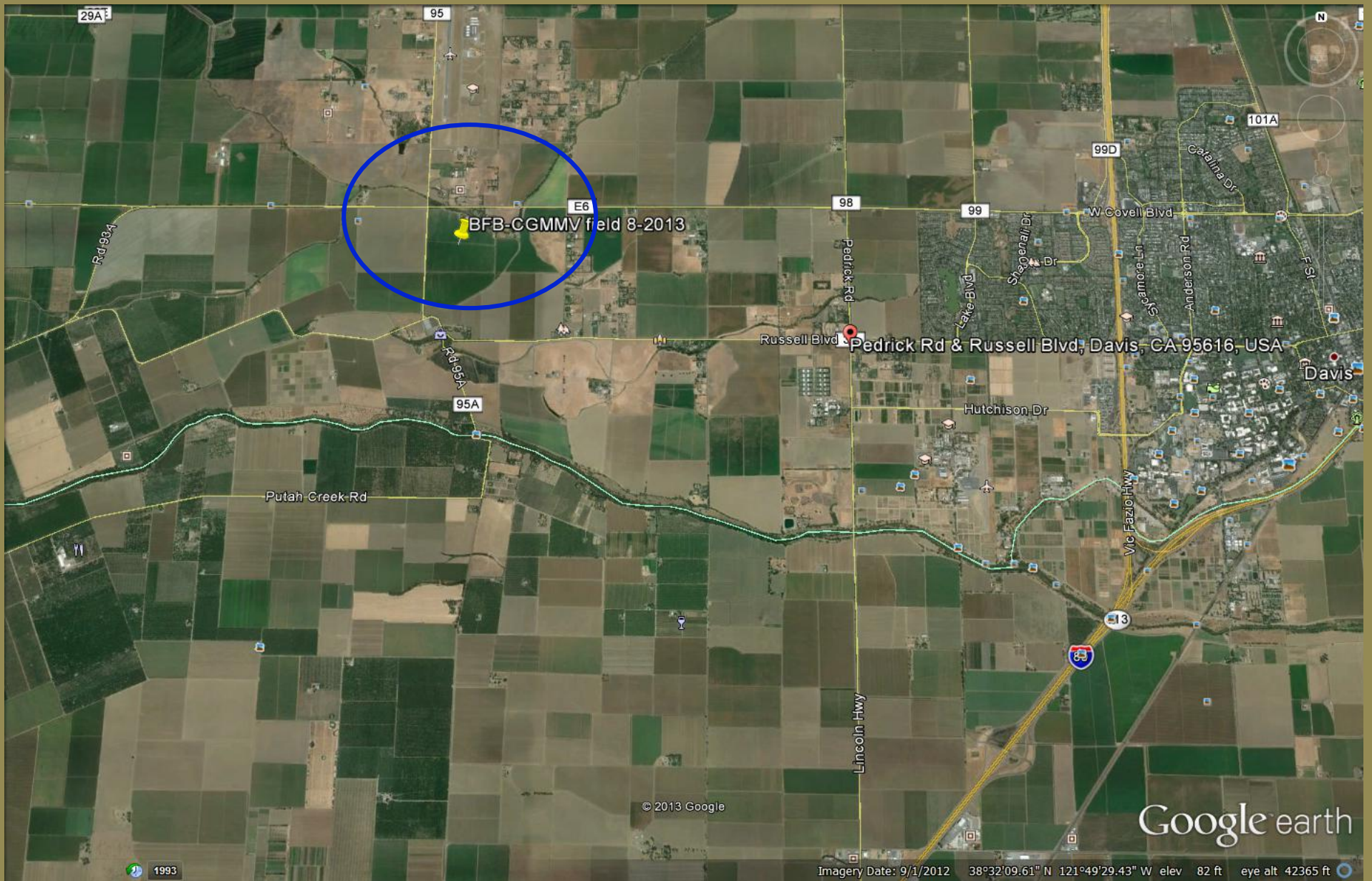
- Collect and test weed samples in and around the field before applying herbicide to the field followed by discing.

  Insect Sweeps –sweep weeds which are collected and test insects.
- Weed monitoring needs to be throughout the year
  2-3 yrs monitoring program?
- Control volunteers
- Comprehensive weed control needs to stay in place for all fields.
- Stay out of field with cucurbits (2 years does not look to be enough) –Utilize GPS coordinates

- Disease pinning map – Best to have an industry map but companies can at least create internal maps regarding there productions.

How to Manage a Field Detect for CGMMV

Pinning Contaminated Fields – Allow to monitor disease and help with crop placement.



Other recognized seed-borne /seed- transmitted cucurbit viruses in CA.

Melon Necrotic spot Virus

Squash Mosaic Virus


Remember: Do Not Assume
“Question” what you see
in the field

Photo Contributors

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