Gold Flecking: More Pieces to the Puzzle

Gold flecking (gf) on plum, grape and round tomatoes

In the past, field trials I have conducted on gold flecking were inconclusive as to its causes as they showed more problems caused by environmental concerns than by thrips or mites. However, upon several visits to growers' fields over the last 4 years that were having mite or thrips outbreaks there were almost always greater rates of gold flecking in the most heavily infested areas of the tomato field.

In the literature there also seems to be no simple answer or consensus as to what causes gold flecking (gf) on tomato

I examine the research that has been conducted over the last 22 years on gold flecking in tomatoes and show the results of some of my work on gf

Gf and Thrips study

Ghidiu, Hitchner and Funderburk, 2006

Tomatoes: *Florida 47,* NJ GH study

Grown in pots-thrips infested plants vs non infested

Fruit striped off until 1-4 left on plant

50 adult and immature thrips placed on a fruit

Only *Frankliniella occidentalis* used

No fruit or plant counts for thrips after infestation

Results

60% of fruit that was infested had gf
None of fruit that was not infested had gf

No ovipositioning marks found on tomatoes

Not all fruit was damaged on the infested plants

It took 3 weeks for damage to appear on fruit
(why would it take so long if thrips were feeding directly on the fruit—it took 3 weeks because thrips were feeding on the plant and that induced gf on the fruit)

Thrips mortality could have been high—numbers were not followed once infested and feeding damage was variable

Gf and mite field Study

Meck, Walgenbach and Kennedy, 2012

Field trial conducted in western North Carolina

Crista variety used in study

Transplanted into black plastic with drip irrigation

Plants were staked and tied

Field plot studies consisted of mite infestations of 1, 8, 17, 25 and 50 mites per tomato leaflet plus a non-infested treatment

Gf and mites Study

3 year study, two planting times-spring and fall plantings

Mites counted weekly by examining the terminal leaflet of the 2nd or 3rd most recently mature leaf-no fruit counts

When mite counts reached infestation levels treatments were sprayed with a miticide

The percent of tomatoes with gold fleck on six plants/plot were used to determine gf damage levels-seemed to be either a yes or no on damage, either tomato had gf or it did not, nothing on the amount or severity of the gf damage

0, 1, 8 and 50 mites confined to a tomato fruit in a GH study

Terminal leaflet used to make mite counts

Results

Not sure how bad gf was on fruit, just that it was there

Half of the trials showed at least 40-60% of the fruit with gf when there were NO MITES present on the plant

Half of the trials showed a good relationship between gf and increasing mite numbers

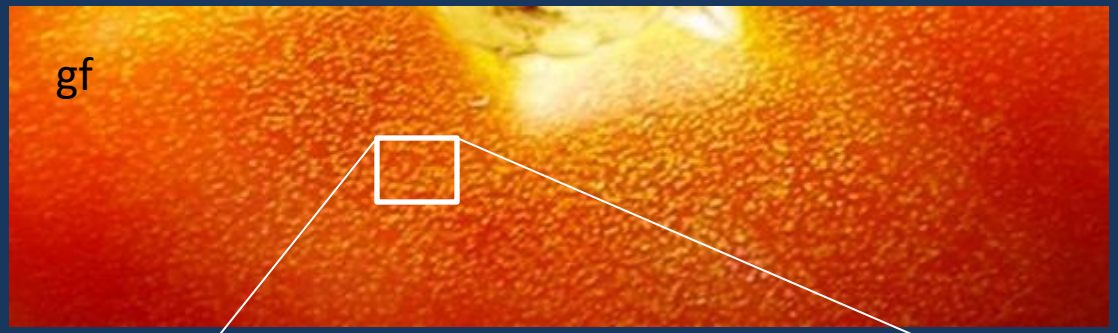
In GH fruit trials only at 50 mites per fruit was there any significant amount gf found on fruit

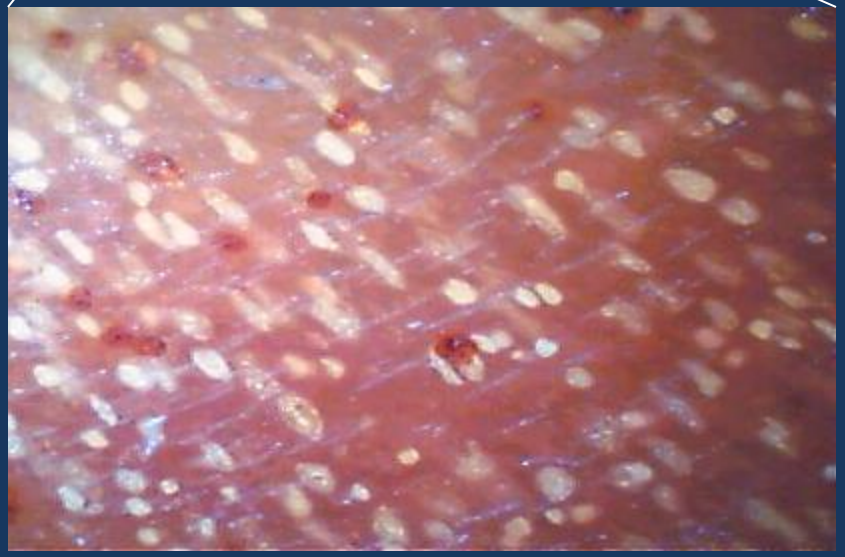
Mite damage (gf?) showed up on infested GH tomatoes within 3-days of infestation. (Damage appeared more as damaged cells rather than gf).

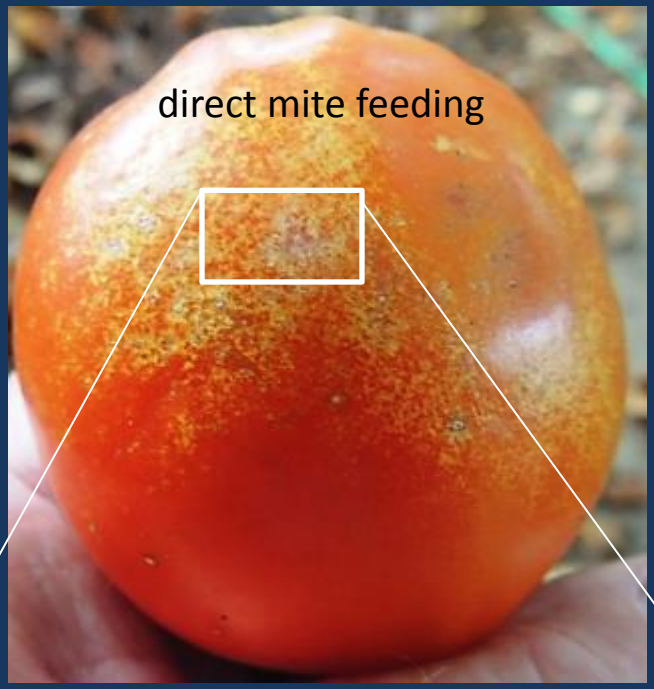
Thrips (and mites too) feeding damage to vegetables

None of this damage looks like gf

Gold flecking vs direct mite or thrips feeding







Physiological explanation as to what gold fleck is

1992 Study

Research conducted in GH pots looking at calcium and phosphate levels as well as humidity

X-ray diffraction examined the gold flecks to see what they were

Looked at either high or low levels of humidity in a day-night pattern

Examined Ca/K ratio at 0.2, 0.6, 1.4, 3.4 and 5.0

Examined 3 levels of phosphate - low, medium, high

Looked at % gf on fruit and its severity as well as calcium levels in plant and fruit

Results

Nutrient trials

Ca/K ratio	% gf	Severity of gf (0-2)
0.2	25	0.60
0.6	35	0.71
1.4	44	1.10
3.4	66	1.49
5.0	84	1.80

Phosphate conc.	% gf	Severity of gf
low	16	0.20
medium	29	0.36
high	35	0.45

Results

humidity levels

Humidity levels	% gf	Severity
L/L	18	0.22
H/L	58	0.78
L/H	54	0.72
H/H	78	1.25

Results

(what is gf)

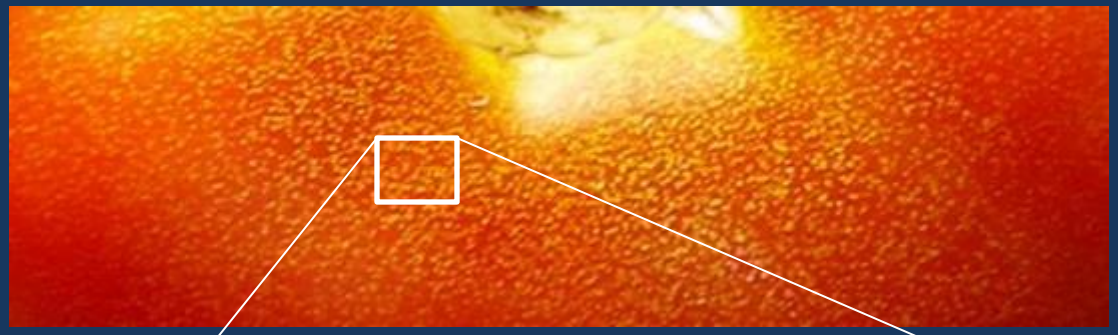
i. Granular masses found in cells of gold fleck fruit

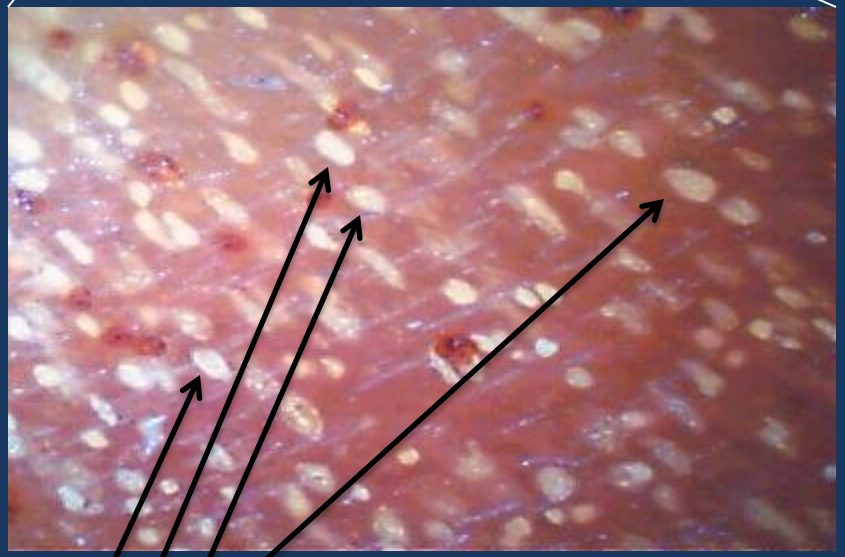
ii. Masses were found to be tiny calcium salt crystals

iii. Examined the diffraction pattern of the crystals

iv. Diffraction pattern is that of calcium oxalate dihydrate and Ca oxalate monohydrate ($CaC_2O_4 \cdot 2H_2O$)

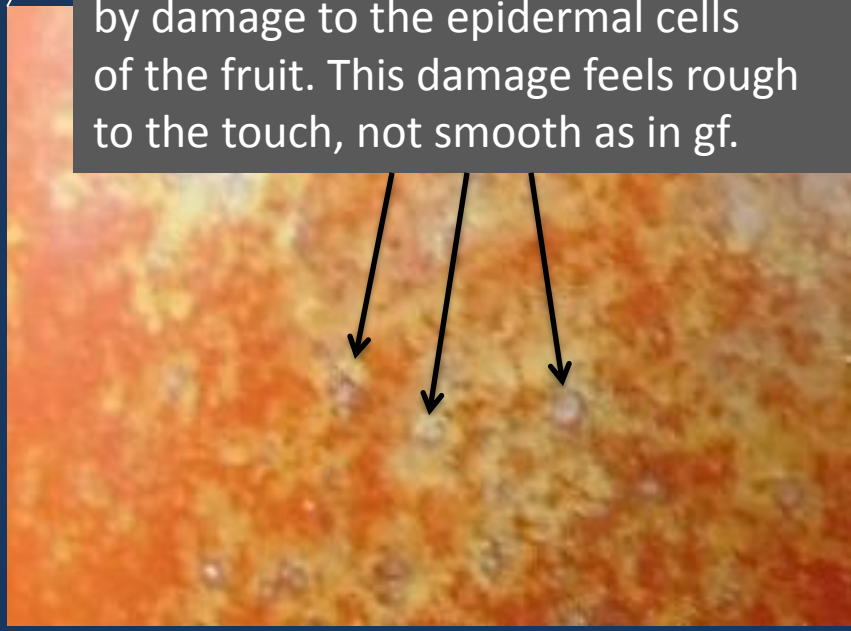
GF vs direct mite or thrips feeding





These white masses that make up gold flecking are calcium crystals inside the plant that are produced when the plant is stressed by thrips or mite feeding, high temperatures and humidity or by high levels of calcium in the tomato fruit. This damage feels smooth because the crystals are inside the cells

This damage is caused by mites feeding directly on the fruit which results in a 'crusty' surface caused by damage to the epidermal cells of the fruit. This damage feels rough to the touch, not smooth as in gf.



Horticulture trials for gf

(summary of the results of 4 different studies)

Summarized by M.M. Peet, 2009

As temperature increased above 88^{o}F so did the incidence of gf

As the Ca/K ratio increased above 2.5-3 so did gf

As fruit temperature increased above 85^{o}F so did gf

As phosphate levels rose above 4.2 mM so did gf

Calcium levels are the highest in the fruit around the calyx

Gold flecks are seen first and foremost around the calyx

My Greenhouse gf studies included thrips, mites, high Ca/P, and high temps and humidity

GH studies took place over a 15-month period

Tomato plants (*Crista or ROMA VF*) were planted into 2 gallon pots

Calcium and Phosphate levels were adjusted to create high (Ca-5,000ppm and P-200 ppm) and normal (Ca-2,500 ppm and P-90 ppm)levels of the two nutrients.

Thrips and mite infestations were done naturally (i.e., the GH bay was already infested with either mites or thrips. Infestation of either lead to white flecks as well as necrotic areas of the foliage, i.e., heavy damage.

My Greenhouse gf studies included thrips, mites, high Ca/P, and high temps and humidity

To keep mites or thrips off tomato control plants (no mites or thrips) tomatoes were grown in large thrips/mite proof cages. Plants were sprayed in cages with Agri-Mek and SpinTor at flowering.

Temperatures and Humidity trials were conducted as high (T-88-95^{o}F day and 68^{o}-72^{o}F night, Dewpoint $\geq$68^{o}F) or normal (T-83^{o}-88^{o}F-D and 62^{o}-68^{o}F-N, Dewpoint 55^{o}F).

Tomato fruit was harvested and the % of the fruit covered with gf and its severity on a 0-5 scale was assessed (0=none, 3=moderate, 5=severe). ANOVA was run with the means separated with orthogonal contrasts.

Greenhouse studies conducted over a 15-month period

Tomato fruit and gf rating examples

Tomato fruit and gf rating examples

Fig. 1 Low to moderate levels of gold fleck on tomato fruit. Fruit still marketable

Fig. 2 Severe amount of gold fleck on fruit. Fruit probably not marketable

For the purpose of this study any rating over 3 would greatly lower the marketability of the fruit

Incidence of gold flecking on GH tomatoes

Ca/P level	Mite/Thrips Levels	Temp/Humidity	% fruit with GF	GF Severity
High	None	Normal	48.1a	3.4a
Normal	None	Normal	5.1b	1.1b


No thrips or mites
High Ca/P
No thrips or mites
Normal Ca/P


No thrips or mites
Normal Ca/P


No thrips or mites
High Ca/P

Incidence of gold flecking on GH tomatoes

Ca/P levels	Mite/Thrips Levels	Temp/Humidity	% fruit with GF	GF Severity
High	None	Normal	48.1 a	3.4a
Normal	None	Normal	5.1 b	1.1b
Normal	High	Normal	50.4a	3.6a
Normal	Low-Med	Normal	8.1b	1.2b

Thrips or mite induced gold flecking

Incidence of gold flecking on GH tomatoes

Ca/P levels	Mite/Thrips Levels	Temp/Humidity	% fruit with GF	GF Severity
High	None	Normal	48.1	3.4
Normal	None	Normal	5.1	1.1
Normal	High	Normal	50.4	3.6
Normal	Low-Med	Normal	8.1	1.2
Normal	None	High	68.7	3.2

Incidence of gold flecking on GH tomatoes

Ca/P levels	Mite/Thrips Levels	Temp/Humidity	% fruit with GF	GF Severity
High	None	Normal	48.1	3.4
Normal	None	Normal	5.1	1.1
Normal	High	Normal	50.4	3.6
Normal	Low-Med	Normal	8.1	1.2
Normal	None	High	68.7	3.2
High	High	Normal	79.4	3.9

Incidence of gold flecking on GH tomatoes

Ca/P levels	Mite/Thrips Levels	Temp/Humidity	% fruit with GF	GF Severity
High	None	Normal	48.1 a	3.4
Normal	None	Normal	5.1	1.1
Normal	High	Normal	50.4 a	3.6
Normal	Low-Med	Normal	8.1	1.2
Normal	None	High	68.7	3.2
High	High	Normal	79.4	3.9
High	None	High	84.7b	3.7

Incidence of gold flecking on GH tomatoes

Ca/P levels	Mite/Thrips Levels	Temp/Humidity	% fruit with GF	GF Severity
High	None	Normal	48.1	3.4
Normal	None	Normal	5.1	1.1
Normal	High	Normal	50.4	3.6
Normal	Low-Med	Normal	8.1	1.2
Normal	None	High	68.7	3.2
High	High	Normal	79.4	3.9
High	None	High	84.7	3.7
Normal	High	High	75.2	3.8

Incidence of gold flecking on GH tomatoes

Ca/P levels	Mite/Thrips Levels	Temp/Humidity	% fruit with GF	GF Severity
High	None	Normal	48.1a	3.4ac
Normal	None	Normal	5.1d	1.1b
Normal	High	Normal	50.4a	3.6a
Normal	Low-Med	Normal	8.1d	1.2b
Normal	None	High	68.7ab	3.2a
High	High	Normal	79.4bc	3.9ac
High	None	High	84.7bc	3.7ac
Normal	High	High	75.2abc	3.8ac
High	High	High	92.1c	4.3c

Tomato from high Ca/P pot

Tomato from high thrips/mites pot

Tomato from high Ca/P pot
1 week after harvest

Tomato from high thrips/mites pot
1 week after harvest

Consistently had greater surface-of-fruit break-down from gold flecking caused by high Ca and P one week after harvest than if gold flecking was caused by mites or thrips feeding (have no idea why)

Better chance for gold flecking

- Ca in soil: ≥4000-5000 ppm
- P in soil : ≥300 ppm
- Ca tissue: ≥5.5%
- P tissue: ≥1.5%
- Ca/K tissue ratio: ≥2.0-2.5
- Thrips: ≥5 per flower or white flecking on leaves
- Mites: >100 per leaf or white flecking on leaves
- Temperatures: >88-90^{o}F and Dew Points: ≥68-70^{o}F
- Tomato type: Grape*>cherry>plum*>round
- Variety makes a difference

*more sensitive to mite feeding than other types

Practices that will help to alleviate gold flecking

1. Add KNO_3 via drip (K decreases the Ca:K ratio-keep below 1.5) and (Use of nitrate decreases gf occurrence).

2. Add Mg (Mg tissue analysis should be 0.5-1.0%)

3. Lower fruit temperature (30% shade over plants)

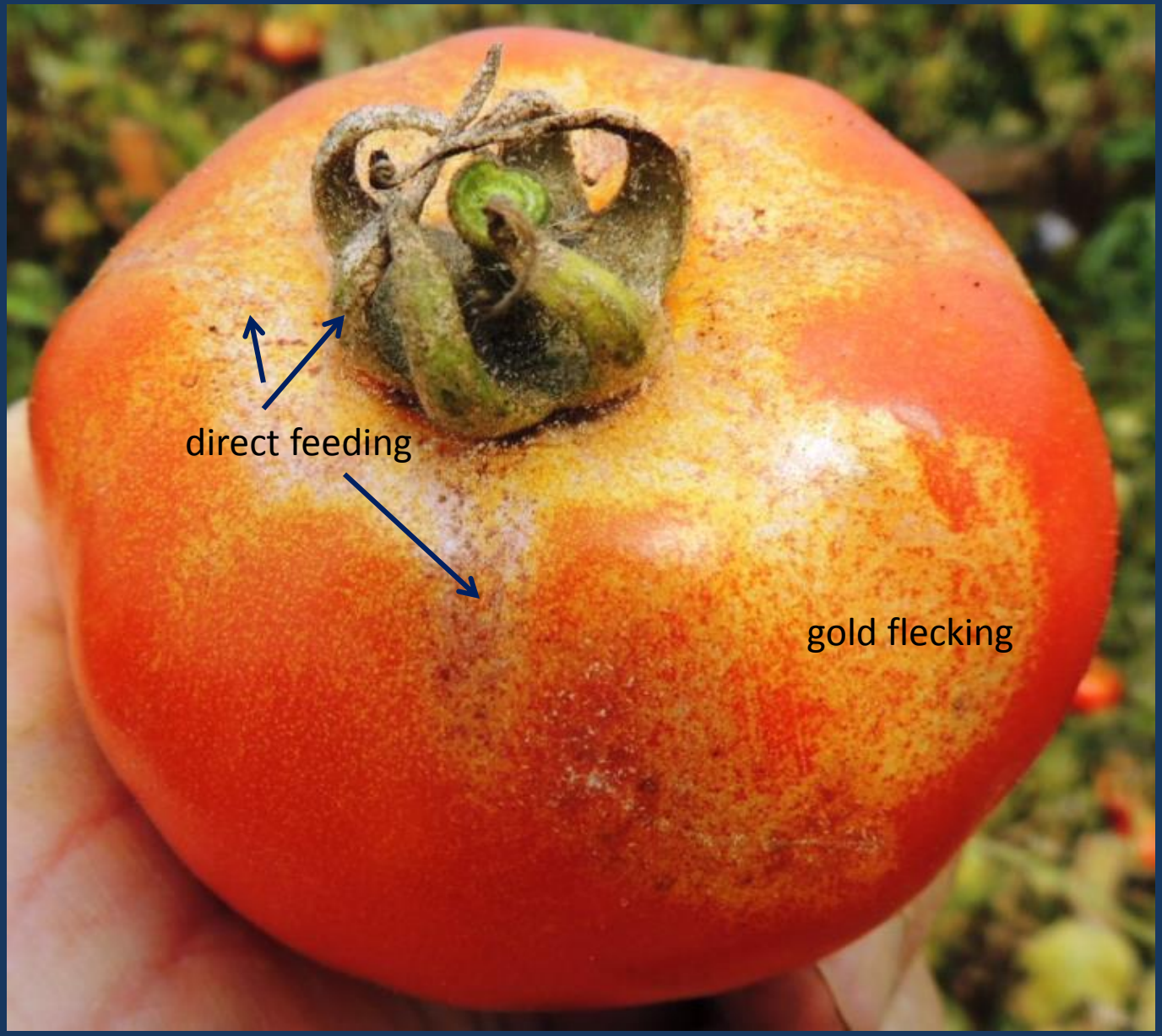
4. Reduce mite or thrips populations below 'high' levels (high levels include 100 mites per leaf or >5 thrips per flower or white feeding flecks on leaves). Low or moderate levels of mites or thrips did not induce greater levels of gf than the control


White speckles on leaves show that mite feeding is too great and will result in a high probability of gold flecking on tomato fruit, especially if grape or plum tomatoes

This is severe mite feeding damage on tomato leaves and will result in not only gold flecking but also direct feeding on tomato fruit because the population is so great

Gold flecking from mites feeding heavily on plant

Gold flecking and direct feeding of mites on tomato fruit—the direct feeding does not look or feel like gold flecking




Practical example: Grape tomato field in September with heavy amount of gold flecking--what was causing the gold flecking?


This area of the picture shows cause of gold flecking (enlarged in next slide)


Arrows show heavy mite feeding on plant, but none on fruit


Leaf shows very heavy mite feeding with white speckles and necrotic edges of leaf

Moral of story

Grape tomatoes are especially sensitive to heavy mite feeding, which results in gold flecking. A moderate amount of mite (or thrips) feeding does not induce gold flecking even in grape tomatoes.

However, just because you find gold flecking in the field does not mean you have a mite or thrips problem.

Probably 70% of the occurrence of gold flecking in mid-Atlantic tomato fields is caused by high temperatures and high humidity (this is why we usually see the damage in mid-July and August).

The other 30% is caused by either too high a Ca/K ratio in the plant or by high levels of mites or thrips. Growers need to see what their Ca:K ratio is in a tissue test before applying any pesticides then check if they have high levels of mites or thrips before spraying, if for no other reason than to find out which pest they have, as the chemical controls will be quite different for the two.

Questions

UNIVERSITY OF MARYLAND EXTENSION
Solutions in your community

jbrust@umd.edu

http://extension.umd.edu/mdvegetables