Heat Tolerance Strategies in (Vegetable) Crop Production

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Extreme Weather and Climate: A Virtual Workshop for NJ Agricultural Technical Service Providers
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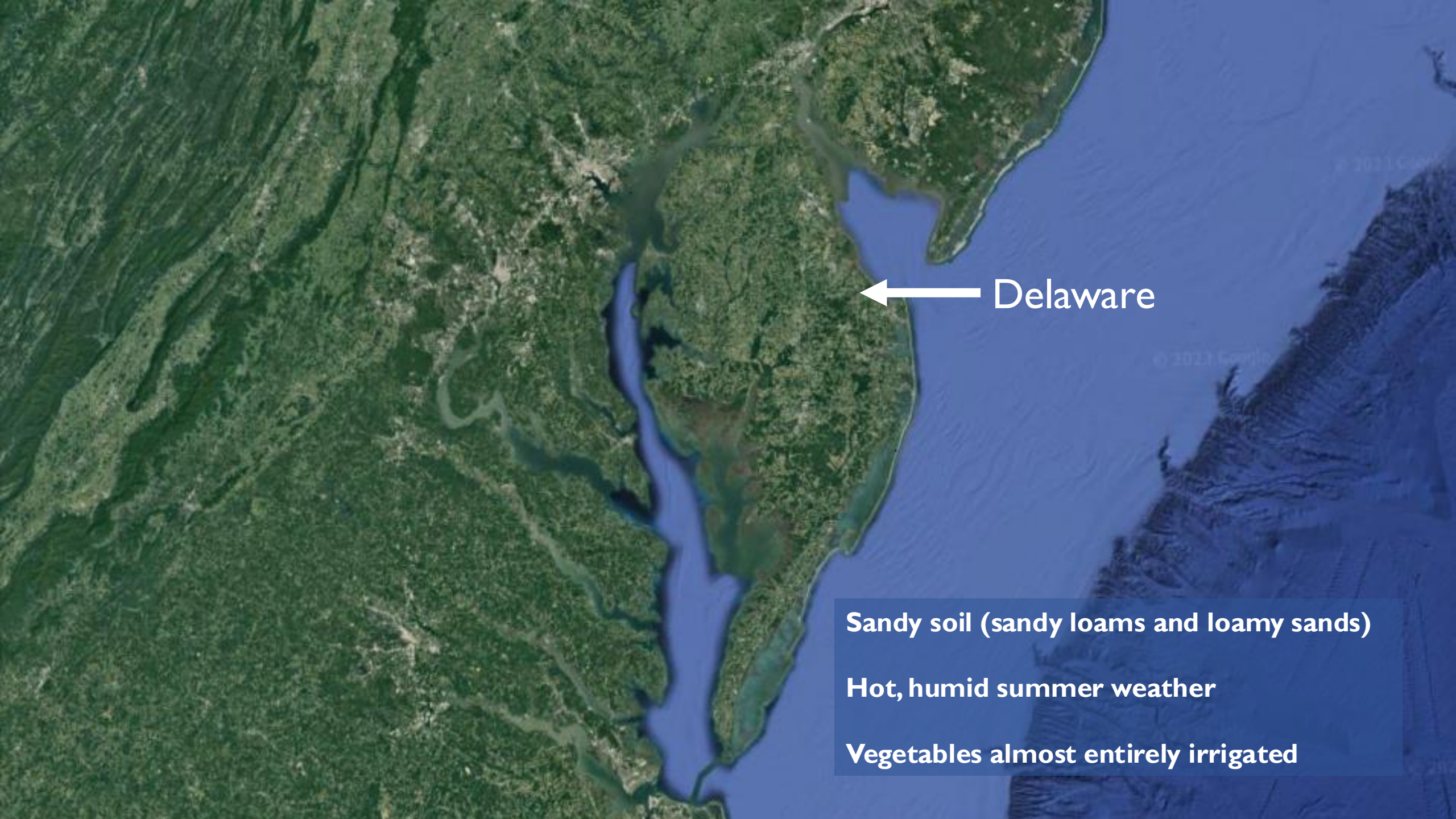

Delaware
Sandy soil (sandy loams and loamy sands)
Hot, humid summer weather
Vegetables almost entirely irrigated

Heat Stress Effects

Heat stress causes yield and quality problems in vegetables.

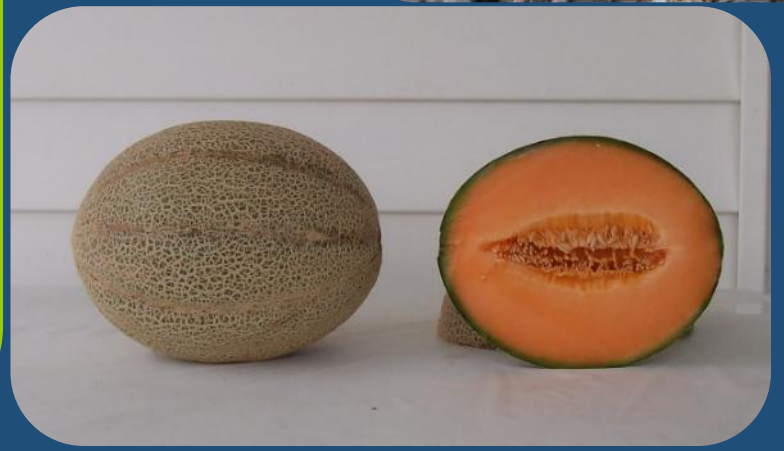
Heat Tolerance Differences Between Crops

Cool Season Crops

Images by E Ernest

Heat Tolerance Differences Between Crops

Warm Season Crops



Heat Tolerance Differences Between Crops

Crops with Potential for Improved Heat Tolerance

Images by E Ernest

Heat and Drought Stress Interact

Heat Stress & Drought Stress

→Often occur together

→Heat stress exacerbates drought stress and vice versa

→Physiological effects of heat and drought are distinct

Drought Stress

→Primary physiological effect is decrease in photosynthesis resulting from stomates closing

Heat Stress

→Primary physiological effects are membrane disruption and protein denaturation

Synergistic Effect of Drought on Heat Stress

Drought stressed plants close stomates to reduce water loss

Closed stomates → decreased evapotranspiration

Decreased evapotranspiration → higher leaf temperatures

Higher leaf temperatures → increased heat stress

Synergistic Effect of Heat on Drought Stress

High temperatures → high rate of evapotranspiration

Increased evapotranspiration → higher water use by plant

Higher water used by plant → increased chance for plant water deficit

Irrigation can solve the problem of drought stress;

<u>however</u> it can only mitigate the problem of heat stress.

Heat Stress Effects on Broccoli

Temperatures above 86°F during early head formation causes uneven floret development and “rough” heads.

Images by E Ernest

Heat Stress Tolerant Broccoli

Eastern Crown
Sakata

Millennium
Sakata

Also: **BC1764, Lieutenant, Imperial, Emerald Crown**

Images by Gordon Johnson, University of Delaware

Heat Stress Effects on Cauliflower

High temperatures (mid to upper 80s) during head formation and growth cause purpling, ricing, fuzziness or leafiness.

Images by E Ernest

Successful Spring Varieties 2020

Bishop 64 days
Rijk Zwaan
87% Marketable

Bermeo 62 days
Bejo
80% Marketable

Denali 67 days
Rijk Zwaan
73% Marketable

Also: **Aquarius, Minuteman**

Images by E Ernest

Heat Stress Effects on Lettuce

> High soil temperatures (>80°F) inhibit germination.

> During growth, high temperatures (>80°F) cause bolting and bitterness.

Images by E Ernest

Heat Tolerant Lettuce Varieties

Baja
Green Butterhead
Adaptive Seeds

Muir
Green Batavia
Various Suppliers

Kalura
Romaine
Various Suppliers

Chalupa
Romaine
Johnny's Seeds

Hanson Red
Red Batavia
Adaptive Seeds

Images by E Ernest

Combining Heat Stress Management Practices

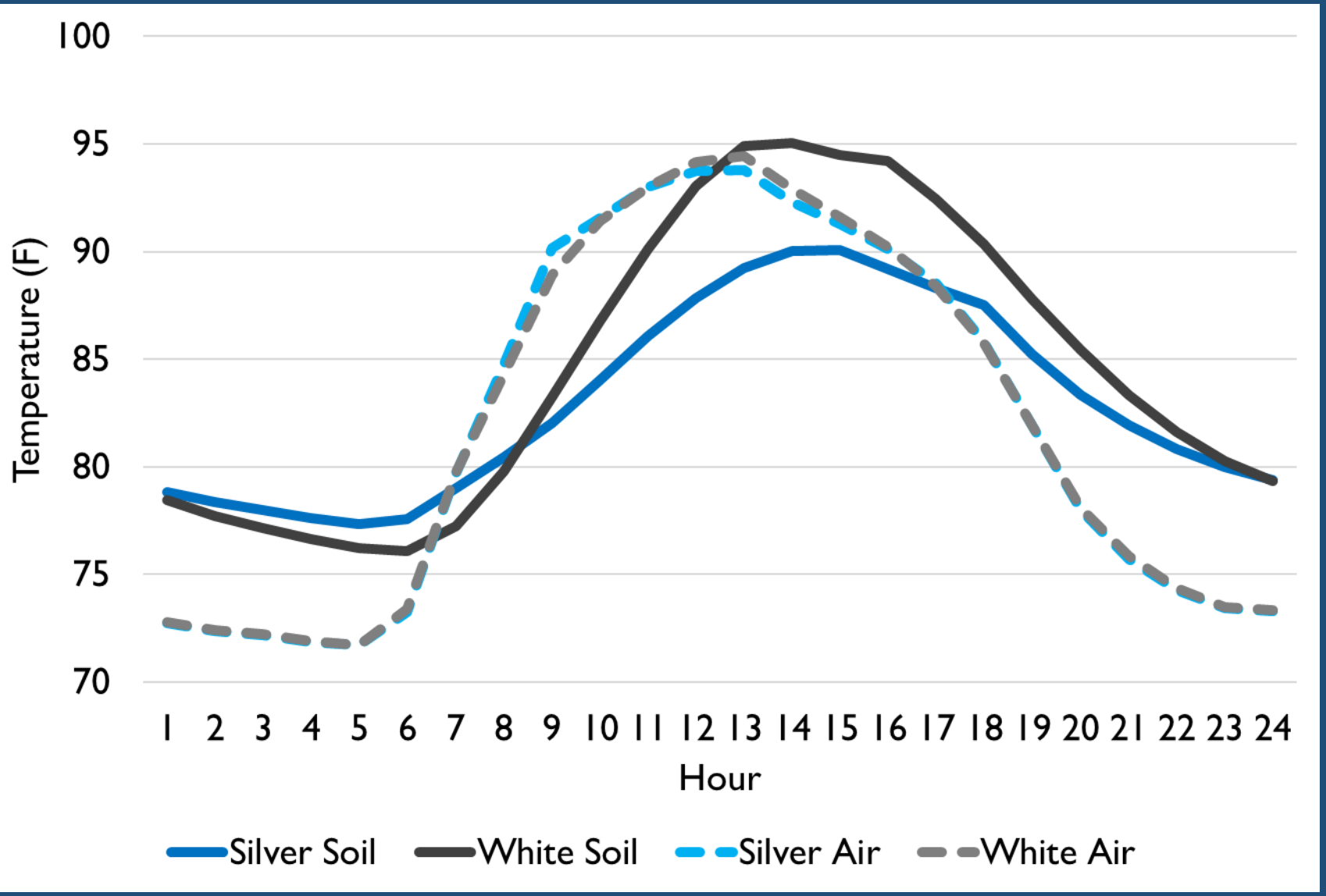
Shade Cloth + HT Varieties (High Tunnel)

or

HT Varieties + White/Reflective Mulch

Images by E Ernest

Mulch Color Temperature Effects in 2025 Lettuce Trials



2025 Temperature Summary

3 loggers per treatment
27 days (Jun 25 to Jul 22)
Logging @ 10-minute intervals

Each hour average is the average of 486 datapoints (3 x 27 x 6)

Silver mulch had 5 °F lower temperatures at mid day but slightly warmer early morning temperatures.

Heat Stress Effects on Sweet Corn

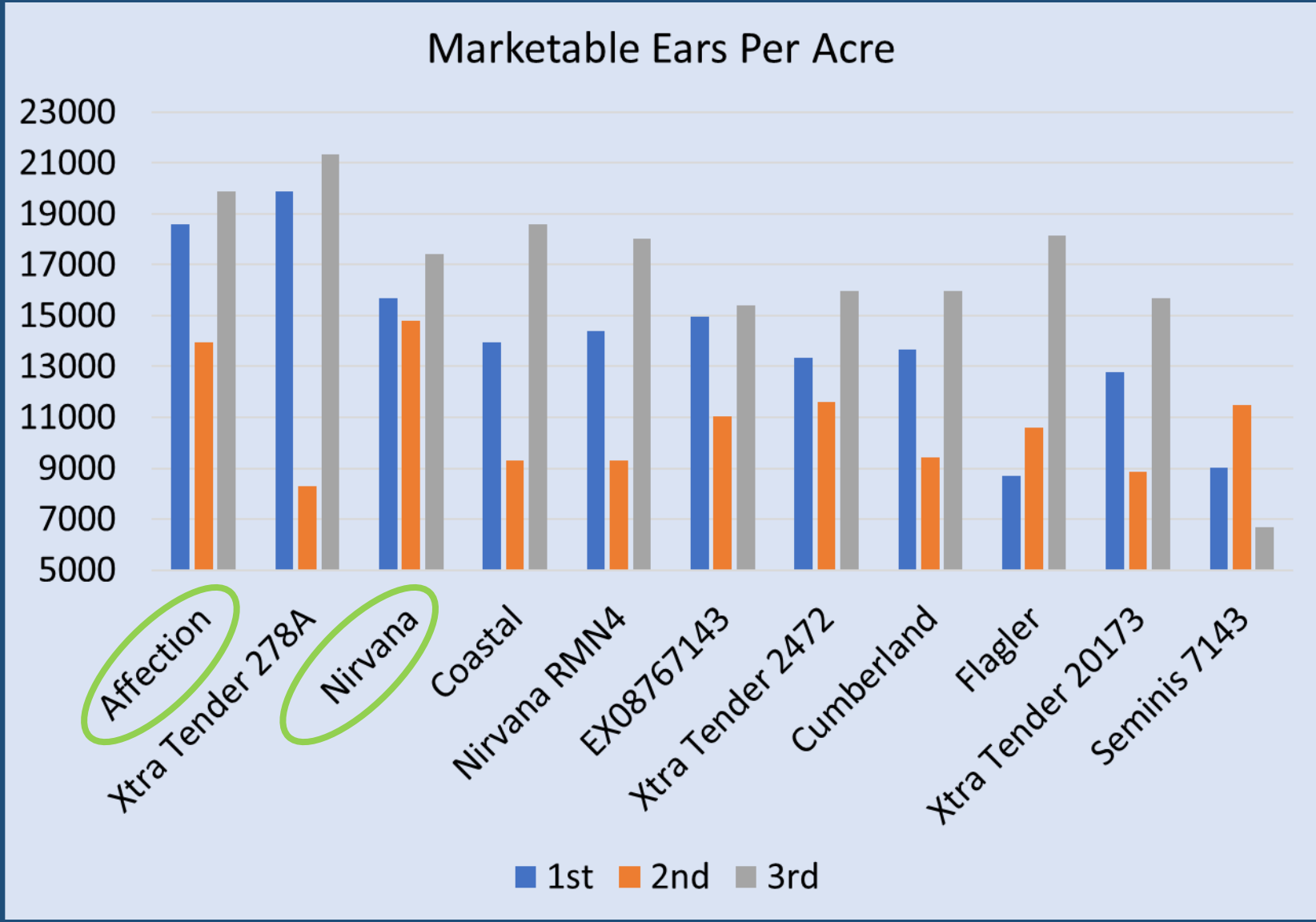
Leaf scald caused by high temperatures.

Reduced ear diameter and poor tip fill.

> Heat susceptible growth stages: pollination to harvest

Images by E Ernest

Bicolor Supersweet Corn Trials in 2019



Heat Tolerant Sweet Corn Varieties

Bicolor Supersweet

Affection

Nirvana

White se

Whiteout

Mattapoisette

Images by E Ernest

Heat Tolerant Sweet Corn Varieties

White Supersweet

White Lightning

Xtra Tender 378A

7401 IMP

Endurance

XTH 3174

Seabright

Images by E Ernest

Heat Stress Effects on Tomatoes

Flower Abortion; Low/No Fruit Set

> Night temps >70°F inhibit pollination

Images by Gerald Brust, University of Maryland

Heat Stress Effects on Tomatoes

Internal White Tissue

Yellow Shoulders Ripening Disorder

> High temps during fruit development cause ripening disorders

> Ripening disorders also related to potassium status of fruit and impacted by root health

Images by G Brust, University of Maryland and Purdue University

Heat Tolerant Tomato Varieties

STM2255

Red Bounty

High Yield
&
Low White Tissue Incidence

Grand Marshall

Red Snapper

Red Mountain

High Yield

Images from seed suppliers

Heat Tolerant Tomato Varieties

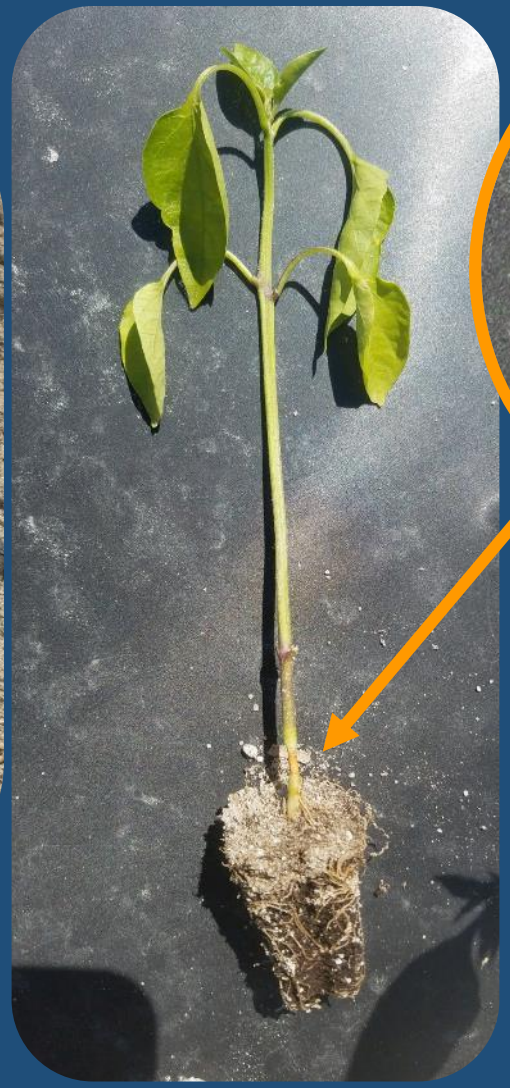
		
Primo Red	Grand Marshall	Mountain Majesty
		
Dixie Red	Red Bounty	Red Mountain
		
Red Deuce	Bella Rosa	Mountain Merit
		
Scarlet Red	Camaro	Biltmore

Images from Gordon Johnson, University of Delaware

Heat Stress Effects on Peppers

Stem Girdling from Heat Necrosis

June 1, 2022



July 20, 2022

Images by E Ernest.

Heat Stress Effects on Peppers

Strategies to Combat Stem Girdling

- Irrigate
- Use larger cell size transplants 72s not 128s
- Plant on bare ground
- Use white plastic mulch
- Spray particle film on black mulch
- Apply shade cloth

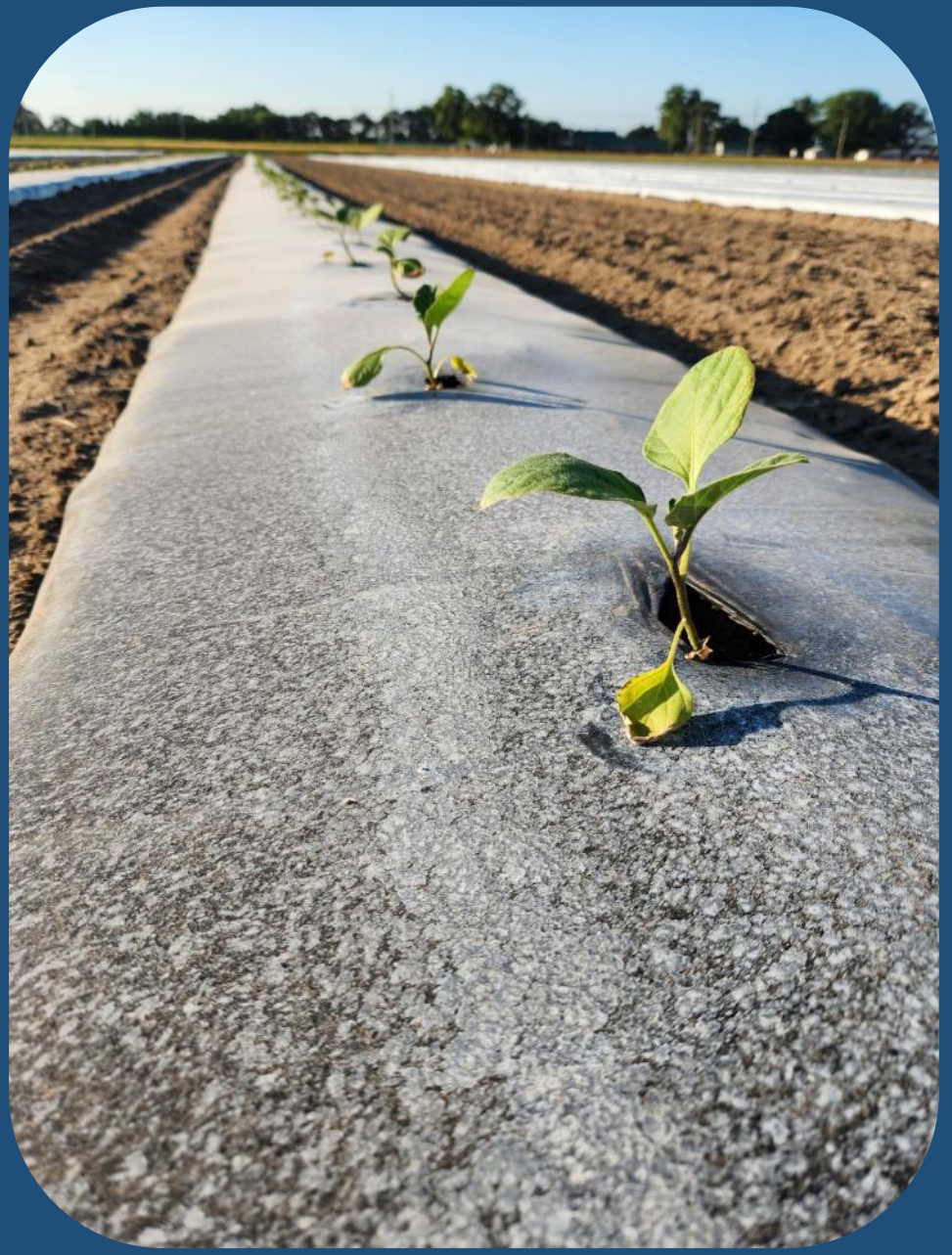


Image by E Ernest

Heat Stress Effects on Peppers

Strategies to Combat Stem Girdling

Unshaded Treatment Jul 20, 2022

Shaded Treatment Jul 20, 2022

Images by E Ernest

Heat Stress Effects on Peppers

Sunburn or Sunscald

Photooxidative Sunburn = too much light

Sunburn Necrosis = too much heat

Skin temps exceeding 105-108°F in peppers

Images by E Ernest

Heat Stress Effects on Peppers

Strategies to Combat Sunscald & Sunburn

- Irrigate
- Stake plants
- Protect foliage from disease
- Apply particle film
- Apply shade cloth

Image by E Ernest.

Heat Stress Effects on Snap Beans

Images by E Ernest

Hot **night** temperatures cause the biggest problems (>68 °F)

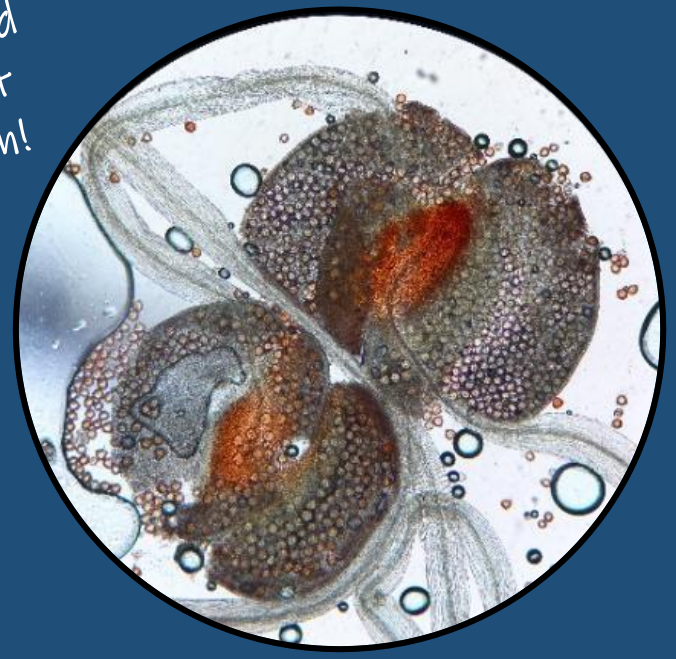
Flowers susceptible to heat damage in the bud stage (in the 10 days prior to opening).

Hot nights cause anther indehiscence (anthers do not open and release pollen).

Hot nights also reduce pollen quality.

Result → fewer seeds per pod, misshapen pods, short pods, pod abortion, delayed harvest

Heat stressed anthers don't release pollen!



Unstressed anthers release pollen when flowers open!

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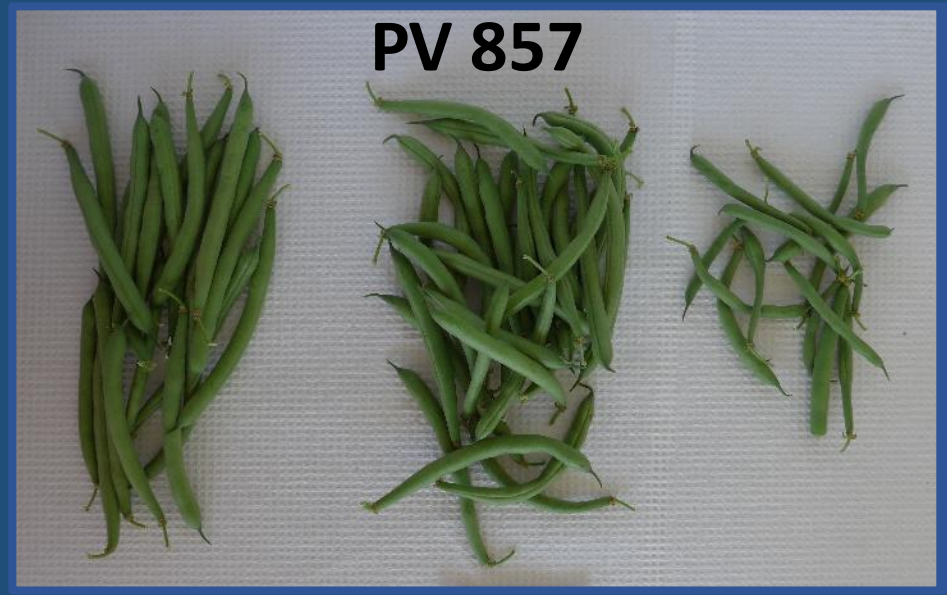

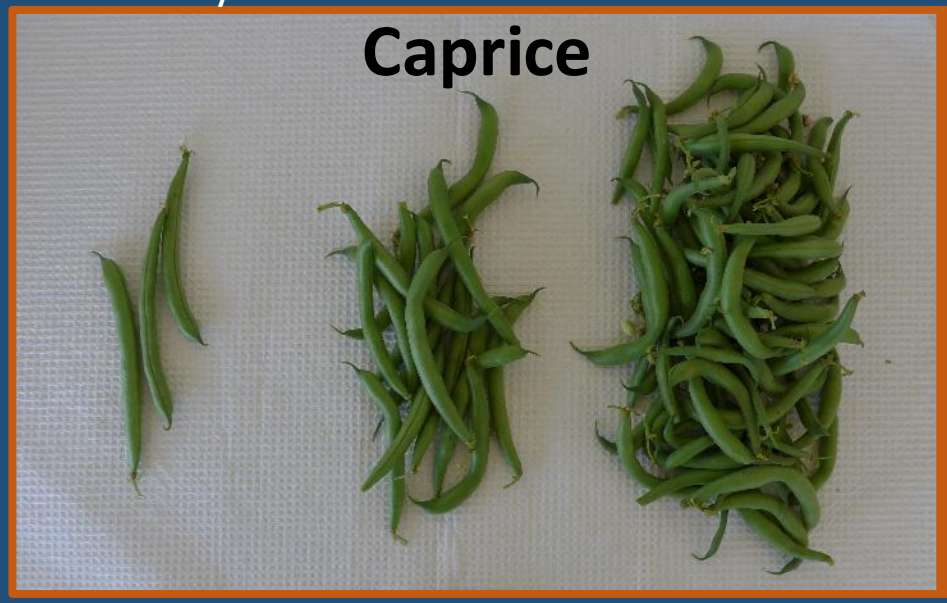

Images by E Ernest

Heat Tolerant Varieties – Bush Beans

PV 857 – Crites Seed
Sieve 3-4
Trialed in 2017, 2018, 2020, 2021, 2023, 2024

Greenback – Syngenta
Sieve 3-4
Trialed in 2023, 2024

Raptor (PV 966) – Crites Seed
Sieve 3-4
Trialed in 2024, 2025

PL 0008 – Pure Line
Sieve 4-5
Trialed in 2021, 2024

Images by E Ernest

Heat Tolerant Varieties – Pole Beans

Early Riser – Adaptive Seed

Cobra – Johnny's Selected Seeds

Images by E Ernest