Soilborne pathogens of lettuce and research updates on Fusarium wilt

Alex Putman, Ph.D.
Assistant Cooperative Extension Specialist
Dept. of Microbiology & Plant Pathology

aiputman@ucr.edu
951-522-9556

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UNIVERSITY OF CALIFORNIA
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Agriculture and Natural Resources

		Vascular wilts (internal)		Roots (external)			Crown	
	Symptoms	**Fusarium**	**Verticillium**	**Pythium**	**Black root rot (Thielaviopsis)**	**Corky root**	**Grey mold (Botrytis)**	**Drop (Sclerotinia)**
Leaves	Stunting	YES	no	YES	YES	YES	YES	YES
Leaves	Wilting	YES	YES	YES	no	YES	YES	YES
Leaves	Yellowing	YES	YES	YES	no	?	YES	YES
Leaves	Collapse	YES	YES	YES	no	no	YES	YES
Crown	Crown rot (external)	no	no	no	no	no	YES	YES
Roots	External	no	no	Large areas of rot	Discrete bands on secondary roots	Bands of cracking on taproot	no	no
Roots	Vascular discoloration (internal)	YES	YES	no	no	no	no	no

Adapted from S. Koike

Vascular wilts – typical symptoms

Can appear very early
Stunting, wilting, yellowing, death
Plants end at different sizes (or are killed as seedlings)

Mostly appears close to harvest
Wilt, yellowing of outer leaves
All plants make mature size

Vascular wilts – typical symptoms

Fusarium wilt

Disclaimer: Foliar symptoms are not diagnostic

K. Subbarao

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Stunting, w
Plants end
killed as seedlings)

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Vascular wilts – typical symptoms

Reddish (orange/brown) discoloration, hollowing, white residue

Fusarium wilt

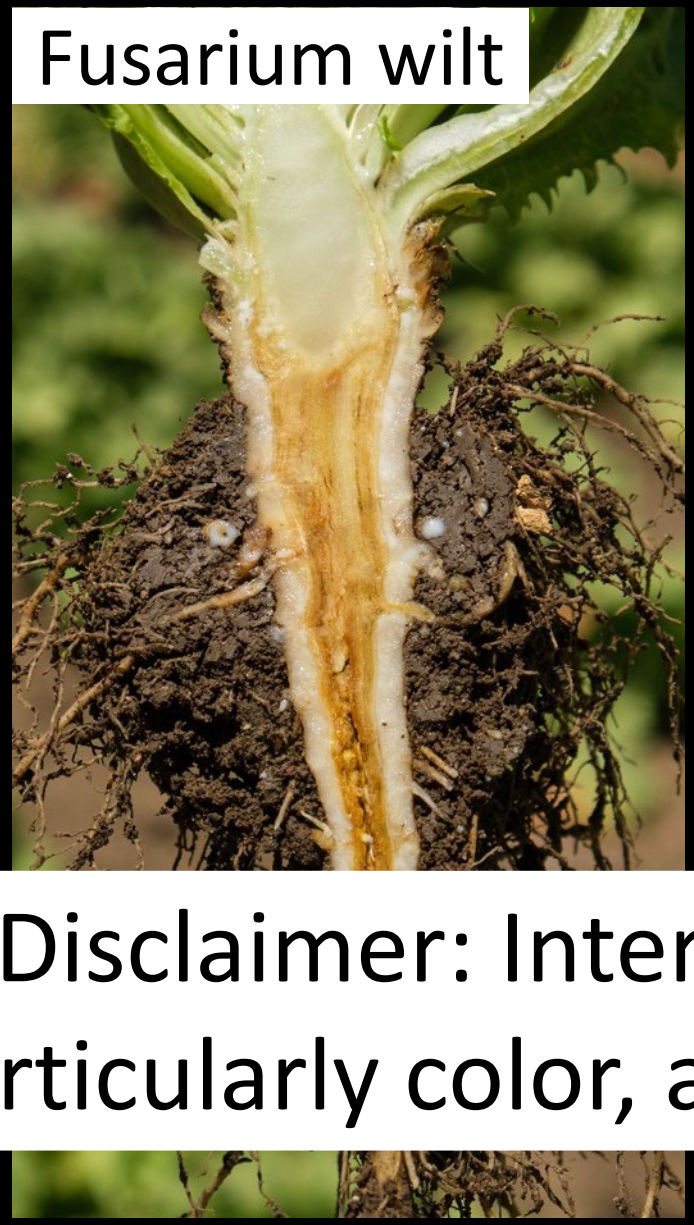
Verticillium wilt

Olive green/black discoloration, little-no hollowing

K. Subbarao

Vascular wilts – typical symptoms

Fusarium wilt



Reddish (orange/brown) discoloration, hollowing, white residue

Verticillium wilt

Olive green/black discoloration, little-no hollowing

Disclaimer: Internal symptoms, particularly color, are not diagnostic

K. Subbarao

Typical symptoms of Fusarium wilt

Healthy Discoloration Hollowing out Rot, white residue

Diseases causing external rots, spots, or bands

Pythium wilt

Can appear early
Stunting, wilting, yellowing
Outer leaves lay evenly flat

Corky root

No image

Poor, uneven growth
Stunting, wilting

Black root rot

Can appear at any stage
Unevenness, stunting
*Minimal yellowing
*NO wilt or collapse

Diseases causing external rots, spots, or bands

Pythium wilt

Large areas of soft rot on secondary roots
Rot of taproot

Corky root

Yellow bands on taproot
Green-brown discoloration with cracking

Black root rot

Black, discrete bands on secondary roots
Taproot only affected when severe

Diseases causing external rots, spots, or bands

Pythium wilt

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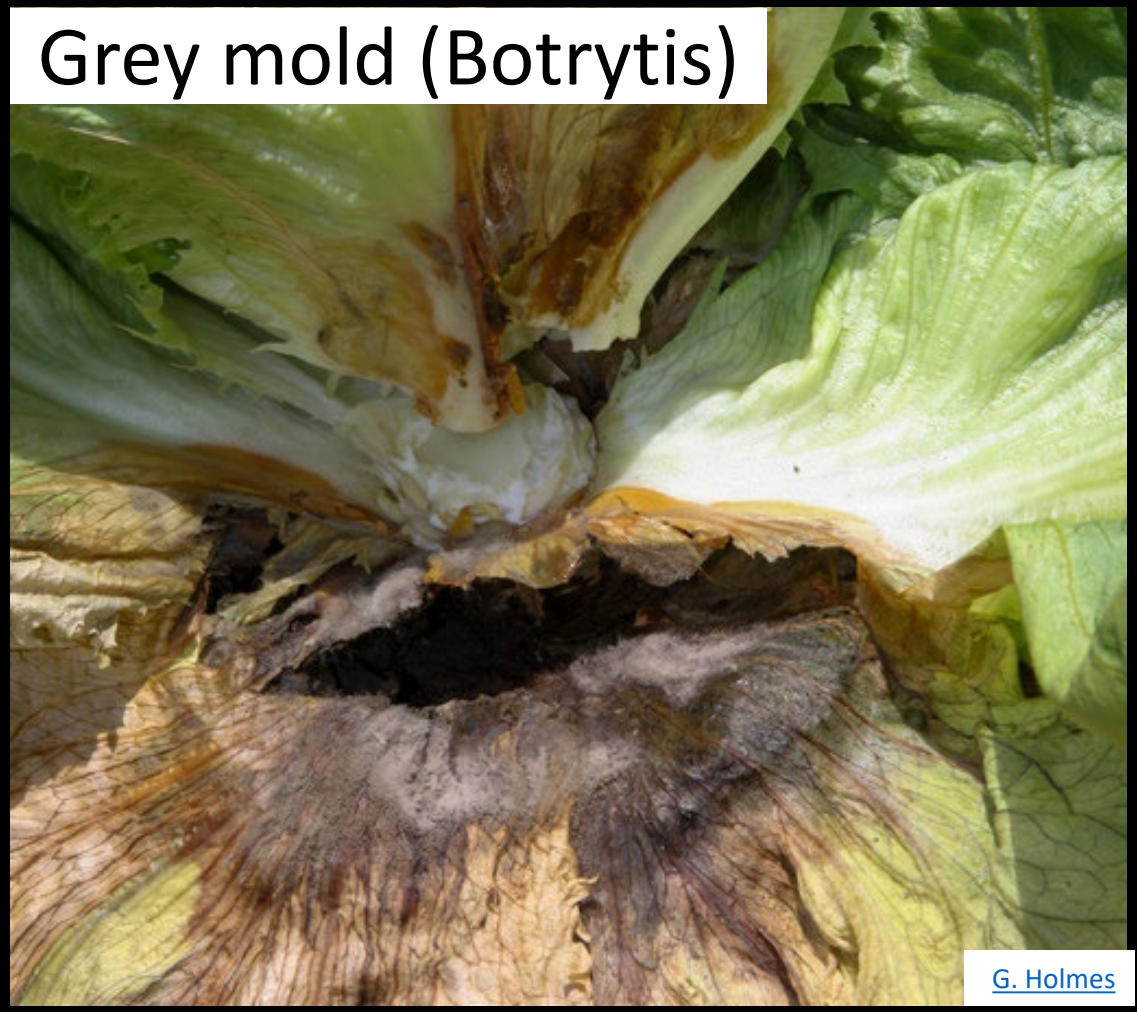
Crown rots

Drop (Sclerotinia)

G. Holmes

Head easily detached from roots
White mycelium
Black sclerotia (1/8th inch)

Grey mold (Botrytis)



G. Holmes

Head easily detached from roots
Grey mycelium

Fusarium oxysporum f. sp. *lactucae*

- Disease-causing ability is host specific
  - *F. oxysporum* f. sp. *lactucae* will only cause disease of lettuce
  - f. sp. = “special form”

- Can grow and reproduce on:
  - Plants on which it cannot cause disease
  - Resistant cultivars of its host plant

- There are many special forms of other hosts
  - Also, there are probably many *F. oxysporum* populations that are non-pathogenic

Colonization of lettuce cultivars and rotation crops by the Fusarium wilt pathogen

Plant	Root cortex[1]		Root stele[1]	
	% pieces infected	Pathogen colonies per gram	% pieces infected	Pathogen colonies per gram
Spinach	67 ab[3]	11.5 a	50.0 b	8.8 b
Cauliflower	33 a	2.6 a	7.4 a	1.1 a
Broccoli	33 a	3.0 a	0.0 a	0.0 a
Lettuce King Henry[2]	93 b	576.0 b	71.0 b	17.0 b
Lettuce Salinas[2]	100 b	1312.0 b	77.0 b	325.0 c

[1] Cortex = outer layer of root, Stele = inner cylinder of vascular tissue
[2] King Henry = Romaine, resistant; Salinas = iceberg, susceptible to Fusarium wilt
[3] Within each column, values the same letter are not significantly different

Scott, McRoberts, Gordon. 2014 10.1111/ppa.12135

Non-host rotation crops can be colonized, but less than lettuce

Within lettuce, resistant cultivar is colonized less than susceptible cultivar

Race survey

Cultivar	race 1	race 2	race 3	race 4	Our Research	
					race 1	CR4 variant*
Patriot	S	S	S	IR	S	S
Costa Rica No. 4	HR	S	S	S	HR	S
Romana Romabella	HR	HR	S	IR	HR	HR
Banchu Red Fire	S	HR	S	IR	S	S
<u>Unofficial</u>						
San Miguel	-	-	-	-	S	IR (HR)

Nayak and Richardson; Putman

HR = highly resistant; IR = intermediate resistance; S = susceptible

*"CR4 variant" is a temporary name

CR4 variant reaction pattern does not match any of races 1-4

Race survey – Geographic Distribution

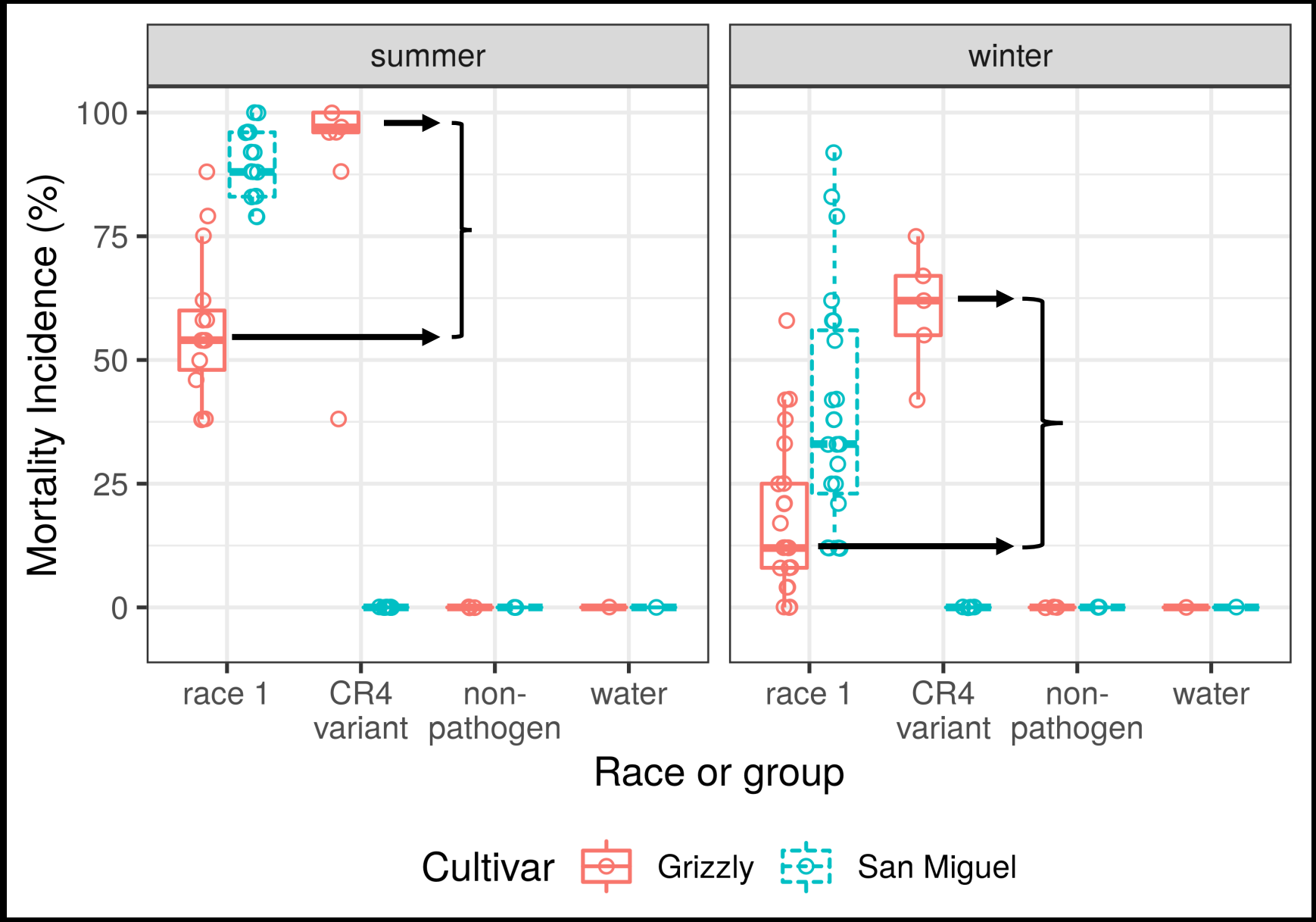
		Isolates collected and evaluated in greenhouse # of isolates (# of locations)				
District	**Sub-Region**	**Total**	**No Data**	**Other**	**Race 1**	**CR4 variant**
Central Valley	San Joaquin Valley	15 (2)	15 (2)	0 (0)	0 (0)	0 (0)
Low Desert	Imperial Valley	17 (2)	17 (2)	0 (0)	0 (0)	0 (0)
Salinas	North County	145 (23)	108 (10)	10 (8)	21 (7)	2 (2)
Salinas	Mid County	59 (10)	52 (7)	2 (2)	0 (0)	4 (2)
Salinas	South County	3 (1)	0 (0)	0 (0)	0 (0)	3 (1)
Salinas	n/a	10 (4)	7 (3)	0 (0)	3 (1)	0 (0)
Santa Maria	Lompoc Valley	9 (1)	9 (1)	0 (0)	0 (0)	0 (0)
Santa Maria	Santa Maria Valley	44 (5)	27 (1)	3 (3)	6 (2)	8 (3)
Santa Maria	n/a	6 (1)	6 (1)	0 (0)	0 (0)	0 (0)
	Total	**308 (49)**	**241 (27)**	**15 (13)**	**30 (10)**	**17 (8)**

*Isolates tested so far are biased toward race 1

Simultaneously detected at multiple location, in multiple valleys

At two locations, both races were found in the same field (but not necessarily the same spot)

Quantitative differences among races? (in greenhouse)



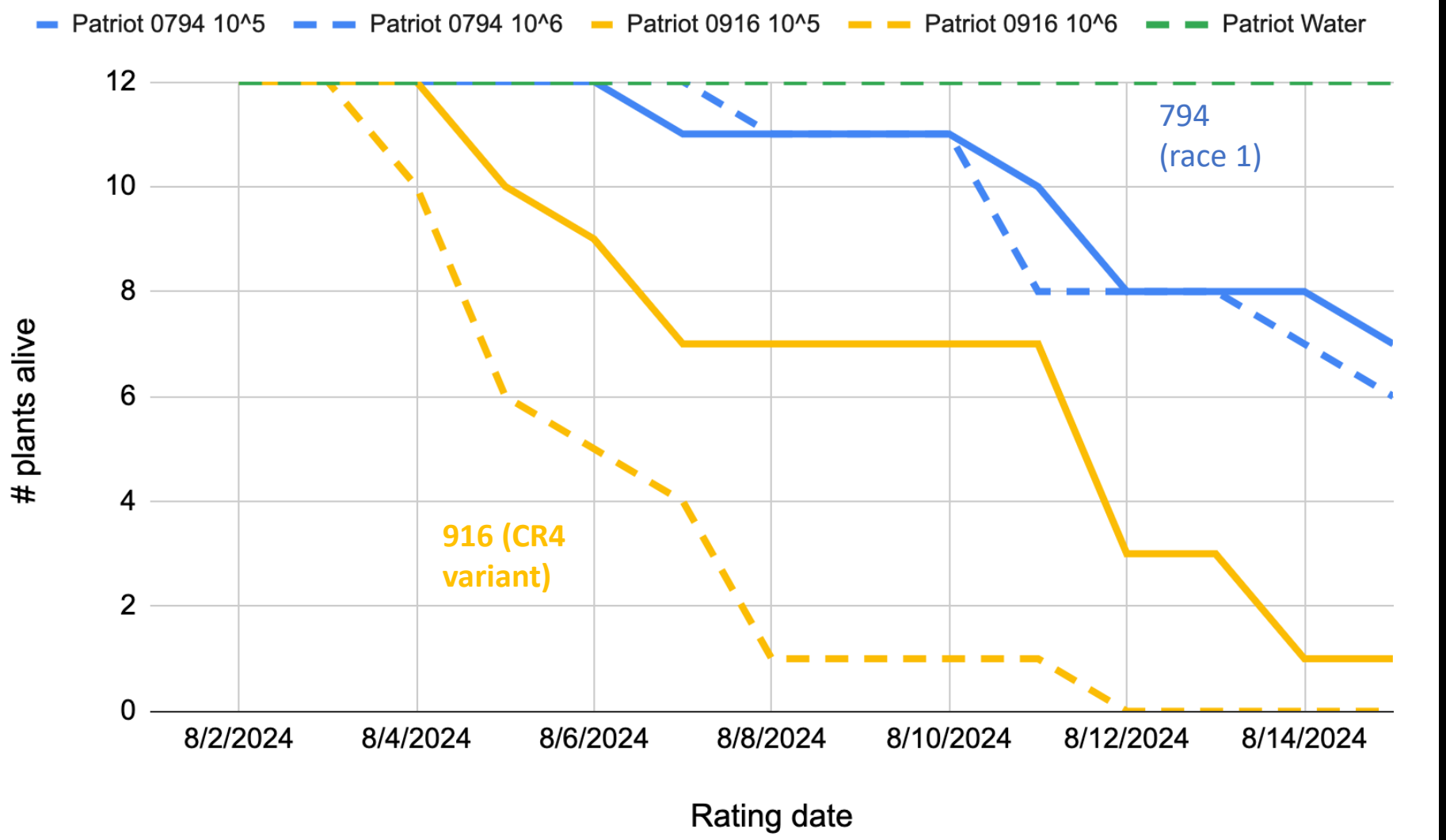
Apparent difference in aggressiveness to Grizzly between race 1 and the CR4 variant

Disease pressure lower for experiments done in winter

- Each point = 1 isolate
- Isolates between summer/winter not same

% mortality of 24 plants

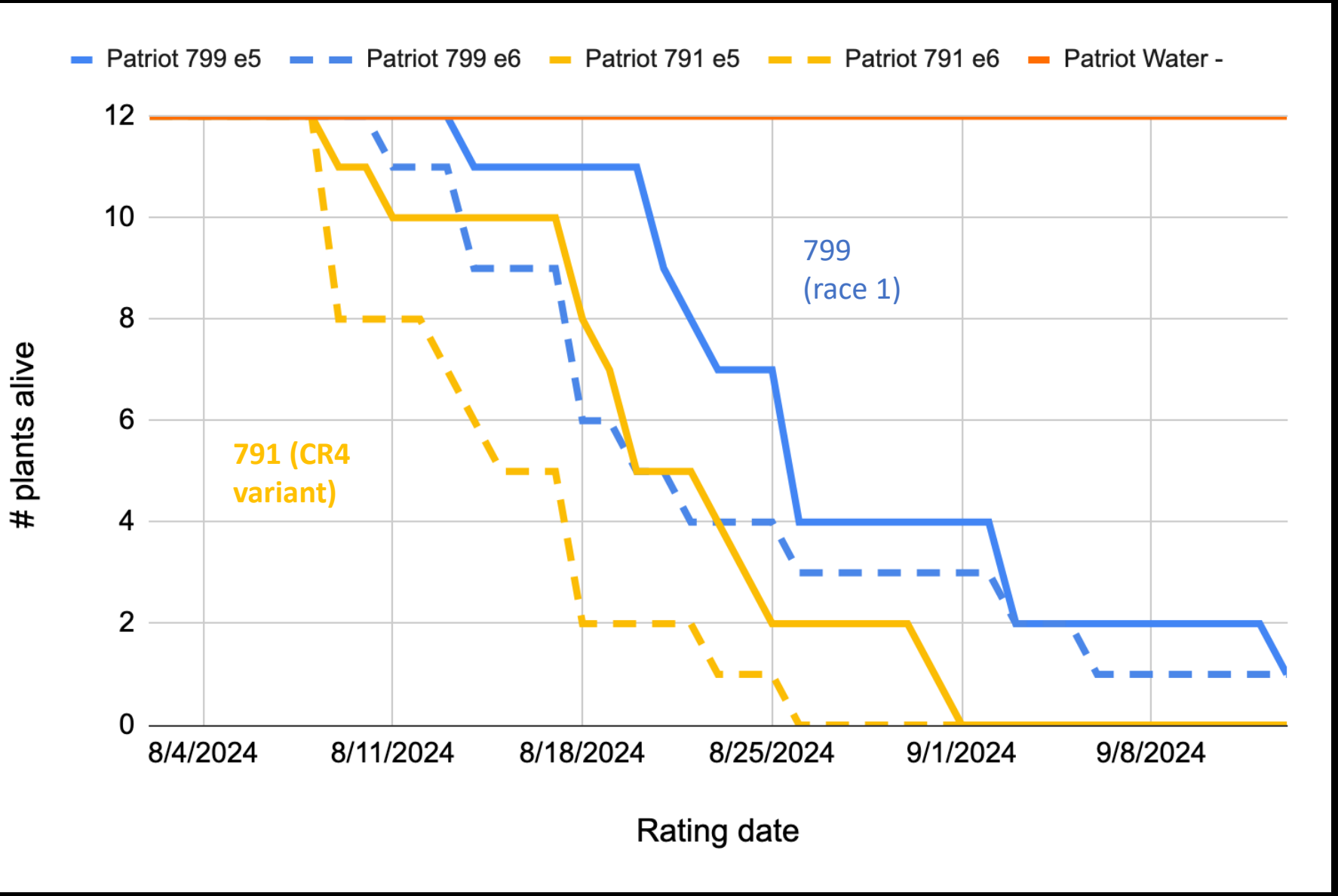
Apparent differences in aggressiveness between races



<u>Greenhouse pots</u>

In variety susceptible to both races, CR4 variant isolate kills more plants and faster than race 1 isolate

Apparent differences in aggressiveness between races



<u>Greenhouse pots</u>

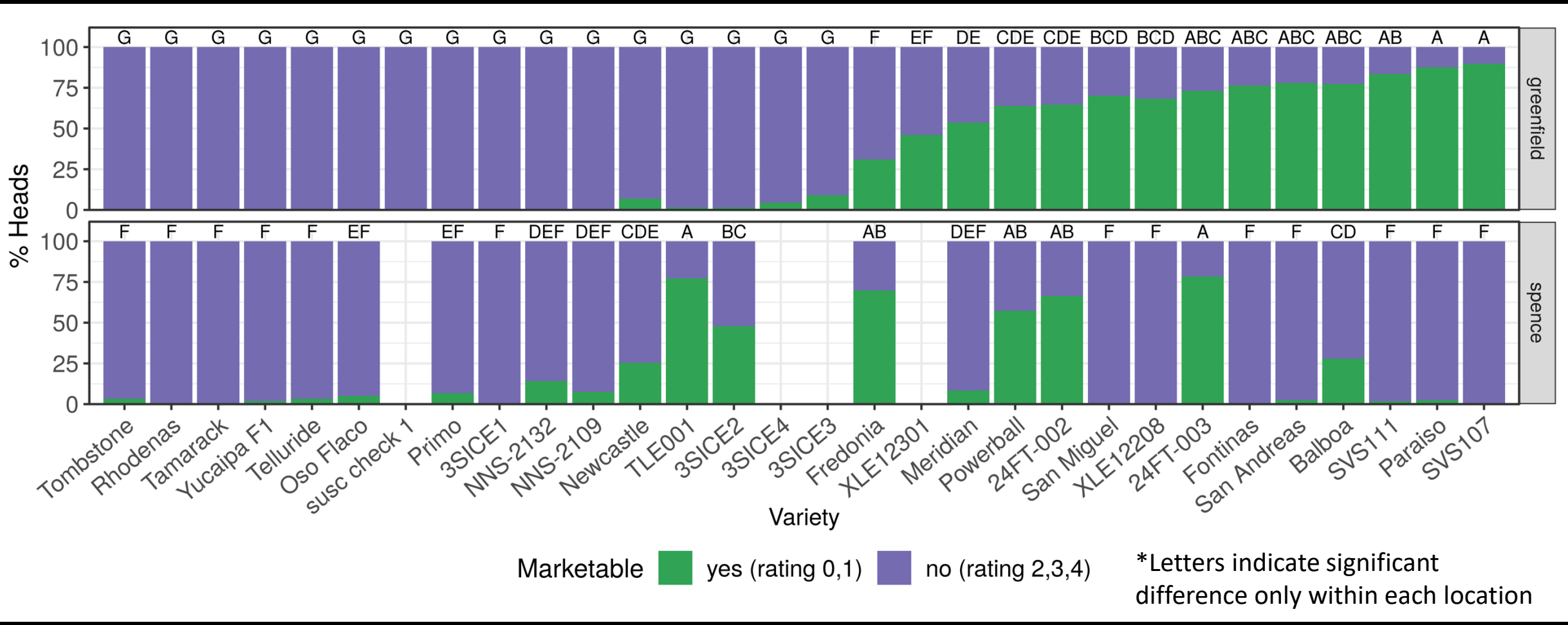
In variety susceptible to both races, CR4 variant isolate kills more plants and faster than race 1 isolate

Pattern seen in three pairs of isolates

Fusarium race survey – Summary

- The CR4 variant is a novel race that is present on the Central Coast
- Race 1 is also present on the Central Coast
- San Miguel is highly susceptible to race 1
  - Several other cultivars show a similar reaction pattern
  - However, yet other cultivars show the opposite pattern
- Ring test to verify and officially name novel race will begin soon
- Underway
  - Increasing throughput of race phenotyping in greenhouse
  - Genome sequencing of more isolates for diagnostic marker development (F. Martin)

Fusarium wilt cultivar trial 2024 – Iceberg

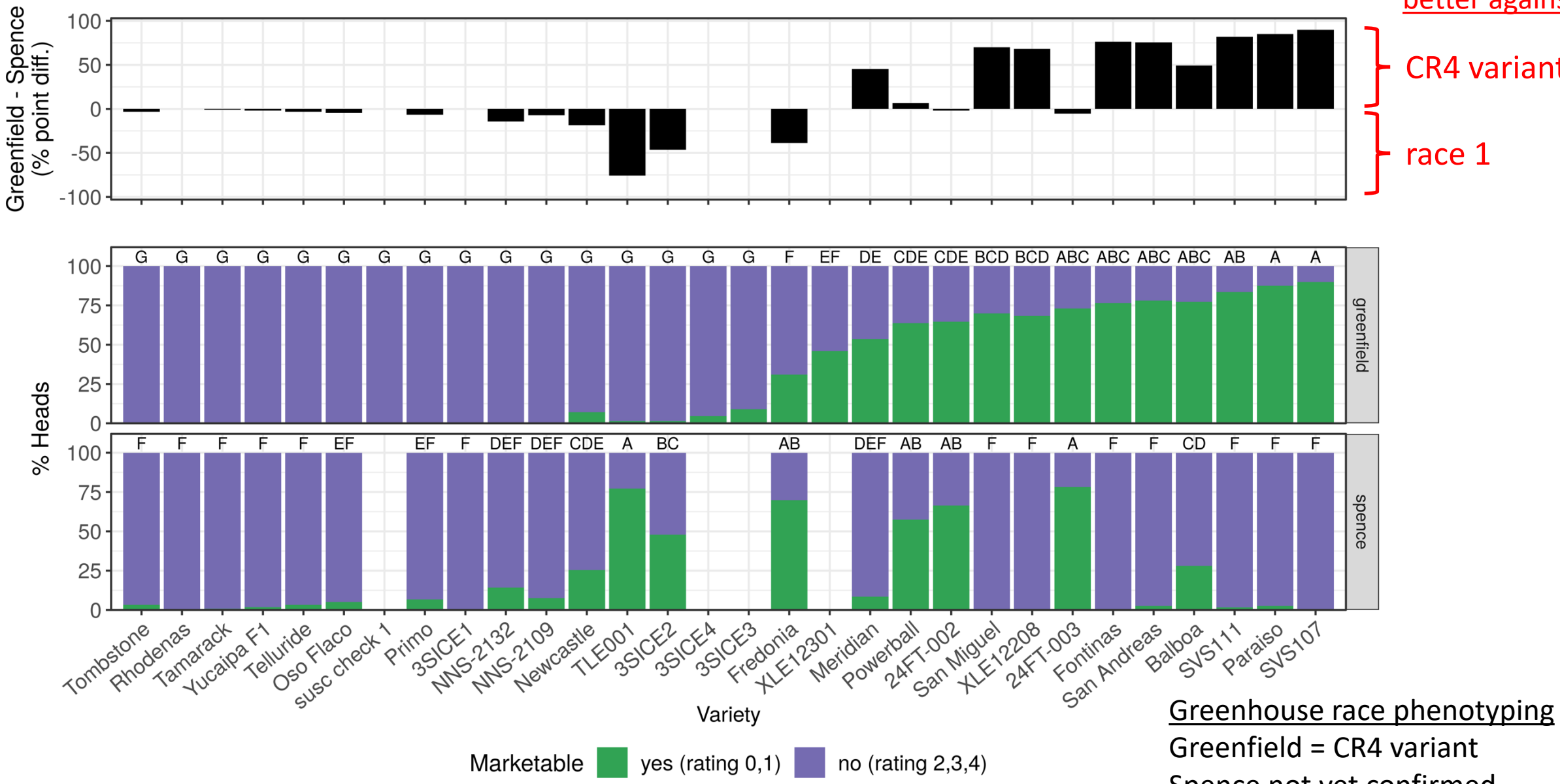


<u>Greenhouse race phenotyping</u>

Greenfield = CR4 variant; Spence not yet confirmed

NOTE: Spence location not farmed to commercial lettuce standards

Iceberg – Difference between locations



Greenhouse race phenotyping

Greenfield = CR4 variant

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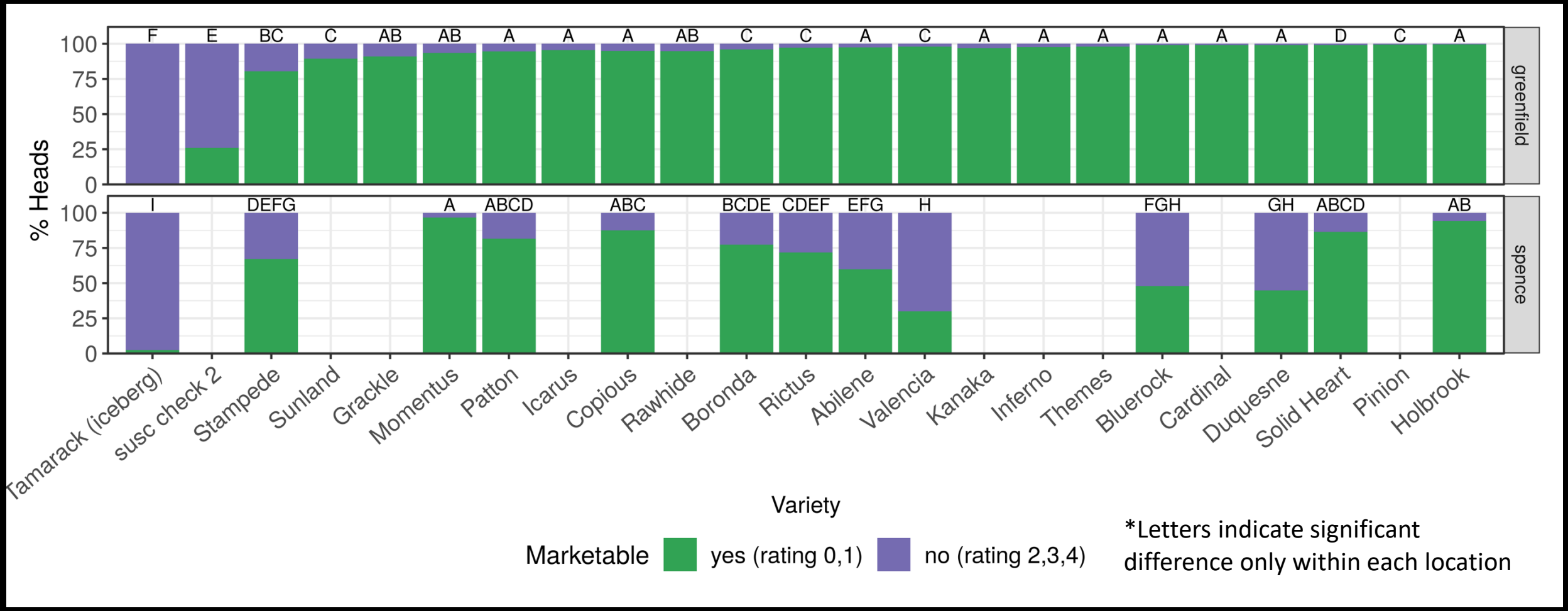
Fusarium wilt cultivar trial 2024 – Romaine

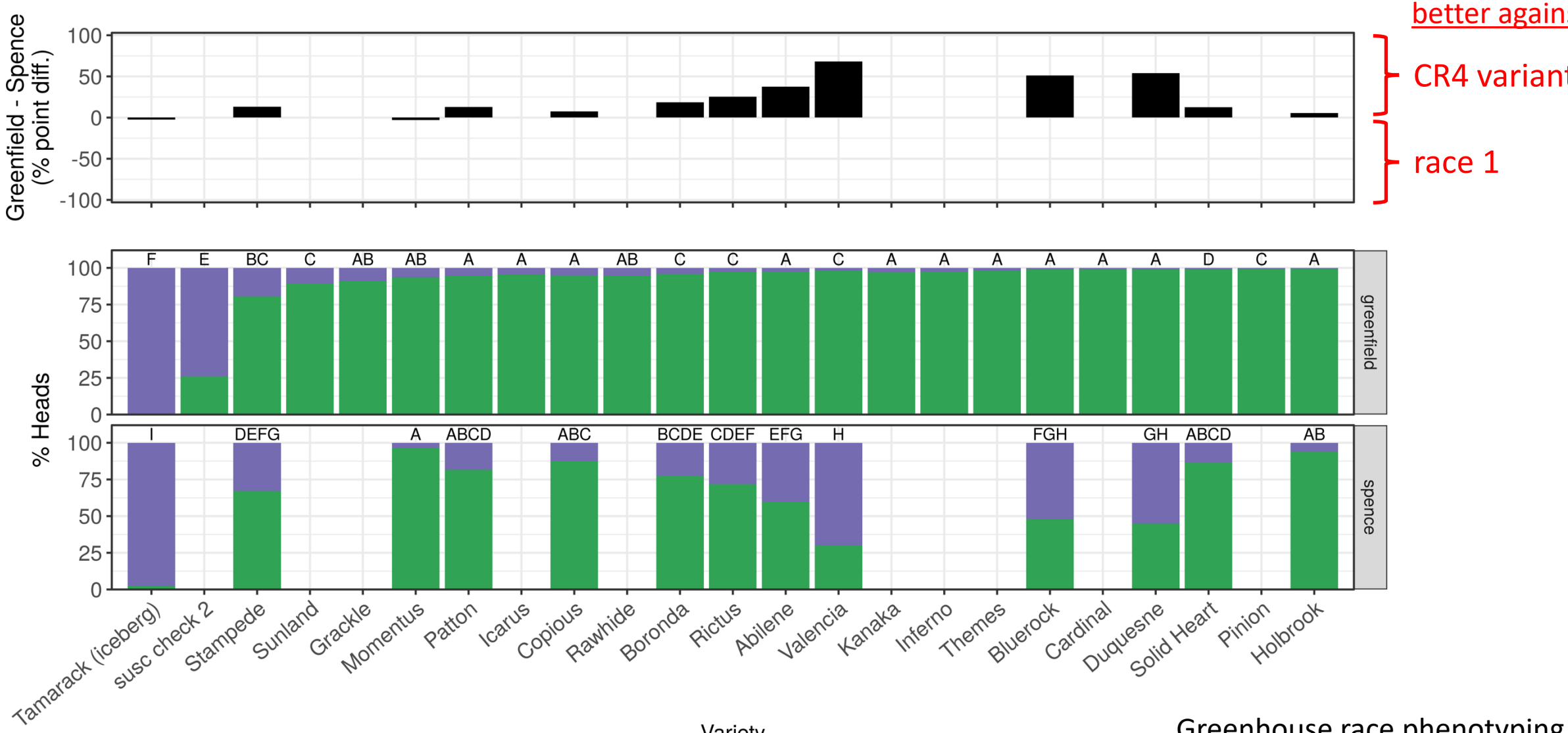


<u>Greenhouse race phenotyping</u>

Greenfield = CR4 variant; Spence not yet confirmed

NOTE: Spence location not farmed to commercial lettuce standards

Romaine – Difference between locations



Performed better against:

CR4 variant

race 1

Greenhouse race phenotyping

Greenfield = CR4 variant

Spence not yet confirmed

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