Integrated Soil-borne Disease Management in Organic Strawberries

UCCE Fumigants and Non-Fumigant Alternatives:
Regulatory and Research updates
Ventura, CA 5/29/2020

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Outline

1. Three common soil-borne pathogens in CA strawberries
2. Needs of diagnostics
3. Organically acceptable practices
    - Crop rotation
    - Anaerobic soil disinfestation (ASD)
    - Resistant varieties
    - Integrated approaches

Three Common Lethal Soil-borne Pathogens in California Strawberry

Disease	Pathogen	Host plant	Survival in soil without a host	Saprophytic
Verticillium wilt (1932)*	*Verticillium dahliae*	>400 species incl. >100 weed species	8-10 years	No
Fusarium wilt (2009)	*Fusarium oxysporum* f. sp. *fragariae*	Strawberry only	< 3 years	Yes (50-68 °F)
Charcoal rot (2008)	*Macrophomina phaseolina*	Strawberry only** (strawberry strain found in CA)	<3 years	Yes (50-68 °F)

* The year first reported in CA.

** Non-strawberry strains infect grains, legumes, cucurbits and others.

Soil-borne diseases in CA strawberries

Verticillium dahliae

Fusarium oxysporum f. sp. *fragariae* (F.o.f.)

Macrophomina phaseolina + F.o.f.

Verticillium dahliae + F.o.f.

No pathogen (ill drainage)

Need diagnostic for disease identification!!

Soil-borne Pathogen Diagnostics

- Plant test → molecular approach available for all 3 pathogens!

- Soil test → quantitative molecular approach
  - Available for *V. dahliae* and *M. phaseolina*, but not for *Fusarium oxysporum* f. sp. *fragariae*(?)
  - Soil test economic threshold: available only for *V. dahliae* (?)

Crop Rotation for Strawberry

- Traditional method to avoid soil-borne diseases in strawberries worldwide
  - Mandatory for organic strawberry production under the National Organic Program
  - Minimum of a 3-year break between two strawberry plantings recommended in EU and Northeast US and Canada
  - Anecdotal local evidence: 2 years or more to avoid Fusarium wilt

Verticillium dahliae; Host Crops vs. Non-host Crops

- Host crops

  cane berry (raspberry, blackberry), blueberry, artichoke, cucumber, watermelon, pumpkin, mint, eggplant, lettuce, pepper, potato, spinach, tomato

- Non-host crops

  cauliflower, cabbage, celery, parsley, radicchio, onion, garlic, bean, pea, carrot, sweet potato, asparagus

- Suppressive crop

  broccoli

Fusarium wilt suppression by Allium crops

Spinach Fusarium wilt suppression by green onion intercropping (Igarashi et al., 2017)

ネギ類の混植によるホウレンソウ萎凋病の抑制

五十嵐千佳[1]・浅野　雄二[2]・西岡　友樹[1]・須賀　晴久[3]・百町　満朗[1]・清水　将文[1]*

Eur J Plant Pathol (2012) 134:87–95
DOI 10.1007/s10658-012-0024-3

Control of Fusarium wilt in banana with Chinese leek

Y. H. Huang · R. C. Wang · C. H. Li · C. W. Zuo · Y. R. Wei · L. Zhang · G. J. Yi

(Received January 15, 2016; Accepted July 10, 2016)

Onion intercropping

UTC

SCIENTIFIC REPORTS

OPEN

Microbial basis of Fusarium wilt suppression by *Allium* cultivation

Tomoki Nishioka[1], Malek Marian[1], Issei Kobayashi[2], Yuhko Kobayashi[2], Kyosuke Yamamoto[3], Hideyuki Tamaki[3], Haruhisa Suga[4] & Masafumi Shimizu[1]

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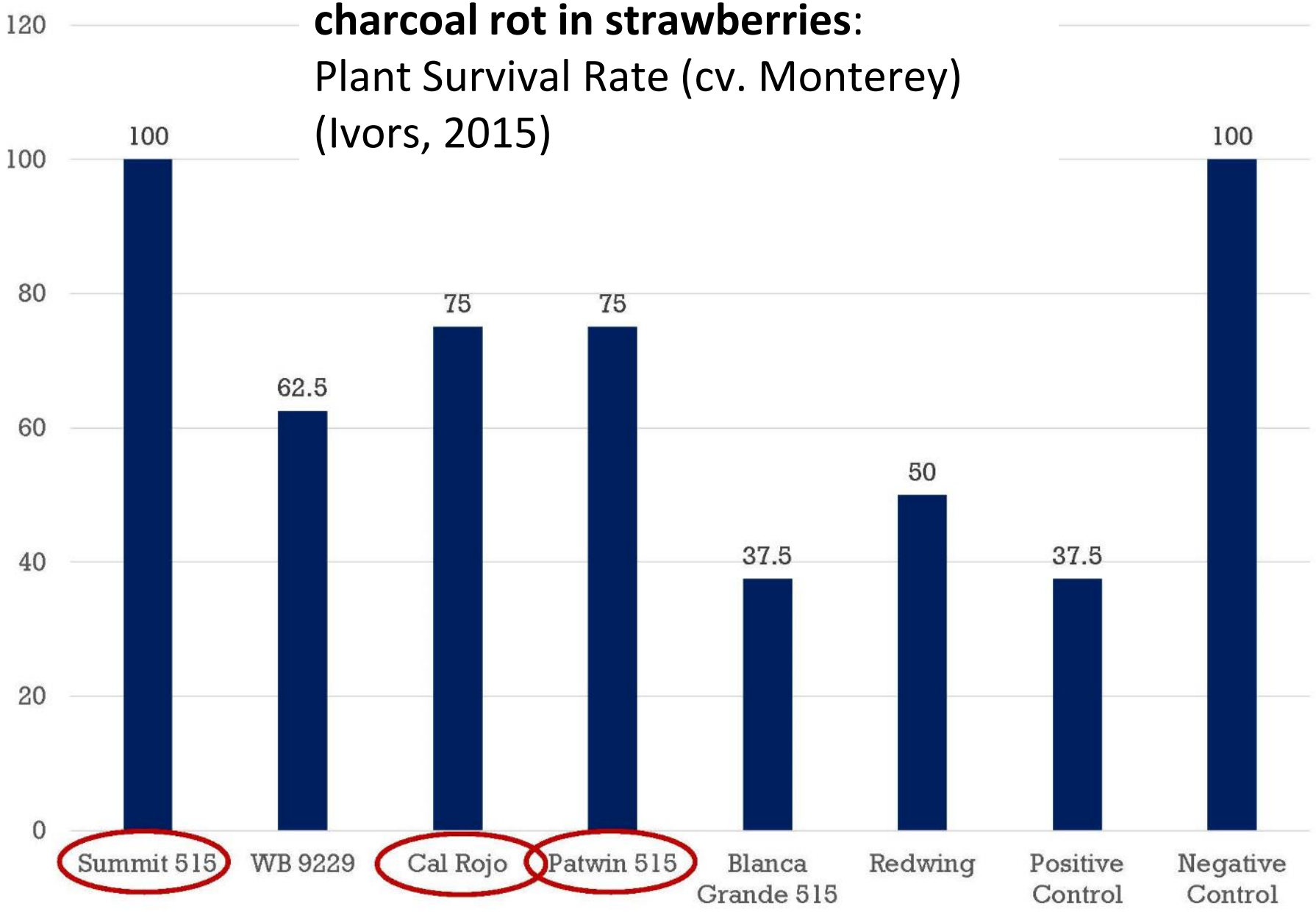
Crop rotation and intercropping with *Allium* plants suppresses Fusarium wilt in various crops. However, the mechanisms underlying this phenomenon have not been fully elucidated. This study was designed to assess the role of microorganisms inhabiting *Allium* rhizospheres and antifungal compounds produced by *Allium* roots in Fusarium wilt suppression by *Allium* cultivation. Suppression of cucumber

Allium roots -> gamma-Glutamyl-S-allylcysteine -> *Flavobacterium* -> *Fusarium wilt suppression*

Specific wheat varieties can suppress charcoal rot in strawberries:
Plant Survival Rate (cv. Monterey)
(Ivors, 2015)



Anaerobic Soil Disinfestation (ASD)

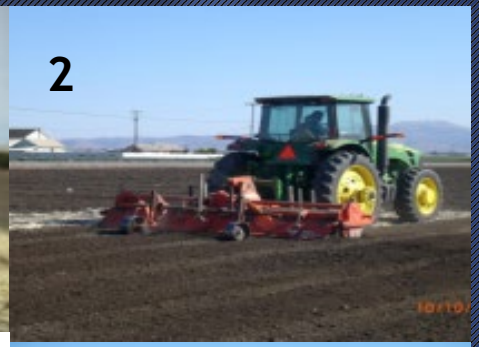
- Developed in the Netherlands and Japan independently ~2000 as a biological alternative to fumigation
- Principle: Acid fermentation in anaerobic soil

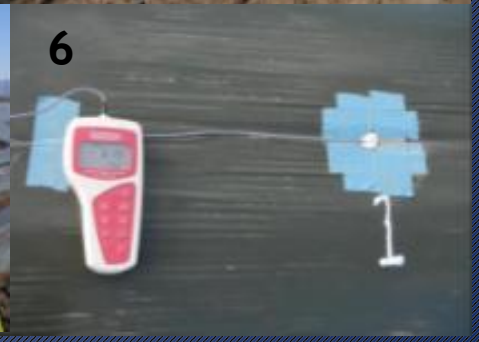
(Van Bruggen, 2014)

(Chiba prefecture, 2002)

Autumn-Anaerobic Soil Disinfestation (ASD) in California Strawberries

1. Broadcast rice bran at 6 - 9 tons/acre
2. Incorporate bran
3. List beds
4. Cover w/ plastic mulch
5. Drip irrigate total 1 to 2 ac-in over 3 wks
6. Leave 3 wks and **monitor soil Eh (redox potential)**





Soil-borne disease control by ASD in California strawberries

- Verticillium wilt by *Verticillium dahliae;* 80 to 100% decrease in *V. dahliae* microsclerotia in soil in field trials (Shennan et al., 2018)---**Autumn ASD**

- Charcoal rot by *Macrophomina phaseolina*; ~50% reduction of plant mortality compared to un-treated control (Muramoto et al., 2017)---**Summer ASD**

- Fusarium wilt by *Fusarium oxysporum* f. sp. *fragariea* can be controlled by **summer-ASD** but **autumn-ASD can make the disease worse** (Muramoto et al., 2017) ---**Rice bran can feed F.o.f!!**

Fusarium oxysporum f. sp. *fragariae** infested field
Strawberry plants (8/14/14)

UTC

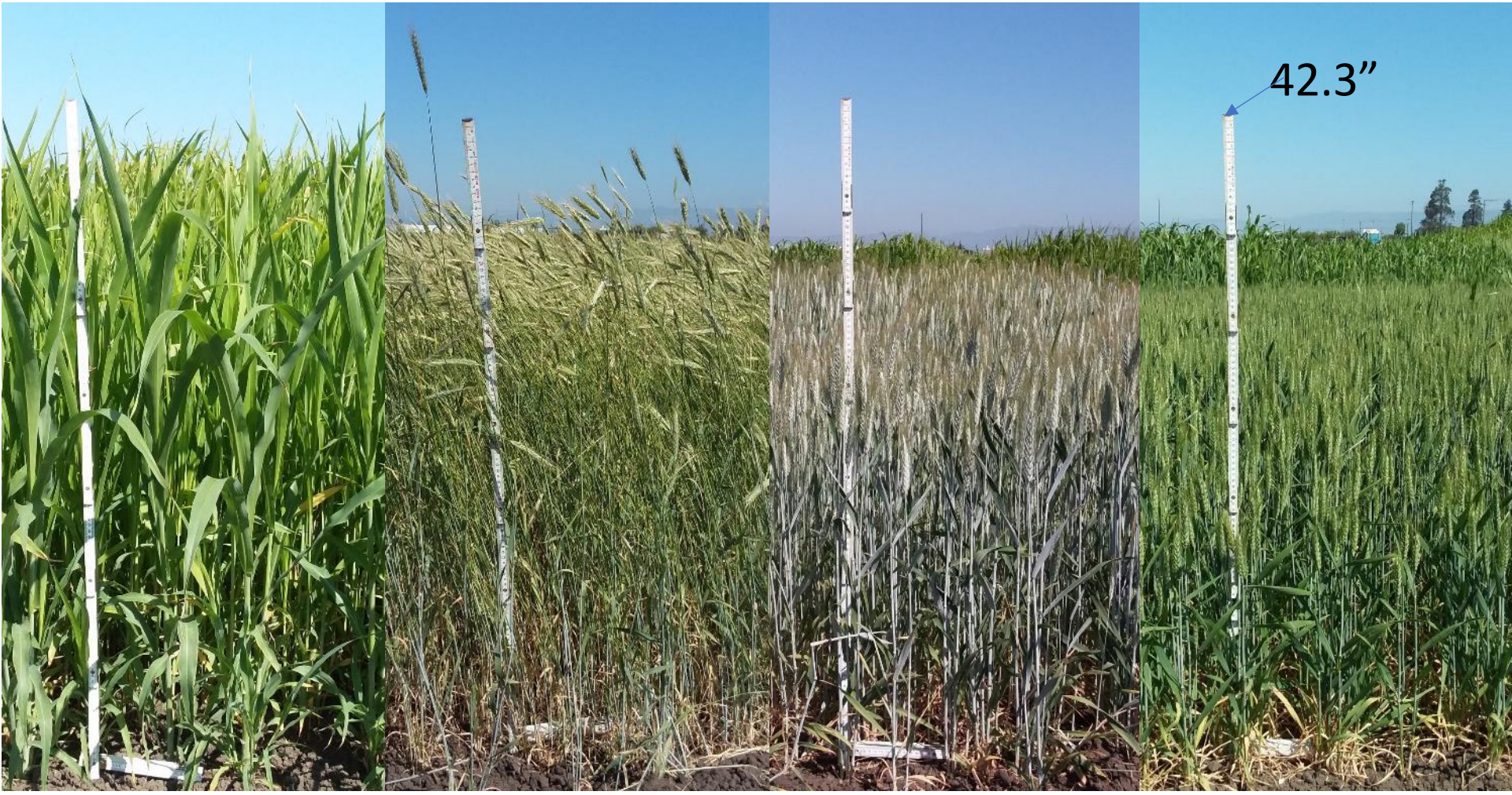
ASD Summer
RB 9t/ac

ASD Fall
RB 9t/ac

Higher temperature threshold for *Fusarium oxysporum*

(>460 hours above 86°F at 8" soil depth (Muramoto et al., Acta Hort. In Press))

Summer Cover Crops (planted: 5/24/18, harvested: 7/30/18)



Sudan grass
(Sweet’n honey)
3.9 t-d.w./acre

Merced rye
3.2 t-d.w./ac

Triticale
(Pancho)
3.5 t-d.w./ac

Wheat
(Summit 515)
3.8 t-d.w./ac

DN or SD

- Select all
- Day Neutral
- Short Day

Variety

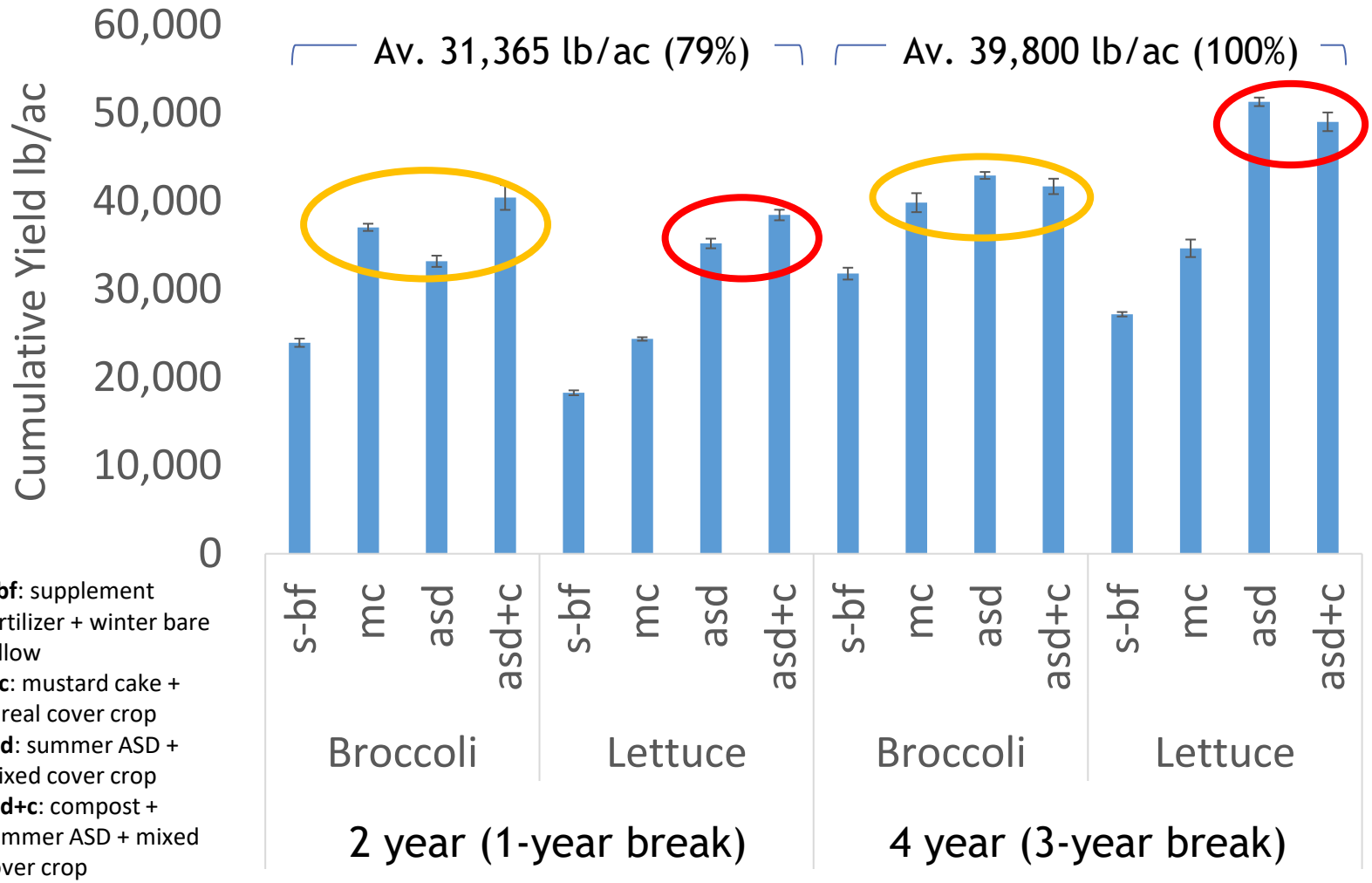
- Select all
- Albion
- Benicia
- Cabrillo
- Camarosa
- Camino Real
- Diamante
- Fronteras
- Gaviota
- Grenada
- Merced
- Mojave
- Monterey
- Palomar
- Petaluma
- Portola
- San Andreas
- Seascape
- Selva
- UCD Moxie
- UCD Royal Royce
- UCD Valiant
- UCD Victor
- UCD Warrior
- Ventana

Legend Acronym	Legend	Resistance Numerical Category
R	Resistant	1
MR	Moderate Resistance	2
MS	Moderate Susceptibilty	3
S	Susceptible	4

Variety	Type	Macrophomina	Verticillium	Fusarium	Phytophthora
UCD Warrior	SD	2	3	1	2
Portola	DN	4	2	1	2
UCD Victor	SD	3	3	1	2
Camino Real	SD	4	1	3	2
Diamante	DN	3	3	1	3
Fronteras	SD	3	3	1	3
San Andreas	DN	4	2	1	3
UCD Moxie	DN	4	2	1	3
Grenada	SD	2	2	4	3
Petaluma	SD	3	2	3	3
Ventana	SD	4	3	1	3
Palomar	SD	3	3	3	3
Selva	DN	3	2	4	3
UCD Royal Royce	DN	3	2	4	3
Albion	DN	4	2	4	3
Cabrillo	DN	4	2	4	3
Merced	SD	4	3	4	2
UCD Valiant	DN	4	2	4	3
Gaviota	SD	4	3	4	3
Mojave	SD	4	3	4	3
Monterey	DN	4	3	4	3
Benicia	SD	4	4	4	3
Camarosa	SD	4	4	4	3
Seascape	DN	4	4	4	3

https://www.calstrawberry.com/en-us/Pest-Management/Breeding

8 year organic rotation trial at UCSC farm
Marketable Fruit Yield at year 8 (cv. Albion)
(*V. dahliae, F. oxysporum* f. sp. *fragariae*, *and M. phaseolina* infested site)



s-bf: supplement fertilizer + winter bare fallow
mc: mustard cake + cereal cover crop
asd: summer ASD + mixed cover crop
asd+c: compost + summer ASD + mixed cover crop

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Thank you!
Question?
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