UNIVERSITY OF CALIFORNIA
Agriculture and Natural Resources

Entomology & Biologicals

# Biologicals in Small Fruit and Vegetable Crop Production and Protection

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**@calstrawberries @calveggies** **strawberriesvegetables**

**eJournals: ucanr.edu/JEB** **and ucanr.edu/pestnews**

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# Studies

1. Improving tomato fertility program with nutrient and biostimulant materials
2. Microbial, biostimulant, and additive materials for improving strawberry growth, health, yield, and quality
3. Organic solutions for the western grapeleaf skeletonizer in grape
4. Entomopathogenic fungi against charcoal rot caused by *Macrophomina phaseolina* in strawberry

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# 2017 Tomato fertility study

| Treatment | | Per acre | | Application | Frequency |
|---|---|---|---|---|---|
| 1 | Grower standard (11-52-0 Monoammonium phosphate) | 250 | lb | Side dress | ~3 wk after planting |
| 2 | AgSil 21 | 8.75 | fl oz/100 gal | Drip for 30 min | Start as soon as the drip is set up and continue every 3 weeks |
| 3 | Yeti Bloom | 1 | ml/gal until root zone is wet | Apply to the roots of transplants until thoroughly wet | 1 or 2 days before transplanting |
| | | | | Drip for 30 min | Every week |
| 4 | Nutrient Technologies Program | | | | |
| | Tech-Flo Omega | 2 | qt/300 gal | Transplant water | N/A |
| | Tech-Flo All Season Blend#1 | 1 | qt/300 gal | | |
| | | | | Drip for 30 min | First bloom |
| | Tech-Flo Cal-Bor+Mo | 2 | qt/300 gal | | |
| | Tech-Flo Omega | 2 | qt/300 gal | Drip for 30 min | 2-3 weeks after first bloom |
| | Tech-Flo Sigma | 2 | qt/300 gal | | |
| | Tech-Spray Hi-K | 2 | qt/300 gal | Drip for 30 min | Start at early color break and repeat every 10-12 days until harvest |

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http://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=26054

# 2017 Tomato fertility study

| Treatment | | Per acre | | Application | Frequency |
|---|---|---|---|---|---|
| 5 | Innovak Program | | | | |
| | ATP Transfer UP | 2 | ml/liter | Spray over the plants to the point of runoff | Just before transplanting |
| | | 28 | fl oz/50 gal | Foliar spray | Start 2 weeks after transplanting and apply every 2 weeks 1 or 2 more times. If plants are stressed, apply at weekly intervals. |
| | Nutrisorb-L | 40 | fl oz | Drip for 30 min | Start 2 weeks after transplanting apply one more during vegetative stage at 2 week interval. Third application at first bloom. And 2-3 more during fruiting at 2 week interval. |
| | Biofit N | 2 | lb | Drip for 30 min | 1st as soon as drip is set up; 2nd 3 weeks after 1st; 3rd at first bloom |
| | Packhard | 50 | fl oz/50 gal | Foliar spray | 2 applications during first fruit development. Additional applications every two weeks during the harvest period |

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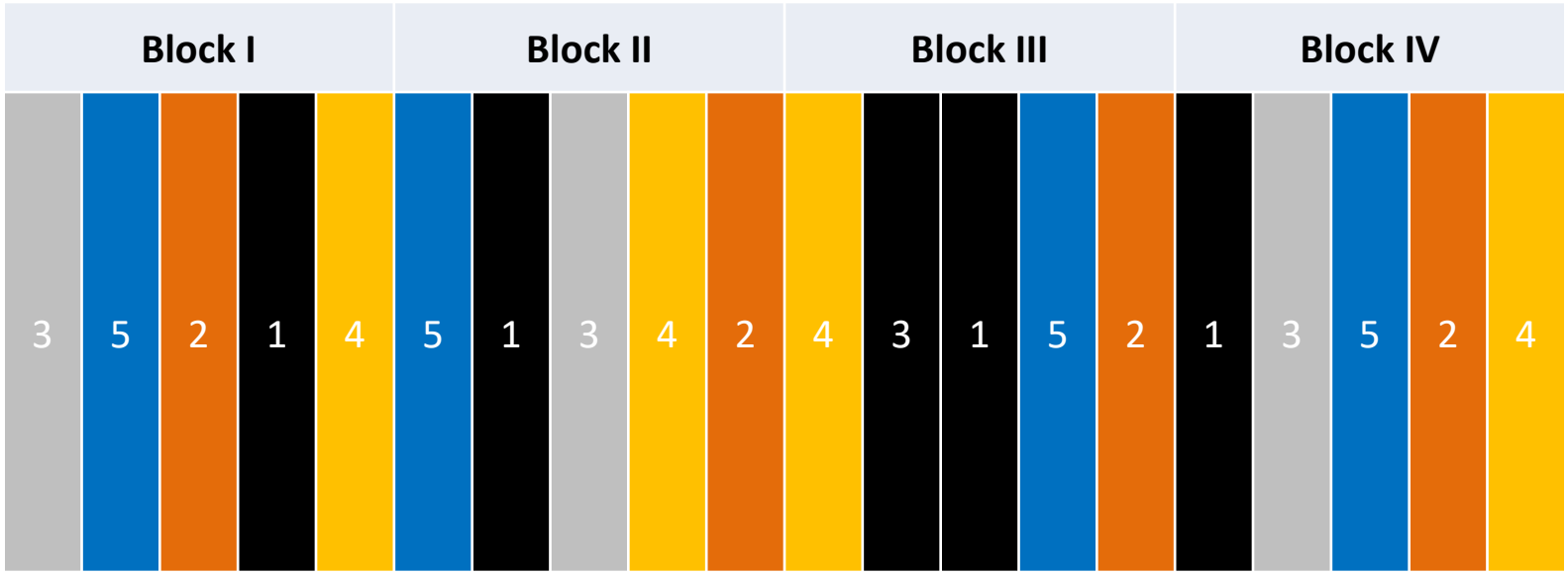
# 2017 Tomato fertility study



# 2017 Tomato fertility study

# 2017 Tomato fertility study

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# 2017 Tomato fertility study

## Cumulative tomato yield/plot (grams)

| Treatments | | 10/11/2017 | 10/18/2017 | 10/25/2017 | 11/2/2017 | 11/10/2017 | 11/15/2017 | 11/22/2017 | 12/5/2017 | Seasonal Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Standard | 0.0 | 32.9 | 106.6 | 432.1 | 578.3 | 694.0 | 694.0 | 1725.9 | 66868.6 |
| 2 | AgSil 21 | 15.9 | 103.2 | 326.6 | 451.3 | 755.2 | 1035.3 | 1368.7 | 4595.0 | 84961.5 |
| 3 | Yeti Bloom | 99.8 | 99.8 | 213.2 | 589.7 | 1080.7 | 1304.1 | 1476.5 | 6944.6 | 88048.3 |
| 4 | Nutrient Technologies | 129.3 | 138.3 | 275.6 | 437.7 | 548.9 | 830.1 | 1106.8 | 2904.2 | 61906.2 |
| 5 | Innovak | 150.8 | 282.4 | 410.5 | 912.9 | 1282.6 | 1653.4 | 1841.6 | 4313.7 | 86851.9 |

## Cumulative tomato yield/plot (pounds)

| Treatments | | 10/11/2017 | 10/18/2017 | 10/25/2017 | 11/2/2017 | 11/10/2017 | 11/15/2017 | 11/22/2017 | 12/5/2017 | Seasonal Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Standard | 0.0 | 0.1 | 0.2 | 1.0 | 1.3 | 1.5 | 1.5 | 3.8 | 147.4 |
| 2 | AgSil 21 | 0.0 | 0.2 | 0.7 | 1.0 | 1.7 | 2.3 | 3.0 | 10.1 | 187.3 |
| 3 | Yeti Bloom | 0.2 | 0.2 | 0.5 | 1.3 | 2.4 | 2.9 | 3.3 | 15.3 | 194.1 |
| 4 | Nutrient Technologies | 0.3 | 0.3 | 0.6 | 1.0 | 1.2 | 1.8 | 2.4 | 6.4 | 136.5 |
| 5 | Innovak | 0.3 | 0.6 | 0.9 | 2.0 | 2.8 | 3.6 | 4.1 | 9.5 | 191.5 |

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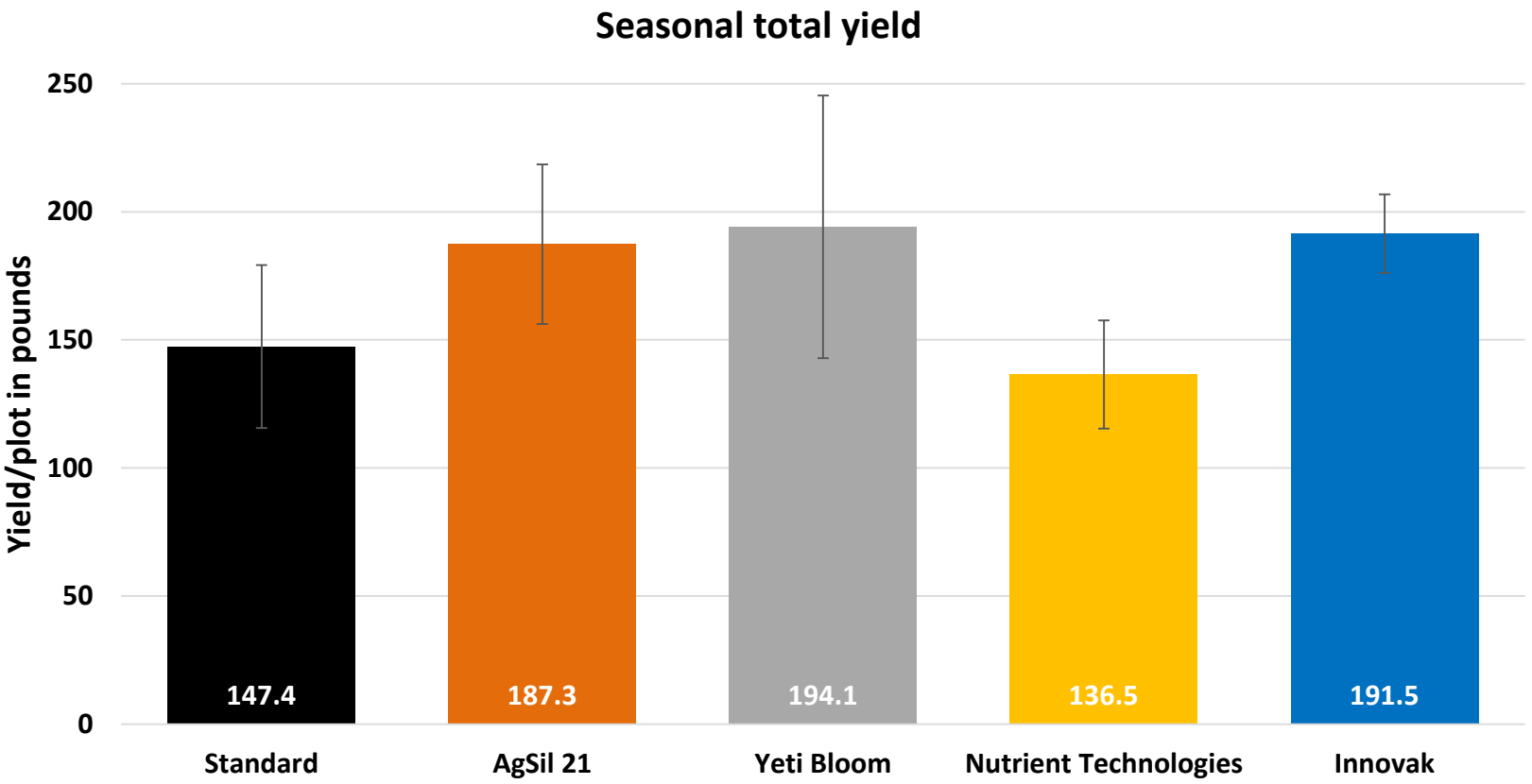
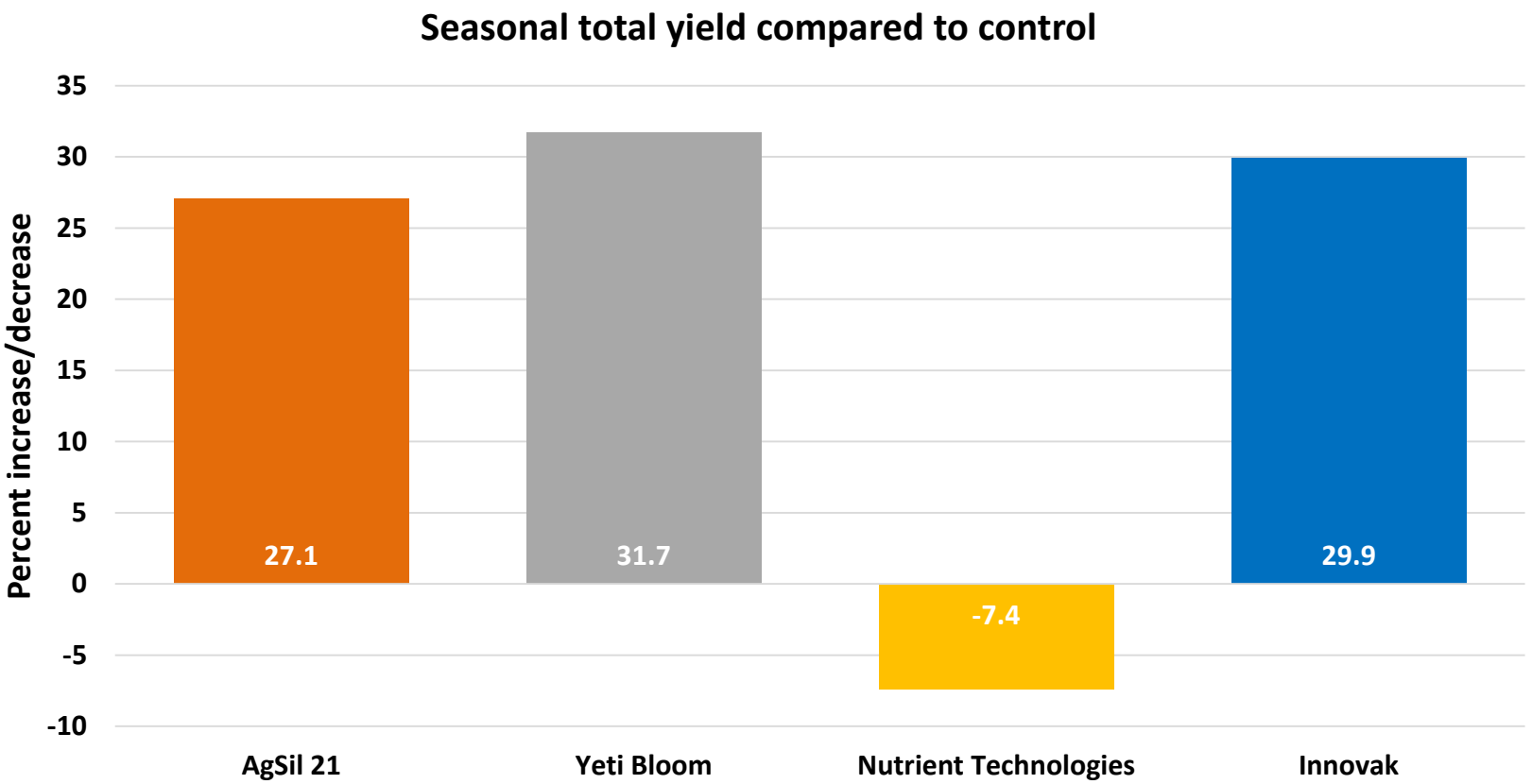
# 2017 Tomato fertility study




*P* > 0.05

# 2017 Tomato fertility study



# 2017 Tomato fertility study

**Conclusions**

- Treatment effects were not statistically significant, but some have a potential to improve tomato yields

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# Bioactives in strawberry-Manzanita 2017-2018

| Treatments | | Product | Transplant dip (per acre rate) | In-season application | Per acre rate |
|---|---|---|---|---|---|
| 1 | Untreated | No Healthy Soil or other fertility treatments | | | |
| 2 | Grower Standard | Switch 62.5 WG | 5 oz/100 gal | Healthy Soil and other fertility treatments | |
| 3 | Innovak Global | Nutrisorb-L | | Start 2 wk after planting and every 3 wk thereafter through drip | 28 fl oz |
| | | Packhard | | At first fruit set (early January) and every 2 wk therafter-foliar | 28 fl oz |
| 4 | TerraVesco | Vermi-extract | 10% or 128 fl oz/10 gal for 3 hours | At 1st drip after planting | 7.5 gal |
| | | | | December | 7.5 gal |
| | | | | January | 7.5 gal |
| 5 | Fertum | Germinal Plus | 1% | | |
| | | Booster | | Late November and late December | 0.5 gal |
| | | Silicium PK | | Late December and once a month starting from mid February (ended on 2 July, 2018) | 0.5 gal |
| | | Foliar | | Mid January and late January | 0.5 gal |

https://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=27891

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# Bioactives in strawberry-Manzanita

| Treatments | | Product | Transplant dip (per acre rate) | In-season application | Per acre rate |
|---|---|---|---|---|---|
| 6 | Shemin Garden | EcoSil | | Early December, early January, early February, early March, early April, and early May | 800 ml |
| | | ComCat | | One week after EcoSil in December, January, February, March, April and May (ComCat and EcoFlora can be applied together) | 20 gr |
| | | EcoFlora | | | 12 oz or 340.2 gr |
| | Shemin Garden | EcoSil | | Early May and early June as foliar | 200 ml |
| | | ComCat | | May and June as foliar (ComCat and EcoFlora can be applied together) | 10 gr |
| | | EcoFlora | | | 12 oz or 340.2 gr |
| 7 | GrowCentia | Yeti-Low | | Each week for 90 min | 0.6 ml/gal of water |
| 8 | GrowCentia | Yeti-High | | Each week for 90 min | 1 ml/gal of water |
| 9 | NanoChem | EX10 | | First drip after planting, in early January (first blom) and mid February (4-6 wk after 1st bloom), and again in May | 1 qrt (32 fl oz) |
| 10 | BiOWiSH | Moj1 | 1 gr/L or 3.785 gr/gal | Start 2 wk after planting and every 4-5 wk there after through drip | 100 gr or 3.53 oz/ac |
| 11 | BiOWiSH | Moj1 | 1 gr/L or 3.785 gr/gal | Start 2 wk after planting and every 4-5 wk thereafter-foliar | 100 gr or 3.53 oz/ac |
| 12 | BiOWiSH | Moj1 | 1 gr/L or 3.785 gr/gal | Start 2 wk after planting with drip and alternate with foliar every 2 wk. (That means drip and foliar alternated every 2 weeks) | 100 gr or 3.53 oz/ac |
| 13 | BiOWiSH | Moj1 | 1 gr/L or 3.785 gr/gal | | |
| | | BiOWiSH Crop 16-40-0 | | Start 2 wk after planting and every 4-5 wk thereafter through drip | 100 gr or 3.53 oz/ac |

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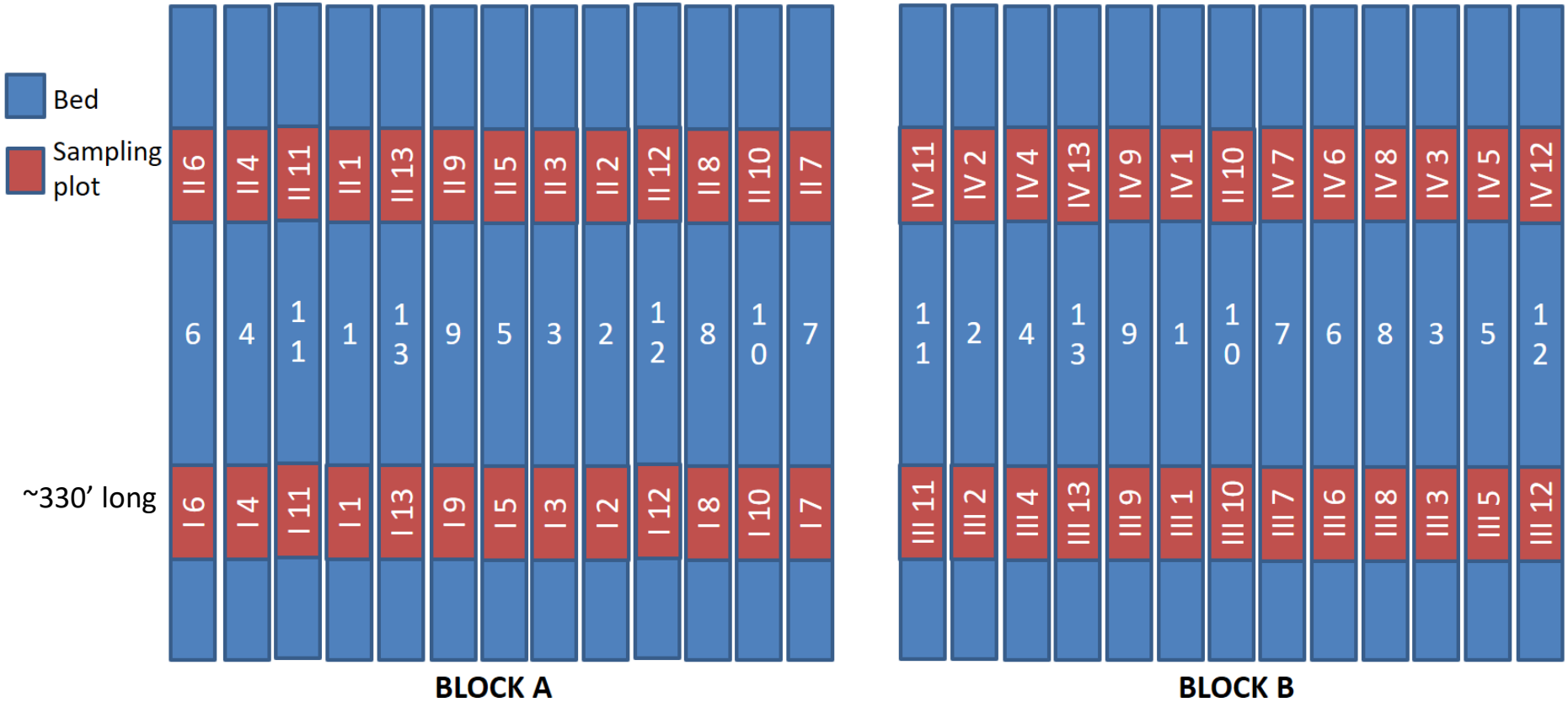
# Bioactives in strawberry-Manzanita



# Bioactives in strawberry-Manzanita

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# Bioactives in strawberry-Manzanita

11 December, 2017
7 and 30 January, 2018
8 February, 2018

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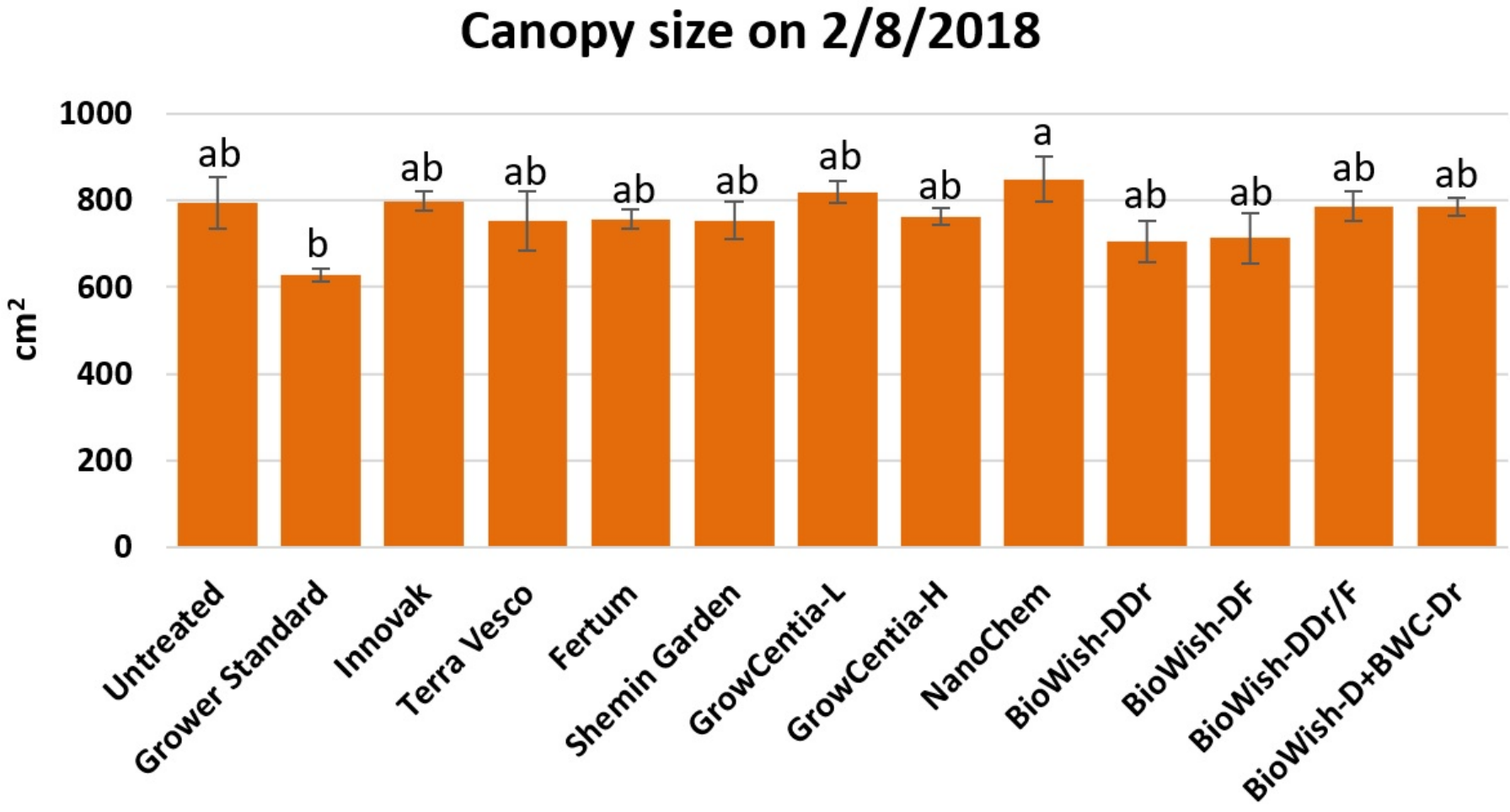
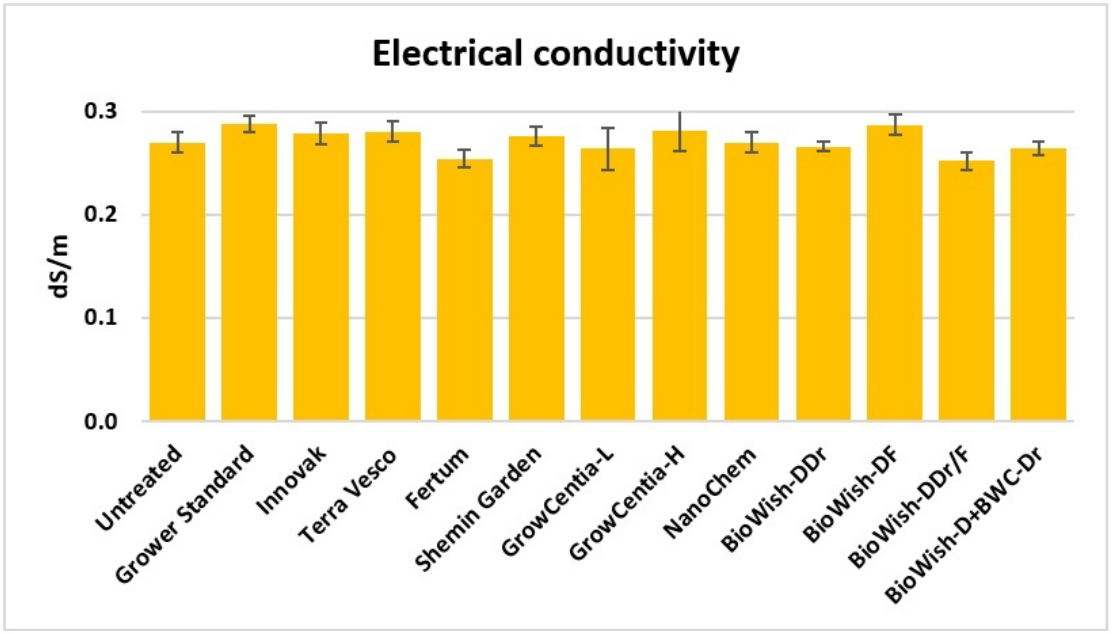
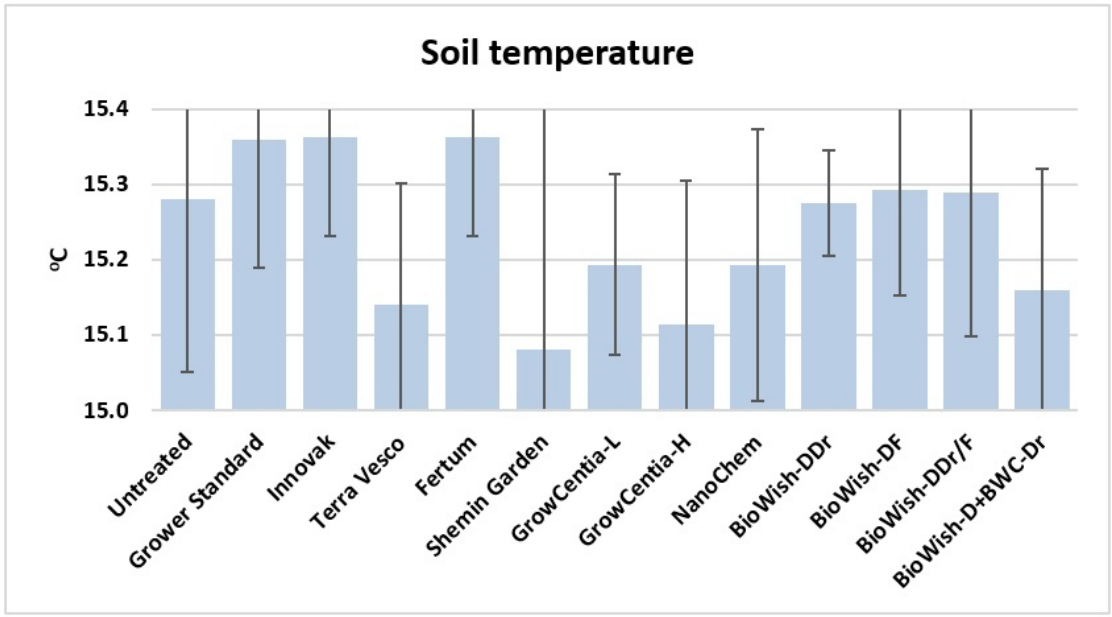
# Bioactives in strawberry-Manzanita




*P* = 0.0261; LSD test

# Bioactives in strawberry-Manzanita



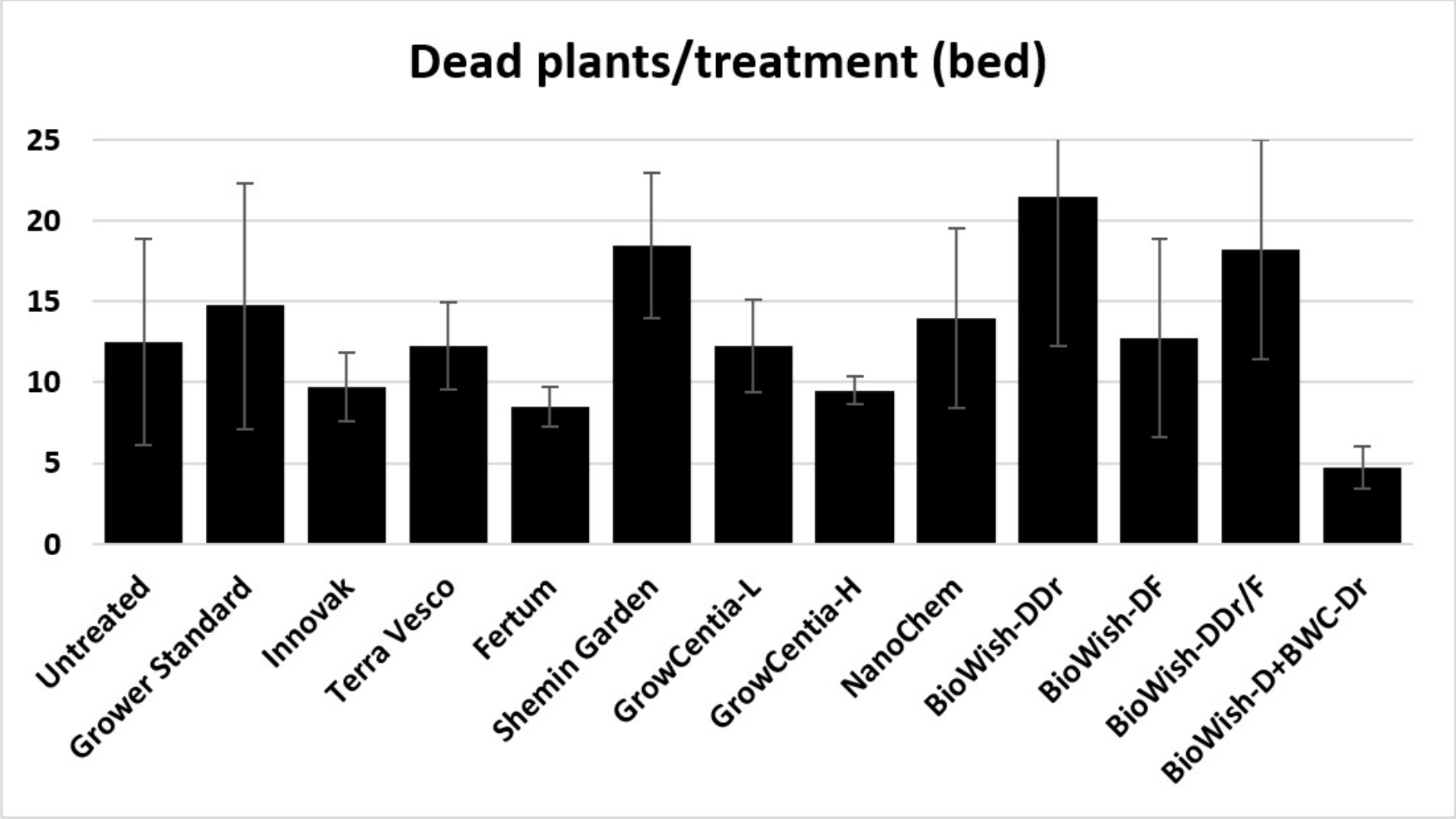




12 and 25 January
7 February
19 March
18 April
29 May, 2018

$P \geq 0.05$

# Bioactives in strawberry-Manzanita

# Bioactives in strawberry-Manzanita

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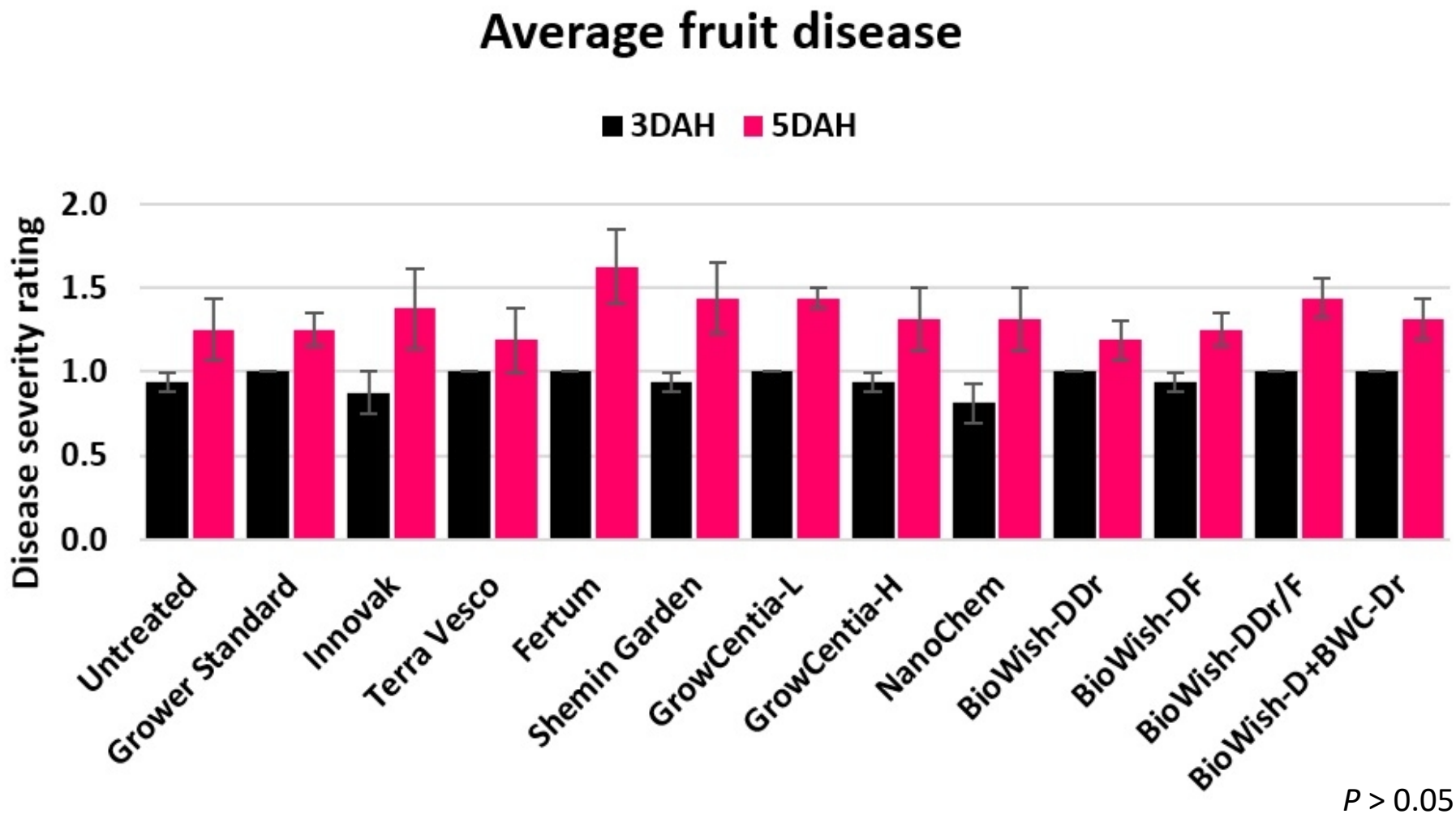
$P \geq 0.05$

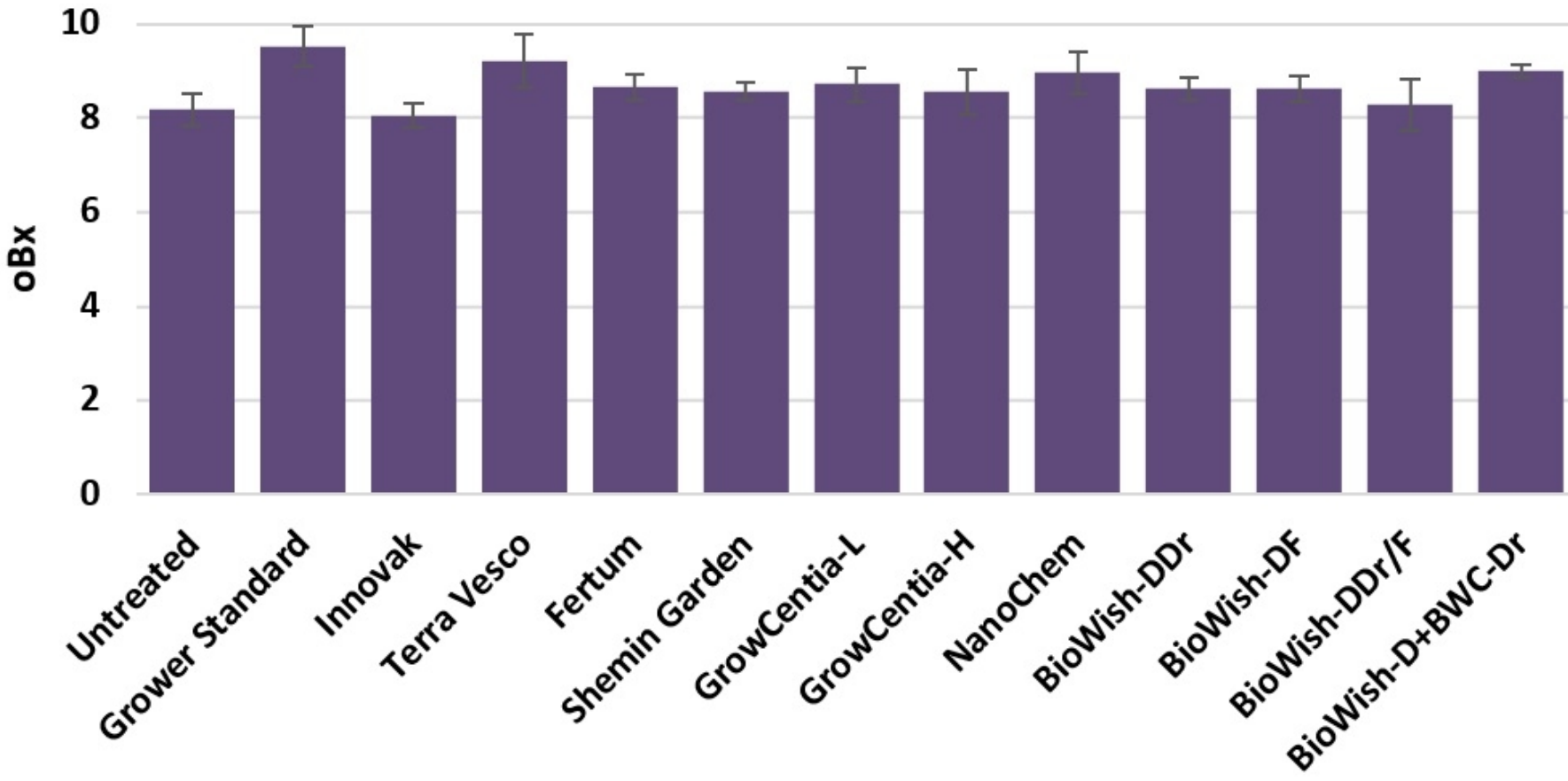
# Bioactives in strawberry-Manzanita




12 March; 3 and 13 April, and 17 May, 2018

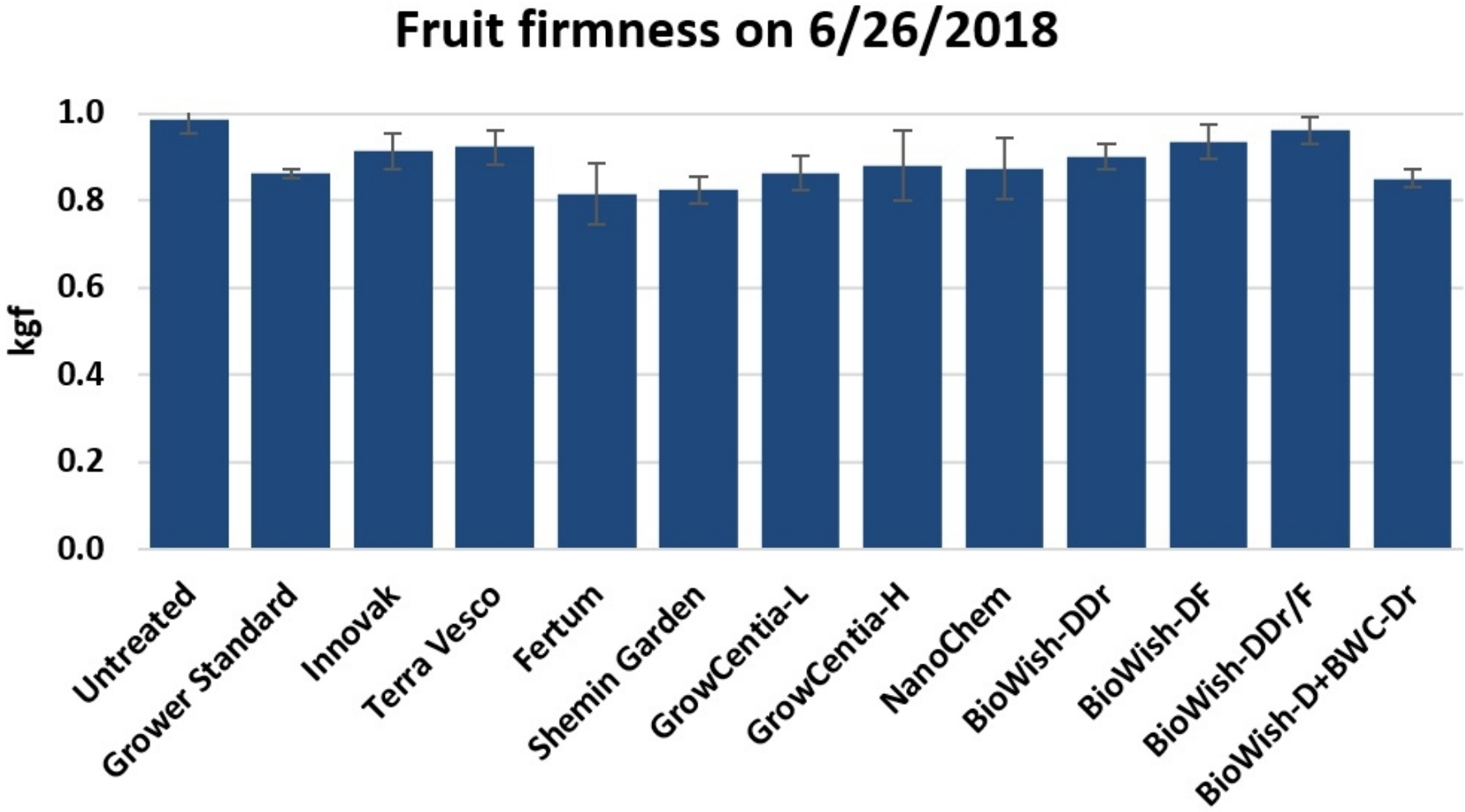
0=no fungal growth, 1=1-25%, 2=26-50%, 3=51-75%, and 4=76-100% fungal growth

# Bioactives in strawberry-Manzanita



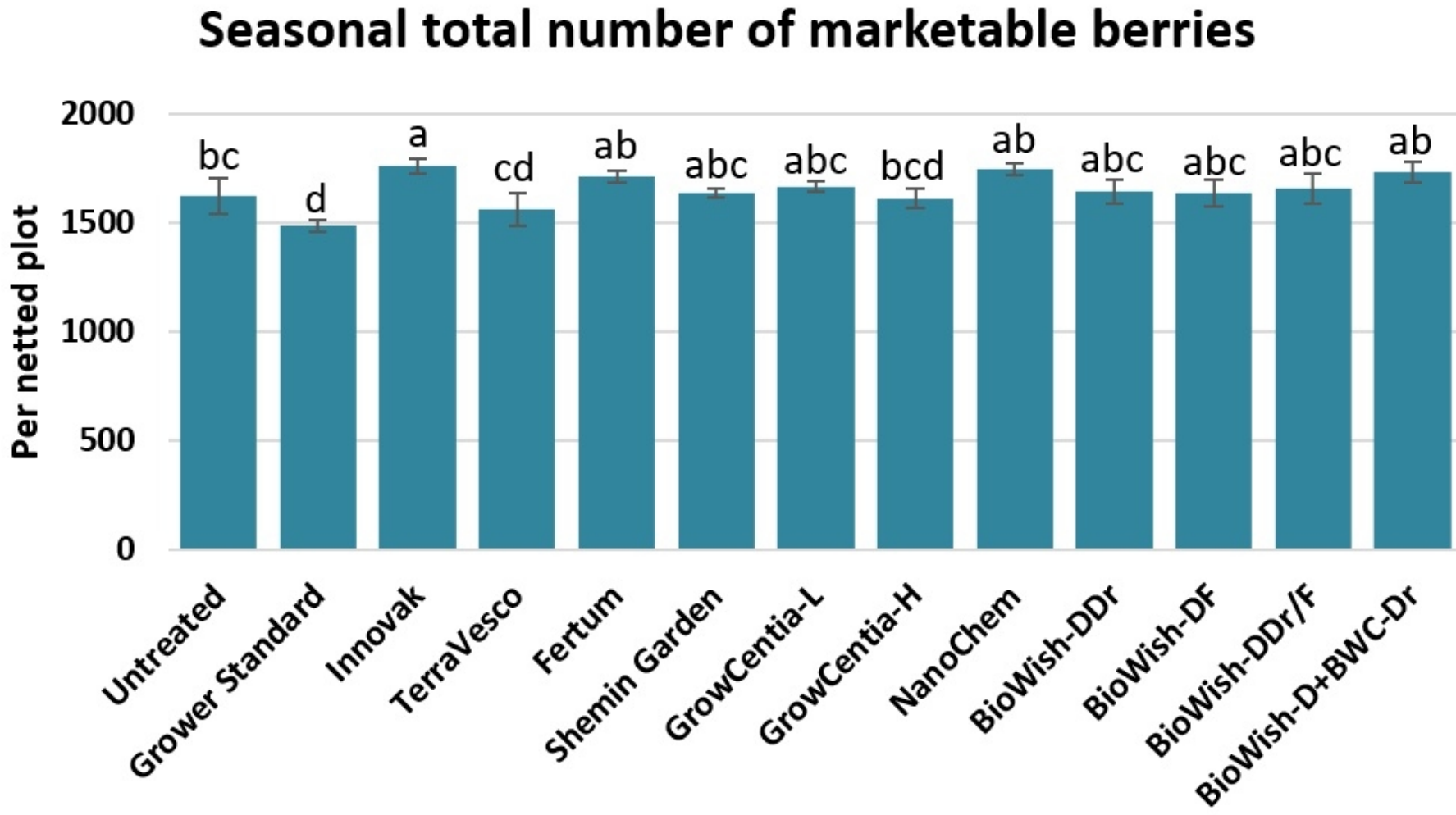

$P \geq 0.05$

# Bioactives in strawberry-Manzanita



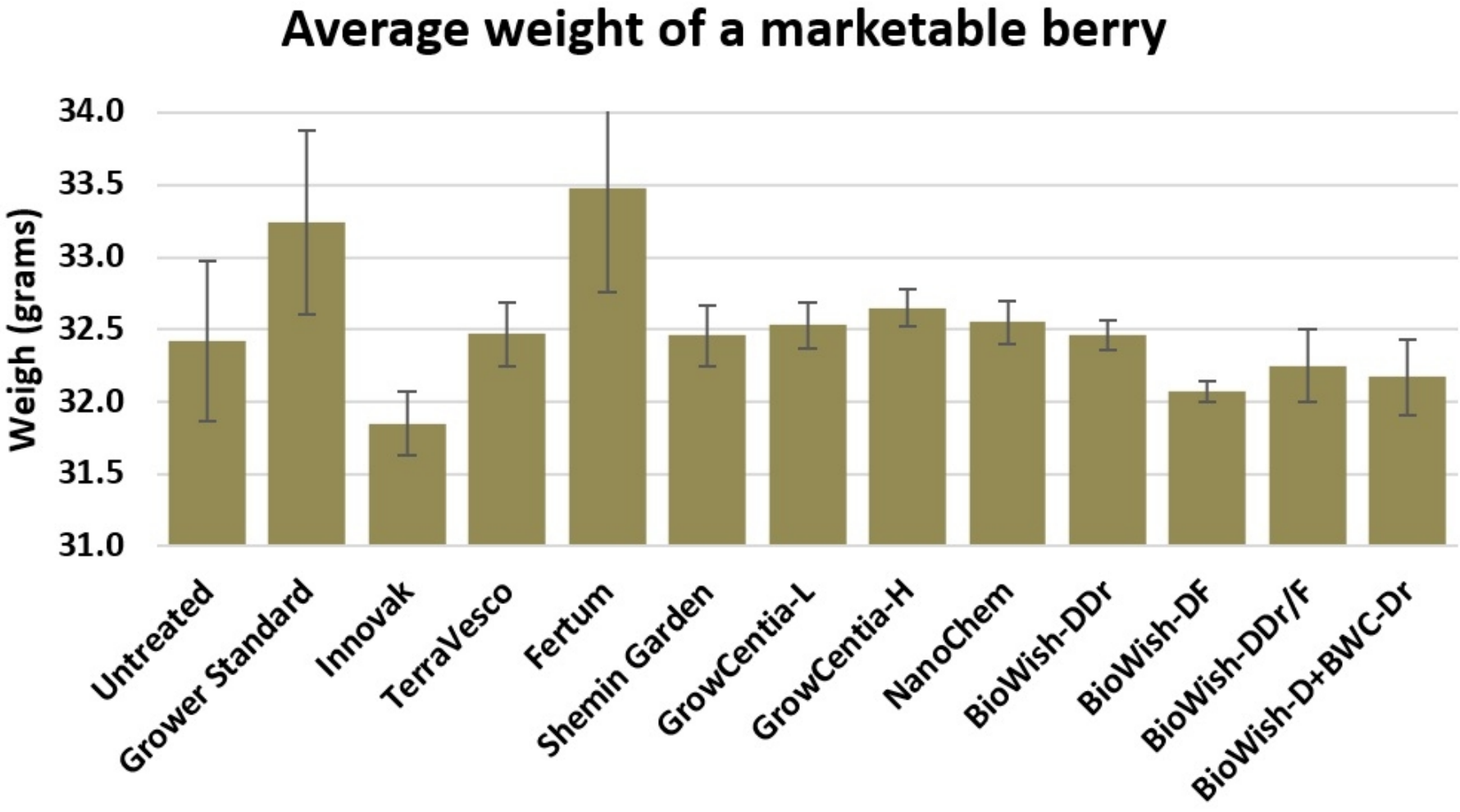

$P \geq 0.05$

# Bioactives in strawberry-Manzanita




*P* = 0.0141; LSD test

# Bioactives in strawberry-Manzanita

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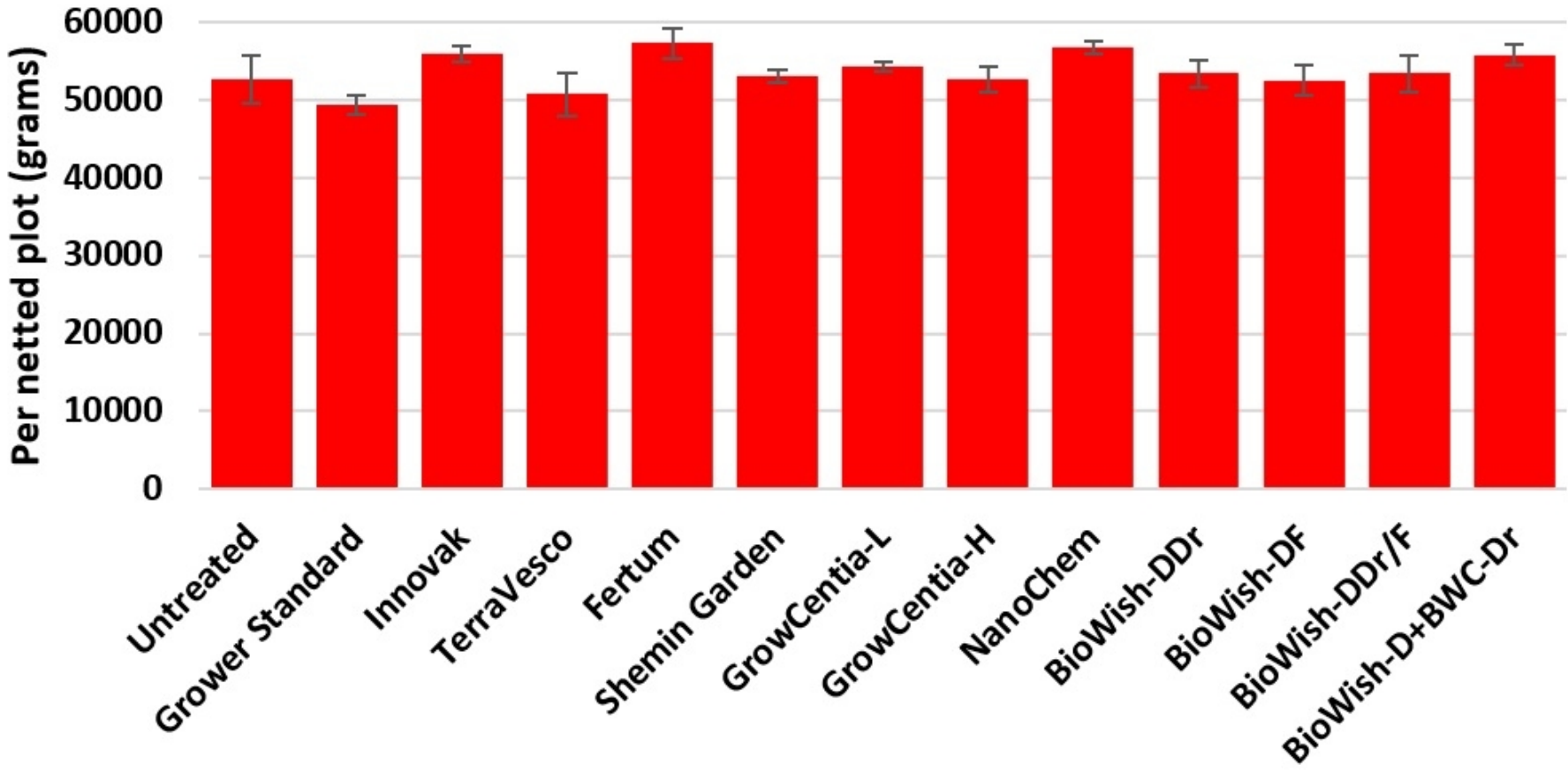
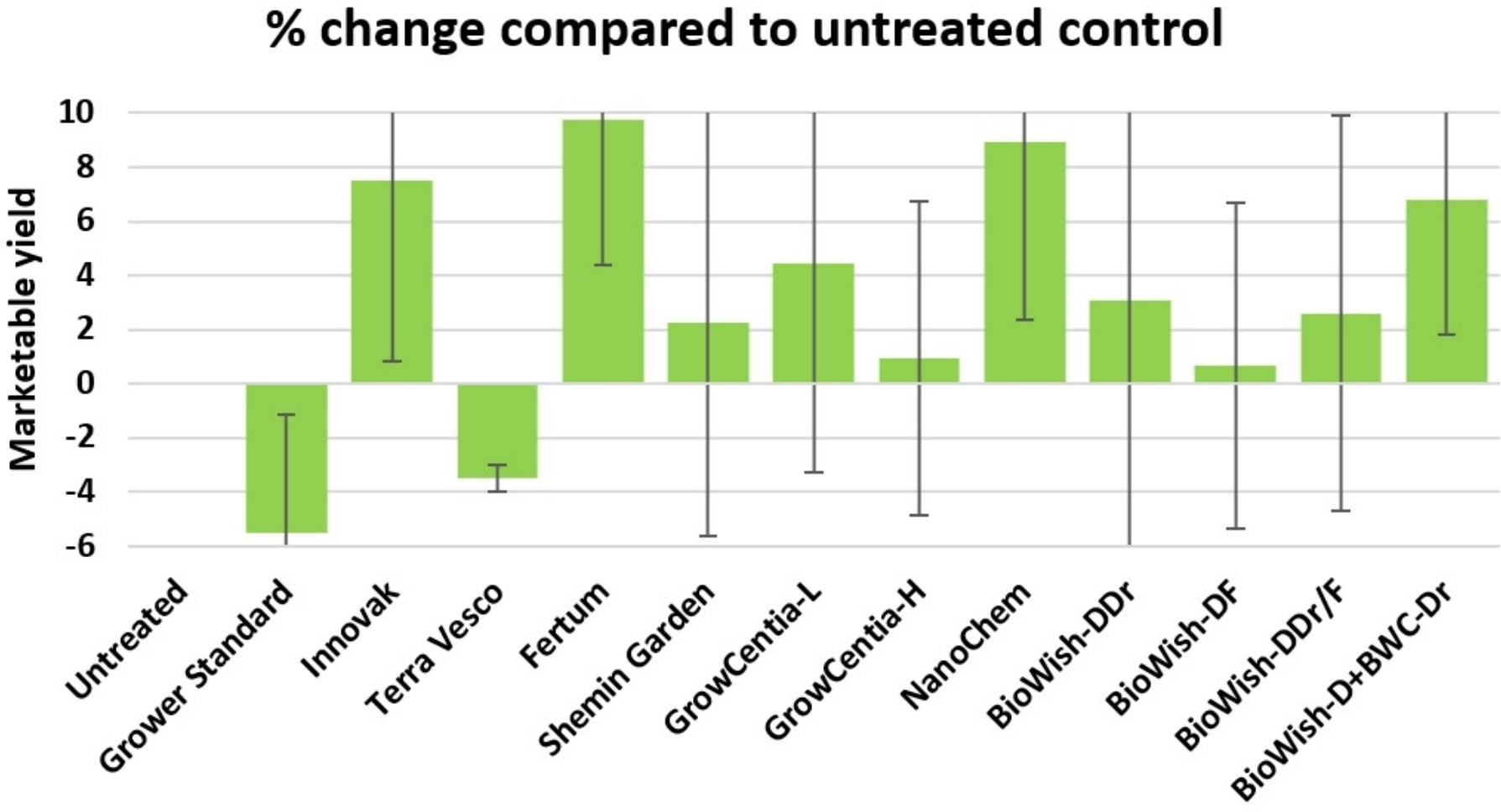
$P \geq 0.05$

# Bioactives in strawberry-Manzanita




$P \geq 0.05$

# Bioactives in strawberry-Manzanita

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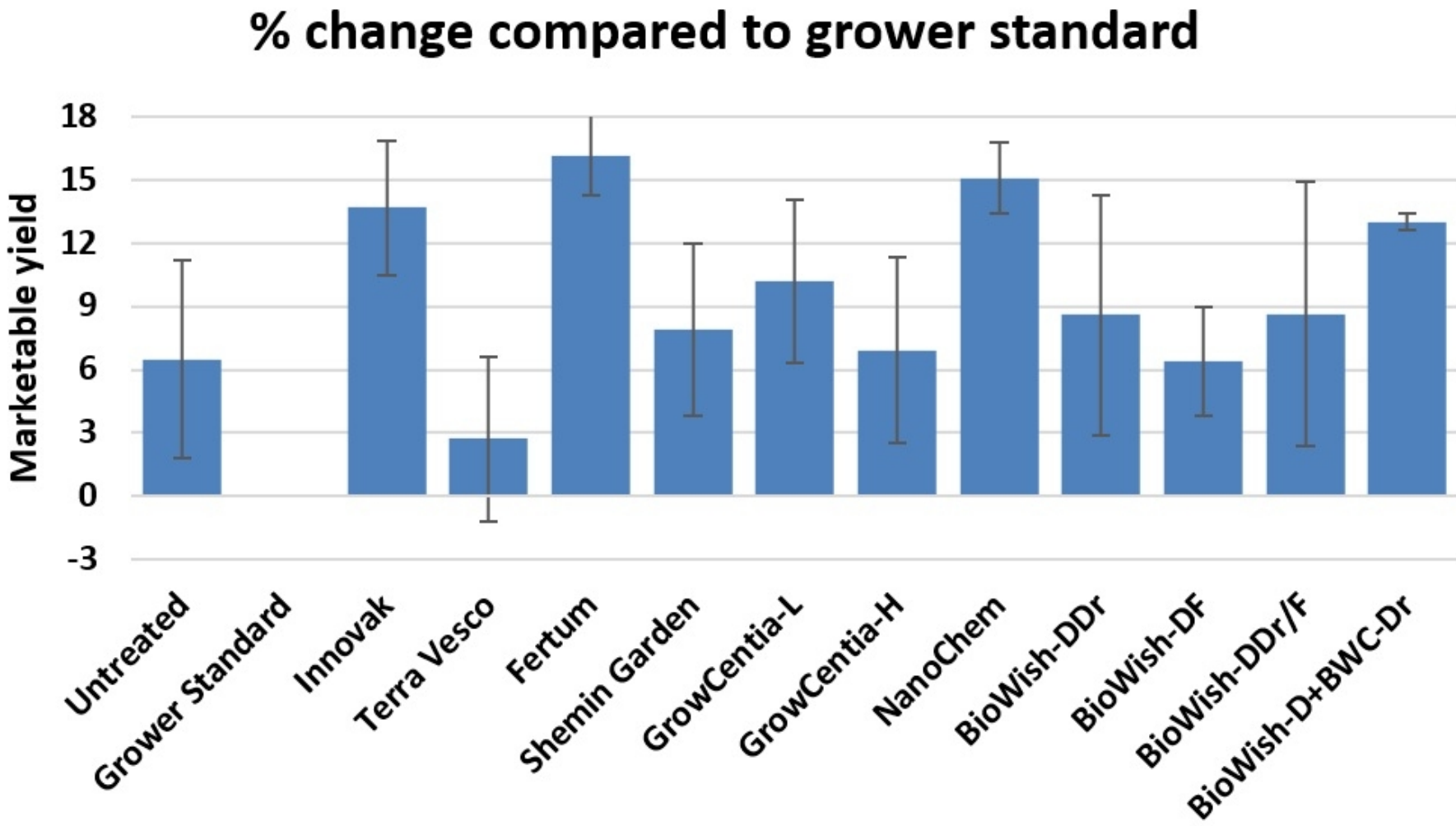
$P \geq 0.05$

# Bioactives in strawberry-Manzanita

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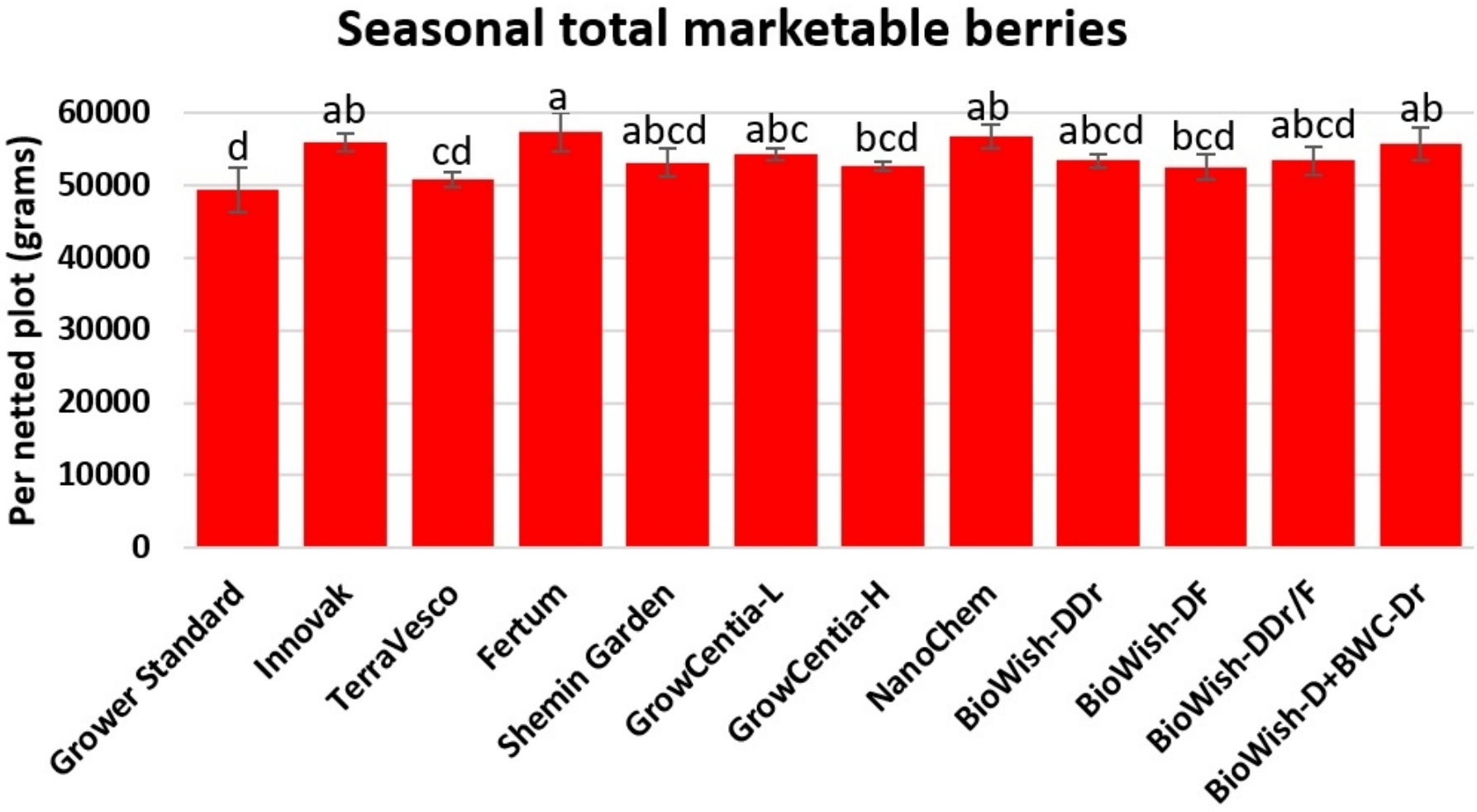
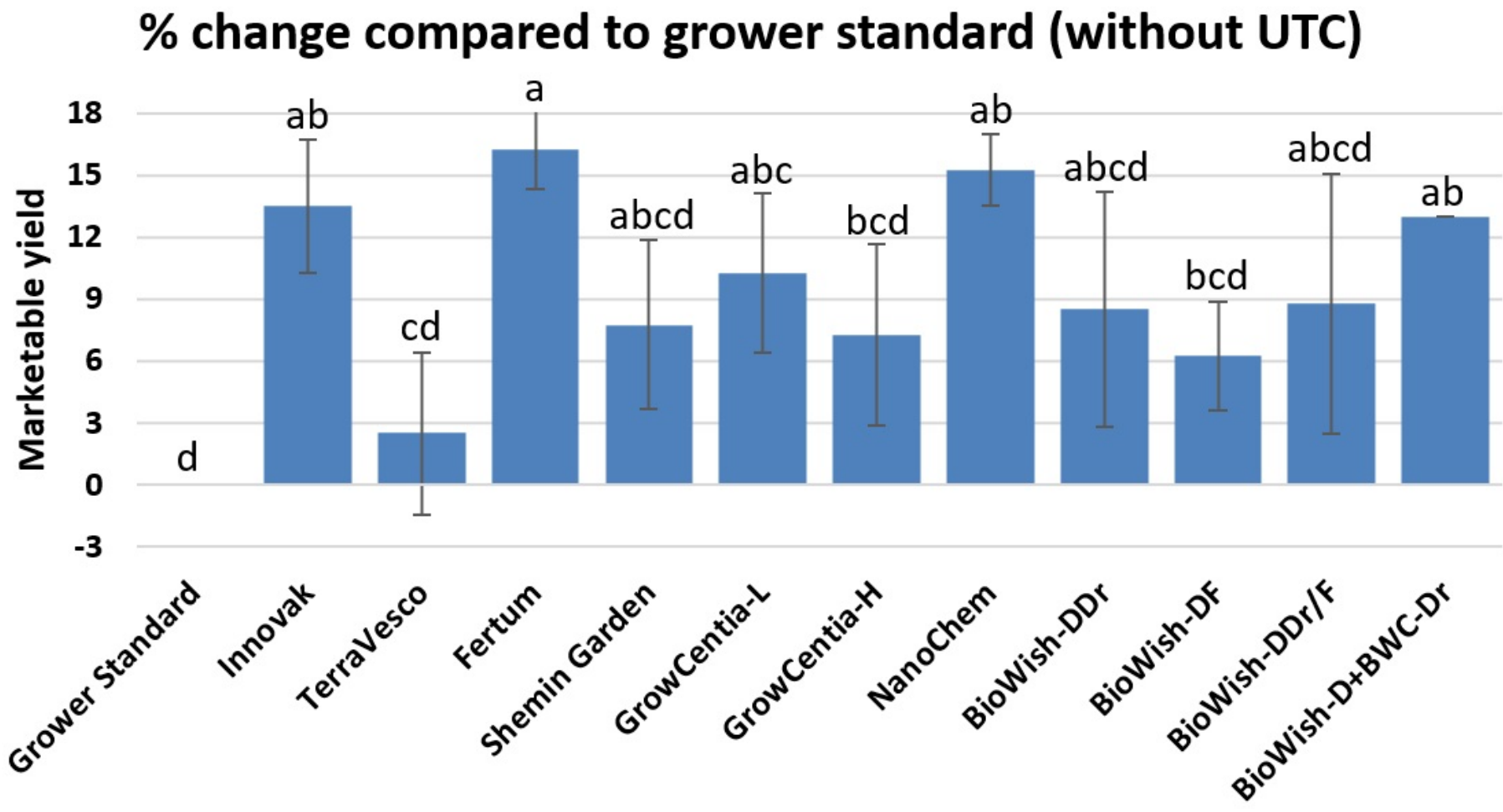
$P \geq 0.05$

# Bioactives in strawberry-Manzanita



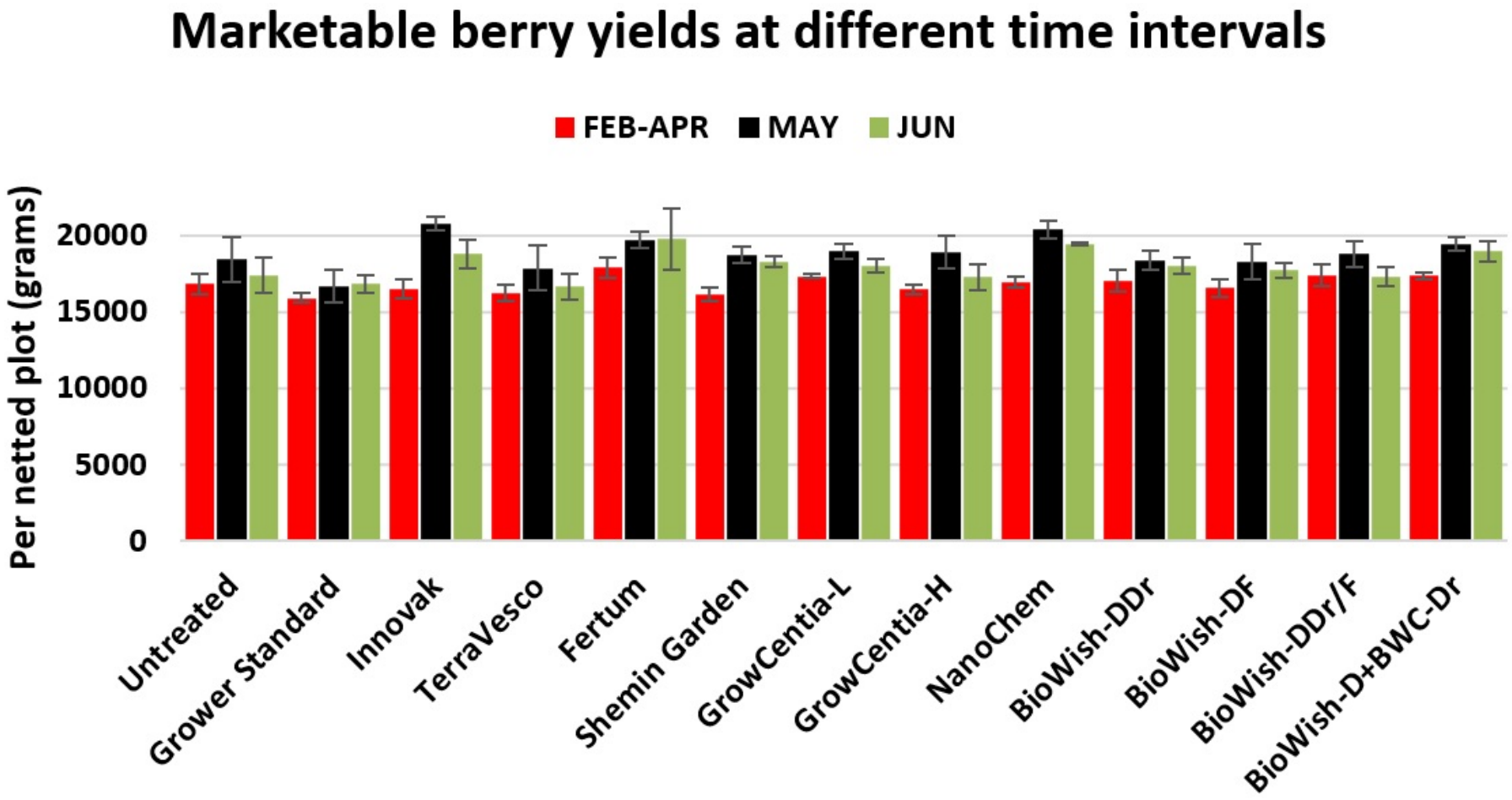

*P* = 0.0279; LSD test

# Bioactives in strawberry-Manzanita




*P* = 0.0301; LSD test

# Bioactives in strawberry- Manzanita




$P \geq 0.05$

# Bioactives in strawberry- Manzanita

**Conclusions**

- Some products improved marketable yield and also appeared to improve crop health or reduce plant mortality
- Should continue research to further explore the potential of biologicals and other materials

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# Western grapeleaf skeletonizer control

*Harrisina metallica* (Lepidoptera: Zygaenidae)

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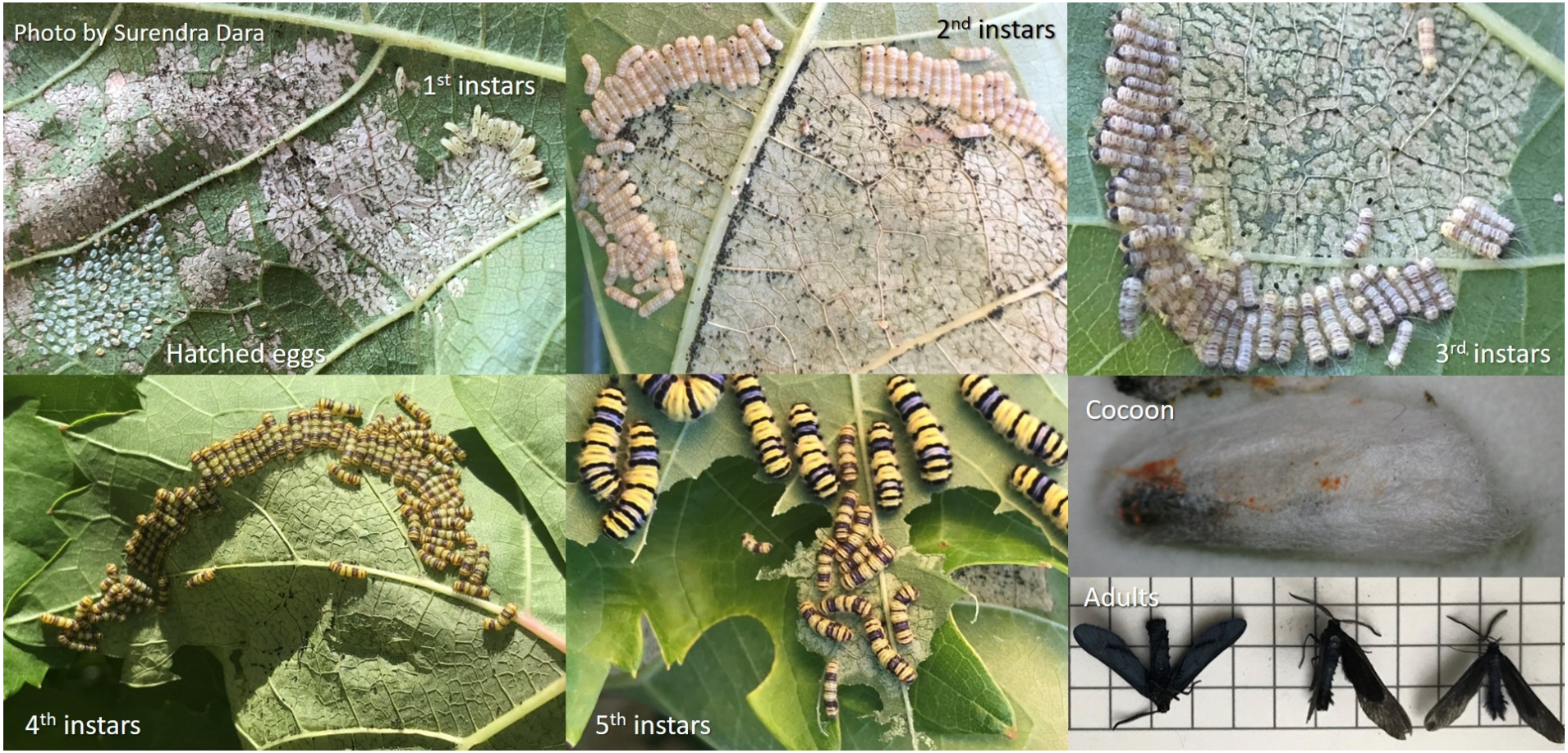
# Western grapeleaf skeletonizer control

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# Western grapeleaf skeletonizer control

# Western grapeleaf skeletonizer control

| Product | Active Ingredient | Rate |
|---|---|---|
| 1. Untreated control | | |
| 2. Entrust | Spinosad | 5 fl oz in 100 gal |
| 3. ARSEF 8318 (California isolate SfBb1) | *Beauveria bassiana* | 1.0E+8 viable conidia/ml |
| 4. ARSEF 8319 (California isolate GmMa1) | *Metarhizium anisopliae* | 1.0E+8 viable conidia/ml |
| 5. Agree WG | *Bacillus thuringiensis* subsp. *aizawai* | 1 lb in 100 gal |
| 6. Deliver | *B. thuringiensis* subsp. *kurstaki* | 1 lb in 100 gal |
| 7. Neemix 4.5 | Azadirachtin | 10 fl oz in 100 gal |

Untreated control | Entrust | *B. bassiana* | *M. anisopliae* | Agree | Neemix

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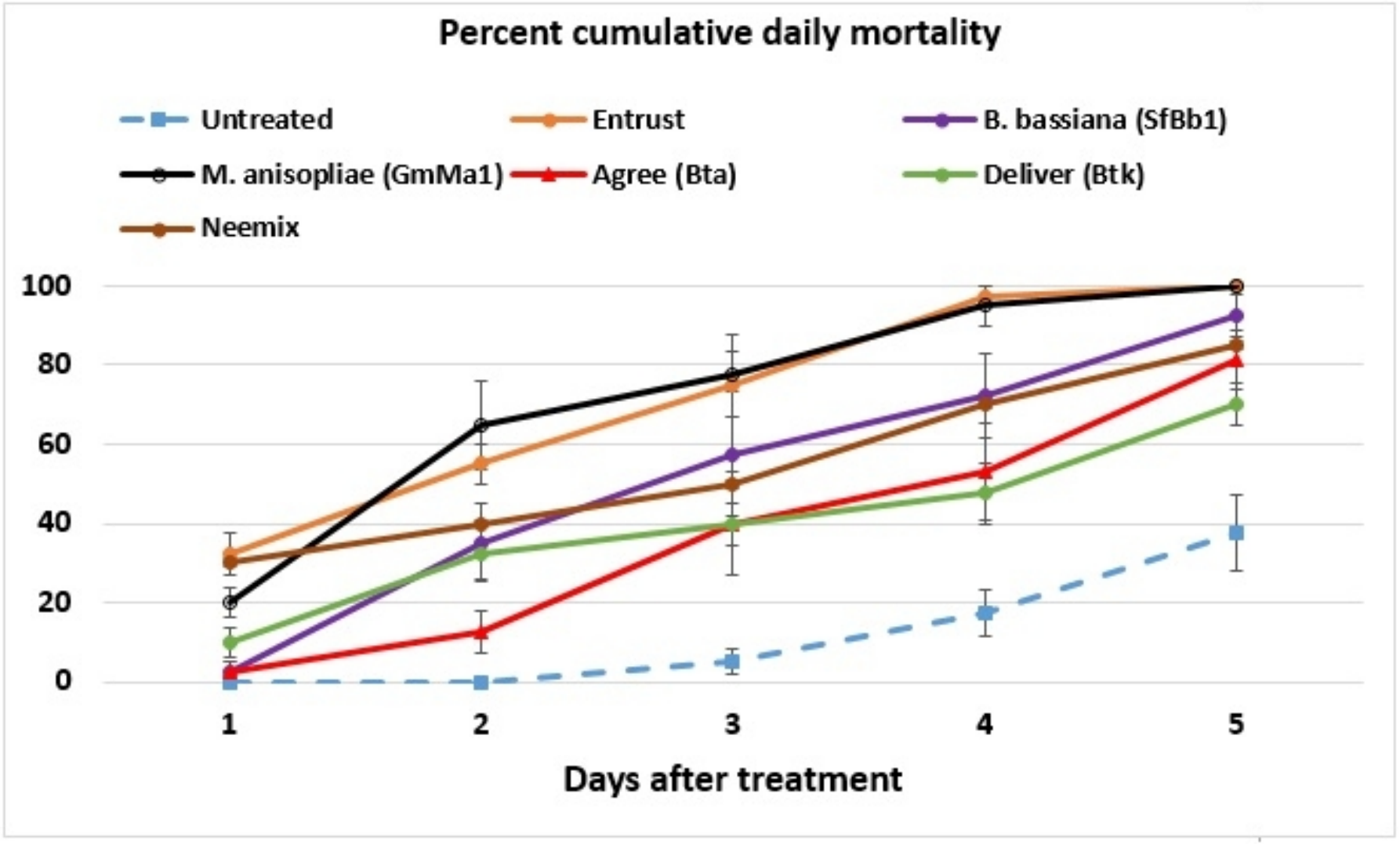
# Western grapeleaf skeletonizer control

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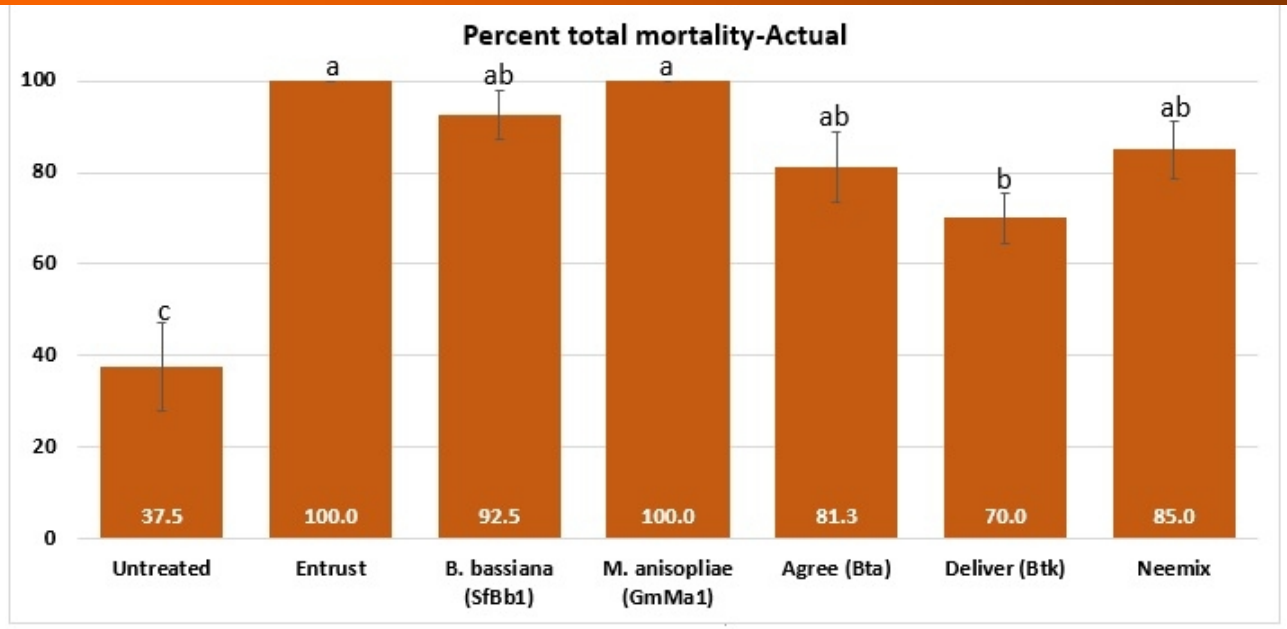
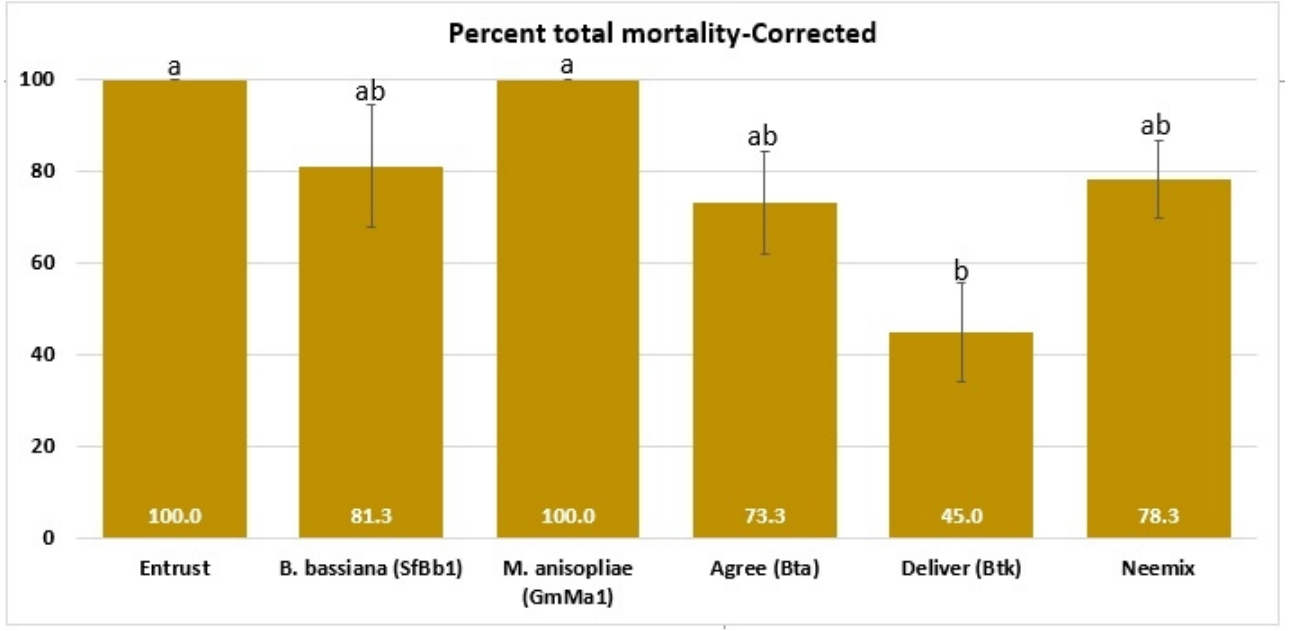
# Western grapeleaf skeletonizer control




Tukey's HSD $P < 0.0001$

# Western grapeleaf skeletonizer control

**Conclusions**

- Entrust and *M. anisopliae* caused the highest total mortality and Deliver had the lowest
- California isolates of entomopathogenic fungi have good biopesticide potential

https://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=29081

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# *Macrophomina phaseolina* vs. EPF

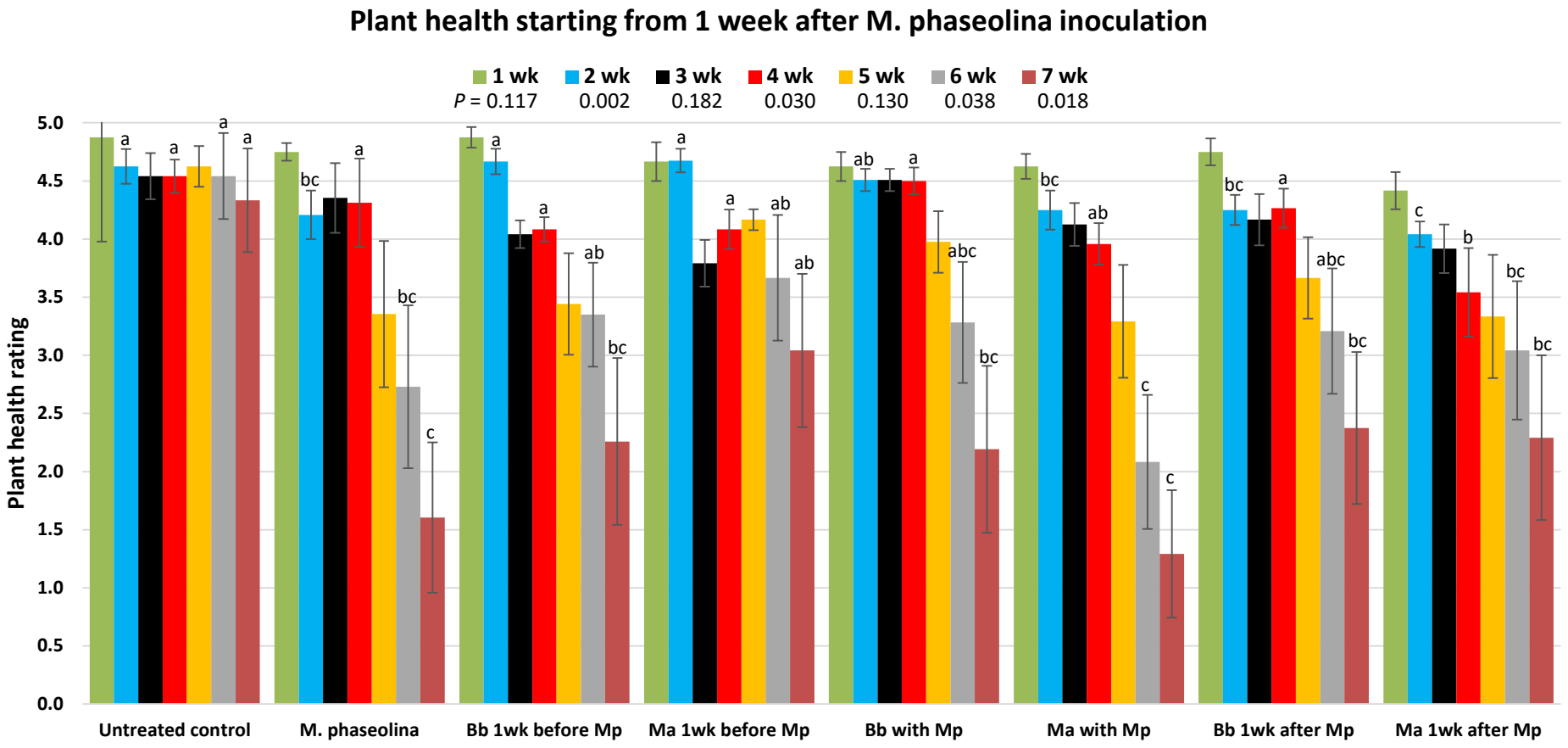
1 Untreated control
2 Soil inoculated with *Macrophomina phaseolina* (5 gr with 2,500 CFU/gr)
3 Soil inoculated with *Beauveria bassiana* 1 week prior to *Macrophomina phaseolina* inoculation
4 Soil inoculated with *Metarhizium anisopliae* s.l. 1 week prior to *Macrophomina phaseolina* inoculation
5 Soil inoculated with *Beauveria bassiana* at the time of *Macrophomina phaseolina* inoculation
6 Soil inoculated with *Metarhizium anisopliae* s.l. at the time of *Macrophomina phaseolina* inoculation
7 Soil inoculated with *Beauveria bassiana* 1 week after *Macrophomina phaseolina* inoculation
8 Soil inoculated with *Metarhizium anisopliae* s.l. 1 week after *Macrophomina phaseolina* inoculation

- Entomopathogenic fungi applied at $1X10^{10}$ viable conidia/pot
- Weekly observations were taken starting from 1 week after the final application
- Plant health was rate on a scale of 0 to 5 where 0=dead, 5=very healthy, and the rest in between.
- Experiment was repeated one more time

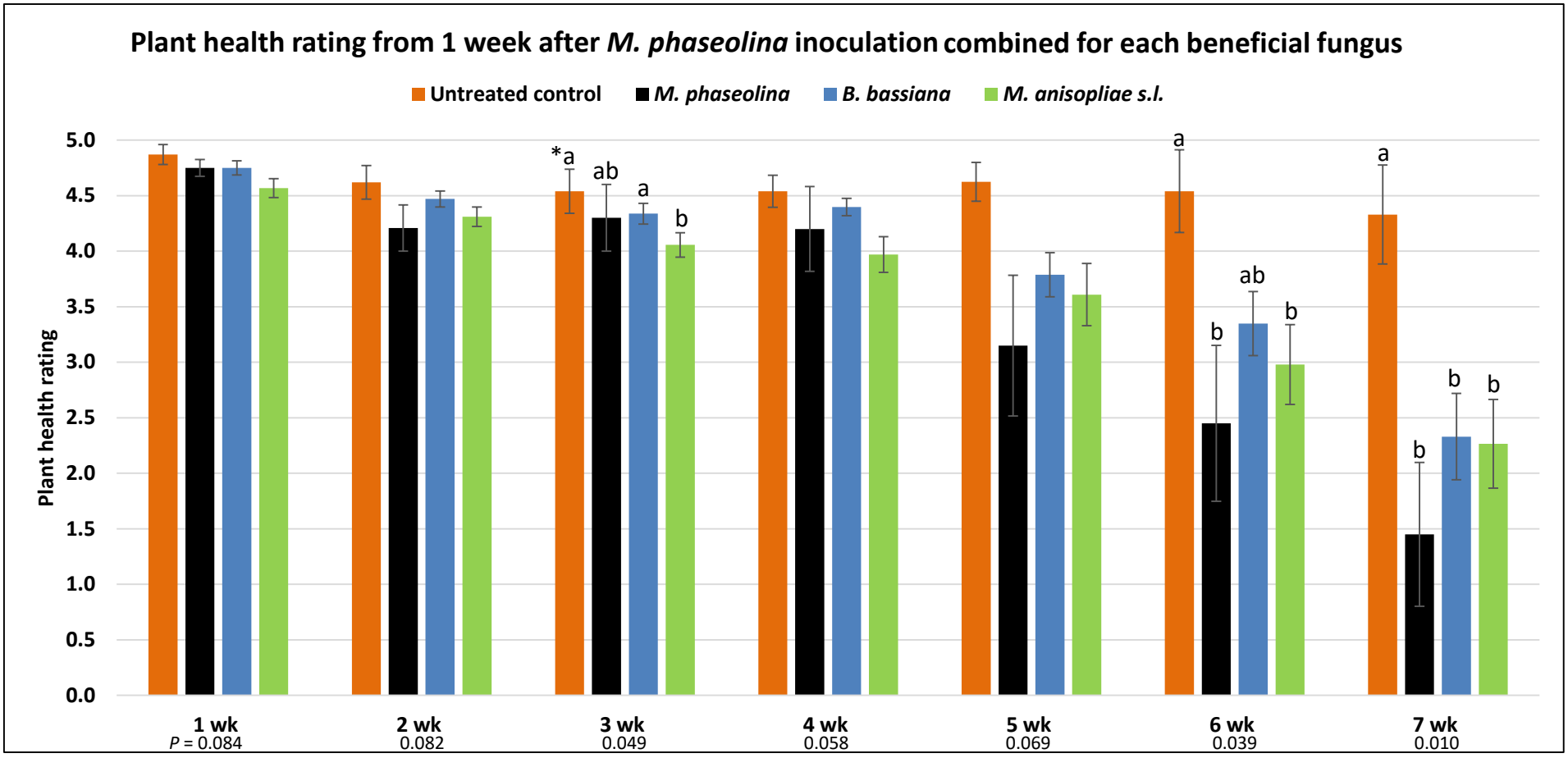
# *Macrophomina phaseolina* vs. EPF

# *Macrophomina phaseolina* vs. EPF

# *Macrophomina phaseolina* vs. EPF



# *Macrophomina phaseolina* vs. EPF




*Bars with no or same letter within each week are not significantly different (LSD test)

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# *Macrophomina phaseolina* vs. EPF

**Conclusions**

- Results are inconclusive, but there appears to be some protection from entomopathogenic fungi against *M. phaseolina* and additional studies are necessary to further validate this effect

https://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=28274

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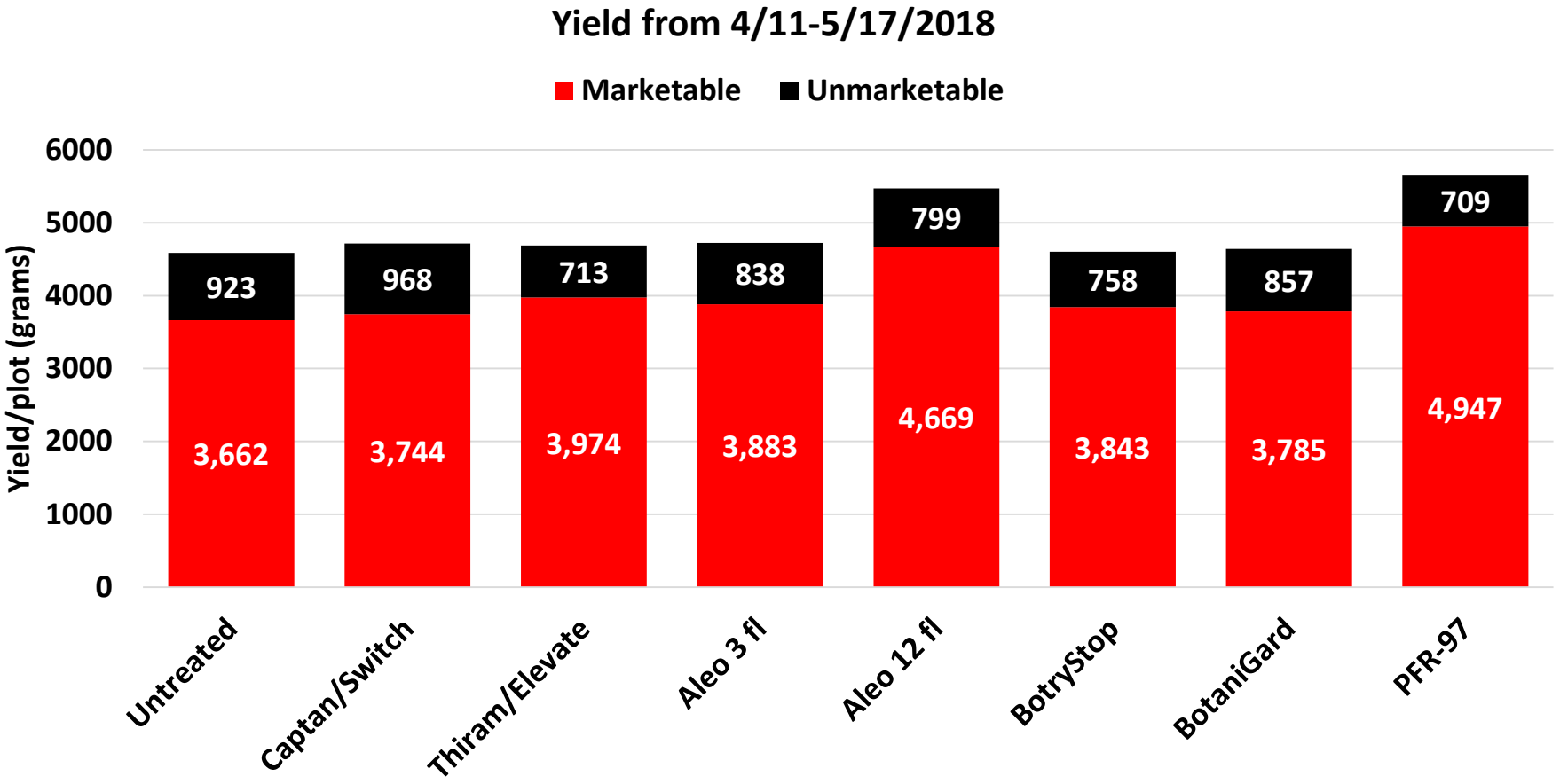
# Biostimulant effect?



# Overall conclusions

- Biologicals work, but we need to understand how they work and know how to use them
- Ensure the continued growth of biologicals with efficacious, high quality products developed with sound research and promoted with solid data

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# Thank you!

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| | |
|---|---|
| eJournals: | http://ucanr.edu/strawberries-vegetables |
| | http://ucanr.edu/pestnews |
| Meeting presentations: | http://ucanr.edu/meetingpresentations |
| Meeting handouts: | http://ucanr.edu/meetinghandouts |
| Strawberry manuals: | http://ucanr.edu/strawberrymanual |
| Spider mite management: | http://ucanr.edu/spidermiteguide |
| Twitter: | @calstrawberries and @calveggies |
| Facebook: | @strawberriesvegetables |
| YouTube | http://ucanr.edu/SDYouTube |

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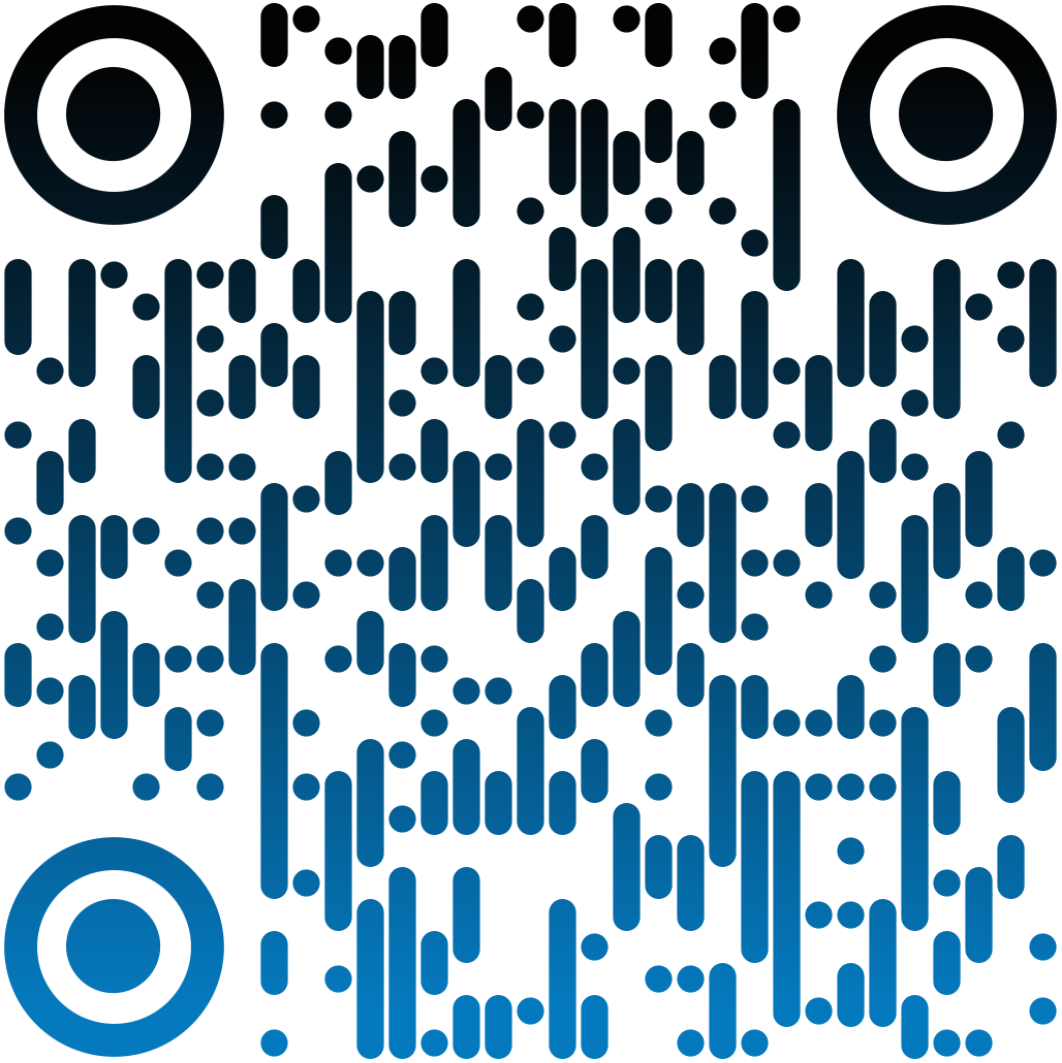
# Feedback survey



https://ucanr.edu/AIC2019survey

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