



Update on breeding and quantitative genetics at USDA

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Breeding progress

Published July 25, 2019

JOURNAL OF PLANT REGISTRATIONS

GERMPLASM

Registration of Oilseed Sunflower Germplasms RHA 485, RHA 486, and HA 487, Selected for Resistance to Phomopsis Stalk Canker and Sclerotinia, in a High-Yielding and High-Oil Background

Kennedy L. Money, Brady D. Koehler, Christopher G. Misar, Michael Grove, William Underwood, and Brent S. Hulke*

Published September 19, 2019

JOURNAL OF PLANT REGISTRATIONS

GERMPLASM

Registration of Oilseed Sunflower Germplasms RHA 478, RHA 479, RHA 480, and HA 481 Providing Diversity in Resistance to Necrotrophic Pathogens of Sunflower

Brady D. Koehler, Thomas J. Gulya, and Brent S. Hulke*

Published September 26, 2019

JOURNAL OF PLANT REGISTRATIONS

GERMPLASM

Registration of Oilseed Sunflower Germplasms HA 482, RHA 483, and RHA 484 Selected for Resistance to Sclerotinia and Phomopsis Diseases

Brian C. Smart, Brady D. Koehler, Christopher G. Misar, Thomas J. Gulya, and Brent S. Hulke*

| Hybrid | Yield (kg ha ⁻¹) | Oil (g kg ⁻¹) | Lodging (score) ^a | Phomopsis (%) ^b |
|----------------------------------|------------------------------|---------------------------|------------------------------|----------------------------|
| New USDA testcrosses | | | | |
| CMS HA 412HO/RHA 485 | 2629 ab ^c | 449 a | 2.6 a | 9.9 ab |
| CMS HA 467/RHA 485 | 2339 ab | 422 ab | 2.6 a | 8.5 ab |
| CMS HA 412HO/RHA 486 | 2614 ab | 418 b | 2.8 a | 0.0 a |
| CMS HA 467/RHA 486 | 2898 ab | 374 d | 2.5 a | 0.0 ab |
| CMS HA 487/RHA 464 | 2532 ab | 402 bc | 1.1 a | 24.8 b |
| CMS HA 487/RHA 468 | 2565 ab | 395 c | 2.5 a | 39.2 b |
| Previous USDA testcrosses | | | | |
| CMS HA 412HO/RHA 373 | 2345 b | 408 bc | 2.8 a | 54.9 bc |
| CMS HA 412HO/RHA 377 | 2094 b | 418 b | 3.0 a | 70.7 c |
| CMS HA 412HO/RHA 464 | 2235 b | 423 b | 1.8 a | 13.4 ab |
| CMS HA 412HO/RHA 468 | 2493 ab | 429 ab | 2.8 a | 12.1 ab |
| CMS HA 467/RHA 464 | 2008 b | 369 d | 2.3 a | 44.7 b |
| CMS HA 467/RHA 468 | 2363 b | 388 ed | 2.5 a | 36.0 b |
| Commercial hybrids | | | | |
| Croplan 3080 | 2582 ab | 422 b | 2.7 a | 50.5 b |
| Croplan 7717 HO/CL/DM | 2872 ab | 407 bc | 2.0 a | 26.2 b |
| Mycogen 8H449CLDM | 2991 a | 439 ab | 2.8 a | 38.0 b |
| Nuseed Camaro II | 2884 ab | 410 bc | 2.3 a | 23.1 b |
| Pannar 7813NS | 2784 ab | 395 c | 2.6 a | 47.6 b |

Phomopsis harms yield and oil content

| | Oil % | Lodging | Phomopsis |
|---------|--------------|----------------|------------------|
| Yield | 0.37 | -0.41 | -0.39 |
| Oil | | 0.05 | -0.29 |
| Lodging | | | 0.17 |

Lodging and pre-mature ripening damage depend on severity of disease and earliness of onset

New Releases – insect resistant germplasm

- HA 488 – Red Sunflower Seed Weevil resistant maintainer
- HA 489 – Banded Sunflower Moth resistant maintainer, IMI, HO

Pending New Releases – DM resistance

- HA 490 – New PI17 female with IMI, HO
- RHA 491/RHA 492 – New PI15 sources with IMI, HO

Early maturing sunflowers

- With short stature
 - Optimum seeding density 25,000 in Fargo – same as standard hybrids
 - Seeded in mid-June: 1642 lbs/A yield
 - Seeded early July: 1451 lbs/A yield
 - New hybrids yielded as 1866 lbs/A mid-June seeding
 - Planned release of these parent lines soon!
- Normal stature
 - Seeded after double crop in Kansas – brutal seedling conditions!
 - Had plots that germinated well and achieved 1654 lbs in double crop
 - Planned release of these are also coming soon!

THE HULKE LAB

Fargo, ND

RELEASED INBRED LINES

Please use the order form to request germplasm.

USDA Released Inbred Lines

| Line Designation | Pedigree | Release Year | Market Type | S-line, R-line | Downy_Mildew | Rust | Branching | Oil | Herbicide | Other_Comments |
|------------------|--|--------------|-------------|----------------|--------------|------|-----------|---------|-----------|----------------|
| HA 407 | HA 405F ranch B-Line bulk | 2017 | Obseed | S-line | | | NA | HO | IMI | |
| HA 402 | HA 400F R | 2017 | Obseed | S-line | | | NA | HO | | |
| RHA 486 | RHA 425RHA 425VCAR 125AS 4375ZF ranch R-Line bulk | 2017 | Obseed | S-line | FL7 | | Branching | | IMI | |
| RHA 485 | RHA 463R ranchor | 2017 | Obseed | R-line | | | Branching | | | |
| RHA 484 | RHA 442RHA 377RHA 34823M34F ranch R-Line bulk | 2017 | Obseed | R-line | | | Branching | HO | IMI | |
| RHA 483 | RHA 442RHA 377RHA 34823M34F ranch R-Line bulk | 2017 | Obseed | R-line | | | Branching | HO | IMI | |
| HA 481 | HA 411RHA 444RHA 411R0M P192M887 CAEBRHA 434HA 412 | 2016 | Obseed | S-line | | | NA | HO | | |
| RHA 480 | RHA 443CLVND | 2016 | Obseed | R-line | | | Branching | | IMI | |
| RHA 479 | RO 12-13RHA 274200B0P6CSARHA 418RHA 4193R012-13RHA 274P105 | 2016 | Obseed | R-line | | | Branching | | | |
| RHA 478 | RHA 443RHA 458 | 2016 | Obseed | R-line | | | Branching | HO | IMI | |
| RHA 477 | RHA 465R-7000 | 2016 | Obseed | R-line | PLARG | | Branching | | IMI | |
| RHA 476 | RHA 344RND 101RNSH10244RHA 418RHA 4193R012-13RHA 274P105B6R-7000 | 2016 | Obseed | R-line | | | Branching | HO | | |
| HOLS 4 | HA 485R 175R4 + 197225R bulk | 2015 | Obseed | S-line | | | NA | HOL/PLS | IMI | |
| HOLS 3 | HA 485RHA 485R3R2RHA 485RHA 485 | 2015 | Obseed | S-line | | | NA | HOL/PLS | IMI | |
| HOLS 2 | HA 485RHA 485R3R2RHA 485RHA 485 | 2015 | Obseed | S-line | | | NA | HOL/PLS | IMI | |
| HOLS 1 | HA 485RHA 485R3R2RHA 485RHA 485 | 2015 | Obseed | S-line | | | NA | HOL/PLS | IMI | |
| RHA 475 | CAR 125R6 4375R0RHA 442RHA 418RHA 425FYUGO R POP | 2011 | Obseed | R-line | | | Branching | | IMI | |
| RHA 474 | RHA 801R6 4375R0RHA 425 | 2011 | Obseed | R-line | | | Branching | | IMI | |
| RHA 473 | RHA 442RHA 801R6 4375 | 2011 | Obseed | R-line | | | Branching | HO | | |
| RHA 472 | RHA 801R6 4375R0RHA 438 | 2011 | Obseed | R-line | | | Branching | | | |
| TOCO B1 | HA 341RHA 821R ranchor 9173ALD-24 | 2008 | Obseed | S-line | | | NA | HO | | Run HPLC |
| TOCO R2 | RHA 3442556-1Y ranchor 9173ALD-24 | 2008 | Obseed | R-line | | | Branching | | | Run HPLC |
| TOCO R1 | RHA 3442556-1Y ranchor 9173ALD-24 | 2008 | Obseed | R-line | | | Branching | | | Run HPLC |
| HA 468 | HA 88NVRHA 434RHA 4123RHA 434SU | 2007 | Obseed | S-line | | | NA | HO | SU | |
| CONFISCL R2 | HA 441CONFISCONF | 2007 | Conflection | S-line | | | NA | | | |
| CONFISCL B1 | HA 411R0M 1R1RHA 4423RHA 441CONFISCONF | 2007 | Conflection | S-line | | | NA | | IMI | |
| RHA 471 | RHA 801R6 4375R0RHA 3773RHA 392RHA 375RUR | 2007 | Obseed | R-line | | | Branching | | SU | |
| RHA 470 | RHA 801R6 4375R0RHA 3773RHA 392RHA 375RUR | 2007 | Obseed | R-line | | | Branching | | SU | |
| CONFISCL R5 | RO12-13RHA 274IdentR5P5CSBACONF R5CONF | 2007 | Conflection | R-line | | | Branching | | | |
| CONFISCL R4 | RO12-13RHA 274IdentR5P5CSBACONF R5CONF | 2007 | Conflection | R-line | | | Branching | | | |
| CONFISCL R3 | RO12-13RHA 274IdentR5P5CSBACONF R5CONF | 2007 | Conflection | R-line | | | Branching | | | |
| CONFISCL R2 | RO12-13RHA 274IdentR5P5CSBACONF R5CONF | 2007 | Conflection | R-line | | | Branching | | | |
| CONFISCL R1 | RHA 442P5CSBACONF R5CONF | 2007 | Conflection | R-line | | | Branching | | | |
| HA 467 | HA 411R0M 1R1RHA 42587CAEBRHA 88NVRHA 434RHA 412 | 2006 | Obseed | S-line | | | NA | HO | IMI | |
| HA 466 | HA 411R0M 1R1RHA 42587CAEBRHA 88NVRHA 434RHA 412 | 2006 | Obseed | S-line | | | NA | HO | IMI | |
| HA 465 | HA 88NVRHA 434RHA 4123RHA 434HA 425 (M) R. SU | 2006 | Obseed | S-line | | | NA | HO | IMI | |
| HA 460 | HA 43479 RHA 340 | 2006 | Obseed | S-line | PL4 | | NA | HO | | |

RECENT POSTS

Internship Projects:
Summer 2017

RHA 485, RHA 486, HA
487 Release

HA 482, RHA 483, and
RHA 484 Release

Lab Picnic!

Intern Highlight: Jonathan
Tetlie

Search ...

SPECIES WE WORK
WITH



Genetics progress



Seed and floret size parameters of sunflower are determined by partially overlapping sets of quantitative trait loci with epistatic interactions

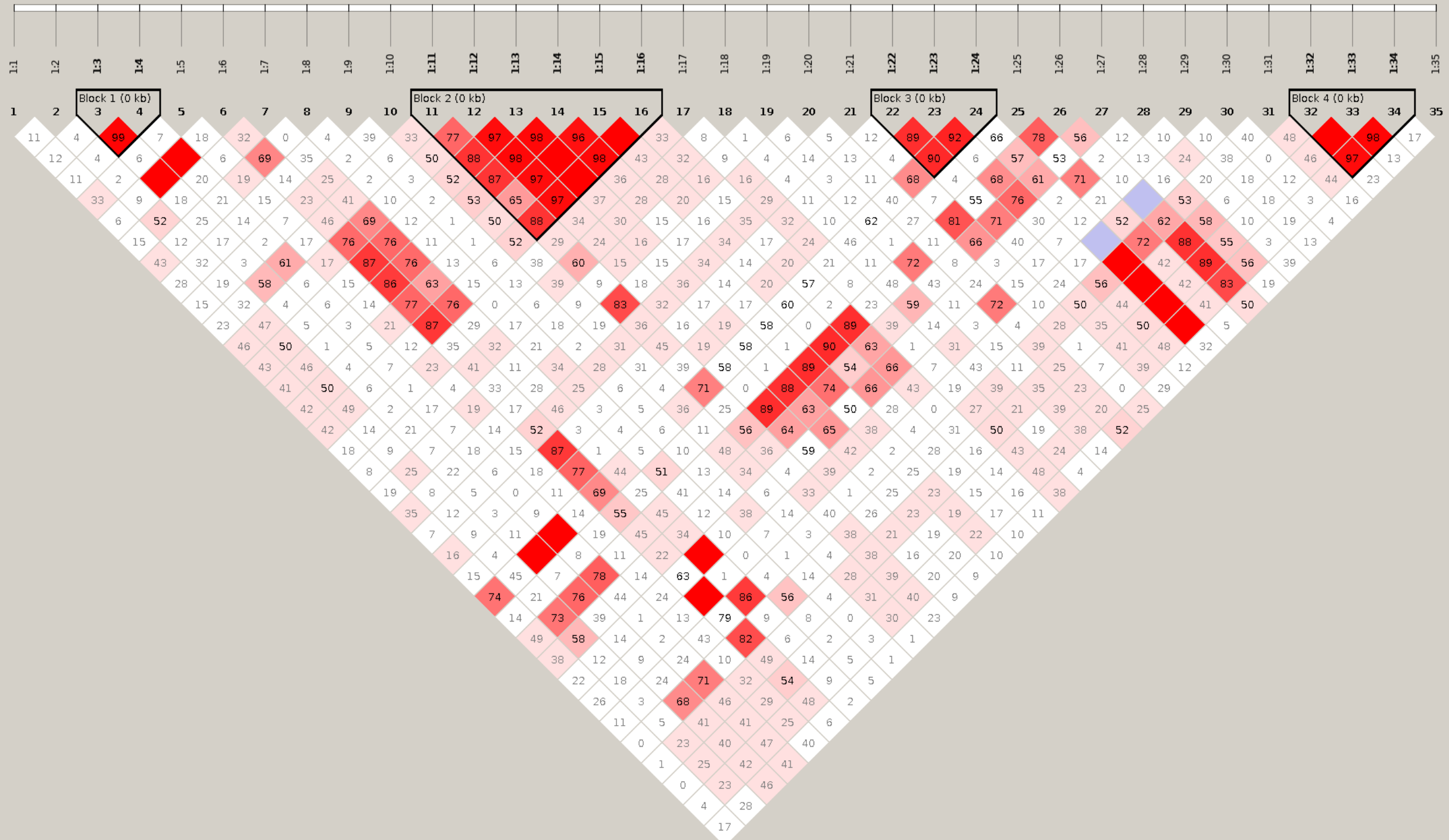
Stephan Reinert¹ · Qingming Gao^{2,3} · Beth Ferguson² · Zoe M. Portlas^{2,4} · Jarrad. R. Prasifka² · Brent S. Hulke² 

Received: 7 March 2019 / Accepted: 10 September 2019

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Table 2. R² values for quantitative trait models incorporating epistasis.

| Model | R ² | | |
|---------------|-----------------|---------------------|-----------------------------|
| | Significant QTL | plus additional QTL | plus epistatic interactions |
| Floret length | 0.3121 | 0.3452 | 0.3902 |
| Seed length | 0.1599 | 0.2130 | 0.4727 |
| Seed area | 0.4720 | 0.7918 | 0.8827 |
| Seed width | 0.8507 | 0.8545 | 0.8818 |



Sclerotinia and Phomopsis disease resistance

Phenotypic correlations

| | HR | PSC |
|----|--------|---------|
| SR | -0.16* | NS |
| HR | | 0.52*** |

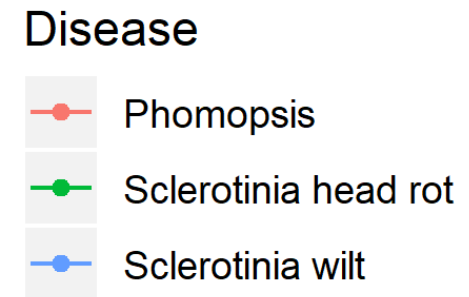
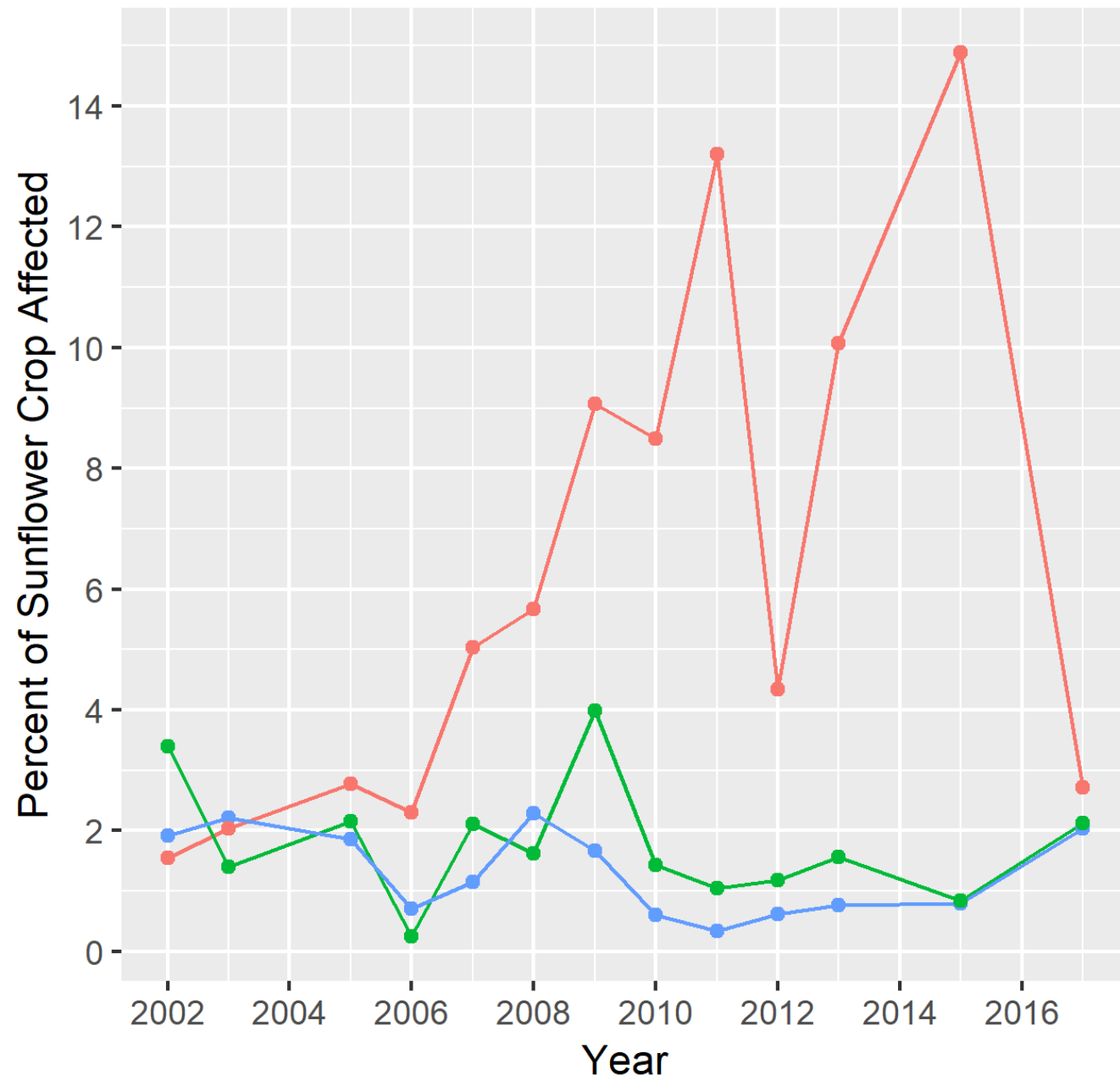
Genetic correlations (Broad Sense)

| | HR | PSC |
|----|--------|---------|
| SR | -0.16* | NS |
| HR | | 0.45*** |

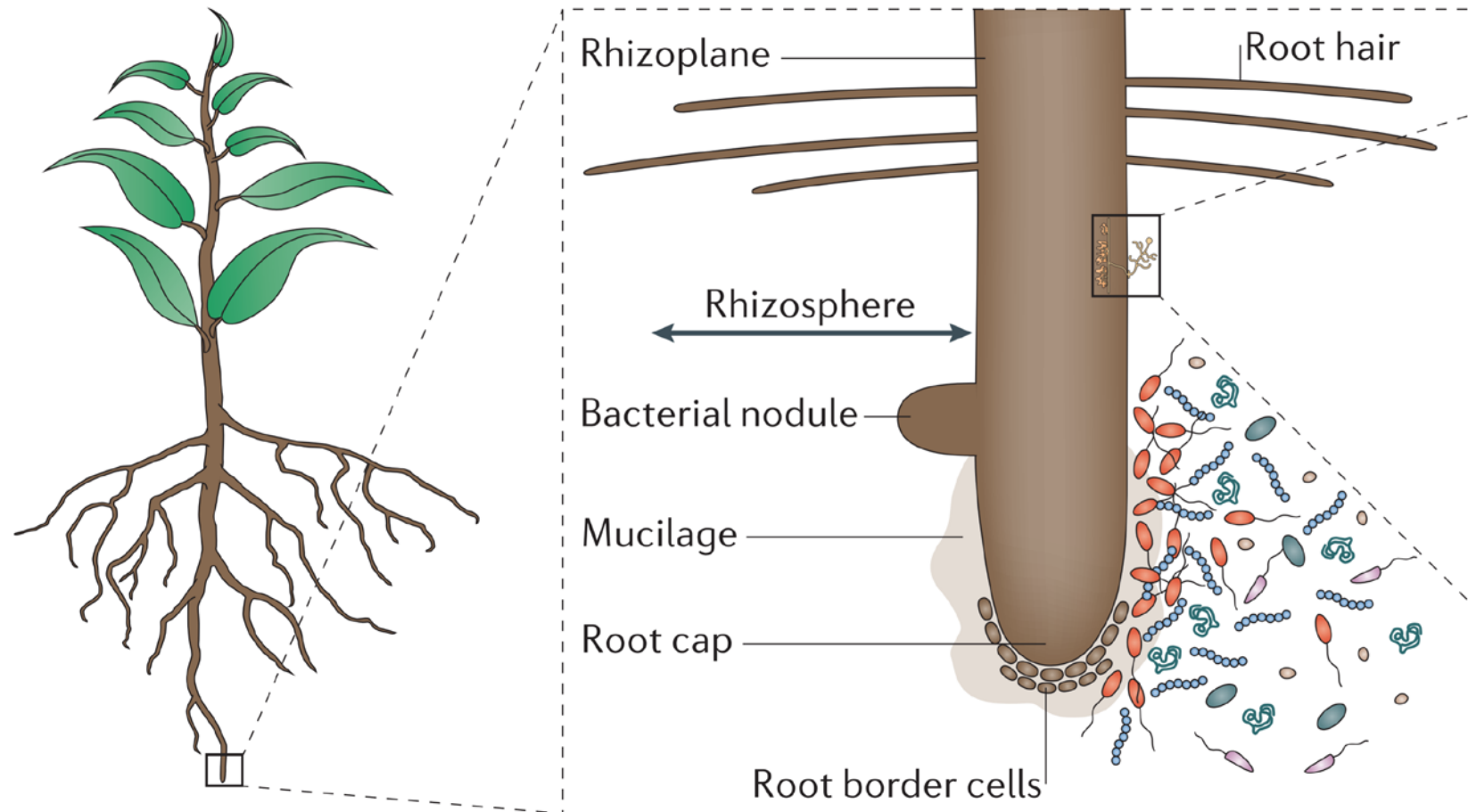
SR: Sclerotinia Basal Stalk Rot

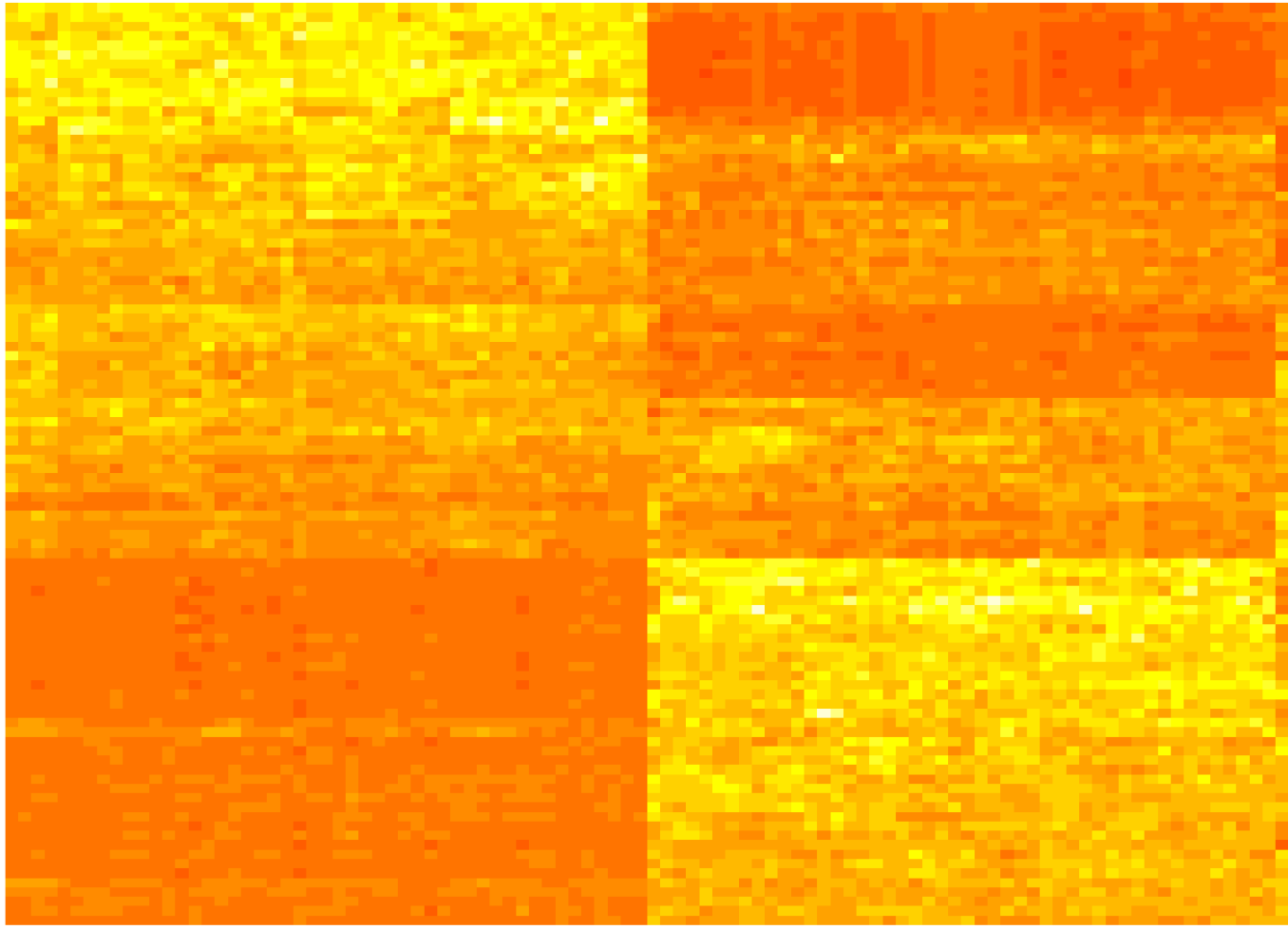
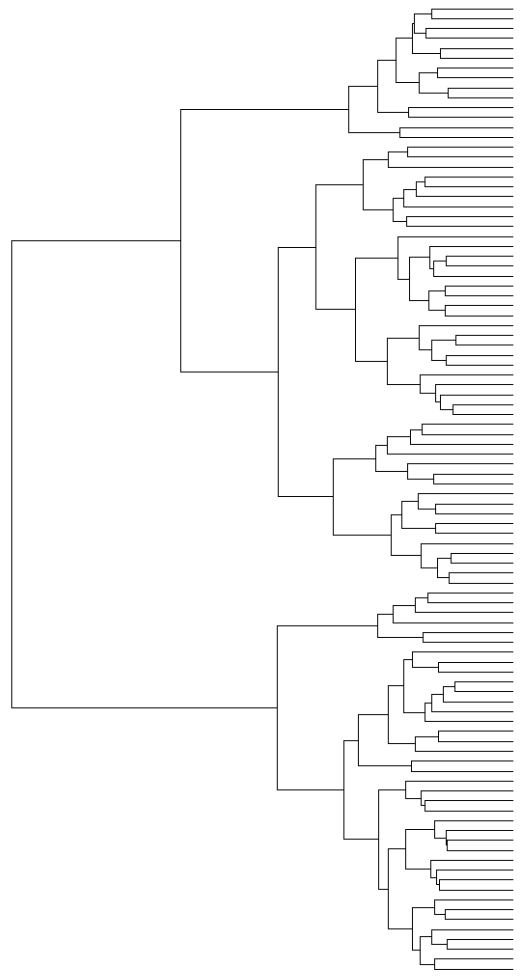
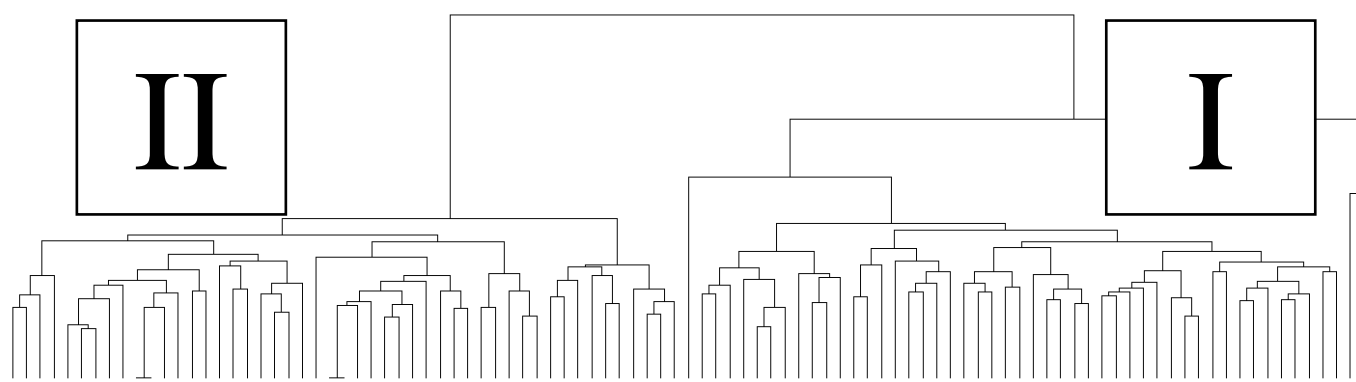
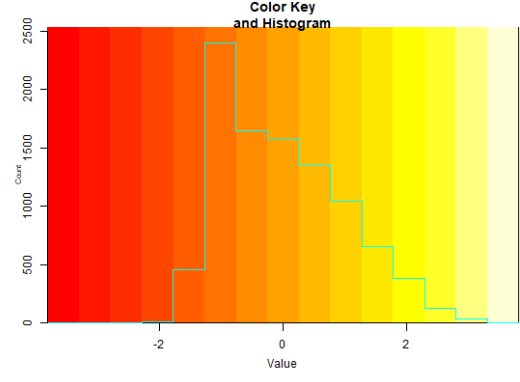
HR: Sclerotinia Head Rot

PSC: Phomopsis Stalk Canker



Getting to the 'root' of basal stalk rot





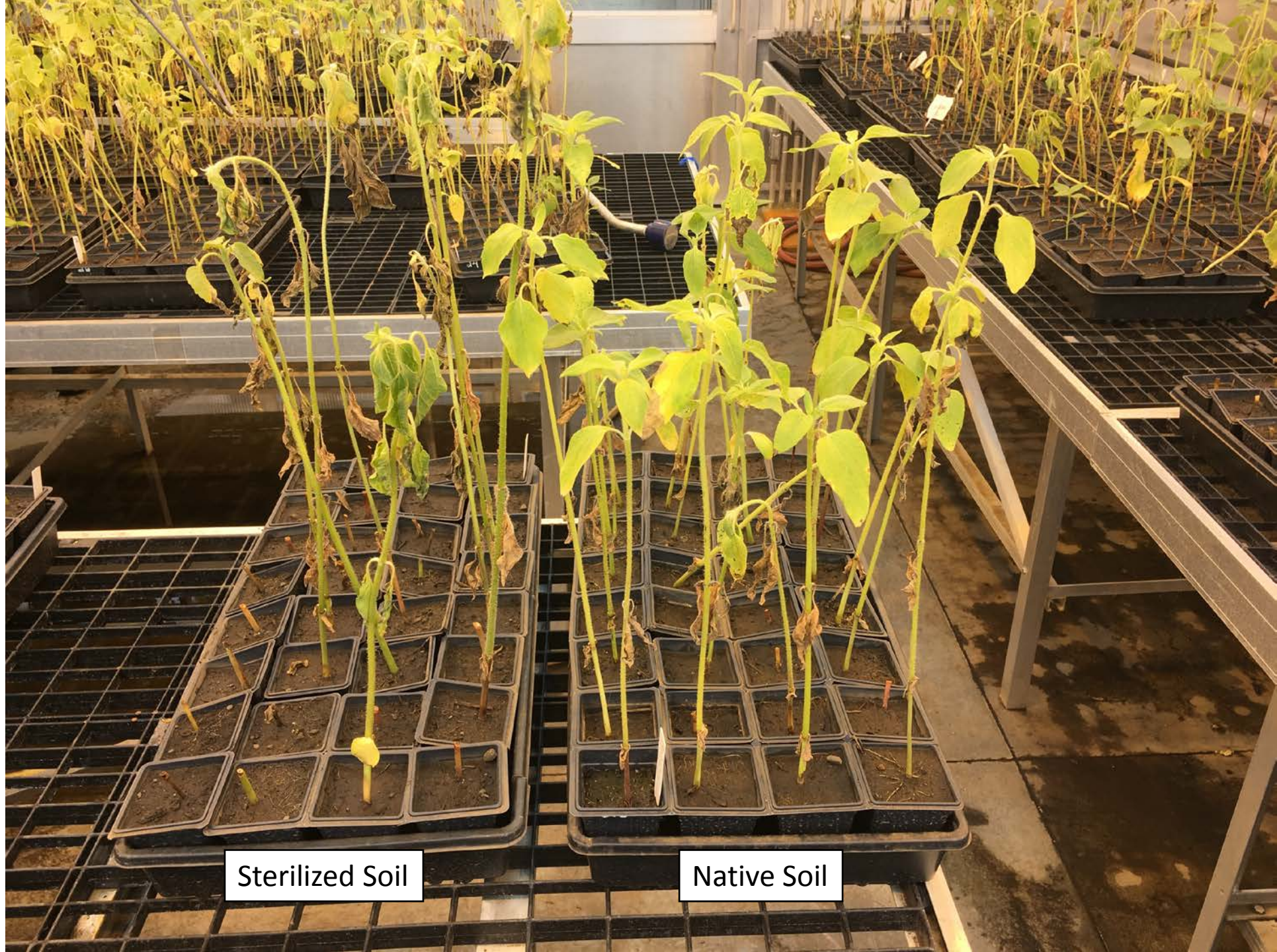
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Table 1.

Pogoda et al., in review, Nature Ecology & Evolution



Sterilized Soil

Native Soil

Supplemental Figure
Pogoda et al., in review, Nature Ecology & Evolution

Fatty acid genetics

- Funded through NSA
- Still threshing and analyzing samples for populations to understand dominance effects of previously mapped loci, also high oleic instability in certain hybrids
- Some of our completed work was presented two years ago
 - Updated in 2019 with new genome data – additional mapping
 - Manuscript in draft
 - Expect out in 2020!

PUBLICATIONS

Peer-Reviewed Publications *(graduate students/postdocs in italics)*

1. Portlas, Z.M., J.R. Tetlie, D. Prischman-Voldseth, **B.S. Hulke**, and J.R. Prasifka. 2018. Variation in floret size explains differences in wild bee visitation to cultivated sunflowers. *Plant Genet. Res.* (in review).
2. Fu, X., L.L. Qi, **B.S. Hulke**, and C.-C. Jan. 2017. Somatic embryogenesis from corolla tubes of interspecific amphiploids between cultivated sunflower (*Helianthus annuus* L.) and its wild species. *Helia* 40:1-19.
3. Gao, Q.M., N.C. Kane, **B.S. Hulke**, S. Reinert, C. Pogoda, S. Tittes, and J.R. Prasifka. 2017. Genetic architecture of capitate glandular trichome density in florets of domesticated sunflower (*Helianthus annuus* L.). *Frontiers Plant Sci.* doi:10.3389/fpls.2017.02227.
4. **Hulke, B.S.**, Q.M. Gao, and M.E. Foley. 2017. Registration of the sunflower oilseed maintainer genetic stocks HOLS1, HOLS2, HOLS3, and HOLS4, possessing genes for high oleic and low saturated fatty acids, and tolerance to imidazolinone herbicides. *J. Plant Registrations* doi:10.3198/jpr2016.09.0043crgs.
5. **Hulke, B.S.**, G. Ma, L.L. Qi, and T.J. Gulya. 2017. Registration of oilseed sunflower germplasms RHA 461, RHA 462, RHA 463, HA 465, HA 466, HA 467, and RHA 468. *J. Plant Registrations* doi:10.3198/jpr2017.04.0023crg.
6. **Hulke, B.S.**, and W.E. May. 2017. Registration of oilseed sunflower restorer germplasms RHA 476 and RHA 477, adapted for short season environments. *J. Plant Registrations* doi:10.3198/jpr2017.07.0048crg.
7. Prasifka, J.R., R.E. Mallinger, **B.S. Hulke**, S.R. Larson, and D. Van Tassel. 2017. Plant-herbivore and plant-pollinator interactions of the developing perennial oilseed crop, *Silphium integrifolium* Michx. *Environmental Ent.* 46:1339-1345. doi.org/10.1093/ee/nvx134
8. Qi, L.L., Z.I. Talukder, **B.S. Hulke**, and M.E. Foley. 2017. Development of diagnostic SNP markers for the downy mildew resistance genes PIArg and PI8, and marker-assisted gene pyramiding in sunflower (*Helianthus annuus* L.). *Mol. Genet. Genomics* doi:10.1007/s00438-017-1290-8
9. Van Tassel, D., K. Albrecht, J. Bever, A., Boe, Y. Brandvain, T. Crews, M. Gansberger, P. Gerstberger, L. González-Paleo, **B. Hulke**, N. Kane, P. Johnson, Y. Ding, B. ...

RECENT POSTS

Internship Projects:
Summer 2017

RHA 485, RHA 486, HA
487 Release

HA 482, RHA 483, and
RHA 484 Release

Lab Picnic!

Intern Highlight: Jonathan
Tetlie

SPECIES WE WORK WITH





Thanks!

Hulke and Kane Lab Staff

- Dr. Stephan Reinert, Postdoc (CU)
- Dr. Cloe Pogoda, Postdoc (CU)
- Dr. Ziv Attia (CU)
- Brady Koehler, Technician
- Mike Grove, Technician
- Brian Smart, Grad. Student (NDSU)
- Neil Olson, Grad. Student (NDSU)
- Numerous undergrad interns!



Funding sponsors

- National Sunflower Association
- National Sclerotinia Initiative
- Genome Canada / Genome BC
- The Malone Family Foundation
- US-Israel Agricultural R&D Fund