Update on breeding and quantitative genetics at USDA

Dr. Brent Hulke, USDA-ARS
& many collaborators!

Sunflower Diversity Panel Screen of Macronutrients

Brent Hulke

Mike Grusak

Karen Fugate

Overview of population and study

- SAM panel
  - 262 sunflower inbred lines (USDA and INRAE programs, also landrace lines)
- Assessed macronutrient content and composition of the same
  - Hull content
  - On the kernel only:
    - Protein (and associated amino acids)
    - Carbohydrates (and associated sugars)
  - Oil content

Ranges

- On a per seed basis:
  - Protein: 10-25 %
  - Carbohydrate: 0.75-8 %
  - Hull 16-64%

Correlations

Macronutrient correlations				
	hull	carb	protein	H20+oil
carb	-0.41		0.05	-0.26
protein	-0.41	0.17		-0.98
H20+oil	-0.92	0.30	0.02	

Interesting outliers for composition

- Carbohydrates
  - One line that has no raffinose and almost all sucrose

Entry	inositol.pk	galactose.pk	glucose.pk	fructose.pk	sucrose.pk	raffinose.pk	stachyose.pk	carbs.ps
Ames 31731	0.95	0.66	0.38	1.92	96.09	0.00	0.00	2.76
Ames 31871	1.48	0.01	0.01	1.65	76.75	19.88	0.22	3.15

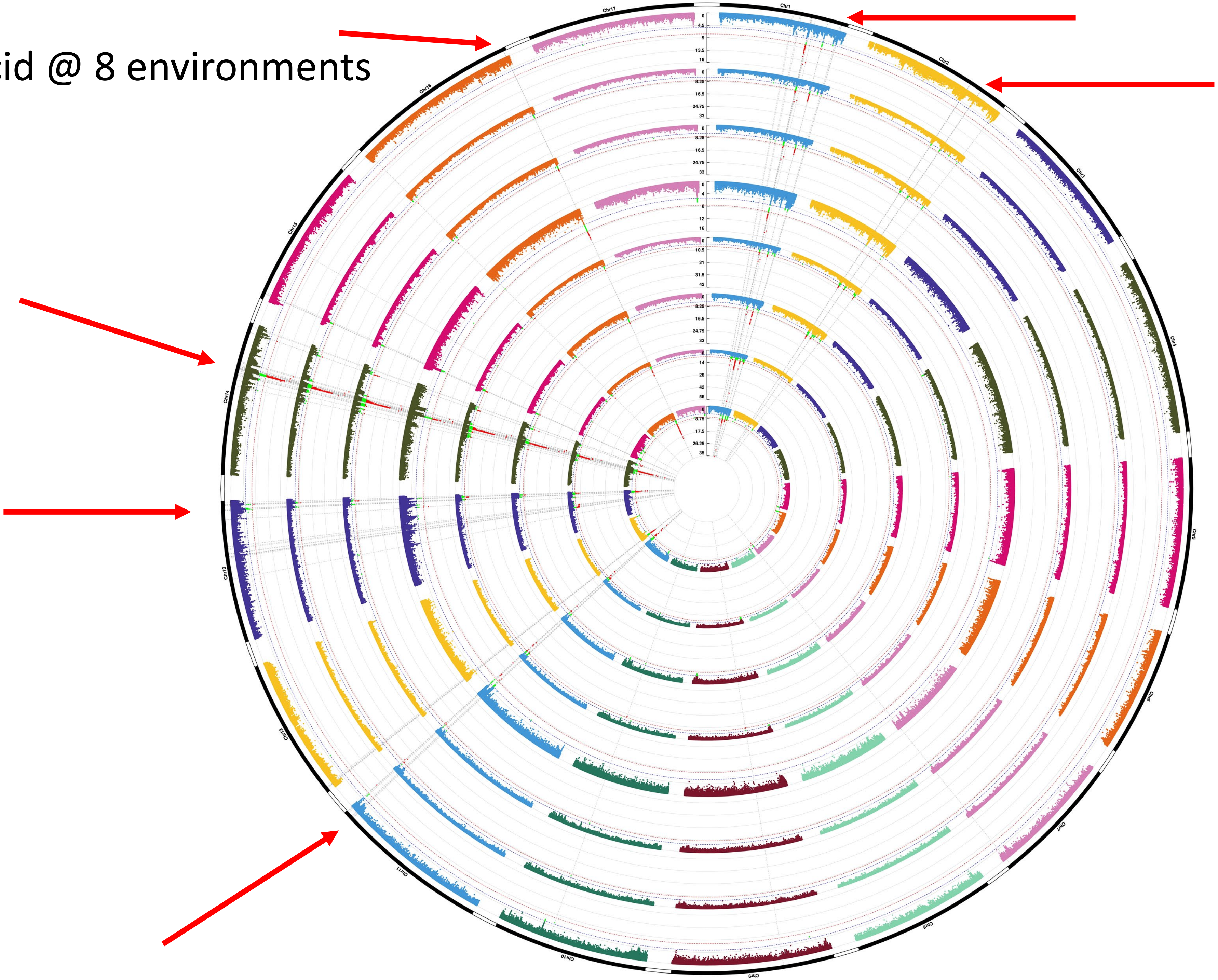
Fatty acid composition in response to climate variation

Brent Hulke
Markus Ingold
Zach Tarble
(many others)

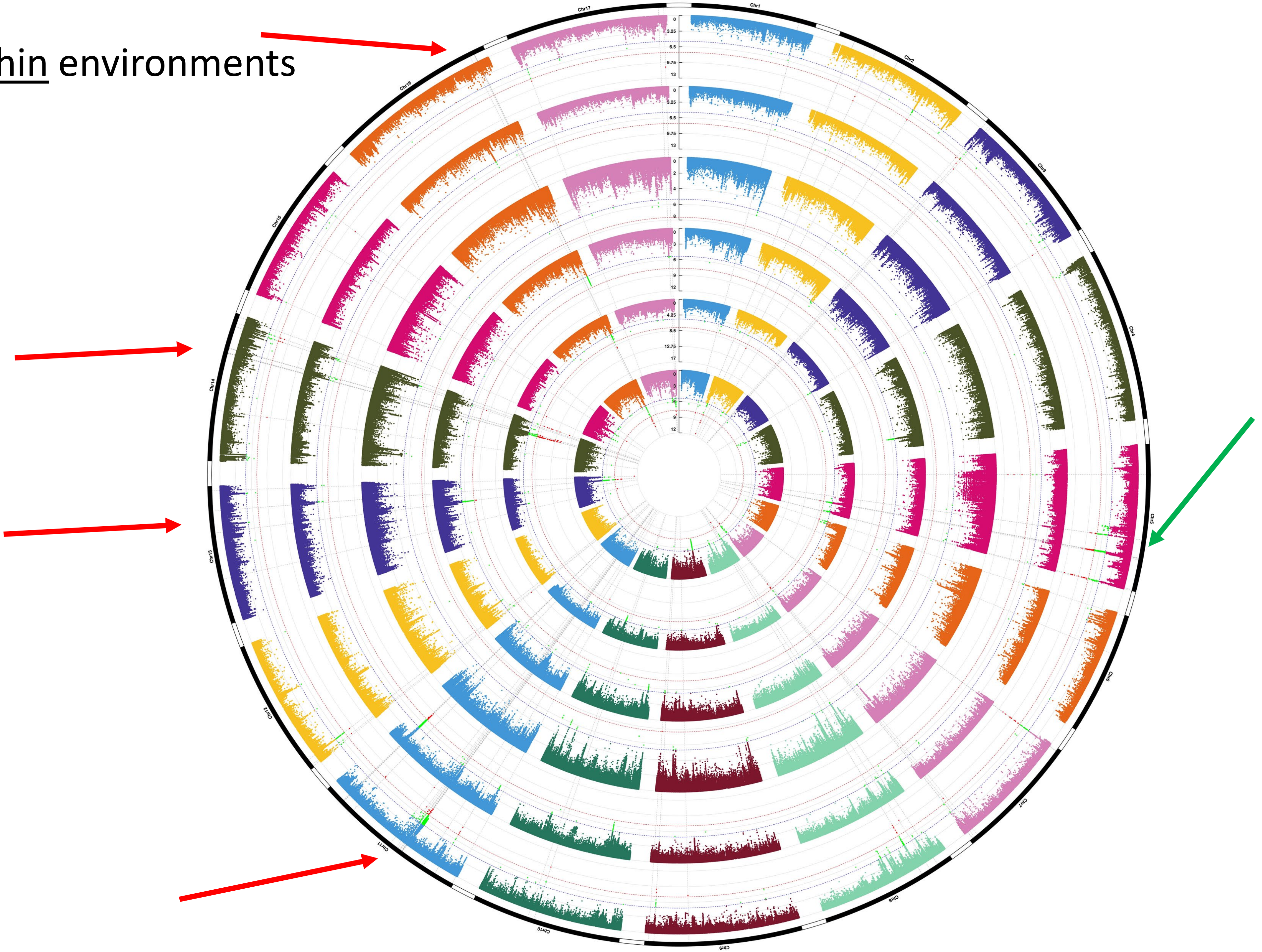
Methods

- The SAM diversity panel, SNP markers called from the HA412-HOv2 reference genome using GATK best practices.
- Eight (8) North American environments were chosen based on spatial variability in climate and yearly variation in weather – ranging from subtropical to cold temperate.
  - Athens, GA (2010); Ames, IA (2010, 2013, 2014); Fargo, ND (2015, 2016 early and late planted); and Vancouver, BC (2010)
- Means and standard errors were calculated for palmitic, stearic, oleic, and linoleic acid in each sunflower line in each environment. Eberhart and Russell's β (1966) was calculated from means across environments.

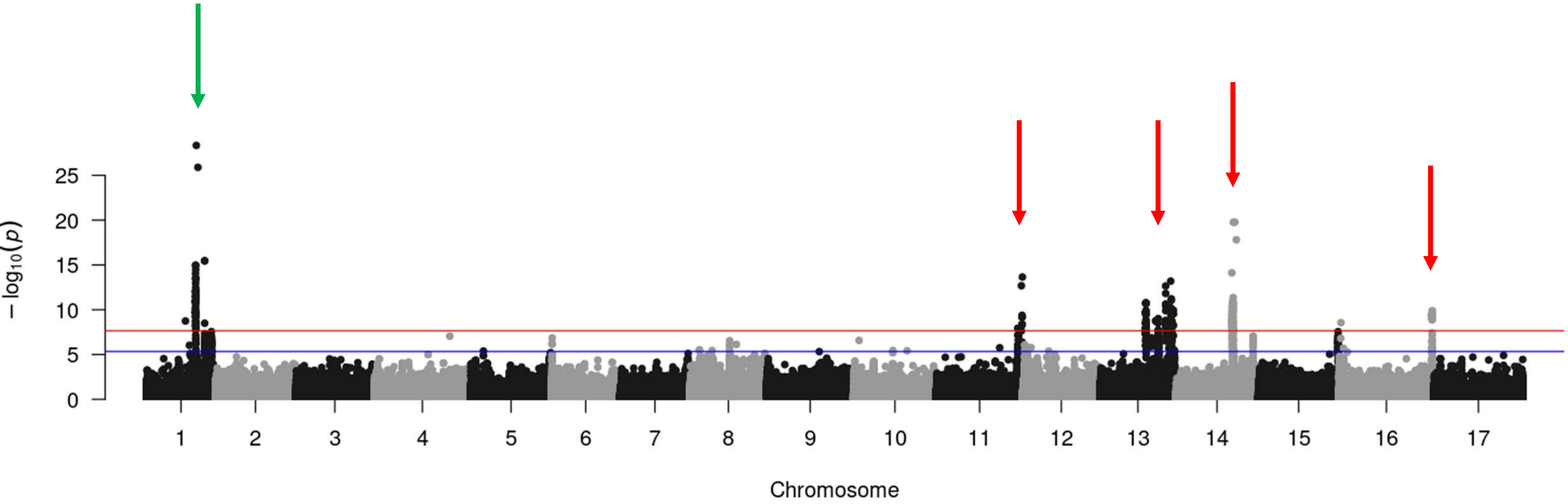
Oleic acid @ 8 environments



4 fatty acid stability within environments



4 fatty acid stability among environments



Results/discussion

- Important genes for fatty acid accumulation in seeds are known to adjust expression to ambient conditions during seed development, notably temperature.
- Not surprising that some of the same loci involved in composition changes are also underlying stability in fatty acid accumulation.
- This indicates there may be a tradeoff between stability and achieving the ideal oil composition for a given purpose.
- The next step is to identify optimal multi-locus haplotypes that provide the best balance between desirable fatty acid composition and stability over environments.

Breeding projects

(work sponsored in part by NSA)

Moorhead, MN mid maturity

yield	hybrid
3198	RHA486/21_2854
3156	Crop 549CL
3130	RHA486/21_2883
3104	CMS487/21_1984
3051	RHA486/21_2773
3044	RHA486/21_2799
2995	RHA486/21_2813
2945	RHA486/21_2789
2858	RHA486/21_2841
2856	CMS487/21_1927
2801	Myc 8H456CL
2784	RHA486/21_2875
2754	RHA468/21_2781
2750	CMS467/21_1984
2743	Pio 64HE101
2742	CMS487/21_1924
2731	RHA486/21_2849
2728	RHA486/21_2749
2726	RHA486/21_2801
2718	RHA486/21_2844
2714	CMS487/21_2067
2712	Nu N4H422CL
2699	RHA486/21_2805
2696	RHA486/21_2867
2695	CMS487/21_2125
2677	RHA486/21_2829
2677	RHA468/21_2854
2676	RHA486/21_2759
2668	CMS467/21_2073
2665	CMS467/21_1916
2652	RHA486/21_2981
2643	CMS487/21_1919
2638	CMS487/21_2133
2629	CMS487/21_1916
2620	CMS487/21_2122
2620	RHA486/21_2939

Onida, SD mid maturity

yield	hybrid
3447	RHA486/21_2939
3239	RHA486/21_2757
3182	RHA486/21_2981
3095	Nu Camaro2
3058	RHA486/21_2787
2999	RHA486/21_2905
2960	RHA486/21_2773
2946	RHA486/21_2793
2941	CMS467/21_1926
2929	RHA486/21_2849
2920	RHA486/21_2753
2915	RHA486/21_2797
2904	RHA486/21_2891
2855	Crop 549CL
2839	RHA486/21_2827
2835	RHA486/21_2767

Bismarck, ND mid maturity

yield	hybrid
2886	Nu Camaro2
2792	RHA486/21_2789
2779	RHA486/21_2825
2774	RHA486/21_2841
2712	Nu N4H422CL
2664	RHA486/21_2939
2590	RHA486/21_2767
2587	RHA486/21_2908
2557	CMS487/21_2133
2544	RHA486/21_2883
2525	RHA486/21_2839
2518	RHA486/21_2854
2477	CMS467/21_1983
2471	RHA486/21_2855
2460	RHA486/21_2749
2455	CMS487/21_1917
2453	RHA486/21_2791
2438	RHA486/21_2787
2399	RHA486/21_2743
2397	RHA468/21_2763
2395	CMS467/21_1984
2374	RHA468/21_2807
2368	CMS467/21_1925
2366	RHA468/21_2767
2363	CMS467/21_1919
2358	RHA486/21_2753
2353	CMS487/21_1926
2352	RHA486/21_2861

Moorhead, MN early maturity (mid June plant)

yield	hybrid
3112	CMS494/21_1881
3024	RHA476/21_2710
2986	RHA476/21_2660
2899	687/21_2678
2864	RHA477/21_2686
2846	687/21_2646
2832	CMS494/21_2105
2817	687/21_2712
2807	687/21_2686
2797	687/21_2728
2764	CMS493/21_2092
2740	687/21_2662
2727	CMS493/21_2096
2724	687/21_2672
2721	CM595A/21_2092
2709	RHA476/21_2730
2685	687/21_2719
2685	RHA477/21_2654
2675	RHA476/21_2646
2663	RHA476/21_2688
2630	Nu N4H161
2627	687/21_2652
2620	RHA476/21_2654
2615	CMS493/21_1884
2605	CMS494/21_1893
2602	CMS494/21_1901
2601	CMS494/21_1882
2595	687/21_2654
2584	RHA476/21_2676
2570	687/21_2733
2566	Myc 8N270CLDM
2550	687/21_2688
2549	CM595A/21_1891
2548	CMS494/21_2092

yield	hybrid
2546	RHA476/21_2652
2543	CMS494/21_1895
2531	CMS494/21_2096
2530	687/21_2710
2527	687/21_2730
2518	RHA476/21_2733
2517	CMS493/21_2100
2503	687/21_2676
2492	687/21_2702
2489	RHA477/21_2646
2485	RHA476/21_2712
2484	RHA477/21_2668
2473	RHA476/21_2728
2469	CMS493/21_2104
2467	687/21_2720
2462	CMS493/21_1882
2457	RHA477/21_2672
2436	RHA476/21_2686
2421	CMS493/21_1903
2414	CMS494/21_2104
2412	RHA477/21_2662
2399	CMS494/21_2100
2395	CM595A/21_1881
2391	687/21_2664
2378	CMS494/21_2110
2374	CMS493/21_1901
2373	CMS494/21_1891
2367	CMS494/21_1896
2344	CMS493/21_2102
2344	RHA477/21_2664
2334	687/21_2642
2324	RHA477/21_2730
2323	CM595A/21_1901
2318	CM595A/21_2110

Still checking data – not yet analyzed

Hutchinson, KS double crop

Indianhead, SK full season

Breeding Results

- Yields were great this year, and shows the potential of a number of new lines
- Oil content data forthcoming (had NMR problems)
- Lines available in different maturities and statures
- Many releases also forthcoming!

PUBLICATIONS

See below for the variety of research topics our lab has completed work on. Feel free to contact Brent Hulke if you would like a reprint of any publications.

Journal Publications

Registration of oilseed sunflower maintainer germplasm HA 489 with resistance to the banded sunflower moth

May 15, 2020

Registration of oilseed sunflower maintainer germplasm HA 488, with resistance to the red sunflower seed weevil

May 7, 2020

Gene banks for wild and cultivated sunflower genetic resources

March 6, 2020

...itate Glandular Trichomes Fail to Provide Significant Resistance to Banded Sunflower

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TYPE Original Research
PUBLISHED 19 December 2022
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Genetic mapping of a pollinator preference trait: Nectar volume in sunflower (*Helianthus annuus* L.)

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Hulke Lab Staff

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- André Gossweiler, Grad. Student (NDSU)
- Ashley Barstow, Grad. Student (NDSU)
- Markus Ingold, Visiting Scholar
- Numerous undergrad interns!
- Collaborators in many states!

Funding sponsors

- National Sunflower Association
- National Sclerotinia Initiative
- The Malone Family Foundation
- North Central Region SARE

Sunflower Focus Group!

- February 14
- 1 pm
- USDA building NCSL (blue roof)
- Contact brent.hulke@usda.gov
- Open to anyone in industry or university who has an interest in our research or collaborating with us
- Updates and discussion on future of the research unit!