

Development of 200 Alfalfa Inbred Lines with Five Generation of Self-Pollination

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Award number: 2018-70005-28792 (9/1/2018-8/31/2022)



Background

The USDA Crop Production Historical Track Records indicate that alfalfa yield trends remained stagnant at 2.1 tons per acre until 1955, followed by a steady increase over three decades. However, over the past 40 years, yield gains have plateaued at 3.3 tons per acre. The primary method for variety development, the synthetic breeding scheme, has contributed to this stagnation. Alfalfa, an outcrossing species with an average self-pollination rate of 30%, experiences significant inbreeding depression. Interestingly, autopoloid alfalfa exhibits inbreeding depression comparable to that of diploid maize, though the reasons remain unclear. Synthetics serve as the foundation for developing varieties to mask deleterious alleles, yet they are susceptible to inbreeding depression, and hybrid performance is constrained by insufficient heterosis.

Methods

To address these challenges, the USDA Alfalfa Forage Research Program initiated a project in 2018 (project #: 2018-70005-28792) aimed at developing 200 alfalfa inbred lines to reduce deleterious alleles and enhance purity. This project conducted the largest self-pollination experiment in history, involving over 5,000 plants. More than 200 inbred lines have been maintained through five generations of self-pollination.

Conclusion

1. Established clones had much higher plant seeding rates than the plants from seeding.
2. Dramatic differences on plant seeding rate among technicians.
3. There was no clear trend that plant seeding rates change over self cycles.
4. These inbred lines are invaluable for exploring heterosis among inbreds and facilitating the development of synthetics from inbred with reduced deleterious alleles.

Reference

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Results

Figure 1. Number of lines, plants, and seed across cycles of self pollination

State	Self	Lines	Plants	Plants with Seeds	Max Seed Number	AVG Seed Number
Yu	1	114	798	292	2077	205
	2	101	565	250	1186	70
	3	86	705	256	923	65
	4	62	675	67	Near 500	34
	5	38	700	72	Near 700	132
Peel	1	146	146	140	6215	892
	2	140	435	246	4391	332
	3	118	238	104	2629	67
	4	61	94	41	827	20
	5	32	114	11	55	9
Wagner	1	15	15	15	648	212
	2	15	121	75	209	38
	3	12	91	58	288	21
	4	9	81	60	270	21
	5	7	300	NA	NA	NA
Total			5,078			



Figure 1. Display of plants at full (a)/early (b) develop stages and seeding plant rate across self cycles and programs. The plants at cycles 1 are established clones in Mike Peel and Stave Wagner programs. The rest are from seed, including Long-Xi Yu at cycle 1.

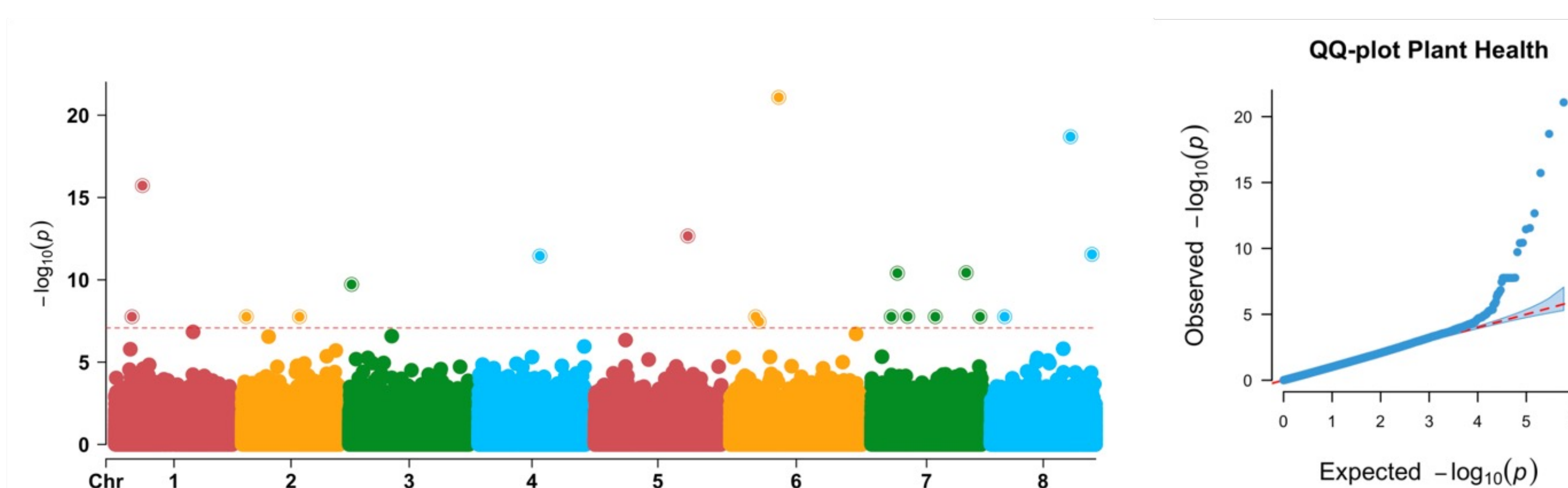


Figure 2. Gene mapping through sequencing bulked plants with strong and weak growth vigor. There 534 individuals which were pooled as 121 samples for sequencing and genome wide association study. Plant with with strong and weak growth vigor were pooled within programs and self cycles.



Acknowledgement

This project was supported by USDA and collaborations with alfalfa breeder Steven Wagner at Alforex, Corteva, and DLF

