Integrated Conventional and Genomic Approaches to Almond Rootstock Development

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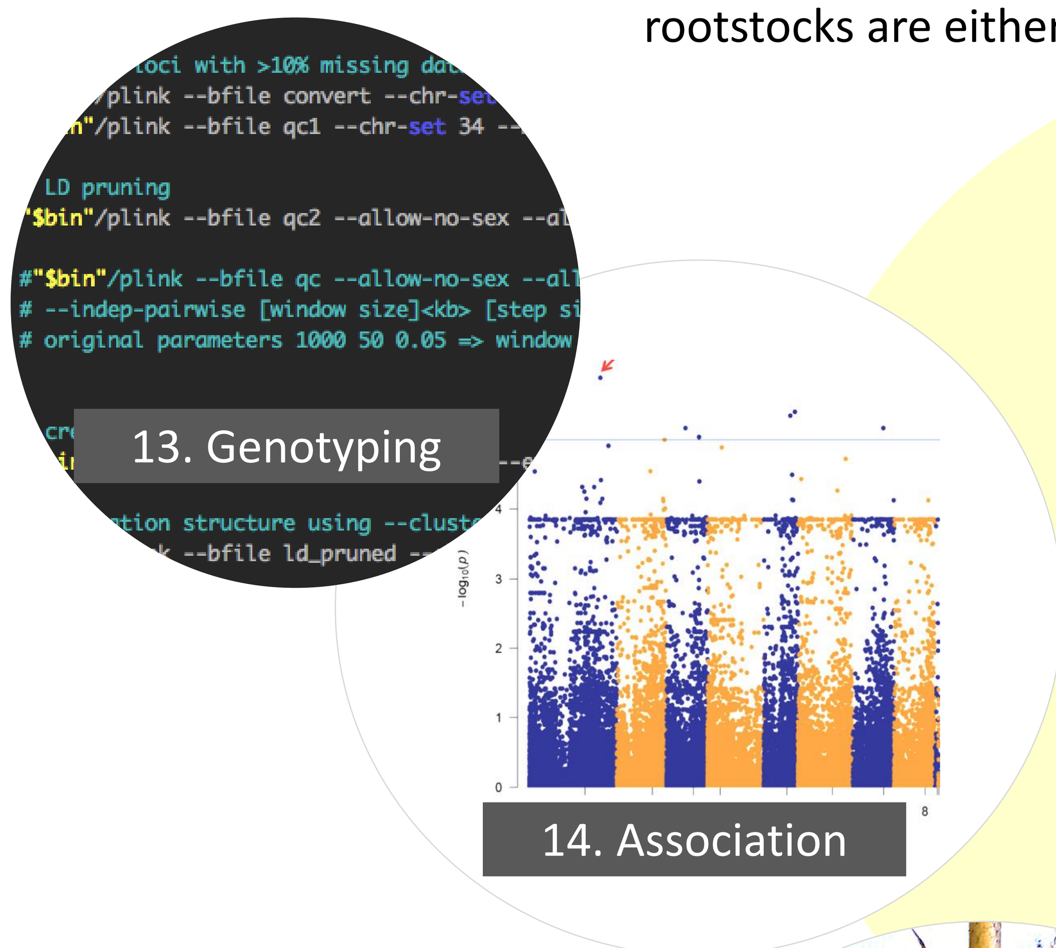
Background

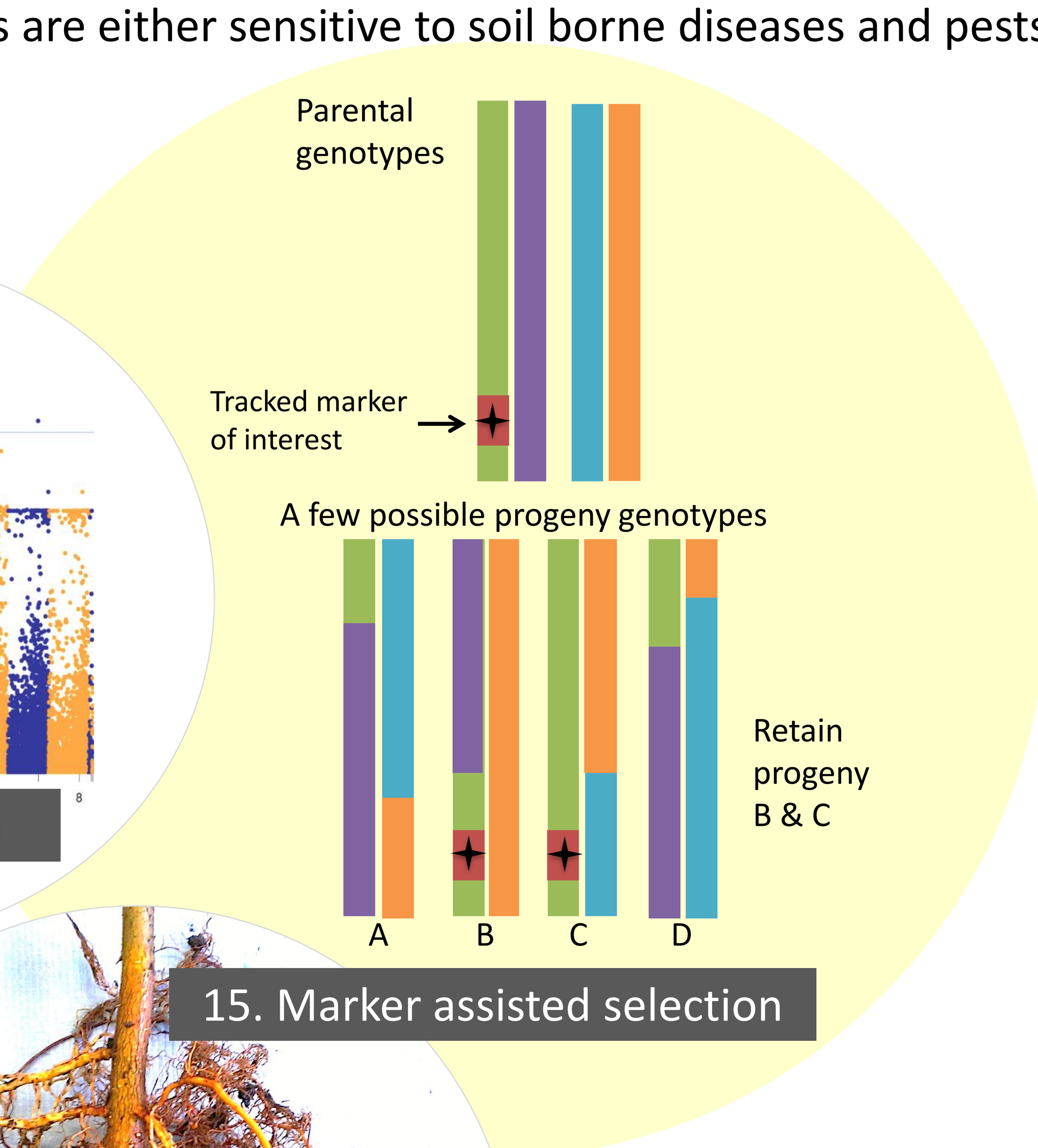
Soil borne pests and pathogens limit the longevity and productivity of almond orchards. With severe restrictions on soil fumigation, there is a great need for sustainable, environmentally friendly alternatives, such as rootstocks with innate resistance or tolerance to the major soil borne pests and pathogens. Current rootstocks are either sensitive to soil borne diseases and pests or abiotic conditions.

Our rootstock breeding program aims to expand the genetic diversity in the almond rootstock breeding populations, identify genetic markers associated with resistance to root pests and pathogens and develop genomic tools for improved selection efficiency and rapid development of improved rootstocks.



13. Genotyping

14. Association



15. Marker assisted selection

11. Crown Gall Tolerant genotype

10. Crown Gall Susceptible genotype

12. Nematodes

9. Maintain and multiply

8. Germinate seed

2016 Highlights

- 22 different cross combinations made in Spring 2016
- 100 embryos were rescued and propagated at Sierra Gold Nurseries
- Second year crown gall screening of hybrids from 2013 and 2014
- Clonal rootstocks distributed for nematode and *Phytophthora* root rot testing
- 232 hybrid seedlings germinated during Fall 2016
- Nursery Industry cooperation for embryo rescue

NEW ROOTSTOCKS WITH HIGH LEVELS OF RESISTANCE

Crown gall

P-2-4[s] P-4-10[t] P-4-25[t]
L-1-2[v] 197-95[w] 197-113[w]
197-199[y] 197-217[z]

Phytophthora

P-4-1[t] P-4-25[t] L-1-2[v]

parentage: [s]'Nemared' x *argentea*; [t]Nemared x *fenzliana*; [v]*cerasifera*; [w]*persica x tangutica*; [y]*persica x davidiana*; [z]*persica x kuramica*

2. Emasculate flowers

3. Developing fruit

1. Track bloom

4. Some to culture

Generating New Rootstocks

Generating diverse experimental rootstocks begins late Winter (upper right) by tracking bloom (1) followed by hybridizing parental species and genotypes that are potential donors of resistance to soil borne diseases (Table 1) by hand pollinating emasculated flowers (2). The fruits develop (3); when embryos are sufficiently formed, immature fruits from cross incompatible crosses are collected for embryo rescue (4). Known cross-compatible combinations remain on the mother trees to mature. Mature fruits are collected early to mid summer and stones extracted (5). Further extract the kernels (6), soak seeds in running water to leach biochemical substances that are known to inhibit germination and stratify them within the folds of paper towels moistened with a fungicide solution (7) for 6 – 9 weeks until radicles emerge. The germinating seeds are sown (8) and kept under mist until established and transplanted into bigger containers and further clonally multiplied (9) for distribution to collaborators for disease testing. Collaborators challenge, evaluate, and score experimental and industry standard rootstocks against soil borne pests and pathogens, specifically crown gall (10, 11), *Phytophthora*, and nematodes (12). All tested materials are genotyped (13) with molecular markers and analyzed for association with disease/pest response (14). Markers with significant association with resistance are validated for use in marker assisted selection (15) of parents and progeny of future crosses to reduce or eliminate labor intensive screening.

5. Defleshed stones

6. Extract seed

7. Stratify seed

Table 1. Interspecific *Prunus* crosses made in Winter 2016 and seedlings germinated in Fall 2016.

Male (across) / Female (down)	*argentea*	*bucharica*	*fenzliana*	*tangutica*	*davidiana*	*kansuensis*	*mira*
dulcis	-	-	-	-	33	10	33
persica	1	10	6	30	55	-	54

Acknowledgements

california almonds Almond Board of California

SG Sierra Gold Nurseries