Development of HLB resistance through inarching novel disease tolerant hybrids, and through breeding.

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Year 3 of 3 (75% Complete)

Objectives

1. Field evaluation of HLB tolerant material in Florida.
2. Generate inarched plants and evaluate HLB tolerance in Florida.
3. Screening rootstock hybrids for HLB tolerance.
4. Continue traditional breeding.

Problem and Significance

Citrus huanglongbing (HLB) has affected many citrus industries world-wide and compromised more than 70% of citrus trees in Florida. The disease has now established in Texas; as of November 2020, over 2100 infected trees have been reported from southern California. Due to the nature of the HLB pathogen and the current methods employed for detection of HLB-infected field trees, several undetected, already infected trees may be present in many regions of southern California. Since there is no cure for HLB, the establishment of the disease will be detrimental to the $2.5 billion citrus industry. Disease mitigation by psyllid control and other methods will provide short term solutions to the HLB situation. Developing disease-resistant varieties is essential for sustainable citrus cultivation. Since the psyllid is present in large numbers in several citrus growing regions and psyllid control is expensive and challenging, the availability of disease-resistant cultivars will provide an economical and sustainable way forward.

Benefit to Industry

Long-term cultivation of citrus will be possible with disease-resistant varieties. Most citrus cultivars are susceptible to HLB. Cultivated citrus has a narrow genetic base – most cultivars of grapefruit, sweet orange, etc. are very similar to each other at the genetic level. A crop grown as a monoculture can be subject to widespread disease issues and severe crop losses when new pathogens establish.

Our project aims to generate HLB-resistant, novel, citrus hybrids by crossing citrus cultivars with known HLB resistant types. Traditional breeding with closely related genera will increase genetic diversity and incorporate disease resistance traits into citrus. We are conducting crosses to generate many different types of citrus hybrids that may be close to grapefruit, pummelo, limes, etc. by carefully choosing the breeding parents. After proper validation, the novel hybrids may replace the currently grown susceptible varieties. In addition, they will be useful as disease-resistant breeding parents for future crosses. We have also generated rootstock hybrids that may be HLB resistant and can be used as novel rootstock types. We will investigate other methods of imparting resistance to scions that are known to be HLB susceptible. If resistant hybrids can impart disease tolerance when used as interstock or inarch for susceptible scion cultivars, they may provide temporary solutions for disease mitigation in existing trees.

Progress Summary

We have evaluated 272 hybrid trees in the field in Fort Pierce, Florida, for about three years. About 100 hybrids have remained highly tolerant or completely resistant to HLB. An additional 137 F1 hybrids were planted in the field during October 2019 and are under evaluation. In this study, the F1 hybrids are obtained by crossing selected mandarin cultivars with HLB resistant citrus relative genera.

In Riverside, about 400 novel hybrid trees generated in our breeding program are under field evaluations for horticultural traits. We have obtained fruits from about 36 field trees in Riverside. Several of the first-generation hybrid trees yield lime-like or lemon-like fruits since one of the parents is an Australian lime.

Earlier experiments using citrus relative genera indicated that inarching of certain HLB tolerant accessions can provide protection against HLB. The proposed follow-up experiments using disease-resistant hybrids as inarch or interstock grafts are in progress.

It is challenging to generate hybrids of rootstock plants because of nucellar embryony, a desired trait in rootstock cultivars. Progeny generated from rootstock varieties are usually true-to-type and identical to the seed parent since the embryos are predominantly derived from the maternal tissues. The zygote generated by sexual reproduction is weak and unable to compete with the vigorous asexual embryos that develop from nucellar cells. The HLB resistant citrus relatives that we use in our breeding trials do not have the nucellar embryony trait, but are not suitable as seed parents in breeding trials. Hence the total number of zygotic seedlings generated from the crosses made is very small. We have been successful in generating about 20 novel rootstock hybrids. The hybrid nature of the progeny obtained is verified by genotyping using 48 DNA markers distributed throughout the genome. Evaluation of HLB resistance of novel rootstock hybrids is in progress in the BSL3 facility in Riverside.

We were successful in generating many back cross, advanced hybrids using previously generated, HLB-resistant F1 hybrids. In the back crosses we have conducted so far, selected F1 hybrids are crossed with different types of citrus with the expectation that these advanced hybrids will produce fruit that is closer to known citrus fruits. From the crosses made in the spring of 2019, we obtained about 1,200 seedlings that are now genotyped with genome-wide DNA markers. In 2020, we conducted a total of 1,600 crosses. We are awaiting the fruits of crosses conducted in 2020. We are setting up HLB evaluation experiments of the novel hybrids in the new BSL3 facility at Riverside.

Some experiments did not progress as per expectations due to two reasons: a). restrictions imposed by the COVID-19 situation; b). lack of facilities for conducting HLB evaluations in California. Now with the contained research facility established in Riverside, we are testing novel hybrids for HLB resistance.

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Publications and Presentations

At the UCR citrus day event held in Riverside, CA during January 2020, fruit from several hybrids generated in our breeding program were displayed to the members of the California citrus industry. Taste panels were conducted with about 120 volunteers and selected varieties were evaluated for fruit acceptability. A poster describing the project was displayed.