FROM THE GROUND UP: INCORPORATING MOLECULAR TOOLS FOR PEACH ROOTSTOCK IMPROVEMENT IN THE SOUTHEAST.

Lorraine Rodriguez Bonilla
Research Horticulturist
USDA ARS
Southeastern Fruit and Tree Nut Research Laboratory

Overview

- Introduction
- Program Goals
- Breeding Overview
- Focus Areas
- Future Goals

Introduction

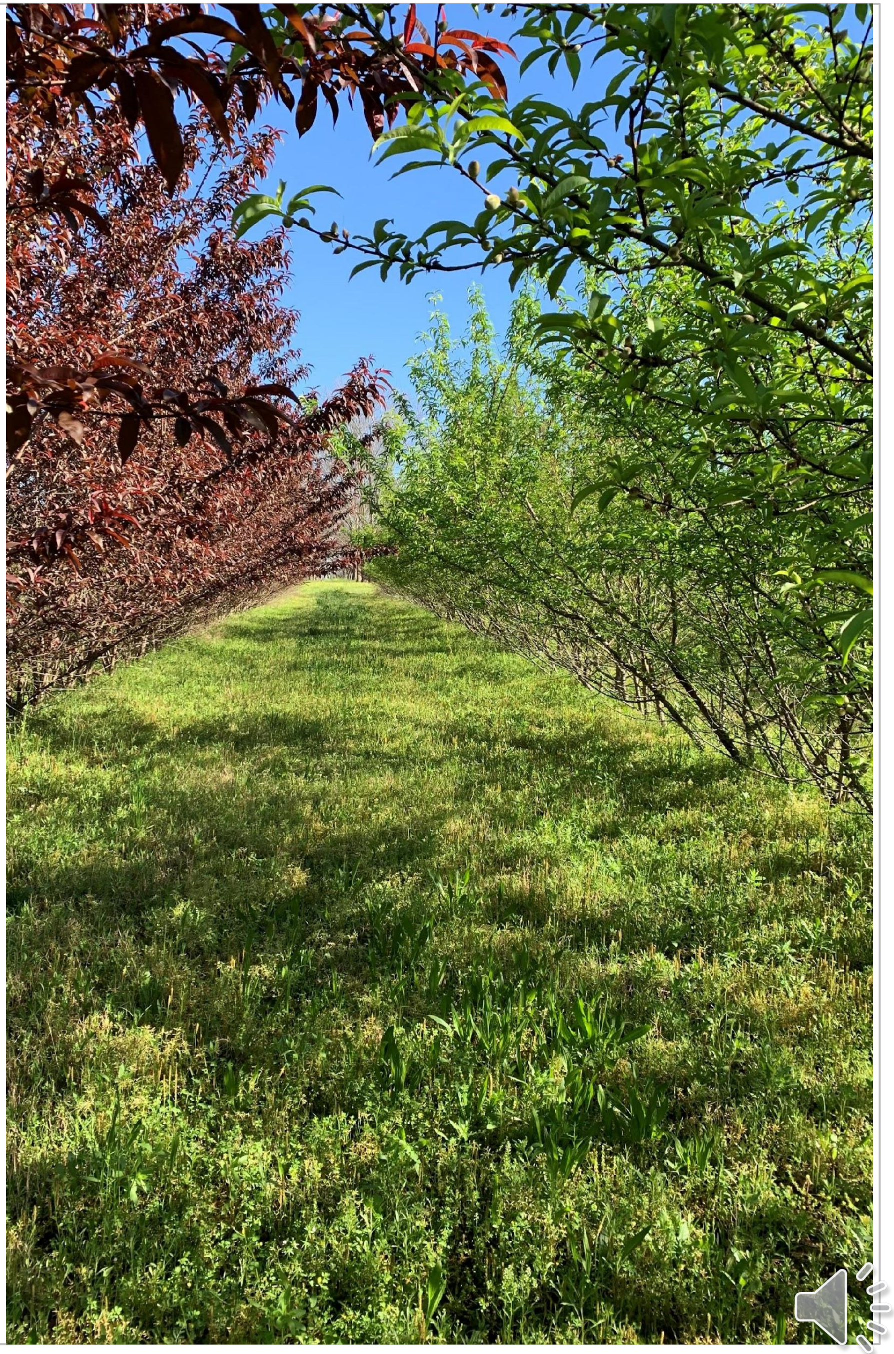
- In tree fruit production, rootstocks play an invaluable role in both management and efficiency of an orchard.
- Rootstocks can influence yield, architecture, disease resistance and crop load amongst other important traits.
- Even though there has been progress made in peach rootstock development the process is still considerably slow when compared to scions.

Introduction

- The long testing periods required to ensure that rootstocks have a consistent and desirable performance are part at fault for this gap between scion and rootstock development.
- In peaches, rootstock provide the much-needed protection against pests an pathogens.
- Guardian, which is a peach seedling rootstock, was released in 1993 by USDA ARS and Clemson University.
  - key to addresses issues caused by root rot nematodes as well as PTSL (peach tree short life).

Introduction

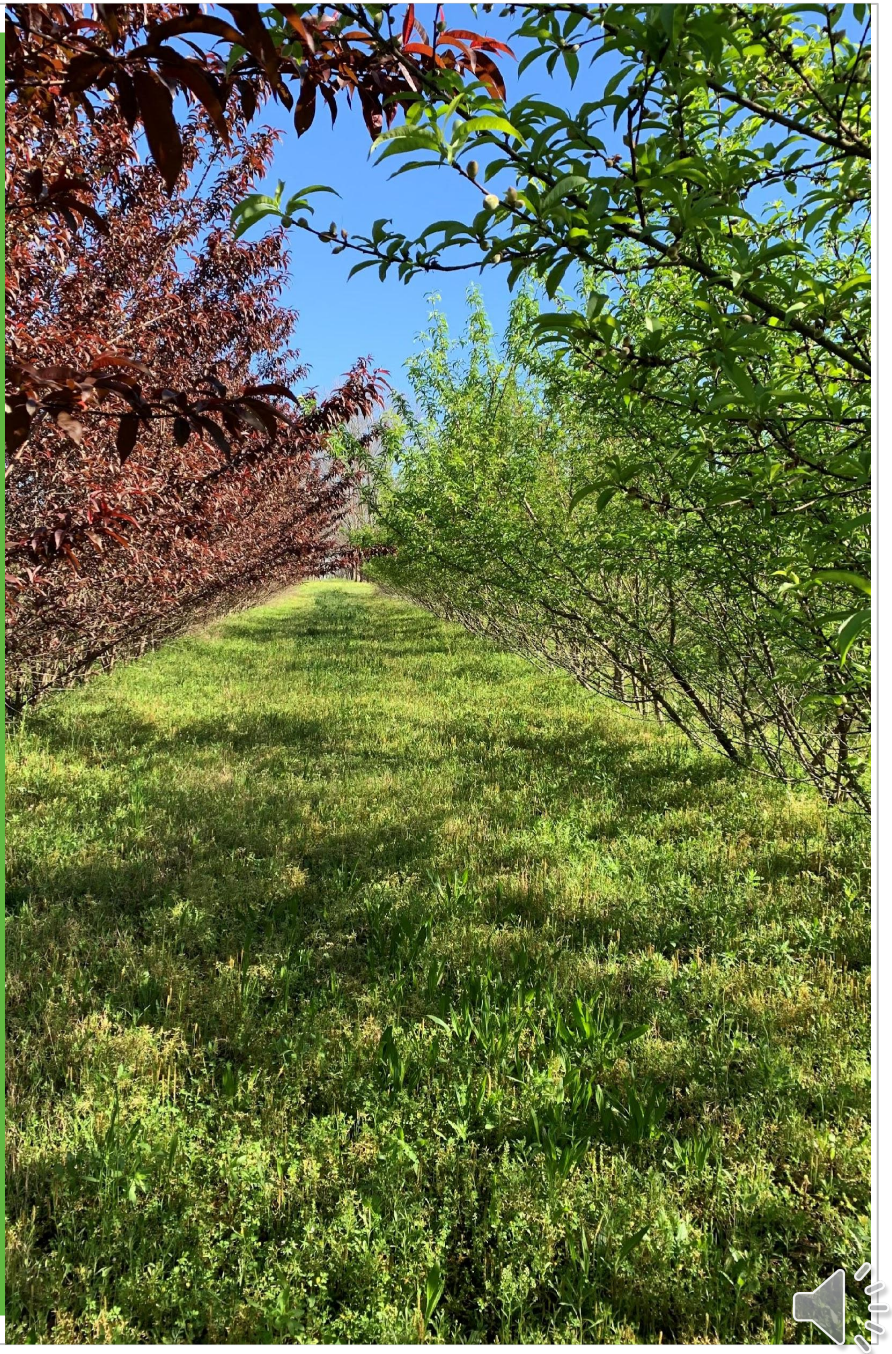
- However other issues such as Armillaria root rot and other root rot nematodes for which Guardian is highly susceptible drove the need for new materials able to address these issues.
- Newer rootstock such as 'MP-29' a clonally propagated plum x peach hybrid have demonstrated resistance to Armillaria root rot, PTSL and RRN including *Meloidogyne floridensis*.



Introduction

- MP- 29 has also demonstrated to effect vigor, being considered a semi dwarfing rootstock, a highly desirable trait when thinking of high-density orchard planning

- However, the clonal nature of the rootstock stalled its potential distribution and impact.



Introduction

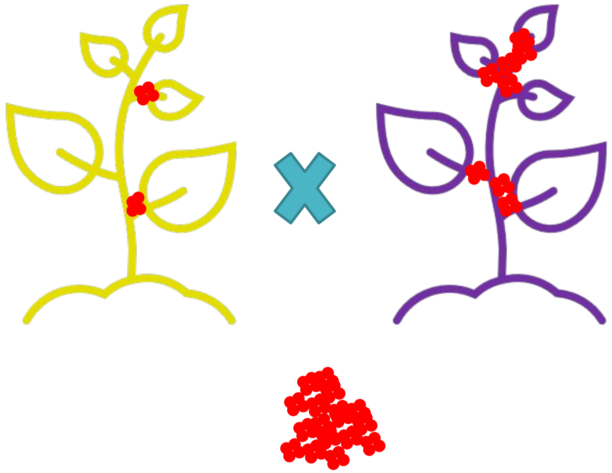
- A rootstock at almost the end of the pipeline is ‘P-22’, produced in collaboration by USDA ARS, UGA and UF.

Introduction

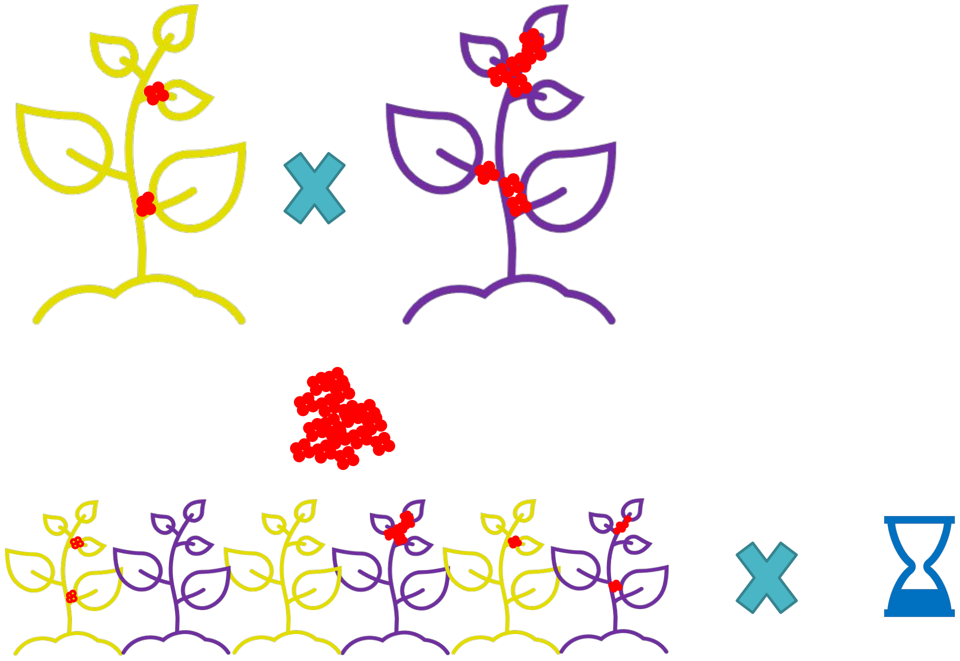
- Even though there has been great success in the development of rootstock materials in peach, to date, there is a lack of molecular tools being used to accelerate the breeding and selection cycles.
- There is a need to genetically characterize and understand plant pedigrees and backgrounds at the molecular level.
- Its crucial to incorporate molecular tools that can help expedite the breeding process.

Conventional vs Molecular Breeding

Conventional vs Molecular Breeding



Conventional vs Molecular Breeding



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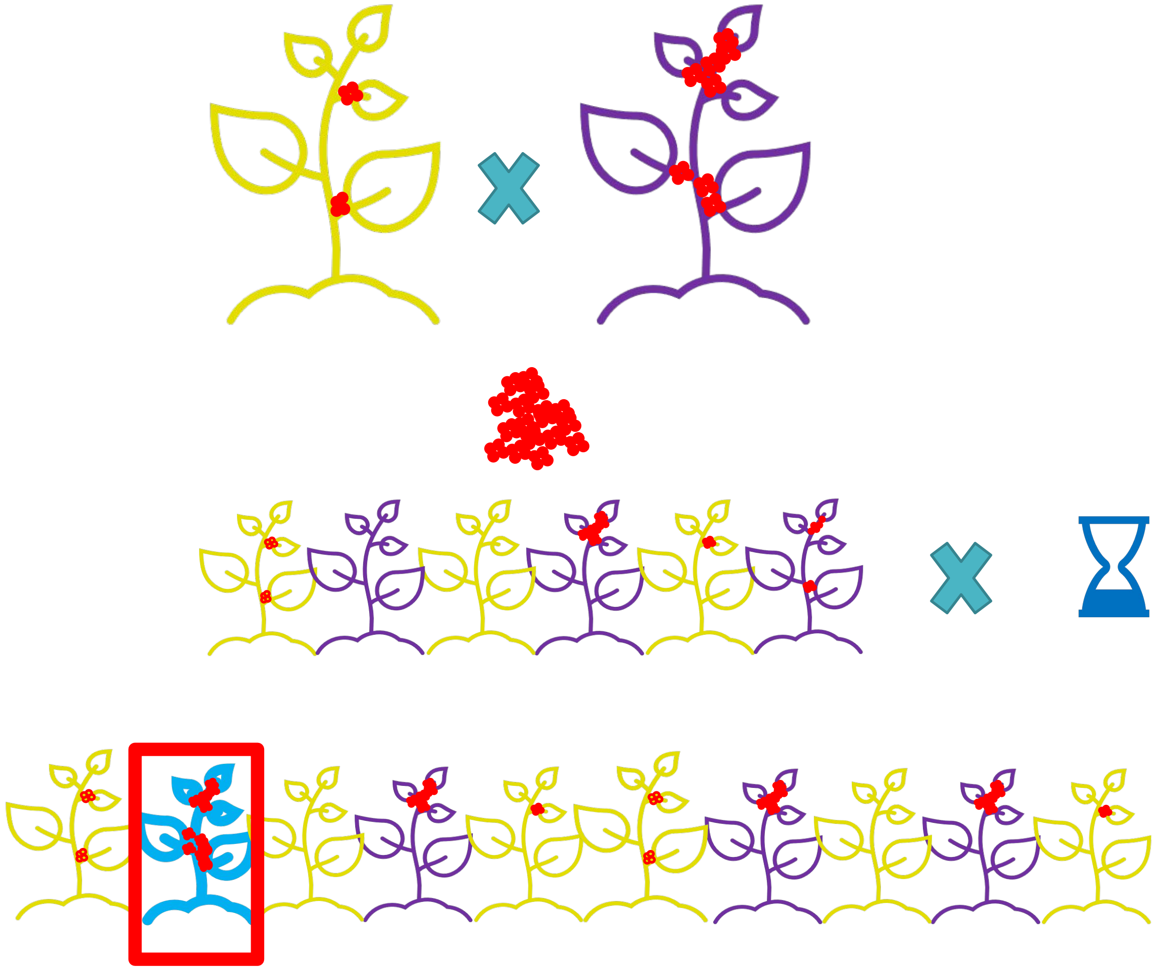

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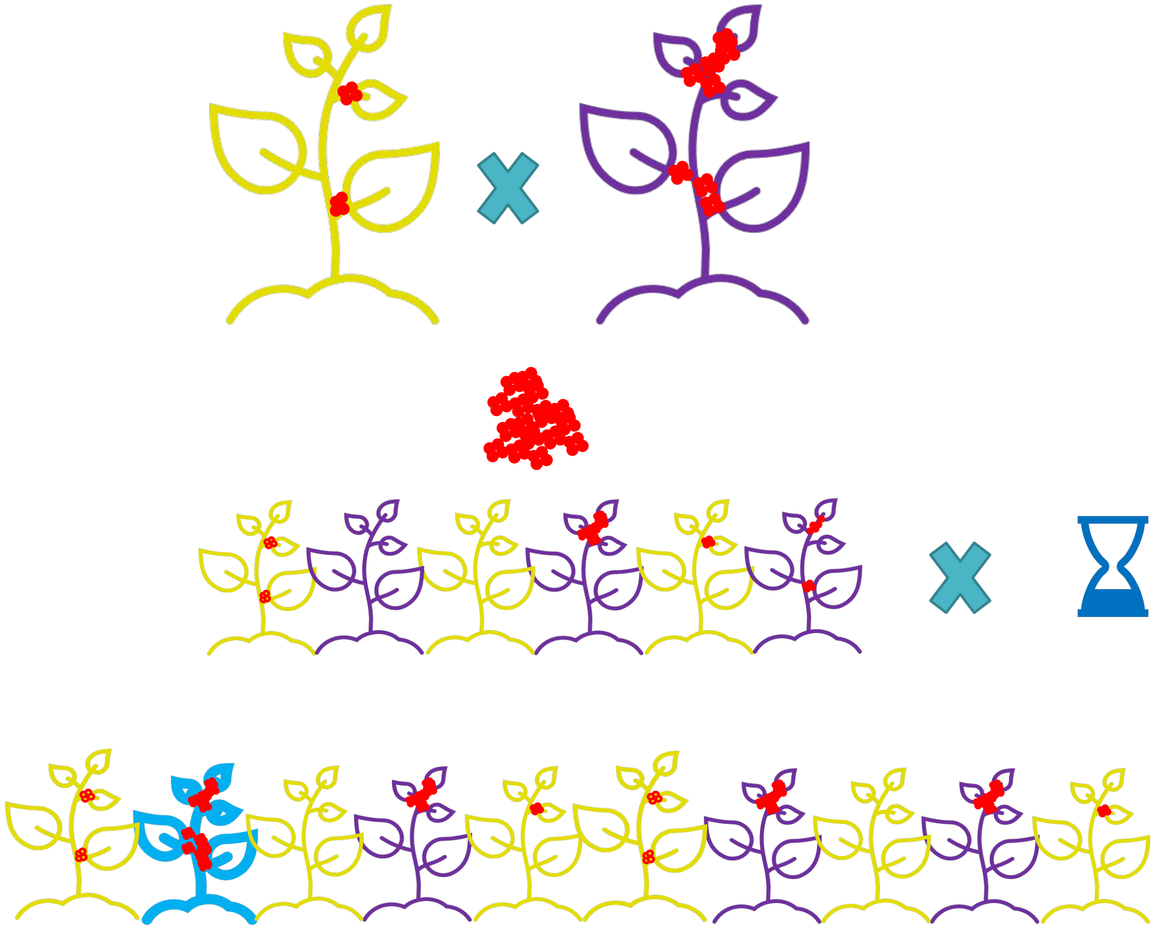

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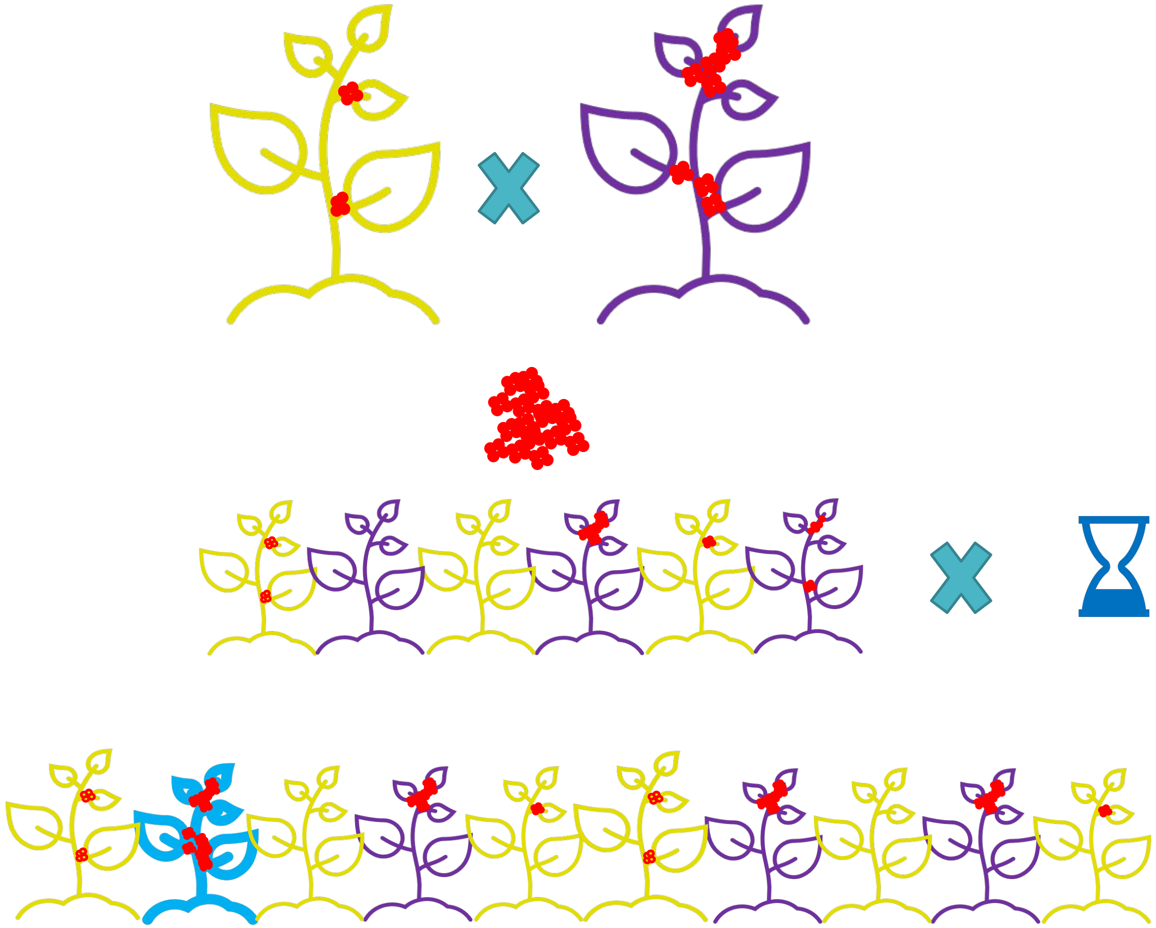

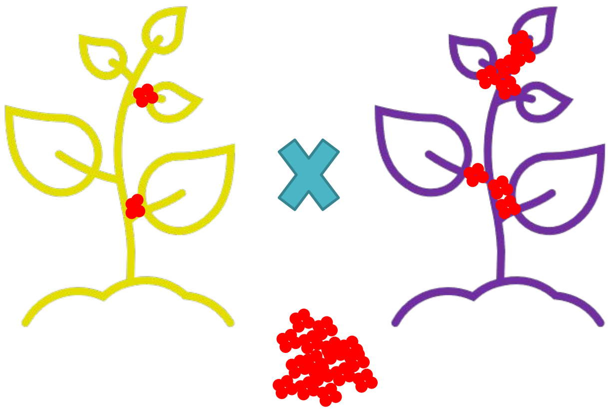

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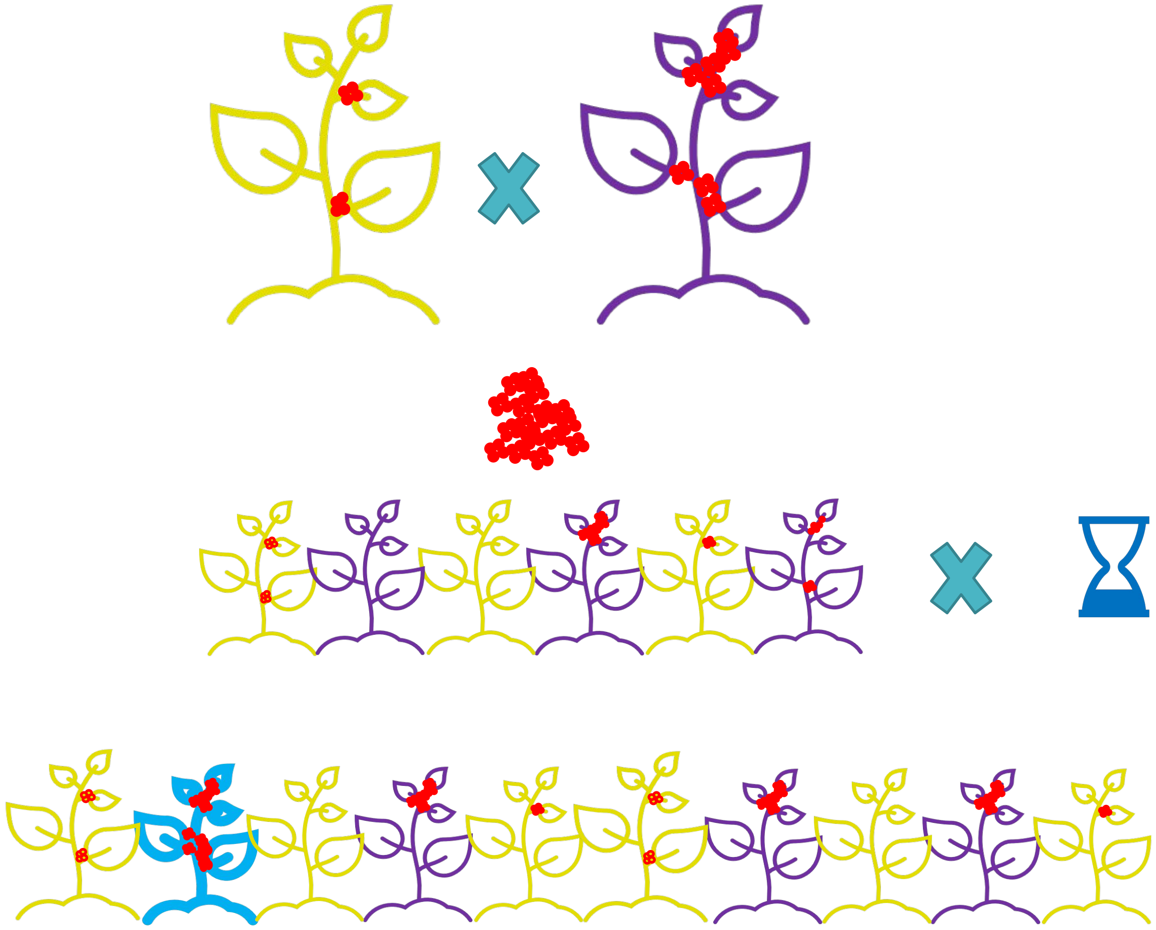

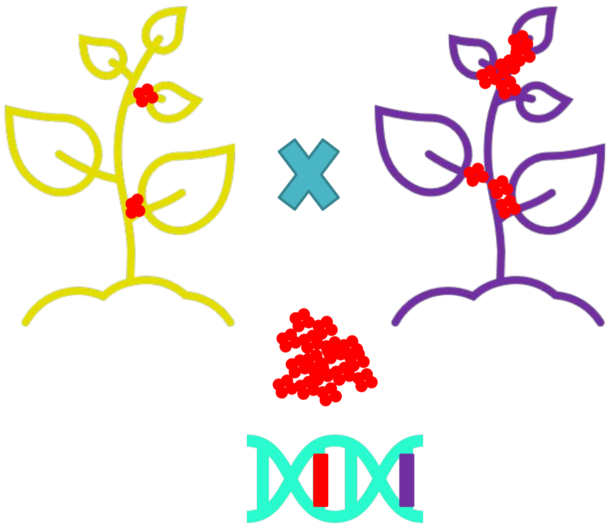

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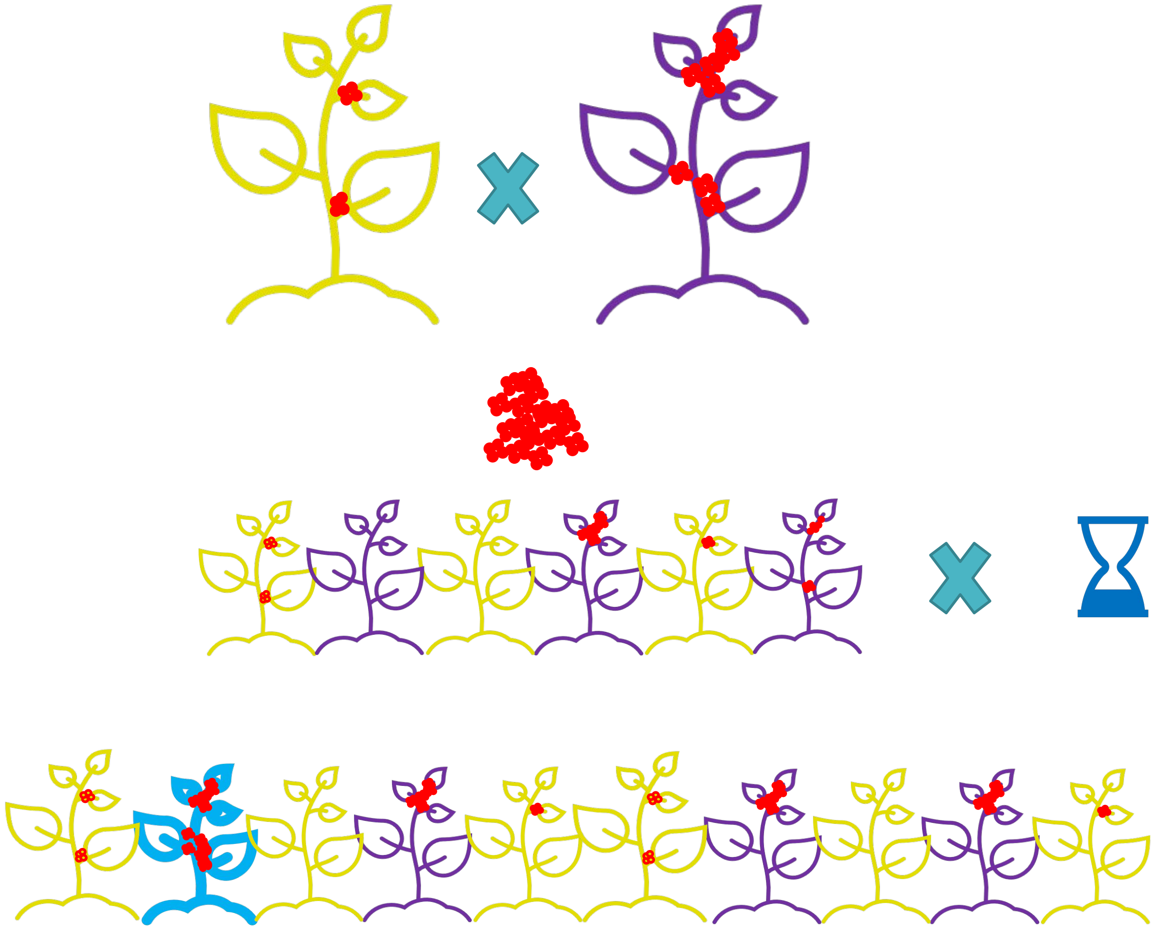
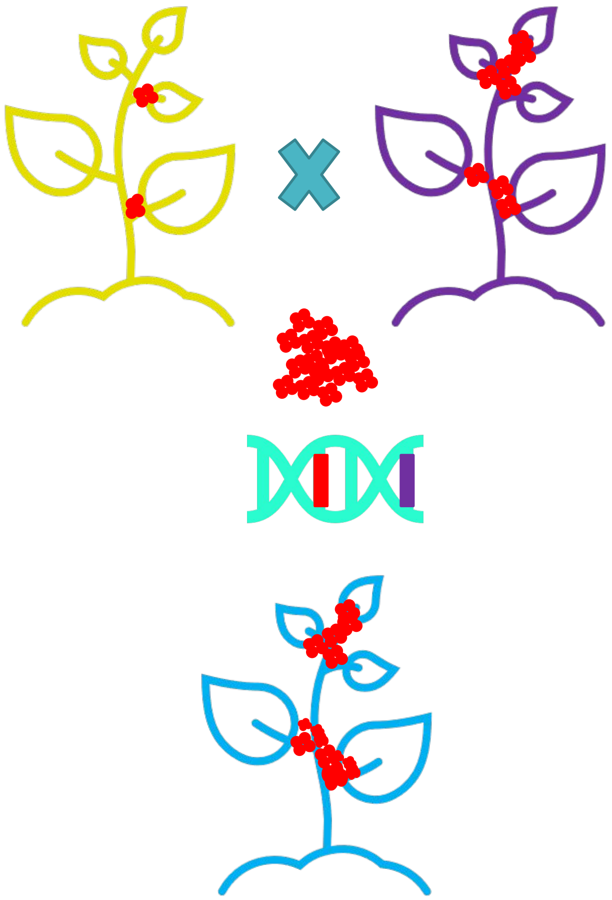




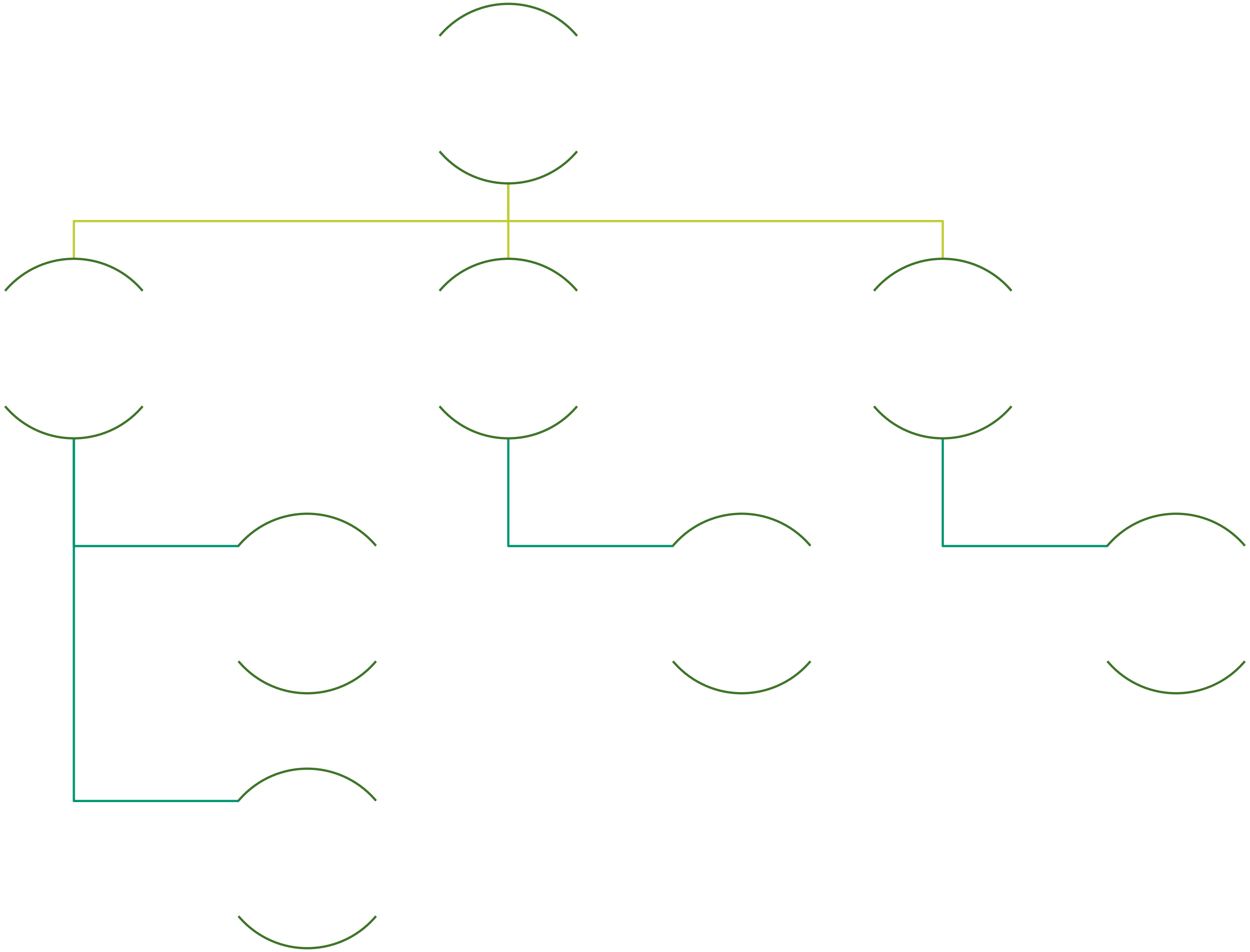
Program Goals

- *Evaluate, characterize and utilize the germplasm available*
  - Collect new germplasm
- *Utilization and development of genetic tools to facilitate breeding decisions*
  - Genetic tools designed inhouse
- *Establishing assays and protocols to accelerate trait discovery*
  - Accelerate screening
  - Invitro/Greenhouse
- *Evaluate and develop new materials that will positively impact growers and producers.*

Program Goals

The ultimate goal is to develop rootstock materials that exhibit disease resistance, desirable architecture, adaptable to climate change using lower inputs.

Focus Areas



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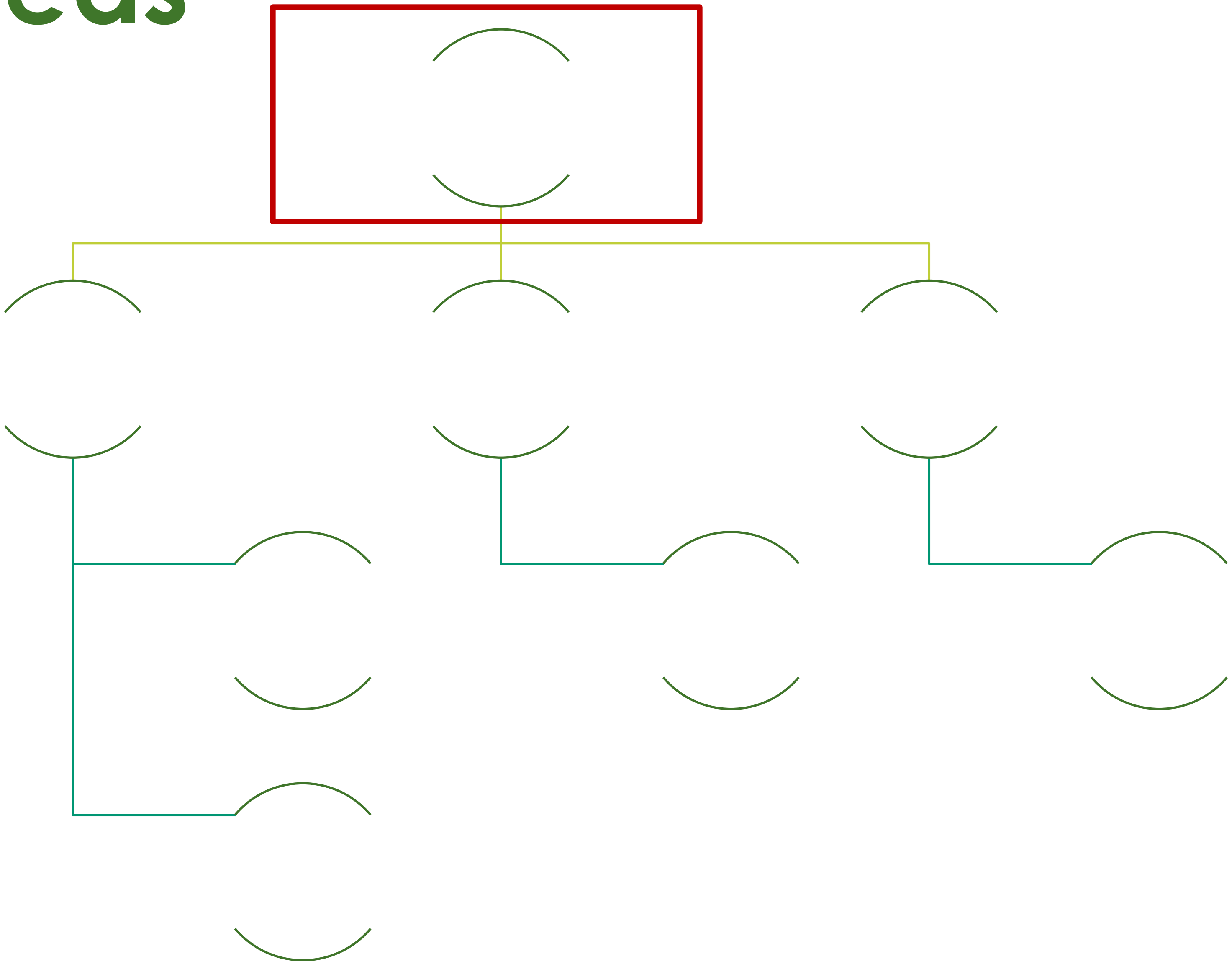
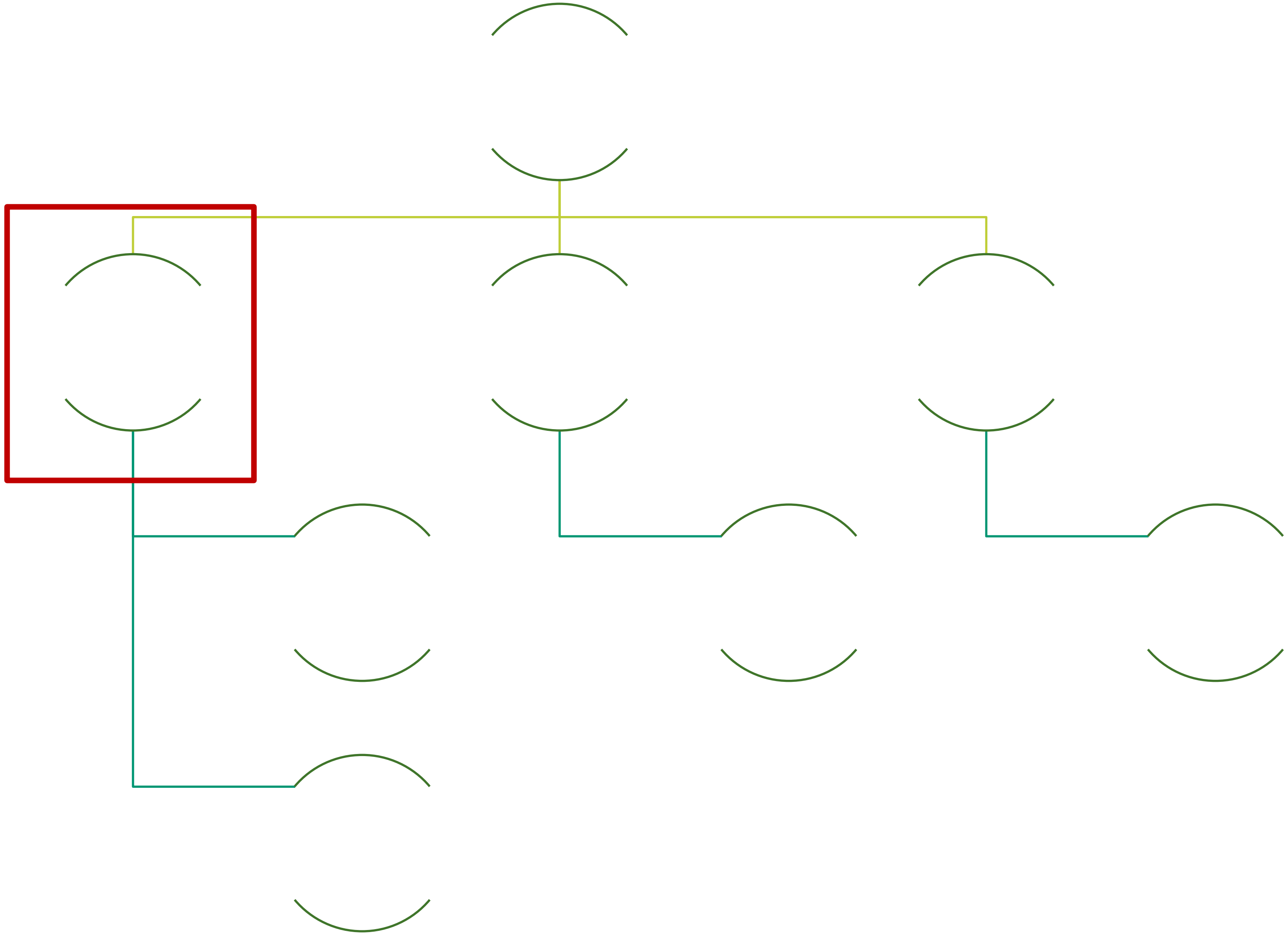


Germplasm

- There is a collection of plant material of different *Prunus* at USDA ARS Byron, GA
- Historical information of pedigree or origin
- Morphological data of disease resistance, chill requirements, bloom density etc.
- Lack of molecular data to identify materials

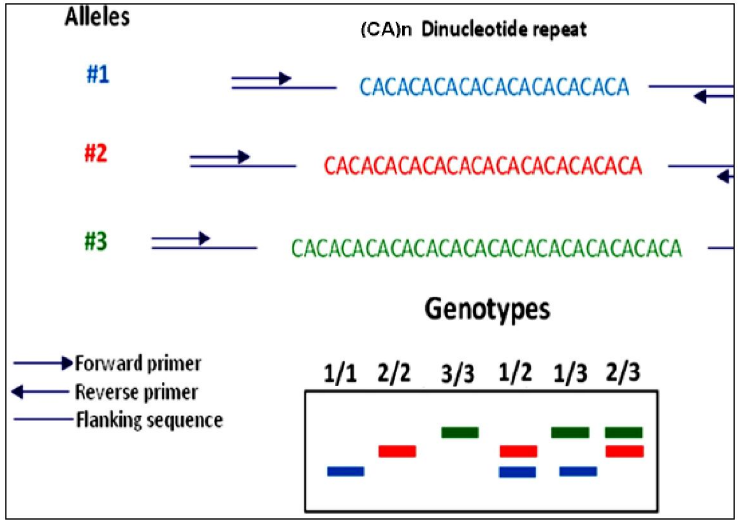
Focus Areas



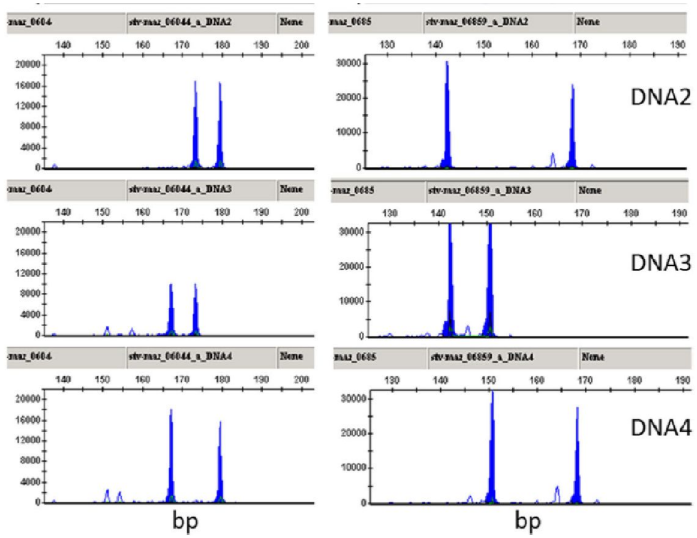
Genomics

Molecular Markers

- Useful discrimination tools to find duplicates or clones in plant material
- Are highly conserved regions among species
- Help us understand and analyze genetic relationships similar to a paternity tests



Alzohairy, Gyulai et al., 2015



Arias, R.S., Ballard, L.L., Duke, M.V. *et al.* Development of nuclear microsatellite markers to facilitate germplasm conservation and population genetics studies of five groups of tropical perennial plants with edible fruits and shoots: rambutan (*Nephelium lappaceum* L.), sapodilla (*Manilkara zapota* (L.) P. Royen), lychee (*Litchi chinensis* Sonn.), mangosteen (*Garcinia mangostana* Linn. and *Garcinia cochinchinensis* (Lour.) Choisy) and bamboo (*Bambusa vulgaris* Schrad. ex J.C. Wendl and *Guadua angustifolia* Kunth). *Genet Resour Crop Evol* **67**, 1715–1731 (2020).

Molecular Markers

- SSR (Simple Sequence Repeats)
  - Low cost
  - Highly reproducible results
  - Extensively studied and used

Molecular Markers

SSR (Simple Sequence Repeats)

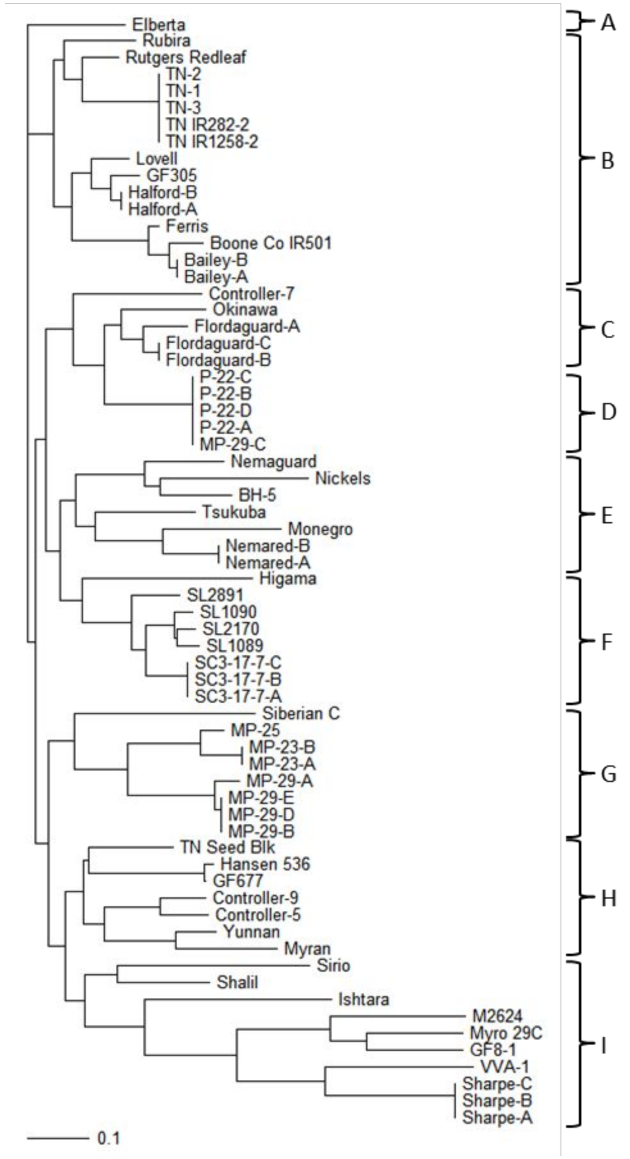
Chen and Okie 2014, 2017

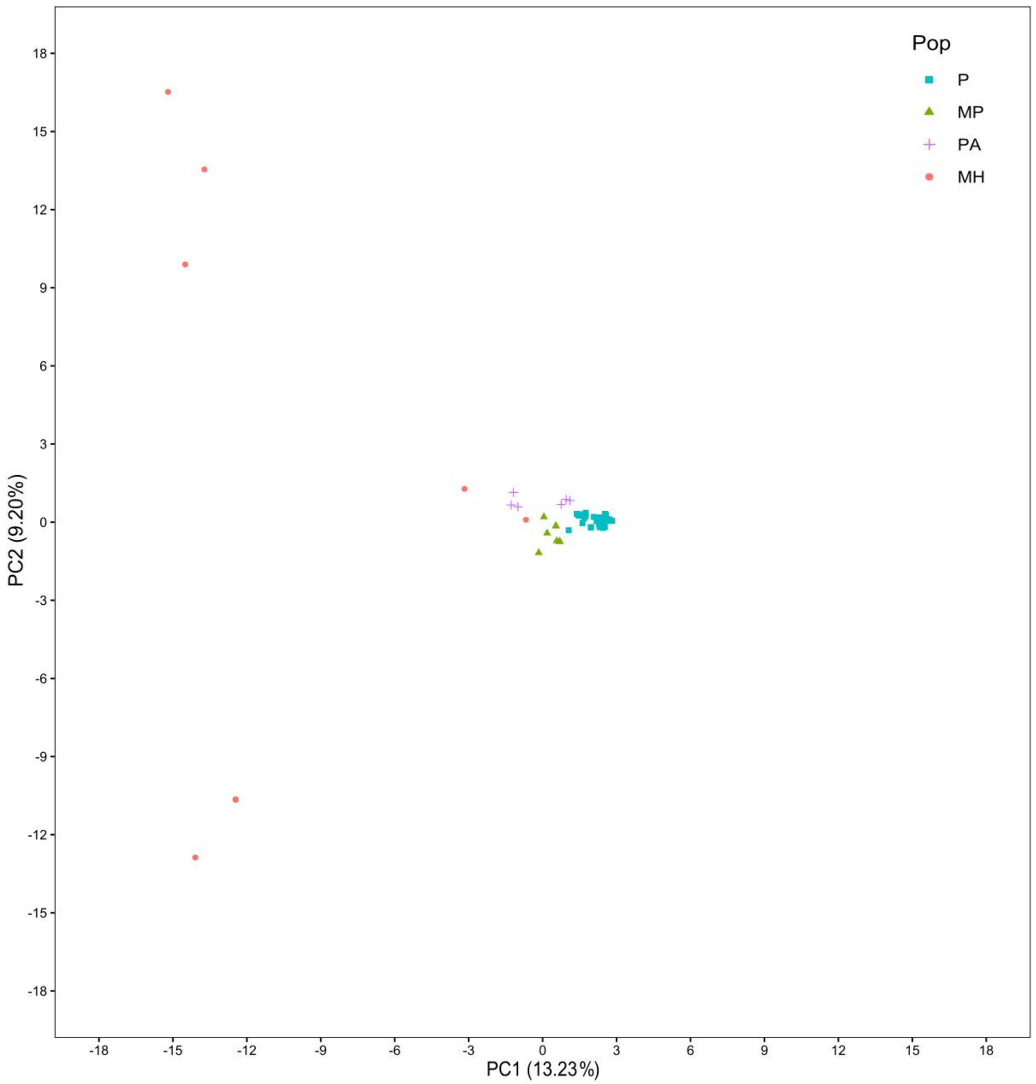
- 28 SSR Markers covering different regions in the genome

Chen and Okie 2021

- Used these markers to analyze genetic relationships and parentage of historical peach accessions/cultivars

Assessment of some *Prunus* rootstock accessions using chloroplast and nuclear microsatellites

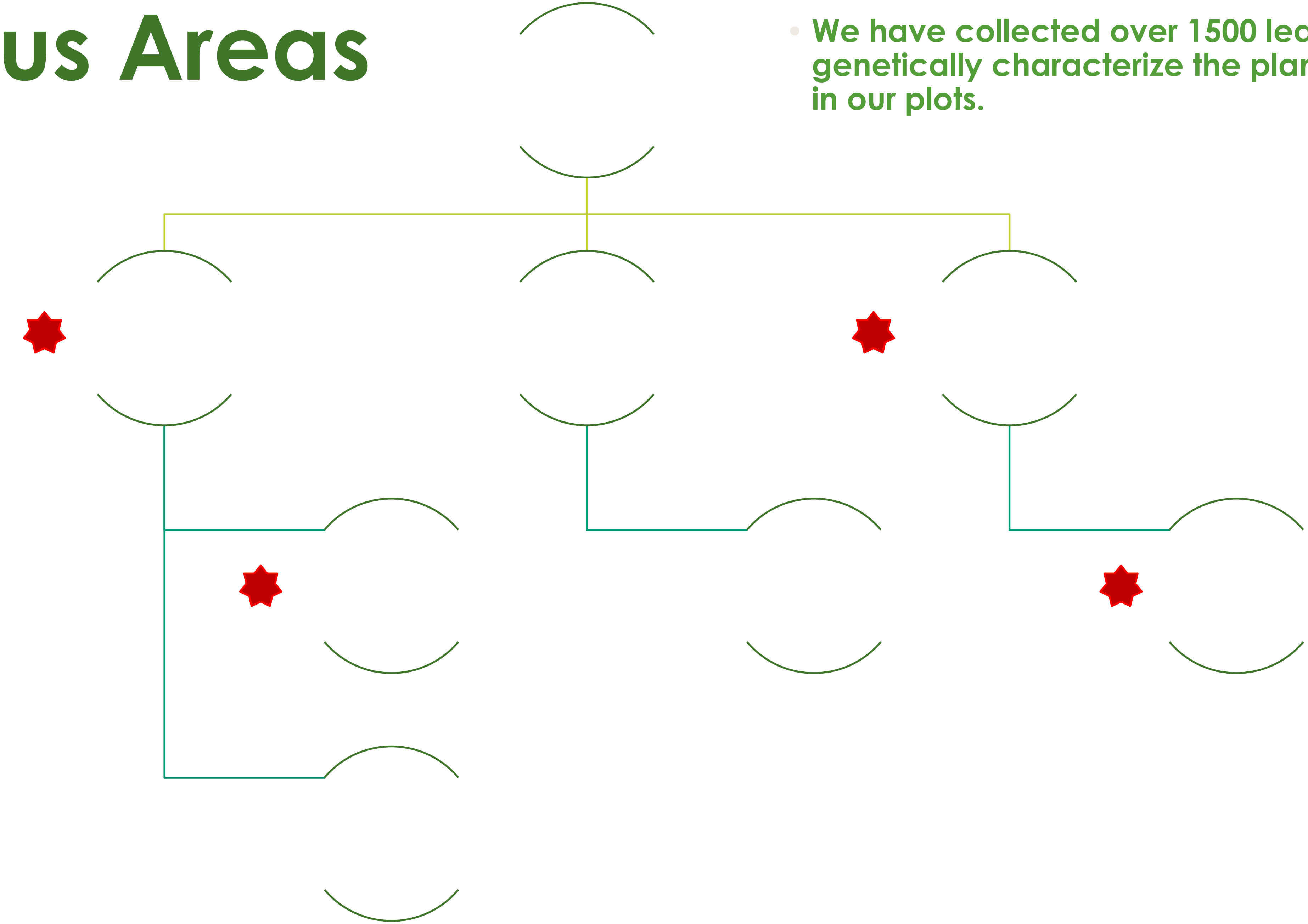




Chen, C. Rodriguez Bonilla, L., Beckman T. Assessment of some Prunus rootstock accessions using chloroplast and nuclear microsatellites. Accepted, In Review.

Focus Areas

- We have collected over 1500 leaf samples to genetically characterize the plant material growing in our plots.



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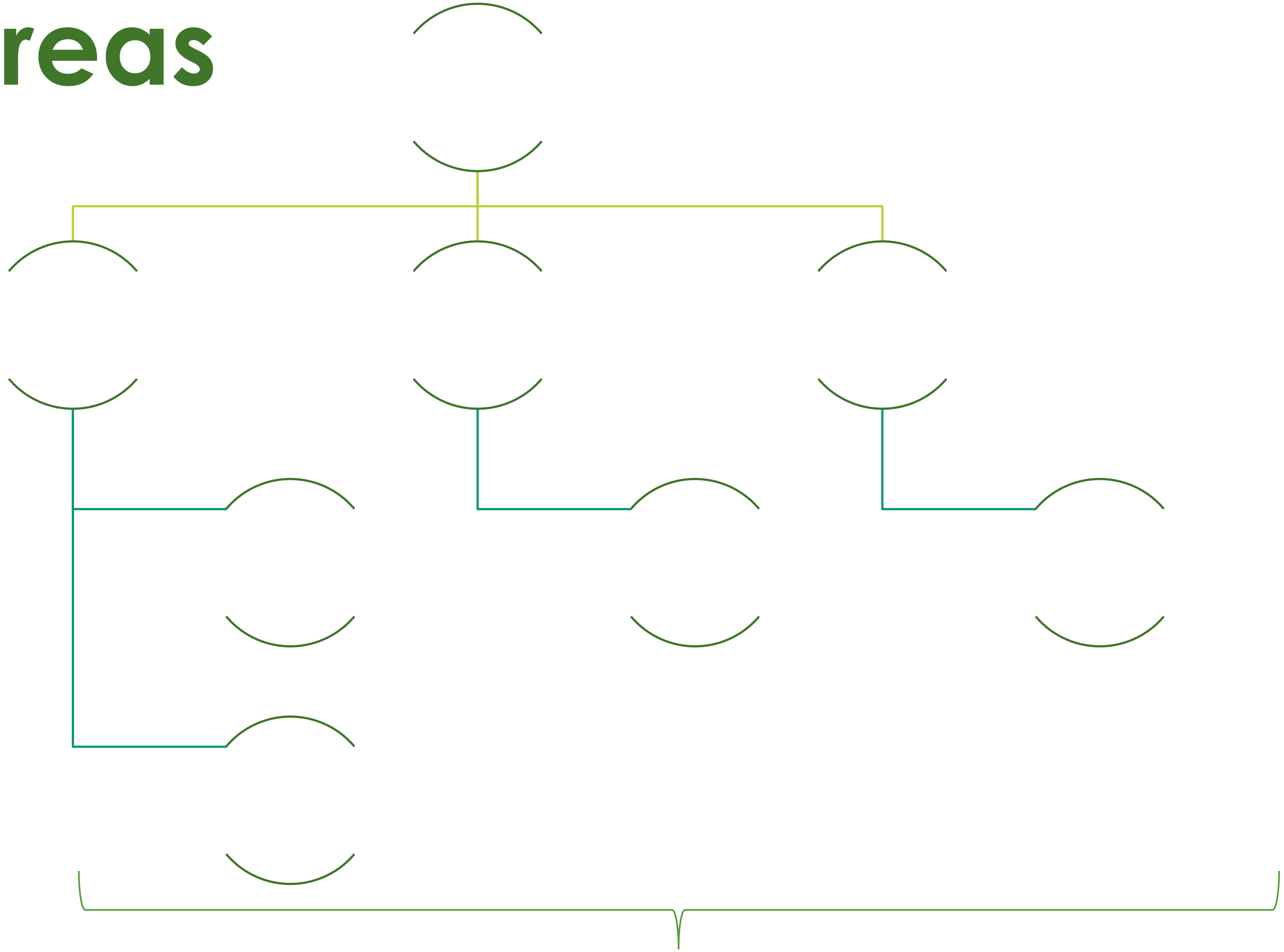

Future goals

Future goals

- Germplasm:
  - Obtain new plant materials to broaden genetic diversity.
    - Plant Expeditions
    - Utilize resources at NGPS
  - Understanding and guarding available resources
    - Continue to characterize USDA ARS Byron materials
    - Establish and invitro/seed collection with the purpose of backing up materials

Future goals

- Germplasm:
  - Phenotyping:
    - Develop bioassays and testing disease resistance at the seedling stage to facilitate selections.
    - Include technologies such as hyperspectral imaging to detect infections early on.

Future goals

- Genomic:
  - Develop new markers that will allow us to do more fine trait association such as SNP's (Single Nucleotide Polymorphisms)
  - Sequence genomes to better understand evolution of traits
  - Characterize gene function and expression
  - Understand trait expression and heritability of disease resistance traits
  - Understand changes in microbiome and exudates related to resistant/susceptible rootstock

Future Goals

- Breeding/Horticulture:
  - Continue to make crosses to develop mapping populations that will allow for trait discovery
    - Increased resistance to *Armillaria*, PTSL
  - Explore the usage of other peach wild relatives that can be grafting and cross compatible

Future Goals

- Breeding/Horticulture:
  - Plant crosses to select for rootstocks that positively influence scion architecture.
    - Plant height, branching, etc.
  - Develop test plots to evaluate rootstock vigor and inputs in fruit quality and yield.
  - Test and evaluate interstems.
  - Evaluate rootstocks in marginal soils such as those with waterlogging/salinity issues.

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Questions

Lorraine Rodriguez Bonilla
Lorraine.Rodriguez@usda.gov