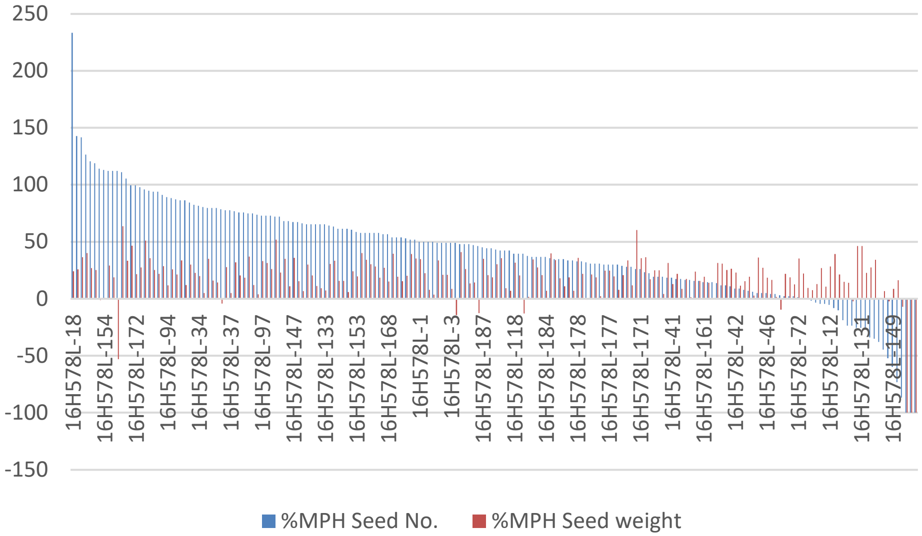
Identification and Characterization of Heterotic Genotypes in Lentils for Enhanced Crop Productivity

Gurpreet Kaur Suri



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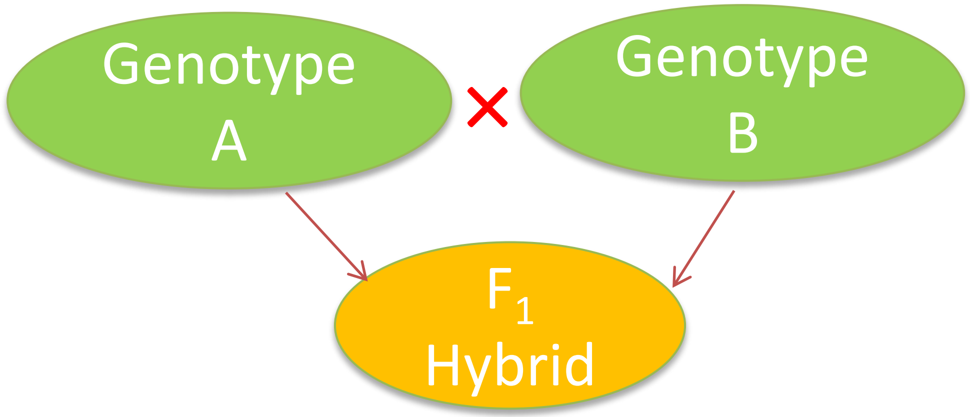
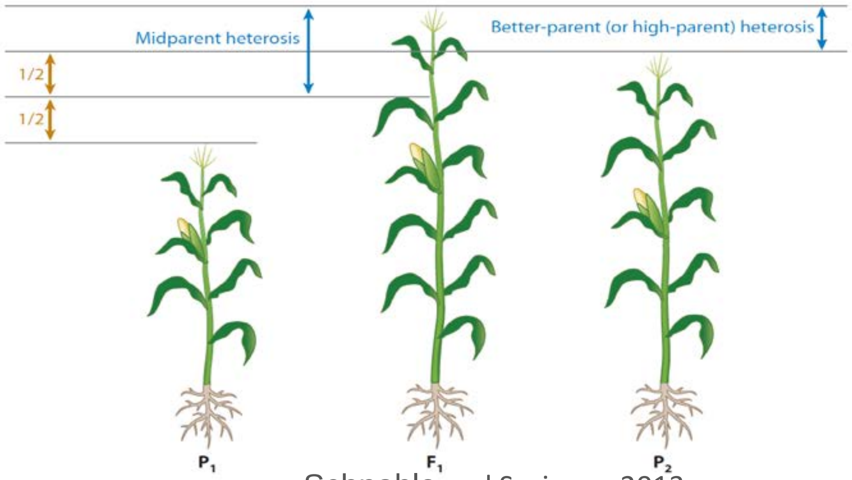
Introduction to Heterosis

- Heterosis -a phenomenon where cross breeding between two genotypes → F_1 hybrid phenotypically and genetically improved offspring/hybrid.



- Types of heterosis
  - mid-parent heterosis
  - better parent heterosis



Schnable and Springer, 2013

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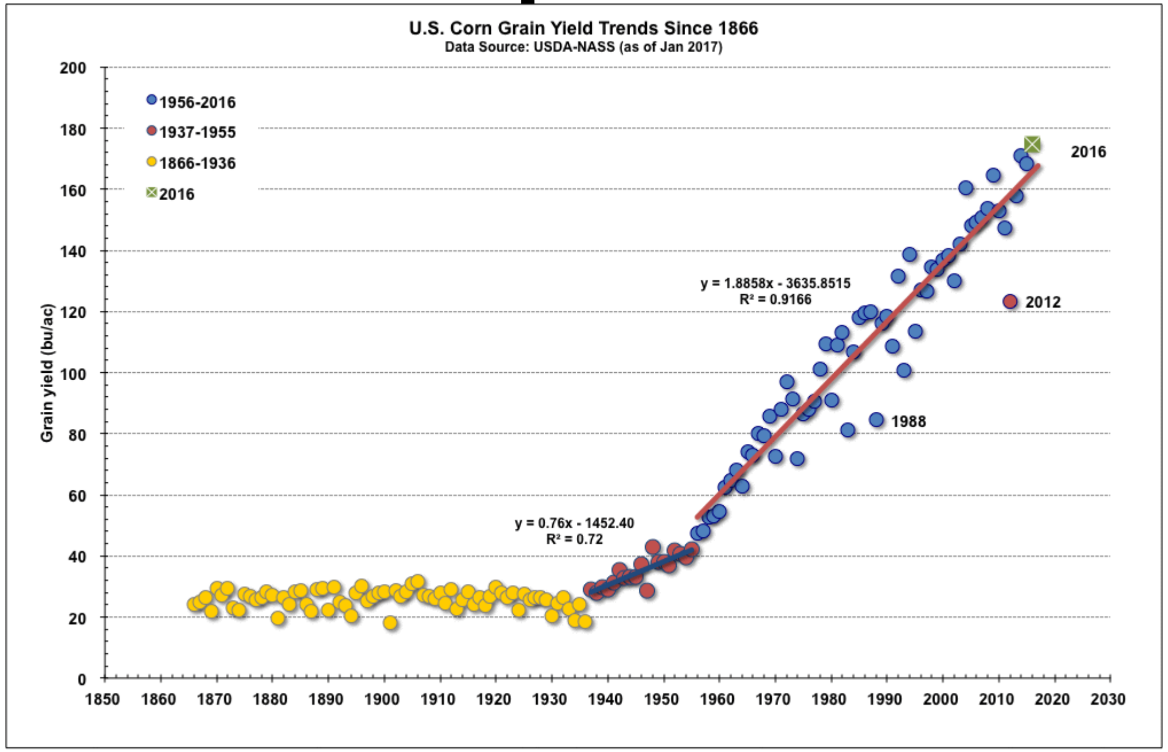
Heterosis and Yield in Crops

- Hybrid maize - 65% of total USA cultivation
- Hybrid rice - 20-30% yield advantage in China
- Hybrid wheat-10-25% yield gain by heterosis
- Hybrid sorghum - yield gains of 35-40% in the USA



Australian export market for lentils (2011-2016)

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Heterosis and Lentils

1. Does heterosis exist in lentils?
2. What happens over generations?
3. What is the genetic architecture of heterosis in lentils?
4. Can we genomically identify regions responsible for heterosis?

Heterosis in Lentils: F_1

- F_1 hybrids outperformed their parents
- One of the best performing crosses exhibited 62% heterosis for seed number and 57% for seed weight
- Top five heterotic crosses (with a negative control) were progressed to F_2

Cross Id	Seed Number	Seed weight	Fresh weight	Height
16H578L	61.90	56.197	39.94	31.23
16H158L	30.69	25.72	17.74	18.33
16H006L	56.78	54.79	49.82	6.21
16H051L	51.63	45.68	46.26	-2.68
16H065L	35.26	41.69	44.20	1.86
16H239L*	-59.21	-34.64	-24.10	-17.07

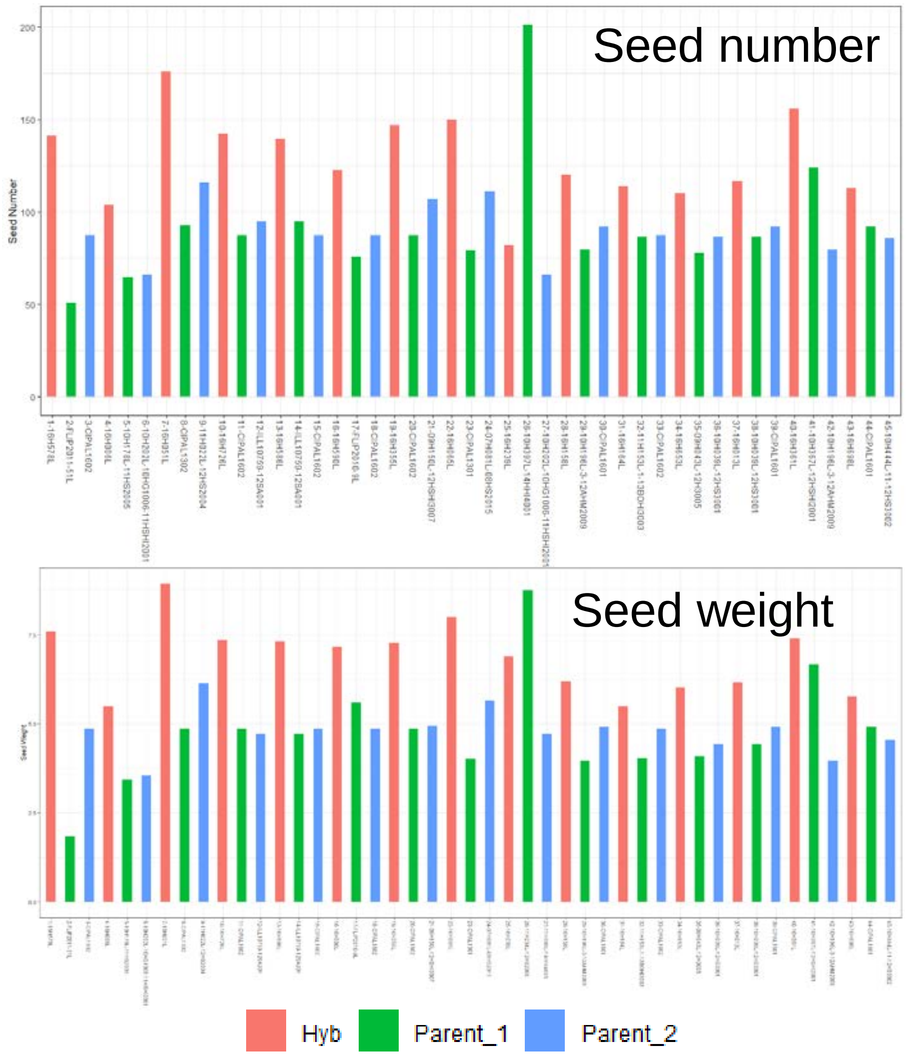


Fig. F_1 hybrids from various germplasms of lentils outperformed their parents in seed number and seed weight. The data includes mean of 4 replicates for 12 F_1 populations exhibiting heterosis with respect to the better parent and 1 negative control (16H239L)

Heterosis in Lentils: F_2

- One of the cross exhibited ~80 to -60% change in heterosis over the population for seed number
- F_2 was more variable in its performance as compared to F_1

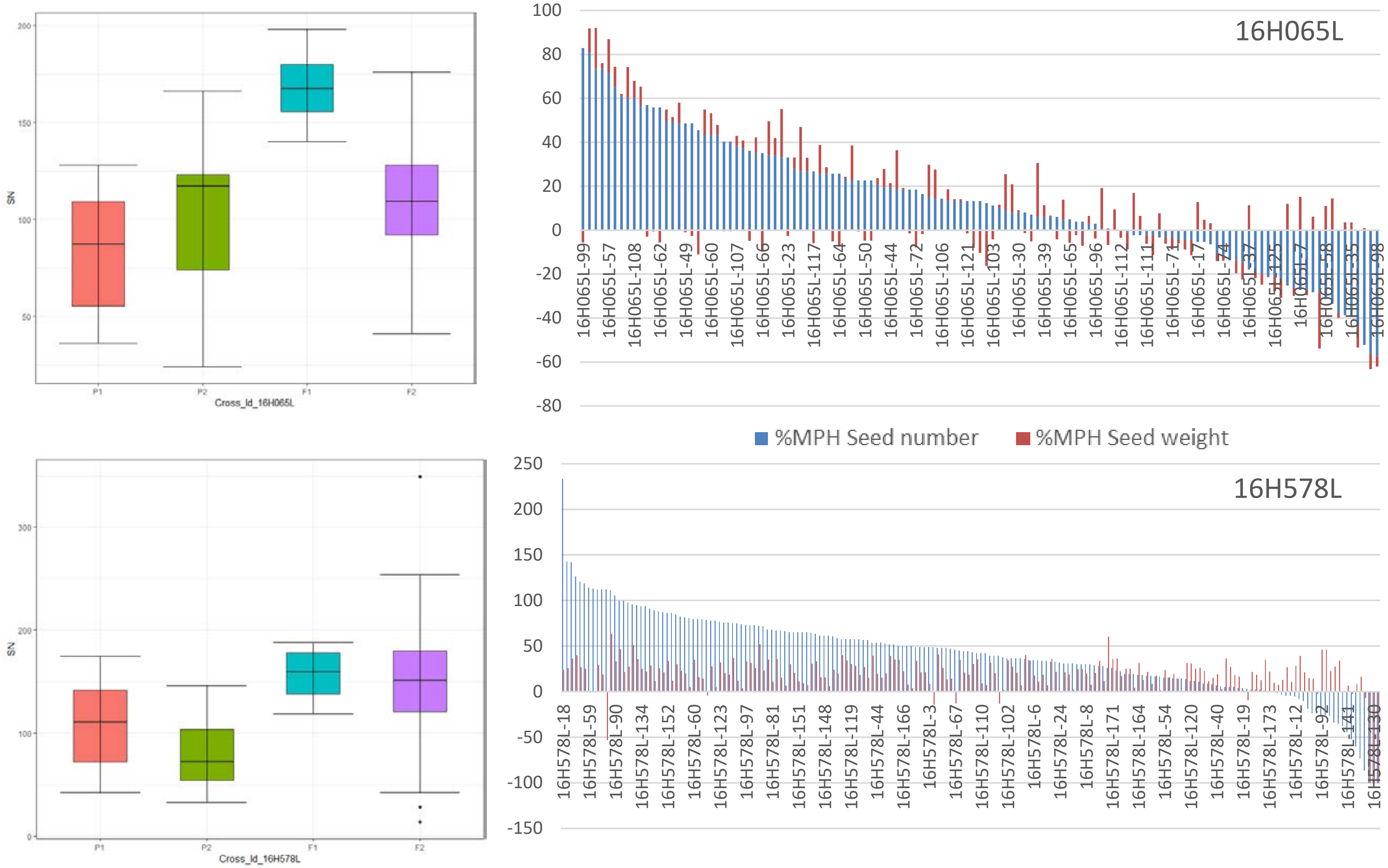
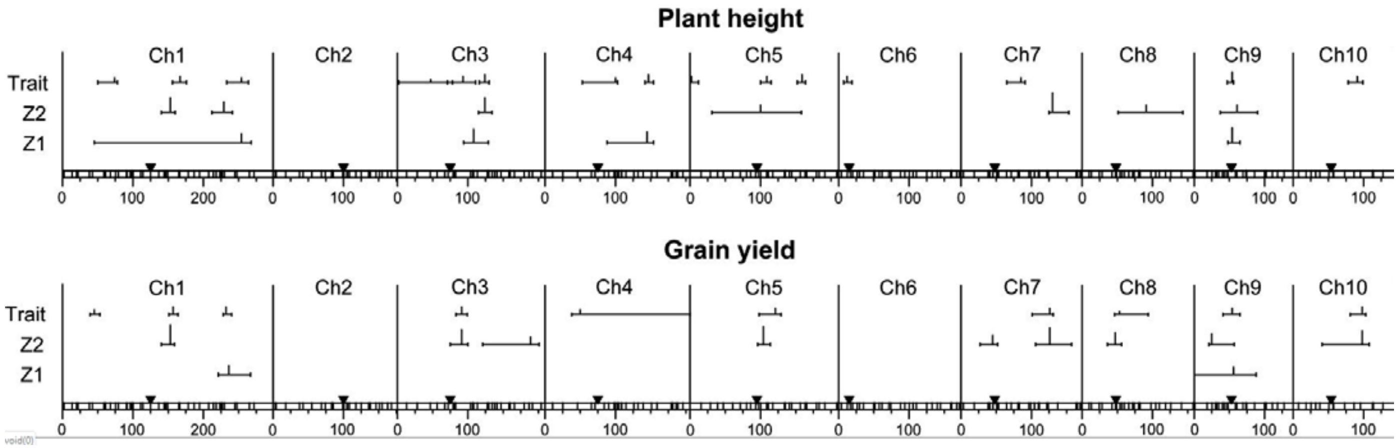


Fig. F_2 hybrids of lentils outperformed their parents in terms of seed number and seed weight. The data represents % heterosis with respect to the mid-parent value (RHS). Box-plots showing the progress of heterotic line in each generation in terms of seed number (LHS)

What is the Genetic Architecture of Heterosis in Lentils?

- Single gene / small genomic segments
  - *Arabidopsis- WUSCHEL, ARGOS, IAA28, GA3*
  - Tomato- *Single Flower Truss* (*SFT*) gene

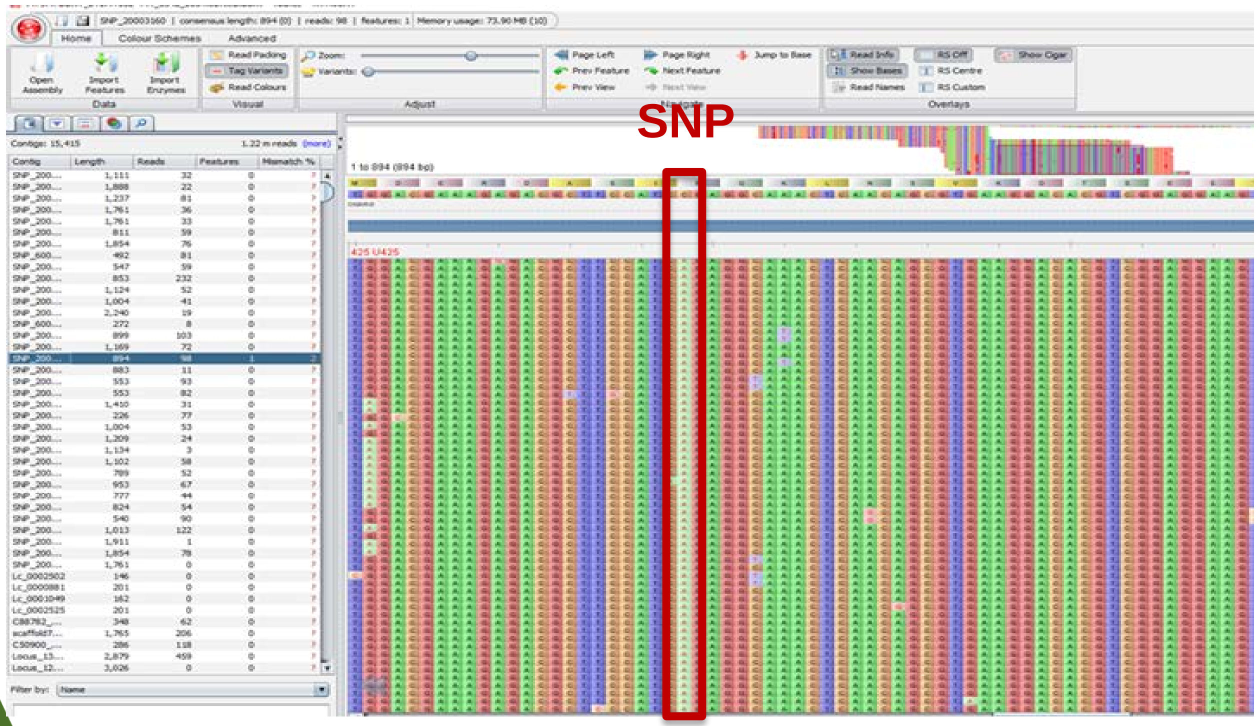
- Polygenic
  - *Maize*
  - Rice



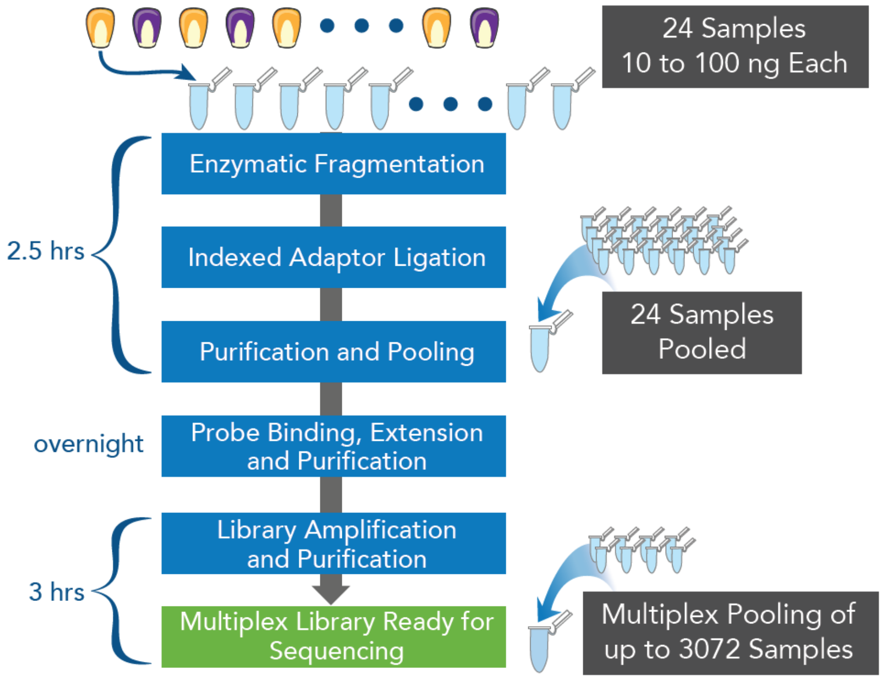
QTL projection for the global design (Trait) and the three NCIII designs (Z_1 and Z_2) for plant height, and grain yield in Maize (Larièpe et al., 2012)

Genomic Analysis of Heterosis in Lentils

- Genotyped 366 lines from F_2 populations using Allegro Targeted Genotyping
- 60,000 SNPs analysed across genome to look at entire population
- Correlation of these SNPs with phenotypic observations for heterosis
- Genotyping F_3 lines to refine and validate initial genomic associations



Tablet view



Allegro targeted genotyping workflow

Heterosis and Lentils

Does heterosis exist in lentils?

What happens over generations?

What is the genetic architecture of heterosis in lentils?

Can we genomically identify regions responsible for heterosis?

Yes

F_1 most consistent
F_2 more variable
Other generations to be screened

F_2 generation genotyped
Analysis to follow

Hopefully

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many
Thanks!