

Improving the market value of peas for human consumption markets

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Market value of field peas

Visual quality requirements to qualify as “Canada No. 1” grade

- Green cotyledon peas
 - Good natural green color
 - Less than 2% bleached seeds
- Yellow cotyledon peas
 - Good natural yellow color



(Official grain grading guide of the Canadian Grain Commission, 2005)

Market value of field peas

Important visual quality traits

- Seed size
- Shape
- Seed surface texture
- Uniformity of the seeds



How to improve the market value of peas

- Need promising varieties with improved grade potential
- Genetic study of these quality traits are challenging
 - Complex inheritance
 - Strongly influenced by the environment
- Identification and characterization of the genetic and environmental control of these traits is vital for plant breeding
- Development of molecular markers to assist the breeding programs

Objectives

- Characterize the genetic basis
 - Green cotyledon bleaching in green pea
 - Seed color in yellow pea
 - Seed shape
 - Seed dimpling in both yellow and green types
- Identification of molecular markers
- Understand the biochemical changes of green cotyledon bleaching
- Investigate the gene action of the seed coats during seed development

Development of test populations

Green pea

Yellow pea



X



CDC Striker

Orb

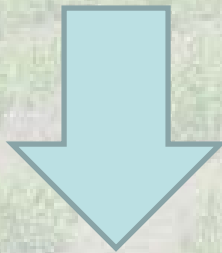


X

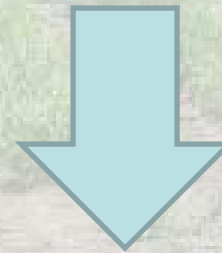


Alfetta

CDC Bronco



90 individuals



121 individuals

Characterization of test populations

- Evaluated in field experiments in 2006 and 2007
- Two locations with two replicates
 - Saskatoon (SPG) and Rosthern
- Seeds harvested were evaluated for the quality traits



Assessment of seeds for visual quality

Color related traits



Hunter Lab colorimeter

Accelerated bleaching



High intensity light chamber

Seed shape



More blocky seeds

More round seeds

Seed dimpling: Visual scale

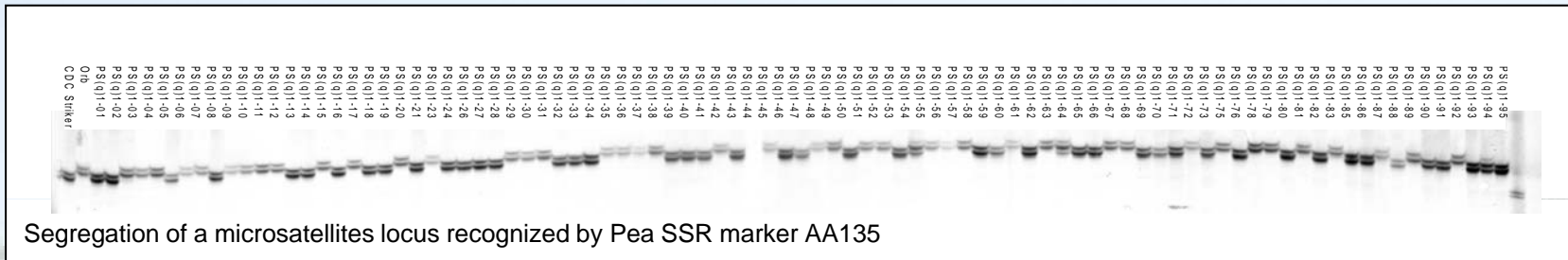


Smooth :1

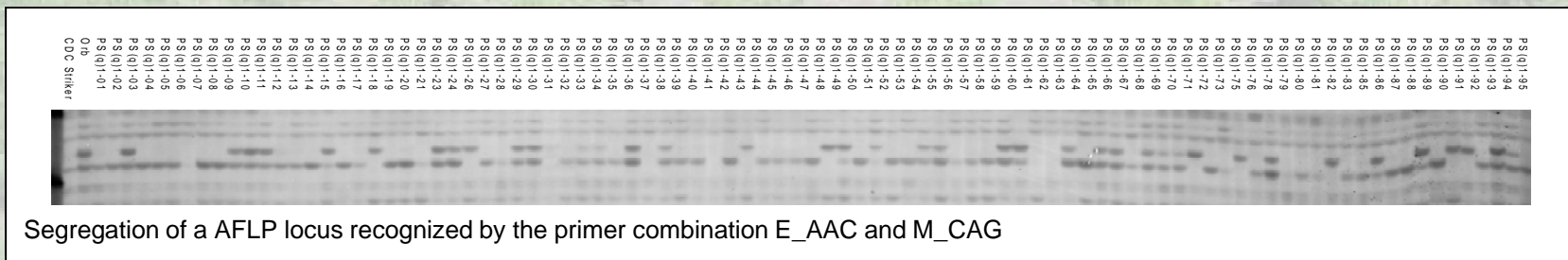
Dimpled: 5

DNA fingerprinting of the two test populations

Pea SSR and AFLP marker analysis of all the test lines



SSR markers

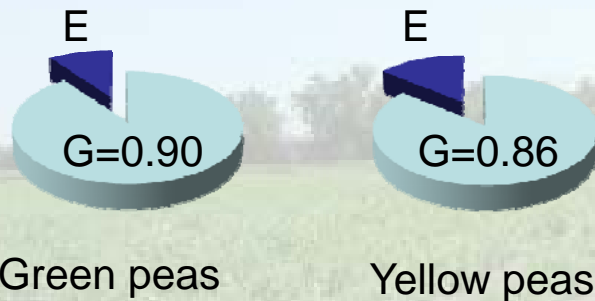


AFLP markers

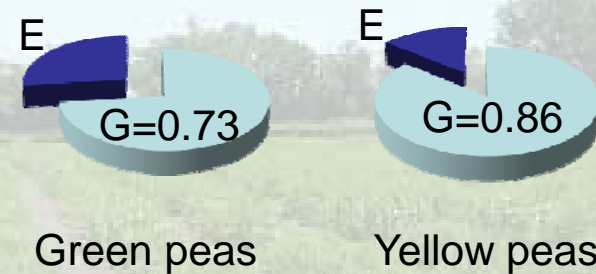
Genetics of visual quality traits

- Quantitative inheritance
- Controlled by several genes

Heritability : Seed shape



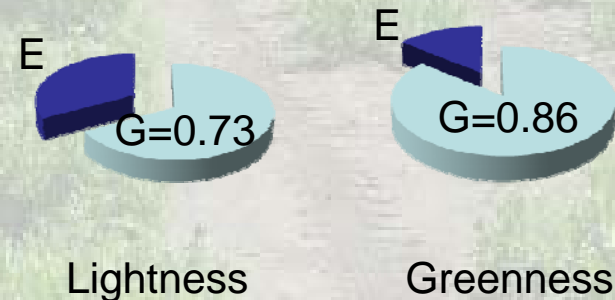
Heritability : Seed dimpling



Heritability : Seed bleaching



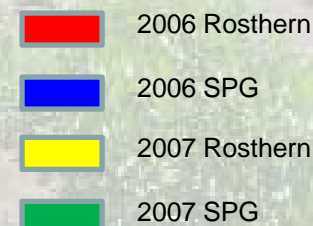
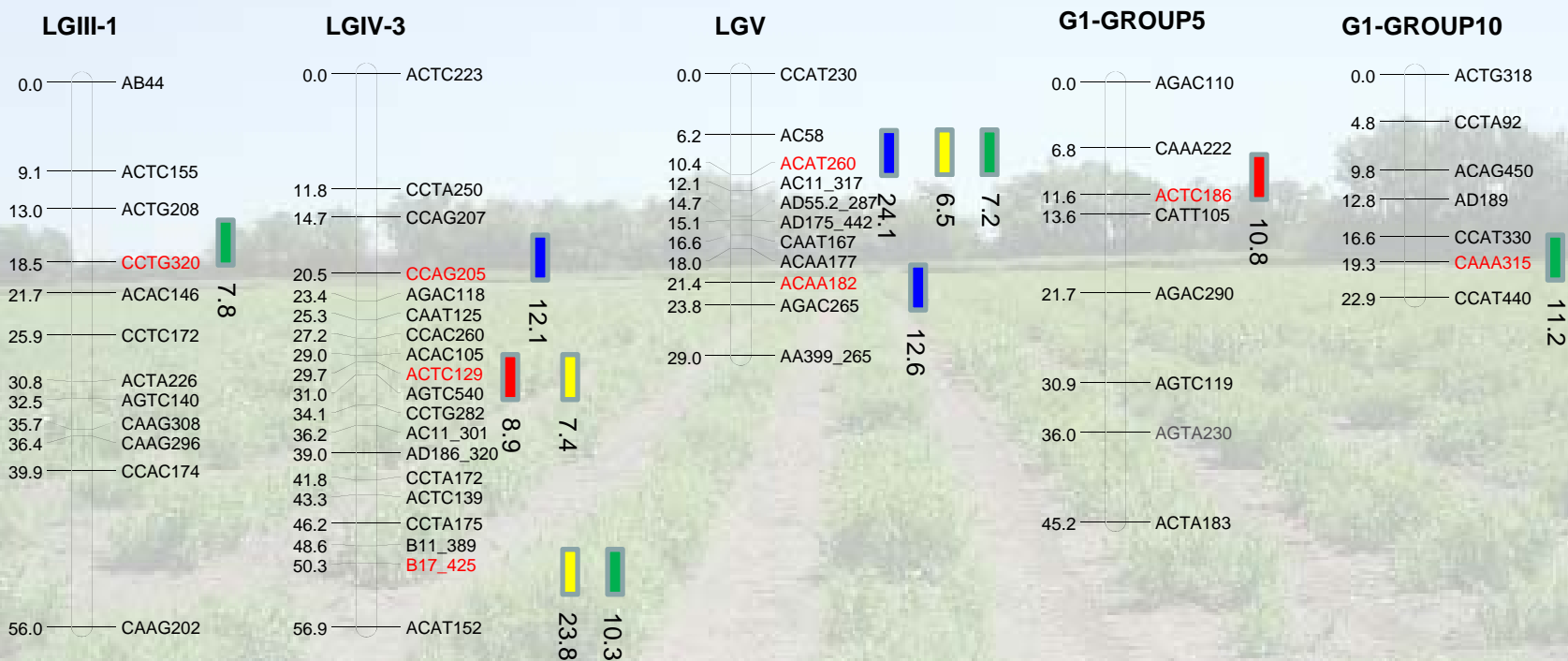
Heritability : Yellow seed color



Genomic regions controlling visual quality traits

Green cotyledon bleaching resistance

Based on Hunter Lab 'a' value of cotyledons after exposed whole seeds to light

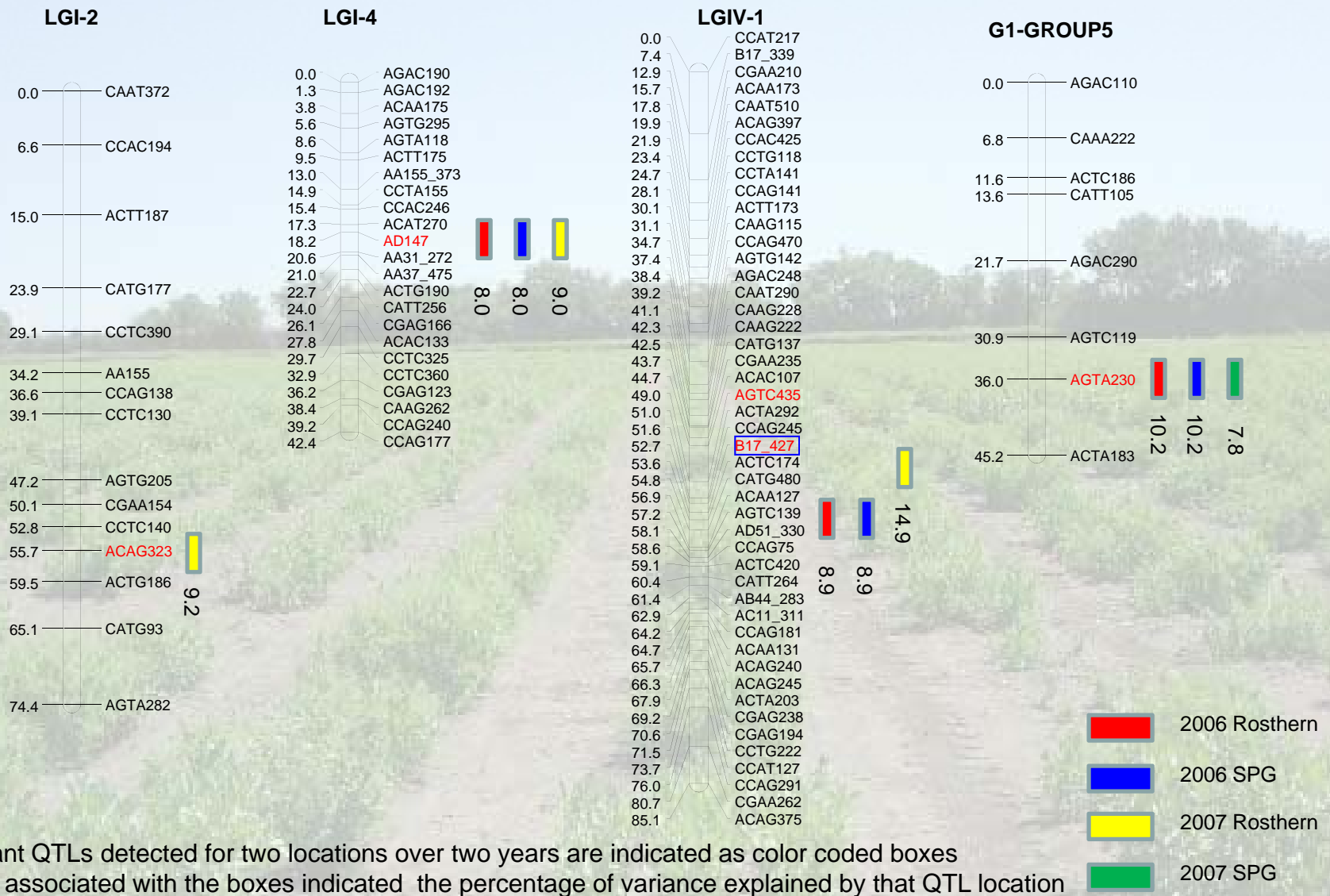


*Significant QTLs detected for two locations over two years are indicated as color coded boxes

*Number associated with the boxes indicated the percentage of variance explained by that QTL location

Genomic regions controlling visual quality traits

Seed shape (Green pea test population)

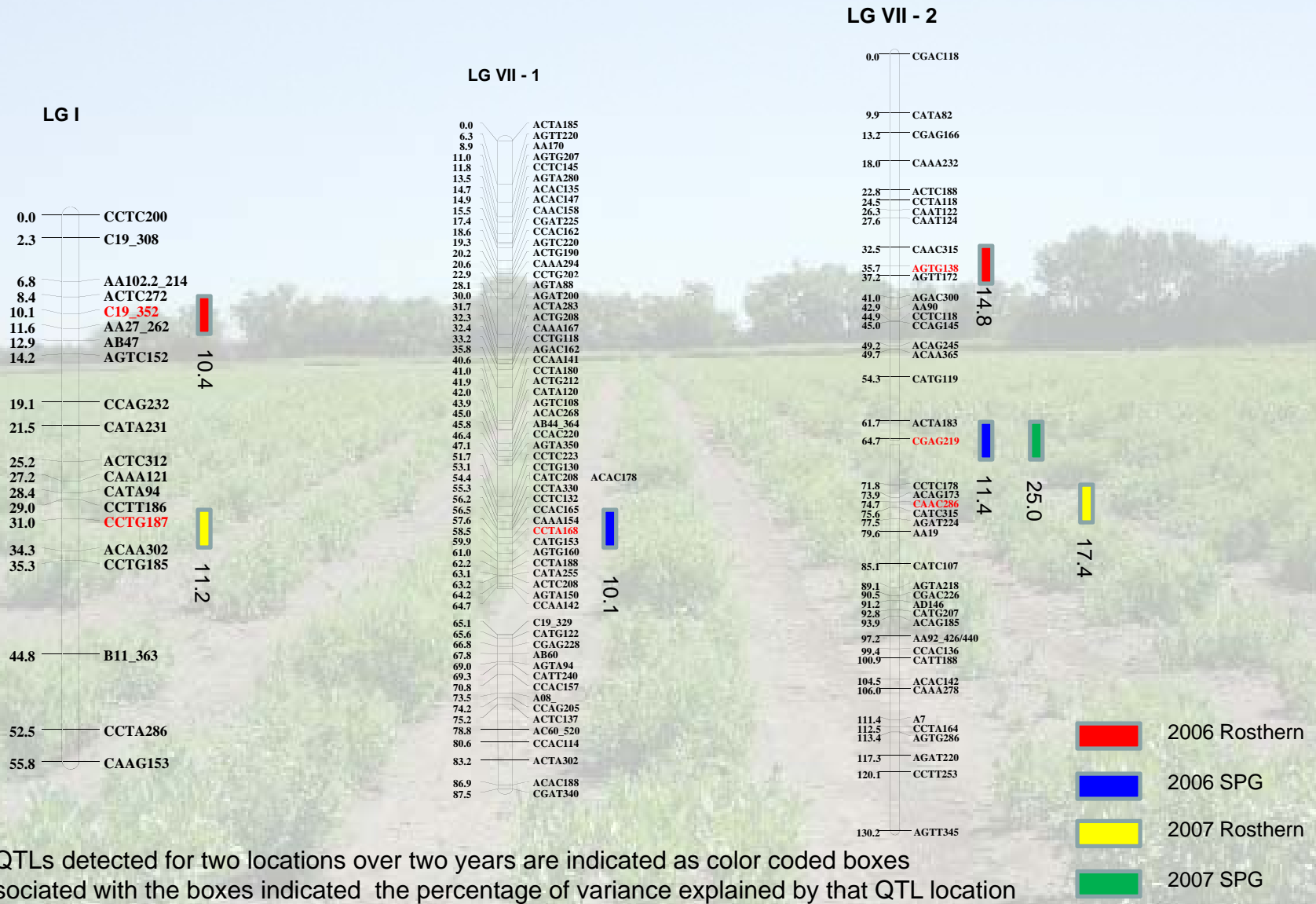


*Significant QTLs detected for two locations over two years are indicated as color coded boxes

*Number associated with the boxes indicated the percentage of variance explained by that QTL location

Genomic regions controlling visual quality traits

Seed shape (Yellow pea test population)

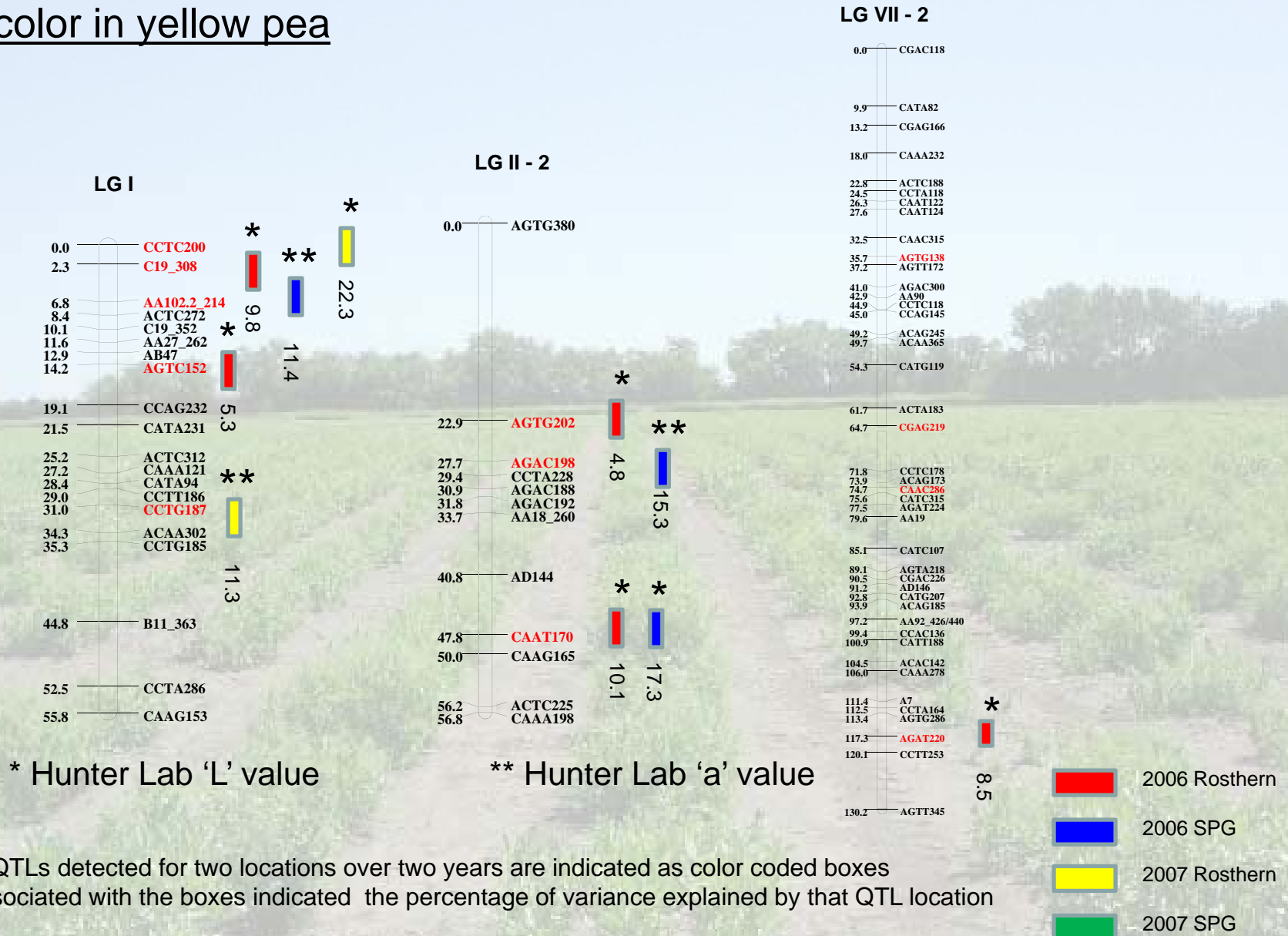


*Significant QTLs detected for two locations over two years are indicated as color coded boxes

*Number associated with the boxes indicated the percentage of variance explained by that QTL location

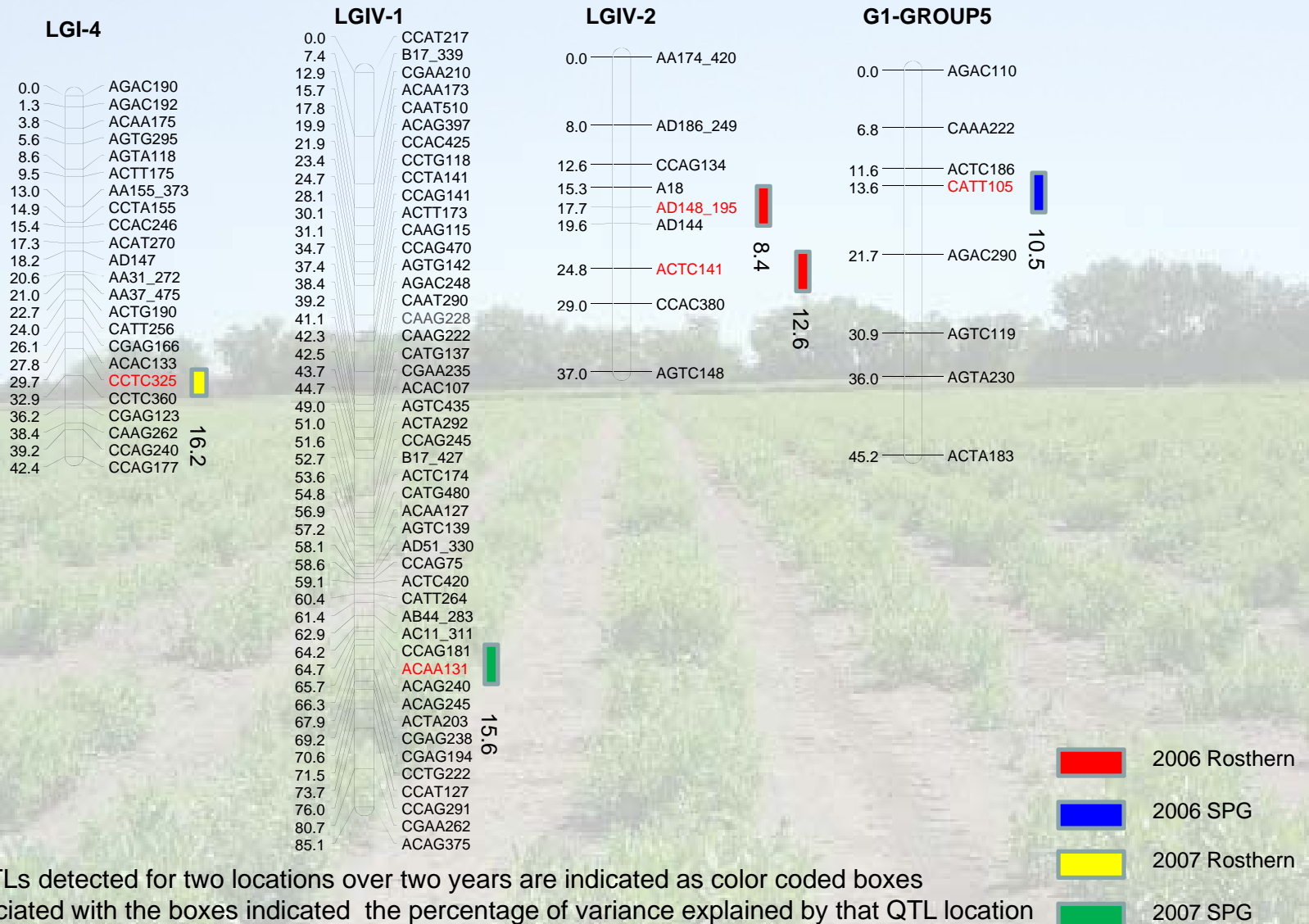
Genomic regions controlling visual quality traits

Seed color in yellow pea



Genomic regions controlling visual quality traits

Seed dimpling (Green pea test population)



*Significant QTLs detected for two locations over two years are indicated as color coded boxes

*Number associated with the boxes indicated the percentage of variance explained by that QTL location



Green cotyledon bleaching resistance

Bleaching whole seeds

Whole seeds

Cotyledons

Whole seeds

Cotyledons

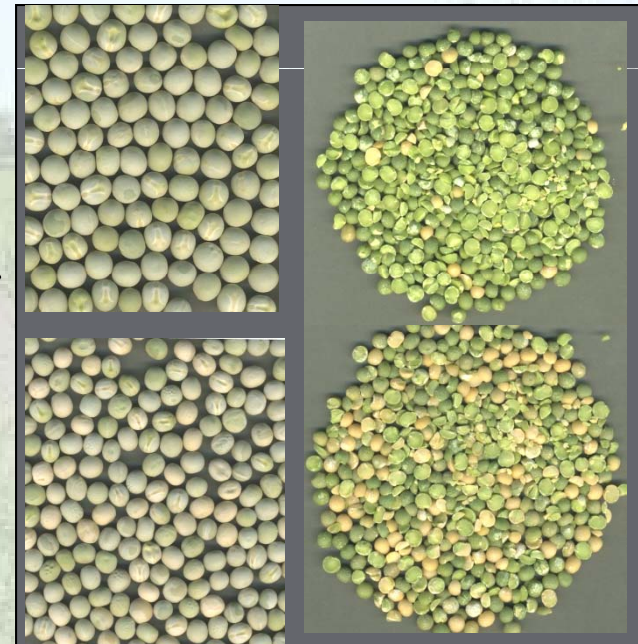


Before exposed to light

CDC Striker

21 days after
bleaching
treatment

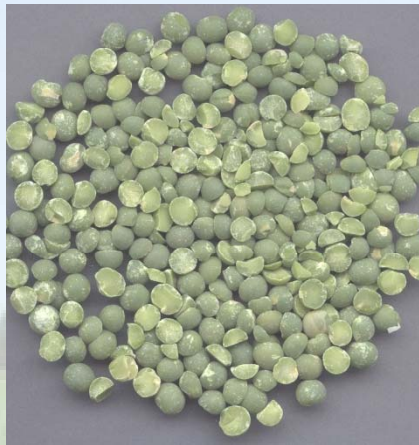
Orb



After exposed whole seeds to light

Green cotyledon bleaching resistance

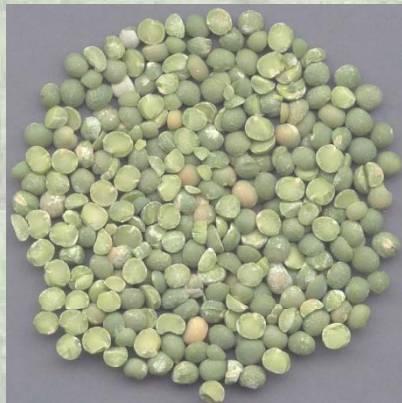
Bleaching of seed coat removed cotyledons



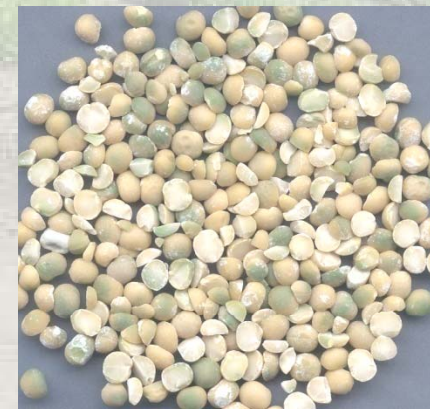
CDC Striker



Bleaching treatment
for 7 days



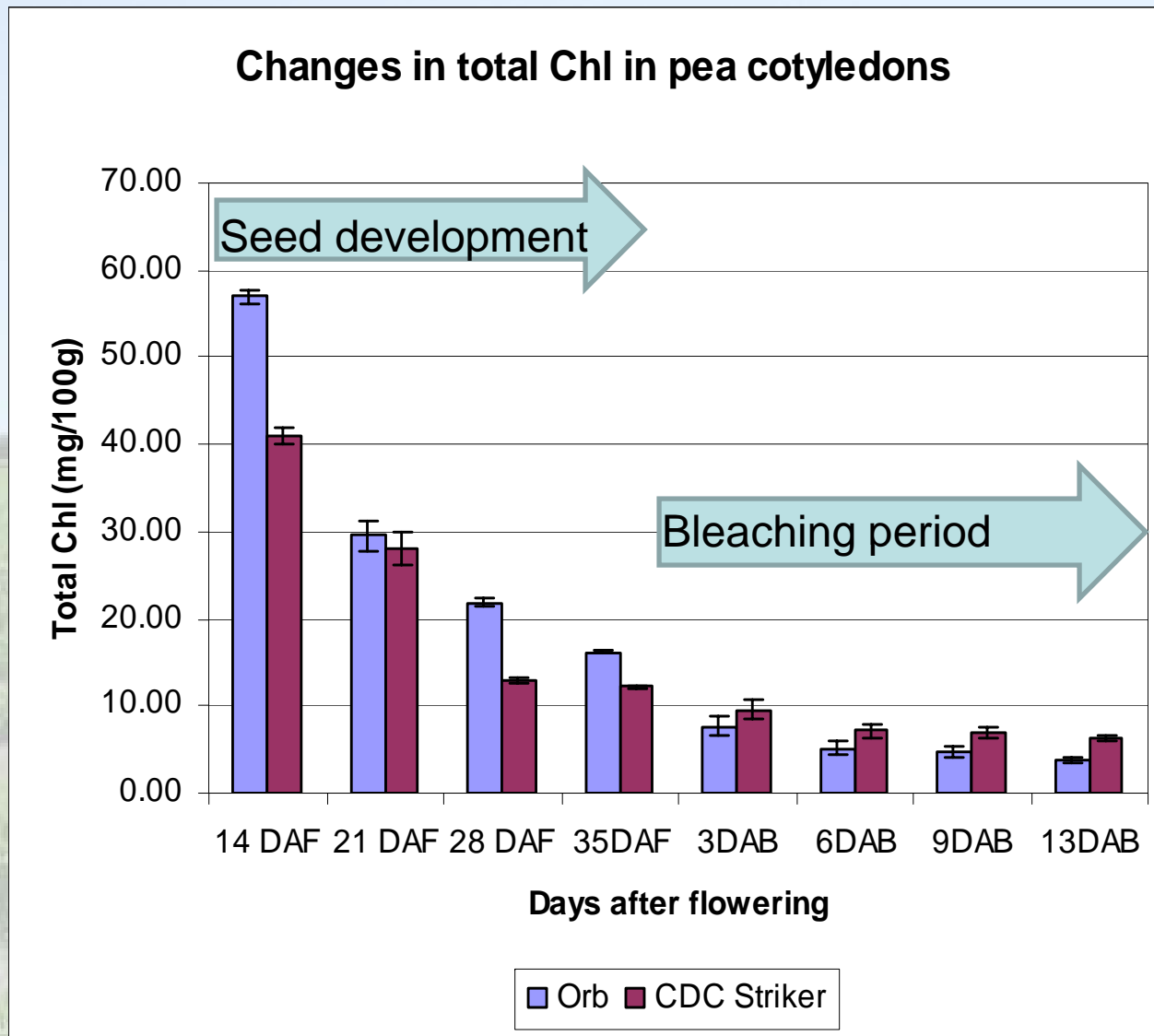
Orb



Before bleaching treatment

After bleaching treatment

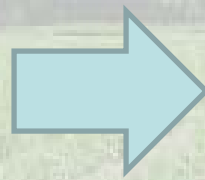
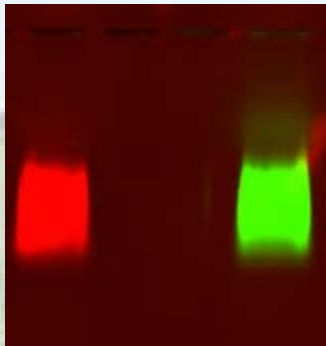
Analysis of bio-chemical profiles of seed coats



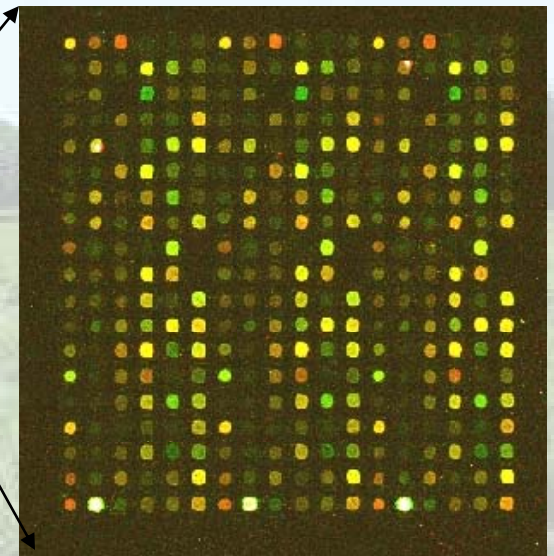
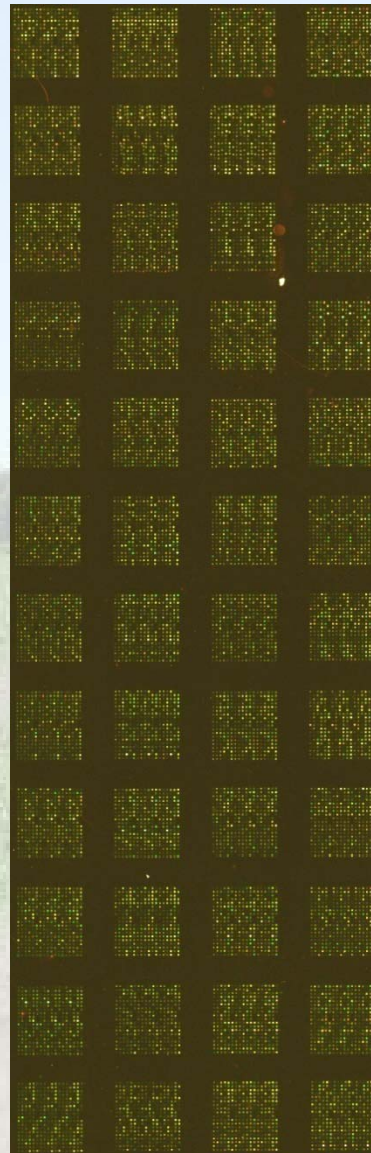
Gene expression analysis of seed coats

CDC Striker 14 DAF

Orb 14 DAF



Labeled messenger molecules from the genes activated at different developmental stages of the seed coats



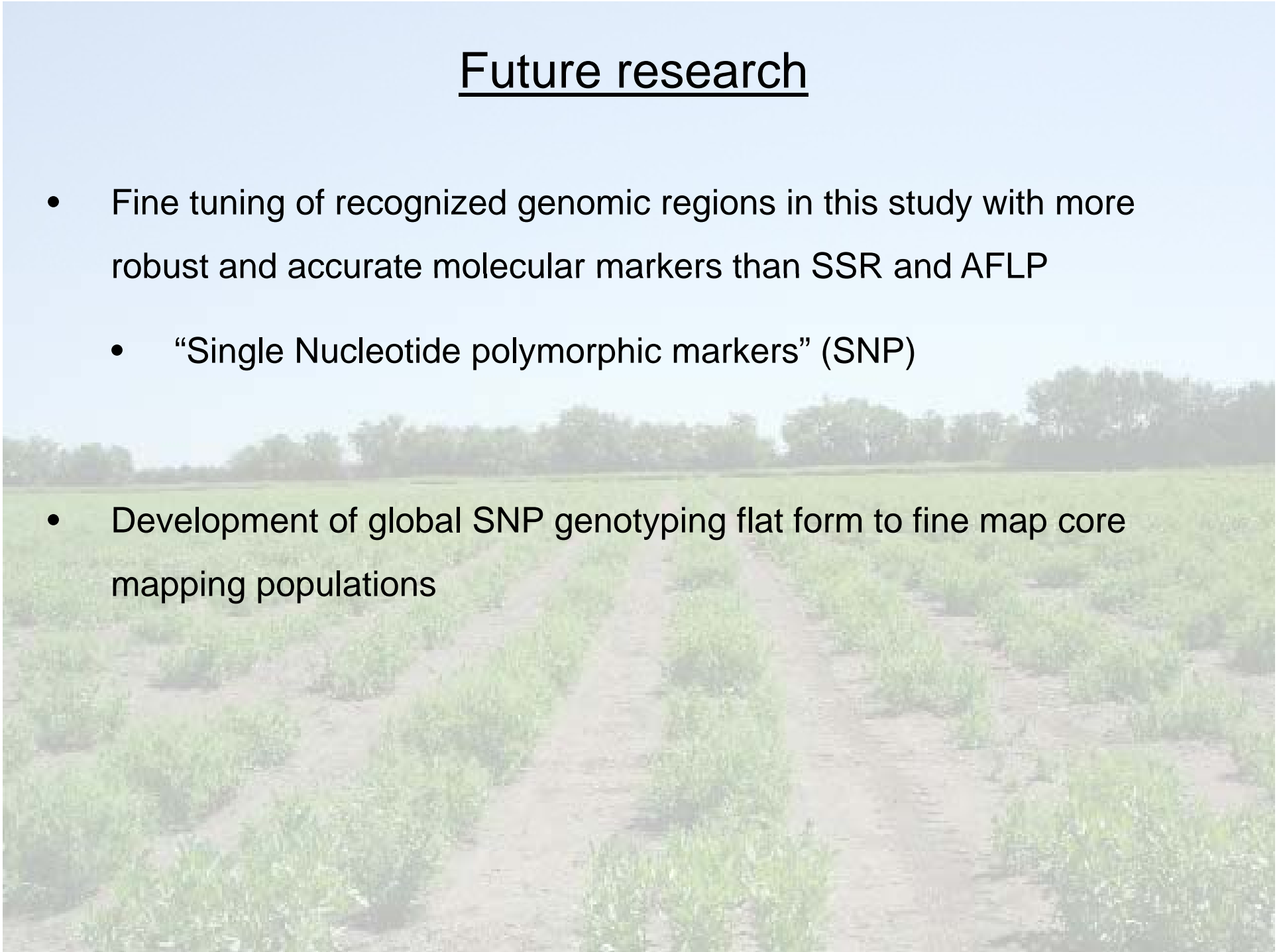
Hybridized "Ps6kOLI1", *Pisum sativum*-16k micro-arrays

Conclusions

- Inheritance of all four visual quality traits are quantitative and under polygenic control with moderate to high heritability
- Recognized several genomic regions controlling the market quality traits
- Molecular markers associated with identified genomic regions could be used to develop markers
- Seed coats protects green pea cotyledon from light mediated bleaching
- Chemical composition of the seeds coats may have an effect on bleaching resistance
- Gene expression patterns are different between two pea cultivars

Future research

- Fine tuning of recognized genomic regions in this study with more robust and accurate molecular markers than SSR and AFLP
- “Single Nucleotide polymorphic markers” (SNP)
- Development of global SNP genotyping flat form to fine map core mapping populations



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