



Effects of post-harvest cold storage in bolting and disease susceptibility (*Botrytis cinerea* and *Fusarium graminearum*) in sugar beet roots

Maria Camila Buitrago Acosta PhD student (MSU)

Rachel Naegele PhD (MSU-USDA ARS)

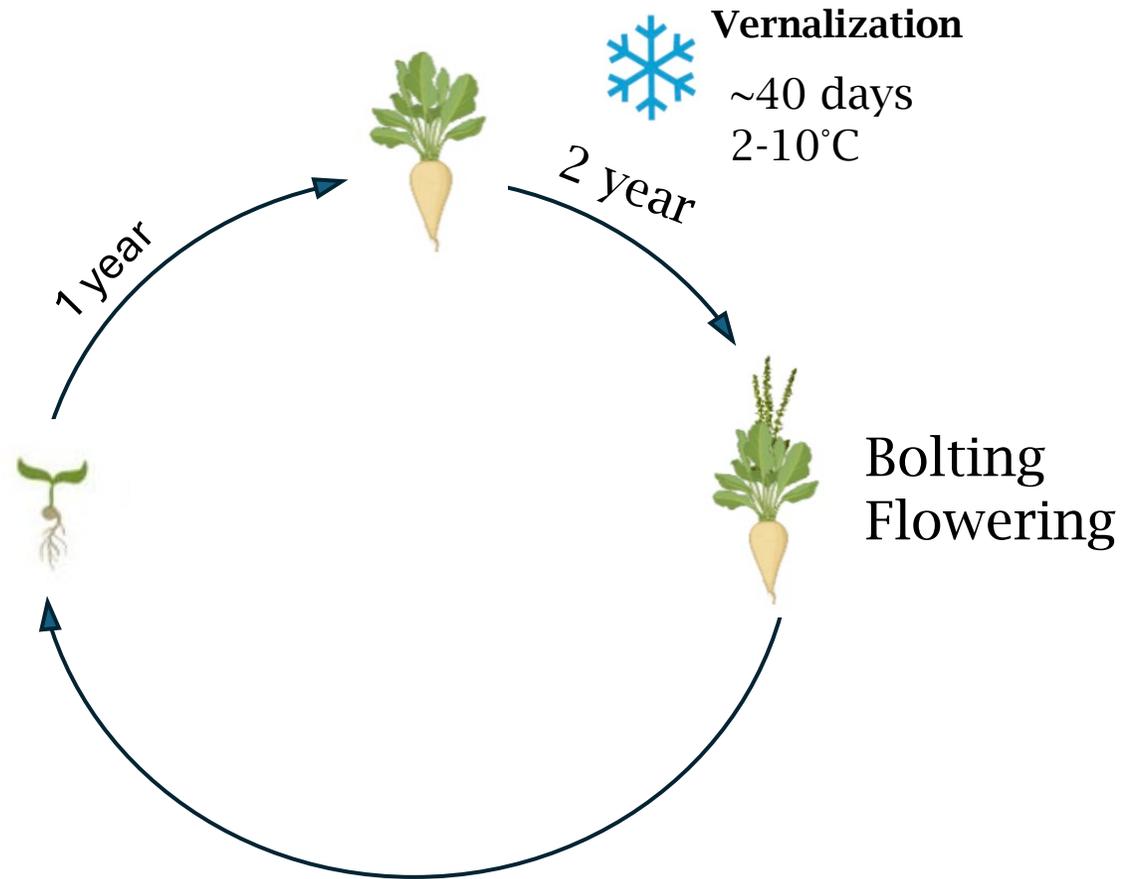
Improving sugar beet production

- Bolting tolerance
- Post-harvest disease tolerance/resistance



Improving sugar beet production

- Bolting tolerance





Why do we want to understand bolting?

- Seed production
- Bolting tolerant varieties-> planted as winter crop, increasing yield
- Selection for bolting -> phenotypic
- Finding genetic markers

Improving sugar beet production

- Bolting tolerance
- Post-harvest disease tolerance/resistance



Sugar beet harvesting



Stock photo



Photo credit: amalgamate sugar company



Photo credit: Gary Stone

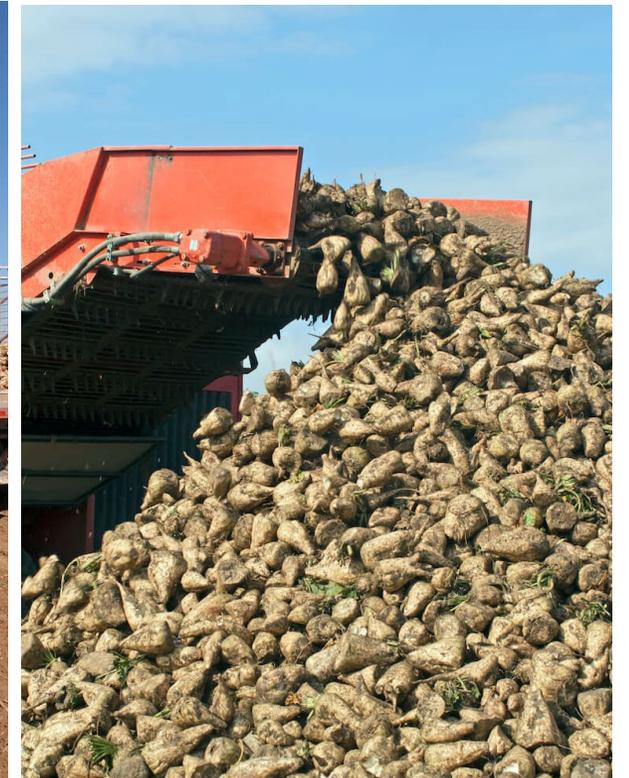


Photo credit: Josef Mohyla

Sugar beet post-harvesting



Photo credit: British Beet Research Organization



Photo credit: Michigan Sugar Company



Photo credit: Idaho Sugar beet storage

Sugar beet post-harvest

- Some regions of Europe and the US (upper midwest) beets can be stored for 3 to 6 months
- In Michigan: temperature fluctuations -> risk

Botrytis cinerea



Fig. 241. Left, The surface of a sugar beet root showing masses of gray spores of *Botrytis cinerea*. **Right,** Longitudinal section of the sugar beet root on the left showing the extent of affected tissue. (Courtesy W. M. Bugbee)

Photo credit: Fugate & Campbell, 2009

- Necrotrophic pathogen
- Gray mold disease
- Management-> maintain cold temperatures, avoid root damage
- #1 in storage rot in beets

Fusarium diseases



Photo credit: C. A. Bradley, M. F. R. Khan, and R. Nelson

- Soilborne disease
- Symptoms: wilting, yellowing petioles, vascular discoloration
- Management-> resistant varieties
- Multiple species can cause disease (Hanson & Hill, 2004; Christ et al., 2011):
 - *F. oxysporum f. sp. betae*
 - *F. acuminatum*
 - *F. avenaceum*
 - *F. solani*
 - *F. verticillioides* (formerly *F. moniliforme*)
 - *F. redolens*
 - *F. cerealis*
 - *F. graminearum*

Objectives

1. Characterize bolting and disease susceptibility in ten sugar beet genotypes

- Is there a difference in disease susceptibility as the time of cold treatment increases?
- Is bolting associated with disease susceptibility?

2. Identify transcriptomic changes related with cold storage in sugar beets genotypes

Methods



Saginaw Valley Research and Extension center

10 genotypes

Rep1-> Apr-Sep 2023

Rep2-> Apr-Sep 2024

Accession	Genotype
EL-A028843	
EL-A15-00006	SR102
EL-A15-00005	5E storage
EL-A1402159	Gp7&8
EL-A15-01064	C869x
EL-A029002	
EL-A19-0451	
EL-A1402163	
EL-A1402164	
EL-A015027	C869

Methods



Saginaw Valley Research and Extension center

Cold room
4°C



0 weeks

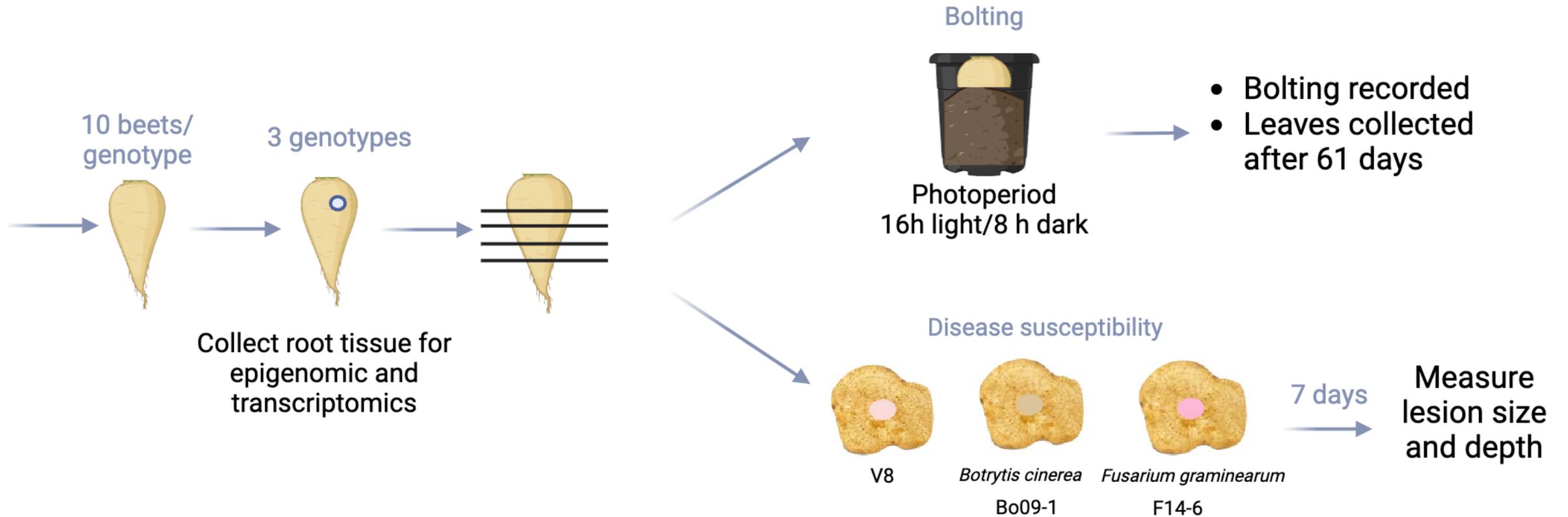
4 weeks

8 weeks

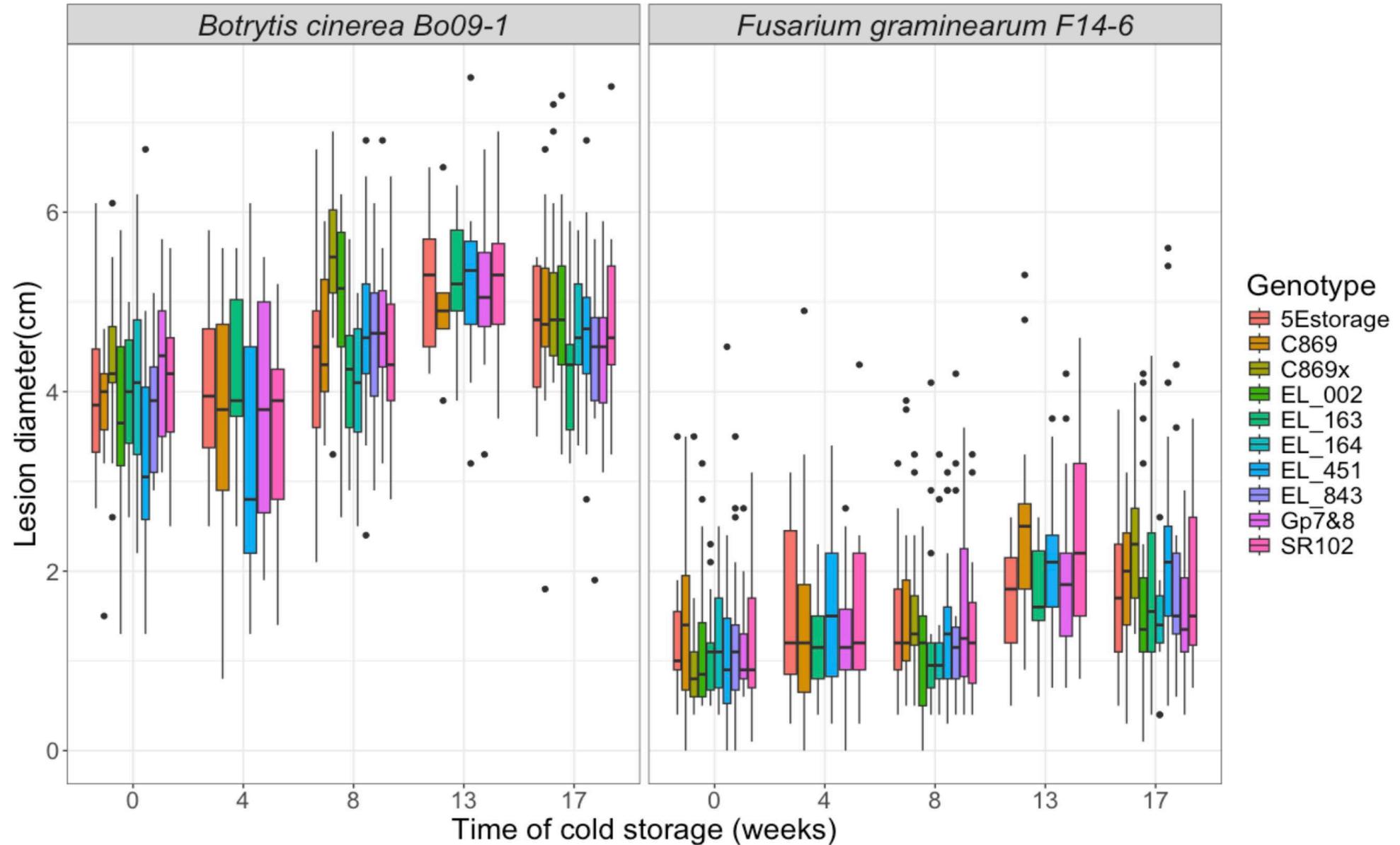
13 weeks

17 weeks

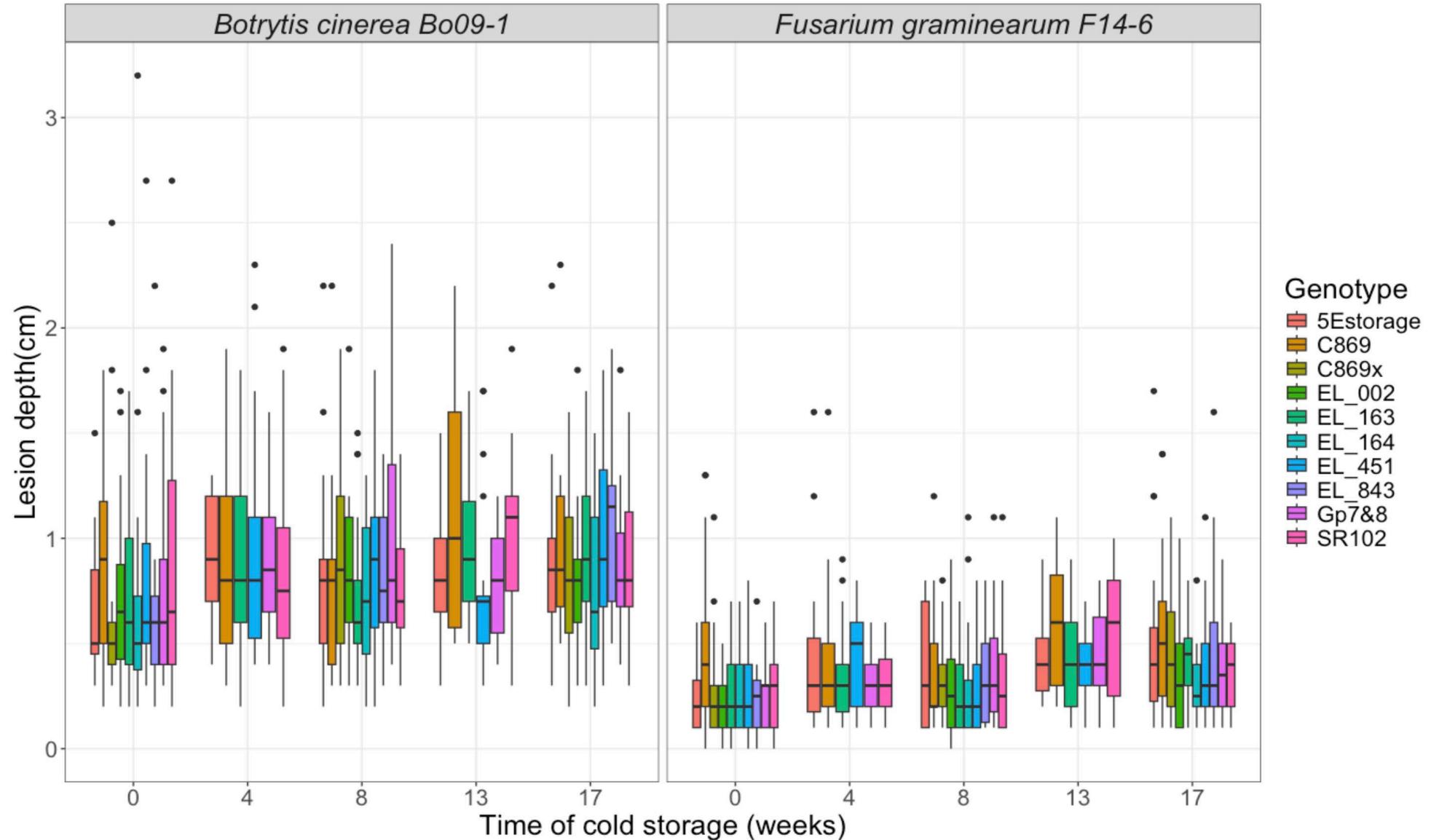
Methods



Disease susceptibility



Disease susceptibility



Disease susceptibility

V8 Control -



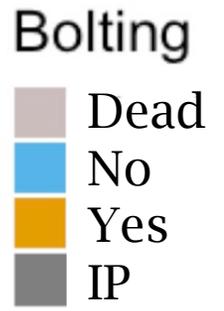
Botrytis cinerea Bo09-1



Fusarium graminearum
F14-6



Bolting

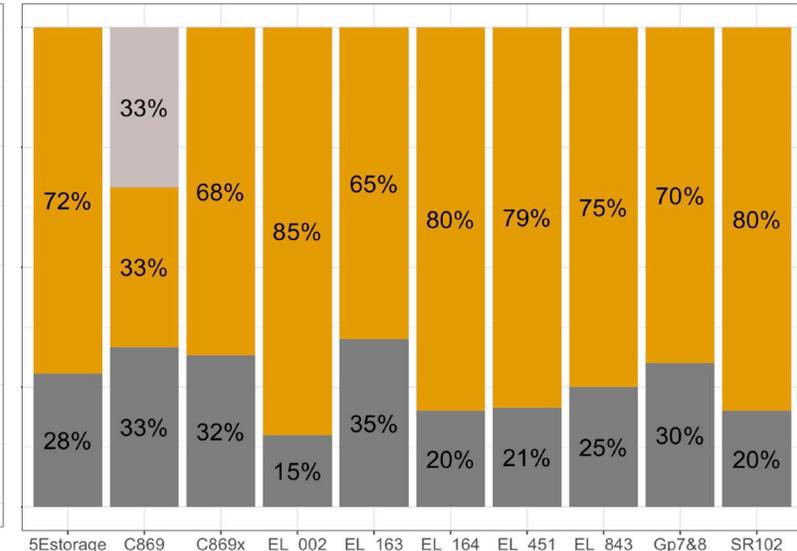
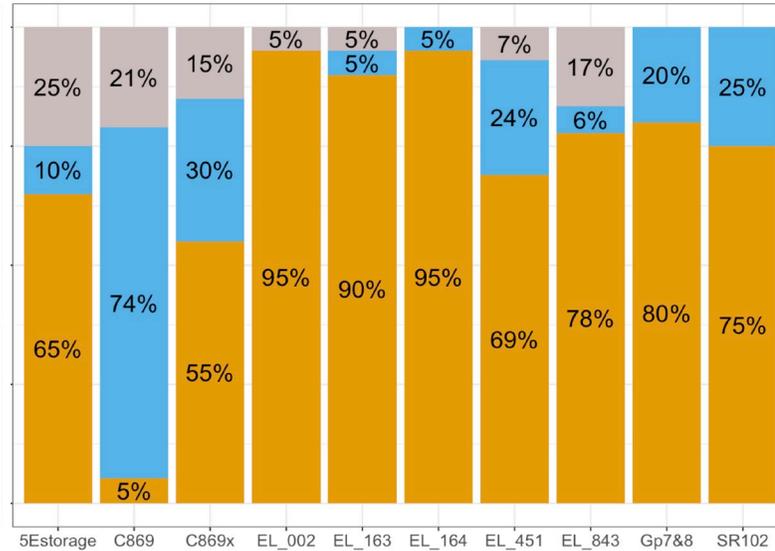
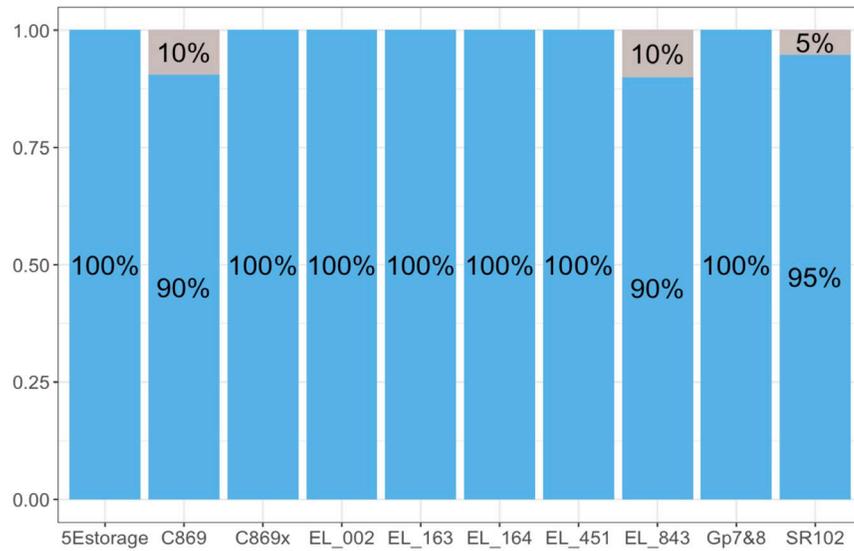


❄️ 0 weeks

❄️ 8 weeks

❄️ 17 weeks

Proportion of bolting plants



Genotype

Note-> IP: T17 Rep2 still in process

Bolting

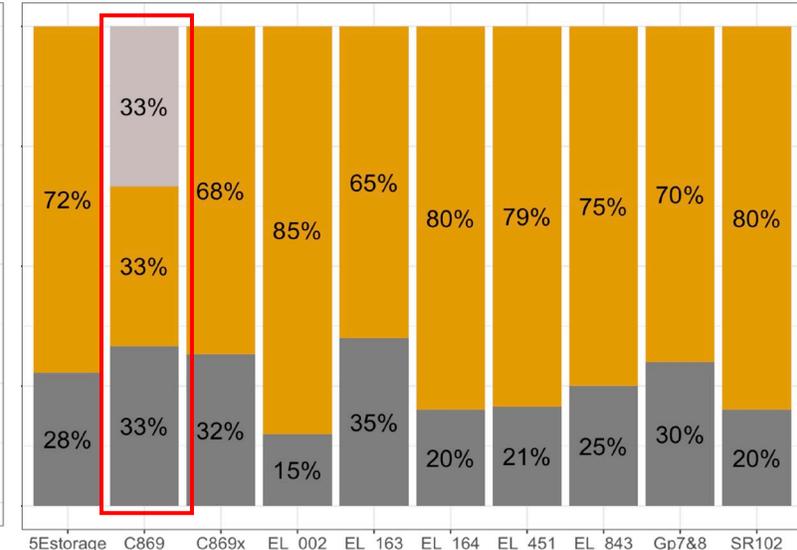
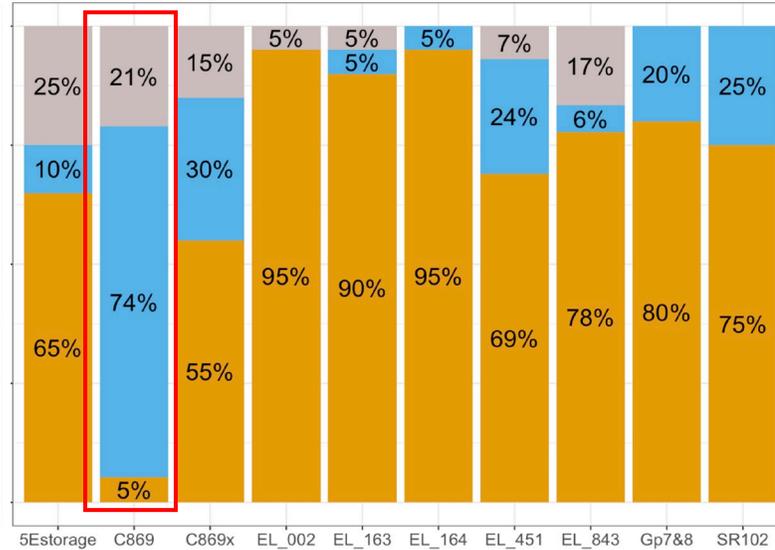
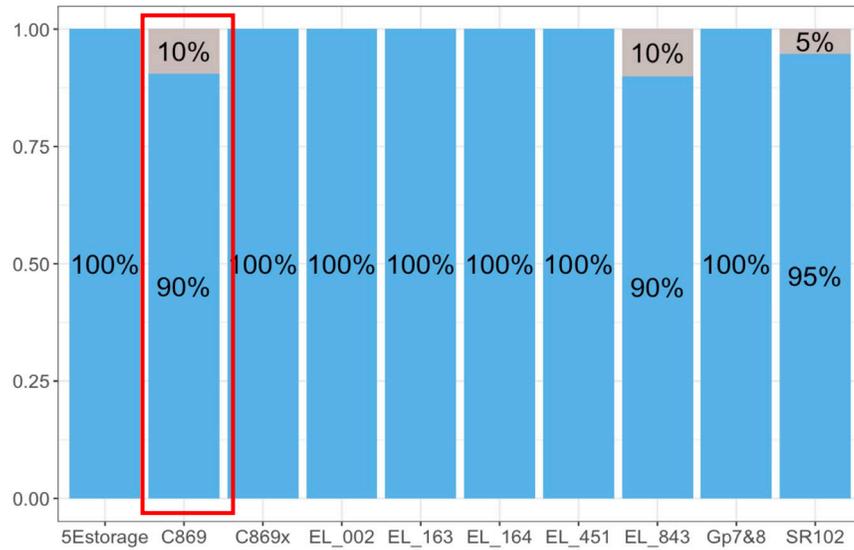


❄️ 0 weeks

❄️ 8 weeks

❄️ 17 weeks

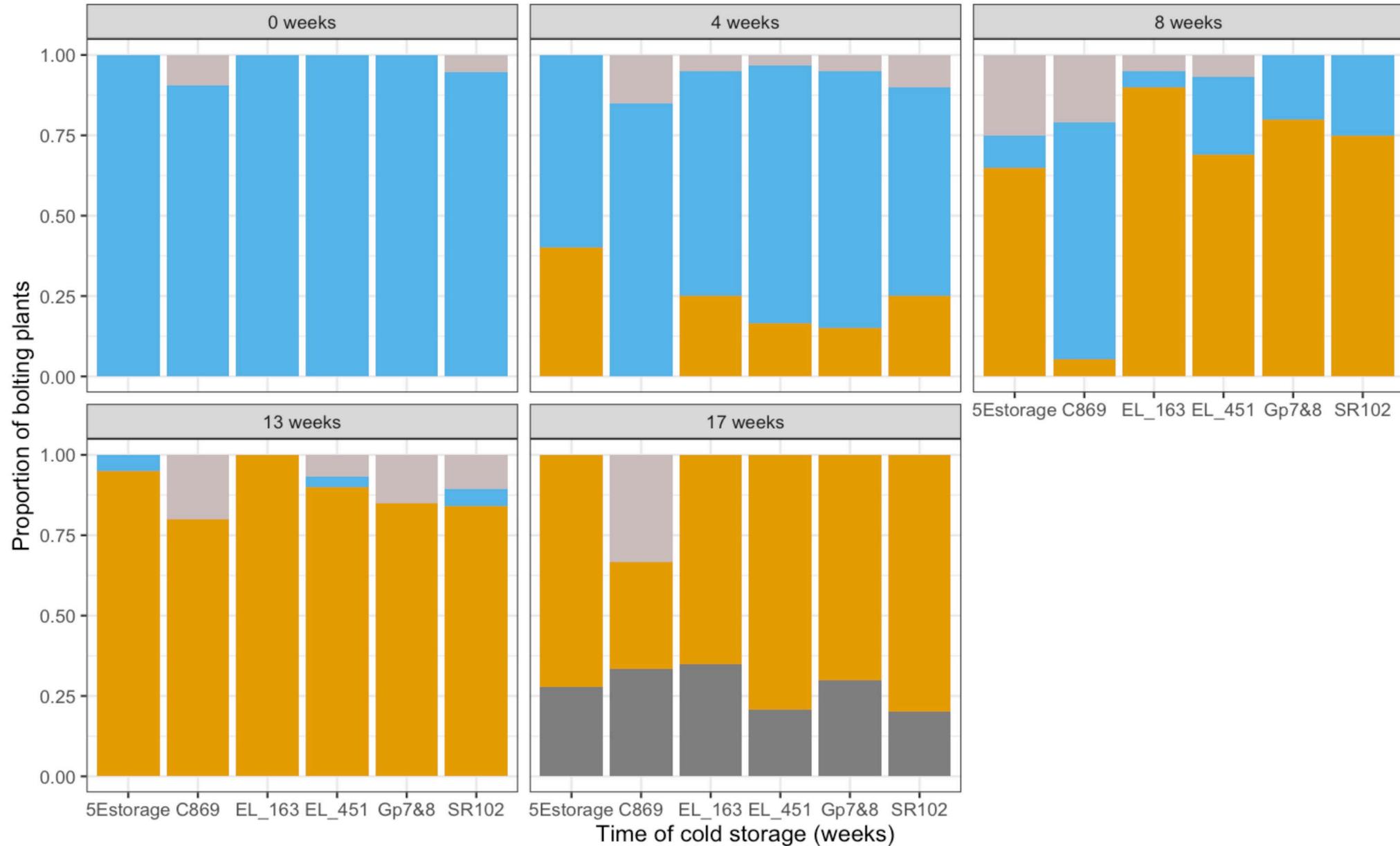
Proportion of bolting plants



Genotype

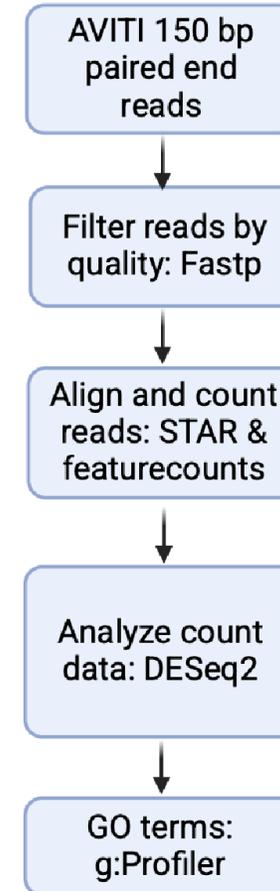
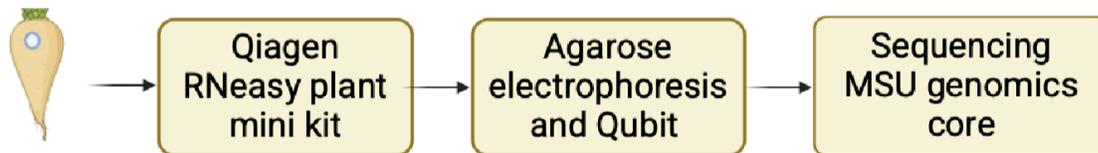
Note-> IP: T17 Rep2 still in process

Bolting

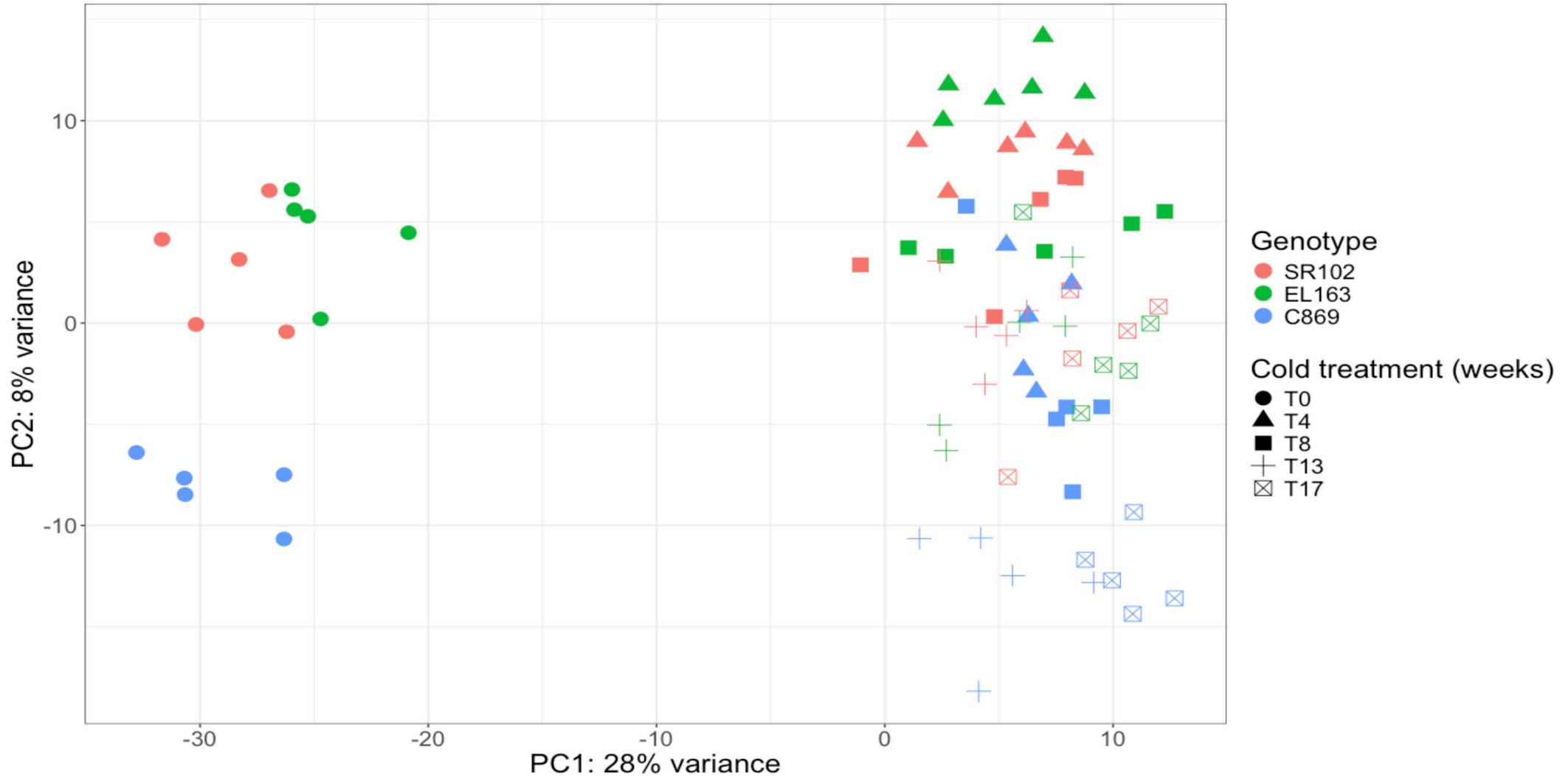


Transcriptomic analysis

- Five time points: T0, T4, T8, T13, T17 weeks of cold treatment
- Three genotypes selected
 - **C869** (late bolting)
 - SR102
 - EL_163



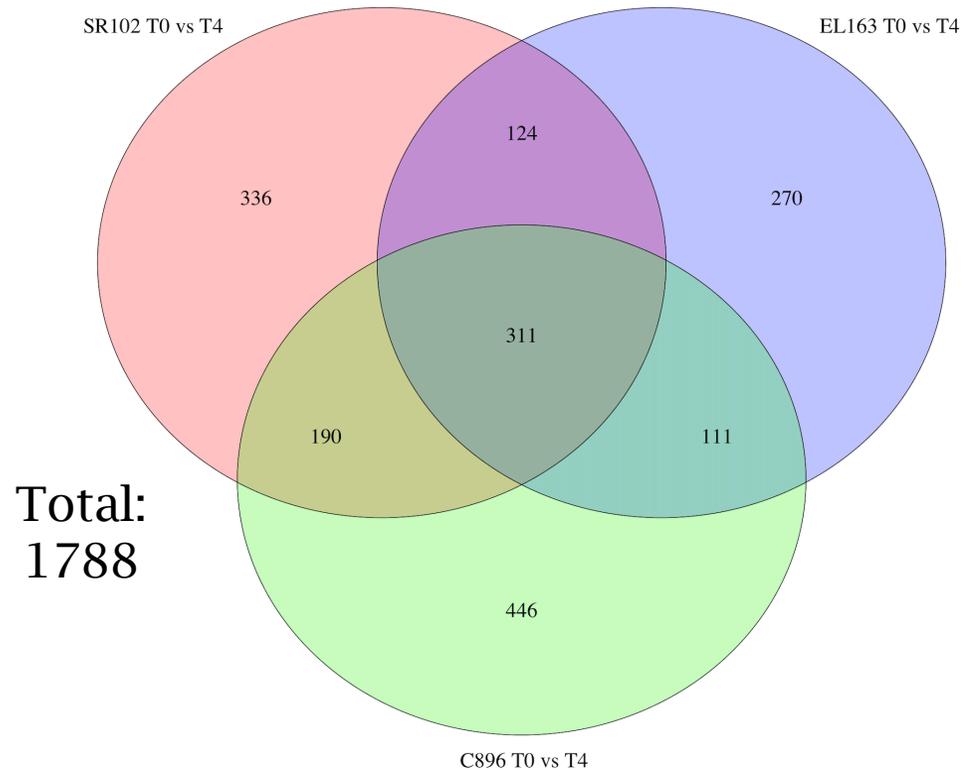
Principal component analysis



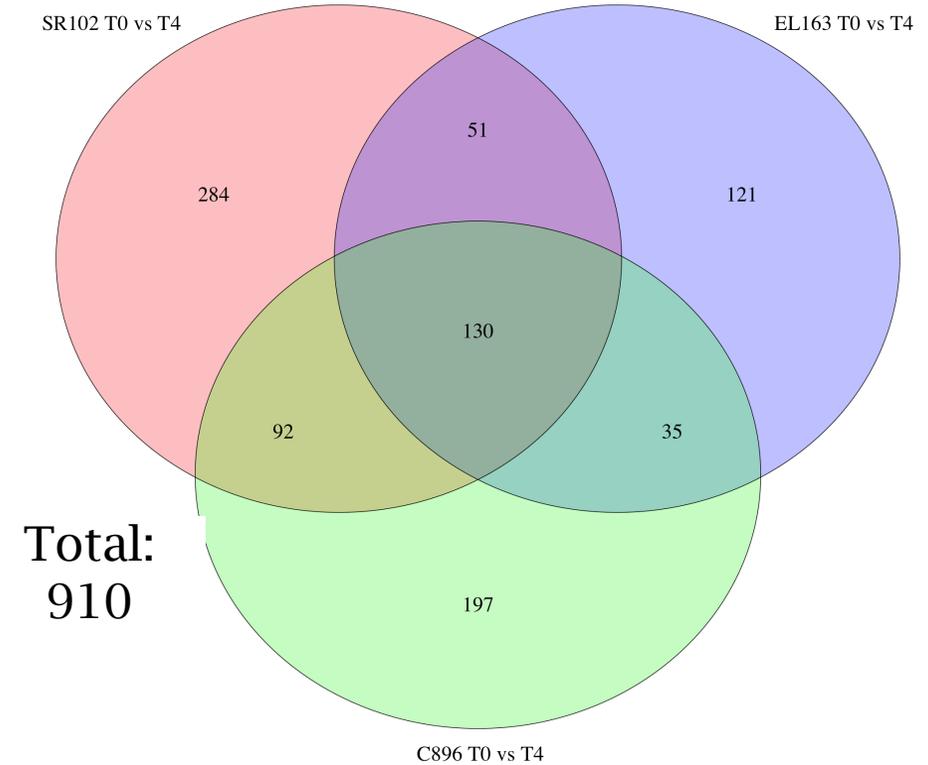
Differential expression analysis

T0 vs cold treatment T4 weeks

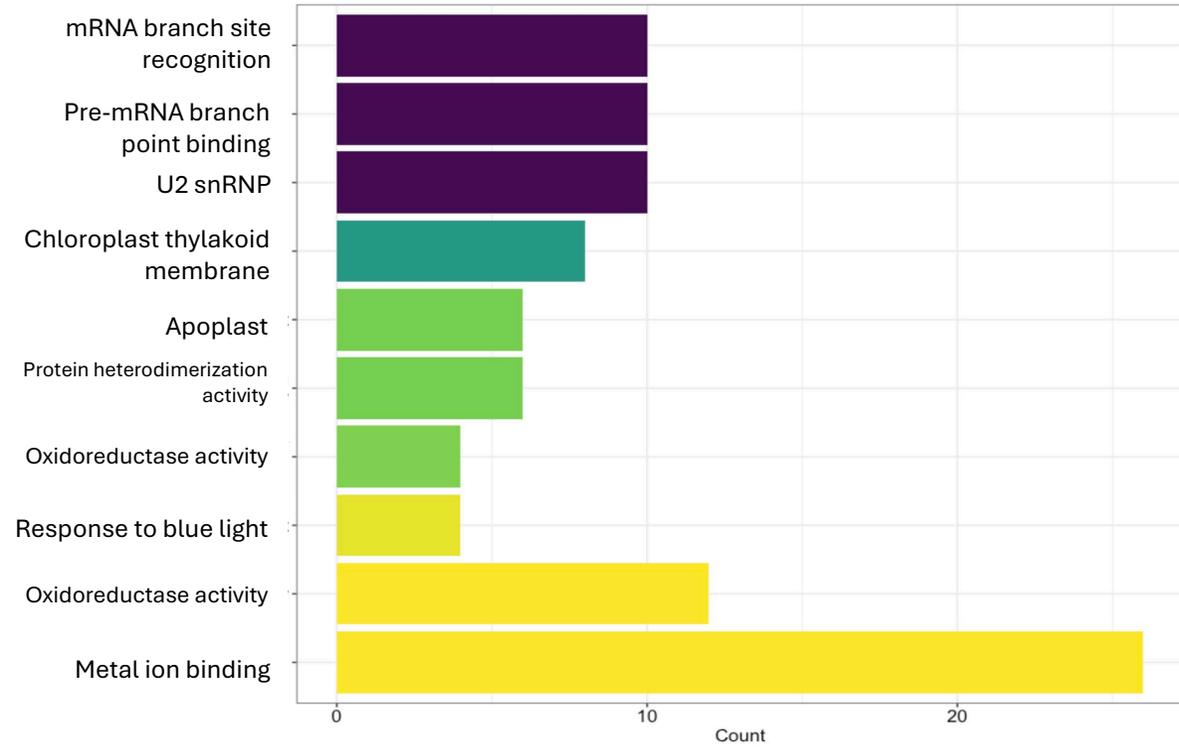
Upregulated



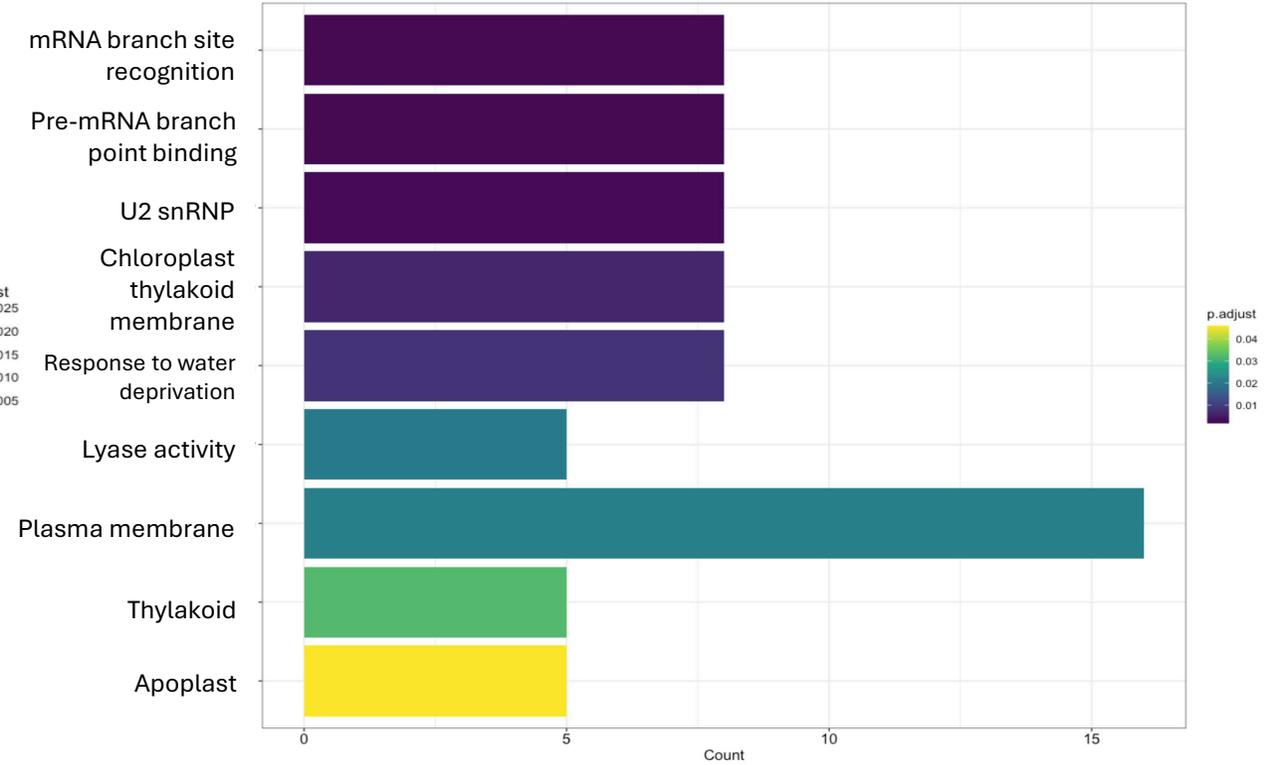
Downregulated



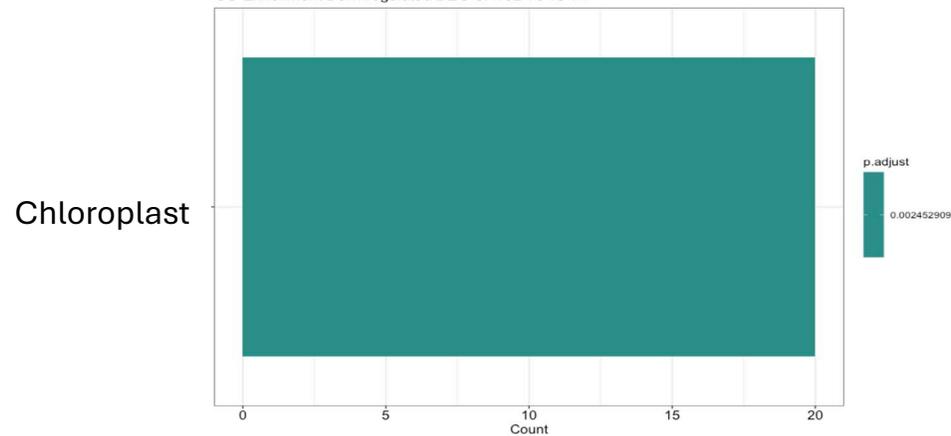
GO enrichment upregulated genes SR102 T0 vs T4



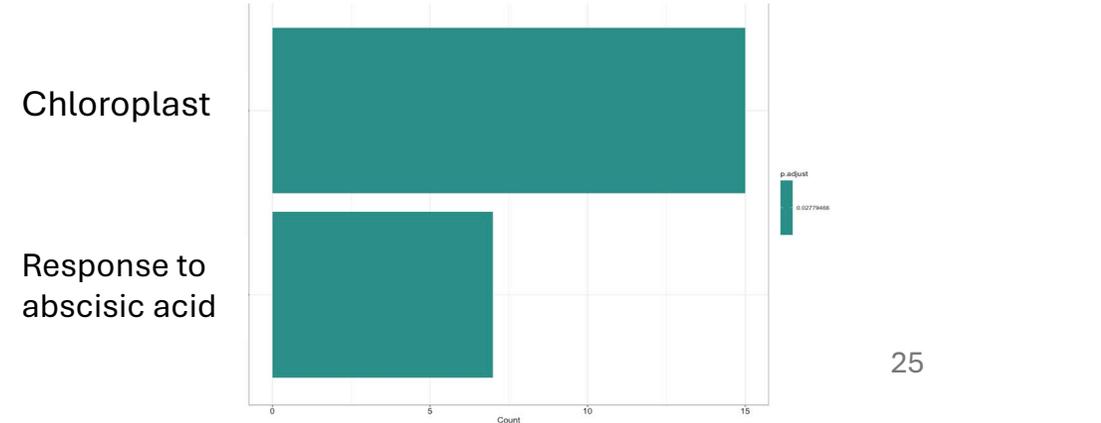
GO enrichment upregulated genes C869 T0 vs T4



GO enrichment downregulated genes SR102 T0 vs T4



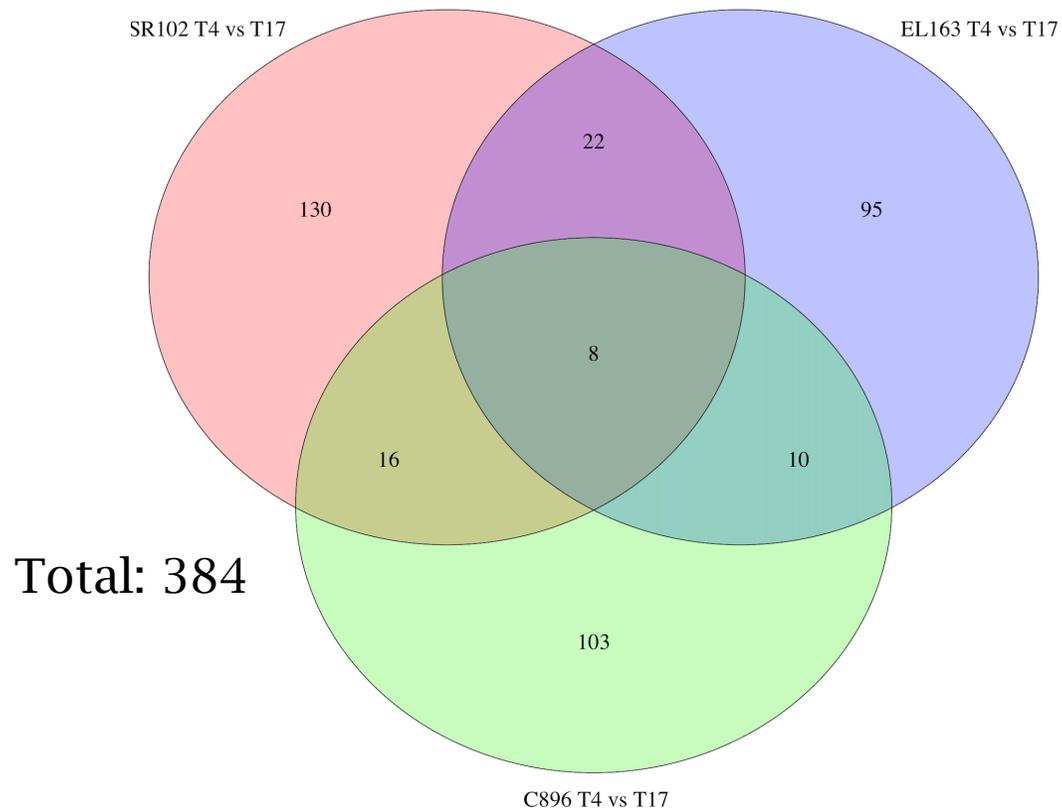
GO enrichment downregulated genes C869 T0 vs T4



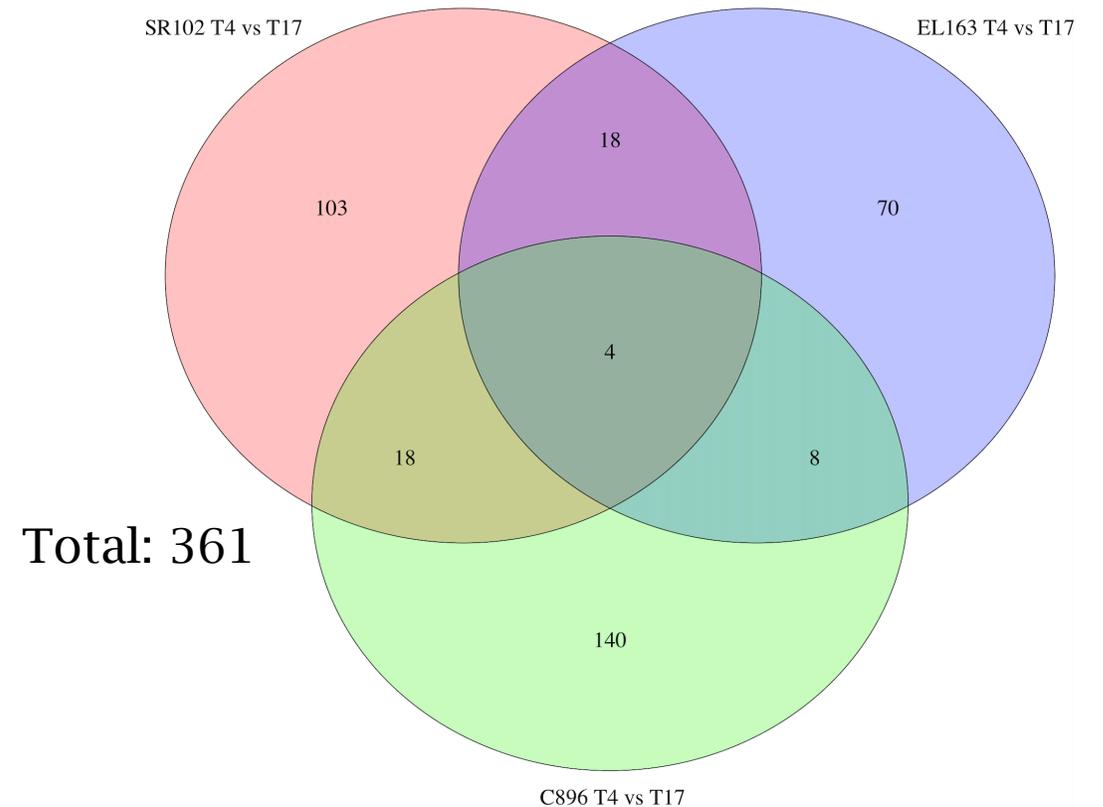
Differential expression analysis

T4 vs T17 weeks of cold storage

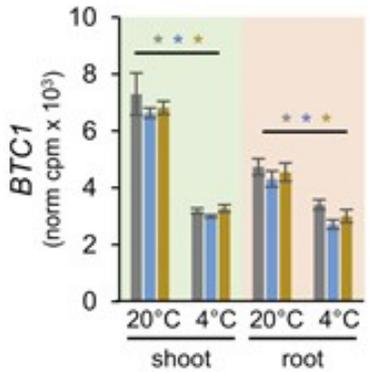
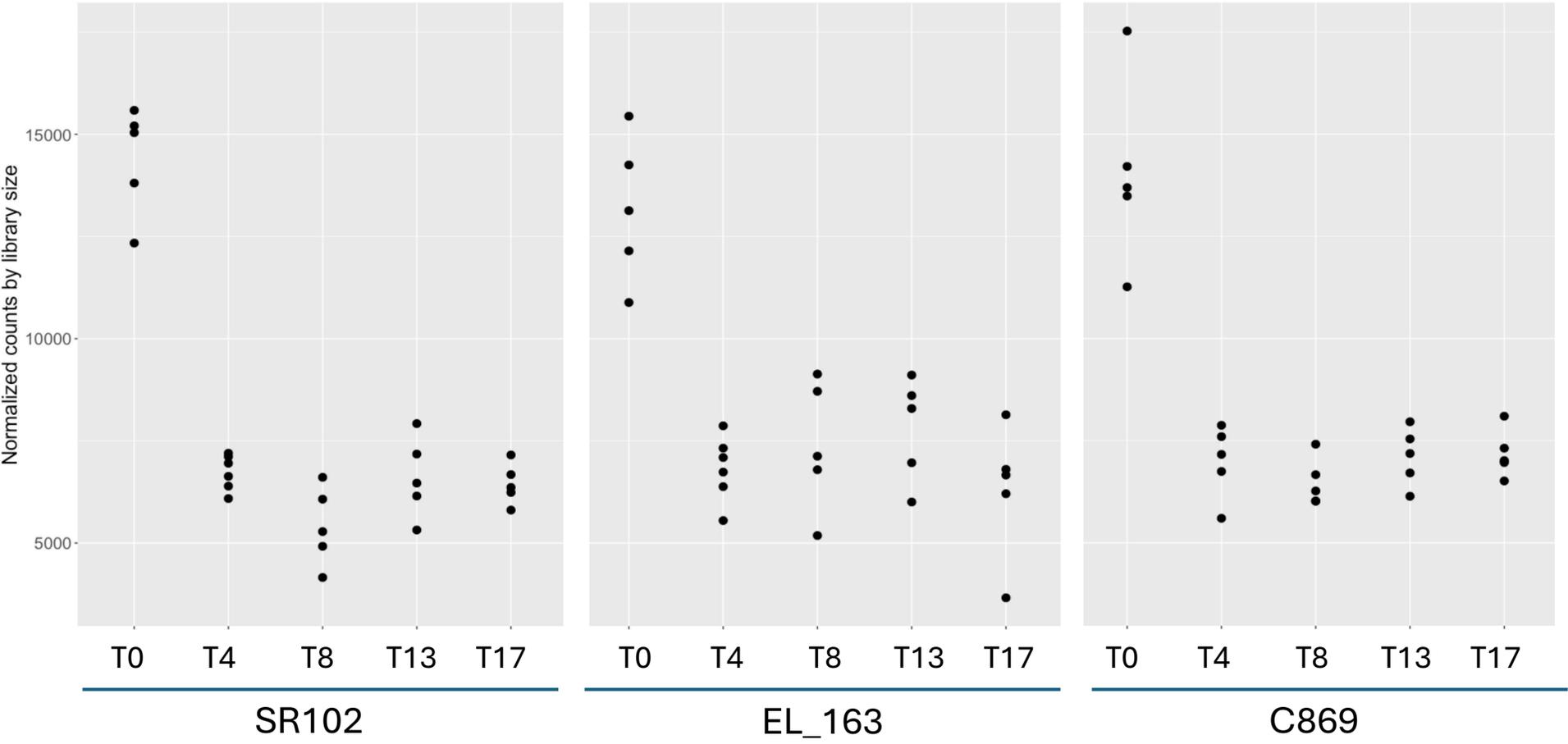
Upregulated



Downregulated

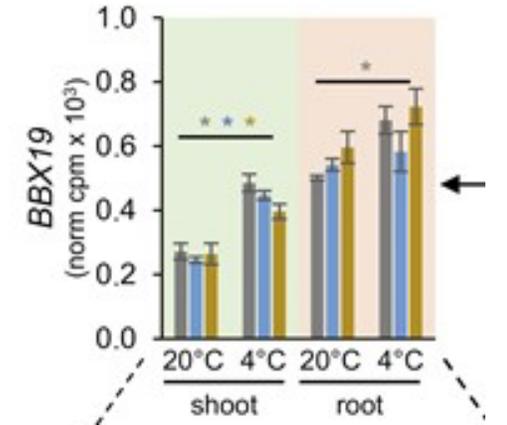
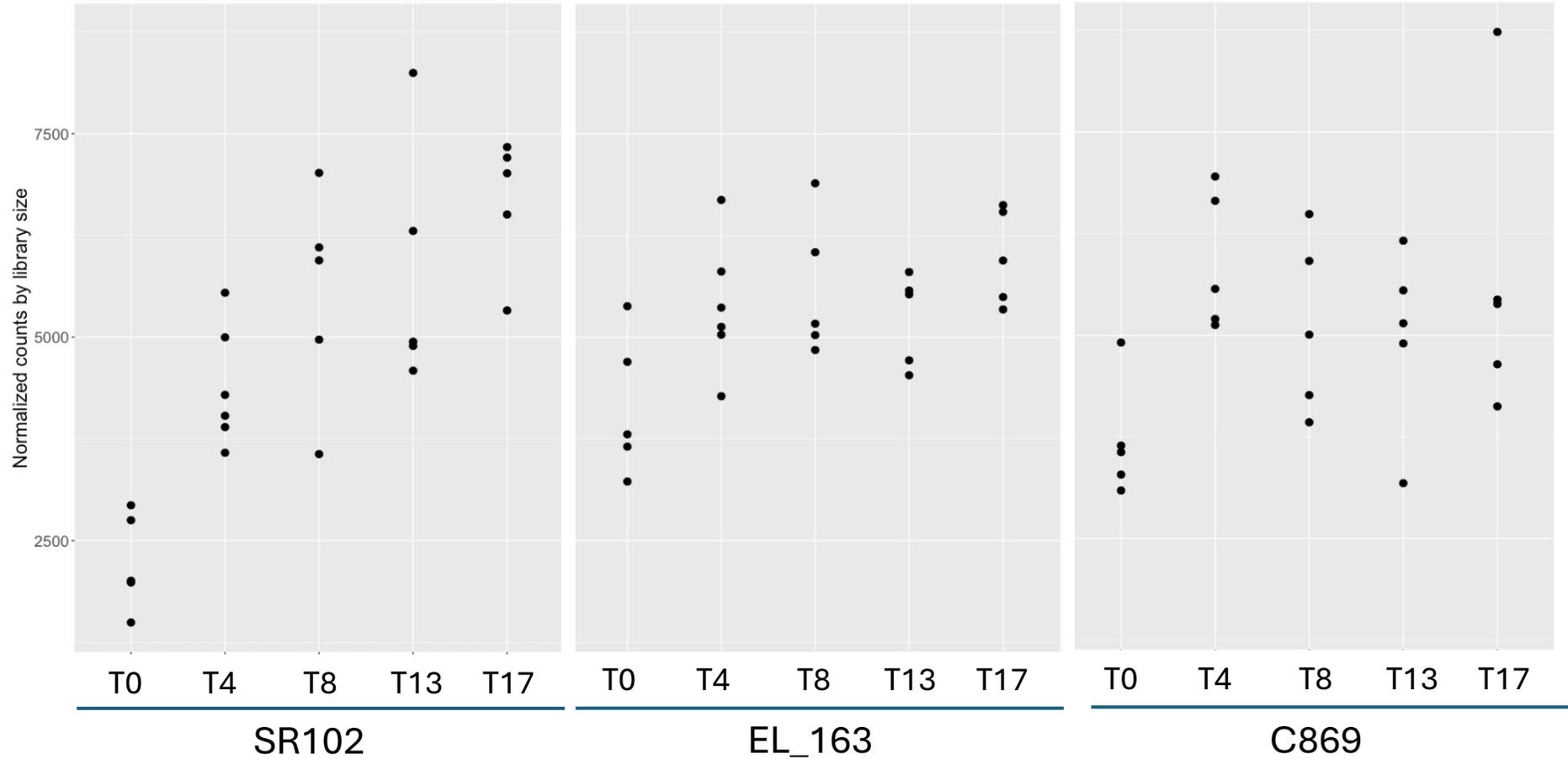


Expression of *BTC1*



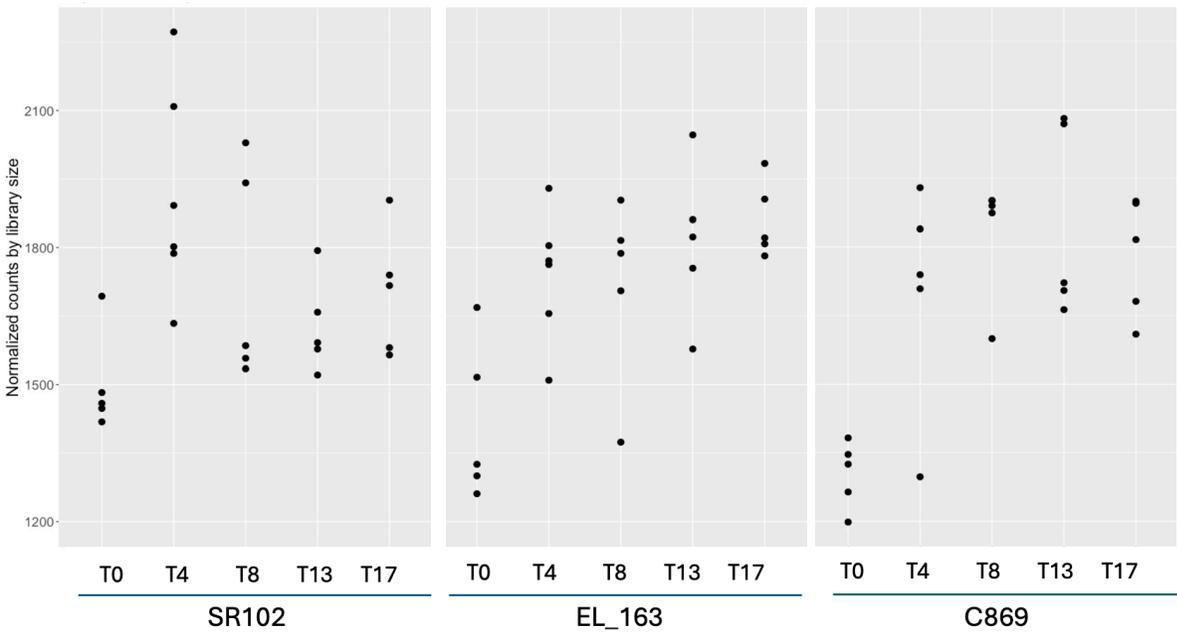
(Rodrigues et al., 2020)

B-box zinc finger protein 19 LOC104904254

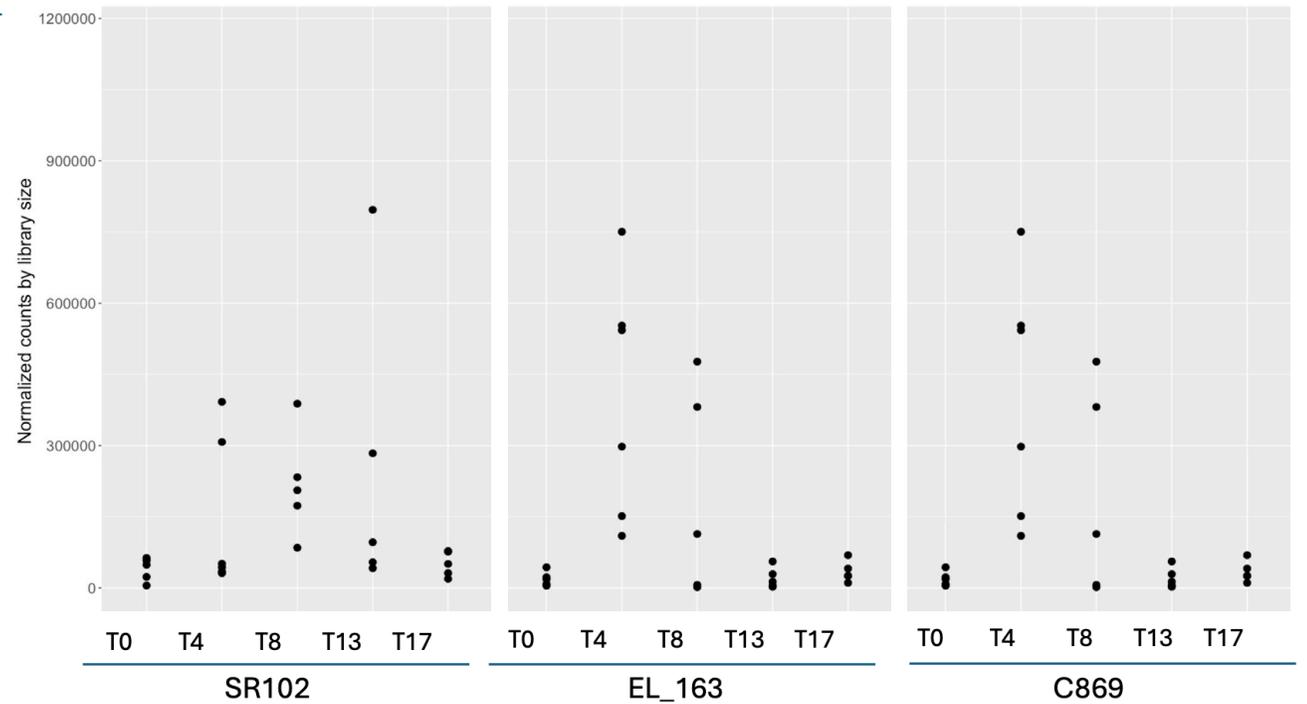


(Rodrigues et al., 2020)

FLOWERING LOCUS D



Cold and drought-regulated protein CORA LOC104897760



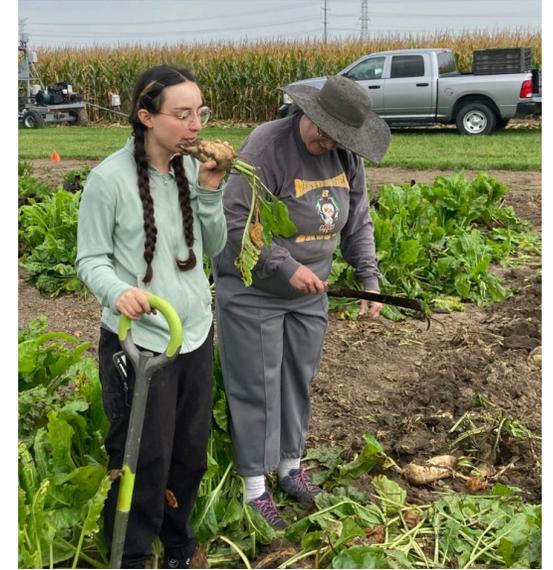
Conclusions

- A **slight increase** in disease susceptibility was observed across genotypes
- We did not observe a relation between bolting and disease susceptibility
- **Genotype C869** (late bolter) showed a **distinct expression profile** across times compared with the two other genotypes (SR102, EL163)
- Genes associated with RNA processing and vernalization were differentially expressed.
- Candidate genes are currently being analyzed to narrow the list to predict bolting.

Acknowledgments



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