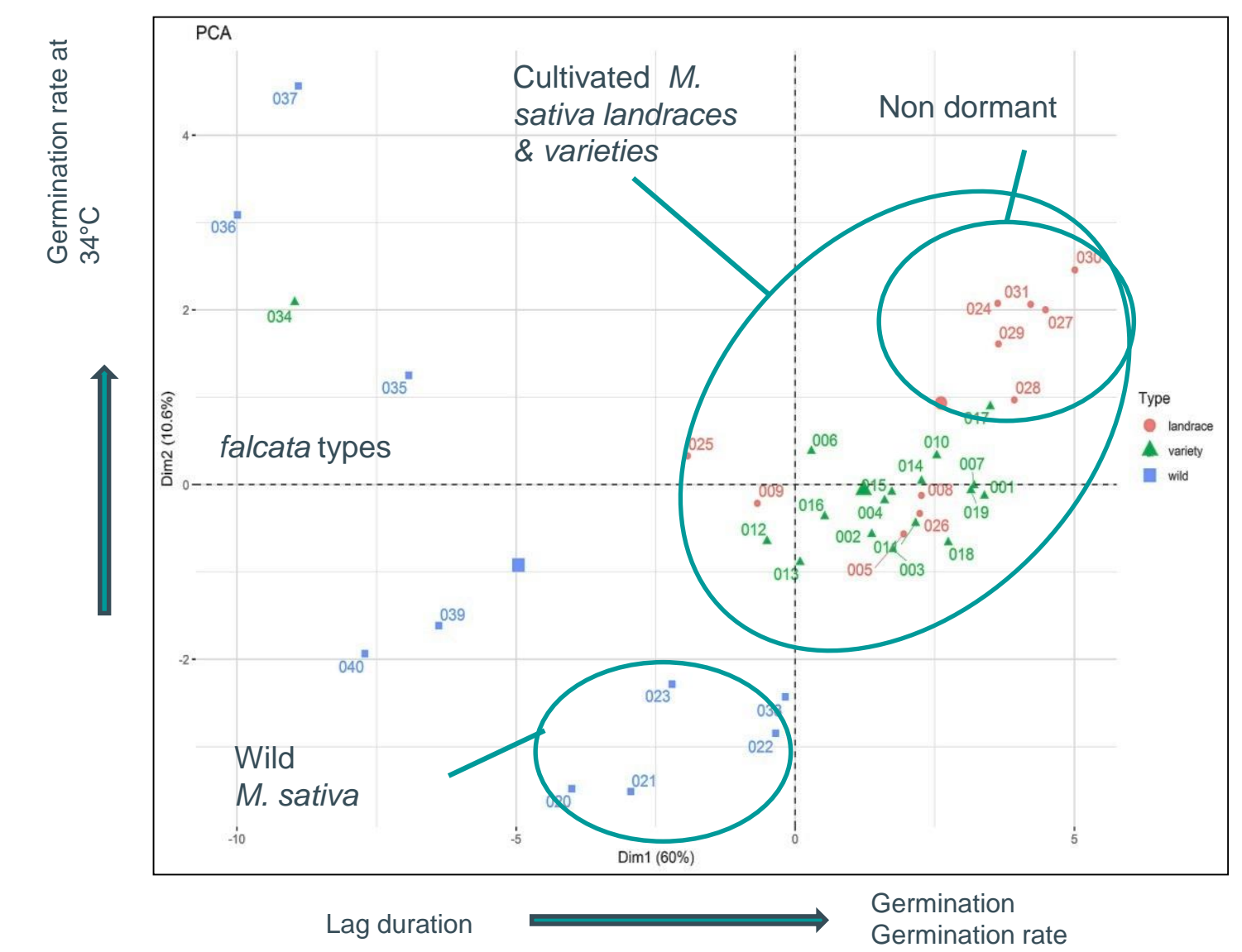


## Context and objectives

- ❑ Germination, as a component of seed lot quality, influences stand establishment
- ❑ Large genetic diversity evidenced in the *Medicago sativa* complex for germination in response to temperature (Ghaleb et al., 2020)
- ❑ Germination ability at low temperatures (5°C) or high temperatures (34°C) were different to that at optimal temperatures (15-25°C)
- ❑ Little genetic diversity for germination within cultivated accessions; ancient and modern breeders have probably selected for the absence of response to temperature
- ❑ Breeding for high germination at all temperatures would benefit to stand establishment

**Objective: What is the genetic diversity within the cultivated lucerne pool ?  
What is the genetic control of germination traits?**



## Experiment and data analysis

### Evaluation of germination of a set of 350 cultivated accessions of lucerne at 3 temperatures: 5°C, 15°C, 34°C

- 5°C and 34°C: raw data and correction by the germination at 15°C  
Corrected germination at 5°C = Germination at 5°C / Germination at 15°C
- 4 repetitions of 100 seeds per accession and temperature

**Genotyping with GBS markers: allele frequency for ~228 k SNP (Pégard et al 2023)**

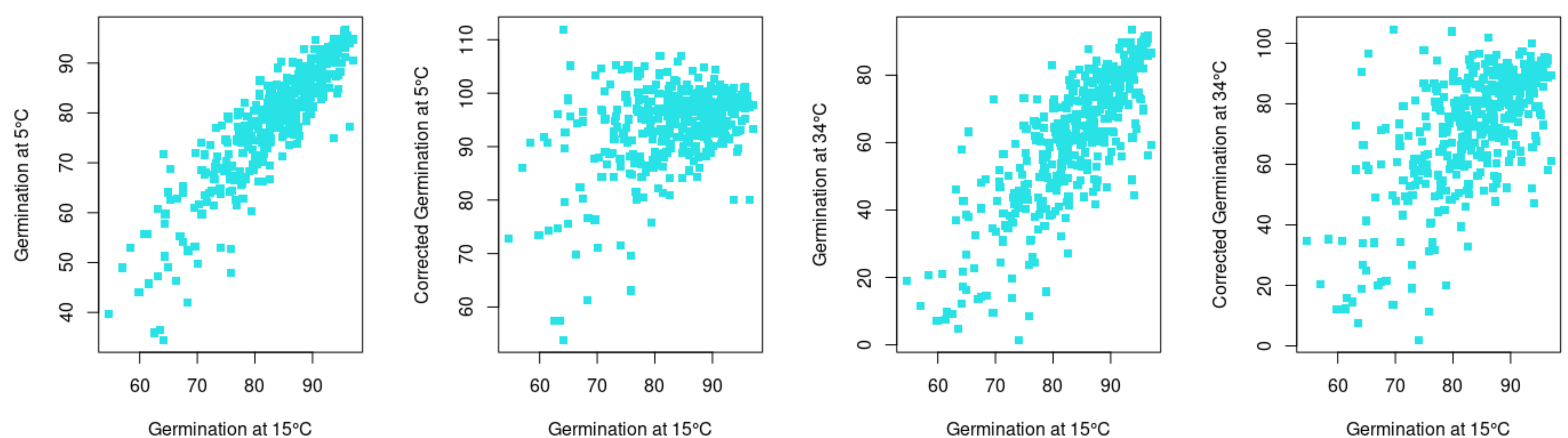
### Data analysis

- Genetic diversity, correlation
- QTL detection with a genome-wide association study (GWAS)
- Genomic prediction with a training population composed of 90% of the accessions

## Results

### A large diversity for germination

- The diversity was the highest at 34°C
- High correlation between germinations at 5°C, 15°C and 34°C
- When the germination at 5°C and 34°C are corrected by the germination at 15°C, the correlations between germination at 5°C or 34°C and germination at 15°C decrease



### QTL detection

- At a threshold of a P value < 10<sup>-5</sup>, 3 to 5 QTL were detected for each trait
- Each explained 5-10% of the variation (not shown)

Trait	SNP *
Germination 15°C	chr2_54684233
	chr3_22201612
	chr8_33081797
Germination 5°C	chr1_6793639
	chr4_80871647
	chr5_74588818
	chr7_32793735
	chr1_74002566
Corrected Germination 5°C	chr4_4295560
	chr4_25930290
	chr4_84972129
	chr5_56035356
	chr2_68206556
Germination 34°C	chr5_27207022
	chr7_18098602
	chr2_68206556
Corrected germination 34°C	chr5_18623931
	chr5_27207022
	chr7_18098602

\* The colours are for the same SNP

### Genomic prediction

- Predictive ability for germination at 15°C was 0 suggesting that the “true” genetic variation was low. The observed variation could be due to seed lot quality mostly. This is not completely surprising in this cultivated material
- Predictive ability for germination at extreme temperatures (5 and 34°C) were low to moderate. The prediction was higher with corrected data than with raw data. The seed lot quality effect has probably been removed

Trait	Predictive ability
Germination at 15°C	0
Germination at 5°C	10%
Corrected Germination at 5°C	30%
Germination at 34°C	20%
Corrected germination at 34°C	24%

### Conclusion

- The germination at 15°C has already been improved in varieties; Seed lot quality hid genetic variation
- Germination at 5°C and 34°C could probably be improved, including with marker assisted selection. This would ease stand establishment under sub-optimal conditions

### References

- Ghaleb W, Qadir Ahmed L, Escobar-Gutiérrez A, Julier B (2021) The History of Domestication and Selection of Lucerne: A New Perspective From the Genetic Diversity for Seed Germination in Response to Temperature and Scarification. *Frontiers in Plant Science* 11, 10.3389/fpls.2020.578121
- Pégard M, Barre P, Delaunay S, Surault F, Karagić D, Milić D, Zorić M, Ruttink T, Julier B (2023) Genome-wide genotyping data renew knowledge on genetic diversity of a worldwide alfalfa collection and give insights on genetic control of phenology traits. *Frontiers in Plant Science* 14, 10.3389/fpls.2023.1196134

