Vernalization Response and Freezing Tolerance of *Poa secunda*, a Promising Perennial Groundcover

Vipul Kumar, Shui-zhang Fei
Department of Horticulture, Iowa State University, Ames, IA 50011

Background

- **Importance of *Poa secunda***
  P. secunda, a native cool-season bunchgrass with early spring growth and summer dormancy, is a promising perennial groundcover (PGC) for providing ecosystem services in Midwest cropping systems.
- **Cultivar development using controlled hybridization in *P. secunda* is lacking**
  P. secunda requires vernalization, an exposure to low temperatures and short-day length for flowering and seed production. The duration of vernalization required for flower induction in *P. secunda* is unknown.
- **Freezing tolerance in *P. secunda***
  Excellent winter hardiness is an essential trait for an ideal PGC. Cool-season grasses acquire freezing tolerance with cold acclimation, an exposure to low temperatures and short-day lengths, a process similar to vernalization. Winter hardiness in *P. secunda* is poorly characterized.

Objective

- **Determine Vernalization Requirements**
  Identify the minimum cold exposure needed to induce flowering across *P. secunda* genotypes and assess variation in flowering intensity and timing.
- **Evaluate Freezing Tolerance**
  Quantify genotypic differences in freezing injury thresholds (LT_{50}) under non-acclimated and cold acclimated conditions using electrolyte leakage assay.

Materials & Methods

- **Plant Material**
  Three *P. secunda* genotypes ('High Plains', 'Hanford', and 'Vale') were used for both experiments. *Poa pratensis* (Kentucky bluegrass, KBG) served as a winter-hardy control in the freezing tolerance assay.
- **Vernalization Experiment**
  Design: Factorial with six vernalization durations (0, 3, 6, 9, 12, 15 weeks), 3 genotypes, and 3 replications.
  Conditions: 5 °C, 8 h photoperiod during vernalization → transferred to 22 °C, 16 h photoperiod for flowering.
  Observations:
  1. Days to first flowering (DOF)
  2. Number of flowering tillers (NFT)
- **Freezing Tolerance Experiment**
  Treatments: Non-acclimated (NA) plants maintained at 20°C with a 12 h day length. Acclimated (CA) plants maintained at 5°C with an 8 h day length for 5 weeks.

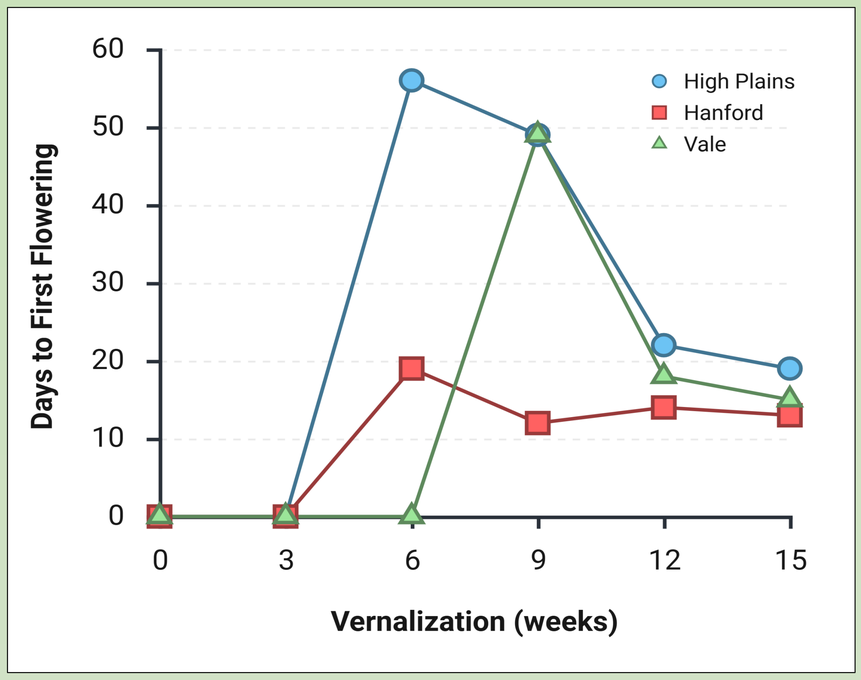

Fig 1. Effect of vernalization duration on the days to first flower in 3 *P. secunda* genotypes

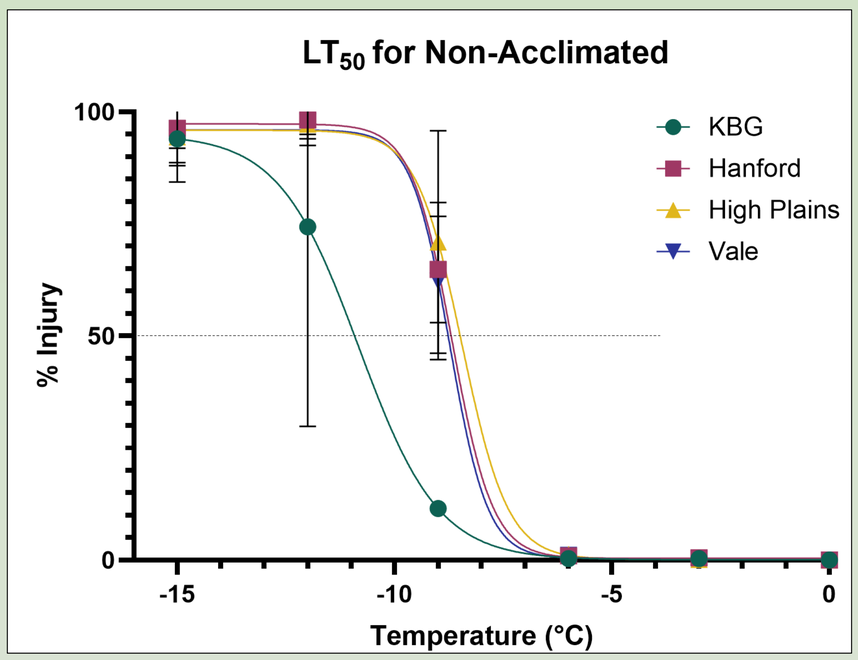

Fig 2. Genotypic variation in freezing tolerance (LT_{50}) under non-acclimated conditions

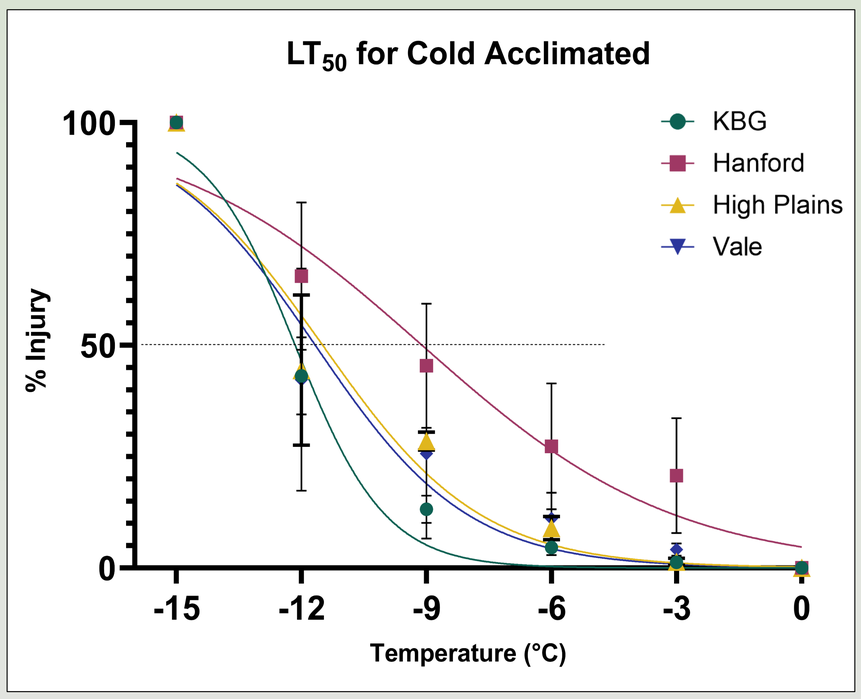

Fig 3. Genotypic variation in freezing tolerance (LT_{50}) under cold-acclimated conditions

Procedure: Leaf samples cooled from 0 °C to -15 °C in a programmable freezer; injury assessed via electrolyte leakage at 0, -3, -6, -9, -12, and -15 °C.

Results

- **Vernalization Requirement**
  1. No flowering occurred without vernalization or with only 3 weeks of vernalization.
  2. 'Hanford' requires the shortest vernalization duration (6 weeks) and fewest days to first flowering (20 days).
  3. 'Vale' required the longest vernalization (≥ 9 weeks) and flowered the latest.
  4. Increasing vernalization duration consistently reduced days to flowering and increased number of flowering tillers across all genotypes.
- **Freezing Tolerance**
  1. NA plants showed little variation among *P. secunda* genotypes, and all were less freezing tolerant than KBG.
  2. CA plants revealed genotypic differences, with KBG most tolerant (−12.2 °C), 'Vale' and 'High Plains' intermediate (~−11.6 °C), and 'Hanford' least tolerant (−9.1 °C).

Genotypes	NA-LT_{50}	CA-LT_{50}
KBG	-10.82	-12.2
'Hanford'	-8.68	-9.1
'High Plains'	-8.45	-11.5
'Vale'	-8.73	-11.7

Conclusion

- *P. secunda* genotypes showed significant variation in vernalization requirement and freezing tolerance, indicating useful genetic diversity for adaptation traits.
- NA plants exhibited moderate freezing tolerance ($LT_{50} \approx -8.5$ °C) with little genotypic variation, whereas CA increased tolerance and revealed differences among genotypes, with 'Vale' and 'High Plains' approaching the winter hardiness of KBG and 'Hanford' remaining less tolerant.
- These results highlight the importance of evaluating both flowering response and cold hardiness when selecting *P. secunda* germplasm for breeding climate-resilient perennial groundcover cultivars.

RegenPGC is supported by Agriculture and Food Research Initiative Competitive Grant no. 2021-68012-35923 from the USDA National Institute of Food and Agriculture. Any opinions, findings, conclusions, or recommendations expressed in this poster are those of the author(s) and do not necessarily reflect the view of the U.S. Department of Agriculture.