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

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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)

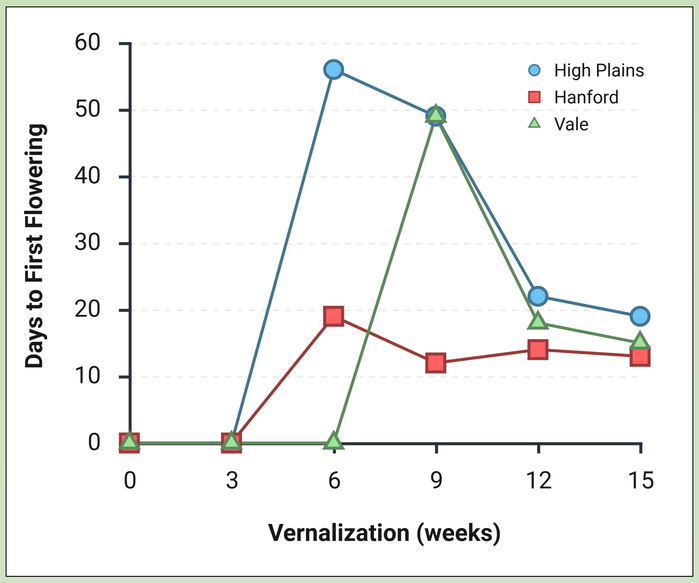

Fig 1. Effect of vernalization duration on the days to first flower in 3 *P. secunda* genotypes.

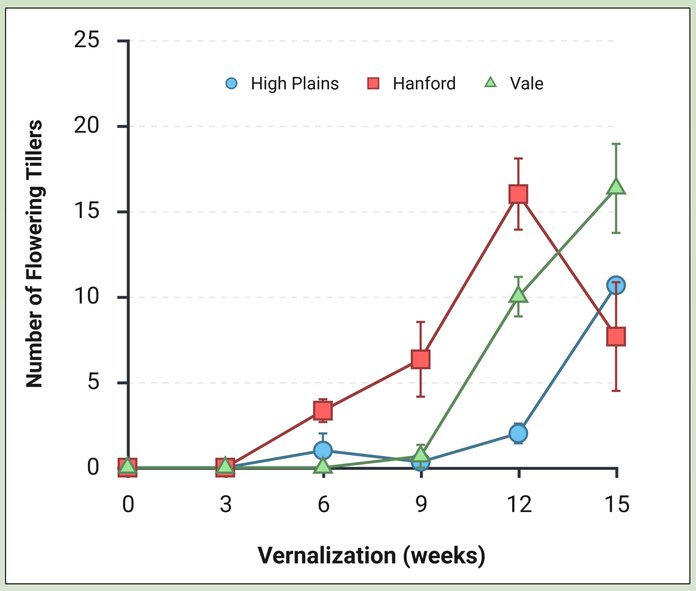

Fig 2. Effect of vernalization duration on the number of flowering tillers per plant in 3 *P. secunda* genotypes.

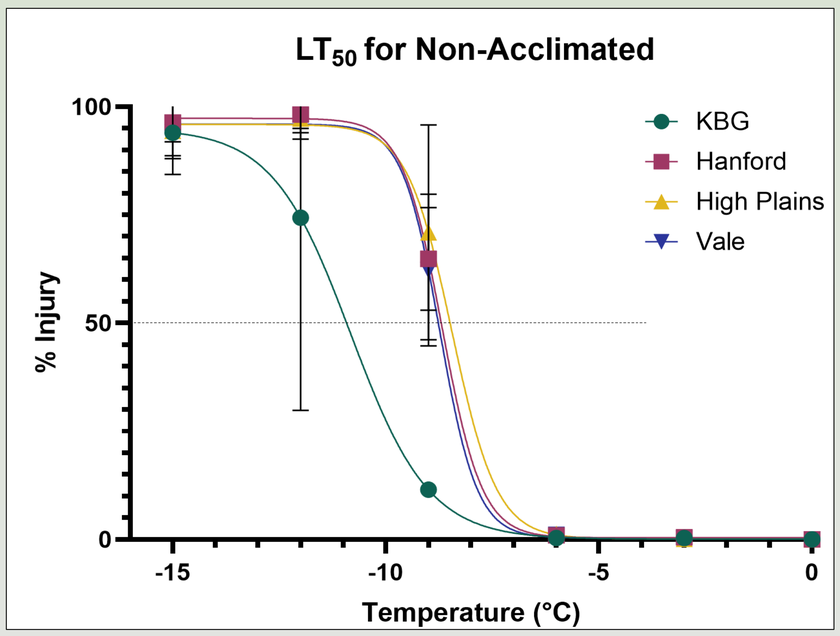

Fig 3. Genotypic variation in freezing tolerance (LT_{50}) under non-acclimated conditions.

- **Freezing Tolerance Experiment:**
  Treatments: Non-acclimated plants maintained at 20°C with a 12 h day length. Acclimated plants maintained at 5°C with an 8 h day length.
  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 flower (20 days). It also produced more flowering tillers with shorter vernalization durations.
  3. 'Vale' required the longest cold duration (≥ 9 weeks) and flowered the latest.
  4. Increasing vernalization duration consistently reduced days to flowering and increased number of flowering tillers across all genotypes.
  5. Strong genotype × vernalization interaction observed, highlighting distinct cold responses among genotypes.
- **Freezing Tolerance:** All *P. secunda* genotypes showed moderate freezing tolerance compared to the more winter-hardy KBG.

Genotypes	LT_{50}
KBG	-10.82
Hanford	-8.68
High Plains	-8.45
Vale	-8.73

Conclusion

- *P. secunda* genotypes exhibited clear variation in cold response traits, reflecting differences in both developmental and physiological adaptation.
- Baseline freezing tolerance (LT_{50} ~ -8.5 °C) across *P. secunda* genotypes suggests moderate cold hardiness compared with the winter-hardy control *P. pratensis*.
- These results inform breeding decisions for climate resilient PGC cultivars, combining efficient flowering response with reliable cold hardiness.

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