Development, Reproduction and Survival of Ten Annual Bluegrass Populations in Indiana

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Resist Poa
USDA-SCRI ANNUAL BLUEGRASS COLLECTIVE

INTRODUCTION

- Annual bluegrass (*Poa annua* L.) is one of the most widespread weeds in athletic fields, lawns and ruderal habitats of all continents across the globe.
- This species belongs to the family of grasses – *Poacea*, and it is still classified as a winter annual. Weak perennial types have been documented and morphological differences have been noticed between these types.
- Peak germination is in late September in Indiana's climate, but a second "flush" is possible in early spring.
- High seed production and high germination rates make it tough to control. The plant has a remarkable capability of thriving in unfavorable conditions such as wet and compacted soils, shade, and low mowing height.
- There is no single practice that is effective in control of annual bluegrass. Combination of cultural, chemical, mechanical and sometimes even biological methods is necessary.
- Annual bluegrass is known as an opportunistic species with high phenotypic plasticity and an ability to adapt.
- Prominent northern golf courses use it as a desirable species on golf putting greens, despite it's low tolerance to heat and drought as well as ice formation during harsh winters.

OBJECTIVE

- Determine differences in phenology and life cycle among ten annual bluegrass populations originating from five different climate zones as a consequence of adaptation to climate conditions in Indiana.

EXPERIMENTAL APPROACH

- Location: The field experiment was planted at Purdue University - William H. Daniel Turfgrass Research and Diagnostic Center, West Lafayette, IN, on November 4, 2020.
- Experimental Design: Completely randomized block system with four replications. Plots were 0.25 m^2 in size. Every plot contained a single plant.
- Treatments: Ten annual bluegrass populations from five different climate zones (Figure 1).

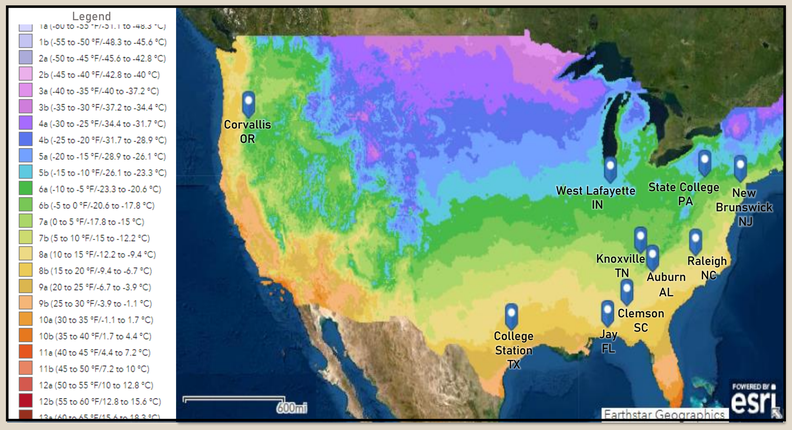

Figure 1. USDA Plant Hardiness Zone Map with annual bluegrass origins of ten annual bluegrass population.

- Data Collection: Plants were observed during the whole season (from November 2020 to October 2021) and numerous measurements were recorded (Figure 4).
- Fall (4WAT): Establishment, Flowering, Number of seedheads, Early vigor and Tiller counts;
- Spring (with beginning of active growth):

  Winterkill (percentage of plants that survived winter);

  Ground cover on a weekly basis for 11 weeks calculated by Digital Image Analysis (Figure 2);

  Height and diameter of bunch-type growth;

  Regrowth potential: plants were clipped at 11 cm diameter and 5 cm in height – two week interval (Figure 3);

  Flowering in weekly intervals for 5 weeks;

  Destructive harvest of 160 out of 400 plants (Figure 5):

  Collection of seed and seed measurements (shattering, rain, weight, total production and number);
  Flag leaf length, width and angle;
  Tiller counts and biomass (plants were clipped at the ground level and dried at 60°C for 7 days);
- Summer: Monthly visual ratings of plant quality and ground cover in July (Digital Image Analysis);
- Plot maintenance: Plants were not fertilized, mowed or irrigated. Weeds were removed by hand and one low-rate application of broadleaf herbicide in early May.
- Data analysis: All data were analyzed using SAS (SAS Institute, Inc). Means separated using Fisher's protected LSD when F tests were significant at α=0.05. A principal component analysis was also conducted with Prism (v.9.0. GraphPad Software, LLC).

Figure 2. Lightbox provides consistent lightening for taking overhead photos of plants for analysis.

Figure 3. Clipped and unclipped plant from South Carolina population for regrowth potential testing on May 24,2021.

Figure 4. Experimental plots with annual bluegrass on May 18, 2021, in West Lafayette, IN.

Figure 5. Destructive harvest of annual bluegrass on June 7, 2021, in West Lafayette, IN.

RESULTS AND DISCUSSION

- PCA analysis resulted in separation of three groups (Figure 6):

  1) Oregon, Pennsylvania and Indiana;
  2) North Carolina, South Carolina, Alabama, Tennessee, Texas and Florida;
  3) New Jersey.
- Plants that belong to the first group had overall better survival and quality during the summer. Flowering of these phenotypes occurred later in the season. Short stolons were developed on some plants during the summer. All vegetative growth parameters including number of tillers, ground cover and biomass were high for Oregon and Pennsylvania population. Plants originating from Indiana had lower vegetative growth in the spring, but were one of the most vigorous during the summer.
- The main characteristic for separation of the second group was earlier death compared to the group one. Populations that are presented on the left side of chart (AL, FL, TX), had very low biomass during the whole season, as well as high winterkill (FL 68%, TX45% and AL13%). Plants from South Carolina are in this group due to their low summer performance and early flowering. Their vegetative growth was higher than the rest of the group. Early flowering in the fall was documented four weeks after planting within AL, TX and SC populations (data not shown). North Carolina population had the highest flag leaf angle of 18.2°.
- The New Jersey population separates as an individual group. These plants were characterized by robust above ground biomass, and exceptionally high seed production. Seed of these plants matured the earliest which was determined by 59% of seed loss prior to harvest.

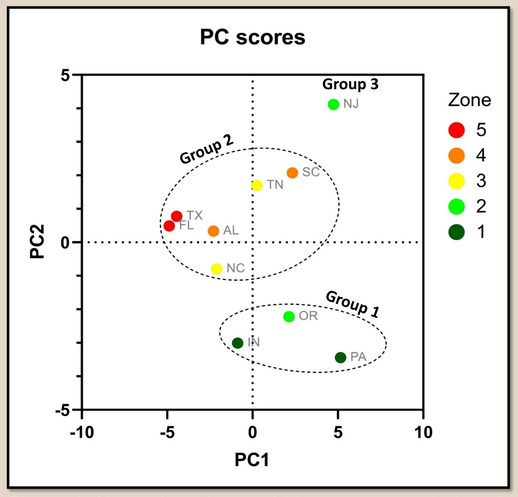

Figure 6. Clustering of annual bluegrass populations by climate zone of the origin.

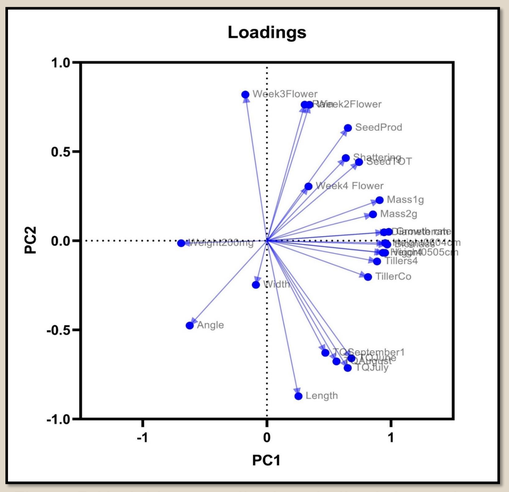

Figure 7. Variables contributing similar information are generally grouped together (vegetative growth, summer survival and seed variables with flowering).

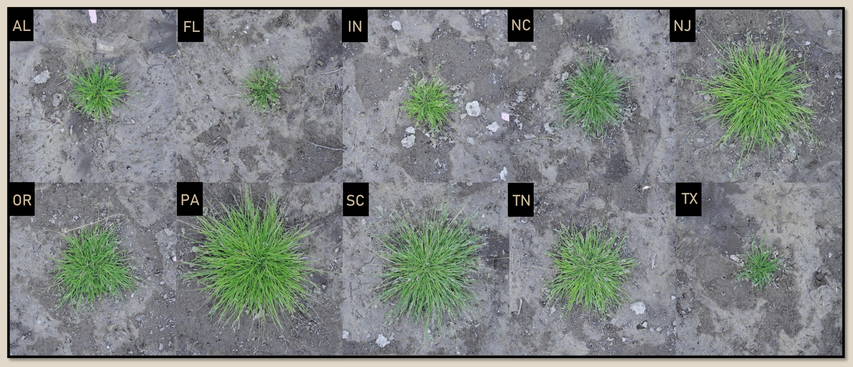

Figure 8. Above ground growth habitat of ten annual bluegrass populations; 10 May, 2021, West Lafayette, IN.

Figure 9. Short stolon on annual bluegrass from the Indiana population, September 27, 2021, West Lafayette, IN.

CONCLUSIONS AND FUTURE RESEARCH

- PCA analysis resulted in clustering of populations according to climate zone of plant origin.
- Populations from colder, northern, climate zones had longer life cycle and some survived until the end of the summer, which indicates a weak perennial life cycle.
- Plants originating from warmer climates and especially from Southern USA (Texas and Florida) had poor winter survival and low summer performance. Even though some of the plants had very low biomass, they were able to produce seed and complete life cycle that is more typical for annual biotypes.
- Future research will also assess the seed weight, size and shape of the annual bluegrass produced in Indiana from these ten populations across the USA.
- At Texas A&M University they will asses the germination rate of seed produced by each population.
- Experiment has been replicated by our collaborators at six locations across the USA (TX, AL, SC, TN, OR and NJ).

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