Summer-Dormant Cool-Season Perennial Grasses - New Productive and Persistent Forages for Semi-arid Environments of the Southern Great Plains

Plots (center of the picture) with traditional, summer-active cultivars of tall fescue after summer drought of 2001 in Vernon, TX

Plots with a summer-dormant tall fescue cultivar Grasslands Flecha after summer drought of 2001 in Vernon, TX

Rationale

For at least three decades, agronomists and plant breeders have been attempting to introduce improved cool-season perennial grasses to semi-arid environments of the Southern Great Plains to complement forage availability from dual-use wheat (*Triticum aestivum* L.) pastures during the fall-winter-spring (October-March) grazing season and from warm-season grass pastures and native rangelands in the spring (March-May) grazing season. The introduction of traditionally recommended (summer-active), improved cool-season perennial grasses has not been successful because of: 1) very limited forage production during winter grazing season, and 2) poor persistence due to inadaptability to severe water deficits accompanied by extreme heat in summer.

Global warming has an effect on the climate of the Southern Great Plains. Within the last 20 years, mean annual temperature has been increasing, while annual precipitation has been decreasing (Fig. 1). Although one may argue this may be a part of natural climate cycle, the fact is that such changes will have an impact on decision making in regard to agricultural crops and practices in affected regions of the world.

Breeders in Argentina, Australia, Italy, and New Zealand have recently developed drought-resistant cultivars of cool-season perennial grasses, i.e., tall fescue [*Schedonorus phoenix* (Scop.) Holub], orchardgrass (*Dactylis glomerata* L.) and perennial ryegrass (*Lolium perenne* L.) based on germplasm originated from the Mediterranean Basin of Europe and Africa. These grasses produce most of forage during autumn to early spring and are summer-dormant, i.e., they cease growth in response to long days and high temperatures even at adequate soil water supply. In contrast, traditionally recommended

cultivars of perennial cool-season grasses for the Southern Great Plains are summer-active, i.e., they continue with growth during summer if soil water is available. Consecutive periods of drought exhaust the plants resulting in high tiller mortality by autumn.

In environments resembling Mediterranean climate with prolonged and severe summer drought, summer-dormant cool-season perennial grasses have been proven more persistent than summer-active types. Their strategy of drought resistance, which is actually similar to drought escape, is superior to that of summer-active types that developed mechanisms of drought tolerance.

Summer-dormant cool-season perennial grasses are not productive during summer months, therefore, they are not suitable for improved, intensive grasslands in the temperate zones of the United States where summer-active type of cool-season perennial grasses are used. This may explain the slower progress of developing summer-dormant cultivars in the USA when compared with other countries. Our long-term (2000-2010) research data indicate that summer-dormant cool-season grasses are perfectly adapted to the transitional semi-arid steppe and warm semi-arid steppe zones of the Southern Great Plains, most likely because the climate here (relatively mild winters and severe summer droughts) is similar to that of their origin.

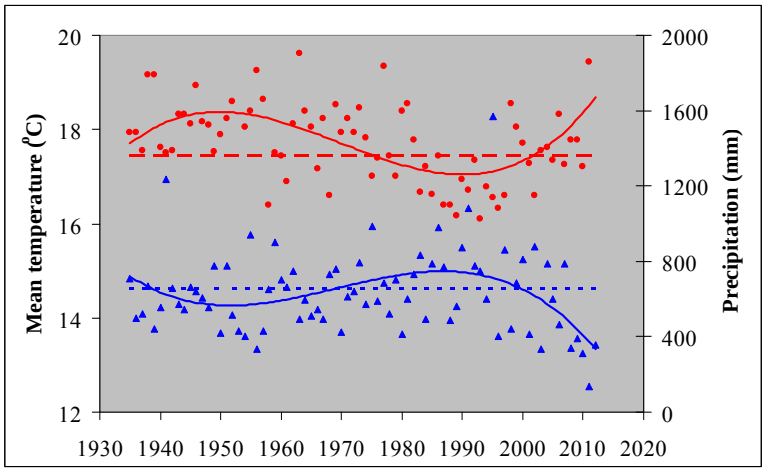

Fig. 1. Long-term trends in mean annual temperature and annual precipitation for Vernon, TX during 1935-2012. ● Mean annual temperature; - Long-term average annual temperature; ▲Annual precipitation; - Long-term average annual precipitation.

Objectives

1. Determine the role of summer-dormant cool-season grasses in grazing systems, including their adaptability, productivity, potential to reduce nitrogen fertilizer input by using annual legumes as components of mixed stands, potential to reduce the carbon footprint in managed agroecosystems, forage nutritive value, animal performance, and system economics;
2. Develop new cultivars of summer-dormant tall fescue, orchardgrass, and perennial

ryegrass;
3. Determine physiological and molecular basis of summer dormancy mechanism in cool-season grasses;
4. Disseminate the new technology to producers.

Research Progress

2000 - 2010	Evaluation of forage productivity and persistence of Flecha MaxQ summer-dormant tall fescue
2002 - 2004	Evaluation of productivity and persistence of tall fescue, orchardgrass, perennial ryegrass, and hardinggrass as a function of summer dormancy
2004 - 2007	Mechanisms of summer dormancy in cool-season perennial grasses - A cooperative project with Dr. Jaime Kigel, The Hebrew University of Jerusalem, Israel.
2005 - present	Breeding program of summer-dormant cool-season grasses for the Southern Great Plains in cooperation with Grasslanz (New Zealand).
2008	Development of a method to differentiate summer-dormant from summer-active tall fescue and orchardgrass accessions at germination stage
2009	Hosting the Field Day at Vernon for participants of the 1st International Workshop on Summer Dormancy in Grasses
2010-2012	Development of advanced breeding lines of summer-dormant cool-season grasses.
2012	Based in part on our long-term research data, summer-dormant tall fescue was included by the USDA-NRCS on the list of recommended grasses for Texas (Technical Note No:TX-PM-12-01)

Summary of Results

Butler, T.J. Interrante, S.M., Malinowski, D.P., and K. Widdup. 2011. Annual medic forage and seed evaluations for the semiarid regions of the Great Plains. Forage and Grazinglands. Available online http://www.plantmanagementnetwork.org/sub/fg/research/2011/medic/medic.pdf.

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Malinowski, D.P., Kigel, J., and W.E. Pinchak. 2009. Water deficit, heat tolerance, and persistence of summer-dormant grasses in the U.S. Southern Plains. Crop Sci. 49:2363-2370.

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