PHYSIOLOGICAL AND MORPHOLOGICAL TRAITS FOR SELECTION OF DUAL-USE WHEAT WITH IMPROVED FORAGE PRODUCTION

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ABSTRACT

There are no clearly defined selection criteria for breeding forage-type wheat. In a series of experiments, we determined relationships between early-season forage production and morphological and physiological traits in a range of wheat cultivars and breeding lines under in a grazing system. Tiller number and specific leaf weight were highly correlated with early-season forage production, while leaf width and leaf length were poorly correlated. Growing conditions did affect the correlations. Concentration of phenolic compounds, metabolites that may play a role in preventing frothy bloat in cattle grazing wheat, was highly depended on weather conditions and varied among wheat entries, suggesting potential for manipulating production of these metabolites.

SUMMARY

Wheat historically has been bred for increased grain yield and for tolerance to abiotic (drought, soil mineral imbalance) and biotic (insects, pathogens) stresses. Although grain yield potential of modern cultivars is higher than older cultivars, breeding progress for forage production, forage quality, and grazing has been very limited. Texas A&M University has released only one variety (Lockett) bred exclusively for grazing and one dual-purpose (TAM-202) wheat variety. The lack of adequate selection criteria has hampered breeding efforts to develop improved forage-type and dual-purpose wheat varieties. Because of a lack of clearly defined selection criteria for breeding forage-type wheat, breeders usually rely on forage quantity and quality during the fall-spring growing season as selection tools. Such an approach may not be the most appropriate to develop disease and insect resistant, productive cultivars with a maximal potential to withstand various grazing pressures and climate fluctuations. Recent studies suggest phenolic compounds may be one group of metabolites in wheat forage controlling frothy bloat, a serious digestive disorder of cattle grazing wheat. In an independent series of studies, we evidenced a relationship between rapid changes in solar radiation and temperature (e.g., during passing cold fronts) and phenolic concentration in wheat forage. Frothy bloat incidences usually amplify during conditions of rapid weather changes in the late winter-early spring season. Previous research evidenced the importance of foam stability in the rumen for the potential of frothy bloat. We showed that wheat entries with low phenolic concentrations exhibited an increase in foam strength measured in vitro.

The objective of this study was to determine morphological and physiological traits for selection of dual-use wheat with improved forage productivity. In this presentation we discuss correlations between forage production in the early grazing season (November-December) and wheat plant morphological parameters, and phenolic concentrations in wheat cultivars and breeding lines.

During the 2003-2005 winter growing seasons we evaluated forage and grain yield, grazing tolerance, morphological and physiological traits, and resistance to pests and diseases of a range of breeding lines and cultivars selected from the Texas Elite (TXE) and Uniform Variety Trial (UVT) wheat collections. Each wheat entry was strip-planted on 0.04-ac plots (18 x 100 ft) in blocks repeated 3 times. Seeding rate was 23 seeds/sq ft, which corresponds to 75 lbs/ac of Lockett wheat (check variety). The experimental site was a part of a 35-ac wheat pasture grazed from December through February each year at 0.75 head/ac stocking rate. Forage yield was measured at 28-d intervals from grazed and enclosed, non-grazed areas by harvesting 5.4 sq ft area of each plot. Tillers were counted from 1-ft row. Wheat samples for phenolic compounds assessments were collected in January, February, and March 2005 during periods of sudden weather changes. The experimental design was a completely randomized block replicated three times. All data were analyzed using the Mixed Procedure of the Statistical Analysis System (SAS, 1999). Replications were considered random and wheat entries were considered a fixed factor. Mean separation was performed using the protected least square means (LSMEANS) procedure. Significance was declared at $P < 0.05$.

The 2003 winter growing season was extremely dry until January 2004. Precipitation during October-December 2003 was only 1.10 inches (long-term average is 4.80 inches). Early forage yield was positively correlated (R^2=0.66) with tiller number in the dryland wheat, but not significantly correlated with tiller number in the irrigated UVT (R^2=0.22) and TXE (R^2=0.16) wheat collections. Precipitation during October-December 2004 (11.63 inches) was above normal (4.80 inches). Under such wet conditions, early forage yield was not correlated with tiller number in the dryland study (R^2=0.07) and weakly correlated with tiller number in the non-irrigated UVT (R^2=0.41) and TXE wheat collections (R^2=0.52). Leaf length was not correlated with early forage yield (R^2=0.08 to R^2=0.25), except for dryland wheat in 2003 (R^2=0.88). Leaf width was also not correlated with early forage yield (R^2=0.004 to R^2=0.16. Specific leaf weight (SLW) was negatively correlated with early forage production in dryland wheat in 2003, but there were weak correlations between these traits in irrigated UVT and TXE wheat collections. In 2004, early yield was negatively correlated with SLW in dryland wheat and non-irrigated UVT and TXE collections. Producing leaves with lower SLW enables the construction of more leaf area per unit of leaf mass, which is a typical strategy of fast growing grass species. Phenolic compounds varied among wheat cultivars and breeding lines during the 2004-2005 growing season. Cultivars TAM 100, TAM 111, TAM W-101, Deliver, and a breeding line TX98V9628 had the highest concentrations of phenolics, while cultivars TAM 400, OK 102, Jagger, and breeding lines TX01V5314, TX00V1117 and TX01U2598 had the lowest phenolic concentrations.

Morphological traits such as tiller number or specific leaf weight are easy to measure and they are correlated with early wheat forage production. It is important to conduct the wheat selection process for increased forage productivity under conditions in which the cultivars will later grow. Leaf parameters such as length or width are not useful in selecting lines for high forage productivity. Concentrations of phenolic compounds (which may play a role in frothy bloat prevention) vary among wheat cultivars and breeding lines, suggesting a potential for selection of wheat with high and stable phenolic content.

REFERENCES

SAS. 1999. SAS user's guide, version 8.0. Statistical Analysis Systems Institute, Cary, N.C.