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Review

Field performance and nutritive value of sweet sorghum in eastern China

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ABSTRACT

The objective of this study was to estimate the feasibility of sweet sorghum (cv. Hunnigreen) as a source of green fodder and its potential as a silage crop in humid environments. One variety of sweet sorghum and two varieties of corn were compared in dry matter (DM) yield and forage quality, as measured by field performance and nutritive value. Forages were grown in a complete randomized block design with 3 replications over a two year period, harvested at the milk stage (MS) and dough stage (DS). The sweet sorghum had higher leaf area index (LAI) and plant height than both Yudan 8 and Denghai 9 corn varieties because of its characteristic lateness. Dry matter (DM) content of sweet sorghum at DS was above the minimum DM content (>247 g kg^{-1}) needed for optimum ensiling though lower ($P < 0.05$) than both corn varieties. Mean DM yield of sweet sorghum (43.0 t ha^{-1}) at DS, in two years, was higher ($P < 0.05$) than both corn varieties (27.0–28.8 t ha^{-1}). Crude protein (CP) in DM and *in vitro* DM digestibility (IVDMD) of sweet sorghum had no significant difference compared to corn (a change of 52.1–56.6 g kg^{-1} DM). Neutral detergent fiber (NDF) and acid detergent fiber (ADF) of sweet sorghum was higher ($P < 0.05$) than that of both corn varieties except for NDF at MS in 2008. Data indicated that sweet sorghum has a higher yield than corn, with similar CP content and IVDMD. Stable nutritive value and multiple harvests of sweet sorghum offers great potential as an alternative silage crop compared to corn in the relatively humid environment of eastern China.

Contents

1. Introduction

In recent years, Sorghum [*Sorghum bicolor* (L.) Moench] has become an increasingly important forage crop in many regions of the world (Zerbini and Thomas, 2003). This trend is a consequence of the high productivity of sorghum and its ability to adjust to different climatic and edaphic-conditions, which includes a hot

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climate such as Sudan (Ibrahim, 1999), or relatively cool climates such as Canada (McCaughey et al., 1996). Some research studies have shown that sorghum has high nutritive value, which may be comparable to corn (*Zea mays* L.) (Nichols et al., 1998; Ward et al., 2001), and as such it has been used successfully for feeding lactating dairy cows (Aydin et al., 1999; Oliver et al., 2004). Previous research dealing with comparative analysis of the quality of sorghum and corn (Miron et al., 2007) fed to dairy cows has shown that sorghum had high nutritive value, higher milk yield and milk fat content. Recent studies suggest sorghum is suitable for both rotational grazing, as a hay crop and could compete with dry matter yield of corn silage in years when wet spring conditions prevent the timely planting of corn (Ketterings et al., 2005). Sorghum is generally considered a species well suited to drought-prone regions, and grain sorghum is a prominent source of food and feed in regions with limited water availability. The higher agronomic and nutritional advantage of sorghum over corn occurred in arid and semiarid regions; however, there is little data on field performance and forage quality of sorghum compared with corn in humid environments.

To expand the utilization of sorghum as a forage crop under different environments, plant breeders have focused on traits likely to affect its productivity, such as yield and/or forage quality. Yield is a reflection of a plant's potential to accumulate dry matter (Miron et al., 2007). Consequently, developing new varieties of sorghum with high DM content at harvest is a desirable agronomic target. Another important trait, for livestock feeding, is high neutral detergent fiber (NDF) and dry matter (DM) digestibility. Various hybrids and varieties of sorghum differ in their chemical composition of crude protein, NDF and ADF. Forage quality of sorghum may also be affected strongly by interactions between the genotype, the maturity stage of the plants at harvest and environmental factors (Cummins, 1981; Pedersen et al., 1982); therefore, any examination of a new sorghum variety should consider the factors of growth stage and environment.

Sweet sorghum is a C4 crop in the grass family belonging to the genus Sorghum, and similar to other sorghum types are well adapted to varied (or diverse) climatic conditions. In eastern China, most forages have been used as fresh crop or for the preparation of silage, and are rarely used as hay. Sweet sorghum contains high water-soluble carbohydrates, which may improve the ensiling quality of a forage by accelerating lactic acid production. Thus sweet sorghum, used as a silage crop may have more potential benefits to compete with corn in rainy areas.

In eastern China, sweet sorghum is likely more adapted than corn to high temperature, excess water, clay soil and low soil pH. Many previous studies have shown that sorghum can be used to make silage, but field performance and forage quality of sweet sorghums are not well know in these humid environments. In this trial, we evaluated sorghum grown as a silage crop under rainy climatic conditions sown in clay soils and compared the field performance and nutritive value with corn at different growth stages.

2. Materials and methods

2.1. Trial location

The field trials were conducted at Nanjing Agriculture University (NAU) (32°01′N, 118°38′E) in 2008 and at an experimental field at Chunhui Dairy Co., Ltd. (CHD) (31°51′N, 119°49′E) in 2009. Both trial sites were situated at the lower reach of the Yangtze River in Jiangsu province, China. The region is characterized as a subtropical monsoon climate with mean annual precipitation of 1106 mm and average temperatures of 15.4 °C. Precipitation during growth stage (from May to September) in 2008 exceeded that of 2009 during the same period (Fig. 1). Soil type in this area is typically clay loam.

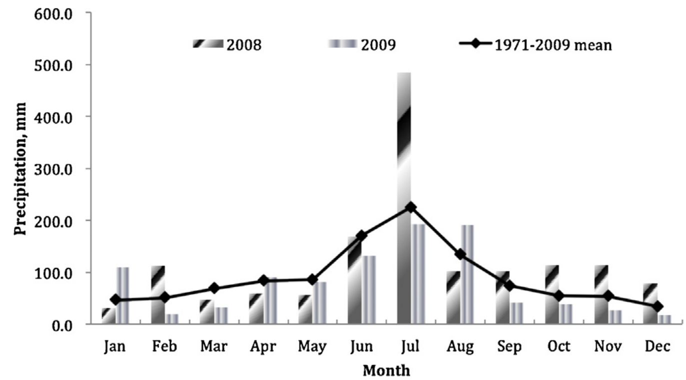

Fig. 1. Mean monthly 2008, 2009, and long-term (1971–2009) precipitation at two experimental locations.

The soil properties are outlined in Table 1 for the two fields used in this experiment. The previous crop was Italian ryegrass (*Lolium multiflorum* Lam.)

2.2. Experimental design and treatments

The field experiment was arranged in a complete randomized block design with 3 replications. Plot area was 15 m^2 (5 m × 3 m), row and plant spacing were 30 and 25 cm, respectively. Two corn cultivars (cv. Yudan 8, Gansu Dunhuang seed Co., Ltd.; Denghai 9, Shandong, Denghai seed Co., Ltd.) and one sweet sorghum (cv. Hunnigreen, Barenbrug Beijing international grass Co., Ltd.) were sown on May 27, 2008 and May 20, 2009. All plots were tilled to depth of 20 cm, and a pre-plant NPK fertilizer (10-7-8) was applied at a rate of 450 kg ha^{-1} with an additional 350 kg N ha^{-1} in the form of urea applied 40 days after planting (early shoot stage). To prevent weeds, 2.5 L atrazine ha^{-1} was sprayed before tillage, and 2-4-D applied a week after germination.

2.3. Harvest scheduling and sample collection

Hunnigreen (sweet sorghum) is a late-maturing variety, which did not flower during the growing season, so sampling times were based on the corn growth stages. The 1st sampling was at the milk stage (MS) of corn on August 19, 2008 (84 days after seeding) and August 15, 2009 (87 days after seeding), while the 2nd sampling was harvested at dough stage (DS) for corn on September 4, 2008 (100 days after seeding) and September 1, 2009 (104 days after seeding). Each sampling included harvesting of three adjacent rows, and ten whole plants were hand harvested 5 cm above ground from each plot. Number of leaves per plant and stem heights was measured immediately after the harvest. Five of the harvested plants were divided into cobs, leaves and stems, and dried at 65 °C for 96 h in an aerated oven. The dry separated parts were weighed and their proportion of the whole plant dry matter (DM) was calculated. DM yield of the three rows of plants was estimated after harvest, according to whole plant dry matter content and

Table 1
Soil physiochemical properties.

Field soil properties	NAU[a]	CHD[b]
Organic matter (g kg^{-1})	20.4	25.6
Total nitrogen (g kg^{-1})	3.92	4.36
Available nitrogen (mg kg^{-1})	10.1	8.80
Available phosphorus (mg kg^{-1})	11.2	9.02
Available potassium (mg kg^{-1})	106	93.2
pH	5.8	5.4

[a] Nanjing Agriculture University.
[b] Chunhui Dairy Co., Ltd.