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EFFECT OF PHYSIOLOGIC AND MANAGEMENT FACTORS

ON YIELD AND QUALITY OF GRAIN SORGHUM

(*SORGHUM BICOLOR* (L.) MOENCH) RESIDUES

by

Danny H. Smith

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L. J. Perry, Jr. and Jerry D. Eastin

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TITLE

EFFECT OF PHYSIOLOGIC AND MANAGEMENT FACTORS ON YIELD

AND QUALITY OF GRAIN SORGHUM (SORGHUM BICOLOR (L.) MOENCH) RESIDUES

BY

DANNY HAROLD SMITH

APPROVED	DATE
L. J. Perry, Jr.	August 12, 1977
Jerry Eastin	August 12, 1977
Terry Klopfenstein	August 12, 1977
John K. Ward	August 12, 1977
Robert Britton	August 12, 1977
E. C. Conard	August 12, 1977
F. A. Haskins	August 12, 1977

SUPERVISORY COMMITTEE

GRADUATE COLLEGE UNIVERSITY OF NEBRASKA

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INTRODUCTION

Crop residue is a term used to describe above ground plant material left in the aftermath of a primary grain harvesting operation. Residue is used as a livestock feed source in many areas of the U.S. Methods of utilization vary depending on the livestock production system and may include grazing, baling, stacking, and preservation as silage. Despite widespread use, research effort to determine optimum systems of residue utilization has only recently been pursued.

Crop residue from grain sorghum (*Sorghum bicolor* (L.) Moench) represents a valuable resource for livestock production. Between 1973 and 1975 grain sorghum was second to corn among feed grains in total harvested hectares in the U.S., averaging 7.5 million hectares annually.[1/] The bulk of grain sorghum production in the U.S. occurs in the Great Plains. Texas, Kansas, Nebraska, and Oklahoma have traditionally been the leading states in both harvested hectares and production (Kramer and Ross, 1970). Nebraska grain sorghum production averaged 3261 kg/ha from 0.78 million hectares during 1973 to 1975.[1/]

Yield and composition of grain sorghum stover during the growing season and immediately after grain harvest

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[1/]USDA. 1976. Agricultural Statistics.

have been fairly well characterized. However, only Martin and Wedin (1974) and Martin (1974) have described the effects of weathering processes occurring after frost on yield and composition. In addition, Martin (1974) has assessed the importance of grain harvest date and the time period between physiologic maturity and frost on composition using a single genotype. The importance of the duration of this interval, however, was not determined. Therefore, research was conducted during the growing seasons and subsequent fall and winter periods of 1974 and 1975 to determine the effect of planting date, maturity, the duration of the period between physiologic maturity and frost, grazing by beef cows, grain harvest date, and residue harvest date on yield, composition, and quality of grain sorghum residues.

LITERATURE REVIEW

Grain sorghum (*Sorghum bicolor* (L.) Moench) is a Gramineae member of the Andropogoneae tribe of the subfamily, Panicoideae (Clayton, 1961). The *Sorghum* genus includes several grass species such as johnsongrass (*halapense*) and sudangrass (*sudanense*), grain sorghums, sorgos, and broomcorns (Martin, 1970). Forage sorghums are commonly differentiated from grain sorghums only by virtue of having fewer dominant dwarfing genes.

Cultivated sorghums probably originated in or near east central Africa and were first brought to the Western Hemisphere during the course of slave trade in the 17th and 18th centuries. Appreciable production in the U.S. did not begin until the late 19th century with the introduction of several sorghum types from Africa, India, and South America (Martin, 1970).

The morphology and plant development of grain sorghum have been described by Freeman (1970). Vanderlip and Reeves (1972) detailed nine developmental stages in photoperiod insensitive sorghums; however, the discussion provided here will follow the three functional stages of development as described by Eastin (1972). Early growth after emergence is characterized by leaf production by the

vegetative apex. This first phase ends with the transition of the shoot apex from the vegetative to the floral phase. Upper leaf expansion, stem elongation, and panicle initiation and differentiation occur during the second developmental stage which terminates with the onset of flowering. Grain filling occurs during the final developmental phase. Physiologic maturity marks the end of this phase. The entire life cycle (emergence to physiologic maturity) is approximately equally divided among these three developmental phases in photoperiod insensitive genotypes adapted to temperate regions (Pauli et al., 1964; Eastin, 1972).

Although sorghum behaves as an annual in temperate climates, the species exhibits perennial tendencies due to the initiation and occasional development of axillary buds along the main axis (Freeman, 1970). Grain sorghums generally show lower tillering tendencies than most grass types.

Yield and Composition

Stover Yield

A partial summary of available grain sorghum stover yield data is presented in Table 1.1. Potential residue yields vary with geographic location, available soil moisture, stage of harvest, genotype, and system of crop production practices utilized.

Table 1.1. Literature estimates of stover yield in dryland and irrigated grain sorghum harvested at maturity over several locations.

Source	Location	Description	Dry Matter Yield (kg/ha)
Bygott, 1956	Australia	Dryland	1612-3158
Burleson et al., 1956	Texas	Irrigated	3786-7840
Brown and Shrader, 1959	Kansas	Dryland	1120-5376
Porter et al., 1960	Texas	Irrigated	7963-10498
Bond et al.,1964	Texas	Dryland	2556-4498
Martin and Wedin, 1974	Iowa	Dryland	3780-4900
Perry and Olson, 1975	Nebraska	Irrigated	3434-5660
Jacques et al., 1975	Kansas	Dryland	4065-7370
Vetter and Ayres, 1973	Iowa	Machine Harvested	4293

Cultural practices have a substantial influence on dry matter (DM) yields of grain sorghum stover. Yield increases have been obtained by row spacing reductions to less than 102 cm under both dryland (Bygott, 1956; Brown and Shrader, 1959; Bond et al., 1964) and irrigated (Porter et al., 1960) conditions. Higher seeding rates can also increase yields in dryland (Brown and Shrader, 1959; Bond et al., 1964; Martin and Wedin, 1974) and irrigated (Porter et al., 1964) production situations.

Nitrogen fertilization will enhance stover yields when applied at or near planting (Burleson et al., 1956; Porter et al., 1960) or as a sidedress (Perry and Olson, 1975). However, the degree of yield response to nitrogen was variable in these studies. Burleson et al. (1956) found that stover yields increased with increasing nitrogen levels up to 134 kg/ha while Perry and Olson (1975) obtained maximum yields at 90 kg/ha. These nitrogen response differences were probably influenced by variation in other factors such as genotype, soil conditions, and climatic factors. Added nitrogen can also affect stover yields when applied late in the growing season. Martin (1974) induced relatively small increases in DM production by applying nitrogen fertilizer either at physiologic maturity or when grain moisture reached 25%.

Significant differences in stover yield can occur due to climatic variation over years (Windscheffel et al.,

1973; Martin and Wedin, 1974). Grain harvest date can also have a significant effect. Maximum DM yields occur at frost since sorghum continues to accumulate photosynthate during the period from physiologic maturity until frost (Windscheffel et al., 1973; Martin and Wedin, 1974; Martin, 1974). Following frost weathering factors can result in substantial yield losses. Webster and Davies (1956) noted continued DM losses during the fall and winter, averaging 33 to 50% of the DM present at frost in eight forage and grain sorghum lines. Martin and Wedin (1974) found that losses during the fall averaged 22%.

Variation in grain sorghum stover yield due to genotype differences have been documented to a limited extent. Within grain types (3-dwarf) medium maturity hybrids have shown yield advantages over early (Martin and Wedin, 1974) and late maturing genotypes (Jacques et al., 1975); however, variability within maturity groups has not been explored sufficiently. Windscheffel et al. (1973) compared two sets of isogenic 2- and 3-dwarf sorghum hybrids and found that taller genotypes (2-dwarf) produced 22% more DM than the shorter hybrids.

Interactions among the factors mentioned above can also contribute to stover yield variation. Where rainfall during the growing season is not adequate for optimum production the positive yield response due to decreasing row widths and increasing plant populations is limited by

soil moisture level at planting (Bygott, 1956; Brown and Shrader, 1959; Bond et al., 1964). Other climatic factors can interact with one or more of the above mentioned variables to produce variability in sorghum stover yield (Martin and Wedin, 1974; Perry and Olson, 1975). These interactions, however, are not well defined.

Dry Matter Content

A summary of available data on grain sorghum stover DM content is presented in Table 1.2. Webster and Davies (1956) noted that sorghum stover retained more moisture when left standing in the field than similar material which had been cut and shocked. Other authors have indicated that grain sorghum stover is higher in moisture than stover from other crops harvested at the same time (Vetter and Ayres, 1973; Perry and Ward, 1975). This is apparently due to high moisture levels retained in sorghum stalks after frost (Wikner and Atkins, 1960; Johnson et al., 1971; Martin and Wedin, 1974; Martin, 1974). The retention of moisture is an important consideration because vegetation decomposition is accelerated at higher moisture levels (Greenhill et al., 1961) due to development of mold (Snow et al., 1944; Sain and Broadbent, 1975) and possibly other factors. Vetter and Ayres (1973) indicated that storage problems will occur