

THE EFFECT OF GLYPHOSATE ON DM YIELD AND QUALITY OF FORAGE SORGHUM

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ABSTRACT

The possibility of improving the forage quality of sorghum (*Sorghum bicolor* L. Moench) by using herbicide was assessed in field trials. Glyphosate (Roundup) reduced cell wall content and increased the digestibility of the dry matter. When sprayed towards the end of vegetative growth, quality improvement could be achieved without reduction in yield. Glyphosate may enhance accumulation of sugars, however, the possibility that the herbicide improves forage quality by affecting cell wall structure and digestibility cannot be ruled out.

KEYWORDS

Forage sorghum, glyphosate, digestibility, cell wall

INTRODUCTION

Earlier work has shown that osmotic stress caused either by drought or by irrigation with saline water, increases the digestibility of forage sorghum (Kipnis et al. 1994a, 1994b). Another strategy to improve forage quality would be to use growth retardants or herbicides. Application of glyphosate (Roundup) delays the loss of soluble carbohydrates and crude protein and also delays the decline in digestibility of senescing grass pasture (Davidson et al., 1988). Armstrong et al. (1992) showed that glyphosate improves the quality of senescing grass only when applied before anthesis. Similarly, Crawford and Simpson (1993) have shown that glyphosate maintains stem in vitro dry matter digestibility (IVDMD) for up to 42 days after spraying. However, it has no effect on digestibility of leaf blades.

Glyphosate, a non toxic and environmentally friendly herbicide is active in the shikimic acid pathway which is involved in deposition of the secondary cell wall. Our objectives were to assess the effect of this herbicide on quality traits in forage sorghum, and, whether quality improvement can be achieved without reduction in yield.

MATERIALS AND METHODS

Forage sorghum (FS5, Dekalb Genetics Corporation) was grown in soil with an excellent water holding capacity. On the day of sowing, the soil water content to a depth of 180 cm was 250 mm and no rain fell after sowing. Only partial results obtained from a two year study will be presented here. The crop was allowed to grow without irrigation and plants in three replicates were sprayed with 100 µM a.i. glyphosate or were left untreated. In the first year the plants were treated during stem elongation, when 8 leaves were fully expanded. In the second year the treatment was given at the boot stage or when the heads were just appearing. All plants in 3m² plots were harvested either on the day of spraying or 20 days later. The plants were weighed, and samples consisting of three plants from each plot were taken for dry matter determination and chemical analyses. IVDMD was determined using the method of Tilley and Terry (1963). Cell wall constituents, and the digestibility of the cell wall were determined according to Goering and Van Soest (1970). In this paper we have omitted the results obtained for leaf quality and present only those relevant to the stem.

RESULTS AND DISCUSSION

Spraying plants at the 8 leaf stage reduced total DM yield by 30.7%. Compared with untreated controls the neutral detergent fiber (NDF) content of glyphosate treated plants declined by 12.0%, and IVDMD increased by 9.2%. Glyphosate sprays reduced the length of young stem internodes and this effect diminished basipetally. In contrast,

glyphosate reduced the content of Acid detergent fiber (ADF) and Acid detergent lignin (ADL) in the lower internodes (Fig.1). In another experiment, we found that cell wall digestibility at stem elongation was 3 percentage units higher in glyphosate treated than in control plants (data not shown).

Total plant DM yield of plants treated with glyphosate between boot and head appearance was similar to that of untreated controls (Table 1). Dry weight continued to accumulate in the stover for more than 20 days following the spray and was unaffected by the treatment. However, the heads were 25% lighter on sprayed plants. The NDF, ADF and ADL content of sprayed plants was 10.0, 13.4 and 15.4% lower than that of untreated plants 20 days after spraying. Concurrently, stem IVDMD and cell wall digestibility increased by 45g kg⁻¹ and 24g kg⁻¹ in treated plants over that found for untreated ones respectively.

We have previously found that sucrose accumulates in the stem of hybrid FS5 when it is grown under moderate drought stress conditions (Kipnis unpublished). Results reported here show that glyphosate reduced cell wall constituents (CWC) and improved stem IVDMD. It seems likely that accumulation of sugars takes part in this improvement. Although the results of this study are not unequivocal, we suggest the possibility that part of the higher dm digestibility is due to increased digestibility of the cell wall. In conclusion, an appropriate concentration of glyphosate applied towards the end of vegetative growth may improve the quality of forage sorghum without reducing its yield.

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Table 1

The effect of glyphosate on dry matter (DM) yield, cell wall constituents (CWC) and stem digestibility of forage sorghum grown under dryland conditions^z

Treatment	DM yield		Stem CWC			Stem digestibility	
	(Mg ha ⁻¹)		NDF	ADF (g kg ⁻¹ DM)	ADL	DM	Cell wall (g kg ⁻¹)
Control	16.3±0.7	(12.1) ^y	559±21	357±21	52±4	667±35	508 ^x
Glyphosate	16.5±1.9	(10.8)	499±24	309±24	44±6	712±25	532

^z The crop was sprayed at boot or when heads were just appearing, samples were collected 20 days later.

^y Standard error of the mean (3 observations per mean), number in brackets represent DM yield on the day of spraying.

^x Analyses were made in duplicate on mixed samples of 3 replicates.

Figure 1

The effect of glyphosate on the distribution of ADF (a) and ADL (b) in stem internodes of forage sorghum grown under dryland conditions. The crop was sprayed at 8 leaf stage, and samples were collected 20 days later. The growth of internodes 7-8 was inhibited. Analyses were made in duplicate on mixed samples of three replicates.

