EVALUATION OF WEED MANAGEMENT STRATEGIES ON GRAIN SORGHUM NITROGEN STATUS AND GRAIN YIELD USING OPTICAL SENSORS

A.A. Lorence, D.A. Ruiz Diaz, J.A. Dille, C. L. Edwards, and A.R. Asebedo
Department of Agronomy
Kansas State University, Manhattan, Kansas

Abstract

Information on weed management options and relation to nutrient status is very limited for grain sorghum production. The objectives of this study were: (i) determine the effects of different weed management strategies on grain sorghum yield; and (ii) evaluate the impact on nitrogen (N) status and development of the crop. This study was established at two locations in 2014 (Smith and Reno Co in Kansas). The study used a randomized complete block design with 4 replications. Two main factors evaluated included N management and weed management for a total of 8 treatment combinations plus a control. Sorghum plant sampling was completed at growth stage 3 for biomass and nutrient content. Weed biomass was collected at growth stage 3 for sorghum and at time of harvest. Harvest was completed form the middle two rows and evaluated for grain yield, test weight and N content. Results show significant difference in nutrient uptake with different weed species, and affecting nutrient uptake in the sorghum crop. Weed management approach and N application time showed a significant effect on sorghum growth and nutrient uptake.

Introduction

Kansas is the top grain sorghum (*Sorghum bicolor)* producing state in the United States; and with good performance under water limited conditions, sorghum can be a good alternative for drought conditions. The grain produced is mainly for livestock feed. However, from all the crops grown in Kansas and the U.S., grain sorghum has the most limited information on weed ecology and management options. Research is needed to cover this information gap and improve our understanding for possible management practices for weed control. This knowledge can help producers to make better decisions and potentially increase the production of grain sorghum. Impact of N and weed management in grain sorghum could be assessed using crop sensors. Sensor readings can be used to indicate potential yield losses due to weed pressure and to recommend optimal N and weed management strategies. The specific objectives of this study include: (i) determine the effects of different weed management strategies on grain sorghum yield; and (ii) evaluate the impact on the nutrition and development of the crop.

Materials and Methods

The study was conducted at two locations in Kansas, Smith and Reno counties. The two locations were contrasting tillage systems, with no-till for the Smith Co location and conventional tillage at the Reno Co location. The different tillage system is typically associated with difference in weed pressure particularly early in the season, with typically lower weed pressure under conventional tillage. Plot size was 15ft wide by 30ft long (4 rows of sorghum).

The experimental design was a complete randomized block design with four replications. A total of 9 treatments were include at each location and are described in Table 1. The treatment structure includes an absolute control and two N application times (planting and split) with herbicide application times (pre, post, both, and no) at each N application time. Prior to planting, soil samples were collected as one composite sample per block and analyzed for pH, Mehlich-3 P and K, and organic matter (Table 2).

The application of N as urea was completed at two timings via broadcast: all at planting or a split application (at planting and Growth Stage 3). Nitrogen application rate was 160 lbs/acre at planting and for the split 80/80 lbs of N. The grain sorghum seed was Concep-treated that provided more herbicide options for preemergence application. Lumax EZ was applied herbicide for preemergence while postermergence was a tank mix of Starene, ½ lb Atrazine, and v/v% crop oil, herbicide choice depended on weed species observed at the site. Sorghum plant sampling was done at Growth Stage 3 for biomass and nutrient content. Weed biomass was collected prior to postemergence herbicide application and at the time of grain harvest. Grain yields were harvested from the middle two rows using a plot combine and moisture content adjusted to 13 %.

Summary

Preliminary results show significant treatment effects on sorghum N content, biomass, and N uptake early in the season (Table 3). Sorghum biomass and N uptake was not affected at the Reno Co location for the early sampling, this may be due to lower weed population at that location early in the season. These results suggest a significant effect of N fertility management as well as weed management on sorghum early growth. Nitrogen content in the sorghum was low for the control (no N application), but also for treatments with no herbicide application regardless of N application management (Tables 4 and 5). This suggest that N fertilizer application only would not be sufficient to optimize plant N uptake, and a proper weed management would be needed to ensure proper N supply to the sorghum.

Nutrient uptake by different weed species can be significant for N, P and K (Figures 1, 2 and 3). Results from early weed sampling showed N removal of approximately 180 lbs/acre with foxtail. This same specie also showed P and K uptake of approximately 47 lbs of P2O5/acre and about 450 lbs of K2O/acre. The potentially large nutrient uptake with weed species that generate high biomass would result in negative impact of the sorghum crop, not only due to competition for light interception and water, but also due to competition for nutrients. Furthermore, a nutrient such as N can be immobilized in the weed biomass limiting availability to the sorghum crop for that season. Early season competition of weeds is often considered low and therefore a low impact on the sorghum crop. However, results from this study show that despite low competition for light interception and water, the competition for nutrients can be significant and likely affecting the sorghum crop for the rest of the season. Therefore, only mid-season weed control (with limited pre-plant control) may not be sufficient to minimize competition for nutrients.

After the completion of this experiment, we expect to better understand the impact of weed control on sorghum yield and nutrition throughout the growing season and ultimately the impact on grain yield. In addition, we also expect to describe soil water availability under different management systems, and the effect of weed control and N application during the growing season.

References

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Table 1. List of treatments, including fertilizer and herbicide application timings.

Treatment	
Nitrogen application time	Herbicide
Pre-Plant	No
Pre-Plant	Pre-Plant
Pre-Plant	Growth Stage 3
Pre-Plant	Pre-plant and Growth Stage 3
Split Application	No
Split Application	Pre-Plant
Split Application	Growth Stage 3
Split Application	Pre-Plant and Growth Stage 3
Control	No

Table 2. Initial soil samples collected as one composite per block at 0-6 in depth and averaged by location.

Location	pH	Phosphorus	Potassium	Organic Matter
		- - - - - - - - - - - - ppm	- - - - - - - - - - - -	%
Smith Center	7.3	76	674	2.4
Hutchinson	4.8	77	234	1.5

Table 3. Significance of sorghum parameters at growth stage 3 for both locations.

	Location (County)		
Parameters	Smith	Reno	Across locations
	- - - - - - - - - - - - - -	p < F	- - - - - - - - - - - - - -
Nitrogen content	0.003	0.067	0.067
Sorghum biomass	0.053	0.146	0.241
Nitrogen uptake	0.018	0.440	0.003

Table 4. Sorghum N content, biomass and N uptake at the GS-3 for the Reno Co location

Treatment							
N application time	Herbicide	N content		Biomass		N Uptake	
		%		g plant^{-1}		g plant^{-1}	
Pre-Plant	No	2.83	cde	18.0	ab	0.51	ab
Pre-Plant	Pre-Plant	3.42	a	16.8	b	0.57	a
Pre-Plant	Growth Stage 3	3.14	abcd	17.5	ab	0.55	ab
Pre-Plant	Pre-plant and GS-3	3.23	abc	16.2	b	0.52	ab
Split Application	No	2.80	de	19.2	a	0.54	ab
Split Application	Pre-Plant	2.91	bcde	19.6	a	0.57	a
Split Application	Growth Stage 3	3.03	abcde	18.4	ab	0.56	a
Split Application	Pre-Plant and GS-3	3.25	ab	16.2	b	0.52	ab
Control	No	2.68	e	17.9	ab	0.48	b

Table 5 Sorghum N content, biomass and N uptake at the GS-3 for the Smith Co location.

Treatment							
N application time	Herbicide	N content		Biomass		N Uptake	
		%		g plant^{-1}		g plant^{-1}	
Pre-Plant	No	2.74	c	8.1	ab	0.22	cd
Pre-Plant	Pre-Plant	3.13	a	8.9	ab	0.28	ab
Pre-Plant	Growth Stage 3	3.03	ab	8.7	ab	0.26	abc
Pre-Plant	Pre-plant and GS-3	3.03	ab	9.4	a	0.28	a
Split Application	No	2.69	c	8.0	ab	0.21	cd
Split Application	Pre-Plant	2.81	bc	9.7	a	0.27	abc
Split Application	Growth Stage 3	3.05	ab	7.4	bc	0.22	bc
Split Application	Pre-Plant and GS-3	3.26	a	8.7	ab	0.28	a
Control	No	2.65	c	6.0	c	0.16	d

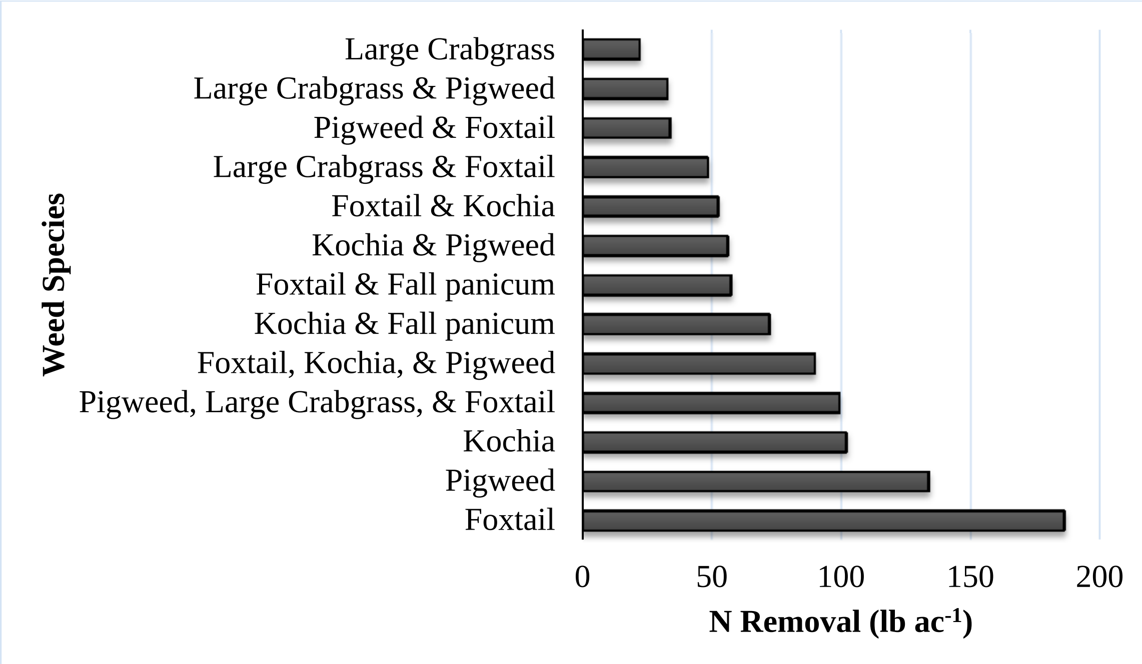

Figure 1. Total nitrogen update by different weed species at the growth stage 3 of sorghum.

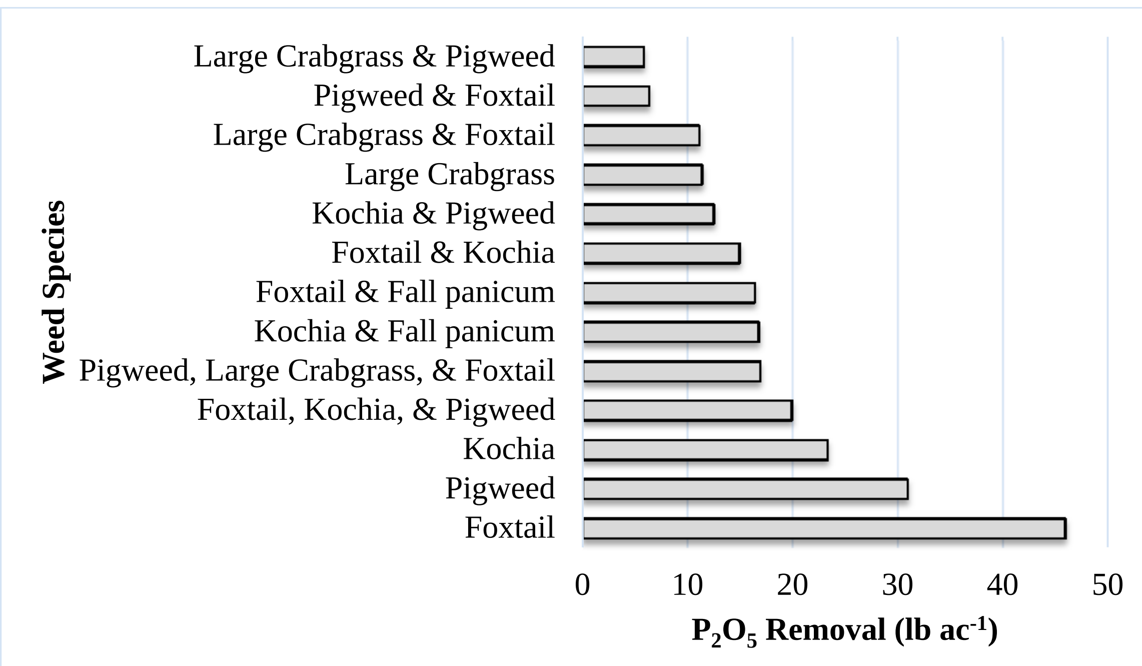

Figure 2. Total phosphorus update by different weed species at the growth stage 3 of sorghum.

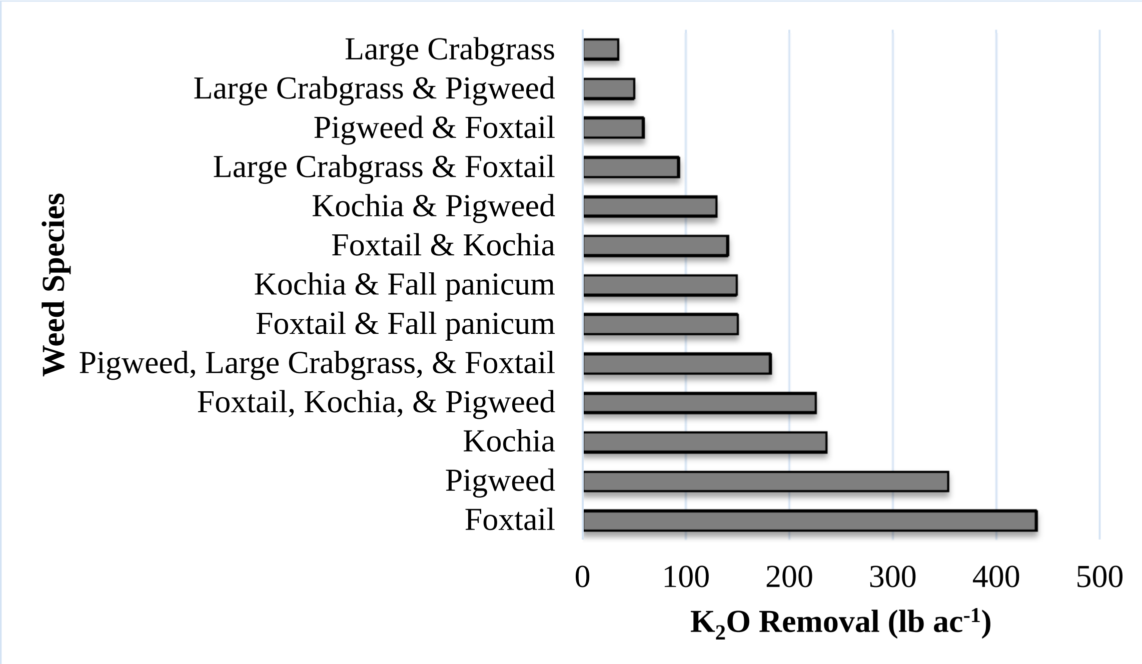

Figure 3. Total potassium update by different weed species at the growth stage 3 of sorghum.

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PROGRAM CHAIR:

James L Camberato
Purdue University
915 W State St.
West Lafayette, IN 47907
(765) 496-9338
jcambera@purdue.edu

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International Plant Nutrition Institute
2301 Research Park Way, Suite 126
Brookings, SD 57006
(605) 692-6280
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