EFFECTS OF CROPPING SYSTEM AND NITROGEN FERTILIZATION ON SORGHUM PRODUCTION

W.B. Gordon and D.A. Whitney

Summary

The 2002 growing season was characterized by a very hot, dry summer. The summer rainfall total was the lowest since1934. The overall test average was only 53 bu/a. When averaged over all N rates, yields of sorghum grown in rotation with soybeans were 9 bu/a greater than continuous grain sorghum.

When averaged over nitrogen (N) rates, 1982-1995 yields were 23 bu/a greater in sorghum rotated with soybeans than in continuous sorghum. When no N was applied, rotated sorghum yielded 32 bu/a greater than continuous sorghum. In the continuous system, grain sorghum yield continued to increase with increasing N rate up to 90 lb/a. In the soybean rotation, sorghum yields increased with increasing N rate only up to 60 lb/a. When averaged over N rate, no-tillage grain sorghum rotated with soybeans reached mid-bloom 7 days sooner than continuous grain sorghum. Two knife-applied N sources (anhydrous ammonia and 28% UAN) were evaluated during 1982-1989. No grain sorghum yield differences resulted from N source. The 21-year soybean yield average was 33 bu/a. Soybean yields in 2002 averaged only 6 bu/a. In 1996, four additional N rates (120, 150, 180, and 210 lb/a) were added to the experiment. When averaged over the period 1996-2002, yields were greater in the rotated system than in the continuous sorghum at all levels of N. Addition of N did not compensate for the rotational effect. Yields in the continuous system continued to increase with increasing N rate up to 90 lb/a. Yields in the rotated system were maximized with application of 60 lb/a N.

Introduction

Crop rotations were necessary to maintain soil productivity before the advent of chemical fertilizers. Biological fixation of atmospheric N is a major source of N for plants in natural systems. Biological fixation through legume-*Rhizobium* associations is utilized extensively in agricultural systems. Using a legume in a crop rotation can reduce the N requirement for the following non-legume crop. Other benefits of legume rotations include breaking disease and insect cycles, helping weed control programs, and decreasing the toxic effects of crop residues. This study evaluates N rates for continuous grain sorghum and grain sorghum grown in annual rotation with soybeans in a no-tillage production system.

Procedures

This study was established in 1980 at the North Central Kansas Experiment Field, located near Belleville, on a Crete silt loam soil. Data are reported from 1982. Treatments included cropping system (continuous grain sorghum and grain sorghum rotated with soybeans) and N rates (0, 30, 60, and 90 lb/a). In 1982-1989, two N sources, anhydrous ammonia and urea-ammonium nitrate solution (28% UAN), were evaluated. Both N sources were knife applied in the middle of rows from the previous year's crop. After 1989, anhydrous ammonia was used as the sole N source. In each year, N was knife applied 7-14 days prior to planting. Grain sorghum was planted at 60,000 seed/a, and soybeans were planted at 10 seed/ft in 30-in. rows. Soybean yields were not affected by N applied to sorghum and are averaged over all N rates. In 1996, four additional N rates (120, 150, 180, and 210 lb/a were added to the experiment to further define N response.

Results

Summer rainfall averaged only 45% of normal. Temperatures also were above normal in July and August. When averaged over all N rates, grain sorghum rotated with soybeans yielded 9 bu/a greater than continuous grain sorghum. In the continuous grain sorghum system, grain yields (1982-1995) continued to increase with increasing N rate up to 90 lb/a (Table 1). Sorghum yields in the rotated system were maximized with an application of 60 lb/a N. When no N was applied, rotated sorghum yielded 32 bu/a greater than continuous sorghum. When four additional N rates were added, yields were greater in the soybean rotation than in the continuous system at all levels of N (Table 2). Addition of N alone did not make up yield losses in a continuous sorghum production system. Over the 21-year period (1982-2002), soybean yields averaged 33 bu/a and were not affected by N applied to the previous sorghum crop (Table 3). Two knife-applied N sources, anhydrous ammonia and 28% UAN, were evaluated from 1982-1989. When averaged over cropping system and N rate, yields were 60 and 59 bu/a for anhydrous ammonia and UAN, respectively. When averaged over N rates, the number of days from emergence to mid-bloom was 7 days shorter in the rotated system than in the continuous system (Table 2).

Table 2. Long-term effects of cropping system and nitrogen rate on grain sorghum yields and number of days from emergence to mid-bloom North Central Expt. Field, Belleville.

N Rate	Cropping System	Grain Yield 1982-1995	Days to Mid-bloom 1992-1995
lb/a		bu/a	
0	Continuous	43	64
	Rotated	75	56
30	Continuous	59	61
	Rotated	84	55
60	Continuous	70	59
	Rotated	92	53
90	Continuous	80	58
	Rotated	92	53
System means			
	Continuous	63	61
	Rotated	86	54
N Rate Means			
0		59	60
30		72	58
60		81	56
90		86	56
LSD(0.05)		9	1

Table 3. Effects of cropping system and N rate on grain sorghum yields, Belleville, 1996-2002

N Rate	Cropping System	Yield							
		1996	1997	1998	1999	2000	2001	2002	Avg
lb/a					bu/a				
0	Continuous	92	51	55	73	37	59	32	57
	Rotated	120	88	87	112	46	75	43	82
30	Continuous	110	71	75	95	40	75	48	74
	Rotated	137	108	115	119	62	113	56	101
60	Continuous	131	110	118	115	68	96	51	98
	Rotated	164	128	142	127	66	128	59	116
90	Continuous	143	121	126	125	69	116	52	108
	Rotated	163	141	144	126	68	129	60	119
120	Continuous	148	122	128	123	69	117	51	108
	Rotated	162	144	145	128	65	128	59	119
150	Continuous	148	120	127	123	69	116	53	108
	Rotated	162	143	145	129	65	129	61	119
180	Continuous	148	121	128	126	68	117	52	109
	Rotated	162	144	145	129	65	129	59	119
210	Continuous	148	122	128	126	66	116	50	108
	Rotated	162	145	145	129	64	129	59	119
System Means									
	Continuous	134	105	111	113	61	101	48	96
	Rotated	154	130	134	125	63	120	57	112
N Rate Means									
0		106	70	71	92	42	67	38	70
30		124	90	95	107	51	94	46	88
60		148	119	130	121	67	112	55	107
90		153	131	135	126	69	122	56	114
120		155	133	137	126	67	123	55	114
150		155	132	136	126	67	123	57	114
180		155	133	137	127	67	123	56	114
210		155	134	137	127	65	123	55	114
LSD(0.05)		8	6	6	6	8	5	6	

Table 4. Yield of soybeans grown in rotation with grain sorghum, Belleville, 1982-2002

Year	Yield	Year	Yield
	bu/a		bu/a
1982	38	1993	56
1983	15	1994	32
1984	20	1995	41
1985	28	1996	61
1986	48	1997	36
1987	48	1998	38
1988	18	1999	42
1989	25	2000	8
1990	30	2001	31
1991	12	2002	6
1992	58	Average	33