Effects of Legume Cover Crops and Tillage on Grain Sorghum Yield

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Introduction

Interest in utilizing winter legumes as a source of nitrogen (N) for non-legume summer crops is prompted by the search for alternate and renewable sources of energy and the need for reducing soil erosion and crop production costs. Residues of winter legumes can serve as a source of N and act as a mulch in a no tillage production systems. Mineralized N from decomposed winter legumes can supply some of the N fertilizer needs for the summer grain crops. The amount of N produced by winter legume cover crops depend on various factors, such as summer grain crop planting date, growth stage of legumes at killing, climatic conditions, and adaptability of the legume to a particular area. The objectives of this research were to evaluate (i) the N contribution of selected winter legumes on grain sorghum yield, (ii) grain sorghum response to cover crops and fertilizer N, and (iii) the effect of tillage on grain sorghum yield.

Materials and Methods

The experiment was established in the fall of 1984 on a Catalpa silty clay (fine, montmorillonitic, thermic Fluvaquentic Hapludoll). This is a deep moderately well drained soil, which has been formed from clayey alluvium and ranges in slope from 0 to 2%. The study was located on the Mississippi State University Northeast Branch Experiment Station, Verona, Mississippi.

The experimental design was a split plot with cover crops as main plots and N rates as subplots with 5 replications. Cover crop treatments included 'Hairy' common vetch, 'Tibbee' crimson clover, 'Meteora' subclover, wheat, and no-tillage (NT) winter fallow (WF). In addition, a conventional tillage (CT) no cover treatment was evaluated. Within each cover treatment, subplots were established by applying fertilizer N at rates of 0, 40, 80, 120, and 200 Ib/acre.

The study received a uniform broadcast application of 300 Ib/acre of 0-17-34 in the fall of 1984 and 1985 and 300 lb/acre of 0-20-20 in the fall of 1986 and 1987. A no-till drill was used to plant cover crops at seeding rates of 45, 30, 20, and 18 Ib/acre for wheat, vetch, crimson clover, and subclover, respectively. These cover crops were planted in a prepared seedbed in the fall of 1984 and no-till planted into grain sorghum residue each fall thereafter. Cover crops in all no-till grain sorghum plots were killed with appropriate burndown herbicides (Table 1) 2-3 weeks prior to planting grain sorghum. The CT plots were chiseled 6-8 inchcs deep and disked a month before planting, and harrowed just prior to planting. Grain sorghum was planted in May of each year (Table 1) at approximately 90,000 seeds/acre in 30-inch rows using a John Dcere 7000 planter equipped with a screw-type fertilizer spreader, trash whippers, and cast iron press wheels. Fertilizer N (urea) at appropriate rates was applied in-furrow, 3 inches to each side of each row, and 2 inchcs deep at grain sorghum planting. Weeds were controlled as needed with appropriate herbicides applied at labeled rates (Table 1).

Cover crop dry matter production was determined by clipping four randomly selected 1/4 square meter samples from all legume cover crop plots approximately 2 weeks prior to grain sorghum planting. The samples were oven-dried for at 150^0 F and thcn analyzed for total N by the Kjeldahl procedure. Grain sorghum yields were determined by harvesting the two center rows of each plot with a small plot combine. The seed samples were weighed and grain yield was adjusted to 13% moisture and expressed as lb/acre. The data were subjected to an analysis of variance procedure and means were separated using least significant differences (LSD) at the 5% level of probability.

Results and Discussion

Cover Crops

Yearly cover crop dry matter yields, nitrogen concentration and N content of cover crops are shown in Table 2. Dry matter production among cover crops was not significantly different in 1985, 1987, and 1988. All cover crops produced the most dry matter in 1985. Cover crop stands in most plots were severely reduced

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Table 1. Grain sorghum varieties, planting dates. herbicides and method of application in a legume cover crop-grain sorghum cropping system study in 1985-88.

Year	Grain Sorghum Variety	Date	Planting Herbicides	lb ai/a	Method of Application*	Crop**
1985	'Funks G-522DR'	5/15/85	2,4-DB	1.0	POT	CC
			fluazifop	a 3	POT	CC
			paraquat	0.5	BD	CC+NT
			metolachlor	2.0	PRE	GS
			atrazine	2.0	E-POT	GS
1986	'Funks G-522DR'	5/16/86	2,4-DB	1.0	POT	CC
			fluazifop	0.3	POT	CC
			glyphosate	1.5	BD	CC+NT
			metolachlor	20	PRE	GS
			linuron	1.0	PD	GS
1987	'Funks G-1711'	5/19/87	2,4-DB	1.0	POT	CC
			paraquat	1.0	BD	CC
			metolachlor	2.0	PRE	GS
1988	'Savannah 5'	5/17/88	HO-39866	a75	BD	CC+NT
			glyphosate	1.5	BD	CC
			metolachlor	20	PRE	GS

* Method of application: POT = post over top. BD = burndown, PRE = pre-emergence, PD = post direct and E-POT = early post over-top.
**Crop: CC = cover crop, GS = grain sorghum.

in the fall of 1985, possibly due to atrazine carry-over from the grain sorghum crop. Crimson clover was the only cover crop that survived and produced dry matter residue for 1986 grain sorghum. However, yield and N content of crimson clover in 1986 was the lowest of the four years evaluated. The average N content for 1985, 1987, and 1988 of wheat, crimson clover, and vetch was 27, 69, and 92 lb/acre, respectively. Although vetch did not produce more dry matter than other crops all of the years, the N content of vetch was the greatest. Subclover did well the first year of the study, but stands were poor in subsequent years and, therefore, it was not harvested.

Table 2. Dry matter production, nitrogen concentratino, and nitrogen content of cover crops in 1985-88.

Cover Crops	1985			1986			1987			1988		
	lb/a	% N	lb N/a	lb/a	% N	lb N/a	lb/a	% N	lb N/a	lb/a	% N	lb N/a
Wheat	4385	1.02	45	---	—	--	1679	1.13	19	2078	1.30	19
Crimson Clover	4385	226	96	1913	225	43	2837	207	59	2952	210	53
Vetch	3295	3.68	121	--	----	-	2099	3.19	67	2500	3.68	89
Sub. clover	5992	2.02	121	---	****	--	****	****	--	****	----	--
Mean	44%	224	96	1913	225	43	2536	213	48	2507	2.36	54

Grain Yield

The influence of cover crops, tillage, and nitrogen rates on grain sorghum yield for 1985-88 are shown in Table 3. In 1985, cropping systems had a significant effect on grain yield, with no differences in 1986, 1987, and 1988. In all years nitrogen rates had a significant effect on grain yield and there was no cropping system X N rate interaction.

In 1985, grain sorghum yield following vetch was greater than the other cropping systems, with no difference when grain sorghum followcd crimson clover, subclover, and CT. All cropping systems produced yields greater than following wheat. Averaged over cropping system grain sorghum yield with 120, and 200 lb/acre were not different and were higher than 0 and 40 lb N/acre. Vetch with no added N produced yields equal to 80 lb N/acre when compared with wheat, subclover, CT, and NT. Grain sorghum after crimson clover and subclover with no added N, was equal to wheat with 40 and 80 lb N/acre, respectively. CT and NT yields were equal across N rates and were great than with wheat.

Grain sorghum yields in 1986 were lower than 1985 with no differences in cropping systems. Cover crop failure in dry matter production and dry weather during the period of mid-June to mid-August attributed to the lower yields in 1986. Averaged over cropping systems grain yield with N rates of 120 and 200 lb/acre were equal and produced higher yield than 80, 40, and 0 lb N/acre. Vetch with no added N, produced yicld equal to 40 lb N/acre with crimson clover, CT, and NT/WF. Vetch and wheat yields were equal across N rates.

In 1987, grain sorghum yields were severely reduced due to maize dwarf mosaic virus infection and cropping system had no effect on yield. Vetch, however, with no added N produced grain yields equal to of 80 lb N/acre with crimson clover and CT and were equal to 120 lb N/acre with wheat, subclover, and NT.

In 1988, grain sorghum yields were similar to 1985 but cropping system had no effect on yield. Vetch with no added N produced grain yields equal lo or greater than all other cropping systems at 200 lb N/acre.

Table 3. Effect of cover crops, tillage, and nitrogen rates on grain sorghum yield in 1985-88.

Cover crop/ cropping systems	N rates (lb/acre) 0	40	80	120	200	Mean
	lb/acre					
1985						
Wheat/NT	1794	2861	3565	3605	4082	3181
Crimson clover/NT	3678	4487	4602	4281	3543	4118
Vetch/NT	4174	4793	4713	4488	4287	4491
Subclover/NT	4004	3591	3928	4448	4138	4022
CT	2977	3854	3871	4577	4602	3976
NTWF	2898	3334	3989	4093	4595	3782
Mean	3254	3820	4111	4249	4208	
LSD (0.05) Cropping system 311			LSD (0.05) N rates 305			
CV (%) 25			CV (%) 14			
1986						
Wheat/NT	23%	2985	3335	3965	4486	3433
Crimson clover/NT	2139	2589	3065	3486	3674	2991
Vetch/NT	2588	3144	3237	4247	4054	3454
Subclover/NT	2767	3044	3321	4095	4710	3587
CT	1646	2672	3655	3868	4593	3287
NTWF	1718	2488	2891	3611	4191	2980
Mean	2209	2820	3251	3879	4285	
LSD (0.05) Cropping system NS			LSD (0.05) N rates 410			
CV (%) 39			CV (%) 24			
1987						
Wheat/NT	1327	1166	1356	1730	2286	1573
Crimson clover/NT	1369	1552	1920	2234	2258	1867
Vetch/NT	1904	1457	1654	2346	2898	2052
Subclover/NT	1556	1595	1505	2434	2482	1914
CT	1626	1429	1834	1768	2182	1768
NTWF	1313	1330	1460	2004	2021	1626
Mean	1516	1422	1622	2086	2355	
LSD (0.05) Cropping system NS			LSD (0.05) N rates 217			
CV (%) 24			CV (%) 20			
1988						
Wheat/NT	3350	4123	4055	5159	5077	4353
Crimson clover/NT	3819	4348	4666	4704	5176	4543
Vetch/NT	5670	4921	5404	4388	5743	5225
Subclover/NT	3566	4284	4146	4718	5468	4436
CT	4022	4086	4695	4443	3790	4207
NTWF	3655	4807	5093	5284	5516	4871
Mean	4014	4428	4676	4783	5131	
LSD (0.05) Cropping system NS			LSD (0.05) N rates 633			
CV (%) 26			CV (%) 25			

Conclusion

Within years there were no significant differences in dry matter production due to cover crops. Crimson clover and vetch cover crops seemed to be better adapted than subclover to the silty clay soil and climatic conditions of North Mississippi. Although vetch usually produced less dry matter than crimson clover, it had a higher N concentration, N content, and higher grain sorghum grain yield.

Poor cover crop stands, grain sorghum disease, and limited precipitation influenced grain sorghum grain yield in 1985-88. Cropping systems had a significant effect on grain yield one of four years, while N rates were significant over all years. Yield generally increased as N rates increased across cropping systems. Vetch with no added N produced yields equal to or greater than 80 lb/acre of added N with all cropping systems in 1985 and 1987-88. In 1985, crimson clover and subclover with no added N were equal to wheat with 120 and 200 lb N/acre, respectively. However, in 1986-88, crimson clover did not increase grain sorghum yield when compared to all cropping systems.