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William F. Heer

Kraig L. Roozeboom

James P. Shroyer

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Austrian Winter Pea: Effects on N Rates and Grain Sorghum Yield in a Cover Crop, Grain Sorghum, Winter Wheat Rotation

William Heer, Kraig Roozeboom, and Jim Shroyer

Introduction

Interest in using winter cover crops to conserve soil and water, as a substitute for commercial fertilizer, and to maintain soil quality has been growing in south central Kansas and other areas of the United States. Annual legumes have been tested in many regions of the United States and found successful in providing or supplementing nitrogen (N) to corn and sorghum. In some cases, the N from cover crops is released late in the growing season, and in others the N may not express itself until later in the rotation. Although plant uptake of N is initially higher from fertilizers than from cover crop sources, more cover crop N remains in soil organic and microbial pools and may be released later.

In addition to the N benefit, yield increases have been documented when fertilizer is combined with cover crop use, possibly a result of soil quality enhancement. Other benefits of cover crops are reduced erosion, uptake of N left from the preceding crop, and providing habitat for soil-improving organisms such as mycorrhizal fungi; however, water use by cover crops also can decrease yields for subsequent crops in dry regions or during dry years (Schlegel and Havlin, 1997).

Winter pea (*Pisum arvense*) growth pattern is very similar to that of winter wheat; it is established in the fall, overwinters, and produces sufficient spring foliage, but is terminated prior to planting of a summer annual crop. Because winter pea is a legume, it can add N to the soil system. A no-tillage research rotation project was established at the South Central Kansas Experiment Field, Hutchinson, Kan., to evaluate the effects of winter pea and its ability to supply N to the succeeding grain sorghum (*Sorghum bicolor*) crop.

Winter pea experiment

Our research was conducted at the Kansas State University South Central Kansas Experiment Field, where hard red winter wheat had been grown previously. No-till production practices were used after the initial wheat crop. Within the rotation, the cover crop treatments consisted of fall-planted (September) winter pea with intended termination dates in April and May and a control with no cover crop (fallow). The peas were chemically terminated, then grain sorghum was planted with four N fertilizer treatments: 0, 30, 90, and 125 lb/a in each cover crop plot. Nitrogen was broadcast-applied before planting grain sorghum. Winter wheat was planted after the grain sorghum to complete the rotation and prepare the area for fall planting of the cover crop. The winter pea treatments were planted at 40 lb/a in 10-in. rows with a grain drill equipped with double-disk row opener. Prior to termination of the cover crop, aboveground biomass samples were taken from a square-meter area within each plot to determine biomass yield N and phosphorous (P) contents. Phosphate was applied at a rate of 40 lb/a P_2O_5 in the row when planting wheat and grain sorghum. Grain sorghum plots were harvested with a plot combine to determine grain yield, moisture, test weight, and N and P contents of the grain.

Winter pea and nitrogen

Each component in the rotation was present every third year, providing winter pea and grain sorghum yields in 1996, 1999, 2002, 2005, and 2008. As the rotation continued through the cropping sequence, the five-year averages show the first increment of N resulted in the greatest change in yield, and the yields tended to peak at the 60 lb/a N rate treatment regardless of the presence or lack of winter peas (Table 2). This same pattern is present in the other rotations at the South Central Field where grain sorghum is included in rotation with other crops and N rates. The greatest five-year average increase in grain sorghum yield was realized in the 90 lb/a N treatment where winter peas were terminated in May, which suggests that the cover crop should be terminated early.

Soil conditions at planting of the winter peas in 1995 were excellent with good moisture. After planting, temperatures cooled and limited fall growth of the peas. Fall ground cover in 1996 ranged from 26 to 36% with no significant differences across treatments compared with 36 to 46% in 1999 (Table 1). The winter months of 1996 were cool and dry, which limited growth and delayed the April termination from early April to mid-May. The May termination was also delayed by wet conditions. Weather conditions in 1999 were favorable for growth of the winter pea. Winter pea aboveground biomass with April termination was about half that of May termination in 1996; however, no significant differences were measured in dry matter (DM) production between the termination dates. Differences in the percentage N in the DM existed only in the treatments for May termination. Large amounts of N were not produced by the cover crop in 1996; N credited to the cover crop based on biomass N ranged from 9.48 to 30.70 lb N/a. The larger amounts of DM produced in 1999 added considerable amounts of N (Table 1).

Grain sorghum yields

In 1996, the low levels of N from the peas did not translate into increased grain yield in the grain sorghum. Only the no-N treatments with and without the cover crop and the April termination with no cover crop and cover crop plus 90 lb/a N treatments had significantly lower grain yields (Table 2). Flag leaf N (%) and whole plant N (%) were decreased in the no-N treatments with or without cover crop. The highest flag leaf and whole plant N occurred in the April termination, 90 lb/a N treatment;

Table 1. Winter pea cover crop and termination date effects on cover crop fall cover, dry matter (DM), and DM nitrogen (N), South Central Field, Hutchinson.

Termination date	N rate[1]	Fall ground cover[2] 1996	Fall ground cover[2] 1999	Winter pea DM yield[3] 1996	Winter pea DM yield[3] 1999	N from winter pea 1996	N from winter pea 1999
	lb/a	%	%	lb/a	lb/a	lb/a	lb/a
April[4]	0	33	46	302	3,061	9.48	103
	30	28	36	413	2,796	12.43	94
	60	30	36	342	2,895	10.26	83
	90	36	40	717	3,317	22.68	109
May[5]	0	36	40	900	4,590	19.71	128
	30	34	39	1,200	4,674	32.4	148
	60	33	41	1,110	4,769	23.98	139
	90	26	43	1,279	3,850	30.7	100
LSD[6] (P = 0.05)		NS	7	812	1,200		

[1] N applied as 34-0-0 after pea termination prior to planting grain sorghum.
[2] Winter pea cover estimated by 6-in. intersects on one 44-ft line transect per plot.
[3] Winter pea DM weight and percentage N and phosphorus determined from samples taken prior to termination.
[4] April termination dates: May 16, 1996, and April 21, 1999.
[5] May termination dates: June 4, 1996, and May 19, 1999.
[6] Unless two yields in the same column differ by at least the least significant difference (LSD), little confidence can be had in one being greater than the other. NS = not significant.

Table 2. Grain sorghum yield as affected by nitrogen (N) rate, winter pea cover crop, and termination date in a winter wheat-winter pea cover crop-grain sorghum rotation, South Central Field, Hutchinson.

		Flag leaf		Grain														
		1996		1996			1999			2002			2005			2008		
Termination date	N rate[1]	N	P	N	P	Yield	N	P	Yield	N	P	Yield	N	P	Yield	N	P	Yield
	lb/a	----- % -----		----- % -----		bu/a	----- % -----		bu/a	----- % -----		bu/a	----- % -----		bu/a	----- % -----		bu/a
April, no pea[2]	0	2.5	0.38	1.6	0.26	86.5	1.1	0.32	72.6	1.5	0.38	78.4	1	0.31	54	1.2	0.32	36
	30	2.7	0.44	1.6	0.27	93.9	1.2	0.29	90.9	1.6	0.4	87.5	1.1	0.29	76	1.3	0.34	50.8
	60	2.8	0.43	1.7	0.27	82.6	1.5	0.32	106.4	1.8	0.4	82.8	1.4	0.31	94	1.4	0.34	59.3
	90	2.8	0.44	1.7	0.25	90.4	1.7	0.34	101.8	1.8	0.35	92.5	1.5	0.31	96	1.4	0.35	61.7
April, with pea[2]	0	2.4	0.4	1.5	0.29	80.2	1.3	0.31	93.5	1.6	0.37	79.9	1.4	0.29	102	1.2	0.35	68.9
	30	2.7	0.39	1.6	0.26	85.7	1.3	0.32	97.4	1.7	0.38	91.1	1.4	0.31	107	1.3	0.32	72.8
	60	2.7	0.38	1.7	0.27	90	1.5	0.33	105.1	1.8	0.4	87.5	1.5	0.31	107	1.4	0.33	73.1
	90	2.9	0.41	1.8	0.23	83.8	1.8	0.32	97.9	2	0.37	77.2	1.6	0.32	98	1.4	0.33	68.9
May, no pea[3]	0	2.1	0.39	1.4	0.3	81.4	1.1	0.34	40.5	1.6	0.41	56.4	1.1	0.31	67	1.3	0.34	47.1
	30	2.4	0.39	1.5	0.28	88.1	1.1	0.32	66.6	1.7	0.4	71.6	1.1	0.3	92	1.3	0.33	73.2
	60	2.6	0.4	1.6	0.27	90.7	1.2	0.3	93.3	1.8	0.4	71.4	1.2	0.31	95	1.3	0.33	66.8
	90	2.6	0.4	1.6	0.26	89.6	1.4	0.31	105.9	1.9	0.4	82.6	1.4	0.33	95	1.4	0.34	65.7
May, with pea[3]	0	2.3	0.4	1.4	0.29	85	1.2	0.31	92.4	1.7	0.39	74.8	1.4	0.31	95	1.3	0.33	74.5
	30	2.5	0.4	1.5	0.31	92.4	1.3	0.31	97.7	1.8	0.38	81.5	1.5	0.3	98	1.3	0.33	78.9
	60	2.6	0.38	1.6	0.26	92.9	1.5	0.3	112.3	1.9	0.36	86.8	1.6	0.3	91	1.4	0.34	77.8
	90	2.7	0.41	1.6	0.25	90.5	1.5	0.32	108.7	1.8	0.39	90.3	1.6	0.31	98	1.4	0.34	87.6
LSD[4] (P = 0.05)		0.2	0.02	0.1	NS	8.9	0.2	0.04	16	0.14	0.05	14	0.11	0.02	15	0.1	0.03	24

[1] Nitrogen applied after winter pea termination prior to planting grain sorghum.
[2] Early April termination. Actual termination May 16, 1996; April 21, 1999; April 13, 2002; and April 27, 2005.
[3] Early May termination. Actual termination June 4, 1996; May 19, 1999; May 25, 2002; and May 18, 2005.
[4] Unless two yields in the same column differ by at least the least significant difference (LSD), little confidence can be had in one being greater than the other. NS = not significant.

thus, the overall effect of the cover crop and N fertilizer on flag leaf and whole plant N and grain yield in 1996 was not always significant or consistent. The increased biomass N and the available water (above normal precipitation) during the 1999 growing season likely explains the excellent grain sorghum yields (Table 2). The lowest yield came from the treatment with no N and no cover crop and the highest yield came from the 60 lb/a N with cover crop (139 lb/a N in biomass) treatment. Grain sorghum yields for 2002 reflect the later planting date (June 22). The growing season in 2002 favored the later-planted summer crops. They emerged after a June 15 hailstorm and were not mature for an August windstorm, so they had little lodging and stock damage, resulting in less secondary tillering and fewer sucker heads than in other years.

The 2008 yields (Table 2) express the presence of the winter pea cover crop. The April termination, no peas, and no N treatments yielded about half that of those that had peas and no additional N. This difference diminished as the N rate increased and for the treatments where the peas were terminated in May. As indicated by the 2008 data, as this rotation continues and the soil system adjusts, the true effects of the winter cover crop in the rotation will be revealed. In dry or normal years, precipitation during the growing season most likely will not be as favorable as it was in 1999.

References

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