DATE OF KILL ON LEGUME N CREDIT TO WINTER WHEAT[1/]

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For legumes to be considered effective N sources for succeeding crops, they must supply sufficient N and they must release the legume N to fill the demand. Ideally, any N containing material (fertilizer, plant, or animal manure) must be able to produce a large pool of mineral N before the period of rapid N uptake by a crop. If the mineral N pool in soil is produced too early, it can potentially be lost to leaching and/or denitrification. If released too late, it will not benefit the crop, and poses a potential threat to groundwater quality via leaching. This may be a particular problem for winter wheat if the wheat is planted soon after the alfalfa is killed or if the wheat is no-till planted (Kelling et al., 2000). The synchrony of nitrogen released from legumes with crop demand for N has been a concern even with crops such as corn, where N uptake can occur throughout the summer (Stute and Posner, 1995). Using mesh bags, these researchers found that 50% of the N from clover or vetch residue was not yet released by 1 June after spring burial. Since uptake of N by wheat generally precedes this time period, the residue decomposition and crop N need may be out of synchrony. This concern was found to be real with spring wheat no-till planted following spring alfalfa kill in Manitoba where the delayed N release resulted in significantly reduced grain yields in two out of five site years (Mohr et al., 1999).

Materials and Methods

This experiment was initiated in the summer of 1998 at the Ashland, Lancaster, and Arlington Agricultural Research Stations with the wheat harvested in July 1999. It was continued on new sets of plots at all three locations in 1999. At Ashland in 2000, the disease take-all destroyed about 60% of the plots; therefore, these data are not presented. In all cases, the fields had been harvested for alfalfa for the previous 2 to 4 years. The plots were split by kill date (after second alfalfa harvest or after third alfalfa harvest) and tillage system (no-till versus moldboard plow except at Ashland) as the main plots and fall nitrogen treatments (± 30 lb N/acre) and spring nitrogen treatments (0 to 60 lb N/acre) were super-imposed on the kill date/tillage split-split main plots. Additional details about the experi-ment are presented in Table 1.

1/ Research support provided by the Wisconsin Fertilizer Research Council, the UW Consortium for Extension and Research in Agriculture and Natural Resources, and the UW-Madison College of Agricultural and Life Sciences is gratefully acknowledged.

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Table 1. Experimental details for the alfalfa N credit trial with wheat.

	Ashland 1998-99	Arlington 1998-99	Lancaster 1998-99	Arlington 1999-2000	Lancaster 1999-2000
Soil	Allendale sl (Alfic Epiaquods)	Plano sl (Typic Argiudolls)	Fayette sil (Typic Hapludalfs)	Plano sil (Typic Argiudolls)	Fayette sil (Typic Hapludalfs)
Alfalfa condition					
Stand density (plants/ft^2)	2.4	2.7	1.9	4.5	3.5
Amount of regrowth (inches)	5	7	14	8	9
Alfalfa kill dates	08/17/98 09/03/98	08/07/98 08/20/98	08/13/98 09/04/98	08/26/99 09/17/99	08/26/99 09/14/99
Wheat					
Variety	Glacier	Dynasty	Pioneer 25R26	Glacier	Pioneer 25R26
Plant date	09/11/98	09/21/98	09/17/98	09/30/99	09/24/99
Fall N application	10/07/98	10/07/98	09/17/98	10/18/99	10/15/99
Spring N application	04/13/99	03/31/99	04/07/99	05/04/00	05/10/00
Harvest date	07/29/99	07/15/99	07/14/99	07/25/00	07/13/00

The alfalfa stand was killed with glyphosate and tilled about 5 days after the September kill date (where appropriate) and planted with no-till or conventional till on 6- to 7-inch centers. The N treatments were broadcast by hand as NH_4NO_3. The grain and straw were harvested by plot combine (Arlington) or three-row cutter/binder and threshed by stationary thresher (Ashland and Lancaster). Lodging ratings were made by visual estimates from three individuals independently evaluating each plot. Data were analyzed using a split/split plot design that included kill date and tillage as the main plots and fall N as the first split and spring N as the final combination. Each treatment was replicated four times at each location.

Results and Discussion

The influence of tillage system on alfalfa N credit to wheat and the general lack of responsiveness of the wheat to fertilizer N has been discussed previously (Kelling and Speth, 1999; Kelling et al., 2000) and will generally not be repeated here. It is important to remember, however, that the alfalfa appeared to be supplying about a 60 lb N/acre credit to the wheat and tillage resulted in about 40 lb/acre more credit than was available no-till. In some site-years and tillage systems, fertilizer application of 20 to 30 lb N/acre was needed to maximize yields, but in all cases, any excess N resulted in severe lodging. We concluded from this work that lodging percentage may be a more accurate evaluation of apparent N availability than grain or straw yield.

For the five site-years of the kill date study, where we were able to collect data, we saw statistically significant effects of time of kill at Arlington in both years, but generally not at the other locations. Furthermore, the interaction terms of the statistical analyses were also not significant except at Arlington in 2000. Table 2 shows the grain yield and percent lodging for the various site-years as affected by alfalfa kill date and tillage system for the check and the highest N rate applied. It is clear from these data that killing the alfalfa earlier in the summer actually decreased yield and increased lodging even when the wheat was planted no-till and no nitrogen fertilizer applied. Moldboard plowing and adding nitrogen fertilizer generally exacerbated the problem. In some site-years (such as Arlington, 1999-2000), the differences are more distinct, but the trends are clearly present in all years except for Lancaster in 1999-2000. These trends were generally true even though the wheat was planted very late in the fall of 1999.

One of the reasons for the general lack of positive response to N fertilizer and the apparent decrease in yield and increase in lodging under those conditions favoring more legume N mineralization is that both the autumns of 1998 and 1999 were very long and warm. Table 3 shows the temperature deviations from the 30-year average for each of the five sites and years. A more normal season might result in the need for the extra mineralization from the earlier kill date or tillage.

Although not shown in Table 2, we never saw a positive response to applied N when the alfalfa was killed in August except at Ashland in 1998-99, and then only to 20 lb N/acre. Conversely three of the five site-years (Ashland, 1998-99, Lancaster 1998-99 and 1999-2000) showed yield increases of 5 to 9 bu/acre to the first 20 lb N/acre when the alfalfa was killed in September.

Summary

Although corn was not used as a comparative test crop for the current study, it does not appear that the legume was providing as large of a nitrogen credit to the wheat as would be expected for corn. Based on these experiments, compared to historic calibration trials, the appropriate N credit to wheat may be only 40 to 60 lb N/acre and it is very likely tillage dependent. Killing the alfalfa following second cutting rather than following third cutting was distinctly no advantage to the following wheat. This and the negative response to applied fertilizer N for the 1998-1999 and 1999-2000 trials at both Arlington and Lancaster may have been due to the extremely long, warm fall in 1998 and 1999. In a more typical growing season, these results might be different. This experiment will be continued for two more seasons, and corn will also be included as a test crop.

Table 2. Effect of alfalfa kill date and tillage system on winter wheat grain yield and percent lodging at three locations in Wisconsin.

Alfalfa kill date	Tillage system†	Grain yield Check	Grain yield 90 lb N/acre‡	Lodging Check	Lodging 90 lb N/acre‡
		--------- bu/acre -----------		----------------- % --------------	
		Ashland 1998-99			
August		55.5	51.9	9.6	71.3
September		62.9	47.4	9.9	54.4
		Arlington 1998-99			

August	NT	67.0	51.4	16.9	
					74.5
	MB	57.3	46.9		45.1
					57.5
September	NT	71.7	56.5	3.8	
					17.9
	MB	62.2	44.1		15.5
					64.7
			<u>Lancaster 1998-99</u>		
August	NT	87.3	56.0	13.0	
					41.6
	MB	82.4	57.7		14.4
					42.1
September	NT	83.5	75.7	12.6	
					39.0
	MB	82.6	58.0		9.2
					45.2
			<u>Arlington, 1999-2000</u>		
August	NT	35.8	16.9	2.1	
					80.4
	MB	33.8	9.2		12.9
					82.5
September	NT	48.1	27.2	0.4	
					25.4
	MB	44.1	18.4		4.6
					42.1
			<u>Lancaster, 1999-2000</u>		
August	NT	55.4	56.0	17.0	
					19.2
	MB	50.7	49.7		15.4

					15.9
September	NT	57.7	58.4	14.9	
					17.2
	MB	59.7	49.2		16.0
					16.1

† NT, no-till; MB, moldboard plow.
‡ Nitrogen was split 33% in fall and 67% in spring.

Table 3. Autumn temperature deviations for alfalfa/wheat experiment.

Month	Ashland 1998-99	Arlington 1998-99	Lancaster 1998-99	Arlington 1999-2000	Lancaster 1999-2000
	---------------------- Deviation from 30-yr average (^{o}F) -----------------------				
September	+5.2	+4.6	+3.7	–1.4	–1.9
October	+3.0	+1.2	+0.1	–1.9	–2.3
November	+4.1	+3.8	+3.6	+6.7	+6.5
December	+6.0	+9.2	+7.5	+3.6	+2.8

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