SIDEDRESSING NITROGEN: USEFUL ON ALL SOILS?

Larry G. Bundy[1]

Introduction

Current high nitrogen (N) fertilizer costs and continuing efforts to reduce N losses from cropland have increased interest in use of sidedress or delayed applications in corn production as a method for increasing the effectiveness of applied N and for avoiding adverse environmental impacts from N use. Theoretically, sidedress N has potential for improving N efficiency because N is usually applied just before the period of rapid N uptake by corn so that possible N losses before the application date are avoided. A common expectation is that a lower N rate applied sidedress will achieve the same yield response as a larger amount of N applied earlier in the growing season. Sidedress or delayed N applications have potential allowing reduced N rates only if early season losses of N from preplant applications are significant and can be avoided by applying N later in the growing season. While this is clearly the case on coarse-textured sandy soils where N loss by nitrate leaching from preplant N is likely, the benefits of sidedressing N is less obvious on medium-textured well-drained soils. The purpose of this paper is to review results from research studies and on-farm research and demonstration work that included or evaluated sidedress N applications for corn.

Results and Discussion

In an early review of N timing options for corn production, Bundy (1986) concluded that sidedress N applications were likely to produce large benefits where the risk of N loss by leaching or denitrification from preplant-applied N were high. Alternatively, little benefit should be expected from sidedress N applications relative to preplant additions where the risk of these loss processes are low such as on medium- and fine-textured soils with moderate or better drainage. Research with various times of N application conducted during 1988-1992, mainly on medium and fine-textured soils, in Wisconsin, Minnesota, and Iowa (Table 1), tended to support this conclusion, but this research was hampered by generally below-normal precipitation during the research period and numerous sites that did not respond to N fertilization. The results from all three states show that the most common result of the N timing comparison was no difference between preplant and sidedress application times. The second most common finding in Iowa and Wisconsin was that preplant application was superior to sidedress or split timings, with few or

Table 1. Corn yield response to preplant, sidedress, or split N timing in Iowa, Minnesota, and Wisconsin (1987-1992).

	Location (years)		
Sites	Iowa (1987-1991)	Minnesota (1989-1992)	Wisconsin (1988-1992)
Total	65	32	39
Responsive	25	28	20
Preplant = SD/Split	15	16	17
Preplant > SD/Split	8	4	3
Preplant < SD/Split	2	8	0

Killorn, et al., IA; Randall, MN; Bundy, WI.

[1] Professor, Dept. of Soil Science, Univ. of Wisconsin-Madison.

none of the sites showing sidedress applications superior to preplant N. In Minnesota, eight of 28 responsive sites showed that sidedress or split N application timing was superior to preplant N. This group of responses occurred mainly on soils developed in outwash parent material with coarse texture and thus was more prone to N losses by leaching (Randall and Schmitt, 2004). Overall, this comparison of N application timings showed little benefit to sidedress application on medium- and fine- textured soils. Only when soils with relatively coarse texture were considered did sidedress applications provide a benefit.

Recent work with sidedress N application timings on medium- and fine-textured soils have raised interest in the possible benefits of sidedress applications on these soils, specifically, whether sidedress N applications have potential for allowing use of lower N rates than would be recommended with preplant applications. Data from on-farm work conducted in several southern Wisconsin counties (Hanson et al., 2002) found that optimum sidedress N rates for corn following soybean were often substantially lower than the currently recommended N rates for the soils used in these experiments. Results from 12 experiments conducted over three years showed that yields were usually optimized with N rates at least 40 lb N/acre less than the 120 lb N/acre recommended for these situations. This work also showed that relative corn yields ranged between 95 and 100 % at all N rates higher than 50 lb N/acre across all 12 experimental sites, indicating that an application of 50 lb N/acre would result in near-maximum yield levels. In subsequent work, sidedress N applications for corn following soybean continued to optimize yields at relatively low N rates, but where sidedress and preplant applications were compared, yields with the two times of application were similar (Table 2).

Table 2. Corn yield response to preplant and sidedress N in replicated on-farm trials in southern Wisconsin, 2002*

Location	Crop system	N timing	N rate (lb/acre)	Yield (bu/acre)
A	Soybean-corn	Sidedress	103	149
		Preplant	110	144
		Sidedress	143	151
B	Corn-corn	Sidedress	135	130
		Preplant	160	135
		Sidedress	176	134
C	Soybean-corn	Sidedress	90	166
		Preplant	90	167
		Sidedress	150	163

* Data from Matt Hanson, Dodge County Extension

While preplant and sidedress applications produced similar yields at generally equivalent N application rates, yields were optimized at lower N rates than were recommended for these cropping systems. For example, 120 lb N/acre would have been recommended for corn following soybean, and 160 lb N/acre would have been recommended for corn following corn.

It is tempting to conclude from this type of N response data that sidedress N applications are responsible for the lower N rates required to optimize yields. However, results from two experiments conducted in 2005 show that low optimum N rates can also occur without using a sidedress N application time. The first of these experiments was a replicated small plot

experiment conducted at the Arlington Agricultural Research Station. Results summarized in Table 3 show that corn yields were optimized at relatively high levels with lower than anticipated preplant N rates. An economic optimum N rate of 54 lb N/acre was obtained from regression analysis of this data and a N:corn price ratio of 0.175 ($0.35/lb of N and $2.00/bu of corn).

Table 3. Corn yield response to preplant N rates in a soybean-corn cropping system. Arlington WI, 2005.

N-rate	Mean yield	Duncan grouping †
(lb/acre)	(bu/acre)	
0	163	B
30	187	A
60	191	A
90	193	A
120	195	A
150	199	A
180	198	A
210	196	A

† Means with the same letter are not significantly different. Data provided by Jeff Osterhaus, Dept. of Soil Science, Univ. of Wisconsin-Madison.

A second trial was conducted as an un-replicated field strip trial in Columbia County, Wisconsin. In this trial, several rates of N were applied to strips of approximately 2.3 acres each using three times of N application: all at planting, all at sidedress, and a split application with 50% of the N at planting and 50% at sidedress. As shown in Table 4, Corn after corn yields appeared to be maximized at the lowest rate of applied N (80 lb N/acre), and there were no apparent responses to time of N application or to higher rates of N even though yields were very good for the 2005 growing season. The standard N rate recommendation for this production situation would be 160 lb N/acre.

Based on recent N response data in Tables 2-4, it appears that the relatively low optimum N rates identified in these and other experiments is probably more related to soil N availability at the experimental location than to the time of fertilizer N application. These results do not provide a clear indication that sidedress N applications are responsible for the low optimum N rates. It should be noted that the two 2005 experiments (Tables 3 and 4) were conducted during a relatively dry growing season where in-season N losses through leaching or denitrification would likely be very low and potential benefits from delayed or sidedress N application times would not be expected.

While the information presented above does not show clear benefits to using sidedress applications on medium- and fine-textured soils, that situation is dramatically different for N timing studies conducted on coarse-textured sandy soils where N loss by leaching from preplant N applications is likely. The expected benefits of sidedress applications on coarse-textured soils with high risk of N loss through leaching are illustrated by the data in Table 5 showing much better performance in terms of yields and N recovery with a split sidedress timing than with preplant applications on a sandy irrigated soil at Hancock, WI.

Table 4. Nitrogen rate and timing effects on corn yield in a field strip trial in Columbia County, WI, 2005.*

N timing			
Preplant	Sidedress	Total N rate	Yield
---------- lb N/acre ----------			bu/acre
40	40	80	210
80		80	214
	80	80	204
60	60	120	207
120		120	208
	120	120	198
80	80	160	194
160		160	200
	160	160	204
100	100	200	209
200		200	207
	200	200	203

* Un-replicated field strip trial conducted on a Plano silt loam soil, corn after corn, planted 4/23/05, Sidedress N on 6/13/05. Data provided by Laura Paine, Columbia County Extension.

Table 5. Nitrogen rate and timing effects on corn yield and N recovery, Hancock WI, 2003-2004.

N rate	Yield (bu/acre)		N recovery (%)	
(lb/acre)	Preplant	Sidedress*	Preplant	Sidedress*
0	96	96	--	--
50	122	142	47	84
100	145	175	45	79
150	164	194	42	73
200	180	202	40	66
250	193	202	37	57
Average	161	183	42	72

* Split sidedress N applied at 4 and 7 wk after planting.

Summary and Conclusions

Results from N timing experiments conducted in the 1990s and the results of current experiments agree that sidedress N applications are usually not superior to preplant N on medium- and fine-textured soils. Optimum N rates substantially lower than current recommendations have been observed with both preplant and sidedress application times and are probably due to high levels of soil N availability at the experimental site rather than to time of N application. These results also indicate that significant losses of preplant N through leaching or denitrification seldom occur on these soils before crop N use. This statement does not imply that sidedress N applications should not be used on these soils; however, reduced optimum N rates or yield

enhancements should not be expected solely from the use of sidedress N. On the other hand, use of sidedress or delayed times of N application on coarse-textured sandy soils is an essential management practice for agronomic efficiency and for avoiding losses of N to the environment. Sidedress N applications are effective on sandy soils because they prevent losses that would likely occur from preplant N applications.

References

Bundy, L.G. 1986. Review - Timing nitrogen applications to maximize fertilizer efficiency and crop response in conventional corn production. J. Fert. Issues 3:99-106.

Hanson, M., T. Novak, and L. Bundy. 2002. Evaluating optimum sidedress N application rates for corn following soybeans. Proc. Wis. Fert. Aglime and Pest Mgmt. Conf. 41:299-303.

Randall G., and M. Schmitt. 2004. Stategies for split N applications in 2004. Proc. Wis. Fert. Aglime and Pest Mgmt. Conf. 43:60-67.