Does it Pay to Sidedress Some of the Nitrogen on Corn?

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ABSTRACT

Dividing the amount of nitrogen fertilizer applied to corn over two or three applications has become a common practice, based on the understanding that waiting to apply some of the N lowers the potential for loss of N, and that applying N during vegetative growth stages enables N to get into the plant quickly when the plant is rapidly taking up N. Across 20 sites, spring preplant ammonia at 200 lb. N/acre, fall-applied ammonia at 100 lb. N/acre + 50 lb. N as UAN injected at planting + 50 lb. N as UAN injected at V5-V6, and 50 lb. N/acre as UAN injected at planting + 150 lb. N as UAN sidedressed at V5-V6 yielded 236, 236, and 238 bu/acre, respectively. Across 14 sites, applying 100, 150, and 200 lb. N/acre as injected UAN at planting yielded 9, 2, and 1 bushel more, respectively, than the same rates of N applied as 50 lb. N as UAN broadcast at planting followed by 50, 100, or 150 lb. N/acre of injected UAN at V5. Averaged over 15 trials, N rates ranging from 0 to 250 lb. N/acre applied either as UAN injected at planting or as UAN injected at planting plus 50 lb. N as UAN dribbled near the row at VT showed no advantage in yield, optimum N rate, or return to N at the EONR from keeping back 50 lb. N to apply at tasseling. That keeping some N back to apply in-season failed to increase yields, even when the weather was wet during vegetative growth, indicates a possible advantage to having more of the N in the soil during early growth, and also that loss of N may be less extensive than we think. At least on productive soils, costs of splitting N to apply some in-season compared to one-time application of N at or before the season are likely to exceed returns.

INTRODUCTION

Managing fertilizer nitrogen to maximize N utilization and economic return to N, and to minimize loss to the environment, continues to be a challenge. Applying all of the N fertilizer at or before planting deemed by some as risky due to possible losses (from fall or early spring applications) and to the fact common-sense idea that while the crop needs some N to get started after emergence, applying some N closer to the time the crop is taking up N should lower the potential for loss and will also get N to the crop when it's needed the most. Based on this understanding, producers and retailers have invested in equipment for in-season application, and are inclined to apply in-season N.

Despite the logic of applying some N in-season, research findings that confirm the agronomic and economic advantages of this practice are relatively scarce. Ruiz Diaz et al. (2008) were unable to find yield or economic benefits from applying some of the N in-season compared to applying all of the N at planting. Rutan and Steinke (2018) reported that providing some N at planting (more N applied 2x2 was more effective that less N applied in-furrow) plus early (V4) sidedress applications were effective, but that delaying sidedressing to V11 was sometimes less effective than earlier sidedressing.

PROCEDURES

With funding from the Illinois Nutrient Research & Education Council, we conducted a series of studies from 2014 through 2017, mostly at University of Illinois Crop Sciences Research & Education Centers at DeKalb, Monmouth, Urbana, and Perry, with some sites also located on farmer fields in East-Central Illinois. Soils at all of these sites except at Perry, which has transitional (Alfisol) soil, are Mollisols, and all are highly productive.

One set of trials was designed to track soil extractable (plant-available) N after applying 200 lb. N as: 1) fall ammonia; 2) 100 lb. N as fall ammonia + 50 lb. N as UAN injected at planting + 50 lb. N as injected UAN at V5-V6; 3) spring preplant ammonia; or 4) 50 lb. N as UAN injected at planting + 150 lb. N as injected UAN at V5-V6. Yield data were taken by hand or machine harvest. A total of 20 trials, 12 on research centers and eight on farm fields, were conducted between 2015 and 2017.

A second set of trials (14 site-years from 2014 through 2017) at the research centers included a subset of treatments in which we compared 100, 150, and 200 lb. N applied all as UAN injected at planting with 50 lb. N surface-broadcast at planting (to simulate the common practice of applying UAN as a herbicide carrier) plus 50, 100, and 150 lb. N applied as injected UAN at V5-6. These trials all included a set of N rates ranging from 0 to 250 lb. N per acre, as well as a number of additional treatments applying 150 lb. N; 100 lb. injected at planting plus 50 lb. N as either injected UAN or urea with Agrotain® injected, or as injected UAN or urea at V5-6.

A third set of trials were conducted in 2016 and 2017 on these same research centers, in which we measured N responses to N rates between 0 and 250 lb. N per acre applied as UAN injected at planting, compared to these rates but with 50 lb. of the N applied as UAN dribbled near the rows at tasseling. There were 15 trials conducted, nine with corn following soybeans and six with corn following corn. Response curves (in most cases the quadratic-plateau function produced the best fit) were fit to the data and optimum N rates, yield at that rate, and return to N at the EONR were calculated based on N and corn prices of $0.35 per lb. and $3.50 per bushel, respectively.

RESULTS AND DISCUSSION

Different ways to apply 200 lb. N per acre produced almost identical yields over the 20 trials conducted from 2015 through 2017, but responses were not consistent among the three years (Figure 1). Rainfall at all of the sites in 2015 was around 10 inches—more than twice the normal amount—making it the wettest June on record in Illinois. That year, the treatment with 50 lb. N at planting followed by 150 lb. N sidedressed as UAN produced an average yield of 242 bushels, about 10 bushels more than the average of the other three 200-lb. treatments. The spring of 2016 was warm with adequate rainfall, and all four of the 200-lb. treatments yielded the same over sites. The 2017 season began with a cool, wet period in late April and early May, and in that year, the spring-split (50 at planting + 150 at sidedressed) yielded more than 9 bushels less than the average of the other three 200-lb. treatments. These three treatments did not separate from one another statistically, when analyzed within or across years.

It is not surprising that applying most of the N at sidedress time increases yield when June is wet. But many producers were unable to apply sidedressed N in June 2015, and in fields with a lot of standing water, crop damage was severe enough that applying might not have increased yields. It is not clear why the planting time-sidedress split application caused yield decreases compared to all-early application in 2017, but it may be that the early wet and cool conditions limited the supply of N from the soil when plants were small, and that plants experienced a shortage of N early in the season from which they could not fully recover. The response to spring-split N was greater when yields without any fertilizer were less, which suggest that early onset of deficiency, which in some cases may indicate relatively low availability of mineralized N, could be a signal that later application of some of the N (or maybe a little more N) might be beneficial.

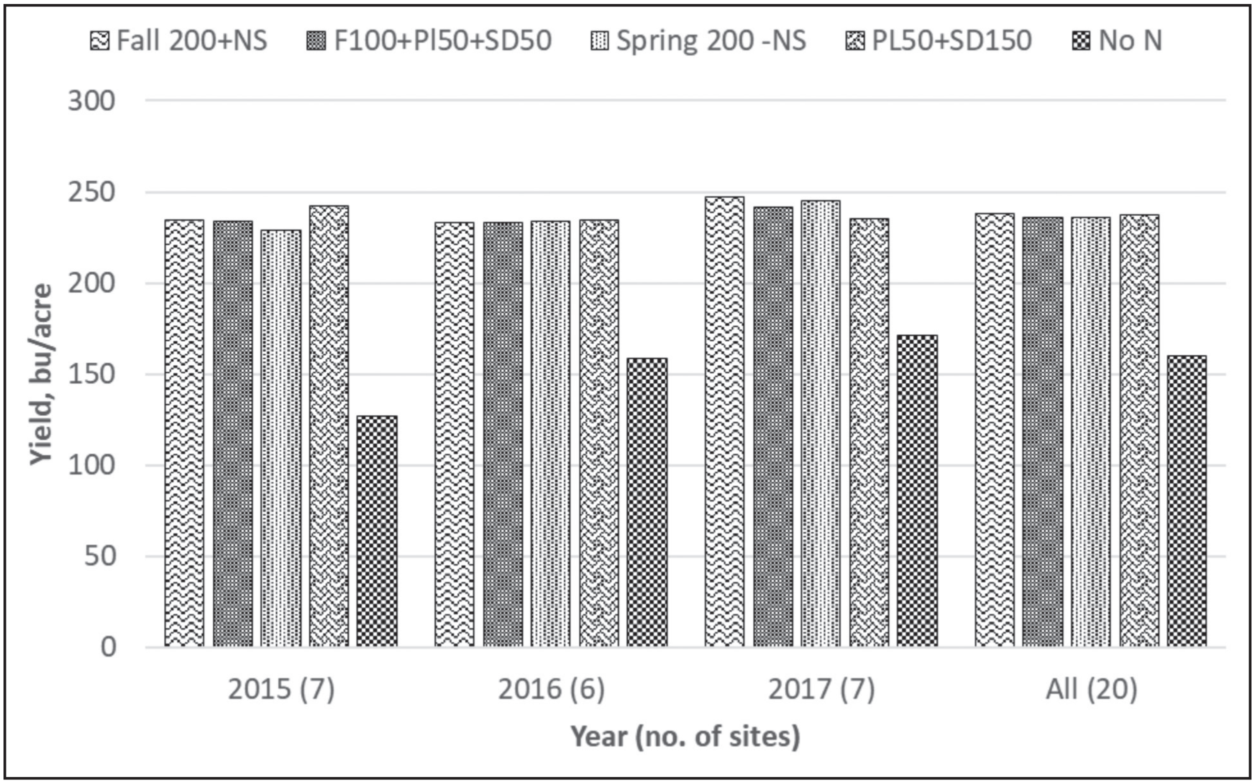

Figure 1. Yield after applying 200 lb. N as fall $NH_3$with N-Serve, Fall-planting-sidedress (3-way) split, Spring NH_3, or split between planting and sidedress N, along with a zero-N control.

Across fourteen sites-years from 2104 to 2017, applying 100 lb. N as UAN injected at planting produced higher yield than applying 50 lb. as broadcast UAN at planting plus 50 lb. at sidedress; at the 150- and 200-lb. N rates, timing of N application did not affect yield (Figure 2). It appears that when the overall amount of N is inadequate (100 lb. in this case), applying it all at planting better allows the plant to make use of the N, while at higher rates, the early N is adequate to provide the plants with enough N to prevent yield loss if enough N is applied later. We did not see higher yields from sidedressing some of the N, however, and these data do not rule out the possibility that early deficiency, as mentioned above, might have limited yields even when more N was added later.

Averaged across sites, applying 100 lb. N at planting and 50 lb. at sidedress produced the same yield as applying 50 lb. at planning and 100 lb. at sidedress, and using broadcast urea with

Agrotain as the N source at sidedressing did not yield differently that using UAN. Applying 100 lb, N at planting and waiting to apply 50 lb. N as sidedressed UAN dribbled between rows or as broadcast urea also had little effect on yield. Application of no N at planting and applying all 150 lb. N as sidedressed UAN at V6 did not lower the yield, but dribbling UAN between rows at V9 reduced yield by about 6 bushels per acre. These results show some risk from waiting too long to apply any N, but do not provide strong support for the idea that yields at the higher rates might have been higher had more of the N been applied early.

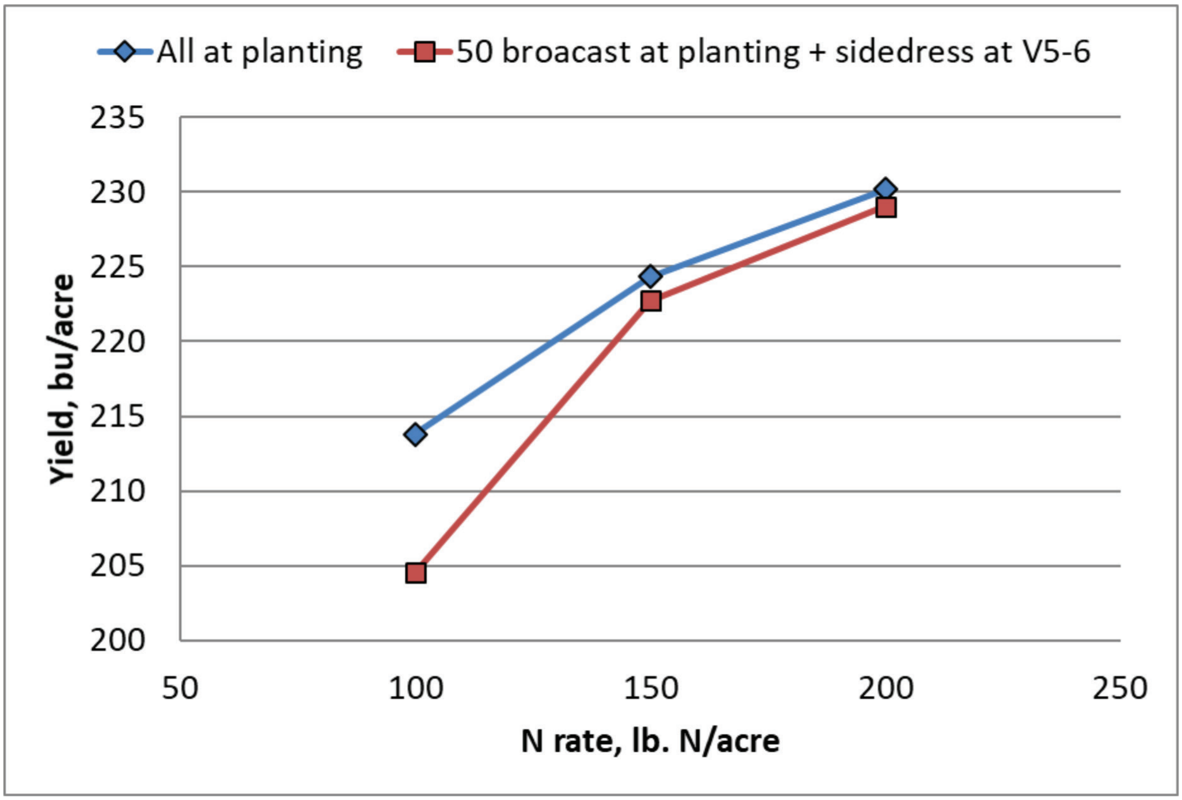

Figure 2. Corn yield following application of three different rates of N, either all injected as UAN at planting or 50 lb. N broadcast at planting plus the remainder of the N as injected UAN at sidedress (V5-V6.) Data are averages across 14 Illinois conducted between 2014 and 2017.

Applying N rates at planting or reserving 50 lb. N to dribble near the rows at tasseling produced virtually identical N responses in both corn following soybean and corn following corn (Table 1.) Averaged over trials, the N rate required to maximize return to N The optimum N rate required to maximize the return to N less to N than early N. Over the three corn-corn trials in 2017, late-split N required 6 lb. less N but yielded 3 bushels less than early-applied N, for a net loss of almost $10 per acre. So with no yield advantage and no overall decrease in the amount of N needed, the cost of late application would lower profits in 2017 – the same outcome as we saw in 2016. In all but one site-year over the past two seasons (DeKalb in 2017), the actual EONR was less than the MRTN had; using MRTN rates instead of calculating differences from the actual N responses in each trial would have produced no change in relative performance; all sites would have received more N than needed.

SUMMARY

Over a substantial number of trials over years and sites, we found surprisingly few instances in which reserving some of the N to apply during vegetative growth of the corn crop increased yield compared to applying all of the N once, before or at planting. Furthermore, in almost no trial did splitting N increase yield by enough to pay the cost of sidedressing. We found more response to delaying some of the N to apply in-season when the weather was wet during vegetative growth, and it's possible that early N deficiency shown by corn plants during such weather might signal the need to splitting (or adding more) N later during vegetative growth.

Most of these trials were conducted under relatively favorable conditions in soils with more than 2 percent organic matter, and yields were high. Because availability of soil N is aided by high mineralization under such conditions, we recognize that there may be more response to sidedressing some of the N in less productive soils or under marginal conditions during crop establishment and early growth. But when the corn crop gets off to a good start in higher-OM soils, applying all of the N for the crop once, at or before planting, appears to be the most cost-effective way to provide N to the crop.

Table 1. Summary over sixteen N rate trials over 2016 and 2017 in which rates of N from 0 to 250 lb. N/acre were applied either all at planting or at planting with 50 lb. dribbled near the corn row at tasseling time.

Measurement	Comparison	Corn following soybeans	Corn following corn
Number of trials		9	6
Optimum N rate	Early	141.8	152.6
lb. N/acre	Late/split	152.0	149.5
	Advantage to late/split	10.2	-3.1
Yield at opt. N	Early	226.7	224.8
Bushels per acre	Late/split	227.0	223.3
	Advantage to late/split	0.3	-1.4
Return to N at EONR	Early	$743.79	$733.30
$ per acre	Late/split	$741.42	$729.32
	Advantage to late/split	-$2.37	-$3.98

REFERENCES

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