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Best Management Practices for Nitrogen Use in SOUTH-CENTRAL MINNESOTA

BEST MANAGEMENT PRACTICES FOR NITROGEN APPLICATION

Best Management Practices for Nitrogen Use in South-Central Minnesota

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Introduction

Nitrogen (N) is an essential plant nutrient that is applied to Minnesota crops in greater quantity than any other fertilizer and contributes greatly to the agricultural economy of Minnesota crop producers. In addition, vast quantities of nitrogen are contained in the ecosystem, including in soil organic matter. Biological processes that convert nitrogen to its mobile form, nitrate (NO_3), occur continuously in the soil system. (For greater detail see ***Understanding Nitrogen in Soils*** **AG-FO-3770**.) Unfortunately, nitrates can be leached from the root zone of the soil. Management guidelines have been developed to assist crop producers manage their nitrogen in ways that optimize profitability, reduce risk, and minimize the loss of nitrate to surface and ground water.

What Are the Best Management Practices (BMP's)?

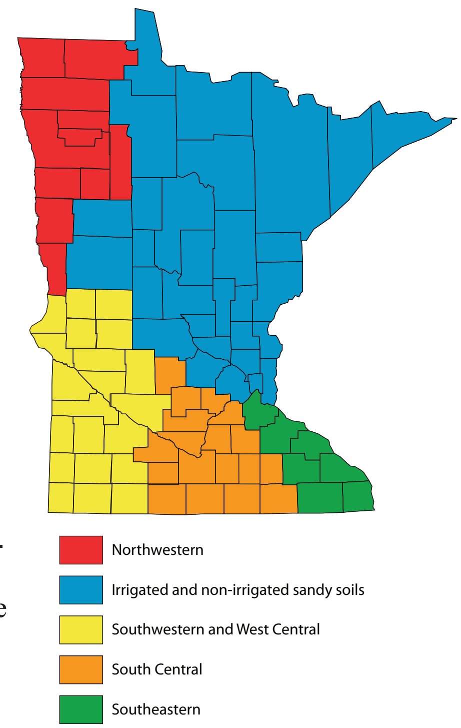
Best Management Practices (BMP's) for nitrogen are broadly defined as "economically sound, voluntary practices that are capable of minimizing nutrient contamination of surface and groundwater". The BMP's recommended herein are based upon research conducted by the University of Minnesota from over 70 site-years of field research in south-central Minnesota and upon practical considerations.

The BMP's are based, in part, upon the concept of total nitrogen management, which accounts for all forms of on-farm nitrogen in the development of crop management plans. BMP's were developed to be adopted on a statewide as well as a regional basis.

BMP's for South-Central Minnesota

South-central Minnesota is characterized by fine-textured soils formed in glacial till and sediments. Most south-central soils have naturally poor-to-moderate internal drainage and are tiled to improve drainage. Average annual precipitation in the region is 27 to 35 inches. Crops are predominantly corn and soybeans. BMP's for the area shown in the map (Blue Earth, Brown, Carver, Dodge, Faribault, Freeborn, LeSueur, Martin, McLeod, Meeker, Mower, Nicollet, Rice, Scott, Sibley, Steele, Waseca and Watonwan counties) have been developed based on field research conducted in some of those counties.

The BMP's in this publication focus on nitrogen use for corn. They are divided into three categories described as: 1) recommended, 2) acceptable but with greater risk, and 3) not recommended. With respect to N management, risks can be either economic or environmental. Economic risks can be either a consequence of added input cost without additional yield or a reduction in yield. Environmental risks pertain to the potential for loss of nitrogen to either ground water or surface waters.



For south-central Minnesota, the BMP's are:

1) Recommended

- Select an appropriate N fertilizer rate using U of M guidelines ("***Fertilizing Corn in Minnesota***" **FO-3790,** 2006 or newer) which are based on current fertilizer and corn prices, soil productivity and economic risks.
- Total N rate should include any N applied in a starter, weed and feed program, and contributions from phosphorus fertilizers such as MAP and DAP.
- Spring preplant applications of ammonia and urea or split applications of ammonia, urea, and UAN are highly recommended. (See Tables 2, 5, 6, 7, 8, 9, 11, 12 and 13)
- Incorporate broadcast urea or preplant UAN within three days to a minimum depth of 3 inches.
- Inject or incorporate sidedress applications of urea or UAN into moist soil to a minimum depth of 3 inches. (See Tables 12 and 13).
- Take appropriate credit for previous legume crops and any manure used in the rotation.
- Under rain fed (non-irrigated) conditions, apply sidedress N before corn is 12 inches tall. (V7 stage)
- When soils have a high leaching potential (sandy texture), nitrogen application in a split-application

or sidedress program is preferred. Use a nitrification inhibitor (N-Serve) on labeled crops with early sidedressed N.

2) Acceptable, but with greater risk

- Fall application of ammonia + N-Serve after soil temperature at the 6-inch depth is below 50°F. (See Tables 5, 6, 8, and 9).
- Spring preplant application of UAN (see Table 11)
- Late fall or spring preplant application of ESN

3) Not recommended

- Fall application of urea and ammonia without N-Serve. (See Tables 5, 6, 7, 8 and 9).
- Sidedressing all N when corn follows corn. (See Table 13).
- Fall application of N to coarse-textured (sandy) soils.
- Application of any N fertilizers, including MAP and DAP on frozen soils.
- Fall application of UAN (28-0-0).

Nitrogen Management Research in South-Central Minnesota

Nitrogen management research for corn primarily involves determining the effects of rate and time of fertilizer N application, source of N, application methods, and additives (Nitrapyrin, N-Serve) on corn production. In addition to measuring crop yield responses to various N treatments, many studies also evaluate crop quality (protein), economic return to N, carryover residual nitrate in the soil profile, nitrate losses to ground and surface (tile drainage) water and N use efficiency. In the following section, emphasis is placed on crop yield, economic return, N use efficiency, and nitrate losses in subsurface, tile drainage to determine economically and environmentally-sound BMP's for south-central Minnesota.

Rate of N Application

Using the correct amount of N optimizes crop yield while minimizing loss of N to the environment. Using the wrong amount reduces profitability for the farmer and can result in excess nitrate being delivered to ground and surface water resources.

Determining the correct amount of fertilizer N to apply for a crop means first estimating how much N is available from the soil and second adding fertilizer N to meet the crop's total N need. Because uncontrollable factors like precipitation and temperature affect the release of N from the soil as well as the amount of N needed by the crop, the optimum amount of fertilizer N can change from area to area and year to year.

Dozens of field research studies have been conducted by University scientists in south-central Minnesota to determine optimum N rates for corn. Data from 128 Minnesota sites were included in a massive effort to arrive at N recommendations for seven Corn Belt states (Iowa State Univ., PM 2015, 2006). Yield goal was found not to be a good predictor of the N rate needed. Instead, the recommended rate of N to apply was determined to be within a range of N rates, depending on the productivity of the soil, previous crop, manure applications, and the ratio of price of fertilizer N to corn price.

For southern Minnesota, the range of N rates for corn after corn and corn after soybeans is found in Table 1. Thus, for corn following soybeans, when N costs $0.25/lb and corn sells for $2.50/bu (a ratio of 0.10), the optimum N rate ranges from 90 to 125 lb N/A with the maximum economic return to N (MRTN) achieved at a rate of 110 lb N/A. In south-central Minnesota, a rate of 110 to 120 lb N/A is recommended on those soils with the highest productivity and yield potential (Nicollet, Webster, etc.), whereas, the 90-lb rate would be suitable for those soils of lower productivity where the yield potential is less due to limited water holding capacity (Clarion, Storden, etc.).

Table 1. Nitrogen rate fertilization guidelines for highly productive soils in southern Minnesota based on N: corn price ratios and economic return for corn after corn and corn after soybean.

Price ratio	Previous Crop: Corn	Previous Crop: Soybean
$/lb N: $/bu corn	- - - - - - - - - - - lb N/A[1]	- - - - - - - - - - -
0.05	130-180 (155)[2]	100-140 (120)
0.10	120-165 (140)	90-125 (110)
0.15	110-150 (130)	80-115 (100)
0.20	100-140 (120)	70-100 (85)

[1] N rates are to be reduced 20 lb/A on soils considered to have a medium yield potential due to yield-limiting factors.
[2] N rate that maximizes economic return to N (MRTN)

The effect of N rate on corn yield, profitability, and nitrate loss to tile drainage is shown in Table 2. Compared with the standard 120-lb N rate applied in the fall, adding an additional 40 lb N/A (160-lb N rate) increased yields 6 bu/A (4%), increased profit by $2/A (3%), and increased NO_3-N concentration in the tile water by 4.9 mg/L (37%). On the other hand reducing the N rate to 80 lb/A reduced yield 22 bu/A (13%) reduced profit $34/A (47%), and reduced NO_3-N concentration in the water by 1.7 mg/L (13%). Greatest yield and profit with a minimal increase in NO_3-N concentration was found with the spring-applied 120-lb N rate. These data clearly demonstrate the importance of using the correct N rate as a cornerstone BMP from an economic and a water quality perspective.

Table 2. Corn production and nitrate loss to tile drainage as affected by rate and time of N application at Waseca, 2000-2003.

N Treatment: Time	N Treatment: Rate	N Treatment: N-Serve	4-Yr Average: Grain yield	4-Yr Average: Net return to N[1]	4-Yr Average: Flow-weighted NO_3-N Conc.[2]
	lb N/A		bu/A	$/A	mg/L
--	0	--	111	--	--
Fall	80	Yes	144	38	11.5
"	120	"	166	72	13.2
"	160	"	172	74	18.1
Spr.	120	No	180	105	13.7

[1] Based on corn = $2.00/bu, fall N = $0.25/lb, spring N = $0.275/lb, N-Serve = $7.50/A.
[2] Across four C-Sb rotation cycles, i.e. four years of corn followed by four years of soybean.

Nitrogen From Previous Legume Crops

As with soybean discussed above, N can also be supplied from other legume crops used in the rotation. Nitrogen credits from these crops are listed in Tables 3 and 4 and should be subtracted from the nitrogen guidelines for corn following corn in Table 1. The N credit for a corn crop in the second year following a forage legume is summarized in Table 4.

Table 3. Nitrogen credits for legumes preceding corn in the rotation.

Previous Crop	1st Year Nitrogen Credit
	---- lb. N per acre ----
Harvested alfalfa	
4 or more plants/ft^2	150
2-3 plants/ ft^2	100
1 or less plants/ ft^2	40
Red clover	75
Edible beans	20
Field peas	20

Table 4. Nitrogen credits for some forage legumes if corn is planted two years after the legume.

Legume Crop	2nd Year Nitrogen Credit
	---- lb. N per acre ----
Harvested alfalfa	
4 or more plants/ft^2	75
2-3 plants/ ft^2	50
1 or less plants/ ft^2	0
Red clover	35

Nitrogen in Manure

Nitrogen in livestock manure is just as important as nitrogen applied in commercial fertilizers. Therefore, any available N in manure should be used as a credit when determining the total amount of fertilizer N needed for corn. The process of determining the amount of N supplied by manure is described in other publications that are listed on page 6 of this bulletin. As with credits from legumes, manure N should be subtracted from the guideline values in Table 1 for corn following corn.

Nitrogen from Other Sources

When determining the total amount of fertilizer N needed, N supplied in other fertilizers cannot be ignored. This is true whether pre-emergence or post emergence herbicides are applied using 28-0-0 as a carrier or applying high rates of phosphate fertilizers using sources containing N (11-52-0 or 18-46-0, 10-34-0). This N must be taken into consideration when the rate of fertilizer N to be applied for corn is being determined.

Time of N Application and N-Serve

A 4-yr study at Waseca, comparing a late-October application of anhydrous ammonia at three N rates plus N-Serve with spring-applied ammonia without N-Serve, showed a 14 bu/A yield response and $33/A economic return advantage for spring application when applied at the 120-lb rate with no difference in flow weighted NO_3-N concentration in the tile drainage (Table 2). Moreover, the 120-lb spring N treatment increased yields 8 bu/A and economic return to N by $31/A while decreasing NO_3-N concentration in the drainage from 18.1 to 13.7 mg/L (24%) compared with 160 lb N/A + N-Serve applied in the fall. Conversely, choosing to apply 160 lb N/A in the fall rather than 120 lb/A in the spring would have cost the grower a 4% yield and 30% economic reduction while increasing nitrate losses in drainage by 32%.

A long-term study, comparing late-October application of ammonia with and without N-Serve with a spring preplant application without N-Serve, showed distinct yield, economic, and environmental advantages for spring application, but not in all years (Table 5). Across the 15-yr period, corn yields averaged about 10 bu/A greater for the fall N + N-Serve and spring N treatments compared with fall N without N-Serve. Also, compared with fall application of N without N-Serve, NO_3-N losses in the drainage water were reduced by 14 and 15%, economic return to N was increased by $9 and $19/A, and N recovery in the grain was increased by 8 and 9% for fall N + N-Serve and spring N, respectively. However, corn yields were significantly affected by the N treatments in only 7 of 15 years. In those seven years, when April, May and/or June were wetter-than-normal, average corn grain yield was increased by 15 and 27 bu/A and average economic return was increased by $22.50 and $51.00/A for the fall N + N-Serve and spring N treatments, respectively. In summary, the 15-yr data suggest that applications of ammonia in the late fall + N-Serve or in the spring preplant were BMP's. However, when spring conditions were wet, especially in May and June, spring application gave substantially greater yield and profit than the fall N + N-Serve treatment. Therefore, fall N + N-Serve application is considered to be more risky than a spring, preplant application of ammonia. Moreover when N-Serve was not used, fall application of ammonia was more risky (lower yields) compared with spring application regardless of tillage system (no-till, strip-till, spring field cultivate, and fall chisel plow).

Table 5. Corn yield and economic return to nitrogen program as affected by time of application and N-Serve at Waseca, 1987-2001.

	Time of Application[1]		
Parameter	Fall	Fall + N-Serve	Spring
15-Yr Avg. Yield (bu/A)	144	153	156
15-Yr Avg. Economic return over fall N ($/A/yr)[2]	--	$9.30	$18.80
7-Yr Avg. Yield (bu/A)[3]	131	146	158
7-Yr Avg. Economic return over fall N ($/A/yr)[2]	--	$22.50	$51.00
Flow-weighted NO_3-N concentration in tile drainage from the corn-soybean rotation (mg/L)	14.1	12.2	12.0
Nitrogen recovery in the corn grain (%)[4]	38	46	47

[1] Rate of applications for 1987-1993 and 1994-2001 were 135 and 120 lb N/A, respectively.
[2] Based on corn = $2.00/bu, fall N = $0.25/lb N, spring N = $0.275/lb N, and N-Serve = $7.50/A.
[3] Only those seven years when a statistically significant yield difference occurred among treatments.
[4] Nitrogen recovery in the corn grain as a percent of the amount of fertilizer N applied.

A split application of ammonia with 40% applied preplant and 60% applied sidedress at the V8 stage was compared with late October and spring preplant applications of ammonia (Table 6). In this 7-yr period, grain yields were significantly greater (6 bu/A) for the split-applied treatments, resulting in slightly greater N recovery in the grain and economic return to N compared with the fall and spring treatments. However, NO_3-N concentrations in the tile drainage were also slightly higher with split-applied N than for the spring N and fall N + N-Serve treatments.

Table 6. Corn production after soybeans and nitrate loss as affected by time of N application and N-Serve at Waseca, 1987-93.

N Treatment		7-Yr Average			Flow-weighted NO_3-N conc. in tile drainage
Time	N-Serve	Corn yield	N recovery	Economic return to N[1/]	
		bu/A	%	$/A	mg/L
Fall	No	131	31	34	16.8
"	Yes	139	37	43	13.7
Spring	No	139	40	47	13.7
Split	No	145	44	56	14.6
LSD (0.10):		4			

1/ Based on corn = $2.00/bu, fall N = $0.25/lb, spring N = $0.275/lb, N-Serve = $7.50/A, and application cost = $4.00/A/time.

A 6-yr study comparing fall versus spring application of N-Serve with ammonia showed a statistically and economically significant 10 bu/A yield response to N-Serve applied in the fall (Table 7). The 4 bu/A yield increase to spring-applied N-Serve was not statistically significant and is considered economically neutral. However, a yield response to spring-applied N-Serve occurred in years when June rainfall was excessive. Because these data do not suggest a consistently significant and economical response to N-Serve applied in the spring and because excessive June rainfall can not be predicted at the time of spring ammonia application, adding N-Serve to spring-applied ammonia is not considered to be a BMP.

Table 7. Corn grain yield after soybeans as affected by fall and spring application of N-Serve with anhydrous ammonia at Waseca, 1994-99.

Time of application	N-Serve	
	No	Yes
	- - - - - 6-Yr Avg. Yield (bu/A) - - - - -	
Fall	161	171
Spring	172	176

Time of Application and N Source

The N source used must also be considered when selecting the proper time of application. Studies at Waseca in 1981 and 1982 compared fall application of anhydrous ammonia and urea, with and without N-Serve, to spring application of the same. Two-year average corn yields (Table 8) indicate: (a) broadcast and incorporated urea was inferior to anhydrous ammonia when fall-applied, (b) spring application of urea was superior to fall application, and (c) a slight yield advantage for spring-applied ammonia compared with fall application was found when averaged across N-Serve treatments.

Table 8. Corn yield as influenced by N source, time of application, and N-Serve at Waseca, 1981-82.

Nitrogen treatment		Time of Application	
Source	N-Serve	Fall	Spring
		- - - - - Yield (bu/A) - - - - -	
None	--	104	
Urea	No	157	164
"	Yes	155	167
An. Ammonia	No	162	168
"	Yes	170	173

A subsequent study evaluated late October application of urea (4" deepband) and anhydrous ammonia with and without N-Serve compared to spring preplant urea and anhydrous ammonia. Three-year average yields show a 33 bu/A advantage for urea and a 14 bu/A for ammonia when applied in the spring (Table 9). Nitrogen recovery in the corn plant ranked: spring ammonia = spring urea > fall ammonia > fall urea. The effect of N-Serve in this study was minimal. Yield responses to the spring treatments were greatest in 1998, when April and May were warm and late May was wet, and in 1999 when the fall of 1998 was warm and April and May, 1999 were very wet. Significant yield differences were not found in 1997 when the fall of 1996 was cold and the spring of 1997 was cool and dry.

Table 9. Corn yield and N recovery in the whole plant as influenced by time of application and N source at Waseca, 1997-1999.

Nitrogen Management			3-Yr Average	
Time	Source	N-Serve	Yield	N Recovery
			bu/A	%
Fall	Urea	No	152	43
"	"	Yes	158	47
"	An. Ammonia	No	168	60
"	"	Yes	170	63
Spr. Preplant	Urea	No	185	76
"	An. Ammonia	No	182	84
--	None	--	112	--
	LSD (0.10):		8	

Fourteen field studies were conducted on glacial till soils in south-central Minnesota to determine the effectiveness of split applications versus a single preplant application of N. Urea was applied preplant in 30-lb increments at rates of 0 to 180 lb N/A. Split applications consisted of preplant-applied urea at 30 or 60 lb N/A and urea injected 4" deep at rates of 30, 60, and 90 lb N/A at the V5 to V6 stage. Corn grain yields were equal between preplant and split-applied N at 7 of 14 sites. Yields from preplant-applied N were < or > yields from split-applied N at 4 and 3 sites, respectively, depending on spring rainfall. In 1991 when May-September rainfall was 56% above normal, yields were increased an average of 11 bu/A by the split-applied treatments (Table 10). In 1992, yields were decreased an average of 11 bu/A by the split applied treatments. Some N deficient corn was visible at the time of sidedressing, indicating the initial 30-lb preplant broadcast rate was insufficient. The plants never seemed to recover completely from this early-season deficiency, suggesting that a 40 to 60-lb rate of broadcast preplant N may be needed to reduce the risk of early-season N deficiency.

Table 10. Corn yield after soybeans as affected by method of application on fine-textured, glacial till soils in 1991 and 1992.

Time of application		Site	
Preplant	Sidedress (V6)	1991 Waseca Co.	1992 Blue Earth Co.
- - - - - N rate (lb N/A) - - - - -		- - - - - Yield (bu/A) - - - - -	
0	0	84	107
60	0	143	144
30	30	161	141
90	0	158	156
30	60	157	137
120	0	165	164
30	90	182	153
Advantage for split =		+11	-11

In summary, these "time of application" studies indicate:

- Spring preplant applications of N generally optimized grain yields and minimized nitrate losses to tile drainage water.
- Acceptability of fall applications (late October) depends on source of N and N-Serve.
- Urea should not be applied in the fall.
- Late-October applications of ammonia with N-Serve optimized corn yields in 10 of 15 years and reduced nitrate losses equal to those from spring-applied ammonia across the 15-yr period. Spring preplant-applied ammonia generated highest yields in years when May and June rainfall were excessive.
- Split applications of N produced yields similar to or greater than spring preplant N in most studies. However, yields were occasionally reduced by split application, suggesting the importance of adequate preplant N coupled with critical timing of sidedress N.
- Sidedress applications tended to generate slightly higher NO_3-N concentrations in the drainage water, especially in the following year when soybeans were planted.

Method of N Application

Split application studies were conducted at Waseca from 2001-03 to evaluate various methods for applying urea-ammonium nitrate solution (28%, UAN) at planting time in combination with a V3 sidedress treatment. The split treatments were compared with single fall and preplant applications of N in two tillage systems (spring field cultivate and strip-till) for corn after soybeans. Three-yr yield averages were generally greatest for the split treatments where UAN was either dribbled 2 inches from the row at planting or broadcast with a herbicide immediately after planting (weed and feed) in combination with 60 to 80 lb N/A sidedress injected midway between the rows at V3 to V4 stage (Table 11).

Lowest yields occurred with a single preplant application of UAN in the spring field cultivate system and either fall ammonia + N-Serve or 40 lb N/A dribbled as UAN at planting next to the seed row in the strip tillage system. Perhaps the 40-lb rate was too high when placed this close to the seed row in the strip-till system. Nitrogen recovery in the plant ranged from 56% for the fall ammonia treatments to 71% for the "weed and feed" UAN treatments when averaged across tillage systems. These results suggest substantial flexibility exists for combinations of preplant, planting, and sidedress applications of N as alternatives to traditional fall-applied ammonia.

Table 11. Corn yield following soybeans as affected by time/method of N application for two tillage systems at Waseca, 2001-2003.

Nitrogen treatment				Tillage system	
Time	Source	Rate	N-Serve	SFC[1/]	ST[1/]
		lb N/A		- Yield (bu/A) -	
--	--	0	--	122	111
Fall	AA	100	Yes	167	161
Spr.	AA	100	No	165	168
Spr.	Urea	100	"	167	166
Spr.	UAN	100	"	161	--
Plant [2/] + SD[1/]	"	20 + 80	"	--	170
Plant [2/] + SD[1/]	"	40 + 60	"	174	163
Plant [3/] + SD[1/]	"	40 + 60	"	172	174

1/ SFC = spring field cult., ST = strip-till, SD = sidedress at V3 to V4 stage.
2/ Dribbled 2 inches from the row at planting
3/ Broadcast pre-emergence with herbicide (weed and feed)

Incorporation

Incorporation of sidedress-applied urea and UAN has been a concern because of the possibility of volatilization losses if rainfall does not occur within a few days of application. Results from a 3-yr study conducted on moldboard plowed continuous corn at Waseca showed a 6 bu/A response to a 120-lb split application where anhydrous ammonia was applied at V6 (Table 12). However, yield reductions of 25 and 18 bu/A occurred where UAN was dribbled on the surface at rates of 120 and 180 lb N/A, respectively, and incorporated by cultivation within two days. In 1986 and 1987, another sidedress treatment consisting of UAN injected 4" deep at V6 gave yields that were 20 bu/A greater than those for the dribbled on the surface and cultivated in treatment.

Table 12. Continuous corn yield as affected by split applications of nitrogen at Waseca, 1985-87.

Application time		Total N rate (lb/A)	
Spr., preplant	Sidedress (V6)	120	180
		- - - - - Yield (bu/A) - - - - -	
None	None	68	
An. Ammonia	None	138	150
1/3 as UAN	2/3 as An. Ammonia	144	151
1/3 as UAN	2/3 as UAN (Drib)[1/]	113	132

1/ Dribbled on soil surface and incorporated by cultivation within 2 days.

Similar results were obtained in a ridge-plant study for continuous corn at Waseca in 1981-83. A single application of ammonia, urea, or UAN at 150 lb N/A was applied either spring preplant or sidedressed at V6. Preplant urea and UAN were broadcast on the soil surface prior to planting, whereas the sidedress treatments were dribbled on the soil surface and cultivated in within two days. Spring preplant applications of ammonia, urea and UAN yielded 5, 17, and 12 bu/A more than the sidedress application, respectively (Table 13). The large yield reductions for urea and UAN incorporated by cultivation suggest that sufficient N did not move down the soil profile and into the active root zone, thereby remaining positionally unavailable. The 5 bu/A reduction for sidedress ammonia also suggests that insufficient N was available to the plant early in the season when all of the N applied was delayed until the V6 stage (14-16" tall corn).

Table 13. Continuous corn yield in a ridge-plant system as affected by N source and time/method of application at Waseca, 1981-83.

N source[1/]	Time/Method	
	Spr., preplant	Sidedress (V6)
	- - - - - Yield (bu/A) - - - - -	
None	91	
An. Ammonia	146	141
Urea	146	129
UAN (28%)	145	133

[1/] Rate of application = 150 lb N/A

In summary, these data for south-central Minnesota support the recommendation of incorporating or injecting sidedress applications of urea and UAN to a depth of 3 to 4".

Managing N for Sandy Soils

Although sandy soils with a high leaching potential are not common in south-central Minnesota, it is extremely important for farmers to practice high-level management of their N inputs on these soils. The following recommendations should be practiced.

- Do not apply fertilizer N in the fall to coarse-textured (sandy) soils.
- Application of N in a sidedress or split-application program is preferred.
- Use a nitrification inhibitor (N-Serve) on labeled crops with early sidedressed N.

For greater detail on BMP's for coarse-textured soils see Best Management Practices for ***Nitrogen Use on Irrigated, Coarse-Textured Soils*** **AG-FO-6131** (revised, 2008).

Potential Helpful Products

Agrotain is a urease inhibitor designed to be used in no-till or other production systems where urea remains on the soil surface without incorporation. It reduces the potential for N loss due to volatilization. This product could be used in south-central Minnesota where corn is planted using the no-till system.

ESN is a product that consists of urea coated with a polymer and thus is intended for use as a slow release nitrogen fertilizer. Research conducted at Waseca from 2003-2006 has shown fall-applied (early November), 4" deep-band incorporated ESN to produce corn yields substantially greater than fall-applied urea and equal to spring-applied anhydrous ammonia. Thus, ESN is acceptable for late fall application or spring application in south-central Minnesota. However, there is a risk. The cost is substantially higher than the cost of N supplied as urea or ammonia. Mixtures of ESN and urea might be appropriate. However, mixtures have not been evaluated.

Summary

Effective and efficient management of nitrogen fertilizers is important for profitable corn production in south-central Minnesota. The research based Best Management Practices (BMP's) described in this publication are agronomically, economically, and environmentally sound. They are voluntary. If these practices are followed, agriculture can be more profitable without the threat of regulation.

Related Publications

08560 (revised, 2008) - Best Management Practices for Nitrogen Use in Minnesota

08557 (revised, 2008) - Best Management Practices for Nitrogen Use in Southeastern Minnesota

08558 (revised, 2008) - Best Management Practices for Nitrogen Use in Southwestern and West-Central Minnesota

08555 (revised, 2008) - Best Management Practices for Nitrogen Use in Northwestern Minnesota

08556 (Revised, 2008) - Best Management Practices for Nitrogen Use on Coarse Textured Soils

AG-FO-5880 - Fertilizing Cropland with Dairy Manure

AG-FO-5879 - Fertilizing Cropland with Swine Manure

AG-FO-5881 - Fertilizing Cropland with Poultry Manure

AG-FO-5882 - Fertilizing Cropland with Beef Manure

AG-FO-3790 - Fertilizing Corn in Minnesota

AG-FO-3770 - Understanding Nitrogen in Soils

AG-FO-3774 - Nitrification inhibitors and Use in Minnesota

AG-FO-2274 - Using the Soil Nitrate Test for Corn in Minnesota

AG-FO-2392 - Managing Nitrogen for Corn Production on Irrigated Sandy Soils

AG-FO-0636 - Fertilizer Urea

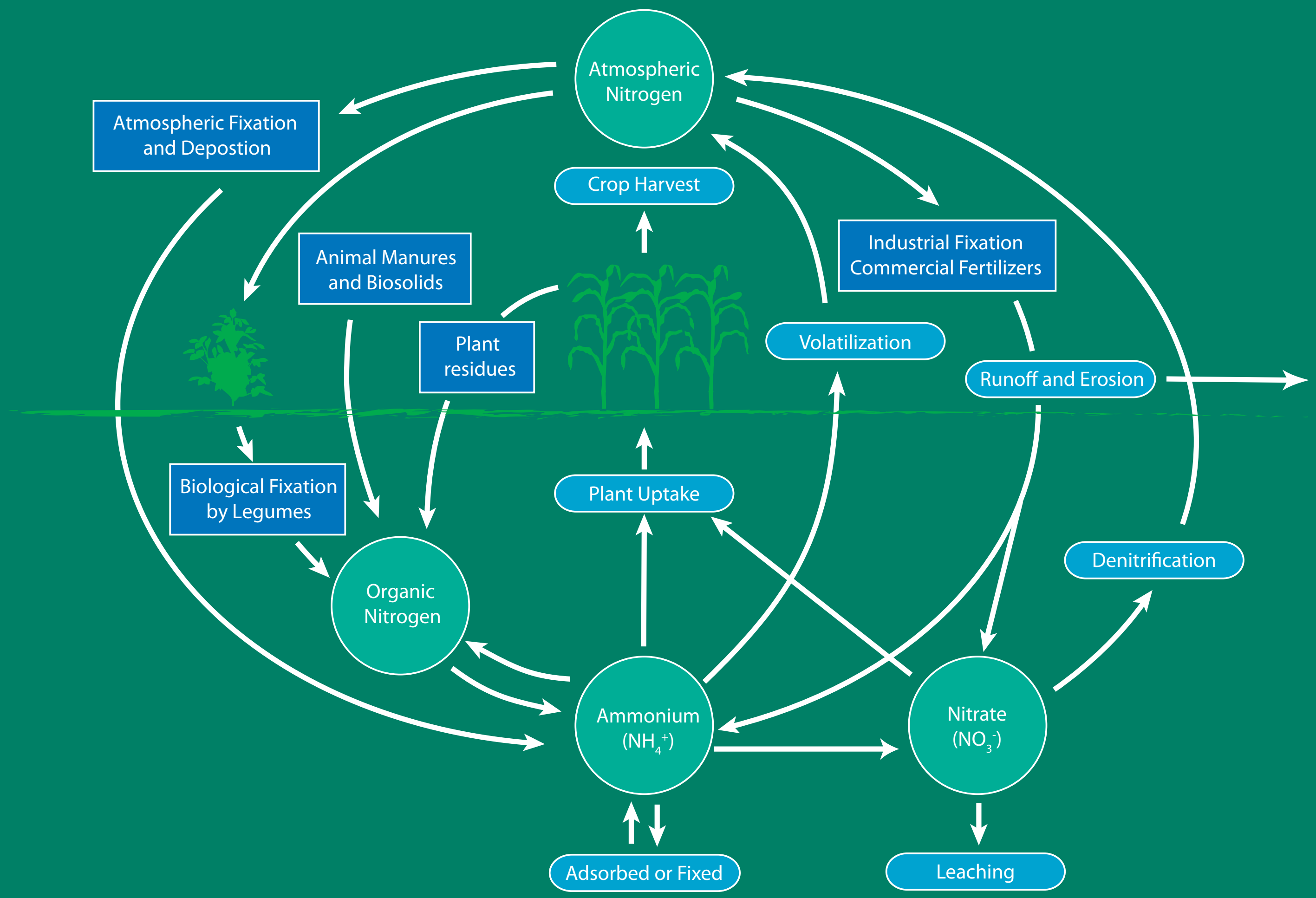
AG-FO-3073 - Using Anhydrous Ammonia in Minnesota

AG-FO-6074 - Fertilizer Management for Corn Planted in Ridge-till or No-till Systems

AG-FO-3553 - Manure Management in Minnesota

BU-07936 - Validating N Rates for Corn

Iowa State Univ. PM 2015 - Concepts and Rationale for Regional Nitrogen Rate Guidelines for Corn



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