POTENTIAL FOR N CARRYOVER FROM 2003 TO 2004

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Introduction

Nitrate can carry over in many medium and fine textured Wisconsin soils especially when growing season rainfall is below normal and yields are lowered by moisture stress. Most areas of Wisconsin received below normal precipitation during the 2003 growing season, and nitrate carryover could be an important factor affecting nitrogen needs in 2004. Taking carryover nitrate into consideration may be particularly beneficial this year due to the expected higher N fertilizer prices.

Research in Wisconsin indicates that nitrate carryover can be frequent on medium and fine textured soils (Vanotti and Bundy, 1994). Testing soils for residual or carryover nitrate has been examined in the northern Midwest, and procedures for adjusting N rate recommendations for corn have been developed in Minnesota and Wisconsin (Bundy et al., 1992; Schmitt and Randall, 1994; Bundy and Andraski, 1995). Wisconsin recommendations for soil sampling and testing for nitrate carryover are shown in University of Wisconsin extension publications A3512 (Bundy et al., 1995) and A3624 (Bundy and Sturgul, 1994). In brief, the procedure involves sampling soils to a depth of 2 ft in 1-ft depth increments in early spring before corn planting and analyzing these samples for nitrate-N. Nitrate-N in the 2-3 ft depth increment is predicted from the nitrate content of the 1-2 ft depth increment using a model (Ehrhardt and Bundy, 1995). The 0-3 ft nitrate-N content is used to adjust corn nitrogen recommendations for as described in A3624 (Bundy and Sturgul, 1994).

Results and Discussion

A predictive model for estimating the amount of nitrate carryover based on climate, soil, and N management information has been developed (Bundy et al., 1993). Initially, nitrogen carryover potential was predicted from the N rate applied to corn the previous year, soil moisture status during August of the previous year, and the amount of water percolation through the soil profile overwinter (October-April). Soil moisture status and overwinter percolation were calculated using the GLEAMS model. Currently, August soil moisture status and overwinter percolation are derived from PALMS model simulations. Estimates of 2004 nitrate carryover for selected Wisconsin soils and locations are summarized in Table 1 and shown on the following web site (http://www.soils.wisc.edu/wimnext/nitrogen/nitro_counties.html).

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Table 1. Estimated nitrate-N carryover (0-3 ft) in several Wisconsin counties and soils, December 2003.

County	Soil	2003 N rate (lb N/acre) 100	150	200
		------ N carryover, lb N/acre ------		
Barron	Santiago	85	159	233
Dodge	Plano	62	62	62
Columbia	Plano	62	112	187
Fond du Lac	Kewaunee	120	195	269
Grant 1 [1/]	Fayette	81	155	229
Grant 2	Fayette	62	105	180
Winnebago	Kewaunee	62	66	141
Waukesha	Plano	128	202	277
Calumet	Kewaunee	71	145	219
Wood	Withee	181	255	329
Portage	Plano	62	112	186
Iowa	Rozetta	166	241	315

[1/] Grant 1 and Grant 2 differed in rainfall amounts

Results in Table 1 suggest that nitrogen carryover potential varies substantially among the locations evaluated, largely due to differences in the amounts of precipitation received. Values in Table 1 should be used as guidance in determining where preplant soil sampling for carryover nitrate is likely to be beneficial. The results are not a reliable substitute for nitrate carryover measurements on preplant soil samples collected this spring. Preplant sampling is needed to account for site-to-site variation and for possible overwinter nitrate losses.

Another indicator of potential nitrate carryover can be obtained from soil nitrate-N measurements performed at the end of the 2003 growing season. Information on end-of-season soil nitrate-N contents is available from two sources. One of these is from two N rate response experiments conducted as part of the Wisconsin Integrated Cropping Systems Trial (WICST) at the Arlington Agricultural Research Station in 2003. In these experiments, corn was grown following either corn or soybean in 2003 with N fertilizer applied at seven rates ranging from 0 to 210 lb N/acre. Residual or carryover nitrate-N in the 0-3 ft soil depth after corn grain harvest in October was measured (Table 2). Corn grain yields obtained with the various N rates are shown in Table 3. End-of-season residual nitrate-N values in Table 2 were usually lower following soybean than corn. Following corn, appreciable residual nitrate accumulation did not occur until N rates reached at least 120 lb N/acre and generally increased with increasing N rates. Estimates of nitrate-N carryover potential for Columbia County (Table 1) are similar to measured residual nitrate-N values found at the 120 to 210 lb N/acre rates where corn was the previous crop. Although 2003 growing season precipitation was below normal at Arlington, yields were relatively high (Table 3), which probably resulted in typical crop

N removal during the growing season and moderate residual soil nitrate-N contents at the end of the growing season.

Table 2. Effect of previous crop and corn N rate on end-of-season soil nitrate-N levels (0 to 3 ft) following corn, WICST, Arlington, WI, 2003.

Previous crop	N rate 0	60	90	120	150	180	210	Mean †
	soil nitrate-N, lb/acre							
Corn	21	41	55	79	93	166	120	82
Soybean	15	29	37	33	53	87	162	55
Mean ‡	18 c §	35 bc	46 bc	56 bc	73 b	127 a	138 a	

† Previous crop $p>f$ = 0.24.
‡ N rate $p>f$ = <0.01. Previous crop x N rate $p>f$ = 0.36. CV = 69%.
§ N rate mean values followed by the same letter are not significantly different at the 0.05 probability level.

Table 3. Effect of previous crop and corn N rate on corn grain yield, WICST, Arlington, WI, 2003.

Previous crop	N rate 0	60	90	120	150	180	210	Mean †
	yield, bu/acre							
Corn	119	157	156	174	176	182	184	164
Soybean	109	161	187	197	185	197	199	181
Mean ‡	115 c §	159 b	172 ab	184 a	180 ab	190 a	190 a	

† Previous crop $p>f$ = 0.58.
‡ N rate $p>f$ = <0.01. Previous crop x N rate $p>f$ = 0.63. CV = 11%.
§ N rate mean values followed by the same letter are not significantly different at the 0.05 probability level.

A second source of data on end-of season soil nitrate-N contents is available from a fall soil sample collection project coordinated by Tim Jergensen, Barron County

Extension Agent. Results from soil nitrate-N tests done on samples collected from 11 Barron County fields in November 2003 are shown in Table 4. The data show substantial variability in potential nitrate-N carryover among the fields sampled with values ranging from 17 to 221 lb N/acre. Five of the fields had little or no adjustment to N recommendations based on the nitrate tests, four fields had adjustments ranging from 26 to 59 lb N/acre, and two fields had adjustments of more than 80 lb N/acre. Compared with the predicted nitrate-N carryover values shown in Table 1, measurements in most fields were lower than the 85 to 159 lb N/acre predicted values for 100 and 150 lb N/acre application rates in Barron County.

Table 4. End-of season soil nitrate-N contents in 11 Barron County corn fields, November 2003.

Field	Soil name	Nitrate-N (0-3 ft)	Adjustment to recommendation
		------------ lb N/acre	--------------
1	Freeon	17	0
2	Spencer	221	171
3	Scoba	45	0
4	Spencer	76	26
5	Freeon	83	33
6	Freeon	62	12
7	Almena	138	88
8	Spencer	90	40
9	Almena	63	13
10	Anigon	109	59
11	Almena	36	0

Summary and Conclusions

Predicted nitrate-N carryover values for various Wisconsin soils and locations indicate a high probability for significant adjustments to 2004 N recommendations for corn at many locations. The predicted values can be used to guide decisions on where preplant nitrate testing may be useful, but should not be considered as a substitute for preplant soil nitrate-N sampling and testing. End-of season soil samples collected at Arlington showed moderate amounts of carryover nitrate-N that were similar to nitrate-N carryover levels estimated with a predictive model. Residual nitrate-N contents in end-of-season samples collected in Barron County varied substantially among fields. Approximately half of the fields tested had residual nitrate-N contents large enough to justify preplant testing. Model predictions and end-of-season soil nitrate-N measurements indicate potential for nitrate-N carryover to the 2004 growing season. Preplant soil nitrate testing is needed to quantify nitrogen carryover at specific sites and to account for possible overwinter nitrate losses.

References

Bundy, L.G., M.A. Schmitt, and G.W. Randall. 1992. Predicting N fertilizer needs for corn in humid regions: Advances in the Upper Midwest. p. 73-89. In B.R. Bock and K.R. Kelley (ed.). Bull. Y-226. Predicting N fertilizer needs for corn in humid regions. Tennessee Valley Authority, Muscle Shoals, AL.

Bundy, L.G., M.B. Vanotti, T.W. Andraski, and P.C. Widen. 1993. Predicting 1993 nitrate carryover in Wisconsin. Proc. Wis. Fert., Aglime, Pest Mgmt. Conf. 32:213-222.

Bundy, L.G., and S.J. Sturgul. 1994. Soil nitrate tests for Wisconsin cropping systems. UWEX Bull. A3624. 24 p.

Bundy, L.G., S.J. Sturgul, and R.W. Schmidt. 1995. Wisconsin's preplant soil profile nitrate test. UWEX Bull. A3512. 2 p.

Bundy, L.G. and T.W. Andraski. 1995. Soil yield potential effects on performance of soil nitrate tests. J. Prod. Agric. 8:561-568.

Ehrhardt, P.D., and L.G. Bundy. 1995. Predicting nitrate- nitrogen in the two- to three-foot depth from nitrate measurements on shallower samples. J. Prod. Agric. 8:429-432.

Schmitt, M.A., and G. W. Randall. 1994. Developing a soil nitrogen test for improved recommendations for corn. J. Prod. Agric. 7:328-334.

Vanotti, M.B., and L.G. Bundy. 1994. Frequency of N fertilizer carryover in the Humid Midwest. Agron. J. 86:881-886.