NITROGEN FERTILIZER REQUIREMENTS FOR NO-TILL CORN

Gary Kachanoski[1]

Conservation tillage is associated with higher surface crop residue levels, larger more stable soil aggregates, and generally higher surface soil water contents compared to conventional tillage. The changes in residue management and overall soil water regime under conservation tillage may result in different spatial distributions (laterally and with depth) of nutrients. In general, nitrogen fertilizer applied as broadcast urea is not recommended for no-till systems because of the possibility of ammonia volatilization losses, and tie up of N in plant residue on the soil surface. Studies have shown that deep placement of urea-ammonium-nitrate solutions (28% N) below the surface residue layer can significantly increase N-fertilizer use efficiency under no-till systems. However, the importance of this will vary depending on soil and climatic conditions, and has not been studied in Ontario.

The objectives of this study were to determine if optimum N fertility requirements for no-till systems in Ontario are different than recommended rates for conventional tillage systems.

Materials and Methods

Field scale, on-farm research trials were conducted in the 1986 and 1987 growing season in cooperation with farm operators. The research was carried out as part of the Tillage-2000 project. Tillage-2000 is a long term, on farm, field scale research and extension project being carried out by the Ontario Ministry of Agriculture and Food (OMAF) in cooperation with the Dept. of Land Resource Science, University of Guelph. The project began in 1985 with 23 farm cooperators and in 1987 had 43 farm cooperators. The project establishes conservation tillage sites on a number of soil and climate conditions in Ontario, which are being used for a number of research projects including this N fertility study.

Nitrogen was applied at six rates as liquid 28% N on both conventional and No-till planted corn. Rates of N fertilizer were 0, 50, 80, 120, 150, and 200 kg N. The fertilizer was applied in a band 5 cm below the surface, in the interrow position.

The response of grain corn yield (15.5% wt) to added fertilizer N was described by fitting a second order polynomial equation to the data,

[1]Assistant Professor, Department Land Resource Science, University of Guelph, Guelph, Ontario Canada N1G 2W1

Table 1. Check yields (zero N applied) for the conventional and no-tillage field plots.

Field Texture/Year	Corn Grain Yield (Bu/Ac)		
	Conv. Tillage	No Tillage	Difference
Sand/86	102.7	94.1	8.6
Sand/87	122.1	93.4	28.7
Sand/87	81.1	96.4	-15.3
Loam/86	117.9	113.4	4.5
Loam/87	124.3	109.5	14.8
Si-loam/86	137.9	146.1	-8.2
Si-loam/87	155.4	150.0	5.4
Clay/86	39.8	29.1	10.7
Clay/87	65.4	49.8	15.6
Average	105.2	98.0	7.2

Table 2. Maximum fertilizer N use efficiency (lb grain corn/lb N).

Field Texture/Year	Efficiency		
	Conv. Tillage	No Tillage	Difference
Sand/86	44.0	54.0	-10.0
Sand/87	41.0	56.0	-15.0
Sand/87	40.0	28.0	12.0
Loam/86	2.0	9.0	-7.0
Loam/87	23.0	42.0	-19.0
Si-loam/86	12.0	29.0	-17.0
Si-loam/87	5.0	9.0	-4.0
Clay/86	12.0	29.0	-17.0
Clay/87	20.0	40.0	-20.0
Average	22.0	33.0	-11.0

Table 3. Maximum economic YIELD (Bu grain corn/Ac).

Field Texture/Year	Economic Yield		
	Conv. Tillage	No Tillage	Difference
Sand/86	154.5	155.9	-1.4
Sand/87	183.9	177.1	6.8
Sand/87	129.8	139.5	-9.7
Loam/86	126.8	126.4	0.4
Loam/87	161.3	154.3	7.0
Si-loam/86	157.1	157.1	0.0
Si-loam/87	162.5	169.6	-7.2
Clay/86	61.8	78.6	-16.8
Clay/87	120.5	114.3	6.2
Average	139.8	141.4	-1.6

Table 4. Maximum economic N fertilizer rate (lb N/Ac).

Field Texture/Year	N Fertilizer Rate		
	Conv. Tillage	No Tillage	Difference
Sand/86	127	125	2.0
Sand/87	164	161	3.0
Sand/87	130	160	-30.0
Loam/86	120	120	0.0
Loam/87	190	130	60.0
Si-loam/86	200	180	-20.0
Si-loam/87	110	200	-90.0
Clay/86	140	140	0.0
Clay/87	200	180	20.0
Average	153.0	155.0	-2.0

$$Y = A + B N_A + C N_A^2 \qquad (1)$$

where Y = grain corn yield, N_A = fertilizer N applied, and A, B, C, are regression coefficients. The rate of yield increase can be found from the first derivative of equation (1) with respect to N_A. The coefficient B is the rate of yield increase for the first pound of fertilizer N added and is an index of the maximum fertilizer use efficiency. The most economic rate of N and the most economic yield can be obtained by setting the first derivative of equation (1) equal to the price ratio of the value of corn and the cost of fertilizer N.

Results and Discussion

A summary of the check yields (zero nitrogen fertilizer applied), maximum N-use efficiency, maximum economic yields, and maximum economic rate of N fertilizer applied are given in Tables 1,Table 2, Table 3, and Table 4, respectively. The results indicate that the check yields (zero N fertilizer) under no tillage are lower (approx. 7 bu/Ac) than conventional tillage systems (Table 7). However, a greater response of corn yield to applied nitrogen fertilizer occurs under No-tillage (Table 8) as indicated by a higher maximum fertilizer use efficiency in No-till. Thus the final maximum economic yields and maximum economic N rate are not significantly different (Tables 3 and 4).

The data indicates that the N response curves are significantly different but only at lower nitrogen rates than the optimum rate, when N is knifed in as a 28% solution. The results also suggest that field trials which do not have optimum rates of N fertilizer will bias the yield comparison in favour of the conventional tillage system because yield decreases will be higher in the no-till compared to conventional tillage system.

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Department of Soil Science
University of Wisconsin-Madison

and

Potash and Phosphate Institute
2805 Claflin Road
Suite 200
Manhattan, Kansas