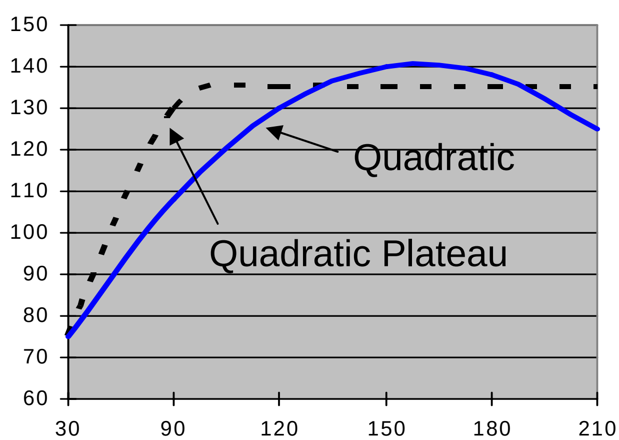
Assessing Nitrogen Requirements in Corn Using the Quadratic Plateau Model

Purpose:

To develop a method that will allow a farmer to assess the profitability of the current rate of nitrogen (N) application on a field and the potential for adopting variable N application. The Quadratic Plateau model of statistical analysis will be compared to the standard Quadratic statistical model for predicting the maximum economic rate of nitrogen (MERN) for a field. Applying the correct amount of nitrogen to a corn crop will maximize the economic return and reduce the amount of nitrogen left after the crop is harvested leaving less to be lost to the environment.

Methods:

The project was conducted on a field scale basis in corn fields with various cooperators. A representative area in the field was chosen for the treatments. Field length strips consisting of several nitrogen rates with full rate treatments located between other rates (in most cases) were established. The treatments consisted of several rates of nitrogen, with 3-4 nitrogen rates below the field's full or normal rate of nitrogen, and one rate above. If the full rate was 135 kg N/ha (120 lbs N/ac) or less, or if equipment settings were limiting, fewer rates were used. The check strips (zero nitrogen strip) were to have up to 34 kg N/ha (30 lbs N/ac) applied as a starter and no sidedress N.



Several thirty centimeter (1') soil nitrate samples were taken from the plots in June. The plots were monitored throughout the season to identify any potential problems that might affect yield. The plots were harvested and weigh wagon weights for each strip were recorded. The yield data was analyzed using the quadratic and quadratic plateau statistical models.

Results:

The St. Clair District Soil and Crop Improvement Association ran the nitrogen project for five years from 2000 to 2004. A total of 44 plots were conducted. The weather had its usual affect on the plots resulting in some data not being useable. There were ~ 25 plots where the MERN could be calculated. The MERN was within 16 kg N/ha (14 lbs N/ac) of the cooperator's normal rate of nitrogen on five of the 25 plots. For ten of the 25 plots the cooperator had the opportunity to reduce nitrogen rates by 34 to 73 kg N/ha (30 to 65 lbs.) of nitrogen without reducing income on the field (refer to Table 1). Four of the remaining 10 cooperators had the potential to reduce the nitrogen rate on their fields by 78 to 95 kg N/ha (70 to 85 lbs). The remaining six cooperators had manure and/or red clover in the rotation and were able to reduce nitrogen rates 78 to 200 kg N/ha) (70 to 180 lbs/ac) from their normal rate of nitrogen (refer to Table 2). In two cases the manure was able to supply the entire nitrogen requirement for the crop.

Table 1. Fields Where N Rates Could Be Reduced 34-73 Kg/Ha (30-65 Lbs/Ac) – No Manure

Location, year	Normal Nitrogen Rate kg N/ha (lbs. N/ac)	Maximum Economic Rate of Nitrogen kg N/ha (lbs. N/ac)	Potential Nitrogen Reduction kg N/ha (lbs. N/ac)
Lambton O, 2004	170 (150)	135 (120)	34 (30)
Essex H, 2002	170 (150)	135 (118)	36 (32)
Lambton B, 2002	140 (125)	100 (90)	39 (35)
Kent A, 2003	175 (156)	135 (118)	43 (38)
Kent S, 2002	170 (150)	125 (110)	45 (40)
Kent A, 2004	175 (155)	130 (115)	45 (40)
Lambton A, 2001	170 (150)	110 (97)	60 (53)
Kent A, 2002	145 (130)	85 (75)	62 (55)
Lambton B, 2004	165 (147)	100 (90)	64 (57)
Lambton A, 2000	160 (140)	85 (76)	72 (64)

Table 2. Potential N Rate Reductions of 78-200 Kg/Ha (70-180 Lbs. N/Ac) – Manure/Red Clover*

Location, year	Normal Nitrogen Rate kg N/ha (lbs. N/ac)	Maximum Economic Rate of Nitrogen kg N/ha (lbs. N/ac)	Potential Nitrogen Reduction kg N/ha (lbs. N/ac)
Kent E, 2003	80 (70)	0 (0)	80 (70)
Lambton W, 2004	175 (154)	95 (84)	80 (70)
Essex D, 2003	220 (196)	125 (112)	94 (84)
Lambton O, 2003	180 (160)	75 (65)	107 (95)
Lambton W, 2003	165 (145)	0 (0)	165 (145)
Essex D, 2003	200 (180)	0 (0)	200 (180)

*sites where manure applied the fall before or has been applied to the field in the past, some were following red clover.

All growers apply an adequate rate of nitrogen to their field (except for the occasional mistake). In most cases there is some insurance built into the rate. With many growers, especially those who practice good soil management and have a good crop rotation, there is an opportunity to reduce nitrogen rates without having a significant impact on yield.

Table 3. A comparison of N recommendations.

Location, year	Normal Nitrogen Rate kg N/ha (lbs. N/ac)	Max. Econ. Rate of N kg N/ha (lbs. N/ac)	Pre Sidedress N Test (lbs. N/ac)	Ontario N Calculator (lbs. N/ac)
Lambton O, 2004	170 (150)	135 (120)	120 (105)	135 (120)
Kent A, 2003	175 (156)	135 (118)	3 (3)	190 (170)
Lambton B, 2004	165 (147)	100 (90)	100 (90)	135 (120)
Lambton A, 2000	160 (140)	85 (76)	140 (125)	145 (130)
Kent E, 2003	80 (70)	0 (0)	39 (35)	90 (80)
Lambton O, 2003	145 (130)	0 (0)	67 (60)	145 (130)

Summary:

The weather had an impact on the results of this project, particularly in 2001 and 2002 when much of the area received little rainfall. This method of determining the nitrogen rate for a field appears to be a good one. Yield monitor data was not collected so it is difficult to determine if there are opportunities for variable N application.

Five of the cooperators identified the potential to reduce their nitrogen rate. Several could reduce rates by 22-34 kg N/ha (20-30 lbs N /ac) while some had potential reductions of 78-90 kg N/ha (70-80 lbs N/ac). Some of these cooperators made adjustments to their N rates based on the results of this project. One cooperator who had cattle manure and red clover in a good crop rotation consistently did not get a response to sidedress nitrogen. They apply ~67-78 kg /ha (60-70 lbs) of N on corn which seems reasonable as this would compensate for uneven manure application or areas of reduced stands of red clover. Others were able to confirm that the rate they were using was correct for the field. Site Essex H had the plot in the same area for two years. The first year showed an over application of ~34 kg/ha (30 lbs.), the second year the lower rate was again the maximum economic rate of nitrogen.

The Essex D 2003 plot had 22 T/ha (10 tons/ac) of turkey manure applied the previous fall so no response to nitrogen would be expected. The Lambton W plot has had regular applications of hog manure so no response would be expected there. Both cooperators could reduce their nitrogen rates significantly.

The soil nitrate test was taken every year on the plots. Samples were taken along various treatments and the slope position of sampling was noted. Some of the plots were sampled later than the ideal time period for the pre-sidedress nitrogen test. There were 10 plots where the PSNT could be related to a yield determined nitrogen recommendation. In only three of the sites did the PSNT come close to recommending the correct amount of nitrogen. In four sites, it under recommended N requirements by 28 to 112 kg N/ha (25-to100 lbs N/ac) and in three it over recommended by 34 to 84 kg N/ha (30 to 75 lbs N/ac). There tended to be a wider range of soil nitrate levels at the sites where the PSNT over or under recommended nitrogen. There was not a consistent trend in nitrate levels between the slope positions. This could possibly be due to the fact that the samples were taken along nitrogen rate strips and may not represent the lowest or highest point in the topography.

The quadratic plateau model was a good method for calculating the maximum economic rate of nitrogen. It seemed to fit the response curve better and tended to give a lower nitrogen recommendation than the quadratic model.

Next Steps:

The project completed its fifth and final year in 2004. The data from the project was included in the larger nitrogen database that Greg Stewart, OMAFRA and Ken Janovicek, University of Guelph.

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