On-Farm Development of A Growing Degree Day Based Management Schedule to Enhance Grass Seed Production and Reduce Potential Environmental Losses of Nitrogen

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BACKGROUND

In 1996 a three year study was set up to investigate the effects of a growing degree day (GDD) based management schedule to enhance seed production and reduce potential environmental losses of nitrogen (N). During the first year of the study we looked at fertilizer N rate and timing effects and their effect on yield of perennial ryegrass (PRG) (Griffith and Thomson 1997). In the second year we again looked at N rate of PRG and added tissue N evaluations with a Minolta SPAD-502 chlorophyll meter(Griffith, Thomson, and Owen 1998).

A third years work was performed to clarify some data and to test additional hypotheses in a field scale setting. In 1996, PRG exhibited linear uptake of N, however the data was confounded by the grower applying 40 lbN/A prior to the initiation of the trial. This years work sought to clarify that 1996 data albeit at another site. At the original site, a third year of data was collected. At another field, the grower agreed to split a field and manage the N on that field to test the hypothesis of reduced N management. Harvest on those plots was obtained with a combine mounted yield monitor and GPS unit.

PROJECT GOALS AND OBJECTIVES

1. Repeat trial on first-year PRG field to determine if the linear N uptake rates noticed in 1996 were characteristic of the crop or due to the large amount of precipitation received in that year.

2. Repeat trial on original site to gain additional data for a third year.

3. Undertake field scale trial on third year PRG site to determine efficacy of reduced N management regime if sustaining yields.

PROCEDURES

<u>Small Plot Trials</u>

On-farm plots were established in what is now a third year perennial ryegrass (PRG) cv ‘Boardwalk’ seed field and another in a new fall-planted field of PRG cv ‘Atlantis’. Plots were located to the west from the area used in the 1996 and 1997 study. N treatments consisted of spring applied fertilizer N in the form of urea-ammonium sulfate (38-0-0-6) at rates of 0, 50, 100, 150, 200 lb N/ac. Results were compared to the grower standard practice (GSP) of 180 lbN/A. For a complete description of all methods, site description and experimental design, see Griffith and Thomson 1997 and 1998. Fertilizer were applied to each plot at approximately 555 GDD (03-20-98). Samples were collected from plots on 673 (04-02), 1112 (05-11), 1354 (06-01), and

1923 (07-06) GDD. The crop was at 3-leaf/ 4 th half-emerged on 673 GDD, full flag to early head on 1112 GDD, full anthesis on 1354 GDD, and seed harvested on 1923 GDD.

Leaf chlorophyll levels were monitored at each of the above evaluation periods with a SPAD-502 Chlorophyll Meter (Minolta Camera Co.). The use of this device allows portable real-time non-destructive sampling of plant tissue in the field. At each evaluation, chlorophyll data obtained from a mid-leaf position of 30 leaf samples per plot were obtained and averaged for a plot value. The sampled leaves were dried, ground and analyzed for Total Kjeldahl Nitrogen (TKN).

Large Plot Trial

Large plots of approximately 2 acres each were established at one end of a growers field and fertilizer was applied by the grower as shown below. All values shown are in pounds of N per acre.

	Date of Application				Total N
Plot	03-06-98	03-31-98	04-18-98	05-07-98	Applied
A	43	49	46	0	138
B	43	0	0	90	133
C	43	49	93	0	185

The plots were evaluated on 04-29-98, 05-18-98, and 06-03-98 at random spots within each treated area. All aboveground biomass was removed from 12 inches of row, bagged , dried, and weighed and TKN values obtained for each sample. At the same location, a SPAD chlorophyll meter was used to obtain chlorophyll readings and subsamples were sent to the lab for N analysis. The plots were harvested and yield data obtained with a combine mounted yield monitor as a weigh wagon was not available at the time, however analysis of the data revealed no usable values for this trial. No small plots were hand harvested in this trial. Data obtained is shown in Table 3.

RESULTS

It appears that reduced N management has a fit in perennial ryegrass seed production. As shown in Table 1, higher rates of spring applied N do not always result in higher seed yield. For the third year, moderate rates of N (100-150 lbN/A) have returned yields which are statistically similar to yields associated with higher N rates (> 150 lbN/A). An economic analysis of the results for this year (Table 2) reaffirms the results from an economic perspective. The greatly reduced yields for the third year “Boardwalk” is most likely due to the severe vole problem this season. Due to the size of the plots, any vole damage has a proportionately greater impact on yield than in the field at large. The greater amount of cover afforded the voles in the higher N rate plots again affirms the value of reduced N management.

From Table 1, it is apparent that the “optimum” amount of spring N varies from year to year. The most plausible explanation for this drift in optimum spring N values is that microbially mineralized N is more available in some years than others. In years favoring microbial activity over the winter, there may be enough mineralized N to supply the needs of the crop. On the other hand in cooler winters the opposite may be true. Unfortunately, due to our lack of ability to accurately predict the future course of climate, we need to have a certain amount of safety margin built in to spring fertilizer applications to optimize crop growth and seed yield. From the 3 years of research funded by this grant and data available from other researchers, it appears that 120-140 lbN/A total N in the spring is adequate. For those more adventuresome souls, they might apply 50-80 lbN/A after a warmer winter, such as 1997-98. On the other hand, in cooler wetter years such as we are experiencing this year, they might apply higher rates of N.

In any event, the tracking of GDD and attempting to apply spring fertilizer N at a plant appropriate time based on GDD knowledge allows the grower another choice for N management.

Although no quantifiable yield data was obtained from the large plot trial, evaluation data obtained through SPAD chlorophyll meter and tissue samples is shown in Table 3. It appears that on the final evaluation on 06-03-98 the low N treatment (B) which had a two split treatments quite far apart, had tissue N values comparable to the high N treatment (C). The low N treatment with 3 split applications (A) had the lowest tissue N values at that time. As no yield data is available, no inferences can be made about the treatments. Visual inspection of the yield map shows the A treatment to have the lowest yield and treatments B and C to be about equal in yield.

FUTURE RESEARCH

Further research to be conducted this year will be looking at a reduced N management program consisting of the following "steps" based on information from this and other research in large scale field trials. This research will continue the concept of reduced N management and add variable rate application into the picture.

A. Full Program (assuming that variable rate (VR) application of dry blends makes agronomic sense)
1.Use either a SPAD chlorophyll meter or lab tissue testing or combination of both to determine the N-status of a field at GDD 300-400. Employ GPS to locate the point of sampling and produce a GIS contour map of tissue-N status.
2. VR apply the blend to the field based on target files from the GIS program.
3. Evaluate the efficacy of the application at GDD 900-1100 with a SPAD meter and lab tests.
4. Based on the SPAD values, foliar N applications can be applied with the phenoxy or fungicide treatments to bring up the tissue N values.
5. Compare yield at harvest to grower standard practice.

B. Full Program (assumes that VR of dry blends does NOT make agro-sense)
1. Apply full spring N load at GDD 400-800 (about 120 lbN/A).
2. SPAD evaluate the efficacy of the application at GDD 900-1100.
3. Based on the SPAD values, foliar N applications can be applied with the phenoxy or fungicide treatments to bring up the tissue N values.

Table 1. Values represent means of perennial ryegrass aboveground biomass, fertile tiller number, and seed yield as a function of N fertilizer rate for the third seed year at the original site and for the first seed year at the new site. Data were collected on 07-06-98.

Nitrogen Fertilizer Rate	Shoot Biomass	Fertile Tiller	Seed Yield
(lbN/A)	(ton/A)	(#/m^2)	(lb/A)
PRG cv 'Boardwalk'			
1996 - First Crop Year			
0	-----	1163 a	761 a
80	-----	1375 a	914 ab
120	-----	1077 a	1033 bc
160	-----	1240 a	1199 c
1997 - Second Crop Year			
0	3.37 a	1532 a	536 a
50	4.50 ab	1220 a	926 b
100	4.75 ab	1436 a	1165 c
150	4.48 ab	958 a	1204 c
200	5.72 b	1434 a	1222 c
1998 - Third Crop Year			
0	5.91 a	137 a	476 a
50	5.85 a	107 a	563 a
100	5.76 a	138 a	558 a
150	6.59 a	107 a	523 a
180	7.56 a	105 a	458 a
200	5.15 a	90 a	459 a
PRG cv 'Atlantis' (First crop year)			
0	5.08 a	193 a	822 a
50	5.44 a	179 b	1152 c
100	6.74 b	170 b	1212 c
150	8.11 c	174 b	1365 c
180	6.97 b	135 b	1092 b
200	6.53 b	108 c	1146 c

Means followed by the same letter were not significant at P<0.05 by Fishers LSD Multiple Comparison Test.

Table 2. A simplified economic analysis of perennial ryegrass seed production. Application and other costs were not included. This is based on a single N application. Multiple applications would further reduce profits.

Nitrogen Fertilizer Rate	Seed Yield	Seed Values	Cost of Fertilizer N	Gross Profit
(lbN/A)	(lb/A)	($/A)	($/A)	($/A)
PRG cv 'Boardwalk' (Third crop year)				
0	476	261.80	0.00	261.80
50	563	309.65	17.50	286.15
100	558	306.90	35.00	265.90
150	523	287.65	52.50	229.15
180	458	251.90	63.00	182.90
200	459	252.45	70.00	176.45
PRG cv 'Atlantis' (First crop year)				
0	822	452.10	0.00	454.10
50	1152	633.60	17.50	610.10
100	1212	666.60	35.00	625.60
150	1365	750.75	52.50	692.25
180	1092	600.60	63.00	531.60
200	1146	630.30	70.00	554.30

Seed value and fertilizer estimated at $0.55 and $0.35 per pound, respectively. An application cost of $6.00 per acre was deducted from all treatments with the exception of the 0 N rate.

Table 3. Evaluation data for large scale reduced N management plots on each evaluation date. SPAD units are dimensionless.

PLOT	Dry Weight	Mean Tissue N	Mean SPAD Value
	(kg/ha)	(%)	
4/29/98			
A	4032	2.8	49.6
B	3131	1.6	37.8
C	3461	3.1	52.2
5/18/98			
A	7465	2.4	51.9
B	4949	2.6	52.6
C	5789	2.3	55.5
6/3/98			
A	6777	1.8	43.4
B	7132	1.8	55.2
C	8711	1.6	48.2