MAKING REMOTE SENSING WORK FOR APPLYING NITROGEN ON WHEAT

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OBJECTIVE

The objective of this experiment is to: 1) Adapt variable rate nitrogen (VRN) technology (Greenseeker) to Kentucky conditions and 2) Fine tune nitrogen recommendations under today's production practices and varieties for the most economical nitrogen rate on well drained and marginally drained soils.

Variable Rate Nitrogen (VRN) Technology

The Greenseeker is a real-time, on-the-go sensor/applicator that senses the health of the wheat crop at the time nitrogen is applied and then simultaneously adds the precise amount of nitrogen that is determined to be needed by the machine. The sensing and application technology part of the machine has been very accurate and reliable. The weak part of the process has been the algorithm (formula) that is placed in the software of the machine to tell it how much nitrogen to add based on the plant health Normalized Difference Vegetative Index (NDVI) readings.

Research at Oklahoma State University and Virginia Polytechnic Institute and State University showed favorable results by increasing or maintaining wheat yields while reducing nitrogen application rates. Both places had different algorithms. Using these two algorithms and adding another that was quite different, the results in Kentucky were not as favorable. Using this technology with existing software is not feasible in Kentucky.

METHODS

Basic research was begun to gain the information needed to develop an algorithm for Kentucky. Small plots using different nitrogen rates applied at different times on different soils was used in the process.

RESULTS

The results for the four years of research are beginning to show some consistency. The first year there was an Easter freeze which caused severe damage to the plants and the results of that year may be atypical of that found most years. The second year was more normal and the curves look much better. The third year, the results (N recommendations from the NDVI Readings) look acceptable for the Feekes 6, but questionable for the Feekes 5 readings. This year the data on the Pembroke soil data looked good. The Zanesville site was abandoned due to poor stand from excessive wetness after planting.

Variable Rate Nitrogen (VRN)

The information gathered from the NDVI readings, and the nitrogen needed for optimum yields are shown in table 1. The relationships with yield (figure 1) show a nice nitrogen response.

The different nitrogen rates explained 90% of the yield differences at Feekes 6. It appears that the technology will be more accurate on the well drained soils and at Feekes 6 growth stage. The fewer outside factors that affect growth (severe weather, drainage, diseases, etc.), the more accurate the readings will be when used for VRN. The height of the curve (difference between highest and lowest NDVI) is excellent this year on the well-drained Pembroke soil. This gives support that the technology may be better used on well drained soils. The extended cool early spring retarded the beginning of the spring growth period. However, it did not seem to affect the NDVI reading at Feekes 5 or 6.

Nitrogen Rates And Yield

It appears that a 150 lbs/ac of N was the rate needed for maximum yields this year. The data is seen in Figure 1. This is higher than that usually required. It is felt this extra nitrogen was required this year due to some nitrogen loss with the excessive rains as well as the extended cool spring that delayed growth and reduced N mineralization. The yields were very good. The excellent weather conditions in May were probably the main factor in the outstanding yields.

Pembroke Soil Four-Year Summary

Tables 2 and 3 show a summary of the four years of information retrieved from the research on the Pembroke soil for growth stages Feekes 6 and 5. The most reliable data is at Feekes 6. The data in 2007 is suspect because of the severe Easter freeze that year. Therefore, only the other three years are used. The yields were very good in 2009 and 2010 and the algorithms are very similar. The 2008 year had good yields and the algorithm was a little different, mainly in the amount of March N needed for maximum yields. The average of the three years is very similar to the average of 2009 and 2010. Either algorithm would probably be a good one.

The Feekes 5 data is less variable and less consistent. Only 2008 and 2010 would give reliable data and the average of those 2 years are shown. The average algorithm from these 2 years is fairly similar to the 3 year Feekes 6 average.

TABLE 1. GREENSEEKER/N WHEAT DATA AND ALGORITHMS 2009-2010							
Feb. N	NDVI		NDVI Difference		March N needed	NDVI Algorithm	
Lb/ac	F5*	F6*	F5*	F6*	Lb/ac	F5*	F6*
PEMBROKE SOIL							
0	0.447	0.472	0.353	0.375	150	≥0.24	≥0.27
30	0.639	0.677	0.161	0.170	120	0.11 - 0.24	0.115 - 0.27
60	0.700	0.782	0.101	0.065	90	0.055 - 0.11	0.045 - 0.115
90	0.769	0.823	0.031	0.025	60	0.030 - 0.055	0.022 - 0.045
120	0.780	0.829	0.020	0.019	30	0.010 - 0.030	0.010 - 0.022
150	0.800	0.847	0	0	0	<0.010	<0.010
*Feekes Growth Stages							
ZANESVILLE SOIL							
No data was gathered due to poor stands caused by excessive wetness in the fall.							

TABLE 2. NDVI ALGORITHMS FOR GREENSEEKER OVER THE LAST FOUR YEARS							
PEMBROKE FEEKES 6							
2007		2008		2009		2010	
Mar. N Needed Lb/ac	NDVI Algorithm	Mar. N Needed Lb/ac	NDVI Algorithm	Mar. N Needed Lb/ac	NDVI Algorithm	Mar. N Needed Lb/ac	NDVI Algorithm
120	≥0.25	120	>0.20	150	>0.26	150	>0.27
90	0.18-0.25	100	0.11-0.20	120	0.115-0.26	120	0.115-0.27
60	0.10-0.17	70	0.05-0.11	90	0.035-0.115	90	0.045-0.115
30	0.04-0.09	40	0.03-0.05	60	0.015-0.035	60	0.022-0.045
0	≥0.04	20	0.01-0.03	30	0.005-0.015	30	0.10-0.022
0		0	>0.01	0	>0.005	0	>0.01

Avg. 2009-2010	Avg. 2008-09-10
150 = >0.26	140 = >0.24
120 = 0.115-0.26	110 = 0.11-0.24
90 = 0.04-0.115	85 = 0.043-0.11
60 = 0.02-0.04	55 = 0.022-0.043
30 = 0.010-0.02	25 = 0.008-0.022
0 = <0.01	0 = <0.008

TABLE 3. NDVI ALGORITHMS FOR GREENSEEKER OVER THE LAST FOUR YEARS							
PEMBROKE FEEKES 5							
2007		2008		2009		2010	
Mar. N Needed Lb/ac	NDVI Algorithm	Mar. N Needed Lb/ac	NDVI Algorithm	Mar. N Needed Lb/ac	NDVI Algorithm	Mar. N Needed Lb/ac	NDVI Algorithm
120	>0.13	120	>0.21	Unreliable Data		150	>0.24
90	0.06-0.13	100	0.13-0.21			120	0.11-0.24
60	0.02-0.06	70	0.06-0.13			90	0.055-0.11
30	>0.02	40	0.03-0.06			60	0.03-0.055
0		20	0.01-0.03			30	0.01-0.03
0		0	<0.01			0	<0.01

Avg. 2008 and 2010	
Mar. N Needed Lb/ac.	NDVI Algorthm
135	>0.23
110	0.12-0.23
80	0.06-0.12
50	0.03-0.06
25	0.01-0.03
0	<0.01

Figure 1.