EFFECT OF CHLOROPHYLL METER READINGS ON IMPROVING NITROGEN USE EFFICIENCY IN CORN PRODUCTION

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ABSTRACT

Chlorophyll meters have received widespread publicity as tools to measure nitrogen status of corn. Less information is available on whether the use of chlorophyll meters will decrease total nitrogen use or increased corn grain yield. One question that remains is, "How low chlorophyll readings need to go before additional nitrogen is needed?" To determine the impact of a 2 and 4% reduction in chlorophyll readings impact on yield (as measured by a SPAD 502 meter) zero, 50, 100, 150 and 200 lbs N/acre were applied at planting. The 200 lb rate was considered the reference area that had excess nitrogen. Specific plots were fertilized with an additional 30 lbs N whenever they read below either 2 or 4% of the reference area. Use of the chlorometer increased yields slightly over all at-planting treatments and increased nitrogen use efficiency when low at-planting N rates were used.

INTRODUCTION

Producers and consultants who want to improve their nitrogen management are excited about the use of chlorophyll meters in their production practices. They want to know how to use the meter to maximum benefit. The University of Nebraska NebGuide, Using a Chlorophyll Meter to Improve N Management, outlines a practical way to use the meter. The procedure compares a reference strip with more than adequate nitrogen to the rest of the field which has had one-half to two-thirds the total fertilizer applied. These recommendations are based on yield response curves and their associated meter readings. Questions remain about how quickly the plants will respond to added N when it is applied. Will the plants recover to the reference strip values or will they remain with lower readings? How long into the season should or can readings be taken and when is it too late to apply more N. What is the best at-planting nitrogen rate to improve efficiency?

The objective of this research was to determine the effect of using the chlorophyll meter to schedule supplement nitrogen in combination with various at-planting nitrogen rates.

METHODS

Experiments were conducted at Elgin, Hartington, and Page, NE on a sandy loam, loam, and sandy loam, respectively, in 1991, 1992, and 1993, respectively. All sites were center pivot irrigated. Cultural practice information is listed in table 1. The experiment was a randomized complete block design with four replications. The treatments consisted of four at-planting N rates (0, 50, 100, 150 lbs per acre as ammonium nitrate) spread on plots 10 ft by 40

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ft. Each at planting N rate was applied to three plots in each replication. One plot received no other fertilizer, except what was farmer-applied. A second plot received 30 lb N per acre hand-spread ammonium nitrate whenever the relative chlorophyll reading was greater than 2% below the reference area. The third plot received 30 lb N per acre treatments whenever the chlorophyll readings were greater than 4% below the reference area. Each replication had a 200 lb N per acre at-planting reference area. A Minolta SPAD 502 meter was used to take the chlorophyll readings. Readings were taken on a ten day to two week interval from about the ten leaf stage to milk stage. Readings were taken as described in the NebGuide cited above . Decisions to treat were based on the average of the four replications and not on a plot by plot basis. Earleaf samples were taken at silks brown, soils samples for nitrate nitrogen were taken to 4 ft after harvest in 1991 and 1993. All yields were adjusted to 15.5% moisture.

Since these experiments were conducted on farmer fields, some nitrogen was applied over the whole experiment before planting, with the planter or with the irrigation system. The experiment was analyzed as a factorial of planting time nitrogen and the percent meter reading at which additional nitrogen was applied.

RESULTS

The mid-season indicator, earleaf, showed response to at-planting nitrogen in all years. The effect of the meter reading treatments tended to increased earleaf in all years, but in 1993 the 4% treatment was similar to the at-planting only treatments (Table 2). In 1991 and 1993 there was an interaction between the at-planting treatments and the meter reading treatments. In 1991 when the at-planting N was low, the meter adjusted treatments showed large increases in earleaf N while the high at-planting N treatments were not affected by additional N. This is to be expected and shows that the plants are taking up the later applied N. This trend was not as clear in 1993. 1993 was a unique year in Nebraska since rainfall was above average and temperatures were below average.

Use of chlorometer adjustments procedure must maintain or increase yields and increase nitrogen use efficiency. This study shows that yields have been maintained or increased by use of the meter in all years. In 1991 yields were increased 12 bushels and in 1992 yields were increased by eight bushels. Yields were essentially the same in 1993. Determining the effect on nitrogen use efficiency is more difficult. Table 3 includes total nitrogen applied for each treatment. Form the data, nitrogen applied for each bushel of corn yield (NPB) can be calculated (data not shown). NPB for the at-planting N (including the 100 and 150, only), 2% chlorometer, and 4% chlorormeter treatments over the the three year experiment was 1.16, 1.22, 1.05 lbs N per bu corn, respectively. The lowest NPB was the combination of the low at-planting nitrogen rates with the 4% chlorophyll reading reduction treatment (0.82).

The chlorophyll meter can be used to fine-tune nitrogen applications. Other levels at which to start fertilizing besides two and four percent need to be examined before recommendations can be made. This study indicates that the two percent treatment, while decreasing nitrogen per bushel, did not do as well as the four percent. Additional savings may accrue at a higher percentage. Other observations include: It appeared that the 30 lb additional application increment may not have been adequate to bring corn readings up to the reference reading at the next reading time. It has not been determined at which growth stage readings and subsequent fertilization should stop. Chlorophyll meters when used with proper fertilization and water management can help improve nitrogen use efficiency.

Table 1. Cultural practices used in Chlorophyll a meter determined N application experiment.

	1991	1992	1993
Cooperator	R. Uhrenholdt	P. Koch	L. Heiss
Location (NE)	Elgin	Hartington	Page
Soil texture	Sandy loam	Loam	Sandy loam
Soil series	Sandy, mixed mesic Haplustoll Udorthentic Thurman fine sand	Fine-loamy, mixed, mesic Udic Argiustoll Thurman-Loretta complex	Coarse-loamy, mixed mesic, Typic Haplustols Anselmo fine sandy loam
OM (%)	1.2	2.7	1.1
pH	6.2	6.3	5.8
P (Bray ppm)	33	14	20
K (ppm)	187	192	206
Zn	11.7 (Index)	1.1 (DTPA)	8.7 (Index)
Sulfur (ppm)	0	--	1
Soil NO_3-N	2.3 ppm to 3 ft	5.2 ppm to 3 ft	3.9 ppm to 3 ft
Planting date	May 2	May 20	May 14
Hybrid	Pioneer 3379	Cargill 7877	Pioneer 3417
Population	28,000	23,200	27,700
Prev. crop	Corn	Soybeans	Corn

Table 2. Effect of Chlorophyll meter determined N application on earleaf and soil N.

At-planting N	Chloro† %	Earleaf N 1991	Earleaf N 1992	Earleaf N 1993	Soil N (4 ft)‡ 1991	Soil N (4 ft)‡ 1993
lbs N/acre	%	%	%	%	lbs NO_3-N/acre	lbs NO_3-N/acre
0	-	2.42	2.50	2.62	17.4	72.2
50	-	2.68	2.55	2.92	16.2	84.1
100	-	2.79	2.81	2.88	22.7	83.9
150	-	3.11	2.84	3.17	37.9	147.4
200	-	3.16	2.87	3.20	59.6	108.2
0	2	3.18	2.76	2.96	52.7	100.0
50	2	3.08	2.82	3.05	46.4	105.5
100	2	3.16	2.82	2.95	91.6	156.1
150	2	3.08	2.90	3.53	50.4	261.2
0	4	2.98	2.56	2.58	53.0	127.1
50	4	3.01	2.59	2.93	59.5	85.1
100	4	3.04	2.93	2.86	34.3	111.1
150	4	3.16	2.91	2.91	48.4	144.5
		ANOVA (Prob. >F)				
At-planting N(PN)		0.0006	0.02	0.028	0.632	0.0004
Meter		0.0001	0.42	0.075	0.0001	0.0121
PN*Meter		0.0003	0.82	0.827	0.011	0.1979
CV(%)		4.7	9.7	12.7	43.1	42.1

†30 lb N increments were applied when plants read 2 or 4% less than reference area.

‡Sampled in the fall after harvest.

Table 3. Effect of planting time N rate and subsequent fertilization based on chlorophyll readings at 2 & 4 percent less than the reference readings.

		1991				1992				1993			
At-plant N	Chloro[&]	Farmer† applied N	Chlorometer determined N	Total N applied	Yield	Farmer‡ applied N	Chlorometer determined N	Total N applied	Yield	Farmer§ applied N	Chlorometer determined N	Total N applied	Yield
	%	lbs N/acre			bu/a	lbs N/acre			bu/a	lbs N/acre			bu/a
0	-	55	0	55	155	30	0	30	127	70	0	70	131
50	-	55	0	105	187	30	0	80	144	70	0	120	131
100	-	55	0	155	184	30	0	130	156	70	0	170	128
150	-	55	0	205	181	30	0	180	144	70	0	220	140
200	-	55	0	255	188	30	0	230	148	70	0	270	131
0	2	55	150	205	195	30	120	150	143	70	90	160	141
50	2	55	120	175	187	30	90	170	168	70	60	180	132
100	2	55	150	205	190	30	60	190	150	70	90	260	136
150	2	55	30	85	192	30	60	140	152	70	120	340	135
0	4	55	150	205	180	30	30	30	152	70	90	160	143
50	4	55	120	175	194	30	90	140	146	70	30	150	133
100	4	55	50	105	180	30	30	160	152	70	30	200	132
150	4	55	50	105	192	30	60	240	153	70	30	250	136
		ANOVA (Prob. >F)											
		df											
At-planting (PN)		3			0.027				0.188				0.20
Meter		2			0.002				0.144				0.54
PN *Meter		6			0.014				0.232				0.58
CV (%)					5.8				9.6				6.6

&30 lb N increments were applied when plants read 2 or 4% less than reference area.
†N applied as 18 lbs N in the starter and 37 lbs N in two pivot irrigations.
‡N applied as 10 lbs N at planting and 20 lbs N with the pivot.
§N applied as 50 lbs N per plant and 20 lbs through the pivot.

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