2009 FIELD SEASON

Can Arkansas Corn Growers Use a Chlorophyl Meter to Improve Nitrogen Use Efficiency?

Investigator: Morteza Mozaffari, Assistant Professor, Director U of A of Marianna Soil Testing and Research Laboratory
Cooperator: Jason Kelly, Extension Agronomist, Wheat and Feed Grains

BACKGROUND INFORMATION

This project evaluates the potential for using a chlorophyl meter (CM) as a decision-aid tool for in-season application of nitrogen (N) fertilizer. The Minolta chlorophyl meter (CM) is an easy-to-use, affordable, handheld spectrophotometer, that is capable of measuring an index of plant chlorophyl content which is related to plant N content. The growers will benefit from development and availability of a new, rapid and reliable tool to apply N only when there is a likelihood of an increase in corn yield and profit margins.

The 2009 cropping season was the second year of this three-year project. Field studies were conducted to evaluate the effect of the N application rate on leaf chlorophyl content, leaf N, corn grain yield, and corn grain N uptake.

EXPERIMENTAL PROCEDURES

Field experiments were conducted at five locations in Arkansas on a commercial corn producer' fields (CLZ92) and University of Arkansas Agricultural Experiment Station Research Farms in Desha (DEZ92), Lee (LEZ92 and LEZ93), and Mississippi (MSZ92) county. Information on previous crop, corn cultivar, and agronomically important dates are listed in Table 1. Before application of any treatments, soil samples were collected from the 0- to 6-inch depth at each site and composited by replicate. Soil samples were processed and important soil properties were measured by standard methods of the University of Arkansas Soil Testing and Research Laboratory in Marianna, Arkansas. When needed P, K, S and Zn fertilizers were applied to each site following University of Arkansas Cooperative Extension Service soil-test recommendations for corn. All sites were irrigated and irrigation timing was managed by the cooperating growers or using the University of Arkansas Cooperative Extension Service Irrigation Scheduler program.

Experimental plots were 25-ft long and 4-rows wide. The experimental design was a randomized complete block with five total N rates of 60, 120, 180, 240, and 300 lb N/acre. A control of 0 N (no N fertilizer) was also included. Each treatment was replicated four times. The total amount f N for each N fertilizer rate was preplant applied and incorporated with Do-all.

Chlorophyl meter (CM) data were collected with a Minolta SPAD 502 CM at two growth stages (V8 to late silk, Table 2) from the newest fully expanded leaf that had a visible leaf collar (Table 3). At least twenty readings were collected from each plot and the average value of those twenty readings were used to calculate the CM measurement for that individual plot expressed in SPAD units. When corn was at mid-silk stage, ear-leaf samples were collected from 15 plants/plot, dried in an oven at 70 C to constant weight, and ground to pass through a 60-mesh sieve. Corn ear-leaf samples were analyzed for total N by Kjeldahl method.

At the AES sites, the two center rows of each plot were harvested with a plot combine. At the commercial farm site, one 12.5-ft long section from each one of the two center rows of corn in each plot was hand harvested. At harvest subsamples of corn grain were collected from each plot and analyzed for total N as described above. Grain N uptake was calculated by multiplying grain yield by N concentration.

Analysis of variance (ANOVA) was performed using the GLM procedure of SAS to evaluate the effect of N application rates on corn leaf N concentration, leaf chlorophyll content, corn grain yield, and grain N uptake. Sites were analyzed separately. When appropriate mean separations were performed by the Waller Duncan minimum significant difference (MSD) test at significance levels of P= 0.10.

2009 RESULTS

Soil texture in the 0-to 6-inch depth range from silt loam to clay loam(13 to 39% clay), soil pH ranged from 6.2 to 7.5 and preplant soil NO3-N ranged from 7 to 18 ppm (Table 2). Grain yield of corn fertilized with any N was significantly (P= 0.10) higher than corn that did not receive any N fertilizer (Table 4). Grain yield of the non fertilized corn ranged from 6 to 100 bu/acre and grain yield of fertilized corn ranged from 51 to 218 bu/acre. Grain yields generally increased with increasing the N application rate and maximal corn grain yields were obtained with applications of 240 to 300 lb N/acre.

Leaf N concentrations of corn fertilized with any N were significantly (P= 0.10) higher than corn that did not receive any N fertilizer at LEZ91, LEZ92, and MSZ92. At CLZ91 and DEZ91 leaf N of corn fertilized with ≥120 lb N/acre were significantly higher than the corn that did not receive any N (table 4). In general leaf N concentrations increased with increasing N application rates. Leaf chlorophyll meter content followed a trend similar to leaf N suggesting that chlorophyll meter reading may be a potential index of leaf N concentration. Grain N uptake of the non-fertilized corn ranged from 7 to 57 lb/acre and N uptake by fertilized corn ranged from 35 to 173 lb N/acre (Table 4). The effect of N application rate on grain N uptake was similar to that of the corn grain yield.

The data from these five sites are consistent with the result of 2007 and 2008 studies and indicate that under our soil and cropping systems the

grain yield, leaf N, leaf chlorophyll content, and grain N uptake are sensitive to N application rate. The data from these studies will be used to generate a database to investigate the correlation between relative chlorophyll meter and corn leaf N concentration, grain yield and grain N uptake. If there is such correlation then additional field research can focus on conducting field calibration research to develop in-season N application rates for improving N use efficiency in corn production in Arkansas.

Table 1. Selected agronomic information for corn N-fertilization experiments conducted at Agricultural Experiment Stations and a commercial field in Arkansas during 2009

Site ID	Previous crop	Cultivar	Planting date	N application date	Harvest date
CLZ92	soybean	DKC-6479	22-April	20-May	11-Sep
DEZ92	corn	Stine-9806	4-April	23-April	25-Sep
LEZ92	corn	DKC-6479	17-April	27-April	10-Oct
LEZ93	corn	10289464_CBX	25-April	29-May	9-Nov
MSZ92	corn	DKC-6723	19-May	8-June	19-Oct

a Seedling emergence occurred 7-10 days after planting

Table 2. Selected soil chemical property means (0 -to 6-inch depth) of samples taken before planting in corn – fertilization trials conducted at Agricultural Experiment Stations and a commercial field in Arkansas during 2009.

Site ID	Soil pH	Soil NO3-N	Mehlich-3-extractable nutrients						Soil physical properties	
		P	K	Ca	Mg	Mn	Cu	Zn	Sand	Silt
Clay	Texture									
		(ppm)								
	(%)									
CLZ92	6.2	18	29	74	818	167	216	0.8	9.8	3
81	16	Silt Loam								
DEZ92	6.8	8	60	116	745	116	117	1.0	3.8	32
52	15	Silt Loam								
LEZ92	7.5	9	57	186	1629	324	128	2.0	5.3	-
-	-									
LEZ93	7.3	7	66	193	1407	293	166	2.0	10.3	5
18	Silt Loam									
MSZ92	7.0	8	55	236	2826	554	41	4.2	8.8	40
21	39	Clay Loam								

a Soil pH was measured in a 1:2 (weight:volume) soil-water mixture.
b NO3-N measured by ion-specific electrode.

Table 3. Corn growth stage and calendar dates of chlorophyll meter data collection for five N-fertility trials conducted at Agricultural Experiment Stations and a commercial field in Arkansas in 2009.

SITE	Growth Stage	Date	Growth Stage	Date
CLZ92	V-8	18-June	late silk	10-July
DEZ92	V-8	16-June	mid silk	26-June
LEZ92	V-10	15-July	late silk	13-June
LEZ93	V-10	25-June	late silk	7-July
MSZ92	V-8	8-July	late silk	10-June

Table 4. Effect of N-fertilizer rate on corn grain yield, leaf N concentration, leaf chlorophyl content and grain N uptake in five trials conducted at Agricultural Experiment Stations and a commercial farm in Arkansas during 2009.

Total-N rate	CLZ92				DEZ92					
	Yield	Leaf N	Grain	N uptake	Leaf chlorophyll at growth stage		Yield	Leaf N	Grain N uptake	Leaf chlorophyll at growth stage
					V-8	late silk				V-8
	mid silk									
lb/acre		bu/acre		- % -	lb/acre		SPAD	SPAD		bu/acre	
	- % -	lb/acre			SPAD	SPAD				
0	100	1.56	57	43	34		62	1.54	36	42	41
60	137	1.89	82	50	45		93	1.63	51	46	49
120	151	2.42	95	51	53		125	1.87	74	52	54
180	167	2.82	123	56	58		162	2.20	109	54	54
240	201	3.13	151	57	63		202	3.08	155	57	58
300	186	2.97	153	51	62		216	3.08	173	57	58
MSD 0.10 a	10	28	0.52	19	8	5		15	0.32	12	4
P value		<.0009		0.0012	<.0001			0.0571		<.0001	
	<.0001		<.0001		<.0001		<.0001		0.0430		

a, Minimum significant difference at P=0.10 as determined by Waller-Duncan

Table 4 (continued). Effect of N-fertilizer rate on corn grain yield and leaf chlorophyl content in five trials conducted at Agricultural Experiment Stations and commercial farms in Arkansas during 2009.

Total-N rate	LEZ92		LEZ93					
	Yield	Leaf N	Grain N uptake	Leaf chlorophyll at growth stage		Yield	Leaf N	Leaf chlorophyll at growth stage
			V-10				V-10	late silk
lb/acre	bu/acre		-- % --	lb/acre		bu/acre	%	
	SPAD	SPAD						
0	64	1.61	48	30	30	1.34	31	31
60	97	2.14	68	38	76	2.14	45	46
120	128	2.59	86	50	122	2.45	50	53
180	158	3.12	117	55	154	2.62	52	56
240	199	3.12	157	59	164	2.90	53	59
300	218	3.20	174.	57	178	2.94	54	59
MSD 0.10 a	19	0.27	21	5	12	0.30	2	2
P value	<.0001		<.0001	<.0001		<.0001		
	<.0001		<.0001	<.0001				

a, Minimum significant difference at P=0.10 as determined by Waller-Duncan

Table 4 (continued). Effect of N-fertilizer rate on corn grain yield and leaf chlorophyl content in five trials conducted at Agricultural Experiment Stations and commercial farms in Arkansas during 2009.

Total-N rate		MSZ92 Yield	Leaf N	Leaf N		Grain N uptake		leaf chlorophyll at growth stage	
					V-8	latesilk			
lb/acre		bu/acre		%	%	lb/acre		SPAD	SPAD
0	6	1.74	1.15	7	27	26			
60	65	2.36	1.42	35	39	34			
120	89	2.74	1.70	49	46	42			
180	97	2.98	2.15	54	51	51			
240	132	3.29	2.43	79	52	57			
300	142	3.32	2.71	92	53	56			
MSD 0.10 a		28	0.4	0.24	25	3	4		
P value		<.0001		<.0004		<.0001		0.0025	<.0001
	<.0001								

a, Minimum significant difference at P=0.10 as determined by Waller-Duncan

N:\Matt King\Mozaffari_complete Report_CM_ACGSPB_2009.wpd