VALIDATION OF THE PRE-SIDEDRESS NITRATE TEST FOR POULTRY MANURED CORN FIELDS

T.A. Bauder[1] D. Quarles[2], R.J. Pearson[1], and S. Van Wychen[1]
[1]Colorado State University, Fort Collins, [2]CO and Parker AG Services
troy.bauder@colostate.edu (970) 491-4923

ABSTRACT

Previous research in northeastern Colorado has shown that the critical Pre-sidedress Nitrate Test (PSNT) level to obtain optimum corn (*Zea mays L.*) grain yields without applying additional sidedress N on non-manured fields is 15 mg kg^{-1} nitrate-nitrogen (NO_3-N). This study was conducted to determine if the critical PSNT level of NO_3-N identified for non-manured corn fields would also apply to those fields receiving an organic N source before planting. The effect of PSNT levels at the V6 crop growth stage on final corn grain or silage yields was investigated at 15 different sites over a three-year period. Poultry manure was applied at a rate of approximately 0, 2, or 4 tons $acre^{-1}$ in the fall before the spring growing season. Sidedress N treatments were randomly applied to plots at the V6 crop growth stage using UAN (32%). In the first two years of the study, field sites with PSNT values greater than 15 mg kg^{-1} had no response to sidedress N. Only one site had a PSNT value below 15 mg kg^{-1} and it responded to additional N. This study confirmed that the critical PSNT level of 15 mg kg^{-1} used for non-manured corn fields in northeastern Colorado is also appropriate for fields receiving an organic N source such as poultry manure before the growing season.

INTRODUCTION

Record high nitrogen (N) fertilizer prices coupled with the need to manage manure nutrients to prevent environmental degradation continue to reinforce the need to improve N fertilizer use efficiency. In-season assessments of soil and plant N status and split applications within the growing season are proven methods of achieving this higher efficiency. The pre-sidedress nitrate test (PSNT) was originally developed for the humid Eastern U.S. to help producers decide, in season, when it was necessary to apply additional N to obtain optimum corn yields. Once a critical PSNT level for optimum yield has been established for a specific crop, the PSNT allows producers to make a more confident decision on whether or not to sidedress with additional N, avoiding unnecessary fertilizer costs or yield loss due to insufficient N. More recently, the PSNT has been revised for use in Colorado on non-manured fields (Bauder et al., 2003).

Previous research in northeastern Colorado on non-manured fields has indicated that if one-foot soil nitrate levels are 15 ppm NO_3-N or higher at the V6 corn growth stage, then additional fertilizer nitrogen is not required for optimal yields (Spellman et al., 1996) . Values lower than 15 ppm NO_3-N generally indicate that the crop would benefit from additional N. The PSNT will answer whether or not enough soil N is available, but not how much additional N is needed to obtain optimal yields. Crop producers must assess their individual field yield potentials as well as soil NO_3-N levels at the sidedress period to determine actual sidedress N rates.

The primary objective of this study was to determine if the critical PSNT level of NO_3-N identified for non-manured corn fields would also apply to those fields receiving an organic N source before planting. The effect of PSNT levels at the V6 crop growth stage on final corn grain or silage yields was investigated at 15 different sites over a three-year period.

METHODS

Study sites were established near Keenesburg and Prospect Valley, CO during the 2005, 2006, and 2007 crop years. All sites were located on-farm and managed according to producer practice. Corn plant populations ranged from 26,000 to 35,000 plants per acre. Sites were either irrigated by center pivot (3) or furrow (12) irrigation methods with both well and ditch water sources. Only sites where soil moisture stress was minimized were used for data analyses. Dry or wet poultry manure from nearby poultry farms was applied at a rate of approximately 0 (2006 and 2007), 2 (2007), and 4 (2005 – 2007) tons per acre. Most of the sites received the manure in the late summer or fall following either the previous winter wheat or spring barley crops. Manure was typically incorporated with subsequent tillage operations.

Sidedress N treatments consisting of 0, 50, 100 or 0, 40, 80 pounds of N per acre were randomly applied to plots at the V6 crop growth stage using UAN (32%). We applied N treatments prior to cultivation or irrigation and utilized Agrotain® volatilization inhibitor to prevent ammonia volatilization. Nitrogen fertility treatments were applied within each non-replicated manure rate in a randomized complete block experimental design with four replications. Plots were 4, 6, or 8 rows (30-inch) wide by 40 to 75 feet long depending upon site conditions and space available. At the V6 growth stage and prior to fertilization, we collected 20 one-foot soil cores from each plot and mixed into a composite sample for each plot. An equal number of cores were sampled from shoulder and furrow locations as described by Spellman et al., 1996. Soil samples were analyzed for extractable NO_3-N and NH_4-N.

Plant nitrogen status was evaluated at the R1 or R2 growth stage using a Minolta® chlorophyll meter. We recorded SPAD readings from the ear leaf on 20 plants and averaged into one value per plot. Grain and silage yield was obtained by hand harvesting methods. Grain and plant tissue was analyzed for total N content.

We utilized PROC GLM and ANOVA procedures in SAS statistical software to evaluate N rate and PSNT impacts on soil, plant, and yield parameters. Sigma Plot software was also used to fit curves to evaluate soil PSNT impact to relative yield and ear leaf chlorophyll.

RESULTS

Soil PSNT levels ranged from a site average of 5.6 to nearly 50 mg NO_3-N kg^{-1} in the top foot over the three year study. Most sites with applied poultry manure were greater than the critical level of 15 mg kg^{-1} (Tables 1-3). Levels were generally higher in the first two years than 2007 largely due to beginning baseline soil NO_3-N levels and better conditions for mineralization. Plant ear leaf chlorophyll (SPAD) levels responded to soil PSNT by increasing exponentially up to about 15 – 20 mg kg^{-1} and then reached a plateau at higher PSNT values (Figure 1). Other researchers (Piekielek, et al., 1995 and Waskom, et al., 1996) have found that ear leaf chlorophyll content during reproductive growth stages was positively related to relative grain yield. Our results seem to agree with these findings.

Yield results from the 2005 sites are provided in Table 1. All sites had PSNT levels that were significantly higher than the critical level of 15 mg kg^{-1} NO_3-N. Thus, additional N applied to plots at the V6 growth stage did not produce a positive yield response to additional N at any of the six manured sites.

Table 1. Average* PSNT values, grain, and silage yields from 2005.

			Grain Yield (15.5% moisture)			N Fertilizer
Site	Manure	PSNT	0 lbs N/ac	40 lbs N/ac	80 lbs N/ac	Response**
	tons/ac	*mg/kg*	---------- *bu/ac* ----------			
Rupple Home	4	36.0	262	260	265	No
SG Beet Dump	4	47.7	182	224	189	No
SG RFI-6	4	25.3	225	226	225	No
			Silage Yield (30% dry matter)			
			---------- *T/ac* ----------			
Amen	4	31.9	26.4	26.3	26.2	No
Rupple B2	4	28.2	20.0	20.2	18.8	No
Rupple C2	4	20.1	22.9	22.9	23.8	No

***PSNT values are a field average and yields are an average of 4 replications for each treatment.**
****Significant at P<0.1.**

The 2006 (Table 2) results also supported that fields with PSNT levels greater than 15 ppm NO_3-N at the V6 crop growth stage do not benefit from additional fertilizer N. Although the Trupp C site had an average PSNT value of 19.4 ppm, a positive yield response to additional N was observed on several plots within that field with PSNTs lower than 15 ppm, however these responses were not significant at $p<0.10$. The non-manured section of the Trupp E field had an average PSNT of 9.4 ppm and statistically significant ($p<0.10$) yield responses were observed at this site.

Table 2. Average* PSNT values and grain yields from 2006.

			Grain Yield (15.5% moisture)			N
Site	Manure	PSNT	0 lbs N/ac	50 lbs N/ac	100 lbs N/ac	Fertilizer Response**
	tons/ac	*mg/kg*	---------- *bu/ac* ----------			
Gingerich N	4	26.6	243	227	235	No
Gingerich S	4	48.7	156	163	140	No
Trupp C	4	19.4	229	221	260	No
Trupp E	4	28.8	211	215	--	No
Trupp E	0	9.4	185	200	--	Yes
Trupp W	4	45.2	259	258	252	No

***PSNT values are a field average and yields are an average of 4 replications for each treatment.**
****Significant at P<0.1.**

Table 3. Average* PSNT values, grain, silage yields from 2007.

Site	Manure	PSNT	Grain Yield (15.5% moisture) 0 lbs N/ac	50 lbs N/ac	100 lbs N/ac	N Fertilizer Response
	tons/ac	*mg/kg*	---------- *bu/ac* ----------			
Trupp Home	0	9	167	--	197	Yes
Trupp Home	2	12.9	206	--	217	No
Trupp Home	4	15.6	246	248	253	No
Trupp South	0	5.6	75	--	140	Yes
Trupp South	4	15.8	201	200	205	No
Trupp C	4	23.9	218	209	205	No
			Silage Yield (30% dry matter)			
			---------- *T/ac* ----------			
Zim	0	9.8	19.9	--	23.6	Yes
Zim	2	10.4	25.3	--	25.0	No
Zim	4	13.5	23.7	24.2	24.3	No

***PSNT values are a field average and yields are an average of 4 replications for each treatment.**
****Significant at P<0.1.**

The 2007 results (Table 3) were a little less definitive with regard to the performance of the critical level. While three of the sites with average PSNT values less than the critical level, did show a yield response (Trupp Home and South, 0 manure rate), the two sites growing silage did not. However, the Zim - 4 ton rate site did have a PSNT value that was close to the critical value (13.5 mg kg^{-1}) and it's possible that mineralization was a little slower at this site. It should also be noted the original critical level was calibrated for grain, rather than silage corn yield response. Figure 2 shows relative yield as affected by soil PSNT from all sites in the non-fertilized plots. As with the chlorophyll response, the data fit an exponential rise equation reasonably well ($R^2 = 0.66$) and the curve flattens out between 15 – 20 mg kg^{-1}.

Overall our results indicate that field sites receiving poultry manure did not respond to sidedress N when PSNT values were greater than 15 ppm. However two sites with values below the critical level did not show a response in silage yield. Results from this study that the critical PSNT level of 15 ppm used for non-manured corn fields in northeastern Colorado is likely appropriate to use for fields receiving an organic N source such as poultry before the growing season. However, additional analyses such as Cate Nelson are required to see if this project will have results that show an adjusted PSNT critical value is warranted. The PSNT should be particularly useful where organic amendments rates are applied based upon phosphorus needs and additional sidedress nitrogen needs are expected.

REFERENCES

Bauder, T., R. Waskom, and J. Schneekloth. 2003. Best Management Practices for Colorado Corn. Colorado State University Cooperative Ext. Bulletin XCM574A.

Spellman, D.E., A. Rongni, D.G. Westfall, R.M. Waskom, and P.N. Soltanpour. 1996. Pre-sidedress nitrate soil testing to manage nitrogen fertility in irrigated corn in a semi-arid environment. Commun. Soil Sci. Plant Anal. 27:561-574.

Piekielek, W.P., R.H. Fox, J.D. Toth, and K.E. Macneal. 1995. Use of Chlorophyll meter at the early dent stage of corn to evaluate nitrogen sufficiency. Agron. J. 87:403-408.

Waskom, R.M., D.G. Westfall, D.E. Spellman, and P.N. Soltanpour. 1996. Monitoring nitrogen status of corn with a portable chlorophyll meter. Commun. Soil Sci. Plant Anal. 27:545-560.

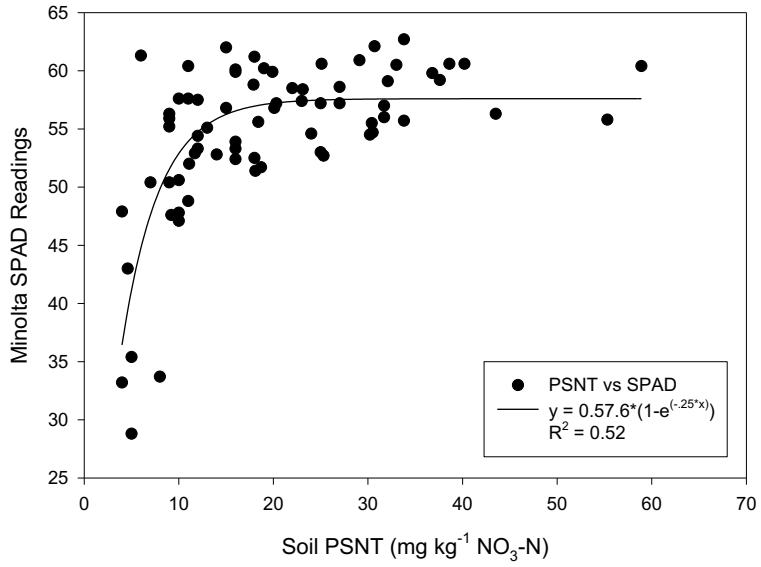

Figure 1. Ear leaf chlorophyll at R2 as affected by soil PSNT in non-fertilized plots from all site years (N = 100).

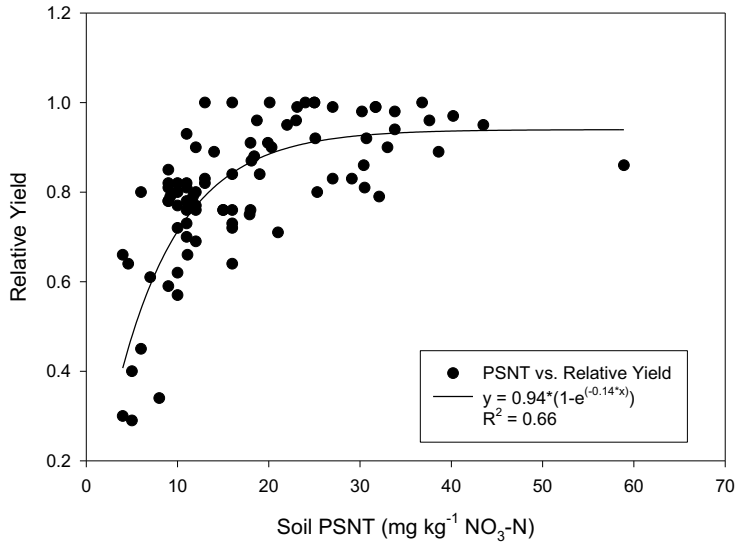

Figure 2. Relative yield as affected by soil PSNT in non-fertilized plots from site years with (N = 100).