NC STATE UNIVERSITY
DEPARTMENT of SOIL SCIENCE

Nutrient Deficiency Diagnosis Training Using Field & Greenhouse Plants

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Introduction/Rationale

- Plants from long-term soil fertility plots and greenhouse pots were used to train professional agronomists to diagnose specific nutrient deficiencies.
- Field scenarios included 4 crops (corn, cotton, soybean, peanut) & several fertility problems (N,P, or K deficiency; low pH, high pH, excessive poultry litter).
- Greenhouse problems included 6 crops (above crops plus rice & tobacco) & several specific nutrient deficiencies (N, P, K, S, Mg, Cu, Mn, Zn, or B) or excess Zn.
- The target audience included Cooperative Extension Agents, other government agronomists, and private industry agronomists.
- One day field training consisted of a brief pre-test and plant nutrition overview, field plot inspection, and greenhouse plant inspection.
- A post-test was given 1 week after the training event via anonymous response to e-mail
- A website with images of nutrient deficiencies and laboratory data was constructed as an ongoing training resource.

Visual ID Questions

Whole plants or leaves retrieved from the field or greenhouse such as those in Figs. 1 and 2 were displayed for the pre-test, and included in a Power Point file for the post test

Sample Multiple-choice Test Questions

Nitrogen to sulfur (N:S) ratios in plant tissue can be an indication of sulfur deficiency. N:S ratios begin to be of concern at ___ or higher.

a. 5:1
b. 10:1
c. 12:1
d. 18:1 (correct)

When magnesium is low on the soil test report and no lime is recommended, magnesium is recommended at the rate of

a. 10 lb per acre
b. 15 lb per acre
c. 25 lb per acre (correct)
d. 50 lb per acre

Field Plots

Figure 1. This field is typically managed with research funding as a RCBD. Periodically the site is used for training with a different crop planted in each experimental block. In 2006, corn, cotton, soybean, and peanut were planted. Treatments resulted in specific nutrient deficiencies that include N, P, or K; as well as low pH, high pH, and optimum and excess rates of poultry litter.

Greenhouse Plants

Figure 2. Greenhouse sand culture was used to grow the same 4 crops plus tobacco and rice with nutrient solutions that were either complete or missing N, P, K, S, Mg, Cu, Mn, Zn, or B; or that had excessive Zn. Plants were photographed at stages with notable deficiencies and were also exhibited during the on-site crop training event.

Training Events July 12 & 13, 2006

Pre-test

- 30 minutes at registration
- 13 visual ID
- 9 multiple choice
- Anonymous

Field plot inspection

- 30 minutes per crop
- Soil & plant tissue analysis results provided
- Plant tissue sampling demonstrated

Greenhouse plant inspection

- 10 minutes per crop
- Well-ventilated barn for shade & wind protection

Website: http://www.soil.ncsu.edu/nmp/deficiency/

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Soil Fertility Training

Nutrient Deficiency Image Collection - Crozier 12/22/06
F=field photo, G=greenhouse photo
Capital letter indicates final processing ok, small letter indicates in prep

Nutrient problem	Corn	Cotton	Soybean	Peanut	Rice	Tobacco	Wheat	other
Normal	F G	F	F		G		F	
N	F F G	F G	G		F G	G	F	
P	F F G	F	F	F			F	
K	F G	G	F G	G	G	G	F	
S	F G	G	G		G	G	F	
Mg (see low pH)	F	G	G			G		
Cu	F G		G				F F	
Mn (see high pH)	F G		G				F	
Zn	F F G G	G			G			
Zn excess	G			F	G			
B		G	G			G		
B toxicity	F							
Low pH	F F	F	F					
High pH		F	F	F				

All photos by C.R. Crozier unless otherwise indicated. Laboratory analysis results are courtesy of Dr. David H. Hardy and Brenda Cleveland, Agronomic Services Division, North Carolina Department of Agriculture & Consumer Services. For more information, contact Carl R. Crozier, Assoc. Prof. & Extension Specialist N.C. State Univ. Soil Science Dept. V.G. James Center 207 Research Station Rd Plymouth, NC 27962 252-793-4428 ext 134

Post-test & Subjective Evaluation

- Test was e-mailed 1 week after training
- Anonymous response via secretary
- Post-test questions were similar in number & type as the pre-test
- Responses included numerous comments that this training was a unique offering that permitted visualization of realistic problems.

	Visual ID	Multiple choice	Comments/observations
	% Correct answers		
Pre-test (n=20)	42	62	Many participants reluctant to turn in test forms
Post-test (n=7)	75	89	2 participants unwilling to answer visual id questions without lab data

Summary

- The 33 attendees included cooperative extension agents and other professional agronomists. They had varying amounts of prior experience, typically agronomy and/or soil fertility courses and some field crop problem diagnosis. Participation was approved for 4 hours of CCA continuing education units.
- Anonymous pre- and post-testing was used to evaluate learning. Mean test scores were higher after the training, but due to small sample sizes, quantitative assessment of effectiveness was not reliable. Several expressed reluctance to submit to testing
- Test scores were lower on visual ID than on multiple choice questions. This indicates a need for more training in comprehensive field problem diagnosis.
- Participant comments were generally highly favorable, and noted that this was a unique training opportunity.
- Long-term soil fertility plots can serve as valuable training resources. Limited cropping modifications are possible while still maintaining soil fertility gradients for future research use,
- The website with the nutrient deficiency image collection is an ongoing training resource that can be upgraded to include additional crop x nutrient problem scenarios.

Figure 3. Website opening matrix links to images provided as .jpg files with available laboratory data and university logo.

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