PROJECT SUMMARY:

Manganese and Potassium Fertility for Soybean Production in Virginia

Manganese and potassium deficiencies are common nutrient problems in Virginia soybean production. Traditional manganese and potassium deficiencies persist in many areas of the state and include regions with sandy textured soils or on farms that receive lime stabilized biosolids or are over-limed. However, recent research studies suggest that glyphosate resistant soybean varieties may see increased manganese deficiencies due to a reduction in manganese uptake efficiency. Likewise, higher yields dictate great nutrient uptake and potassium deficiencies are becoming more prevalent. The overall objective of this research project is to assist producers with management decisions regarding manganese and potassium deficiencies and yield responses as they relate to glyphosate resistant soybeans. More specifically, objectives include: 1)Determine yield responses to foliar manganese applications on standard pH soils (5.7 to 6.5) and high pH soils (above 7.0), 2) Determine foliar manganese application rates for Virginia, 3) Determine foliar manganese application timing for Virginia, 4) Determine appropriate tank mix strategies and yield response for producers wishing to apply foliar manganese with their herbicide or insecticide programs, 5) Develop new manganese sufficiency ranges for Virginia glyphosate resistant soybean varieties, 6) Determine if higher potassium application rates are needed, and 7) Disseminate research information to farmers to integrate into their production systems. No-tillage soybeans will be planted at five locations in the Coastal Plain of Virginia on sandy loam soils with varying pH levels. The overall project design at each location is a factorial arrangement of 4 manganese rates (0, 0.5, 1.0, 2.0, and 3.0 lbs/acre) and 4 potassium rates (0, 50, 100, and 150 lbs/acre).

Budget: $19,041 for labor, travel, materials and supplies for field and laboratory analysis.

VIRGINIA SOYBEAN BOARD

PROJECT PROPOSAL - 2012

TITLE: Manganese and Potassium Fertility for Soybean Production in Virginia

DATE: July 1, 2012 – June 30, 2013

ESTIMATED DURATION: Three years for sound scientific research and demonstration. Subject to renewal on a yearly basis. This funding request is for year 3 for the manganese trial and year 1 for the potassium trial.

OBJECTIVE: The overall objective of this research project is to assist producers with management decisions regarding manganese and potassium deficiencies and yield responses as they relate to glyphosate resistant soybeans. More specifically, objectives include:

1. Determine yield responses to foliar manganese applications on standard pH soils (5.7 to 6.5) and high pH soils (above 7.0).
2. Determine foliar manganese application rates for Virginia.
3. Determine foliar manganese application timing for Virginia.
4. Determine appropriate tank mix strategies and yield response for producers wishing to apply foliar manganese with their herbicide or insecticide programs.
5. Develop new manganese sufficiency ranges for Virginia glyphosate resistant soybean varieties.
6. Determine if current potassium fertilizer rates are sufficient for our high yielding production systems.
7. Disseminate research information to farmers to integrate into their production systems.

JUSTIFICATION: Manganese deficiency is a common nutrient problem in Virginia soybean production. Traditional manganese deficiencies persist in many areas of the state and include regions with sandy textured soils or on farms that receive lime stabilized biosolids or are over-limed. However, recent

research studies suggests that glyphosate resistant soybean varieties may see increased manganese deficiencies due to a reduction in manganese uptake efficiency (Huber, 2007). Likewise, a research study published in January 2010 from the central United States indicated that glyphosate resistant soybean varieties had higher yield responses to manganese fertilizer than conventional varieties in some cases but saw the inverse in other cases (Loecker et. al., 2010). Regardless of genetic background, yield responses to manganese fertilizer was seen when leaf concentrations were above current accepted leaf sufficiency concentrations and the authors feel that further investigation in modern soybean cropping systems is warranted.

Potassium fertility recommendations are dated and may need to be increased to match current high-yielding crop production systems. Currently, many farmers are consistently harvesting 50 to 60 bu/acre; which removes approximately 70 to 85 lbs K_2O/acre in their soybean seed (International Plant Nutrition Institute, 2011). Using current Extension recommendations, a soil testing "High" would dictate 30 lbs K_2O/acre for nutrient replacement. Any nutrient removal higher than this level would then be "mining" the soil for the remainder of the nutrient. Years of "mining" a soil for nutrients will eventually cause soil test to drop, yield losses and large fertilizer bills within a single year if soil nutrient concentrations are not maintained over time.

BACKGROUND: Manganese deficiency in Virginia soybean production has been a long-time concern and received considerable research attention in the 1970's by faculty at Virginia Tech (Alley et. al., 1978). In Alley and coworker's study, they found that soybean yields were generally lower in treatments that had soils with a higher pH; which mirrored soybean tissue manganese concentrations. Overall, Alley and coworkers found that manganese deficiencies in conventional soybean varieties could be corrected using foliar, banded, or broadcast applications and the manganese application rate had to be adjusted according to the proposed method of application.

Scientists at Virginia Tech continued to work on manganese soil test and tissue tests concentrations through the early 1980's to help producers increase their soybean yields. Studies conducted by Gettier and coworkers (1984, 1985a, 1985b) agreed that manganese deficiencies caused yield reductions in Virginia and worked towards using soil testing as a prediction of manganese deficiency. Numerous soybean varieties were grown on several soil types to develop sufficient soil test and plant tissue test concentrations. These research projects also demonstrated that manganese could effectively be foliar applied and that numerous foliar applications would be beneficial for increasing yields. Of the foliar applications, later applications seemed to have higher tissue concentrations but earlier applications resulted in higher yields.

Past research remains an excellent starting point for manganese fertilizer recommendations in Virginia soybean productions systems, but genetically modified crops may have differing nutrient requirements or concerns. Research varies on claims and assertions that glyphosate resistant varieties may decrease manganese uptake and efficiency. A Kansas study conducted by Loecker and coworkers (2010) found that manganese efficiency did vary based on genetic characteristics of the crop, but overall they could not conclusively say that glyphosate resistant varieties needed more manganese fertilizer. However, they did conclusively state that higher yielding varieties and differing cultural practices suggested that sufficient leaf status measurement concentrations should be increased.

Generally, Virginia Tech and Virginia Cooperative Extension soil testing guidelines are well established and tested due to many years of research (Maguire et. al., 2009). However, many of these research experiments were conducted in fields producing significantly lower yields, with different varieties (non-glyphosate resistant vs. glyphosate resistance for example), and using different management practices (conventional tillage vs. no-tillage, etc.). Testing should be conducted using modern production practices to verify soil testing guidelines.

PROCEDURES: No-tillage soybeans will be planted at five locations in the Coastal Plain of Virginia on sandy loam soils. Two sites will be established on the Eastern Shore of Virginia; one at the Virginia Tech Eastern Shore Agricultural Research and Extension Center (AREC) and one in a commercial production field with a history of manganese deficiency. Two sites will be established in Prince George County in commercial farm fields. One location will have an agronomically acceptable pH (5.7 to 6.5) and one field will have an agronomically high pH for soybean production (above 7.0). A fifth site will be planted at the Tidewater AREC that matches treatments at the Eastern Shore AREC. At each site, manganese will be applied using different rates, application times, and application methods. EDTA chelated manganese will be foliar applied at 0.5, 1.0, 2.0, and 3.0 in one application, along with a no-manganese control. At each manganese rate, two different timing regimes will be used (early and late). The early treatment will be applied based on a herbicide application program with the treatment occurring at V6 (sixth set of unfolded trifoliate leaves). The late application will entail manganese based on an insecticide application program with the application occurring at the early reproduction phase R2 (full bloom – an open flower at one of the two uppermost nodes). At Eastern Shore AREC and Tidewater AREC only, for each application rate and timing, two application methods will be used (mixed and delayed). The mixed treatments will have EDTA manganese mixed with either glyphosate or insecticide. The delayed treatments will have manganese applied one day with the glyphosate and insecticide treatments applied 24 hours later. All treatments will be applied using a compressed CO_2 backpack sprayer. Potassium will be tested by applying 4 potassium rates (0, 50, 100, and 150 lbs/acre) using Muriate of Potash (0-0-60) using granular fertilizer at-planting. All other production practices will be made according to Virginia Cooperative Extension recommendations for no-tillage soybeans and based on Mehlich-1 soil tests (Holshouser, 2001). Soybean leaf tissue will be collected to test for sufficiency ranges prior to fertilizer application.

Leaf tissue will be digested using nitric acid and hydrogen peroxide and analyzed using inductively coupled atomic plasma spectroscopy (ICAP). Grain test weight and moisture will be reported for each treatment. Yield will be collected using a plot combine and corrected to 13% moisture. The overall project design for manganese at each AREC location is a factorial arrangement of 2 application timings × 2 application methods × 4 manganese rates replicated four times in a randomized complete block design. Each project located in a producer's field includes 2 application timings × 4 manganese application rates plus a 0-fertilizer control. All potassium studies are a randomized complete block design of 4 application rates. All data analysis will be conducted in SAS at *alpha* = 0.05.

PERSONNEL AND FACILITIES:

Project Leader: Mark S. Reiter
Assistant Professor, Nutrient and Soils Management
Eastern Shore Agricultural Research and Extension Center
Department of Crop and Soils Environmental Sciences
Virginia Polytechnic Institute and State University
33446 Research Drive
Painter, Virginia 23420
757-414-0724 ext. 16 (phone)
757-414-0730 (fax)
mreiter@vt.edu

Other Assistants: J. Scott Reiter, Agriculture and Natural Resources Extension Agent, Prince George County Unit, Virginia Cooperative Extension
David L. Holshouser, Associate Professor, Soybean Agronomist, Tidewater AREC, Virginia Tech
John Mason, Research Specialist II, Eastern Shore AREC
Summer Technicians, Eastern Shore AREC, Virginia Tech

Facilities: Soils and Nutrient Management Laboratory, Eastern Shore AREC. Contains equipment for drying and grinding of plant tissue, instrumentation necessary for plant tissue digest, ICAP for manganese concentration determination, and extraction equipment necessary for soil. Also has a plot combine and necessary equipment for planting, precision application of treatments, and agronomic production of soybeans.

OTHER COOPERATING ENTITIES: Farmers in Prince George County, Virginia for the use of their commercial soybean production fields.

SOURCE OF OTHER FUNDS: No other sources of funding have been identified for this research.

BUDGET:		
	Hourly Wages	$13,736
	Hourly Fringes (7.50%)	$1,305
	Travel	$2,000
	Materials and Supplies	$2,000
	Total	$19,041

The Virginia Soybean Board is paying for 100% of these research projects.

WORKS CITED:

Alley, M.M., C.I. Rich, G.W. Hawkins, and D.C. Martens. 1978. Correction of Mn deficiency of soybeans. Agron. J. 70:35-38.

Gettier, S.W., D.C. Martens, and T.B. Brumback, Jr. 1985a. Timing of foliar manganese application for correction of manganese deficiency in soybean. Agron. J. 77:627-630.

Gettier, S.W., D.C. Martens, and S.J. Donohue. 1985b. Soybean yield response predictions from soil test and tissue manganese levels. Agron. J. 77:63-67.

Gettier, S.W., D.C. Martens, D.L. Hallock, and M.J. Stewart. 1984. Residual Mn and associated soybean yield response from $MnSO_4$ application on a sandy loam. Plant Soil 81:101-110.

Holshouser, D.L. 2001. Virginia soybean production guide. Information Ser. 443. 111 p. Tidewater Agric. Res. Extension Cntr., Virginia Cooperative Extension, Suffolk, VA.

Huber, D.M. 2007. What about glyphosate-induced manganese deficiency? Fluid J. 15:20-22.

Loecker, J.L., N.O. Nelson, W.B. Gordon, L.D. Maddux, K.A. Janssen, and W.T. Schapaugh. 2010. Manganese response in conventional and glyphosate resistant soybean. Agron. J. 102(2):606-611.

SUBMITTED BY:

Signature: Mark S. Reiter
Printed Name: Mark S. Reiter
Title: Assistant Professor of Soils and Nutrient Management
Federal or State Government Program or Private Sector Company's Name: VT Eastern Shore AREC