Canada-Africa 4R Solution and Precision Nutrient Management – Online Series

Nutrient Sources

Webinar Panel #4, 14 September 2020 – Key Points

This panel was the fourth in a series of webinars aimed at increasing the visibility of the 4R Solution Project, creating a network of African and Canadian scientists in its support, and increasing the engagement by African universities in 4R Nutrient Stewardship. The following report highlights the key points made by each speaker, and describes the discussions in response to questions. For more detail, see the recorded two-hour presentation and the presentation slide deck.

Introduction & Welcome

Clyde Graham, Fertilizer Canada, and moderator Ed Rege welcomed participants, outlined the theme and introduced the speakers.

1. Unlocking the hidden potential through integrating fertilizers with organic nutrient resources in infertile soils. Regis Chikowo, Professor, University of Zimbabwe/Michigan State University

Infertile soils are the only soil resource that many African farmers have. The yield gaps in crops like maize, groundnuts and rice amount to 100% to 400% of current yields. In soils without problems in terms of pH and aluminum, simply adding N and P fertilizer can easily raise maize yields to 5 tonnes per hectare, but many soils have additional constraints limiting such responses. In some soils, fertilizing with all macro and micro nutrients may result only in low yields insufficient to pay for the fertilizer. These soils generally need more organic matter, which can be supplied by growing more legumes, or applying manure or composted material. Since supplies of the latter two are limited, there is a real need for integration of legumes. Comparing two soils derived from granite, one with 0.35% soil organic carbon showed far smaller responses to fertilizer—and even to manure—applications than did a similar soil with 0.89% soil organic carbon. Legumes, including pigeonpea, "harness N_2 at scale on smallholder farms."

Questions:

1. On what basis can one choose which of the micronutrients to be added? How can one know which micronutrients are limiting crop yield? *Answer: With continuous cultiviation you can be assured that the soil will become depeleted in micronutrients, to the point of limiting yields. Soil tests can help identify the ones most limiting.*
2. You presented interesting data on crop response, comparing soil with 0.35% organic carbon to soil with 0.89%. From which country and region do these data come? *Answer: They come from granite-derived soils in northern Zimbabwe. Typically their soil organic carbon is below 1%.*
3. Given the difficulties in managing weeds and hardpans (soil compaction), what is the relevance of no-till practices or conservation agriculture? *Answer: managing to improve soil organic carbon requires precision in all practices. Planting at the right time is critical to attaining the levels of plant productivity to build soil carbon. One cannot expect to double soil organic carbon in a short time.*

2. Inhibitors of urease and nitrification, controlled-release coatings, and biofertilizers. Dr. Rigas Karamanos, Senior Agronomist, Koch Fertilizer Canada.

Enhanced efficiency fertilizer (EEF) products have a clear definition that includes characteristics that allow increased plant uptake, compared to a reference fertilizer, which is often urea. Urease inhibitors and slow release fertilizers slow the process of urea hydrolysis, lessening the rate of pH rise and opportunity for ammonia volatilization surrounding the urea granule. Another commonly used alternative is "right place," ensuring the urea is placed at 3 to 4 inches depth so that the soil

above absorbs the ammonia. Nitrification inhibitors slow the action of ammonia mono oxygenase. Enhanced efficiency fertilizers are best evaluated at rates of N application that are below optimum or recommended rates. In one example, urea with EEF at 70% of recommended rate produced the same yield as urea without EEF at 100% of recommended rate. Polymer-coated urea controls N release by diffusion through a polymer membrane; to attina this, contact with soil moisture is need, so broadcast application is not ideal. Yield response to EEF varies across sites and years. You can expect them to work best in high volatilization environments. They can also act as seed row safeners, reducing risk of salt or ammonia injury to seedlings. Biofertilizers contain live microorganisms—bacteria, blue-green algae, fungi—and should not be confused with manures and composts and extracts. Their two major mechanisms are nitrogen fixation, and phosphorus solubilisation. Plant growth promoting rhizobacteria also produce phyto hormones that influence crop growth and development.

Questions:

1. Two related questions on unintended effects of EEF: i) Is there a long term negative effect of polymer-coated urea? Is there an effect of inhibitors on soil microbial biomass and biodiversity? *Answer: As long as they are registered as fertilizers, there is no need for concern. The registration requires that polymers be shown to biodegrade in soils, and that inibitors be shown not to cause harm.*
2. Do you look at the effect of nitrification inhibitors on microbial activity and diversity in soils? *Answer: No, I have not personally, but research by Agriculture Canada found they do not change the biodiversity of micro organisms.*
3. At what soil surface pH is ammonia volatilization no longer a concern for broadcast or surface banded urea? What if there are crop residues on the soil surface? *Answer: At acid pHs it slows, but never stops. There are examples of soil with pH of 5 and 5.5 in research by Montana State University where broadcast urea raises soil surface pH by 2 units, and there was some volatilization. When soil is bone dry, there is little loss. But when soil is dry with morning dew – Washington State University research showed 2 mm of moisture could result in 75% of the N in urea being lost as ammonia released to the aire. Rain or irrigation in larger amounts (25 mm) could reduce the loss to 5%.*
4. What are your thoughts on the option of sulphur coating on urea? Or neem coating of urea? *Answer: I have a little bit of experience with sulphur coating. For turf and ornamental uses, sulphur coating is preferred over polymer. The sulphur reduces loss owing to both the coating and the reduced pH it causes as it is oxidized.*

3. The use of microorganisms to improve P use efficiency. Adnane BARGAZ, Professor, University Mohammed VI Polytechnic University

Phosphorus fertilizer is a critical input for crop production. Around the year 2010, P fertilizer consumption amounted to ~40 Tg P_2O_5, and is expected to increase to 55-60 Tg by 2030-2040. Phosphorus plays essential roles in the biochemistry of plant growth and is important for biological nitrogen fixation. Many African and Brazilian soils have high levels of aluminum and low levels of available phosphorus. Phosphorus is strongly retained by soil and thus the P depletion zone is merely 3 mm from root surface. Rhizosphere management is thus essential for increased P uptake. Acid phosphatase activity is involved in higher plant P acquisition and uptake. Such activity can be induced by inoculation with P solubilizing bacteria. These bacteria also influence root traits. Plants also release organic acids to aid in P transport from the soil to the root. Choice of crop and cropping system can enhance soil microbes. Root and rhizosphere efficiency practices are most effective when soils are at optimal levels fertility and fertilizer use. Consider additional Rs: right micro organism, right mixture, right crop, and right carrier.

Questions:

1. Are there effects of crop cultivars on phosphorus solubilizing bacteria? *Answer: Yes, this aligns with "right crop." When we find a strain of bacteria that works for wheat, maize, etc., we see opportunity to test it on other crops in the same family as well. We can also test the same strain in legumes, which could have benefits for nitrogen fixation. There is opportunity to test in many crops, but repeatability is not really the same for each crop.*
2. Phosphates or organic acids: which is the better strategy for African soils? *Answer: Mechanisms are site specific. If the soil is organic rich, phosphatases are best. But we can't generalize because African soils are diverse.*

4. The Role of Sulphur Nutrient Sources in a Balanced Nutrient Management Program. Dr. Kent Martin, Martin Agronomic and Environmental Consulting, LLC

Sulphur has in the past 10-15 years become much more a part of research programs. Fertilizer sources for the elemental form include sulphur bentonite (widely used), and also raw elemental, which can be co-granulated into phosphate or urea fertilizers in a micronized form. There are also many soluble sulphate forms including ammonium sulphate, potassium sulphate, and sulphate of potash magnesia, among others. Sulphur in soils is highly correlated with soil carbon and nitrogen. Bentonite forms are made into larger pastilles. The bentonite clay attracts moisture from the soil, which breaks up the pastille over time. In the co-granulated forms, the soluble fertilizer dissolves away leaving the elemental sulphur to oxidize. Many micro-organisms, including thio bacillus, assist in this process. Adding elemental sulphur to soils increases the populations of oxidizing microbes, a priming effect aiding the solubilizaiton of future applications. Particle size within pastilles ranges from 60 to 2000 microns, most between 60 and 300 microns. Smaller particles oxidize much more quickly. The cogranulated forms use even smaller particle sizes, 20-40 microns. One example is SuperS: 75% S in a urea matrix. It has faster release than bentonite sulphur. Crops uptake curves for sulphur are similar to those for other nutrients. Soil testing for sulphur is difficult owing to poor correlation to crop response. One needs to couple soil tests with understanding of soil organic matter and with what the plants are telling you through their symptoms.

Questions:

1. One slide noted Special S and another SuperS. What is the difference? *Answer: Actually they are one and the same; Special S was superseded by SuperS. The product is 11% N and 75% S co-granulated urea.*
2. There seems to be less emphasis on secondary nutrients like sulphur as compared to NPL and micronutrients. What is the right balance among these sources, as well as their balance with

right time and right place? *Answer: Zinc is indeed highly important. Focus today was on sources. These products differ in rate and timing. They differ in seed safety, and thus careful attention needs to be paid to rates when applying with the seed. Sulfate is the product of choice for rescue applications, as it has the fastest release. For fertilizer applications made months before the crop, sulphur bentonite is the product of choice. It is applied at higher rates since it can last two or three growing seasons.*

5. General Discussion

Clyde noted that next month's webinar will focus on extension methods and on-farm research. It is scheduled for Monday 19 October 2020. Details of speakers and program are to be posted on the 4R Solution website.