University of Idaho Extension

Nutrient Management Newsletter for Idaho

Nutrient Digest

VOLUME 2, ISSUE 3 SPRING, 2010

PHOSPHORUS REMOVAL BY SILAGE CORN IN SOUTHERN IDAHO

By Amber Moore, Steve Hines, Brad Brown, Mario de Haro Martí, Christi Falen, Mireille Chahine, Tianna Fife, Rick Norell—UI, and Jim Ippolito-USDA ARS

Corn silage is the predominant crop in Idaho used for recovering phosphorus (P) that has accumulated in soils from dairy manure applications. However, little is known about how much P and other nutrients are being recovered under Idaho conditions. The objective of the study is to estimate P removal by irrigated silage corn cultivated throughout southern Idaho with variable soil test P concentrations, and to identify effects of increasing soil test P on tissue P concentrations and plant P uptake.

Forty-two different corn silage fields in 2008 and 2009 were selected throughout southern Idaho for soil and whole plant sampling at harvest. Soils were analyzed for Olsen P, plant tissue was measured for total P content, and dry and wet yields were calculated based on field weights and drying of plant tissue.

The year did not appear to have a significant effect on yield, dry matter percent, P concentrations in the corn plant tissue, or P uptake, therefore the results from 2008 and 2009 were combined for this discussion. Average dry yield, wet yield, and dry matter % were similar to current averages for

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MEASURING MANURE APPLICATION RATES ON THE FARM

By Rick Norell—UI

Nutrient management plans frequently specify variable manure application rates between fields. Achieving these variable application rates is challenging for on-farm and commercial applicators. On-farm procedures can be used to determine ballpark application rates and to assess appropriate overlapping of spreader loads. A general discussion of the commonly recommended procedures is provided below.

Tarp Method. For rear discharge spreaders, the maximum manure application rate typically occurs directly behind the manure spreader. The tarp method takes advantage of this fact. To run the test, three to five tarps of known size are placed in the field down range and the applicator drives the spreader over the tarps while applying manure.

Tarps are weighed after application and rate is calculated by equation (expressed in tons/acre). If application rate is outside the planned range, a second set of tarps is used and the applicator varies ground speed or discharge rate from the spreader. Through trial and error, the applicator finds the appropriate speed and discharge rate to achieve desired application rate.

The tarp method has several key advantages: 1) application rate can be tested at any time, 2) the procedure estimates maximum application rate, 3) does not require on-farm scales to measure load weight, and 4) the process is suitable for any size operation. There are a few disadvantages as well including: 1) process is time consuming, 2) does not

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COPPER SEQUESTRATION USING LOCAL WASTE PRODUCTS

By Jim Ippolito-USDA-ARS

Dairies utilize copper sulfate ($CuSO_4$) foot baths to control hoof infections. Typical solutions are 5 or 10% $CuSO_4$ (pH ~6), equal to 12,500 or 25,000 ppm Cu, respectively. When spent, hoof bath solutions are usually disposed of in waste lagoons and subsequently utilized for irrigation. In the Magic Valley, this practice appears to be causing soil Cu concentrations to increase. The goal of our research was to use local waste products to sequester Cu from a simulated hoof bath solution and to use waste products to adsorb excessive Cu from Cu-affected soils.

We utilized lime waste and fly ash from the Amalgamated Sugar Company, LLC (Twin Falls, ID) to identify Cu sorption maximum as a function of pH. In triplicate, solutions containing one gram of material and increasing Cu concentrations (0, 2500, 5000, 12500, 25000 ppm Cu) were shaken for one month buffered at either pH 6, 7, 8, or 9. Materials shaken at pH 6 adsorbed the greatest amount of Cu, but concentrations up to 250,00 ppm did not maximize all adsorption sites. Thus, additional solutions containing waste materials and Cu concentrations of 75000 and 100000 ppm Cu were shaken for one month at pH 6. Results showed that at pH 6, lime waste and fly ash adsorbed a maximum of ~ 45000 and 26000 ppm of Cu. The use of lime waste to sequester Cu from spent dairy $CuSO_4$ hoof baths appears to be a viable option.

Because lime waste adsorbed a greater quantity of Cu as compared to fly ash, we investigated the ability of lime waste to sequester Cu from Cu-affected soils. A soil from the Logan Soil Series (Typic Calciaquoll; pH 8.0; CEC = 14 meq/100g; % lime = 50%) which had received 0, 250, 500, or 1000 ppm Cu approximately one year earlier was utilized. Using a completely randomized design with four replicates, lime waste was applied at 0, 0.5, 1, and 2% by weight (~0, 10, 20, and 40 tons/acre), thoroughly incorporated, and allowed to incubate at 90% of field capacity for 3 months, after which 15 alfalfa (*Medicago sativa* L.) seeds were planted in each pot. Plants were allowed to grow for 2.5 months, and then were harvested at ½" above the soil surface, oven dried at 60°C for 72 hours, ground, weighed, and analyzed for total Cu content. Soils were air-dried, ground to pass a 1/16" screen, and then diethylenetriaminepentaacetic acid (DTPA; a measure of plant-availability) extractable Cu was measured. Soils were also subjected to a sequential metal extraction procedure which identified Cu associated with a) soluble species, carbonates, and cation exchange sites, b) iron and manganese oxyhydroxides, c) organic matter and sulfides, and d) residual phases. Increasing soil Cu application rate decreased alfalfa yield, but increasing lime waste application rate had no effect on improving alfalfa yield. Increasing soil Cu application also increased plant Cu concentration, while increasing lime application rate caused a decrease in plant Cu concentration. Increasing soil Cu application increased DTPA extractable Cu content, while increasing lime application rate did not affect extractable soil Cu content. Increasing Cu application rate increased Cu bound in all soil phases. Lime waste significantly affected Cu associated with most soil metal phases, but the changes were not large enough to help decrease soil Cu concentrations to below levels that would affect alfalfa growth and Cu accumulation. The use of lime waste to sequester Cu from Cu-affected soils, unlike from solution, does not appear to be a viable treatment process. Results of these studies will be published in a peer reviewed journal later this year.

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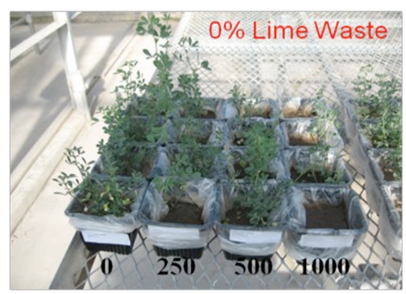

measure swath width or pattern, 3) must calibrate each spreader, and 4) better calibration results occur when using multiple tarps at each speed setting.

Swath Width and Distance: Area Method. With this method, the applicator spreads a full load of manure in the field. The width of the swath and distance of spread is measured. Application is estimated by dividing the weight of manure spread by area of application. If application rate is outside the planned range, the applicator applies a second load of manure and varies ground speed or discharge rate from the spreader. Through trial and error, the applicator finds the appropriate speed and discharge rate to achieve desired application rate. The advantages of this method include: 1) application rate can be tested at any time, 2) suitable for any size operation, and 3) easy to perform. Disadvantages include: 1) requires accurate estimate of load weight, 2) requires accurate estimate of spread width and distance, 3) underestimates application rate because it does not include overlap application, and 4) time consuming to measure several loads.

Swath Width and Distance: Tarp Method. The objective of this method is to measure the width of the swath and determine the distance between applications to optimize manure uniformity plus determine application rate from entire load. A series of tarps are laid out in the field and the applicator drives over the center of the tarp pattern. Maximum application rate is determined from the tarps in the center. The side tarps are weighed to determine the point where side application is approximately 50% of the maximum application rate. Optimal interval between swaths (on center) is equal to two times the 50% distance. For example, if the 50% point occurs 7 feet from the center of the application swath, then the next swath should occur 14 feet from the previous swath (distance measured from center of swath).

The advantages of this method include: 1) it detects uneven spread patterns, and 2) determines optimum overlap distance which should increase application uniformity. Disadvantages include: 1) time consuming to measure distance traveled, weigh tarps, and perform calculations, and 2) accurate estimate of load weight required.

Loads per field is the quickest and easiest method for estimating application. The evaluator needs three pieces of information: number of spreader loads applied to field, area of field, and average load weight. Average application rate is calculated by multiplying the number of loads times the average load weight and then dividing by the number of acres. This method has three primary disadvantages. First, application rate in not determined until the job is done. It is too late to adjust the rate if it is above or below target rate. Second, the loads per field method does not measure application variability across the field. In some situations, average application rate will be correct but there is a several fold difference in application rate across the field. Crop yield will vary dramatically across the field with this scenario. Third, loads per field requires a reasonably accurate average load weight.

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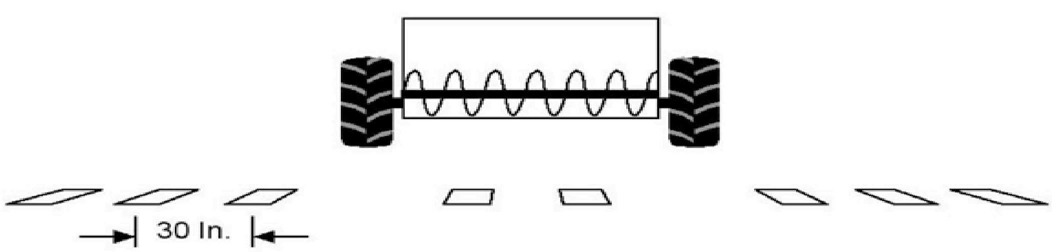

Figure 1. Common sheet layout pattern for a rear-beater spreader.

Phosphorus Uptake By Silage Corn in Southern Idaho, continued from pg. 1

Idaho. Yield (on a dry matter basis) was not affected by increasing Olsen P from 3 to 200 ppm.

Average P concentration in the whole plant tissue at harvest was 0.21 %, with 39 of the 42 fields sampled between 0.15 and 0.25 %. Increasing levels of Olsen P in the soil from 3 to 200 ppm had no significant effect on tissue P over 20 ppm, therefore there is little potential for luxury P uptake with higher Olsen P (figure 1).

Table 1. Whole plant tissue analysis, yield, dry matter, and uptake for corn silage harvested from 21 fields in 2008 and in 2009 throughout Southern Idaho with varying fertilizer and manure application histories. Soil test P varied from 3 to 300 ppm Olsen P.

Variable	Mean	Std. Dev	Minimum	Maximum
Yield (wet ton/ acre)	31.7	7.0	15.7	47.2
Yield (dry ton/ acre)	11.2	2.6	5.2	17.4
% dry matter	33.8	6.4	23.8	54.5
Tissue P (ppm)	2078	361	1163	3067
P uptake (lb/ acre)	43.7	11.7	17.0	76.3

Based on our findings, it appears that the corn tissue % P value used in all nutrient management plans derived from the Idaho OnePlan June 2007 will likely underestimate P removal by corn silage. Using updated values based on our findings, these producers will be able to account for more P removal from corn silage, and therefore apply more manure to their fields.

However, producers who have nutrient management plans that were written before June 2007 were grandfathered in with P uptake based on a tissue P of 0.26 %. As only 3 of the 42 fields measured at or above 0.26 % tissue P, producers using this estimate for P removal are most likely overestimating P uptake by corn silage, over-applying manure, and therefore increasing Olsen P concentrations. Producers with older nutrient management plans should use the 0.21 % value for tissue P supported by this study, or actual values measured from the harvested corn chop, when estimating P removal by silage corn. Silage corn P removal estimates that are more accurate should lead to better balance between manure P, applied P, and crop P removal. This will help to avoid further enrichment of southern Idaho soils.

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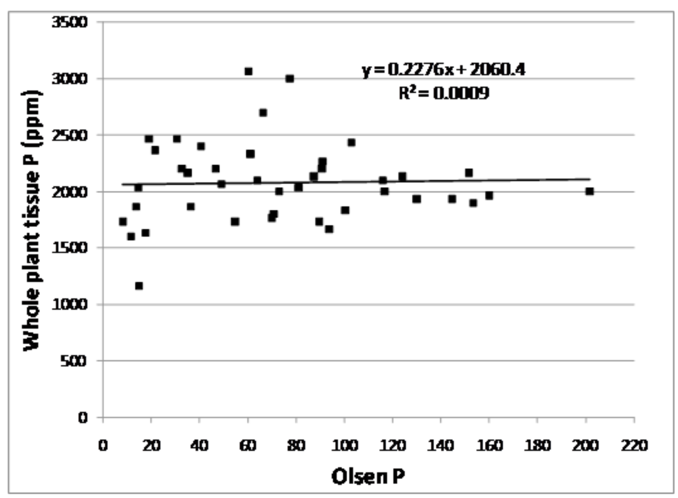
Figure 1. Whole plant tissue P analysis related to Olsen P for corn silage harvested from 21 locations in 2008 and 21 locations in 2009 throughout southern Idaho.



"Silage corn P removal estimates that are more accurate should lead to better balance between manure P, applied P, and crop P removal."

LIMITATIONS OF UREA AS A NITROGEN SOURCE

By Brad Brown

Urea's high N analysis and easy handling have made it the most popular dry N source for southern Idaho. Our reliance on urea increased with 9-11, and the loss of ammonium nitrate from the marketplace.

While urea has much to recommend it as a dry N source, it has its limitations. There is potential for loss of ammonia N from urea applied as a top-dress to soils, particularly if subsequent rainfall is sufficient to dissolve urea but not enough to move it beyond the surface and into the soil. A number of factors affect ammonia loss including soil surface pH, clay content, organic matter, temperature, and soil moisture to name a few. A Montana publication, "Management of Urea Fertilizer to Minimize Volatilization" Montana State University Extension Bulletin EB173 covers many of the principles involved with ammonia volatilization from urea. The publication is available online for downloading at http://msuextension.org/publications/AgandNaturalResources/EB0173.pdf.

In addition to volatile ammonia N losses, ammonia toxicity is another limitation relative to other dry N sources. Urea placed too close to seed can both delay and reduce emergence. Urea toxicity to seed is well known when it is banded with seed. Less known are the affects of broadcast urea on crop emergence. Broadcast urea at low to moderate N rates has little effect on emerging crops. At higher rates, urea can cause significant reductions in plant populations.

A study at the Parma R & E Center was conducted for three years to compare fall broadcast applied urea with other dry fertilizers for onions planted the following spring. Urea was broadcast at rates of 100 and 200 lb urea N/A in mid November and shallowly incorporated just prior to the forming of beds. Onions were planted the following March. Figure 1 shows the poor onion stands in the rectangular plot area resulting from the excessive 200 lb urea N rate applied four months earlier. Significant reduction in stand resulted in two of the three years of the study. Of course yields were also reduced when stands were reduced as much as shown in the picture. Stands were affected by urea N rates as low as 100 lb urea N per acre under these conditions. Slow release urea did not *Continued on page 6*

Figure 1. Onion stand from fall applied urea at 200 lb N/acre.

Limitations of Urea as a Nitrogen Source, continued from pg. 5

always fully mitigate the effects of urea at the highest N rate, but they were safer.

The results caught even the researchers by surprise. With the urea applied four months earlier, we did not anticipate the striking effects of the high urea N rates on onion stands. Dry and nearly frozen soils in mid November precluded dry urea dissolution and conversion to ammonia. Little conversion of urea in frozen soils occurred over winter. Warming soils in March provided temperatures that allowed the enzymatic conversion of urea to ammonia. Ammonia release from urea increases soil solution ammonium-N concentrations. Under higher temperatures, microbial nitrification converts the ammonium in solution to nitrate-N which is less phytotoxic to seed. However, in cold soils, as in March, the nitrification process is slower than the conversion of urea to ammonia and ammonia concentrations increase to the point of affecting germinating seeds.

Shallow incorporation of urea is not uncommon prior to fall bedding. Soils in the surface two to three inches cool more rapidly than deeper soils in the fall and are likely to be dryer; both conditions can slow urea hydrolysis. Shallow incorporation also concentrates the fertilizer N in the seed planting depth. Earlier or deeper incorporation of fall applied urea would likely have had less influence on onion seed germination and emergence. However, fall applied urea N, even when it does not affect onion stand has not been as effective as spring side-dressed N for onions. A delayed onion planting may also have avoided the effects of urea on final plant populations.

As in our study, the affects of late fall shallowly incorporated urea N may not occur every year, depending on conditions. Urea can be an effective N fertilizer for onions but high one-time broadcast N rates can be problematic.

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Questions from the field

Will constant irrigation acidify our alkaline Idaho soils?

The addition of water to arid, alkaline soils can lower soil pH by accelerating the following acidifying process: 1) Leaching of salts (calcium, magnesium, potassium, and sodium), 2) Plant uptake of salts, 3) Decomposition of organic matter, 4) Mineralization of organic nitrogen, and 5) Oxidation of sulfur. In Idaho, leaching of salts has the greatest impact on lowering soil pH. Factors that contribute to deep percolation include deep sandy soils, furrow irrigation, and poor irrigation management (over-irrigating, poor timing, poor distribution, etc.).

While the processes listed above are going on to some degree in all irrigated fields, alkalinizing processes usually prevent soil pH from decreasing to any significant degree. These processes include 1) Upward movement of soil water through evaporation and transpiration, 2) Continuous release of salts from soil minerals (including free lime), and 3) Addition of salts from irrigation water, fertilizers, and manure applications.

So, to finally answer this question directly, if you have a deep sandy soil, high rates of percolation, little free lime, heavy sulfur inputs, and minimal salt inputs, you could potentially see your soils acidify over the long-term. As the majority of irrigated fields in Idaho do not meet these qualifications, most growers will not see any changes in soil pH related to irrigation over the long-term.

NITROGEN AND PHOSPHORUS FERTILIZER PLACEMENT IN CORN PRODUCTION

By David Tarkalson and Dave Bjorneberg

The use of strip tillage and other conservation tillage practices are used to conserve soil and soil water through residue management and reduce tillage costs in many areas of the Corn Belt. However, in the Pacific Northwest these tillage practices are less common. Strip tillage is becoming more common in the sugar beet industry in southern Idaho, and due to the high dairy cow populations, corn production is increasing. The dual use of strip tillage for sugar beet and corn production will likely continue to develop, increasing the need for strip tillage best management practices in this region.

Strip tillage is a practice that creates a residue free and tilled zone, approximately 6 to 15 inches wide and 6 to 8 inches deep. The remaining portion of the field is not tilled and the residue from the previous crop remains on the soil surface. Strip tillage allows for deep banding of fertilizers via a shank to a depth of at least 6 inches. Comparisons of common fertilizer placement strategies with strip tillage needs to be compared to common conventional tillage fertilizer placement practices in order to assess overall differences between the systems. Many studies have observed mixed results when evaluating fertilizer placement in corn production. Most studies, though, have shown that starter fertilizer placed in a band near the seed can benefit early corn growth. However, increases in corn grain yields are less common. Low initial soil test phosphorus concentrations are the most common conditions in which corn grain yields increased as a result of starter fertilizer applications.

In this study, we evaluated the effects of common and logical nitrogen and phosphorus placements with strip tillage and conventional tillage on grain yield on four sites during 2007 and 2009 at the USDA-ARS Northwest Irrigation & Soils Research Laboratory at Kimberly, ID. During each year, two locations (eroded and non-eroded soils) were utilized in the study. Band placement of fertilizer with strip tillage increased corn grain yield by 12.5% (11 bu/acre) and 25.9% (26 bu/acre) on the eroded locations compared to broadcast nitrogen and phosphorus and 2×2 nitrogen (2 inches to the side and below seed with planter) under conventional tillage in 2007 and 2009, respectively. The grain yields for all treatments and years ranged from 86 to 125 bu/acre on the eroded sites. There were no differences in grain yields between all fertilization practices on the non-eroded locations during both years of the study (average grain yields were 100 and 124 bu/acre in 2007 and 2009, respectively). The increased grain yields on the eroded areas likely resulted from better utilization of phosphorus by the plant due to concentrated placement in a band below the seed and not due to difference in tillage practice. The eroded areas of the study had free lime content that was on average two times greater than on the non-eroded areas (20.3 vs. 10.2% free lime). The band application of the phosphorus likely reduced the "tie up" of plant available phosphorus with calcium. The differences in free lime content between sites resulted from the erosion of topsoil on the top end of the fields, exposing the calcareous subsoil associated with many soils in this region. Reduced costs of strip tillage with associated band placement of fertilizer could increase the economic productivity of many acres of eroded/low fertility land in the Pacific Northwest used for corn grain production.

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UPCOMING EVENTS

July 21 —Twilight Tour. Kimberly, Idaho. Call 736-3605 for more information.