MANAGEMENT OF MANURES IN CORN AND SORGHUM

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ABSTRACT

There are two "camps" in New Mexico when it comes to utilizing manure for production agriculture: regulated versus unregulated. Those that are regulated by the state environment department have to adhere to rules promulgated from the water quality control commission. Those that are not tied to regulations either apply manure based on affordability or actual nutrient value. On close inspection it is possible to see that manure can be used in both "camps" for corn or sorghum to meet yield and quality goals, meet environmental regulations, and be good stewards of the land.

Key Words: corn, sorghum, manure, nutrient management, salinity

INTRODUCTION

Silage is a major component in the feeding of livestock such as beef and dairy cows. A typical 3000 cow dairy may require 15,000 tons of silage for the year. Either corn or forage sorghum can meet this need as long as growing conditions lead to a high quality feed to help meet target milk production. Variety selection plays a major part in meeting quality standards but so does meeting the basic needs of water, plant nutrition, and crop protection from insects, weeds, and diseases. Manure from dairies and feedlots can be an asset to improving overall soil fertility for crop production but it can also be a liability in the form of salinity, sodium, and excessive nitrogen and phosphorus. Most states have regulations in place that require an accounting of nitrogen and/or phosphorus in order to protect both surface and underground water resources.

Most of the concerns with manure stem from over-application of this resource. Hauling distances, lack of spreading equipment calibration and lack of testing the soil and manure for nutrient content contribute to either poor crop production or increased pollution potential from excessive nitrate or phosphorus. These concerns can be minimized by proper sampling of manure, soil testing, timing nutrient applications, practicing good irrigation water management, and following crop growth.

Corn and forage sorghum for silage can be similar in feeding value but management is different from one crop to the other. One distinct advantage to forage sorghum is that it takes less water than corn to produce almost similar yield and quality. Sorghum is also more heat tolerant than corn and will often exceed corn yield under drought or hot growing conditions. Another advantage is that sorghum is more tolerant to salinity than corn.

The objectives of this paper are to show: 1) importance of soil testing; 2) how manure rates are determined; 3) timing applications to meeting crop needs.

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STRATEGY 1: SOIL TESTING FOR SALINITY CONTROL AND NUTRIENT NEEDS

Critical to determining how much manure that may be needed in growing corn or sorghum is to know what the soil is like both in nutrient content and salinity. A standard analysis of the topsoil should include pH, salinity, sodicity, plant available N (organic matter and plant available N in the form of nitrate-N and ammonium-N), phosphorus (Olsen procedure for high pH soils), potassium, exchangeable sodium, magnesium and calcium to determine the sodium adsorption ration (SAR), and micronutrients (iron, zinc, manganese, and copper). An estimate of soil texture is also helpful with making management decisions.

Salinity. Corn is moderately sensitive to salinity with a saturated paste threshold of 1.7 mmhos/cm and a slope of 12% (Rhoades et al., 1992). Sorghum, on the other hand is moderately tolerant with a saturated paste extract threshold of 6.8 mmhos/cm and a slope of 16% (Rhoades et al., 1992). Should a soil test come in with a salinity measure of 3 mmhos/cm sorghum would not be affected by the salinity. Corn on the other-hand, would have a potential yield loss of 15%. The recommendation for corn would state that the salinity should be lowered by leaching the soil with excess water. Excess water may or may not be available for leaching and there is also a chance that leaching the soil would move nitrate-N further into the profile making it less likely to be taken up by an annual crop such as corn or sorghum. Leaching nitrates is a loss of fertilizer value and is not popular with New Mexico's regulatory agency.

The saturated paste method, while usually more expensive to perform at soil testing labs, has worked well in New Mexico to predict yield reductions due to salinity. However, 1:1 soil:water can be misleading so a relationship between 1:1 and saturated paste extracts was developed using several different NM soils (Figure 1). This allows for a better interpretation of crop response to salinity using information by Rhoades et al., 1992. It also helps plan irrigation water management for salinity control.

Sodic Soil. Soil testing is very useful for determining whether or not there will be water infiltration issues due to soil aggregate dispersion due to the sodium ion. A soil test report will usually calculate the rate of gypsum or other suitable calcium source needed to reclaim the soil. Hopefully, the soil will not have excessive amounts of nitrate as leaching must occur after adding a calcium source in order to reclaim a sodic soil. Leaching will reduce the amount of plant available N in the case of high nitrate-N in the soil profile.

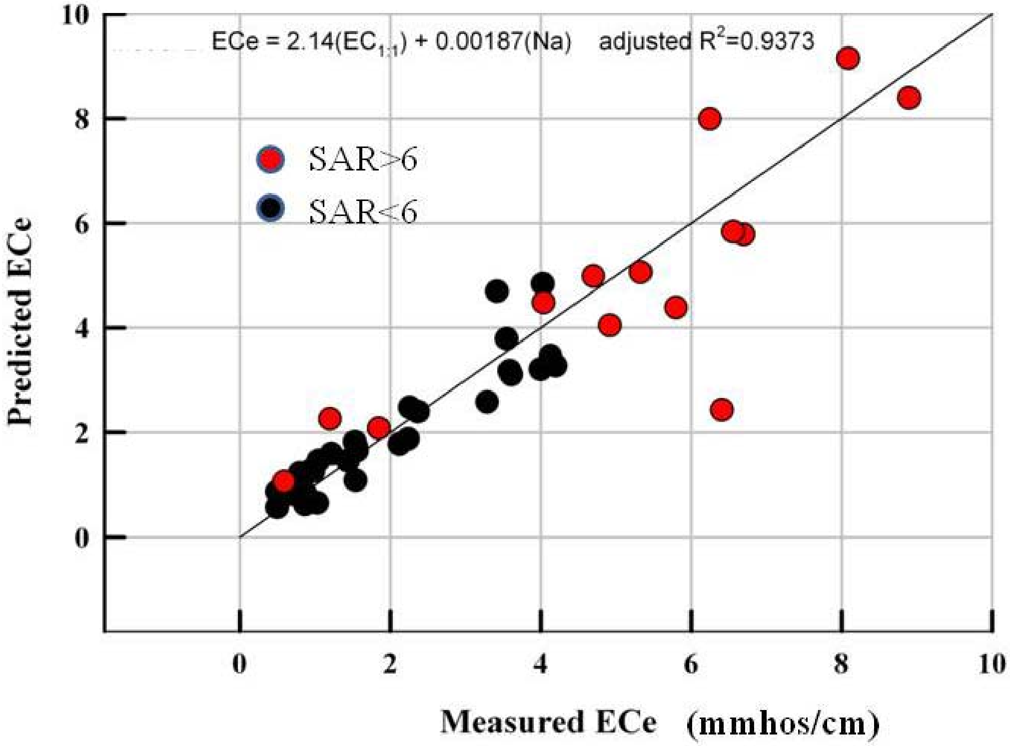

Figure 1. Model for predicting ECe when provided 1:1 EC from soil test results in NM.

Organic Matter. Manure applications, over time, can increase soil organic matter. This is a good thing for western soils that are typically low in soil organic matter. Soil organic matter mineralizes nitrogen during the growing season and is accounted for in many soil test recommendation. New Mexico credits 30 lb N/A-ft per percent organic matter.

Nitrate-N or Total Inorganic-N. New Mexico's Groundwater Quality Bureau requires dairy farms (and other permit requiring operations) where manure or effluent water is applied to cropland to report nitrate-N concentrations to a depth of three feet, in one foot increments. Nitrate-N that increases over time in the third foot will often result in a change in management to lessen the amount of nitrogen moving beyond the root zone. Sampling done with depth in New Mexico suggests that leaching is more prevalent on pivot irrigated fields that receive manure as compared to those that had received synthetic fertilizer (Figure 2).

Forage sorghum could be a better choice than corn for managing nitrate. Stone et al., (2001) found that maximum rooting depth of grain sorghum was 6 feet. Nickel et al., (1995) found that corn roots reached as far as 2.87 feet. It isn't a bad idea to sample to at least three feet in order to assess nitrate-N with depth. This sampling aids in assessing how well the crop is keeping nitrate-N in the root zone of the crop or if significant leaching is occurring.

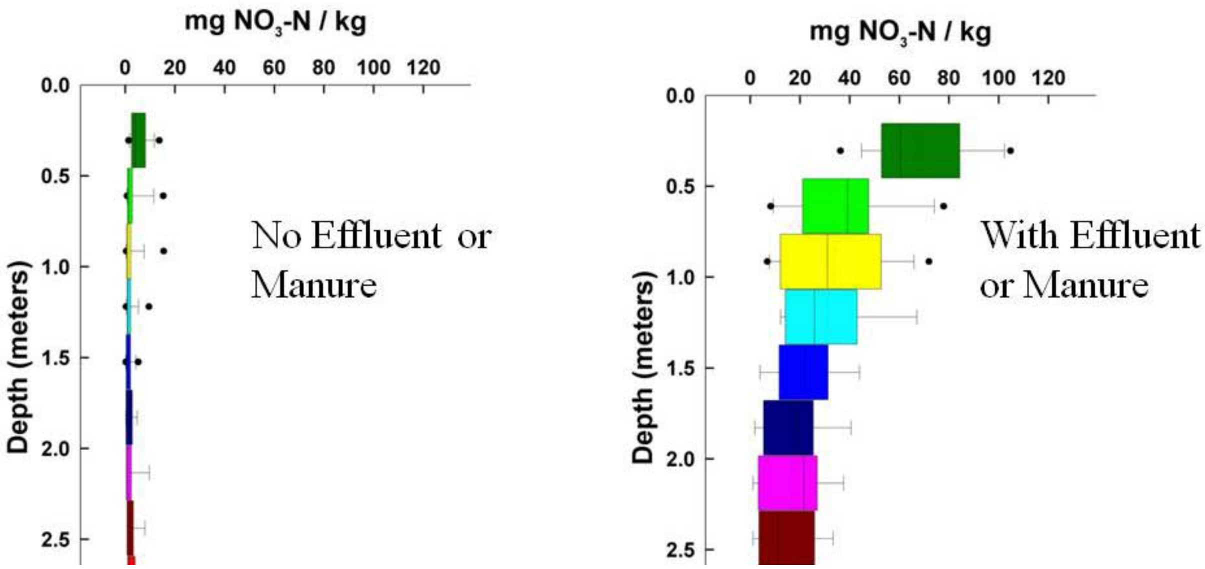

Figure 2. Box plots of soil nitrate-N with depth on farms that had received no dairy effluent water or manure versus those that had.

Both corn and sorghum can accumulate nitrate-N in their stalks which isn't a problem as long as the concentrations in the feed stay below 2500 ppm. The ensiling process will also reduce the nitrate concentration in the forage by 40-60%. Ensilage should always be checked for nitrate-N concentrations before being fed especially if grown under high nitrate-N conditions.

Preplant testing of soil nitrate is beneficial in assessing the need for nitrogen for corn or sorghum. The need for nitrogen will be balanced against yield goal, application timing, and if any leaching is expected prior to the critical period of plant growth. Pre-sidedress soil nitrate testing can be very effective at assessing the need for additional nitrogen before it is too late to be of any good to the plant. Most soils that have received manure do not need any starter N. Soil test levels above 25 ppm when sampled at the 4-leaf stage (just prior to sidedress application) are considered adequate.

Post harvest soil nitrate-N concentrations are useful for evaluating vulnerability to leaching prior to the next crop (Hart et al., 2009). Soil nitrate-N levels less than 20 ppm post-harvest can be considered satisfactory.

Phosphorus. New Mexico and other western states generally prefer using sodium bicarbonate extractable P (Olsen P) for determining plant available levels. Manures added to soil typically increase plant available P. Work with various manures done in Idaho by Leytem and Westermann (2005) showed that water soluble and Olsen P increased in order of Fertilizer P > Olsen P > liquid P > solid or composted P when applied to calcareous soil. But P availability from swine manure P > inorganic P and beef manure P < swine P and fertilizer P.

Fertilizer P is recommended for sorghum and when Olsen-P levels are less than 20 ppm (Marsalis and Bean, 2010) and below 15 ppm for corn (Davis and Westfall, 2009). It is entirely possible that fields that have received manure over an extended period will have Olsen-P levels well above 100 ppm. In many areas the P-Index tool is used to assess whether manure can be applied at all, applied at P removal rates, or at rates to meet partial or full N rates.

Potassium. Ammonium acetate is the preferred method for determining the need for K fertilizer. Dairy manure sampled from NM dairies showed an average of 55 lb K_2O per dry ton. Moist soils with more than 120 ppm K at the start of the season is usually considered adequate (Davis and Westfall, 2009). Too much potassium in the soil can result from long-term applications of manure. Grass crops like corn and sorghum should always be evaluated for grass tetany concerns grown under high soil K conditions.

Micronutrients. Iron, Zinc, Manganese and Copper are routine analyses that should be determined for both sufficiency and possible toxicity. Copper toxicities have been observed in corn and sorghum where DTPA extractable Cu exceeds 14 ppm. High Cu soils have been observed in NM where diary effluent water has been applied over 10 to 15 years.

STRATEGY 2: DETERMINE CROP N REQUIREMENT AND MANURE N VALUE

The soil test data is used to predict how much additional fertilizer will be needed for production under ideal conditions. Corn and sorghum can have similar N requirements. Corn recommendations vary but approach 260 – 300 lb N/A at yield goals above 30 Ton/Ac. Each state has specific recommendations for N rate but all give credit based on soil test values, previous crop, and yield goal.

Soil tests that reveal low levels of nutrients makes manure a good choice as a starting point in nutrient application. Yield trials can be very helpful in determining the best varieties with best yield. The maximum yielding varieties, however, may not always yield the most milk per ton of silage for the dairy. Traits to consider for forage sorghum silage production include (1) high grain and dry matter yield, (2) moderate maturity ratings, (3) moderate height, (4) high lodging resistance, and (5) resistance to insects and disease (Marsalis and Bean, 2010). Additionally, there are genotypic variation in forage sorghums and producers may be wise to consider selecting 2-3 different cultivars for silage production.

The majority of N in manure is in an organic form. As such, Gale et al., 2006, found that N availability could be predicted under warm moist conditions if the C/N ratio of the manure were known. In their study they found that dairy manure had C/N of 20-32 and averaged 9% potentially available N. A sampling of 90 dairies in New Mexico revealed a C/N range from 11 – 46 with a median of 16 which would put the potentially available N near 18% or roughly 7 pounds of plant available N per dry ton. If 200 lb N/A were needed for either corn or sorghum then a target application rate would be 29 dry tons of dairy manure per acre. However, that same rate of manure would supply 182 lb P_2O_5/A and 384 lb K_2O/A. Overall, it would be best to use local data on how much N will mineralize from manure during the growing season. Regardless, the majority of the N is mineralized within the first 30 days of application and as such should be applied in time to meet peak demands of either corn or sorghum.

STRATEGY 3 – TIMING MANURE APPLICATION

Corn for silage should be monitored closely at all times during the growing season. The critical time to be sure of adequate N for crop growth is when corn is at the 4^{th} – 6^{th} leaf. This stage of growth begins a period of rapid nutrient uptake by the corn plant. The rate of N uptake peaks at a point mid-way to maturity. It is at this point that most N should be available to the plant according to the C/N ratio of dairy manure.

For sorghum there is a key growth stage referred to as the Critical Differentiation Point (CDP). The stage occurs approximately 30 to 35 days after emergence, perhaps a few days longer for full-season hybrids, and sooner for early maturity hybrids. It can correspond with the 7 to 8 leaf stage. According to Marsalis and Bean (2010) sorghum can tolerate significant stress from drought, hail, and even freezing temperatures prior to this stage. Stress at the CDP stage can significantly impact yield. The growing point is above the soil surface, and the plant is approximately 12 to 15 inches tall. It is at this point that nitrogen needs to be readily available for sorghum growth including that coming from manure.

CONCLUSIONS

Manure provides the most benefits on soils with deficient to adequate levels of nutrients. Soils with high to excessive levels of nutrients are not a good choice for manure use, because the nutrients in manure are less likely to benefit crops and more likely to leach into groundwater or run off into surface water. If you have excessive levels of nutrients in your soil, limit applications of those nutrients to recommended starter levels, and use an alternative source of organic matter input, such as growing cover crops. Not knowing the nutrient content of manure can lead to large errors in nutrient application rate. We strongly advise you test the manure you plan to use. If you buy manure from a commercial source, they should be able to provide you with nutrient test values; you would not need to do further testing.

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