LAGOON WATER, MANURES AND BIOSOLIDS APPLIED TO ALFALFA: PROS AND CONS

Roland D. Meyer, Blake L. Sanden and Khaled M. Bali[1]

ABSTRACT

Alfalfa is the major forage used for feed in the dairy and other animal industries in California and the United States. It is grown on approximately ten percent of the irrigated acreage in California and is a major forage crop in many other states. The large numbers of dairy and other animals as well as the large human population generate large amounts of waste materials that need to be utilized or disposed of in an environmentally safe manner. Animal wastes are a valuable resource in the production of a number of forage crops. Many, including alfalfa require large quantities of nitrogen, phosphorus, potassium and other nutrients which can be supplied by lagoon water and solid manures. Besides nutrients, waste products such as manures and biosolids can furnish organic matter which increases the organic matter content of soils, aids in the reclamation of salt affected soils through increasing water infiltration and assists in developing soil structure. Alfalfa is particularly beneficial because it requires large amounts of nitrogen and can utilize nitrate-nitrogen that has been moved to the lower depths of the soil profile. Unfortunately, manures may contain weed seeds; high levels of salts such as sodium and chloride, and in some cases promote disease and insect problems. Biosolids may contain elevated concentrations of elements such as molybdenum and other heavy metals that could increase animal health problems.

Key Words: alfalfa, nutrients, nitrogen, phosphorus, potassium, lagoon water, manure, biosolids, hay quality, weed and disease problems, water infiltration, soil reclamation, nutrient uptake-groundwater protection

INTRODUCTION

Alfalfa is grown on nearly ten percent of the irrigated acreage or one million acres in California and on large acreages in many of the other states in the United States. It requires large quantities of the nutrients nitrogen, phosphorus, potassium, calcium, magnesium, sulfur and, others like the micronutrients in smaller amounts. Although corn, cereals and other nonlegume crops will provide greater economic benefit to the producer from the nitrogen contained in lagoon water, manures and other wastes, alfalfa production can be enhanced and serve as desirable crop to receive these waste materials. Alfalfa with its deep rooting system is often able to utilize nitrate-nitrogen that has been leached below the root zone

[1]Roland D. Meyer, Extension Soils Specialist, email: rdmeyer@ucdavis.edu, University of California, LAWR Dept., One Shields Ave., Davis, CA 95616; Blake L. Sanden, UCCE Farm Advisor, Kern County, 1031 S Mt Vernon Ave., Bakersfield, CA 93307; Khaled M. Bali, UCCE Farm Advisor, Imperial County, 1050 East Holton Rd., Holtville, CA 92250; **In** 2000 National Alfalfa Symposium, 10-12, December, 2000, Las Vegas Hilton, Las Vegas, NV.

of other crops. There are however, some increased management challenges such as greater weed populations, perhaps more disease and more likelihood of waste materials being harvested in the hay.

LAGOON WATER APPLICATIONS

Many dairies in California have liquid flush systems to collect the manure from concrete lanes and alleys. The solids are removed from the liquid by mechanical separating devices, settling ponds or basins. The solids may be hauled and spread on the dairy or adjacent farms, dried and used for bedding or composted and moved off the dairy to export some of the excess plant nutrients. Depending on the method used on the individual dairy the solids percentage in the lagoon water may vary considerably. Total solids concentrations in samples collected from dairies in California ranged from 0.5 to 2.5% (Meyer and Schwankl, 2000). The lagoon water is stored on the dairy and piping systems convey it to mixing chambers or 'boxes' where it is mixed with incoming irrigation water and delivered to fields growing crops. In order to provide informed application of nutrients, these piping systems must be equipped with 1). flow measuring devices and 2). sampling valves to determine nutrient concentrations so that the amount delivered to each irrigation check can be estimated while irrigating and final application amounts calculated after each irrigation event. Meyer and Schwankl (2000) found that total nitrogen (N) concentrations in liquid manure ranged from 115 to 848 ppm in 19 ponds sampled in the summer of 1996. Ammonium-nitrogen concentrations were 35 to 77% of the total nitrogen. In the lagoon water applied in one of the case study dairies, the phosphorus (P times 2.29 equals P_2O_5) content ranged from a trace to approximately 35% of the total N and potassium (K times 1.21 equals K_2O) ranged from 50 to 150% of the total N. Since a major fraction of the nitrogen and even more of the potassium will be contained in the lagoon water rather than the solids, it may be necessary to use the potassium concentration in lagoon water to determine the rate of application to alfalfa. Applying high rates of potassium may be of some benefit in suppressing the effect of certain diseases, but producing alfalfa that contains higher than 2.5 to 2.75% potassium may be undesirable when building rations for most types of animals. Applying no more than 75 lbs K/A (90 lbs K_2O /A) at a single application will reduce the likelihood of excessively high potassium concentrations in the forage. Potassium fertilization reduces the magnesium concentration in the plant but with generally high magnesium levels in the soils and alfalfa of California, this is of minor concern. There are however sandy soils where magnesium as well as potassium levels may be low for the production of high yielding-high quality alfalfa. Magnesium applications may be necessary to increase the forage concentrations up to the desired range (>0.15%). Reductions in the concentration of sodium in alfalfa by potassium may be of some benefit in California and other Western States because of the high sodium levels in the soils and in the alfalfa plant.

MANURE APPLICATIONS

The plant available phosphorus, potassium and other nutrients are known to increase following the application of manure. Alfalfa yields are often higher following manure applications as compared to equal rates of fertilizer phosphorus and potassium or nitrogen, phosphorus and potassium (Kelling and Schmitt, 1995, Meyer, 1989). It is not well understood why this occurs, whether the manure is

supplying other nutrients or it has an effect on the physical properties of soil such as water infiltration, soil aggregation to improve aeration and drainage or some other aspects of plant growth. Meek and coworkers (1982) found considerable increases in soil organic matter and water infiltration as well as greatly reduced total infiltration times in the latter part of the alfalfa growing season. Mathers, A. C. et al., (1975) found that alfalfa is capable of taking up significant amounts of nitrate-nitrogen from deeper depths in the soil profile before it is moved to the groundwater. Significant reductions in nitrate concentrations were observed in the 0 to 6 foot depth and the 6 to 12 foot depth as well during 2 years of growing alfalfa. As with lagoon water, manures often contain weed seeds and with the nitrogen applications encourage grass and other weed growth in alfalfa. The higher rates of manure applied on the soil surface to established stands of alfalfa may also reduce the effectiveness of herbicides used to control weeds. Some dry manure may even be picked up during the swathing or windrowing operation which may have a detrimental effect on the market value of the hay.

BIOSOLIDS APPLICATIONS

Biosolids or sewage sludges represent another waste product with considerable variation in nutrient concentrations and potential detrimental elements. Nitrogen, phosphorus, potassium and other nutrient concentrations may be nearly in the same range as animal manures but generally have considerably higher concentrations of some micronutrients like zinc, copper, chromium, cadmium, lead, molybdenum and others. In some areas like the San Joaquin Valley and Imperial Valley as well as large areas in several of the Western states where molybdenum concentrations in alfalfa and other forages are naturally very high, even to the point of causing animal health problems, additions of this element if they result in increased concentrations in the forages, exacerbates an already serious problem. Little research has been done to indicate just how serious a potential problem this may be but recent attempts will be presented, as laboratory analyses have not yet been completed. The benefits of utilizing biosolids in soil reclamation where sodium levels are very high also need to be more clearly documented. Food processors have taken a firm stand in that they will not accept produce grown on soils which have received any biosolids for human consumption. This is a risk-based decision and not necessarily based on scientific investigations. As with manures, biosolids have most of the nitrogen in organic forms which is not released in any consistent pattern. Based on a number of field observations, nitrogen release rates the first year after application are generally in the 30-35% range rather than the often calculated 20%.

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