TIMING NITROGEN APPLICATIONS IN CORN AND WINTER FORAGE

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ABSTRACT

Rates and timings of nitrogen applications to forage crops have taken on new importance because of the need for more precise management of nutrients in dairy manures.
Book values can be used to determine potential nitrogen uptake of both crops, but a better value can be calculated using yield and nitrogen or protein content. Corn nitrogen uptake for silage corn appears to follow a 2/3 prior to silking, 1/3 after silking pattern; rather than a traditional pattern for grain corn where the majority of the nitrogen is taken up prior to silking. Winter forage nitrogen uptake patterns are more complex because of differences in planting dates, varieties and nitrogen availability.

Keywords: corn, silage, nitrogen, fertilizer, manure, lagoon water, waste management

INTRODUCTION

Rates and timings of nitrogen applications to forage crops have taken on new importance because of the need for more precise management of nutrients in dairy manures. An understanding of the amount of nitrogen that can be utilized by a crop is important in developing a plan for land application of manure nutrients generated by the dairy. In addition, some dairy operators are installing the necessary hardware and irrigation systems to allow for relatively precise metering of lagoon nutrients into the irrigation system and are using lagoon nitrogen to replace commercial water run nitrogen fertilizers. These controls are necessary to avoid groundwater contamination while at the same time maintaining crop yields.

NITROGEN UPTAKE

Book values for N uptake

There are several sources of information on how much nitrogen is taken off in the aerial (above ground) portion of forage crops. They differ somewhat in the amount of nitrogen allowed. Standard sources for this information include:

1) Western Fertilizer Handbook, 8th edition published by the Western Fertilizer Association
2) Land Application of Sewage Sludge, a Guide published by the United States Environmental Protection Agency [EPA/831-B-93-002b]
3) Agricultural Waste Management Field Handbook, chapter 6 published by the Natural Resources Conservation Service [210-AWMFH,4/92]

Of these, the NRCS handbook has by far, the most complete information on this topic.

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Measured values for N uptake

Winter forages can be extremely variable in nitrogen concentration, ranging from low protein, nitrogen deficient oats, to triticale with nitrogen in both the protein and nitrate form. Where nitrogen is excessive, there is also the potential for excessive amounts of nitrate to be accumulated in the plant, posing a hazard for the animal consuming it. While it is possible to obtain some very high uptake values, on a whole field basis such values are not common. One reason is that in order to obtain these values, usually very excessive amounts of nitrogen are applied, such as after application undiluted dairy lagoon nutrient water. Such high application rates often bring other yield limiting factors such as waterlogging, salt burn, and lodging.

The most accurate way to determine nitrogen uptake is to measure this value directly when the crop is harvested. Since most forage crops involve harvesting the entire aerial portion of the crop, the yield and nitrogen content can be used to calculate crop removal. A representative sample can be taken and sampled for percent total nitrogen. Percent total nitrogen (divided by 100) multiplied by pounds of dry matter per acre will give pounds of nitrogen removal per acre. Nitrogen removal may also be determined from protein content. Multiply pounds of dry matter per acre by percent protein (divided by 100) to obtain pounds of protein per acre. Divide this number by 6.25 to obtain pounds of nitrogen per acre. An alternative method for silage at 70% moisture is to multiply tons per acre by percent protein (<u>not</u> divided by 100) and multiply the result by .96.

TIMING OF APPLICATION

When do crops take up nitrogen?

Corn takes up nitrogen in an S shaped curve, with low uptake during the first 30 days of growth, then taking up nitrogen very rapidly until silking. Uptake after silking is less rapid. Classic work conducted in 1962 (Iowa State) indicated that 75-80% of nitrogen in corn is taken up by silking. This classic work has recently been conducted again using modern hybrids by Schepers and Francis, USDA ARS, at Lincoln, Nebraska. In this study, a silage hybrid with a stay-green trait did continue to accumulate nitrogen after silking. This hybrid took up 61 percent of the total nitrogen prior to silking. (Schepers, unpublished data). This work corresponds well to recent work done in Hilmar, California by Roland D. Meyer et al, where an average of 64% of nitrogen (range 52-79%) was taken up at silking in six location-years (figure 1). This approximately 2/3 – 1/3 ratio was also found in a study by Karlan, et al at Rutgers Research Center, New Jersey in 1984.

Winter forage nitrogen uptake patterns are more complex because differences in planting dates, varieties and nitrogen availability will all influence the pattern of nitrogen accumulation. Where little growth is made before cold weather sets in, relatively little nitrogen uptake will occur. In a normal year in the northern San Joaquin Valley, substantial amounts of nitrogen accumulation occur beginning in late January to early February and continue through harvest. Nitrogen concentration in cereals is highest around flowering, after which the rate of accumulation decreases and the concentration is diluted by the increasing carbohydrate in the grain.

When wastewater is used as a nitrogen source, it is often necessary to make applications of the nutrient water in the fall in order to maximize the amount of lagoon storage capacity going into the winter. If nitrogen is applied during warm weather, there is potential for leaching of nitrate before the crop has made sufficient growth to take up the nutrients. One option to utilize these nutrients is to plant very early in the fall, make a cutting during the winter, and allow the forage to regrow in the spring. Overall yields and nitrogen uptake were higher with this system than with a single cut system (table 1). Cutting during the winter will require a period of dry weather to wilt the silage, and difficulty in getting on wet ground with equipment. Planting early and leaving the crop uncut can lead to disease and lodging problems in the spring.

How much nitrogen can be applied at one time?

Soils vary in their capacity to store and retain crop nutrients. Heavier soils (clays, clay loams) will hold more nutrients than lighter soils can (sands, sandy loams). Nitrogen applied from commercial sources is most commonly in an ammonium form, or in a form that will rapidly convert to an ammonium form. Once in the soil, natural bacterial processes convert the ammonium to nitrate. Ammonium has a positive charge which is attracted to the negatively charged soil particles. Nitrate is negatively charged and is therefore less attracted to soil particles and is subject to being leached out of the root zone during irrigation or rainfall events. Similarly, organic-form nitrogen bound in plant fiber and microbial bodies in manures and crop residues is not prone to being leached until after it has been mineralized into ammonium and then nitrified into nitrate. Nitrate is also subject to denitrification, where bacteria convert the nitrate into nitrogen gas, which is then lost to the atmosphere. Denitrification only occurs in the absence of oxygen, so it is most likely to occur in saturated soils. Heavier soils are more prone to saturation than are sandy soils, so this process can be a source of significant nitrogen losses. Understanding these processes is key to applying nitrogen in a way that will avoid yield losses and prevent leaching of nitrate.

Proper application of nitrogen to forage crops such as corn and winter forage involves applying both the proper total amount of nitrogen, and applying the nitrogen at the proper time. Because soils differ in their capacity to hold nutrients, it may be more feasible to apply nitrogen well in advance of crop need on some soils, but on others, such as sandy soils, it may be necessary to "spoon feed" the crop. Another factor is the rate at which ammonium is converted into nitrate. Since this process proceeds only slowly on cold soils, it may be possible to apply ammonia-form nitrogen in advance of crop uptake during the winter with minimal leaching losses. This can be an important consideration when applying dairy lagoon nutrients because it is often difficult to apply very low rates of nitrogen due to insufficient water available for dilution. In summer, the amount of nitrogen that can be applied at one time is limited not only by potential for leaching of excess, but also by avoiding application of too much salt at one time. In general, applications of 50 lbs of available nitrogen or less can be safely applied assuming good quality dilution water. However, in the early corn irrigations, application rates may be further limited by the need to avoid ammonia toxicity. Applications which supply less than 30 lbs/A nitrogen are recommended for the first irrigation on corn. Applications of over 60 lbs/A ammonium nitrogen are not recommended because of the potential for burn of leaves and excessive losses due to volatilization.

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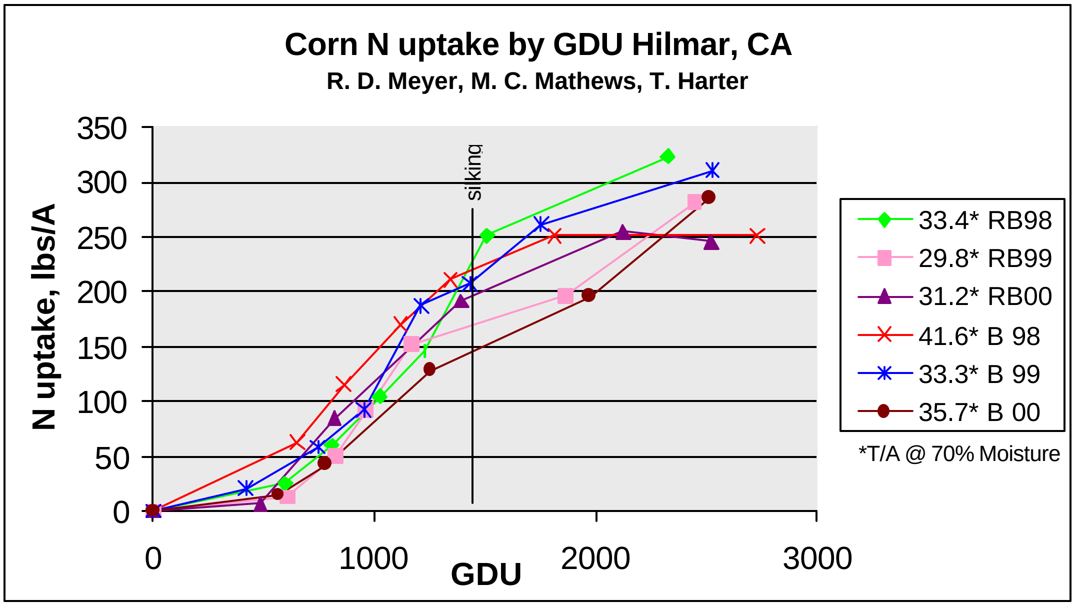

Note: Growing degree units for corn fit California conditions better when a 95° maximum temperature is used rather than the 86°F maximum used in other parts of the U.S.

Yield and Nitrogen Uptake by Planting Date Ceres, 2000

			Yield (T/A @ 70%)		Lbs N/A uptake			
Variety	Planted	stage	1st harvest	final harvest	1st harvest	final harvest	total T/A	total lbs N/A
Cauyse	18-Oct	just past flower		21.3		219	21.3	219
	18-Oct	e flower	2.9	16.1	64	180	19.0	244
	5-Nov	e flower		17.9		209	17.9	209
Dirkwin	18-Oct	full kernal		16.5		218	16.5	218
	18-Oct	1/2 kernal	4.1	15.4	94	183	19.5	277
	5-Nov	1/2 kernal		15.6		194	15.6	194
Swan	18-Oct	milk-sd		19.9		211	19.9	211
	18-Oct	milk	3	17.1	66	175	20.1	241
	5-Nov	milk		19.8		212	19.8	212
T 2700	18-Oct	boot		14.9		189	14.9	189
	18-Oct	boot	2.8	12.6	67	190	15.4	257
	5-Nov	boot		9.9		174	9.9	174