TIMING NITROGEN APPLICATIONS IN CORN AND WINTER FORAGE

Marsha Campbell Mathews 1

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

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.

INTRODUCTION

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

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Modesto, CA 95358, e-mail: mcmathews@ucdavis.edu IN: Proceedings, 31st California Alfalfa and
Forage Symposium, 12-13 December, 2001, Modesto, CA, UC Cooperative Extension, University of
California, Davis. (See http://alfalfa.ucdavis.edu)
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 (not 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.
# REFERENCES


Iowa State University, “How a Corn Plant Develops”, Special Report No. 48
www.extension.iastate.edu/pubs

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**Corn N uptake by GDU Hilmar, CA**

R. D. Meyer, M. C. Mathews, T. Harter

![Graph showing Corn N uptake by GDU Hilmar, CA](image)

**Note:** Growing degree units for corn fit California conditions better when a 95°F 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

<table>
<thead>
<tr>
<th>Variety</th>
<th>Planted</th>
<th>stage</th>
<th>1st harvest</th>
<th>final harvest</th>
<th>Lbs N/A uptake</th>
<th>N/A</th>
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<td></td>
<td>1st</td>
<td>final</td>
<td>1st harvest</td>
<td>final harvest</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>T/A @ 70%</td>
<td>T/A @ 70%</td>
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<td>just past flower</td>
<td>21.3</td>
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<td>244</td>
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<td></td>
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<td>2.9</td>
<td>16.1</td>
<td>64</td>
<td>180</td>
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<td>5-Nov</td>
<td>e flower</td>
<td>17.9</td>
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<tr>
<td>Dirkwin</td>
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<td>full kernal</td>
<td>16.5</td>
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<td>4.1</td>
<td>15.4</td>
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<td>15.6</td>
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</table>
Crop Culture and Nitrogen Application. Corn silage and soybean crops were grown before winter triticale at both sites. Fields in Ames were prepared for corn and soybean planting with one pass of a field cultivator. Management and harvest timing of forage crops is a balance between yield and quality of the aboveground plant matter (Collins and Fritz, 2003). A common goal of forage producers is to harvest the greatest forage quantity possible while keeping forage nutritive value at levels needed to optimize performance of the type and class of livestock being fed (Collins and Fritz, 2003). Full Length Research Paper. Oats forage management during winter and nitrogen application to corn in succession. Deise Dalazen Castagnara. 1. Times and methods of N fertilizer application on corn are widely studied in agriculture, especially in systems exclusive for direct seeding. However, in crop-livestock integration systems, N application studies are still scarce (Sandini et al., 2011). Its handling is more complex due to the great dependence on climatic conditions (Cantarella and Duarte, 2004), and techniques that maximize the absorption of N by plants and minimize their losses to the environment can contribute to improving the sustainability of production systems. Timing nitrogen applications in corn and winter forage. Marsha Campbell Mathews. 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.