Nutrients and Water Quality

Introduction

Successful crop production depends on an adequate supply of nutrients to the crops in order to achieve maximum yield. However, soil nutrients need to be managed properly to meet the fertility requirements of crops without adversely affecting the quality of our valuable water resources.

The nutrients of greatest concern, relative to water quality, are nitrogen (N) and phosphorus (P) where N management mainly concerns groundwater quality.

On a typical dairy farm, all nutrients are cycled from soil, to crops, to animals, and finally back to the soil as manure. However, nutrient recycling on almost all farms is not a closed loop system and nutrients leave the farm in various ways. Sold feed, animals, and animal products such as milk, cheese, and meat are examples of nutrients that are leaving the nutrient cycle in a good way. There are other ways, however, whereby nutrients leave the farm and will be lost to the environment. Examples include soil erosion, phosphorus runoff, nitrogen leaching, and manure ammonia volatilization which not only make nutrient cycling inefficient but also impose negative impacts on water quality. Dairy producers must then purchase off-farm nutrients (fertilizer) to compensate for those that have left the farm in any form. A proper nutrient management plan helps ensure that nutrients are used efficiently for economic production of feed and animal products, as well as for the protection of air and water quality.

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Phosphorus

Phosphorus (P) is an essential plant nutrient required for photosynthesis, respiration, root growth, among many other critical functions. Plant roots absorb dissolved or soluble P from the soil solution. While soils generally contain 500-1000 ppm of total P (inorganic and organic), most of the P is bound to soil particles and is unavailable for use by plants. The concentration of P in the soil solution of fertile soils is typically very low (0.01-1 ppm) and a value of 0.2 ppm is commonly accepted as the concentration of soluble P needed to meet the nutritional needs of most agronomic crops. The solubility of P is controlled by many factors including soil moisture, temperature, pH, and concentrations of certain nutrients such as calcium, iron, manganese, and aluminum in the soil solution.

Application of a nominal rate of N fertilizer before corn emergence followed by measuring soil NO_3 in the top 12" of the soil when corn is about 10-12" high is highly recommended.

When manure and crop residues are decomposed by soil microorganisms (mineralization), inorganic forms of P are released for plant use. Phosphorus mineralization to meet plant needs is often slow, particularly when soil temperature is low. Therefore, crops grown in cold and wet conditions often respond positively to the application of P starter fertilizer.

A major loss of P is through surface runoff. Just a small amount of P in surface waters, including ponds and lakes, stimulates the excessive growth of aquatic weeds and algae (eutrophication). The consequences of increased aquatic plant and algae growth include the depletion of dissolved oxygen contents of the water resulting in fish kill, as well as reduced aesthetics and recreational values of the lakes. Critical levels of P in surface water that can trigger algae bloom have been reported by USEPA (2000) to be as low as 0.01 ppm for the lakes. Sometimes the visible impact of P on water quality can occur miles away from the point where P leaves the land and enters a body of water.

On dairy farms with relatively long history of manure application, P level in the soil is likely to be far above the level required for optimum crop production. This situation increases the risk of P transport to the surface water and accelerates eutrophication. Phosphorus in P rich soils may even be prone to leaching and therefore contaminating groundwater.

Nitrogen

Plants require large amounts of N for their normal growth. All types of N, with no exception are very soluble and can easily be leached into groundwater if not managed properly. Applying the appropriate rate of N fertilizer and proper timing of application can have a substantial effect on reducing NO_3 leaching into underground water.

Many corn fields in Massachusetts receive fall application of N, primarily as manure. This practice, if not integrated with cover cropping, can greatly increase the risk of N leaching into groundwater by fall and spring precipitation. In fields with a long history of manure application, the rate of N release, through mineralization after corn is planted, is faster than N uptake by plants. In general, farmers can expect between 10-40 lb N per acre released by mineralization for each percent of soil organic matter. Application of a nominal rate of N fertilizer before corn emergence followed by measuring soil NO_3 in the top 12" of the soil when corn is about 10-12" high is highly recommended. This N management method is known as Pre Side-dress Nitrate- N Test (PSNT). If the PSNT indicates that the soil NO_3 content is below a critical level (25 ppm), additional N fertilizer is immediately side-dressed. The amount of N for side-dress is determined by measured soil N content.

Resources

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For more information visit www.umass.edu/cdl

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