4 nutrient stewardship

DECISION-MAKING GUIDE NITROGEN

The 4R Nutrient Stewardship Framework provides a comprehensive approach of managing plant nutrients to increase food production while improving the ecological integrity of farms. When correct decisions are made regarding the 4R's (using the right nutrient source, at the right rate, at the right time, and in right place of application) there are many benefits, including better crop growth, decreased nutrient leakage to the environment, and the protection of natural areas and wildlife.

Implementing 4R principles is challenging because there is no single set of correct practices that can be universally adopted. Each farmer and crop adviser makes decisions best suited to local conditions and crops—adjusting practices for each field and soil, production targets, weather conditions, economic objectives, water quality concerns, and regulations—to meet the overall goals. Because local conditions determine the appropriate 4R practices, nutrient management decisions are best made at a local level, rather than with centralized regulations.

Nitrogen (N) is the essential plant nutrient that most commonly limits crop growth and it is the most widely used fertilizer material. When the N supply is limited, plants rapidly become stressed, resulting in a loss of crop yield and quality.

Nitrogen fertilizer added to soil is susceptible to a variety of chemical and microbial transformations that make it challenging to manage. Using the 4R principles provides the best approach to getting the maximum amount of the all-important nutrient into the plant, while minimizing losses to the environment.

Some of the fertilizer N that is not recovered in the crop is incorporated into organic compounds, where it helps build soil organic matter and ties up carbon dioxide. Some of the unutilized N may move through the soil into groundwater or into nearby creeks or streams. A small portion of the unrecovered N may be transformed into nitrous oxide gas and lost to the atmosphere, where it has undesirable greenhouse gas effects.

The principles of 4R Nutrient Stewardship provide a scientific basis for a farmer to make fertilizer decisions to achieve production goals in an environmentally acceptable manner that meet social objectives.

Right Source

Provide a balance of essential plant nutrients, considering the use of all available nutrient sources. *Plant roots only take up nutrients in a soluble form and they must be present when the plant needs them. Nitrogen fertilizer sources should be selected based on soil properties, the crop requirement, and potential losses into water or the atmosphere.*

Examples of Right Source

- Use a N source that will not lose ammonia gas from the soil surface, or mix it into the soil shortly after spreading.
- Consider using appropriate microbial inhibitors to slow N transformations and to increase plant nutrient recovery.
- Select N fertilizer sources that are less susceptible to loss by nitrate leaching or by gas emissions to the atmosphere.

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Add fertilizer based on the soil nutrient supply and the plant demand. *Application rates should be adjusted based on regular soil nutrient analyses to account for the existing nutrient supply. Realistically attainable predictions of crop performance and yield should be used to estimate crop requirements and nutrient removal. Nutrient application rates should also account for fertilizer use efficiency. Nutrient applications should provide a balance of all the essential plant nutrients to optimize crop nutrition and performance.*

Examples of Right Rate

- Adjust N fertilizer application rates based on expected crop yield for each individual field and an appropriate soil test.
- Account for variable weather conditions before making decisions on fertilizer application rate.
- Recognize that N application beyond the capacity of the crop to use it will result in greater risk of unwanted losses to water or air.

Fertilizer decisions should account for the nutrient demands of the crop, the soil nutrient supply, potential losses, and the ability to get application equipment into the field. *In general, it is preferable to add fertilizer as close to the time of plant uptake as possible. For some nutrients [such as phosphorus (P) and potassium (K)], fertilizer application can precede crop uptake by months. However the risk of N loss from the soil will increase the longer fertilizer remains in the soil before plant uptake.*

Examples of Right Time

- Understand the time of peak N demand by the plant and then apply fertilizer in advance of that time as closely as possible.
- Be aware of forecasted weather events and drainage conditions that can move applied N fertilizer below the root zone.
- If ammonium-based fertilizer is applied in the fall, verify that soil temperatures are consistently low enough to inhibit microbial transformations (< 50˚F) and the soil will continue to cool.

Plant nutrients need to be in a soluble form before roots can acquire them. *Some nutrients are not very soluble and do not move in the soil. Soluble N in soil is largely in the form of nitrate, which moves freely with soil water. Fertilizer should be applied to the soil surface and incorporated by rainfall, irrigation, or minimal tillage, or it can be banded in concentrated zones beneath the surface to help maximize plant recovery. The concept of "right place" also refers to applying fertilizer only in field zones where crops will positively respond to nutrient additions. In consistently low-yielding areas, reduce fertilizer applications to match crop needs to avoid risk of excessive loss.*

Examples of Right Place

- Place N fertilizer near the crop root zone or where it will move into the root zone based on root development and architecture.
- Adjust N fertilizer application rates for field zones based on soil conditions and the potential productivity of the crop.
- Avoid broadcast applications of N fertilizer onto the soil surface if significant ammonia loss is possible before tillage, irrigation, or rainfall occurs; or where there is a risk of runoff (such as sloping land). Additional details on managing specific fertilizer N sources can be found at:

www.ipni.net/NitrogenNotes
www.ipni.net/specifics