e-GRO Alert

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N is for Plant Health

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N

Nitrogen
14.006

Nitrogen (N) form affects medium pH and root-disease incidence.

In this alert, we will discuss the chemical properties of N and how we can use it to manage medium-pH and prevent root diseases.

Plants take up nitrogen at a larger quantity than any other mineral element. For this reason, nitrogen has a large effect on plant quality and medium-pH.

Nitrogen Forms in Fertilizers

Nitrogen in fertilizers can come in the form of ammonium (NH_4^+), nitrate (NO_3^-), urea (CH_4N_2O) or other organic sources. Fertilizers typically have more than one source ((Fig 1).

Nitrate and ammonium are stabilized in fertilizer salts by combining them with an element of the opposite charge.

Nitrate has a negative charge and is bound to elements with positive charges such as calcium, magnesium, and potassium.

Ammonium has a positive charge and is combined with molecules with negative charges such as phosphates, sulfates, and nitrates.

Urea is an organic molecule. Other organic-N sources come in the form of organic matter (e.g. fish emulsion, manure, etc).

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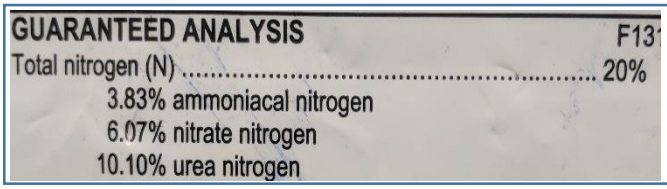

This fertilizer will have an acid reaction. It has 70% of the total nitrogen from NH_4^+-N and urea. Fertilizers with 20% or more of the total N in the form of NH_4^+-N +urea will have an acidic reaction. The higher this number, the more acid the reaction.
Calculation: (3.83% ammoniacal nitrogen + 10.10% urea nitrogen) /20% total N = 0.6965 *100% = 69.65% of N in the form of NH_4^+-N and urea.

Fig. 1. Example of fertilizer label with three nitrogen sources.

Plants take up nitrate, ammonium, and urea

Plants take-up N in the form of ammonium or nitrate.

Plants readily use ammonium after uptake. For this reason, plants respond ("green up") very quickly to ammoniacal nitrogen applications, which is also why too much ammonium can cause phytotoxicity (Fig 2).

Fig. 2 Vinca minor with ammonium phytotoxicity.

Plants absorb nitrate and store it in the cells. Plants need to convert nitrate to ammoniacal nitrogen before using it.

Plants can take up urea, but they cannot directly take up N from organic matter (e.g. fish emulsion).

Organic matter has to go through a series of processes before plants can absorb them. Microbes break down organic matter and then transform organic-N into ammoniacal nitrogen. Other microbes then transform ammoniacal nitrogen to nitrate nitrogen. These reactions depend on the presence of microbes and environmental conditions. Therefore, nutrient availability from organic sources is slower and less predictable compared with inorganic sources.

Take-Home Message #1: Plants take up N mostly as ammonium and nitrate only. N in organic matter is not readily available for plant uptake.

Nitrogen forms affect medium-pH

Ammoniacal nitrogen (NH_4^+-N) lowers pH-medium via interactions with plants and microbes. When roots take up NH_4^+ they instantaneously extrude H^+ protons (acid). Microbes in the media convert NH_4^+-N to NO_3^-N and H^+ protons are a by-product of the reaction. The higher the concentration of H^+ protons, the more acid the solution in the medium. These reactions happen more frequently and faster at temperatures at which plants and microbes are active.

Nitrate nitrogen (NO_3^-N) reacts with the plants only and results in pH neutral or basic reaction in the medium.

Fertilizers with 20% or more of the total nitrogen in the form of ammonium and urea will result in a net acidic reaction. See figure 1 for an example on how to calculate this number.

Growers must match fertilizers to water alkalinity and crop requirements. Growers can use the acid and basic reaction of fertilizers to adjust medium pH in the container.

Ammonium at high concentrations can affect uptake of elements with positive charges such as calcium, potassium, and magnesium.

Take-Home Message #2: Ammonium-N reduces medium-pH. Nitrate-N has a pH neutral or basic reaction in the medium.

Root diseases affected by N form

Nitrate suppresses Fusarium wilt on asters, basil, chrysanthemum, cyclamen, dianthus, and gladiolus. Whereas, Fusarium wilt on mums and cyclamens can be higher when using ammoniacal nitrogen.

Ammonium suppresses Black root rot on several crops including pansy and vinca. Nitrate nitrogen applications can increase Black root rot on Pansy.

Pythium root rot increases with increasing N levels, regardless of the source.

For more information on this topic go to: https://www.youtube.com/watch?v=nd0EPVb04vU&t=948s

Take-Home Message #3: Nitrogen form can affect disease severity. The effect is specific to N-form, host, and pathogen.

Summary

- ✓ Fertilizers contain nitrogen in the form of ammonium, nitrate, urea or other organic forms.
- ✓ Plants take-up nitrogen in the form of nitrate, ammonium, and urea.
- ✓ Plants cannot directly take-up N bound to organic sources. Microbes break down organic-N sources into ammonium and nitrate.
- ✓ 20% or more of the total nitrogen in the form of ammonium and urea will result in an acidic reaction. The exact reaction in the container will depend on water alkalinity and plant genetics.
- ✓ Root diseases can increase or decrease with different N-forms. If your crop has a high incidence of a root disease, try switching to a different N-source or lower N-rate.

Nitrogen Form in Fertilizers	Plant absorption	Effect on medium-pH	Effect on root disease
Ammonium (NH_4^+)	Direct uptake and use.	Acid	↓ Black root rot, ↑ Fusarium wilt
Nitrate (NO_3^-)	Direct uptake, stored in cells. Plants transform it to NH_4^+before use.	Neutral or basic	↑ Black root rot, ↓ Fusarium wilt
Urea (CH_4N_2O)	Direct uptake or microbes transform to NH_4^+ before plants absorb it.	Acid	N/A
Other organic sources	No direct uptake or use. Microbes transform to NH_4^+ before plant can taken it up and used it.	Acid	N/A

TAKE-HOME MESSAGE: Know your nitrogen forms and read fertilizer labels.

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