UREA REACTION IN THE SOIL

Plant roots do not absorb nitrogen in the form of urea. Chemical and biological reactions in the soil convert urea to ammonium (NH_4^+) and nitrate (NO_3). Both form are readily absorbed by roots.

The equations below summarize the reactions in the soil that convert urea into ammonium and nitrate.

AMMONIFICATION

$(NH_2)_2CO + 2H_2O \rightarrow (NH_4)_2CO_3$

urea + water → ammonium carbonate

Urease, a naturally occurring soil enzyme, converts urea to ammonium carbonate.

$(NH_4)_2CO_3 + 2H^+ \rightarrow 2NH_4^+ + CO_2 + H_2O$

ammonium carbonate + hydrogen → ammonium nitrogen + carbon dioxide (given off as gas) + water

NITRIFICATION

Some of the ammonium formed above will be absorbed directly by plant roots. Some will be converted to nitrate nitrogen by the following two natural soil reactions:

$2NH_4^+ + 3O_2 \rightarrow NO_2^- + 2H_2O + 4H^+ + \text{energy}$

ammonium nitrogen + oxygen → nitrite + water + hydrogen ions + energy

Naturally occurring *Nitrosomonas* and *Nitrococcus* bacteria in the soil convert ammonium N to nitrate.

Nitrate nitrogen is not taken up by the roots. Another immediate, if not simultaneous natural reaction, takes place in the soil that converts nitrate to nitrate nitrogen.

$2NO_2^- + O_2 \rightarrow 2NO_3^- + \text{energy}$

nitrite + oxygen → nitrate nitrogen + energy

Naturally occurring *Nitrobacter* bacteria in the soil oxidizes nitrite to nitrate.

Plant roots readily absorb both ammonium and nitrate nitrogen from the soil solution.

*Carbon dioxide, a greenhouse gas, is given off to the atmosphere when urea is converted to ammonium. It should be noted that fertilized crops absorb large quantities of carbon dioxide from the atmosphere from the production of carbohydrates during photosynthesis. Carbohydrates, in turn, are consumed by humans and livestock for food. In addition, carbon dioxide is used in the production of urea.

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