THE pH OF CALCIUM NITRATE AND UREA AS FERTILIZERS

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Calcium nitrate is acid and urea is neutral in solution. This is true when first applied as fertilizer to root media. It is NOT TRUE in ultimate effect. Calcium nitrate produces a rise in pH and urea acidifies soil.

When calcium nitrate hydrolyzes in water, some nitric acid and calcium hydroxide result. Since the resulting nitric acid is stronger than the calcium hydroxide formed, the pH of the solution is acid, about 5.0. When the nitrate is absorbed by plants or leached, the calcium remains and the net result is an increase in pH. Calcium nitrate is alkaline in ultimate reaction.

Urea is a nonpolar substance and in pure form does not affect the pH of a solution. When applied to soil, urea is converted by urease (an enzyme produced by soil microbes) to ammonium carbonate (2). This is alkaline and increases the pH. This is temporary.

There are many bacteria in the soil which utilize ammonium nitrogen as an energy source. They oxidize the ammonium nitrogen to nitrates, utilizing the energy derived from this oxidation for their growth. This oxidation converts the ammonium nitrogen (alkaline) to nitrate nitrogen (acid) and results in acidification of the soil. Urea results in soil acidification.

Fertilizers are rated by their reaction in the root medium in terms of the calcium carbonate (limestone) equivalent, usually as the amount required to neutralize a ton of fertilizer. The following list is adapted from The Fertilizer Handbook published by The Fertilizer Institute (1). Note that applying a ton of calcium nitrate is equivalent to adding 400 lbs of limestone while a ton of urea would require 1680 lbs of limestone to neutralize the acidity produced.

Equivalent	Calcium Carbonate	
	lbs./ton	lbs./lb. N
Ammonium nitrate, 33-0-0	- 1180	- 1.76
Ammonium sulfate, 21-0-0	- 2200	- 5.24
Calcium nitrate, 15-0-0	+ 400	+ 1.29
Sodium nitrate, 16-0-0	+ 580	+ 1.81
Urea, 46-0-0	- 1680	- 1.83
Urea-form, 38-0-0	- 1360	- 1.79
Superphosphate, 0-20-0	0	-
Potassium chloride, 0-60-0	0	-
Potassium sulfate, 0-50-0	0	-
Diammonium phosphate, 20-50-0	- 1500	- 3.75
Monoammonium phosphate, 11-48-0	- 1300	- 5.91
Potassium nitrate, 13-44-0	+ 520	+ 2.00
Sulfur (99.6%)	- 6320	-
20-20-20 (Peters)	- 597	- 1.49
20-10-20 (Peters)	- 422	- 1.05
20-5-30 (Peters)	- 153	- 0.38
15-16-17 (Peters)	- 215	- 0.72
15-15-15 (Peters)	- 261	- 0.87

This is why the immediate reaction from an application of calcium nitrate is acidic but the ultimate result is basic. It also explains why urea will cause a rise in pH as soon as it is enzymatically converted to ammonium carbonate in the root medium and why the end result is acidification. Why worry? Urea is a major component in many soluble fertilizers. It acidifies soils and is the reason that more limestone is necessary in root media used in soft or acid water areas such as New England.

FURTHER NOTES

A problem with the oxidation of ammonium nitrogen (as from urea) to nitrate arises from soil disinfestation. Pasteurization or chemical treatment may (and almost always does) kill the nitrogen oxidizing bacteria. Even if a few escape, the population of these microbes may not increase rapidly enough to avert a toxic build-up of ammonium nitrogen. If they are all killed, reinoculation of the soil

by these microbes must depend upon reintroduction by dust or irrigation, a chancy liklihood. But it does eventually occur.

It is this recolonization by nitrogen oxidizing microorganisms that led to the recommendation of using muddy sugar water to alleviate toxic ammonium nitrogen levels in root media (3,4). If a pound of sugar is dissolved in 10 gallons of water and about a cup of native soil (hopefully free of pests) is stirred in and applied with agitation as a normal watering, two things may happen. Most native soils contain Nitrosomonas and Nitrobacter species, the common bacteria that oxidize ammonium nitrogen, and the sugar prompts a population explosion of the common soil microbes which then use up the available soil nitrogen in the process of building their bodies. The nitrogen (and soluble salt) level is lowered while the ammonium oxidizing microbes are becoming established.

The reaction is fairly rapid. The population of many bacterial species may multiply ten-fold in one day while the soluble salt reading may decrease by 20% or more. The plants may not be able to obtain sufficient nitrogen. For this reason, the muddy sugar water application should be followed by an application of nitrate nitrogen at about 300 ppm N at the next irrigation. This should be calcium nitrate if potassium levels are adequate. Otherwise use a combination of calcium and potassium nitrates. A ratio of 2:1 will be a 15-0-15 while a ratio of 3:2 will be 15-0-18 soluble fertilizer.

References

(1). Anon. 1976. The Fertilizer Handbook. The Fertilizer Institute, Washington, DC 20035. 208 p.

(2). Ferguson, R. B., D. E. Kissel, J. K.Koelliker and Wes Basel. 1984. Ammonium volatilization from surface-applied urea: effect of hydrogen ion buffering capacity. Soil Sci. Soc. Amer. J. 48:578-582.

(3). Koths, J. S. 1972. Sugar soil treatment. Conn. Greenhouse Newsletter 48:1-6.

(4). Koths, J. S. 1979. Oxygen levels in soils treated with sugar. Conn. Greenhouse Newsletter 92:16-19.