# MEASURE AND MANAGE

## Calcium More than Just Limestone

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Calcium has been linked to soil pH along with Magnesium for many years. Soils which are low in pH < 6.1 usually (depending on the crop) need to have limestone applied to increase the soil pH into a more favorable range to maximize nutrient uptake efficiencies. On the soil report the pH value is one of the most important test parameters if the pH is too low most crop growth is impaired because of nutrient tie-up caused by the precipitation of some of the essential plant nutrients. If the pH is below 5.0 toxicity is caused by greater availability of manganese and aluminum can occur. Liming to a higher pH reduces their solubilities and allows for better plant growth.

In some of the sandy soils, with low CEC values less than 10, have inherently low calcium levels sometimes less than 1000ppm with a pH of 6.0 or greater. Sandy soils are most desirable for horticulture crops, most of these crops such as potatoes, tomatoes, broccoli, peppers, cabbage etc. have high calcium requirements. Characteristics of sandy soils are the lower buffering capacity and poor diffusion rates, low organic matter and lower amounts of available water. Calcium reaches plant roots by mass flow and moves into the plant in the transpiration stream. Root massing and available moisture as well as nutrient levels and balance need careful management.

Calcium performs a lot of functions beyond pH remediation in crop production.

**Calcium in the Soil**
**Calcium in the Plant**
**Calcium and Disease Control**
**Calcium and Nitrogen Regulation**

### Calcium in the Soil

Calcium is a cation containing 2 positive charges Ca++. Extractable calcium (the levels reported on a soil report) can range from 200( sand) to 16000 ppm(muck). This is a measure of the soils ability to supply calcium from the exchange complex to soil solution it should be viewed as an index of availability rather than an absolute amount of calcium. The exchange complex is related to the clay content of a soil. The higher CEC Cation Exchange Capacity the greater the clay content and the higher the calcium level. Soil solution calcium (water extractable) ranges from 30 to 300 ppm. The cation balance in sandy soils can become critical especially when high rates of potash are used.
The Cation Saturation Percentage for soils with ph < 7.0 and CEC less than 15 use the following formulae to calculate and determine fertilizer rates to balance the soil.

K CEC (5.0- Base Sat on Soil Report)/ 100 x 936 = lbs of $K_2O$ per acre.

Mg CEC (15- Base Sat on Soil Report)/ 100 x 240 = lbs Mg per acre.

Ca CEC (75- Base Sat on Soil Report)/ 100 x 400= lbs of Calcium per acre.

Maintaining a calcium saturation of 75 % on most crops is adequate, there are other conditions where 90 % is desirable (club-root control).
There are circumstances where it is desirable to build the soils up over a period of 2 –5 years, rather than all at once.

If pH adjustment is needed use limestone if no pH adjustment is needed but calcium is, then use gypsum.

**Calcium in the Plant**

Calcium uptake is by mass flow. Calcium contained in the soil solution moves into the root system with the influx of water and is carried in the transpiration stream to the various plant organs. Usually those areas with the greatest activity receive more water and therefore more calcium. Mass flow delivers more calcium than plants take up. Calcium uptake is generally genetically controlled. One of the restrictions is the fact that only newly expanding unsuberized root caps can absorb calcium. Any environmental factor that limits root expansion limits the uptake of calcium predisposing plants to physiological disorders.

Calcium functions in the plant as an osmotic regulator, an integral part of cell wall structure in all meristem and storage organs. Without adequate calcium storage quality suffers and with extreme deficiency growth points die.

**Calcium and Disease Control**

There has been evidence in recent years of the role calcium plays in plant nutrition relative to lessening the impact of Pythium, Sclerotium, Botrytis and Fusarium in crops. Calcium has important roles in the integrity of cell walls which infers a resistance mechanism to reduce penetration of diseases. As well any plant that is void of nutrient stresses will be in a position to resist the attack of pathogens and out-grow the diseases. Part of disease resistance is related to the overall nutrient management of plants. Nitrogen, in particular nitrate nitrogen can be problematic in maintaining plant health.

**Calcium and Nitrogen Regulation**

Nitrogen plays a very important role in crop production the appropriate rates of N promotes fast vigorous growth and high yields. However too much in particular too much nitrate nitrogen can cause increased susceptibility of disorders and predispose plants to pathogen infection. Environmental concerns arise with excessive nitrates available to potentially leach to ground water.

Nitrate nitrogen tends encourage soft succulent vegetative terminal growth at the expense of reproductive growth. Ammonium Nitrogen uptake alters the plants sugar metabolism. This encourages not only more sugar production but a greater rate of export out of the leaves to the roots and on the way to the roots, fruits and storage organs can grab the sugars and enhance growth, yield and quality and decrease the susceptibility to diseases. If plants can utilize 50 % of their N as ammonical forms the crop can use more Nitrogen to produce more yield and quality. Nitrogen Use Efficiency is increased when a crop can produce more yield with the same N level.
Nitrate nitrogen tends to accumulate in the leaves and increase organic acid production, which increases the demand for Calcium to neutralize the acidity, if this calcium is in short supply calcium may be mobilized from the roots. This movement of calcium from roots is the demise of the root integrity and can lead to leaky roots and ethylene production signaling the plant to shut down.

Work done at Texas A & M Extension Service by Sam Feagley and Llyod Fenn demonstrated the value of urea fertilizer combined with soluble calcium to enhance yield. The addition of calcium chloride enhanced more ammonium N uptake, potassium, phosphorus, magnesium, copper, and zinc in the crops. The rates that were used were 1 pound of calcium chloride for each pound of urea.
In the case of onions within 30 hours of an application bulb weights increased 50 %. However the entire plant weight did not increase as much as the bulbs demonstrating that more sugar was disproportionately deposited in the bulbs.

Timing of application is best done in the spring. The authors do recognize the need to fertilize later in the season and calcium ammonium applications worked as well foliar later in the growing season. They worked so well they suggested that a foliar application may be a way to extract more latent nitrate nitrogen out of a soil and enhance crop yields and reduce nitrate carry over. With Nutrient Management Planning pending and ground water quality issues this needs to explored.

No discussion on calcium is complete without talking about Boron the two are linked functionally in the plant. Boron helps to cement calcium in place in the cell walls. Boron is also involved in sugar translocation and greatly assists ammonium N and calcium in moving sugars and reducing the accumulation of nitrates in leaves. Boron should be applied whenever calcium is applied.

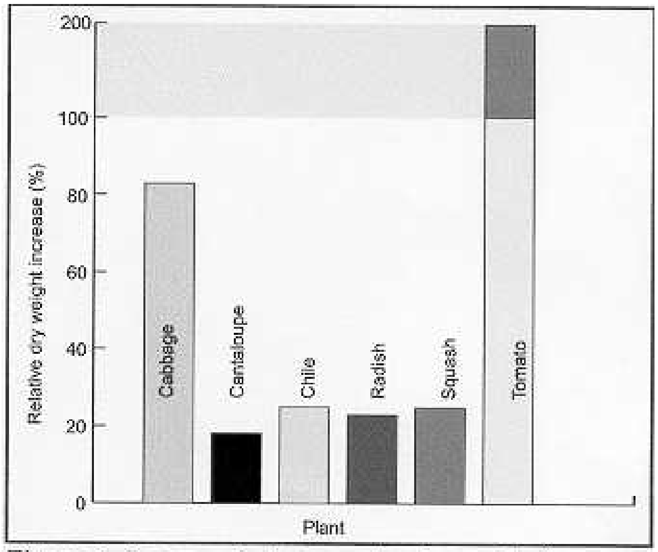


**Figure 1. Increased photosynthesis results from calcium application.**

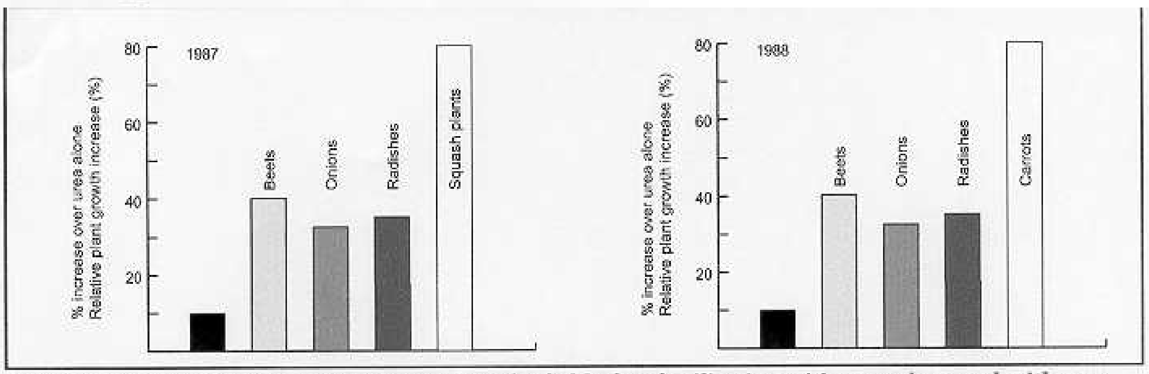


**Figure 2. Relative yield of vegetables grown in the field after fertilization with urea alone and with urea plus calcium chloride (Fenn et al., 1990, 1991, 1994).**

## Summary

As a result of thorough soil tests, monitored by plant tissue a series of strip trials should be laid out in replication to test urea, calcium, and boron plus other limiting micro-nutrients foliar, to validate the research findings. As with anything new to management you should go slow and document the results.