Available Calcium a Factor in Salt Balance for Vegetable Crops.*
Tiedjens, V. A., and L. G. Schermerhorn. Soil Sci. 42.
Reviewed by Norvald Gomness.

Low calcium soils and the response of plants to the addition of calcium salts.

Several years ago some New Jersey vegetable soils ceased to respond to side dressings of ammonium sulfate or sodium nitrate. If there was a response, the type of growth was unsatisfactory and the quality of the crop was poor. Soils from some of these problem farms were brought into the greenhouse, placed in pots, treated with various chemcals and planted with seeds or plants.

*This review covers only the calcium -- potassium ratio. The calcium - sodium ratio will be covered in Bulletin 16.

These soils were tested with "quick tests" and supplementary tissue tests were employed in some cases. The tests showed a low amount of available calcium (less than 100 ppm) but the usual amounts of all the nutrients present in a mixed fertilizer. Very often high concentrations of potassium were found, or if potassium was not high, it was assumed from the growers practice and a high pH reading, that sodium was present in liberal amounts.

The technique was to supply sodium nitrate, calcium nitrate, calcium chloride, calcium carbonate (limestone), super phosphate, gypsum and in some cases potassium nitrate, dolomite, and calcium-magnesium silicate slag to separate pots. Growth of the plants was then observed. When the problem involved a calcium deficiency, the more soluble calcium salts gave a better response. Calcium nitrate was highly effective. If the pots were kept well watered, super phosphate proved very beneficial, and gypsum was satisfactory. If the soil was kept quite dry, calcium nitrate was very effective but calcium sulfate was ineffective. Calcium nitrate had to be supplied at 3-weeks to monthly intervals.

On these calcium deficient soils sodium and potassium had a depressing effect on growth. The degree of injury (unless some form of calcium was supplied with it) depended upon whether the soil had abundant potassium or whether in the past it had been supplied with relatively large amounts of sodium nitrate.

Low calcium - high potassium soils and plant growth

This experiment was made with cucumbers.

When watered freely the plants made rapid growth but were not normal. Internodes were long, foliage light green and leaves small. They were grown on strings to wires seven feet above the soil. When the growing tip reached the wire, many of the veins of the older leaves showed a brown water-soaked condition soon followed by gradual death of the entire leaf, with the result that the plants soon had only the tip leaves left. It was determined that mosaic was not the cause. The tissue was micro-chemically examined and was found to be packed with potassium and nitrate but calcium was entirely lacking. Roots were kinky and rough and the cortex sloughed off prematurely.

Similar observations were made on tomatoes growing in another house.

Quick chemical tests showed a pH range of 5.8 to 6.6. Less than 50 ppm of calcium was present. Potassium was exceptionally high and fluctuated with the water supply. After heavy applications of water, potassium was low. When the soil dried out, potassium was again very high. Apparently very little potassium was tied to the colloidal part of the soil, hence was easily leached to lower levels. Phosphorous was high with only a trace of magnesium. Nitrate concentration was high. The soil baked very hard when dry and was slippery when wet. Organic matter was low.

The results of these observations indicated that a deficiency of calcium, magnesium or both was causing the symptoms. Roots resembled those of plants growing with insufficient calcium. The tops, however, did not show symptoms of calcium or magnesium deficiency. A soil test was made. The soil colloid was found to be approximately 87% calcium and 2% magnesium saturated.

Soil was taken from the poorest section of the beds, placed in pots and treated with individual salts. A plant was set in each pot.

Soluble calcium salts gave a normal type of growth when compared with those growing in soil with no treatment. Calcium nitrate and calcium chloride were more effective than calcium sulfate. Super-phosphate gave some correction. Calcium sulfate or super phosphate were more effective when the pots were kept well watered. Plants grown with sodium or potassium salts gave no response or were injured when the sulfate ion served as the carrier.

From these results the following assumptions have been made:

1. Correction was brought about by the addition or greater availability of calcium.
2. Additions of potassium sulfate tended to decrease the availability of calcium, thereby producing a low calcium - high potassium ratio, to the extent that potassium prevented the absorption of calcium by the plant.

The relationship between calcium and potassium was repeated in sand culture. The following results were noted:

1. As long as calcium was maintained at a high level it was impossible to injure growth.
2. If the calcium concentration was low, the effect of large amounts of potassium was to produce a type of growth not symptomatic of any particular deficiency, but soft and succulent with yellow green foliage.

As a result of these tests recommendations were made that (1), one ton of dolomitic limestone be applied per acre each year unless soil reaction tests indicated otherwise; (2), that calcium nitrate be used as a source of nitrogen; (3), super phosphate for phosphoric acid, and (4) that potash be withheld until a test showed it was needed.

Two years later the following observations were made.

1. Crop growth was much improved. Roots were white and vigorous.
2. Tests showed the presence of sufficient available calcium and of potash in liberal quantities.
3. The soil no longer baked when dry nor packed down so firmly.
4. It was possible to heat the soil thoroughly since the large clumps were missing, and nematodes, which had been present, were eradicated.
5. Aeration of the soil was greatly improved.