Calcium-Sodium Ratio and Growth of Tomato in Sand Culture
Abstract from an article by V.A. Tiedjens and L.G. Schermerhorn. Soil Sci. 42:419-435. 1936.

Reviewed by Norvald Gomness

During the early thirties tomato growers along the coastal plain of New Jersey noted more abnormal plants in their fields each year. They had been using large amounts of sodium nitrate and very little calcium carrying materials in their fertilizer program.

A critical examination by the authors showed that potassium was not the cause of the abnormal growth (See Bull. 15 on Potassium). The calcium-sodium relationship was suspected because of the grower's fertilizer practices.

Tomato plants were grown in sand culture supplying all the necessary nutrients, but varying the ratio of sodium and calcium from 9 Ca - 1 Na to 1 Ca - 9 Na. It was found that the higher the proportion of calcium to sodium the greater the percentage of dry matter in plants. In other words, with higher sodium there was more water present in the plant tissue.

A brief discussion of their results follows:

Plants grown with an optimum amount of calcium are apparently dark green, possess a composition that is resistant to change in environment and present fewer physiological disorders because they assimilate nitrogen and carbon most rapidly. Even though the plants in the two groups, one with optimum calcium supply and the other with adequate mineral nutrition other than calcium made an equal volume of growth, the quality of growth was vastly different. As the calcium content decreased and the sodium increased, the tissues contained more water. Under conditions of rapid transpiration, the high calcium plants showed no signs of wilting, whereas the low calcium plants wilted severely. In these cultures the ratio of calcium to sodium was not low enough to cause injury to roots.

The difference in water content may be explained by the difference in affinity for water by calcium and sodium ions. It would seem possible that there are associations between sodium and proteins in the cell which would require the presence of more water. The dehydrating effect of calcium introduced into such a system would tend to counteract the effect of sodium. In view of the fact that potassium has a similar effect to sodium, although to a smaller degree, it is entirely possible that one of the functions of potassium is to counteract the dehydrating effect of an over abundance of calcium.

From these results it would seem that a very important function of calcium is to hold the cell protoplasm in an equilibrium conducive to synthetic processes that build up proteins rapidly. This accumulation of proteins in turn gives stability to protoplasm. The amount of calcium needed for optimum synthesis being determined by the heredity of the plant. Thus plants which require a high pH also require a high calcium supply. A high soil pH brought about by materials other than calcium is not satisfactory.

A high proportion of proteins to soluble organic nitrogen determines a certain quality (color and hardness) of growth. A high % of organic nitrogen means more dry matter and less water or more substance to a given volume of growth. The importance of the ratio of calcium to other minerals cannot be over estimated. The effect it has on the quality of growth makes it possible to blame much of our quality problems on lack of available calcium, particularly since its availability may vary between conditions of drought and abundant soil moisture.

From the results presented on the relation of calcium to sodium and potassium ions, it is safe to assume that even though sodium is not important as a nutrient for plant growth, it probably has a marked effect on plant growth and is worthy of serious consideration in our fertilizer practices.