Calcium

Calcium (Ca) nutrition plays a vital role in the production of highquality crops. It also has an important function as a valuable soil amendment in many situations.

Calcium in Plants

Calcium is classified as a "secondary nutrient" that is needed in relatively large amounts by plants in the form of Ca^{2+}. In some species, the requirement for Ca is greater than for the macronutrient phosphorus (P). The critical Ca concentration in plants varies widely, ranging from about 0.2 percent in grasses, 1.0 to 1.25 percent in fruit crop foliage, to 2.0 percent in cotton leaves[1]. The amount of Ca taken up by various crops is listed in **Table 1**.

Calcium plays a key role in cell wall structure and membrane integrity. In addition to plant stability, strong cell walls help prevent invasion by numerous fungi and bacteria. Calcium also promotes proper plant cell elongation, participates in enzymatic and hormonal processes, and plays a role in the uptake processes of other nutrients.

Calcium in Soils

The total amount of Ca in soils normally ranges from 0.7 to 1.5 percent in non-calcareous, temperate soils. Highly weathered tropical soils typically have a lower Ca content, ranging from 0.1 to 0.3 percent, while calcareous soils may contain as much as 25 percent Ca. Although there may be tens of thousands of pounds of total Ca/A in the root zone, it is common to have less than 100 lb of Ca actually soluble at any one time. The solubility of Ca depends on several soil factors, including:

- Soil pH – soils with higher pH typically contain more available Ca on cation exchange sites
- Cation exchange capacity (CEC) – available Ca is affected by both the soil cation exchange capacity and the Ca saturation on the soil cation exchange sites
- Presence of other soil cations – Ca is preferentially adsorbed on cation exchange sites. Its solubility and plant availability are influenced by other cations in the soil.

Calcium has an important influence on soil properties, especially as it prevents dispersion of clay. An abundant supply of Ca can help reduce soil crusting and compaction, leading to improved water percolation, and reduced runoff.

Fertilizing with Calcium

Calcium is not typically formulated into fertilizer sources specifically to meet plant Ca requirements, but rather as a component of other materials. The most common Ca sources are liming materials, mainly $CaCO_3$. Most acidic soils that have been limed to the proper pH will not have Ca nutritional problems. Calcium is often supplied as gypsum as an amendment to improve soil chemical or physical properties.

Clays can disperse in soils with high sodium (Na) content, resulting in poor soil structure and reduced water permeability. Added Ca replaces the Na^+ on the cation-exchange sites and corrects clay-dispersion problems. Calcium is a component of several common nitrogen (N) and P fertilizer materials **(Table 2)**.

Table 1. Calcium uptake in the harvested portion of various crops[2].

Crop	Yield Level	Ca uptake, lb
Alfalfa	8 tons	175
Bermudagrass	8 tons	52
Corn	200 bu	49
Cotton	1,000 lb lint	14
Grain Sorghum	140 bu	60
Oranges	540 cwt	80
Peanuts	4,000 lb	20
Rice	7,000 lb	20
Soybeans	60 bu	26
Tomatoes	40 tons	30
Wheat	60 bu	16

Table 2. Common calcium fertilizer sources.

Source	Ca content, %
Calcitic Limestone ($CaCO_3$)	32
Gypsum ($CaSO4 \cdot 2H_2O$)	22
Triple Superphosphate ($Ca(H_2PO_4)_2 \cdot H_2O$)	15
Calcium Nitrate ($Ca(NO_3)_2$)	19
Calcium Ammonium Nitrate Solution	8
Chelated Calcium (Various Formulations)	2 to 5
Calcium Chloride ($CaCl_2$)	36
Calcium Thiosulfate (CaS_2O_3)	6

Blossom end rot in tomato and peppers can develop when inadequate calcium moves with transpiration stream to the end of the fruit.

Bitter pit develops in apple fruit when supplied with inadequate calcium.

Tip burn in romaine lettuce is associated with inadequate calcium uptake.

Stunted development of the growing point of corn is caused by calcium deficiency.

Calcium fertilizers are most often applied directly to the soil, but foliar applications are also common for fruits and vegetables. Foliar applications are made during the growing season to correct deficiencies and improve crop quality. Soluble Ca fertilizers are sometimes applied through the irrigation system.

Calcium Deficiency Symptoms

Calcium deficiencies are not common in most crops, but may occur in acidic soils. Deficiencies occur with some horticultural crops where Ca is not adequately supplied to developing plant cells due to restricted uptake or movement within the plant. Calcium is not moved from older plant tissue or redistributed, so young tissues rely on the continual supply of Ca in the transpiration stream. Since transpiration is low in young leaves, in fruit, and in enclosed tissues, various Ca-related disorders can occur.

Deficiencies of Ca typically occur:

1. In young expanding leaves (such as tip burn in lettuce)
2. In enclosed tissues (such as black heart in celery)
3. In plant tissues fed primarily by phloem (such as blossom-end rot in tomato, pepper, watermelon; bitter pit in apples; empty pod in peanuts)

Other symptoms associated with Ca deficiency may include:

1. Abnormal development of growing points (terminal buds)
2. Abnormally dark green foliage
3. Premature shedding of blossoms and buds
4. Weakened stems

Crop Response to Added Calcium

As with all essential nutrients, when soluble Ca concentrations fall below a critical level, crops are likely to respond favorably to fertilizer application. Calcium uptake occurs primarily at the root tip, so conditions that damage root health will also impair Ca uptake.Since most soils have Ca present, favorable crop responses are generally due to enhancing the Ca supply to developing leaves and fruit (**Table 3**), or as a result of improving the physical condition of the soil (**Figure 1**). Local recommendations should be obtained before adopting techniques to boost the Ca concentrations in plant leaves and fruits that may be lacking an adequate supply.

Table 3. Increase in apple fruit Ca concentration from foliar or soil applied treatments compared with untreated control apples.[3]

Treatment	Increase in fruit calcium concentration, ppm
8 foliar sprays (22 lb Ca/A)	45
5 foliar sprays (12 lb Ca/A)	25
2 foliar sprays (5 lb Ca/A)	10
Gypsum on soil (440 lb Ca/A)	12

All foliar sprays were made with $CaCl_2$ diluted to 300gal/A. Apples with low Ca concentrations can be susceptible to cork spot and bitter pit, resulting in nonmarketable fruit.

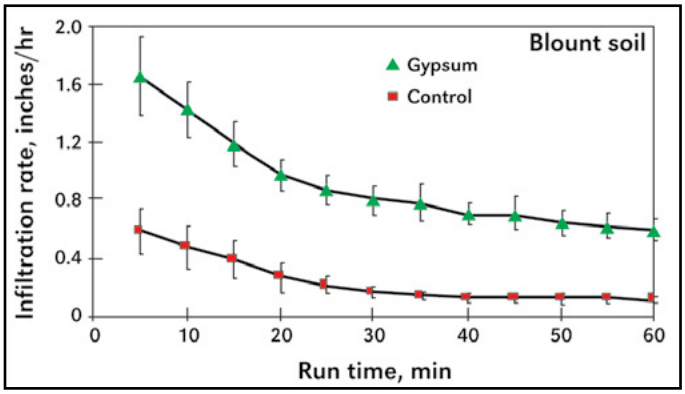

Figure 1. Calcium sulfate (gypsum) can improve soil physical properties by enhancing water infiltration and percolation in some soils.[4]

References

1. Plank, C.O., and D.E. Kissel. 2013. Plant Analysis Handbook for Georgia. http://aesl.ces.uga.edu/publications/plant/default.asp (verified Apr 2019).
2. IPNI. 2006. Soil Fertility Manual. International Plant Nutrition Institute. Norcross, GA.
3. Autio, W.R., and W.J. Bramlage. 2001. Univ. Massachusetts Extension Factsheet F-119R.
4. Chen, L. and W.A. Dick. 2011. Ohio State Univ. Bull 945.

Further Reading

de Freitas, S.T., and E.J. Mitcham. 2012. Hortic. Rev. 40:107-146.

This information was originally developed by the International Plant Nutrition Institute.