Module 6: Calcium and Magnesium Management

To view the chapter for this topic click here.

Introduction

- Calcium (Ca) and magnesium (Mg) are secondary nutrients.
  - Called secondary due to lower plant uptake and less fertilization need compared to macronutrients like nitrogen, phosphorus, and potassium

- Both occur in the soil:
  - as soluble divalent cations (Ca^{+2} and Mg^{+2})
  - on cation exchange sites (as Ca^{+2} and Mg^{+2})
  - in carbonate minerals

- Ca and Mg nutrient cycles are similar to K except for the absence of clay fixation with Ca and Mg.

Calcium

- Importance:
  - essential for plant growth, cell division (growing point), and cell enlargement
  - component of cell membranes
  - important for developing the root system, shoot tips, and storage organs
  - aids in pollen development and helps plants retain foliage
  - strengthens cell walls, helping to reduce bruising and plant disease

- Deficiency symptoms in plants:
  - appears in the younger tissues (immobile nutrient)
  - growth disorders
  - may result in the death of the plant's growing point
  - may cause blossoms and buds to drop prematurely
  - can increases handling damage and have a longer shelf life
  - reduces nutritional value of vegetables

Calcium

- Ca is usually the dominant basic cation on the soil exchangeable complex.
  - Typically accounting for more than 70% of base saturation.

- Exchangeable Ca exists in equilibrium with the soil solution.

- A low exchangeable Ca content in soil often causes acidity problems.

- Liming acidic soils with limestone ($CaCO_3$ and $MgCO_3$) is a common practice and replenishes plant available Ca.

- Ca promotes aggregation of soil particles (flocculation).

Magnesium

- Importance:
  - critical role in all parts of plant metabolism and protein synthesis
  - activator of enzymes
  - essential constituent of chlorophyll
  - aids in the formation of sugars, oils and fats

- Deficiency symptoms in plants:
  - leads to reduced photosynthesis
  - appears on older plant leaves first (immobile nutrient)
  - leaf tissue between the veins turns yellow or reddish in color, while the veins remain green
  - may cause leaf margins to curl if severe

Magnesium

- Present in several mineral forms that are relatively resistant to weathering and represent a large fraction of total soil Mg.
- Mg can also be present in calcareous soils as $MgCO_3$.
- As with Ca, Mg helps with soil flocculation and soil structure.
- A common Mg deficiency problem in cattle is called grass tetany or hypomagnesemia.
- Lime application to acidic soils often supplies adequate Mg.

Calcium and Magnesium in Harvested Portions of Crops

Crop	Unit of Yield	Pound of Ca per unit of yield	Pound of Mg per unit of yield
Corn	bu	0.01	0.05
Soybean	bu	0.18	0.18
Oat and Straw	ton	4	4
Wheat	bu	0.03	0.15
Barley	bu	0.03	0.05
Alfalfa	ton	28	5
Clover	ton	28	7
Adapted from Modern Corn and Soybean Production. 2000. MCPS Publications.			

Calcium and Magnesium Soil Testing

- Soil extraction with ammonium acetate or Mehlich-3 and evaluation of the amount measured against critical levels.
- U.S. soils typically contain more than adequate levels of Ca and Mg for most crops.
- Due to adequate available Ca and Mg in most soils, critical soil tests are not needed.
- Universities normally do not publish soil test Ca or Mg interpretations.
- Exceptions: crops like potato and forage for grass tetany
- The Ca:Mg ratio is not a viable basis for fertilization.
- Having sufficient levels of exchangeable Ca and Mg (through soil testing) is the proper method of evaluation where reliable field calibrations are available.

Application Timing and Placement

- Calcium and Mg sources can be applied prior to or at planting time.
- In-season applications are normally not recommended for these nutrients.
- Broadcast is the most usual way of applying Ca and Mg, especially if lime is the selected source.
- Banded applications with the planter can be used at lower rates.

Sources and Application

- Application of Ca and Mg occurs most commonly through liming practices.

- As long as acidic pH problems are corrected through liming, Ca and Mg supply will be maintained and at amounts more than removed with crop harvest.

- Some exceptions where Ca and Mg fertilization is practiced:
  - Calcium application in special crops like potato
  - Magnesium application in grasses to prevent grass tetany

- Also, there are several fertilizers or amendments that contain these nutrients.

Calcium and Magnesium Sources

Source	Formula	Element concentration
Calcium		------ % ------
Calcium chloride	$CaCl_2$	36
Calcitic limestone	$CaCO_3$ (and $MgCO_3$)	Approx. 32
Dolomitic limestone	$CaCO_3 + MgCO_3$	21 to 30
Gypsum	$CaSO_4 \bullet 2H_2O$	50
Magnesium		
Dolomitic limestone	$MgCO_3$ (and $CaCO_3$)	6 to 11
Magnesium sulfate	$MgSO_4 \bullet H_2O$	17
Potassium magnesium sulfate	$K_2SO_4 \bullet 2MgSO_4$	11

Summary

- Secondary nutrients such as Ca and Mg are no less essential to plant growth.

- The mineralogy, texture, and liming of many U.S. soils maintain high levels of available Ca and Mg and typically alleviates need for fertilization.
    - Exceptions could be sandy soils and certain crops, like potato, or interaction with application of other nutrients like K.

- Because plants require relatively small amounts of these nutrients and leaching is a minor loss, Ca and Mg deficiencies are not common.

- Liming adds plant available Ca and Mg, thus reducing the probability of deficiency.