Co-Dependent Nutrients

Nutrient management is essential for optimal crop growth in organic systems. Nutrients are enabled and disabled for plant use by many factors, including the availability of other nutrients in the soil/plant/air/animal complex. Promoting balanced nutrition is important[3].

This publication aims to identify co-dependencies amongst nutrients essential to crop growth and to discuss examples of nutrient management in organic systems that promote optimal nutrient availability.

INTRODUCTION TO CO-DEPENDENT NUTRIENTS

Nutrient interactions affect plant growth when one nutrient is in excess supply and the other(s) is insufficient, or when two (or more) nutrients are both deficient[5]. When in proper balance for your production and area type, synergism occurs amongst many nutrients – that is, they enhance the utilization of one another for optimal benefit [4].

The effect of nutrient co-dependencies on crop growth may not be easy to recognize (as positive or negative) or to isolate from other factors. Interactions that may impact nutrient management include: climate (moisture, temperature), crop plant varieties, soil health and the soil nutrient profile[2, 5]. As well, biological nutrient transformations are vital to proper nutrient balances and interactions[4].

IMPORTANT NUTRIENTS FOR CROP GROWTH AND THEIR INTERACTIONS

Nitrogen (N), phosphorus (P) and potassium (K) are the plant nutrients[3] needed in the greatest volume and different crops require different amounts and balances for various growth support (i.e. N for leaf growth of corn). Plants also need different levels of assorted nutrients at different points in their life cycle. Nutrient use efficiency resulting in good uptake and maximum growth is dependent on an optimum balance of N, P, and K as well as other factors[6].

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Co-Dependent Nutrients

Nitrogen (N)

Nitrogen interacts with the following nutrients:

Effect:	
Delay in crop maturity If N in excess to:	P, K, S
NH_4^+ form of N competes for uptake with[5, 8]:	Ca, Mg, K
NO_3^- (nitrate) assimilation affected when there are high or low levels of:	S

Table 1: Nitrogen Interactions.

-Imbalance of N compared to other nutrients can reduce their availability to crop plants[8].
-N and S interactions are important to crop growth. For instance, bean plants show different NO_3^- uptake in response to different levels of available S as NO_3^- is limited by both S toxicity and deficiency (Ideal level is 0.8–12.5 mg/g leaf weight[7]).

- When N and P are in sufficient supply, plant response to other essential nutrients is more likely and may be enhanced, particularly with K and S[2].
-C and N interactions are important to assess when adding fresh organic inputs (manures, crop residues, etc), where available N is affected[8]; too much carbon added, soil nitrogen will be tied up in the soil.

Phosphorus (P)

Phosphorus is affected by soil pH and other nutrients:

In Alkaline Soil	**In Acid Soil**	
P immobilized by		Ca
	P immobilized by	Zn, Fe
P interaction important with		Cu, Zn, Fe[5]

Table 2: Phosphorus, pH and Other Nutrients.

-P is immobilized at both high and low pH: by Ca in alkaline soils and by zinc (Zn) and iron (Fe) in acidic soils[1]. In high pH soils, P-Iron (Fe), P-Copper (Cu), and P-Zinc (Zn) are important nutrient interactions to consider[5].

CATIONS (K, Mg, Ca, etc)

-Cations such as K, Mg, and Ca are dependent on one another as their availability is directly determined by their ratio to one another and their concentrations in the soil solution[8].

Due to their similar positive charges and attraction to the negative surface charges of soil particles; an excess of one cation causes the deficiency of another. Cations are prone to accelerated leaching in some soils leading to more pronounced symptoms of deficiency[4, 5].
*Cation ratios become more important in soils with low clay or low organic matter.

Potassium (K)

-K is required for plant uptake of N, including increasing N fixation by leguminous plants[2].

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Magnesium (Mg)

-Mg and P are interrelated in that Mg helps to move P in the plant[3].

- Mg and K must be in balance for good performance of both nutrients[1] (see role as cation above).

-Both K and Ca compete with Mg for a place in the soil solution[8]: greater Mg is needed where high K:Mg or Ca:Mg ratios are found to be present (this is why Mg containing dolomite may be recommended for liming acid soils).

MICRONUTRIENTS

Important micronutrient interactions include:

Condition:	Effect:
Alkaline Soil ⇒ & High Ca Soil ⇒	↓Fe ↓Cu ↓Mn ↓Zn ↓B
Mo↑ ⇒	Cu↓
S ↑ ⇒	Se ↓

Table 3: Micronutrient Interactions

-Alkaline and soils high in Ca inhibit the uptake of Fe, Cu, Manganese (Mn), Zn and Boron (B).

-Soils high in Molybdenum (Mo) may experience Cu deficiencies. Examples occur in forage-based operations in the BC Central Interior (I.e. Vanderhoof).

-S can compete with plant uptake of Selenium (Se) (their ionic forms SO_4, and SeO_4 are very similar chemically). Se deficiencies caused by S fertilizing has commonly led to Se deficiencies in livestock.

-If micronutrients such as Zn are limited in low organic matter or high pH soils, there is potential for the addition of another nutrient, such as P, to have negative effects on crop yields[2].

OPTIONS AND SOLUTIONS

Maintain proper nutrient balance by being familiar with your soil, plant, and management systems. Utilize regular soil chemical analyses (consult on method) to gain knowledge about specific nutrients that can be problematic in your soil type & texture, or crop or variety. Utilize tissue analyses to identify nutrient imbalances and toxicities early, especially at critical times during the growing season; by the time visual symptoms of nutrient imbalances and deficiencies appear on plants, it may be too late to reverse the situation effectively[5]. Forage analysis may be useful in diagnosing livestock deficiencies and interactions. Organic fertilizers often contain more than one nutrient; langbeinite for example contains K, Mg and S. Try to ensure that these elements interact positively and do not worsen negative nutrient interactions.

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