PURDUE EXTENSION | HORTICULTURE & LANDSCAPE ARCHITECTURE

# Nutrient Management for Vegetable Crops

# Plant Nutrients and Fertilizer Sources

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January 11, 2017

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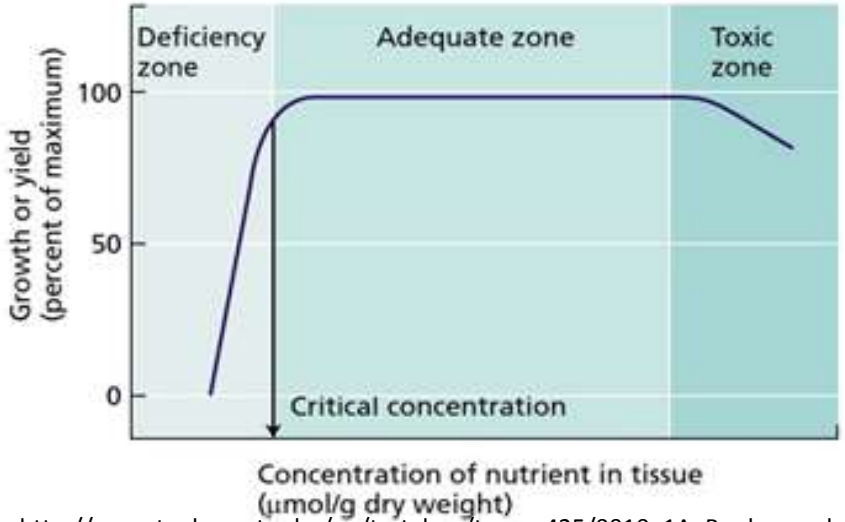
# ❖ Goals of Plant Nutrient Management Plan

- ✓ Ensure supply of essential nutrients dose not limit crop growth
- ✓ Optimizing the economic returns from fertilizers
- ✓ Minimize the negative impact of nutrients on the environment

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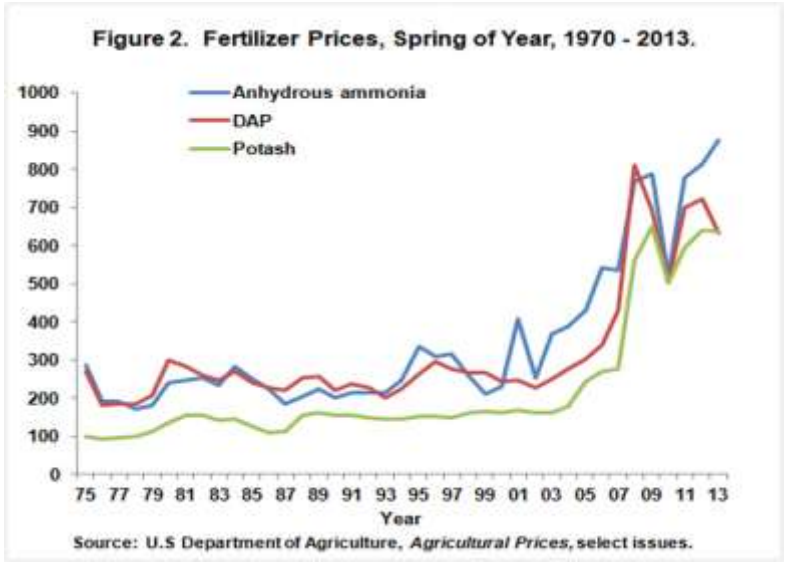


http://farmdocdaily.illinois.edu/2014/01/controlling-costs-with-lower-crop-revenues-fertilizer-costs.html

http://extension.usu.edu/aces/htm/fertilizer-management

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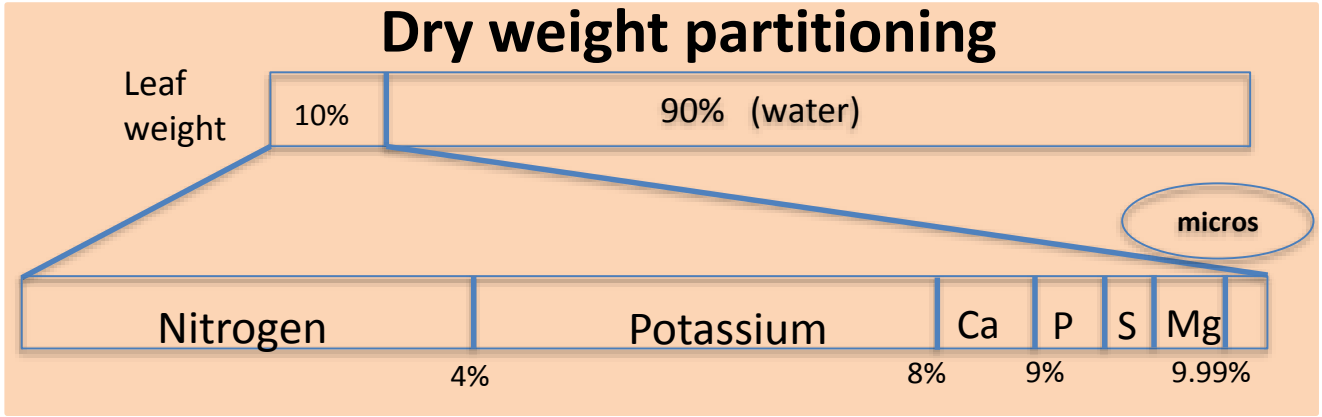
# ❖ Essential Nutrients

## Macronutrients:

- Nitrogen N
- Phosphorus P
- Potassium K
- Calcium Ca
- Magnesium Mg
- Sulfur S

## Micronutrients:

- Boron B
- Chlorine Cl
- Copper Cu
- Iron Fe
- Manganese Mn
- Molybdenum Mo
- Zinc Zn




## Which nutrient is the most important one?


*A crop's yield is restricted by the lack of a single element, even though there may be sufficient quantities of all other essential nutrients*

# ❖ Essential Nutrients

## Macronutrients:

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## Micronutrients:

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- Manganese Mn
- Zinc Zn
- Chlorine Cl
- Iron Fe
- Molybdenum Mo

## ❖ Nitrogen

### ✓ Nitrate ($NO_3^-$) and Ammonium ($NH_4^+$)

- *Plants take up N in both forms. Excess ammonium can cause ammonium toxicity*
- *Fertilizers can provide N in both forms.* Nitrate is the main source of nitrogen under soil temperature above 55 °F and aerated conditions regardless of fertilizer use

### ✓ Nitrogen lost

- Ammonium, *volatilization* if not incorporated
- Nitrate: *leach, denitrification*

## ✓ Nitrogen Fertilizers

- Anhydrous ammonia (82% N) ammonium-N
- Urea (46% N) ammonium-N
- Nitrogen solutions (UAN, 28-32% N )
  Ammonium : nitrate = 3:1
- Ammonium sulfate (21% N), ammonium,
  recommended to lower soil pH
- Ammonium phosphate (10-21% N), ammonium,
  supply P, also contribute N
- Calcium nitrate (15.5% N), nitrate
- Potassium nitrate (14% N), nitrate

| Fertilizer forms | Advantages | Disadvantages |
|---|---|---|
| Nitrate-N fertilizers | • Ready source of N when soil temperature is low, and soil nitrate is low<br>• Supply important cations: K, Ca | • More expensive<br>• Subject to leach<br>• Increase soil pH |
| Ammonium-N fertilizers | • More economic source of N fertilizers<br>• Less leach concerns | • Subject to volatilization<br>• Under suboptimal growing conditions (low soil temperature, saturated, low soil pH) and excess application, plant uptake excessive ammonium may lead to ammonium toxicity<br>• Excess uptake of ammonium may reduce uptake of K, Ca and Mg.<br>• Soil acidification |

*Nitrate form of nitrogen is considered when immediate source of nitrogen is needed while soil is cool (less than 55°F) and has low pH, or after water-logged soil has drained*

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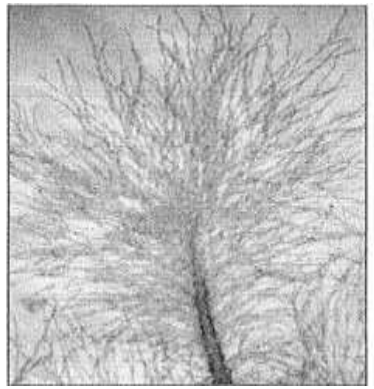
## ❖ Phosphorus

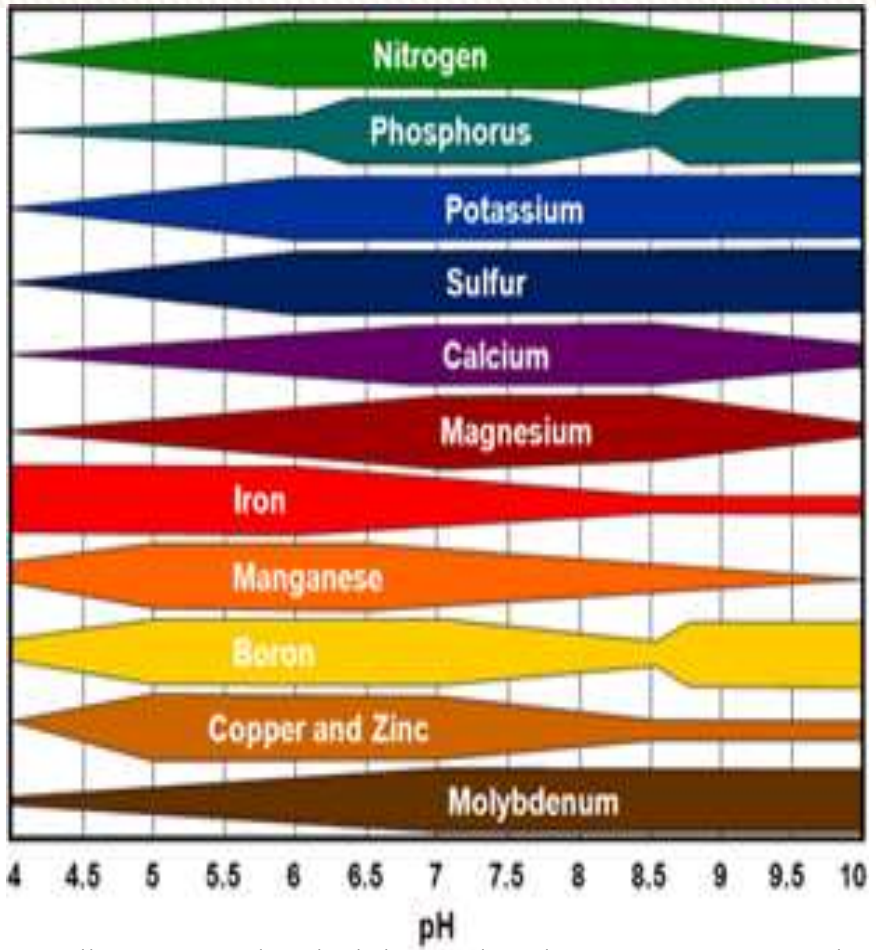
### ✓ Most soil P is not available

- Soil pH management
- Mobility of phosphorus is very limited.

*Mycorrhizal fungi* increase phosphorus uptake



http://www.soillifeforyoursoilandcrop.com/about-mycorrhizal-fungi.html




https://www.pioneer.com/home/site/us/agronomy/library/soil-sampling-test-interpretation/

## ✓ Apply P fertilizers

- P is mostly applied in preplant fertilizer
  - Difficult to recover from phosphorus deficiency
  - Young seedlings are the most sensitive
  - Leaching is less a concern
- Band or broadcast
  - Soil with high phosphorus, broadcast is adequate

## ✓ Phosphorus fertilizers

- Monoammonium phosphate (MAP) (11% N, 48% $P_2O_5$)
- Diammonium phosphate (DAP) (18% N, 46% $P_2O_5$)
- Ammonium polyphosphate (APP) (10% N, 34% $P_2O_5$)

*Phosphorus is more readily available when applied with nitrogen*

- Superphosphate (20% $P_2O_5$)
- Rock Phosphate

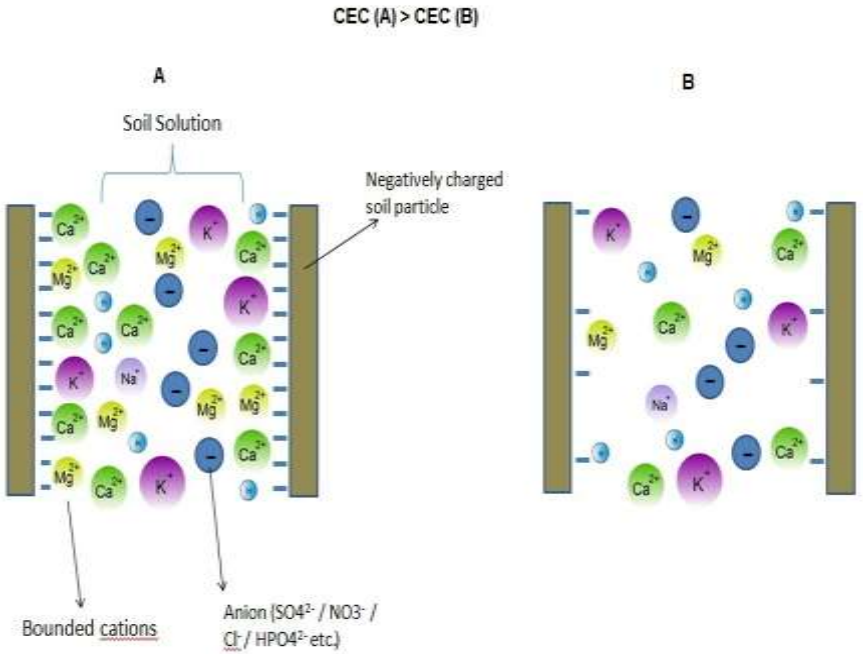
## Potassium

- Potassium is between N and P in mobility
- Leached in sandy soil, split application
- Recommendations takes into account Cation Exchange Capacity

## ✓ Potassium fertilizers

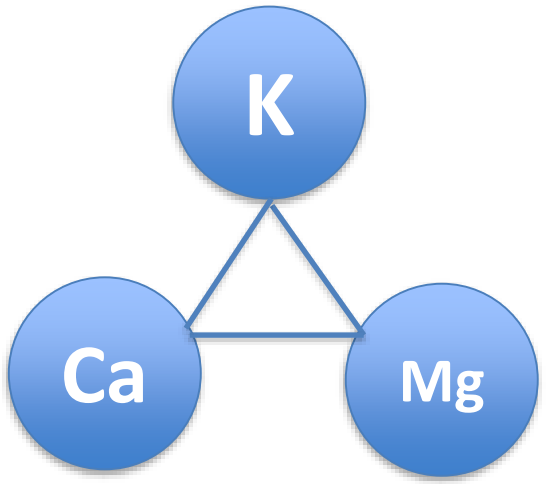
- Potash, potassium chloride (60-62 % $K_2O$)
  - High salt index, avoided if salinity is a problem
  - split apply if high rate is required
- Potassium sulfate (52% $K_2O$, 18% S)
- Sulfate of potash-Magnesia (K-Mag)(22% $K_2O$, 11% Mg, 22% S)
- Potassium nitrate (44% $K_2O$, 13% N)

# Calcium and Magnesium




http://www.smart-fertilizer.com/articles/Cation-Exchange-Capacity

- Mg deficiency likely to occur in acid sandy soil with low CEC
- Most soil contain sufficient available calcium, soil moisture play a major role for plant to take up of calcium




## ✓Antagonistic effects of K, Ca and Mg

- Excessive Ca may induce Mg deficiency
- A very high soil K can cause Ca and Mg deficiency
- High Mg and Ca may result in K deficiency

*Base saturation: Ca at least 60%, Mg 10-15%, K 1-5%*

Source: MSU E2934

## ✓ Calcium and Magnesium fertilizer sources

- Calcitic and dolomitic limes (3-12% Mg)
- *If pH is adequate,* apply Calcium sulfate (gypsum), and Magnesium sulfate (Epsom salt)
- Calcium nitrate (15.5% N, 19% Ca)
- Calcium chloride (36% Ca)
- Potassium magnesium sulfate(22% $K_2O$, 11% Mg, 22% S)

## ❖ Sulfur

- Primary source: soil organic matter, atmospheric deposition
- Sandy soil low in organic matter may show sulfur deficiency

## ✓ Sulfur fertilizer sources

- Potassium sulfate
- Gypsum
- Magnesium sulfate (Epsom salt)
- Element sulfur
- Ammonium sulfate

# Micronutrients

## ✓Boron

| Table 1. Potential for a crop response to boron when applied to boron deficient soils. | | |
|---|---|---|
| RESPONSE TO BORON | | |
| LARGE | MODERATE | SMALL |
| Alfalfa, apple, broccoli, canola, cauliflower, celery, red beet, sugar beet, sunflower, turnip | Cabbage, carrot, clover, grape, lettuce, onion, radish, spinach, strawberry, and tomato | Asparagus, barley, blueberries, field corn, cucumber, oats, pasture grasses, pea, pepper, potato, raspberry, rye, soybean, sweet corn, and wheat |

- Recommendations based on crops.
- Boron should be broadcast with other fertilizers
- Foliar application

## ✓Boron fertilizer sources

- Borax
- Sodium tetraborate
- Boric acid
- Solubor
- Sodium pentaborate

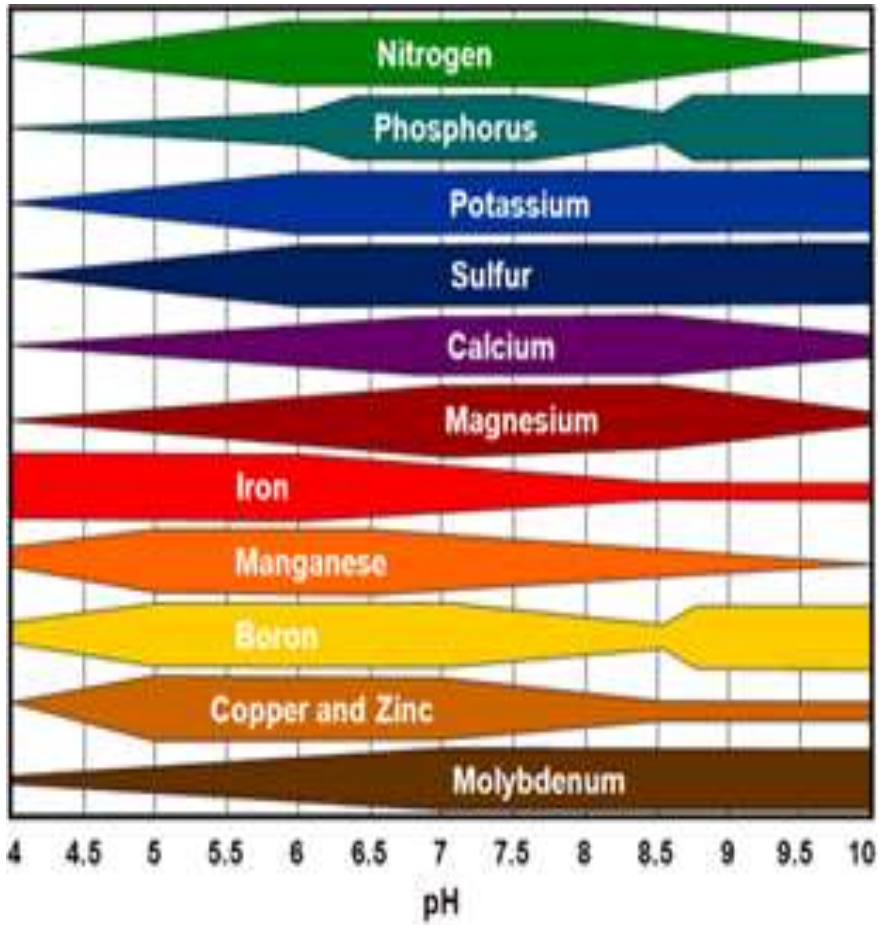

Figure 1. Areas of manganese deficiency.

Source: Purdue AY-276-W

- ✓Some fungicide application supply Mn, Zn, Cu
- ✓Manganese deficiency is likely on higher pH soils with higher levels of organic matter
- ✓Zinc deficiency likely on higher pH soils with high P

| Element | Source | Highly responsive crops |
|---|---|---|
| Mn | Mn sulfate | Bean, cuke, garlic, greens, lettuce, onion, pea, potato, pumpkin, radish, spinach, squash, sweet corn |
| Zn | Zn sulfate | Bean, onion, spinach, sweet corn |

Source: MSU, e2934

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## ❖ pH influence plant nutrient availability

- Optimal range pH 6.0-6.8
- Lime increase soil pH
  - Reduce Ca, Mg deficiency,
  - Reduce Mn toxicity
- Add element S or ammonium fertilizers reduce soil pH
  - Increase availability of Fe, Zn, Mn

## Foliar fertilization

- Can be a viable way to supply a micronutrient if it is in unavailable form in the soil or soil application is not practical
- Not a practical approach for routinely supplying macronutrients

Possibly an option for overcoming temporary macronutrient deficiencies when soil conditions prevent root uptake (e.g. flooded soils)

# Fertilizer solubility

- When dissolve a fertilizer,  not exceed its solubility

Solubility g/L

| Fertilizer /Temperature (°F) | 41 | 50 | 68 | 77 | 86 | 104 |
|---|---|---|---|---|---|---|
| Potassium nitrate | 133 | 170 | 209 | 316 | 370 | 458 |
| Calcium nitrate | 1020 | 1130 | 1290 | | | |
| Mono ammonium phosphate | 250 | 295 | 374 | 410 | 464 | 567 |

- Fertilizer compatibility

*Fertilizers contain calcium are incompatible with fertilizers contain phosphate and sulfate in a fertilizer concentrate*

Calcium nitrate × Epsom salt

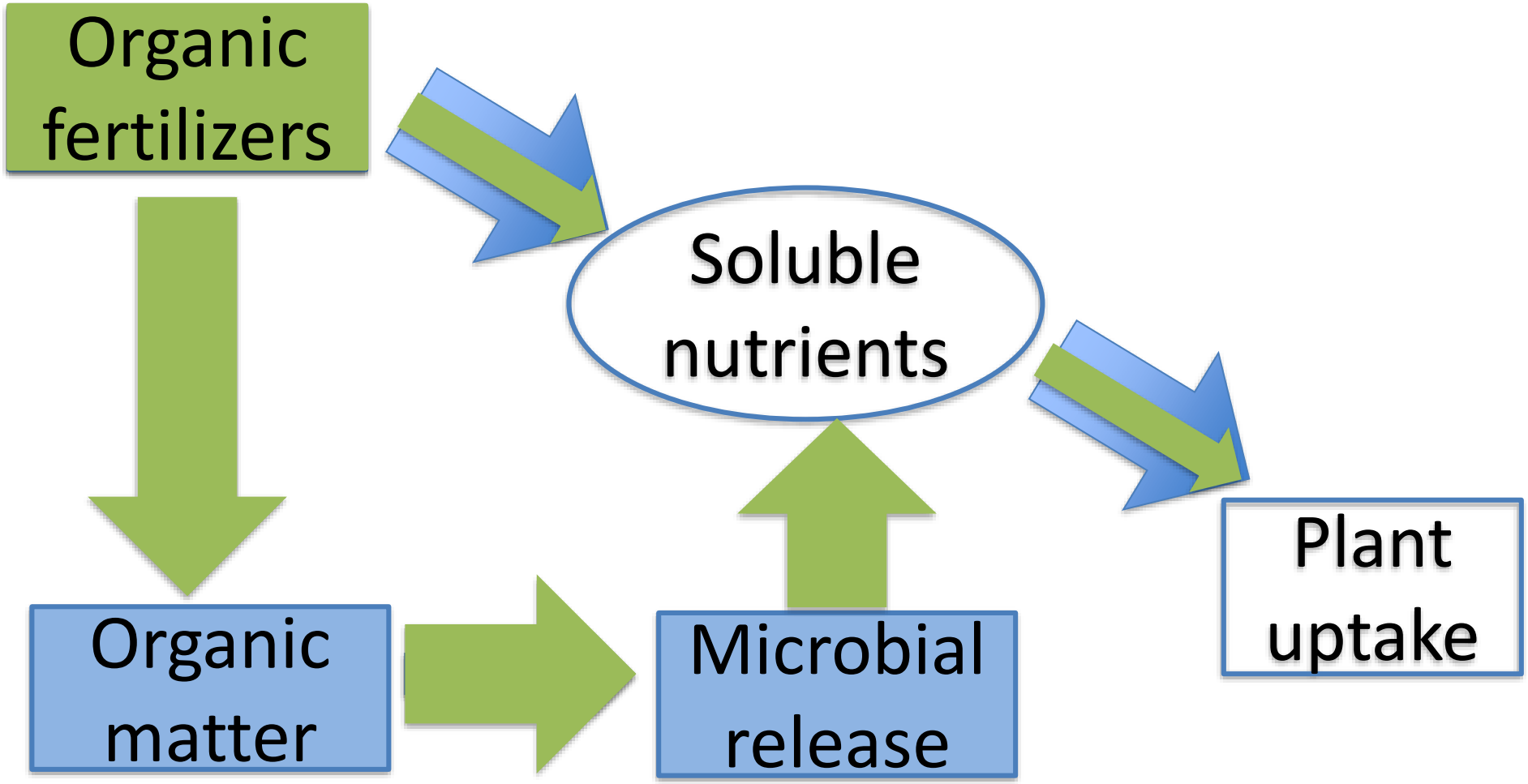
Calcium nitrate × Ammonium Sulfate

Calcium nitrate × Ammonium phosphate

**Jar Test**

http://www.smart-fertilizer.com/articles/fertilizer-solubility

## Plant nutrient management in organic systems



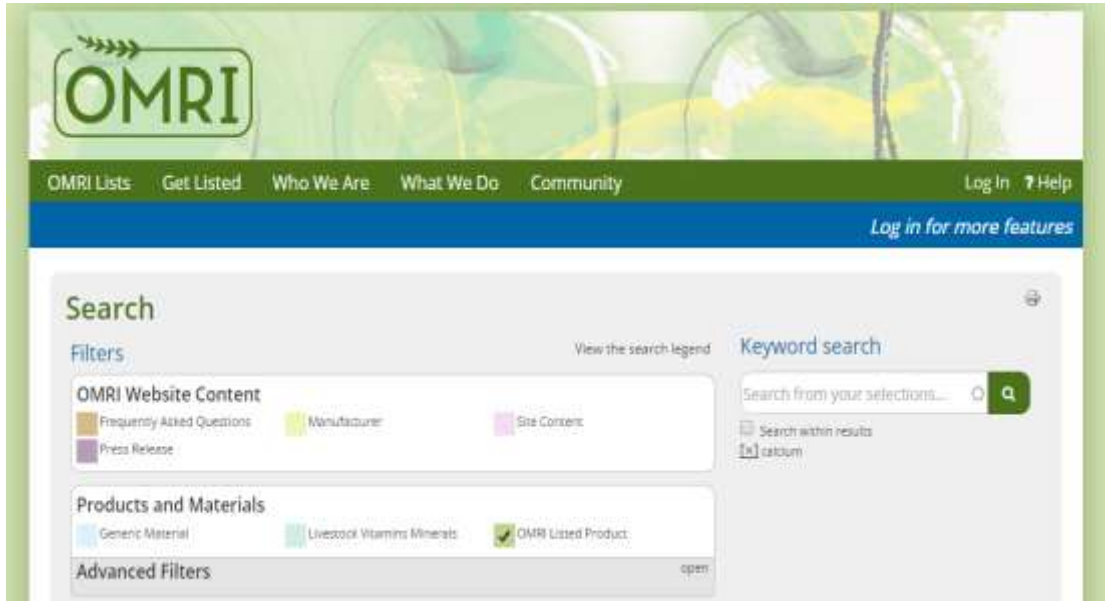
- ✓ **Manure and compost**
  - Availability in current season:
    - 80% availability for $P_2O_5$
    - 90% availability for $K_2O$
    - Soluble Nitrogen plus 10-50% of N in organic form
  - Manure should be applied at least 4 month prior to harvest
  - Caution of building up P,

    Compost: 1-3%N, 1-2%P, 1-2%K
- ✓ **Cover crops**

## ❖ Other fertilizer sources used in organic production

| N | P | K |
|---|---|---|
| Feather meal | Bone meal | Greensand |
| Blood meal | Rock phosphate | Kelp meal |
| Fish product | Bat Guano | Potassium sulfate |
| Amino acid | | Potassium magnesium sulfate |

http://www.omri.org/



# Questions & Comments

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