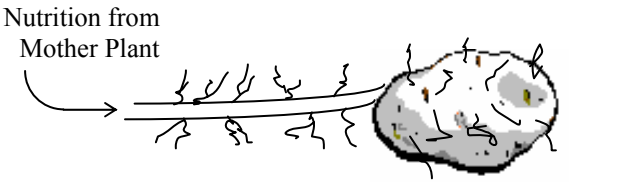
Language Of The Potato Tuber

The potato tuber is a subterranean plant with an umbilical cord connected to the mother plant.



Roots for Supplemental Nutrients

Although most of the food comes from the mother plant, the tuber and stolon has roots in order to absorb additional nutrients.

Since the tuber does not convert photosynthates, all of the photosynthates must be supplied from the mother plant.

Since the tuber is a plant, it must control cellular formation and control cellular pH … or cells will collapse and sugars will be lost back to the mother.

There are two nutrients that are critical in changing sugars to starch in the tuber … potassium and phosphate.

Potassium encourages the conversion of sucrose to starch. High levels are desirable in the tubers.

Phosphates, on the other hand, discourages starch formation. Phosphate deficient plants accumulate starches in their leaves. Phosphate deficient tubers will accumulate starch and avoid sugar end as well as bad coloring during the frying process.

Now comes the problem of tuber development. Both phosphate and potassium are phloem mobile (they rapidly move from the leaves to the tubers). If the mother plant has ample amounts of P & K, they will both rapidly move to the tuber.

Phosphates rapidly move from the leaves to new tissue … meristemic tissue … roots, growing points and tuber cells.

Potassium accumulates in the leaves and mainly moves to tubers when sucrose is transferred from the leaves to the tubers … primarily during bulking.

PHOSPHATES

Phosphates move first to the tubers.

Phosphates can precipitate calcium in the presence of monovalent cations.

This is why hollow heart and IBS start early in the tubers … unless the tuber has an abundance of calcium present in the tuber.

Since the mother plant needs an abundance of phosphate to manufacture sucrose, the only answer to the above "tuber problems" is to have and abundance of calcium.

If enough calcium is present in the tuber, it will precipitate phosphate and allow the tuber to make more starch … increasing quality and desirable color.

The mother plant transfers little calcium … because calcium is not phloem tissue mobile. The roots on the stolon and tuber must absorb a large amount of calcium.

POTASSIUM

Potassium will move to the tuber with sucrose transfer through the phloem tissue. This is good, because potassium helps the tuber make starch.

What happens if too much potassium moves into the tuber?

It upsets the cation balance of the subterranean plant … (Ca^{++}, Mg^{++}, $K^{+)}$. If too much K^{+} is located in the root zone of the stolon and tuber, the calcium and magnesium levels in the tuber will be greatly affected.

Results:

- Poor cell wall formation
- High cell pH
- More cellular exudates
- More disease problems in the tuber

Ample amounts of calcium and magnesium must be in the tuber zone. Potassium must be kept out of the tuber zone. Potassium should be preferably banded in the root zone of the mother plant … below the tuber zone.

High P in tuber is bad
Very High K in tuber is bad.
UNLESS TUBERS HAVE AMPLE CALCIUM AND MAGNESIUM.

NITRATES

There is one other important consideration … high levels of nitrate nitrogen will accumulate sucrose in the mother plant's leaves. This reduces the movement of sucrose and potassium to the tubers. Since nitrate nitrogen is NOT phloem mobile, it stays in the leaves until it is reduced to amines, amino acids, and protein.

As nitrates accumulate in the leaves, cellular pH is reduced. The plant is found to take up more potassium which will increase cellular pH. This is why high nitrate use always demands high K use in order to maintain or increase yields.

Remember, when high K rates are used, the tuber can have an "unbalanced cation condition" … poorer quality and more disease.

When high rates of nitrates are used without ample K, lower amounts of sucrose are transferred to the tuber. Less calcium is needed to balance the calcium in the tuber.

We now have the understanding to explain why "tuber calcium levels" can not be used to predict quality of tubers under all conditions.

The subterranean plant (tuber) must regulate its cellular pH. This is done by cations … Ca^{++}, Mg^{++}, and K^{+}.

Under severe drought or stress conditions

- Nitrates will be high in leaves
- K^{+} will be low in tubers

Therefore, tubers will need more calcium to maintain cellular pH and precipitate more phosphates (which accumulate due to less root growth and top growth).

Under more perfect conditions

- Nitrates in leaves will be lower
- More sucrose and K^{+} will be transferred to tubers

Therefore, tubers will need less calcium to balance cellular pH and precipitate less phosphates (which are reduced due to larger root growth and top growth).

Remember, these two extreme conditions can occur any time during the growing season … several times. STRESS is the problem of any time during the growing season.

STOLON ROOT GROWTH

One final point; calcium and phosphates will help grow root length. Lateral root branching will not occur unless ample boron is present in the root zone. Stolon roots and tuber roots need all of the lateral root hairs that are possible to generate. Boron is not easily absorbed under stress conditions.

In addition to calcium, phosphates and boron, the hormone IBA will greatly increase root growth and root hair growth.

Summary

In order to achieve maximum yields and quality under STRESS conditions:

Replace nitrate nitrogen with Nitro Plus (amine nitrogen). Nitrates will reduce sugar movement from leaves to tubers … if present in high concentrations.
Place potassium below the tuber forming zone. Do not allow it to compete with calcium at the surface of stolon and tuber root hairs.

Place phosphate under the tuber forming zone. Do not allow it to precipitate calcium in the tuber zone.

Maintain high levels of soluble calcium in the tuber forming zone … during the total growing period. It will maintain cation balance in the tuber and precipitate excessive phosphates which inhibit starch formation in the tuber.

Maintain adequate amounts of magnesium and boron in the tuber zone for cation balance and lateral root hair growth for stolon roots.

Calcium and Boron are non-mobile in the phloem tissue. A goodly amount must be soil applied.

- Gravity (low) and color (poor)
  To much phosphate in tuber
  Not enough potassium in tuber
  Not enough calcium in tuber

- Disease (high)
  Too much nitrate in plants
  Not enough potassium in plant
  Not enough calcium in plant and tubers.

- Physiological and Storage problems
  Not enough calcium in tubers.

Calcium is the regulator nutrient for all other nutrients. Under STRESS conditions, the % calcium in plants and tubers increase. Under non-stress conditions, % calcium levels in plants and tubers decrease. If enough calcium is available, it may be impossible to have plant stress or disease.

Side Note:

Have you noticed that many plants will have numerous tubers early in the season and fewer tubers at the time of harvest?

What happens?

During the season, phosphates move rapidly to new tubers. If sucrose movement and potassium movement lags (due to stress or rapid vegetation growth), the phosphates promote starch turning back to sugar. The sucrose leaves the tuber and goes back up into the mother plant. This "new found" sucrose goes either to

- Growth of the mother plant

  or

- Back down to other bulking tubers

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