

SILVER RABBIT: POLYAMINE-BASED CHELATION TECHNOLOGY

Polyamine-Based Chelation Technology

Successful delivery and uptake of formulation constituents applied to Cannabis plants can be a difficult proposition given that nutrient and supplement sources within product formulations are often subject to:

- 1) Adverse interaction with other plant nutrients (antagonism)
- 2) High carbonate and bicarbonate levels that may exist in water sources (often referred to as "hard water").
- 3) pH related fixation ("tie up") of phosphate ions by metals such as iron and aluminum (under low pH), and calcium and magnesium (under high pH) on or near media surfaces.

SILVER RABBIT

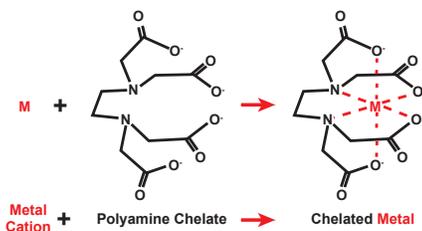
Breakthrough Polyamine-based Cation Complexing Technology

Key Grow Solutions has achieved a delivery system breakthrough with tremendous ramifications for Cannabis growers as it applies to nutritional element and supplement availability and consistency. This technology is resident in a number of our products for Cannabis production including a stand-alone product – Silver Rabbit.

Silver Rabbit cation complexing technology can be used by growers to address problems with elemental antagonism, bicarbonates and issues associated with pH through its novel delivery technology that utilizes a polyamine cation complexing technology – resulting in programs that enhance the development of truly balanced nutritional programs.

The polyamine complexing (chelating) technology used in Silver Rabbit possesses the capacity to form stable chelate rings with the ions of aluminum, iron, calcium, manganese, magnesium and other metal cations in media or in application solutions.

The "ring-like" molecules that are formed are chemically inactive and are incapable of participating in reactions that form precipitate compounds or "binding" reactions with cation metals on media surfaces and in the media solution.



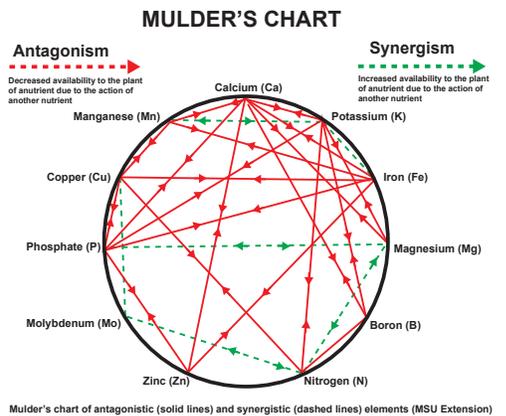
Metal chelates formed with Silver Rabbit polyamine technology are soluble in aqueous solutions and are readily available to the Cannabis plant.

Dealing with Element Antagonism

Interactions between nutrients occur when the supply of one nutrient affects the uptake, distribution or function of another nutrient. Inefficient uptake of nutritional products can occur when they come in contact with other elements in formulations or are exposed to other elements (particularly metal cations) resulting in the formation of insoluble precipitates.

For example, phosphorus is an essential plant nutrient element and is a functional requirement in a number of biological systems and biochemical processes during the Cannabis plant's life cycle.

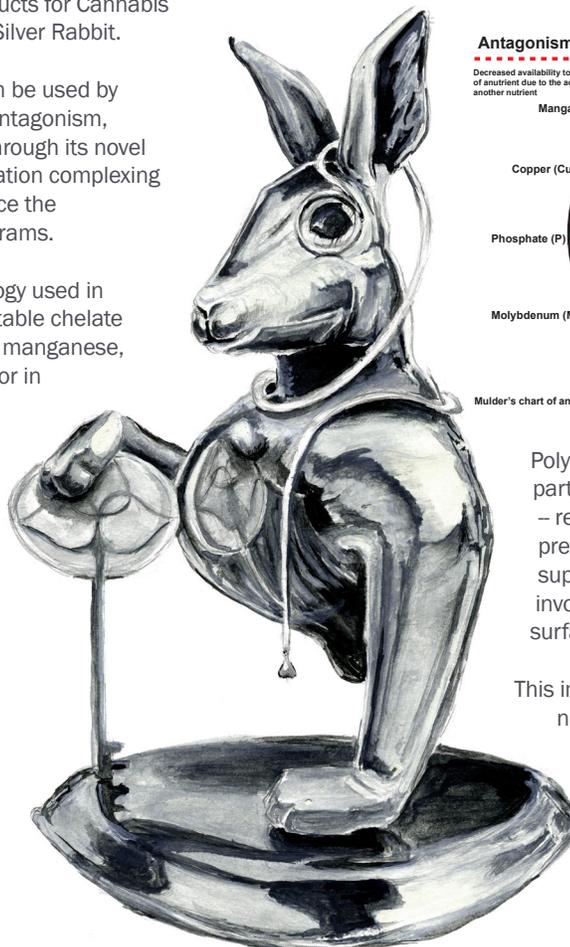
However, phosphorus interacts negatively in the simultaneous presence of calcium, sulfur, zinc, copper, potassium and iron cations. Other examples of such "antagonisms" that impact other elemental "nutrients" are depicted on the Mulder's Chart below.



Polyamines used in Silver Rabbit have a particular affinity to chelate metal cations – rendering them incapable of forming precipitates with nutrient constituents and supplements as well as preventing their involvement in fixation reactions on media surfaces.

This improves the efficiency and efficacy of nutrient and supplement formulations. It also allows balanced formulations to be developed without concern over antagonism.

As Silver Rabbit polyamines move through the media they react



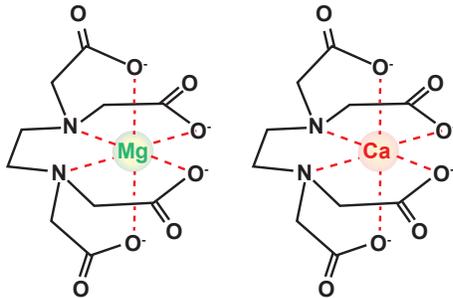
(chelate) with metal cations in the media solution and metal cations on media surfaces. Studies have shown that in general, polyamine chelated metals actually increase the overall plant availability (solubility) of these metal cations – improving the fertility of the media profile.

High Carbonate and Bicarbonate Levels in “Hard” Water

Reactions with carbonates and bicarbonates often render nutrients ineffective due to the formation of insoluble precipitates that cannot be absorbed by the Cannabis plant.

High levels of carbonates and bicarbonates in application water or media solutions often lead to poor quality irrigation water. These ions attract cations such as calcium and magnesium forming insoluble carbonate molecules that precipitate from the media solution, Calcium and Magnesium are no longer available for plant nutrition. This often results in plugged irrigation nozzles, crusting of growing media surfaces and blockage of media micropores that can disrupt air-to-water ratios.

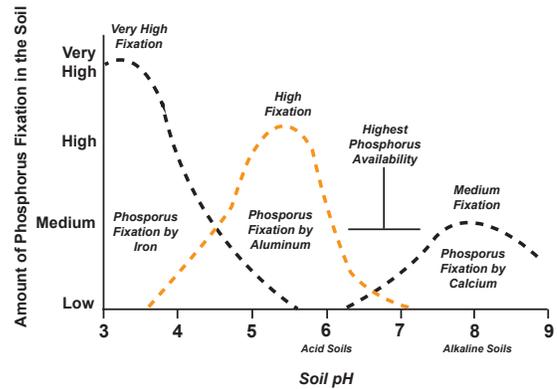
Within irrigation water and the media solution, the Silver Rabbit polyamines chelate calcium and magnesium cations in application/media solution and on media surfaces – preventing these cations from participating in reactions that produce precipitates that reduce elemental availability, weaken media structure and block irrigation emitters. Moreover, the polyamine chelated forms of calcium and magnesium remain soluble and available for nutritional use by the Cannabis plant.



Problems with pH Related Fixation of Phosphorus

It is generally recognized that pH can have significant impact on nutrient availability in nutritional programs. Problems with the availability of nutrients to plants may occur when pH levels fall out of optimum ranges.

These usually are the result of the type and amount of antagonistic metal cations that are solubilized from the media under acidic or alkaline conditions. Nitrogen (N), Potassium (K), and Sulfur (S) are major plant nutrients that appear to be less affected directly by media pH than many others, but still are to some extent. Phosphorus (P), however, is an example of an important nutritional element that is directly affected by pH.



It has been estimated that, up to 70% of P applied to these types of growth media can become almost immediately unavailable for plant uptake due to natural chemical binding and chemical transformations.

Fixation occurs when Phosphorus reacts with other minerals to form insoluble compounds and becomes unavailable to the Cannabis plant. There are three peaks of P fixation. The two highest peaks occur in the acid range of pH 4 and 5.5, where P precipitates with iron and aluminum. The overwhelming majority of acid media contain significant amounts of hydrated iron oxides that are distributed as a thin layer over media particles – an ideal condition for phosphate fixation.

It is very difficult to supply sufficient phosphorus for Cannabis needs when P solubility is being controlled by cations “freed” by low or high pH conditions.

Silver Rabbit polyamine technology has a significant effect on the reduction of antagonistic cations under a wide range of acidic and alkaline environments. The polyamine molecules will react with and chelate the majority of metal cations under any pH condition. This creates a significant degree of protection for nutrients and supplements combined with Silver Rabbit technology.

Optimizing cannabis plant nutrient use efficiency (defined as yield per unit P input) is a challenge made far more attainable using the Silver Rabbit polyamine technology.

WHAT KEY GROW SOLUTIONS POLYAMINE TECHNOLOGY PROVIDES TO YOU

- Enhanced fertilizer efficiency and effectiveness
- Allows for development of nutrient and supplement mixes that are not affected by hard water or pH
- Provides protection to phosphate from fixation with iron, aluminum, calcium, magnesium and carbonates
- Reduces the occurrence of carbonate and bicarbonate precipitates that plug media pores (causing poor air-to-water ratios) and promote degradation of media profile
- Provides the ability to provide well balanced, highly available, low salt nutrients
- Significantly improves overall nutrient availability and plant uptake
- Safe to handle

Key Grow Solutions Polyamine Technology is included in all of the KGS products.