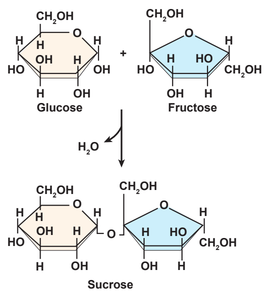
TECHNICAL BULLETIN

GREEN DRAGON: SUGAR SIGNALING IN CANNABIS PRODUCTION

Terpene and Cannabinoid Production

It is well established that in plants, production of carbohydrates (sugars) via photosynthesis is a vital process, and these sugars such as glucose and sucrose play a central role in the control of plant metabolism, growth and development.



Many Cannabis growers may be surprised to learn that adequate levels of glucose and sucrose represent significant requisites required by the plant in order to advance to the next developmental stage during key transitional phases between juvenile-to-adult vegetative development and between adult vegetative-to-flowering stages.

Glucose and fructose are simple 6 carbon sugars formed via photosynthesis and are associated with early organ growth and metabolism in plants.

Sucrose is a 12 carbon simple sugar molecule composed of glucose and fructose is the final product of photosynthesis. Sucrose is produced naturally in plants and is closely associated with the maturity, differentiation and full functionality of plant organs.

If the Cannabis plant detects that insufficient carbon (primarily sucrose) exists, the plant is deemed "incompetent" to complete the next developmental program and developmental transition is delayed or discontinued.

So how does the cannabis plant know when to support new developmental events from prior stages such as moving from adult vegetative to flowering?

It is now understood that sugar signaling pathways within the cells of the Cannabis plant that interact with the developmental regulation also control the timing of transitions of developmental stages of plant life cycles.

Glucose and sucrose serve a dual function in plant. In addition to their roles as substrates in carbon and energy metabolism and in polymer biosynthesis (i.e., cellulose), carbohydrates (sugars) function as primary messengers in signal transduction during the entire life cycle of the Cannabis plant.

Sugar sensing and signaling in cannabis plants are involved in the control of growth and development during the entire life cycle.
For example:

Sucrose transport and hydrolysis as sensed by the signaling pathways indicate plant development competence and leads to:

- Juvenile to Adult Phase: Major morphological changes characterized by increased leaf complexity as well branching of shoots.
- Vegetative to Reproductive Phase: Adequate carbohydrate reserves (particularly sucrose) indicate "competence" to respond to floral induction signals where shoot meristems become committed to flowering.

Optimizing Carbohydrate Status and Developmental Transitioning in Cannabis

Carbohydrate Deficit. In an ideal world, photosynthate production is normally sufficient to provide levels of carbohydrates to support growth, development and function as well as satisfy glucose needed for respiration.

However, nutrient deficiencies and environmental stresses (light, temperature, salinity, etc.) can adversely affect photosynthesis and output of photosynthetic machinery. As a result, photosynthate production can fall below optimum levels. Such a condition is often referred to as carbohydrate deficit.

If carbohydrate reserves are not available to correct carbohydrate deficits, Cannabis growth and development can quickly degrade, resulting in less than optimum production results.

Successful Cannabis production must support efforts to balance Photosynthesis (carbohydrate production), Respiration (amount of carbohydrates needed for energy requirements) and Carbohydrate Reserves (allocation and storage of excess photosynthate production).

GREEN DRAGON

Green Dragon is a proprietary potassium acetate-based supplement developed to provide Cannabis growers with a product that can significantly improve the amount, efficiency and balance of carbohydrate production (particularly under stress) – contributing to exceptional Cannabis plant growth, function, development, and production.

Potassium Acetate Technology

Green Dragon is a proprietary combination of an inorganic salt reacted with an organic acid to form a potassium acetate fertilizer. The acetate carrier component of the formulation is a natural plant metabolite that is more rapidly and readily absorbed by plants and significantly enhances potassium use efficiency.

The formulation also contains proprietary polyamine-based chelation technology that is exclusive to Key Grow Solutions in the Cannabis industry. The polyamine technology optimizes the availability and effectiveness of its formulation constituents.

Green Dragon has a very low salt index and has excellent compatibility with other fertilizers.

The Potassium Constituent

Green Dragon's potassium constituent is involved in many important biochemical reactions in plant culture. Many of these functions are directly related to improved photosynthetic characteristics and accelerated accumulation of photosynthate.

Potassium triggers activation of important biochemical enzymes for the generation of Adenosine Triphosphate (ATP) that provides energy for other chemical and physiological processes.

Potassium is also responsible for synthesis, translocation and storage of starches, sugars, and fats; stimulation of root growth; regulation of plant stomata opening/closing and thus, water use; maintenance of cell internal pressure and ionic balance and environmental resistance and tolerance.

Without question, inclusion of a Potassium constituent in any program to improve plant carbohydrate status is mandatory.

The Acetate Constituent

What makes Green Dragon unique is in the origination of the acetate molecule -- its organic-based carrier anion. Acetate is a natural plant metabolite that has many important functions within the plant. It provides a base chemistry from which many plant compounds are thereby formed, which includes but not limited to the following:

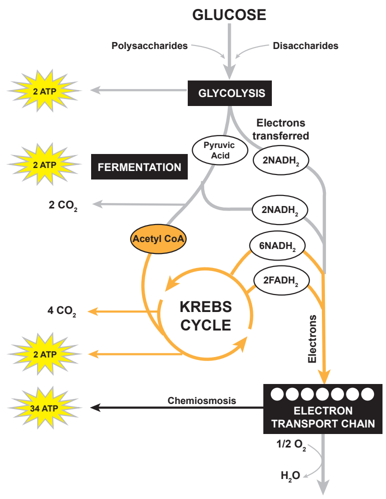
- fatty acids
- sterols
- phenolic acids
- carotenoids
- terpenes / cannabinoids
- flavonoids
- amino acids
- chlorophyll

An often unnoticed benefit of the organic acid acetate molecule is the beneficial impact it can make on the carbohydrate status of the Cannabis plant. Improvement in carbohydrate status is accomplished by its involvement in two important pathways – The Citric Acid Cycle (KREBS Cycle) and the Glyoxylate Pathway.

Acetate and the Citric Acid Cycle

It is well documented that the KREBS Cycle defines the process of enzymatically converting photosynthate in the form of glucose (glycolysis) into Adenosine triphosphate (ATP), the complex organic chemical that provides energy that drives many processes and functions of the Cannabis plant.

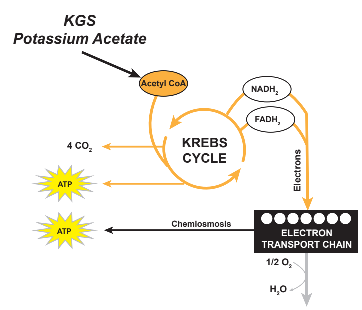
It should be clear however, that production of ATP comes at the expense of carbohydrate supply (i.e. carbohydrate status).



Looking at the chart of the KREBS Cycle would lead many to believe that glucose was the starting material. This is not the case. A closer look reveals that acetyl coenzyme A (Acetyl CoA) is the actual start of the KREBS Cycle. Its main function is to deliver the acetyl group to the citric acid cycle (Krebs cycle) to be oxidized for energy production.

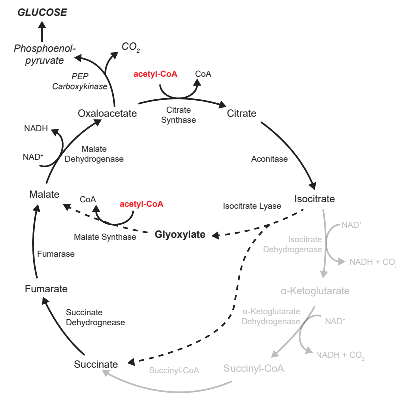
Research has shown that if degradation of the photosynthetic machinery (such as caused by abiotic or biotic stress) is detected by the plant, plants will utilize acetate to compensate for glucose until adequate photosynthate levels are restored.

The acetate molecules in Green Dragon can provide an alternate source of Acetyl CoA (via Acetyl CoA synthase) without using carbohydrate (glucose) reserves required by glycolysis. This results in an increase in the plant's net photosynthetic status.



Acetate and the Glyoxylate Pathway

The Cannabis plant uses acetate in yet another way to improve or optimize carbohydrate status through use of a pathway related to the citric acid cycle called the Glyoxylate Pathway.



If energy reserves are adequate, the plant may option to use a shortcut across the Citric Acid Cycle is taken called the Glyoxylate pathway or Glyoxylate Shunt. This pathway basically redirects the pathway from the decarboxylation reactions that produce ATP in the KREBS cycle.

Because of this, all six carbons of the KREBS cycle survive and do not end up as CO_2. The glyoxylate pathway shortcut (shunt) now produces malate and extra oxaloacetate that can be used to make other molecules, including glucose. Many scientists refer to this as gluconeogenesis or reverse glycolysis.

The plant uses acetate to produce Acetyl CoA to improve its carbohydrate status through increased starch production or higher lipid accumulation (if starch reserves are adequate).

Researchers report that the supplementation of organic carbon, specifically acetate, has been demonstrated to strongly extend the phase and rate of starch and lipid accumulation.

The glyoxylate cycle provides Cannabis plants with another aspect of metabolic diversity by allowing Cannabis plants to use acetate as both a carbon source (starch, lipids, etc.) and as a source of energy.

THE POWER OF GREEN DRAGON

- Delivers the most effective source of potassium
- Provides unparalleled photosynthetic integrity under stress conditions