Clearing up the Carb Controversy: Do Carbohydrate Supplements Really Produce Bigger Yields and Root Systems in Hydroponic Gardens?

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Whether you're a hobbyist gardener or a professional grower, sooner or later you are going to hear about the carb controversy…

What I'm talking about is this: Some people claim carbohydrates cannot be absorbed by plants at all, and that carbohydrate supplements are little more than snake oil.

Others agree your crops could use an extra boost, but they wrongly assert that carbs cannot be taken up by the roots. Better to apply them by foliar spray, they say. In fact, nothing could be further from the truth.

And believe it or not, there are even old-timers who still insist that all you need is molasses. High-grade molasses which is low in sulfur can indeed benefit your plants (if it doesn't clog up your lines). But what your crops really need is the full spectrum of carbohydrates that matches their species profile.

Let's face it, with so many contradictory viewpoints and misinformation out there, it is no wonder so many growers feel confused. The forums, as always, are abuzz with advice. Everyone has an opinion, and different people will tell you different things.

But what does the science say?

Get the facts: This white paper explains the importance of carbohydrates to your plants. It describes the role they play in plant formation, dispels the most common myths about carbohydrate supplements, and sets the record straight on the carb controversy.

What are carbohydrates and how do they produce bigger yields?

Sugars, saccharides, carbs—they are all the same thing. That's the short answer. And the miracle of it all is that plants themselves manufacture carbohydrates. The following chemical equation demonstrates that when carbon dioxide and water combine in the presence of light, the leaves produce oxygen and carbohydrates in a process known as photosynthesis:

$$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$$

To put it simply, carbohydrates are the primary and most abundant products of light-energy transformation by plants. Leaves take the solar energy from your lamps or the sun, the CO_2 from the air, and the water from the growing medium to produce the energy your plants need to grow and thrive.

The fact is carbohydrates represent roughly a quarter of all organic soil matter, a substantial amount of which is derived from polysaccharides in roots and plant debris. Carbs can be as simple as sucrose, which is table sugar, or as complex as cellulose, which is the tough, fibrous polymer that plants are made of. All carbohydrates end in –ose. All contain energy.

Furthermore, plants utilize this versatile source of energy in a variety of ways. They use carbs to grow tissues and build construction materials of all kinds: roots, stems, leaves, blossoms.

In fact, they metabolize carbohydrates into almost everything imaginable, from starch, an energy accumulator, to THC.[1] Carbs are even involved in the synthesis of DNA—deoxyribonucleic acid, whose name is derived from deoxyribose, a carbohydrate.

Any excess carbohydrates your plants do not burn off, they store up in specialized bodies called vacuoles. These reserves are made readily available later on when your plants channel all that energy into producing denser flowers and fruits.

Indeed, carbohydrates play their most critical role in the weeks just before harvest. It is during ripening that buds make their biggest weight gains while burning through those precious energy reserves.

Because of this, an enormous amount of metabolic energy is expended on manufacturing carbs throughout the late vegetative and early flowering stages. Once ripening sets in, carbohydrate production all but stops, and plants must rely almost solely on their carbohydrate reserves.

You see, the more carbs your plants have access to, the bigger the yields. That’s the bottom line.

If plants create carbs, why do they need a carbohydrate supplement?

Good question. Is it really necessary to buzz your crops with a sugar high? Isn’t photosynthesis supplying all the carbs they need?

The answer is: yes and no. If they have sufficient nutrients, light, and CO_2, your crops will do just fine. But if monster yields are what you’re after, you have got to strive for more. Here are the major benefits of adding a carbohydrate supplement to your feeding schedule:

[1] Glucose is metabolized into acetyl-CoA, used to synthesize diverse compounds, including terpenes such as THC.

Extra carbs free up energy for vital processes. If, in the weeks prior to ripening, you supply your plants with most of the carbohydrates they need, they will not have to struggle to manufacture their own.

In other words, they won't have to live hand to mouth. By giving them an abundant source of ready-made energy, you will enable your crops to channel more of their own energy into biosynthesizing amino acids and important secondary metabolites, such as phenols, terpenoids, and THC.

Think of it as a race. Athletes talk about carbo-loading—consuming a high-carb diet to infuse their muscles with energy before the big event. That way, they can tap into those reserves when they need that big burst during the final lap. Star athletes and stellar crops have similar energy needs. If you infuse your plants with pent-up power, they can leverage it on demand for a strong finish.

Extra carbs top off your plants' own reserves.
Bear in mind that a significant amount of unused carbohydrates will be saved for future use. However, plants have limited capacity to store extra energy.

Therefore, it is advisable to supplement their natural stores, particularly during ripening. You do not want your crops to be running on empty right when their fruits and flowers are packing on their most weight.

Extra carbs safeguard your crops. Hydroponics is the Formula 1 of agro. Every parameter is pushed to the limit: lighting, CO_2, nutrient concentration. In fact, the concentration of inorganic nutrients can approach the point where plants experience osmotic shock.

So you see, carbs supplied to the root system can substantially increase root resistance to osmotic stress. We're getting deep into science here. Let it suffice to say that carbohydrate feeding can make hydroponic growing less risky.

Extra carbs energize beneficial microbes. The beneficial bacteria and fungi that live in the growing medium and colonize the rhizosphere help to fend off harmful microorganisms and disease. They also fix nitrogen, break down macro- and microelements into plant-available forms, and contribute to other vital processes. Feed those good bugs, and they will multiply.

To sum up, there is a relationship between the amount of carbohydrates made available to and stored by your plants and the eventual size, weight, and quality of their yields.

Furthermore, carbs make hydroponics safer for your crops.

Last but not least, they help to feed the beneficial microbes that inoculate the roots and help to break down complex carbohydrates and other nutrients into plant-available forms.

All of this translates into heavier harvests.

That's great! So, what's the controversy?

We've established the role of carbohydrates in plant formation and the benefits of feeding your crops as many carbs as possible. But those questions introduced at the start of this white paper remain unanswered. Let's clear them up, one controversy at a time:

Can plants even absorb the carbohydrates I feed them?

The answer is a resounding "yes." The following is just a smattering of the evidence:

Growers have long fed carbs to plants, begging the question: If carbohydrates didn't work, why would growers use them? While noteworthy, tradition per se is insufficient proof. The folk wisdom could be wrong. We've promised you science. We're going to give you science.

Scientists have long fed carbs to plants. Interesting! If carbohydrates were useless, why would scientists apply them to the soil or the nutrient solution during research?

For example, *Arabidopsis thaliana* is widely used in scientific research as a model for plant development. In the agricultural sciences, this humble plant plays the role that mice and *Drosophila* flies play in animal biology.

Arabidopsis is typically cultivated in an artificial medium, such as agar. For over a century, scientists have observed that adding carbs to agar enhances growth and "modulates adventitious rooting" in *Arabidopsis*. In other words, carbohydrates promote strong root development.

Numerous other studies have demonstrated that carbohydrates influence ion uptake by the roots and other developmental processes (e.g., Bechtold, et al., 2000; Kobayashi, K., et al., 2003). All this points clearly to carbohydrate uptake by plants.

Scientists have confirmed the existence of carbohydrate transporters in roots. Indeed, the mechanism of carbohydrate absorption by plants has been discovered: Roots have special transporter proteins that recognize carbohydrate molecules, bind to them, and translocate them into the roots (Saglio and Xia, 1988).

Researchers believe the primary function of these transporters is to capture root exudates—i.e., to prevent carbohydrates from leaching from the roots. However, these transporters will take up all carbs made available.

For example, in natural soils, transporters take up carbohydrates resulting from plant decay. It should be noted that the process of carbohydrate transport is costly for plants. Carb absorption does require energy. However, the energy gained from ready-made carbohydrate molecules far exceeds the energy expended on transport.

The mere existence of an active transport system suggests that the active uptake of carbohydrates has a net positive benefit for plants. Spectacular examples include carrots and sugar beets. Their roots, already rich in carbohydrates, avidly absorb more carbs whenever given the opportunity. Your plants do too.

What is the best method of applying a carbohydrate supplement?

The argument for foliar application of carbohydrates runs something like this: Since carbs are manufactured and stored in the leaves, why not deliver them to the leaves directly.

Let's not write off foliar application of carbs completely. For many nutrients, foliar sprays do indeed serve as a beneficial form of supplemental feeding. However, they should never serve as the primary form of feeding of any nutrient, carbohydrate or otherwise.

Despite what you may have heard, it is self-evident that the root system is where the vast majority of organic nutrients are absorbed by plants.

This is apparent from plant physiology. Plants have evolved roots for a reason. Roots have clear, specific functions—above all, the absorption of water and nutrients. Plants do not bury their leaves in the ground in search of food and water.

I know it may sound silly to point out, but even plants that grow laterally, such as vines—and which may affix themselves to superficies with root-like tendrils, or even sprout secondary roots at new locations—get the bulk of their nutrition from their base root systems.

Moreover, spraying carbohydrates directly onto the leaves entails certain risks. It should be done with great care, if it is done at all.

Why?

Sugars are saccharides are carbs, remember? And sugars are sticky. So even when using a high-quality surfactant, you run the risk of gumming up the stomata, the microscopic openings on the leaves and stems. The stomata, or stomates, facilitate gas exchange—in other words, transpiration: breathing. Sticky leaves may even attract insects.

But won't good ol' molasses do the trick?

Molasses can be used as a carbohydrate supplement—in soil. Old-timers may insist they get away with it in hydroponics. But raw molasses is gooey, and it can clog up your lines. Residue may also build up in the reservoir, in the growing medium, or in the root system.

This in turn could lead to root rot or other complications. A high-quality carbohydrate supplement will be properly processed and suspended in solution in order to be safely applied hydroponically.

Another difficulty is that molasses and other over-the-counter sugars are inconsistent. They vary significantly in quality and composition—not only among brands, but also from one batch or bottle to the next.

So when you use raw sucrose or fructose from molasses or some other source, you are rolling the dice. You cannot rely on the quality or consistency of what you are getting.

To get the maximum benefit, a carbohydrate supplement must have the correct profile—ideally, one that is tailored to your plant species. The right carbs must be applied in the right ratios and doses.

A word of caution though: Variety is also a key factor. Plants grow better when multiple carbohydrate sources are applied, as shown in the photo in Figure 1 on the next page. And while molasses does indeed contain one or two types of carbohydrates, it does not contain the full spectrum of carbs that your plants need.

It takes a lot of R&D spending—and tests done on thousands of field crops—to get the formula just right. Let's look more closely at the science to learn why:

Firstly, individual carbohydrates vary enormously, from simple sugars to highly complex compounds. For example, glucose, fructose, and xylose are all monosaccharides, sucrose is a disaccharide, and cellulose is a polysaccharide.[2]

Glucose is an aldose (i.e., it contains an aldehyde group), while fructose is a ketose (i.e., it contains a ketone group). Both have the same brutto formula, $C_6H_{12}O_6$, but their chemistry is slightly different. A slight difference in chemical makeup can mean a significant difference in how a carb reacts to or affects biology.

Secondly, different plant species have different preferences for different carbohydrates. They can take up some carbs better than they can take up others.

For example, tomatoes and sugar beets prefer sucrose to glucose, while melons prefer fructose to glucose or sucrose (Thomas and Weir, 1967). Decades ago, researchers even considered certain carbohydrates—namely, galactose and mannose—to be toxic for most plants because when applied on their own they inhibited plant growth (Figure 1).

[2] Carbohydrates were first called saccharides on the basis of table sugar, which was the first studied carbohydrate. Nowadays, "saccharide" is used only in composite names, such as mono-, di-, olygo-, and polysaccharides.

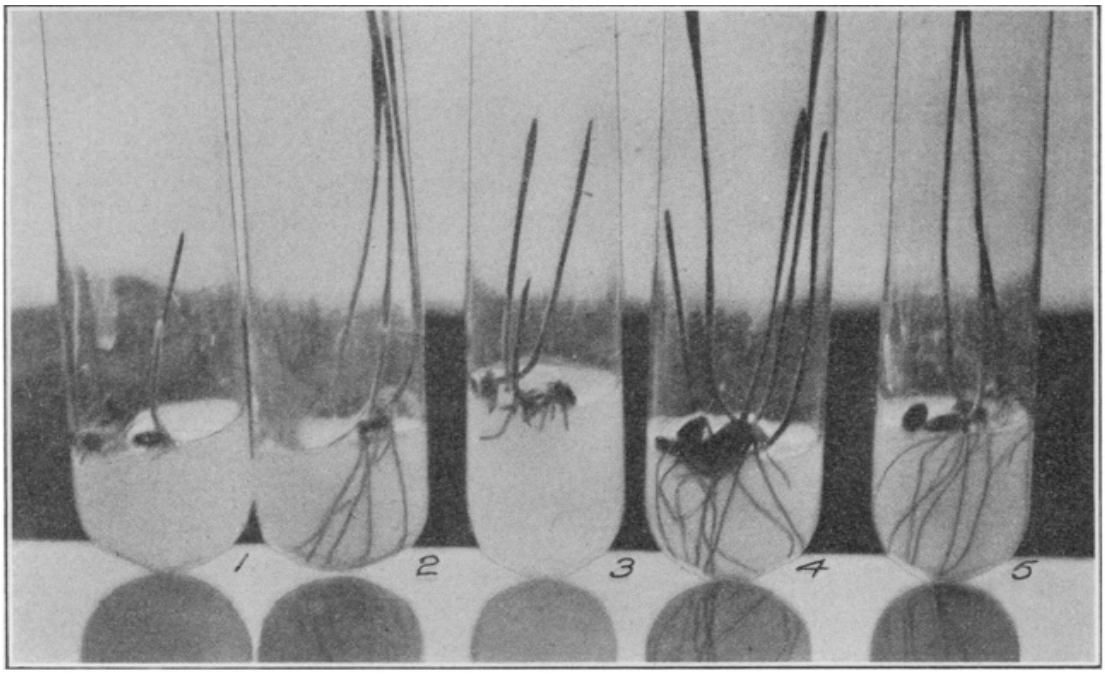

FIG. 3. 1. Galactose .025 mol.
2. Mannose .025 "
3. Mannose .025 " + galactose .025 mol.
4. Mannose .025 " + glucose .025 "
5. Pfeffer's solution. No sugar.

Figure 1. Originally labeled Figure 3, this photograph has been reproduced from the *American Journal of Botany*. Taken in 1917, it shows the effect of various carbohydrates on wheat. The plants grew most substantially in test tube 4, where more than one carbohydrate was present.

However, when used along with other carbs, neither has any detrimental effects. We might say that such carbohydrates, when applied on their own, are junk food for plants. Regardless, the point is that certain plants have certain carb preferences, so feeding your plants just any carb is not likely to do the trick.

Thirdly, different carbohydrates compete for the attention of root transporters at different stages of plant development. Plants absorb from the soil or the growing medium only those carbs that are most valuable at any particular stage of growth.

The rest of the carbohydrates are wasted, are taken up by the roots later on, or are consumed by beneficial microbes. Thus, the profile must also match a given species' nutritional needs at specific stages of growth.

Clearly, determining the correct carbohydrate profile for your plant species, and for each stage of its development, is a complicated, scientifically intensive process. Plants, like human

beings, feel better when their diet is varied and in harmony with their nutrient needs. Do not rely on folk wisdom. Choose a carbohydrate supplement that has solid scientific research behind it.

What's the downside?

The downside is that most of the carbs you feed your plants will probably go to waste. Scientists estimate that in standard growing conditions less than 10% of the carbohydrates added to the soil or the growing medium are absorbed by plants (Jones and Kuzyakov, 2006). That's not much.

So this begs yet another question: How can the rate of carbohydrate uptake be increased?

Add oxygen. It is common scientific knowledge that oxygen substantially increases the rate of absorption of carbohydrates by the root system (Beevers and Grant, 1964). In this respect, hydroponics is an extraordinary growing system because the nutrient solution is circulated continuously and remains well aerated. Hydroponic media are therefore rich in oxygen.

Add plant hormones. A further increase in carbohydrate uptake results when certain plant hormones are present near the roots. Auxin—indole-3-acetic acid, or IAA—is particularly effective. A concentration of one micromole per liter IAA nearly doubles carb uptake, although lower concentrations are probably more effective (Kanayama, Ofosu-Anim, and Yamaki, 1998).

Hydroponic systems are not auxin-friendly, however. IAA is synthesized only in the parts of the plant that are above ground but in the shade—and there isn't much shade in a grow room.

As a result, plants cannot synthesize sufficient IAA to stimulate their roots for increased carb uptake. IAA, or other auxin-like chemicals, can be added to the growing medium, but this can be done safely only in the earlier stages of development since auxins interfere with flowering.

Fortunately, auxin-facilitated absorption of carbohydrates can be increased by other means:

- **Humic acids have auxin-like properties**. Humic acids exhibit auxin-like effects on plant roots. Thus, humic acids mimic auxins and increases the uptake of carbohydrates;

- **Some microorganisms produce auxin-like compounds while increasing nutrient uptake**:

  – Beneficial bacteria and fungi voraciously absorb the carbs supplied to the roots, and microbial activity is beneficial for plants, creating a favorable medium for root development.[3] Although they compete for carbohydrates, these same bacteria and fungi also increase the rate of nutrient uptake;

[3] For example, they may decompose dead root matter, freeing up space for the growth of fresh roots.

– Certain bacterial strains even synthesize auxin-like chemicals that increase the rate of carbohydrate absorption by the roots. By carefully selecting which strains to include in microbial supplements, scientists can substantially improve the carbohydrate-absorbing capacity of your crops.

Maintain the growing medium pH at an optimal level for carb uptake. Carbohydrate transporters work best when the pH of the growing medium is 5–6 (Wyse, 1979). Therefore, a well-buffered growing medium will enhance carbohydrate absorption.

One carbohydrate supplement, designed by the scientists at Advanced Nutrients, meets all these criteria and more: Bud Candy.

Why is Bud Candy an ideal carbohydrate supplement?

- **Decades of R&D**. Bud Candy has been developed through thousands of lab hours and hundreds of field tests on the plants you grow. Our research scientists have determined which profiles work best, at what rates of application, and when they are needed;

- **Carbohydrate diversity**. Bud Candy contains a full spectrum of carbohydrates that have been dialed in at the correct ratios and dosages for the plants you grow. It contains 15 ingredients, of which seven are high-grade sources of carbohydrates;

- **Ideal for hydro**. Bud Candy is used in hydroponic agriculture and gardening, where the root systems are well aerated for high carb uptake. The product is properly processed and suspended in solution, so it will not clog up your lines or leave unhygienic residue;

- **Humic acids**. Bud Candy is commonly used in combination with other nutrient products containing humic acids, which are desirable for their auxin-like properties;

- **Bacteria and fungi**. Bud Candy is commonly used in combination with Voodoo Juice, Tarantula, and Piranha—products which are rich in select beneficial microorganisms. The bacteria in Voodoo Juice and Tarantula even have auxin-like properties;

- **Optimal pH**. Bud Candy is an integral part of the Expert Grower Level® of the Bigger Yields Flowering System®. When used in tandem with any pH Perfect® base nutrient (pH Perfect Grow, Micro, Bloom; pH Perfect Sensi Grow A & B; pH Perfect Sensi Bloom A & B; or pH Perfect Connoisseur A & B), the System maintains the nutrient solution and growing media within a pH range optimal for high carbohydrate uptake. (To learn more about pH Perfect Technology, read the white paper at http://www.advancednutrients.com/breakthrough/.)

- **And much more**. Bud Candy combines the best of Carboload, one of the oldest and best-selling Advanced Nutrients products, with a former product called Sweet Leaf. As such,

in addition to loads of carbohydrates, Bud Candy contains numerous other ingredients that enhance the quality of your yields.

Conclusion

The carbohydrates in Bud Candy have been derived and refined from sweet molasses as well as sugar cane, sugar beet, cranberry, and grape extracts.

As it turns out, all these natural carbs are sources of reduced carbon, enabling plant cells to grow and divide and providing crops not only with ready-made energy for immediate use or storage, but also with some of the very building blocks of life.

A few more thoughts in closing: If the natural energy levels of your crops are supplemented, your plants will suffer less stress. Suboptimal environmental conditions, insect problems, and anything else that sets your plants back do so because they diminish their ability to produce and store chemical energy.

A good carbohydrate supplement will help to keep energy levels at a surplus even when conditions are less than optimal. Therefore, even if you face some challenges in the growing environment, your crops will fare better than they would have done on their own.

Essentially, the whole purpose of photosynthesis is to produce carbohydrates. So why not give your plants exactly what they need in the form they need it? Why not give them Bud Candy?

* * *

Bud Candy is included in the Expert Grower Bundle® of the Bigger Yields Flowering System®, —guaranteed to give growers huge yields of the highest quality. It can also be purchased and used on its own. To learn more about how Bud Candy gives you bigger harvests, dial Advanced Nutrients Tech Support at 1-800-640-9605 or visit www.advancednutrients.com/BudCandy.

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