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Tree Chemistry for Fun & Profit With Dr. Alex L. Shigo

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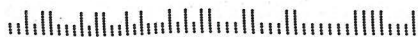
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Tree Chemistry for Fun & Profit

By Dr. Alex L. Shigo

Introduction

The word "chemistry" sends chills down the spines of most people. Arborists say, "How dare he talk about that word. I got into the tree business so I could get out of chemistry class."

I want to examine chemistry in several ways—not only the chemistry involved in water, food and fertilizer ... but chemistry in a different sense. You have heard about the chemistry of love or business, which refers to the makeup of a business or relationship. The makeup is what chemistry is all about.

Let me start with a definition: Chemistry is all about arrangements and rearrangements of matter and the changes in properties of products. The problem we have had with this subject is in the way chemistry has been presented. There is no such thing as a complex understanding. What we need is to find simple ways to give simple meaning to complex subjects.

I will try to convince you not to be afraid of chemistry. If I change the words, you'll see that you use chemistry every day—every time you have a drink of water, you are drinking chemicals; every time you eat, you are eating chemicals. We have to remind people of that, because we will be in trouble as a profession if we do not start using chemistry.



Actinorhizae on alder, collected from a swamp in midwinter in New Hampshire. Many beneficial soil organisms are active in very cold conditions. The organisms supercool when temperatures go very low. These actinorhizae benefit the host tree by fixing nitrogen.



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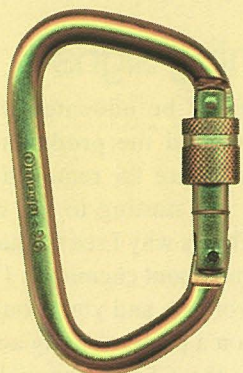
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be banned. People signed a petition to ban water! Laugh, if you want, but these types of ignorant overreactions are around our corner.

I'm frightened when I see airline magazine articles about chemicals that we use every day. Some of these people do not understand the benefits of some of the chemicals we use, and, if someone starts a petition drive, life could become awfully difficult for us.

Some people have said that I am against fertilizer. I'm against pruning, too, when it's done incorrectly. I'm against watering, when a tree is overwatered, but I'm not against di-hydrogen oxide being used correctly. No treatment or product is failsafe. You can't go out and buy the very best hammers and screwdrivers and automatically make a nice house.

It's important to know about the products we use and employ them expertly. We'd better start fighting back against ignorance. One way to do that is to let people know that we understand a little bit about chemicals, and that we understand what fertilizers are and how to use them correctly, because I believe in the use of fertilizers.

Fight back with knowledge

There are only six actors (C.H.O.N.P.S.) that make up 98 percent or more (by weight) of your body and of trees. I don't think it's asking too much for arborists to know just a little bit about those six. They can kill you, they can make you happy, they can give you lots of fun, and lots of profit, or they can make your life very miserable. There are only a few combinations of these we need to know.

We need to know what makes us run. Is it so difficult or irritating to know $C_6H_{12}O_6$?

We need to understand our fuel, our glucose. One test I often give in my talks is to ask participants to name 30 general similarities between people and trees. Then, show me (or tell me) how those 30 similarities are different in their specifics. Start with glucose. Both trees and people use glucose as fuel. What's the specific difference? Trees make it, we get it ready made.

Let me give you another example. You are made up of bags of chemicals, and trees are made up of bags of chemicals. The difference is, our bags are in fatty little boundaries. Tree boundaries are made up of carbohydrates, mostly. People are primarily protein, whereas trees are primarily carbohydrates.

There is a long list of these similarities and differences. One of my favorites

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Photos courtesy Dr. Alex Shigo

Mite galls on a birch leaf. Many insects "inject" chemicals into living cells and the cells alter their chemistry in ways that benefit the insects.



Good things come in threes

There are three important parts of your life. (You will notice how many things come in threes.)

- 1) Get something started;
- 2) Keep it running once it's started;
- 3) Do something productive once it's started and running.

For instance, if you start something but are headed in the wrong direction, you will have serious problems. It's not a matter of how fast you are going, but whether you are going in the right direction. It's not a matter of how many things

you know, but how many things you know that are correct. You can start your chain saw, but if you don't know which limb to cut you won't accomplish much that is positive.

I believe very strongly in the power of words. The way you can suddenly become a bigger, more powerful, more profitable, more fun-loving person is to define yourself. If you can't define who you are, that might be your first problem. And if you can't do it in 25 words or less, you may have a serious problem. Otherwise, you may get up in the morning and start, but you aren't going in the right direction.

Motivators and stimulators

I have found that there are three motivators in life—faith, fear and fun. Faith motivates because we think something good will happen through our efforts.

Fear motivates because we are afraid something bad will happen if we don't act. As for fun, we say, "Oh the heck with it all, let's go fishing or hunting ... Let's have some fun."

There are also three major stimulators in life—pleasure, pain and curiosity. The reason I want to talk about the "S" word and the "M" word is because we get these words confused. The best I can hope to do is stimulate someone ... I cannot motivate anyone, however.

How can I stimulate you so that you will be motivated to pursue a greater understanding of chemistry? As I noted above, there are three possible ways I can stimulate you:

I can stimulate you through pleasure. I can tell you lots of nice things that will make you feel good.

I can irritate you and cause pain. Sometimes, pain is not a bad stimulator, because people repeat what you said

even though it may have hurt them. I hope I will not irritate you with this discussion, but if I do, it will be because I am pushing you to learn more about trees. If you are to be an engineer, you must learn about mathematics and rules; if you are to be a doctor, you must know the heart, the body; if you are to be a mechanic, you must understand motors. I believe if you are to be an arborist, you must understand trees.

Curiosity is another fine stimulator. The NAA has wonderful reading materials. ISA has wonderful journals. Are you using them? Are you reading? We all know that exercising is good for the body—thinking, through reading, is exercise of the mind. I don't mean you have to read every word, but you should at least flip the pages and know what's hot. One of the greatest fears I have is that something wonderful has happened and I don't know about it.

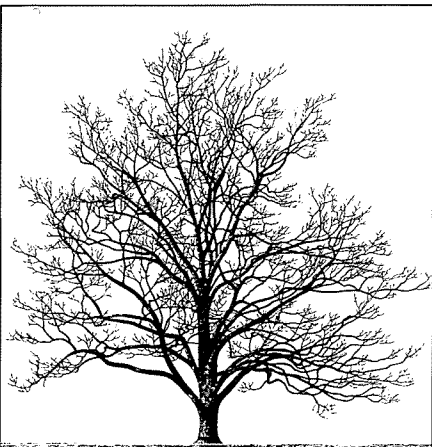
Warning signs

You must be educated about tree chemistry and the products you use. People who are far removed from our industry are starting to get closer and closer. This is why I see the handwriting on the wall about chemistry. I'm getting a little worried, and you should be, too.

I was on a plane recently and read an essay by the CEO of an airline about fertilizers as pollutants. The CEO wrote about how our oceans and drinking water are starting to reach the limits of their capacity. He outlined some of the potential targets ... He was getting awfully close to us.

Let me give you another reason why I get frightened at where we are headed. As part of a high school science project, a student decided to show how little people understand about chemistry. He got a petition signed by hundreds of people to outlaw di-hydrogen oxide.

He described how di-hydrogen oxide has killed people; how people have been burned by di-hydrogen oxide; how cars have been known to slide off the road and people have been killed all because of di-hydrogen oxide. People signed the petition, figuring that anything that could be so bad that it could kill people should



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is that when any living organism has its survival threatened, it will do something to continue to live. You do something when your survival is threatened, and a tree does something when its survival is threatened.

When threatened, a tree responds in many ways—and it responds the same way you must respond, both as an organism and as a business person.

When your business is threatened, you need some ready cash. You can tap into some of your profits you have kept in reserve. It's the same with your body, which stores reserve energy and it's the same for a tree.

The tree converts its profits into starch. The reserve energy for the tree is in the form of starch most of the time, and when the tree's profit begins to go down, bankruptcy comes in. The chemistry of the tree is no different than the chemistry of your business. The chemistry of business is called cash flow, and the chemistry of the tree is called energy flow. In your business, you call it money. In the chemistry tree business, we call it ATP.

In general, you better have some fuel when your survival is threatened. Those are the similarities. What about the specific differences?

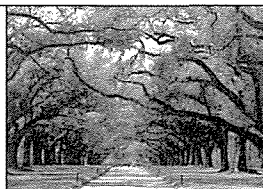
Your chemistry is such that you have

mobile units that will go to the injury. The way a tree responds is altogether different from the way an animal responds. A tree begins to form boundaries by walling off the injury. People are constantly dying and replacing the dying parts to stay alive. Trees can't do that, but trees have a better system. A tree is not a regenerating organism, it is a constantly generating system.

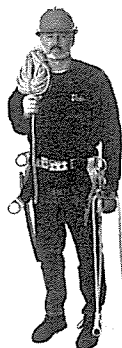
If you are in business, you'd better understand money. ATP is a universal currency in nature. Why do you require phosphorous? Because phosphorus in ATP is the major "money mover" in all living things. I'm not saying you have to understand the detailed chemistry of all this, but all arborists need to be aware, at least, of what ATP and glucose are and what they do.

If someone calls and asks what is happening to a tree, you can tell him or her if you know chemistry. You can turn a customer into a client. People come to you as customers, they should leave as clients. Customers come and go, clients come and stay.

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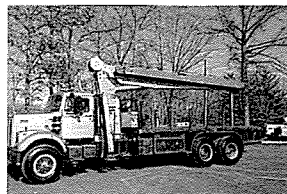


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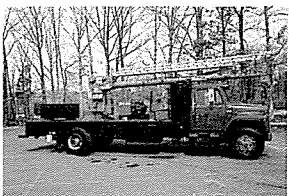


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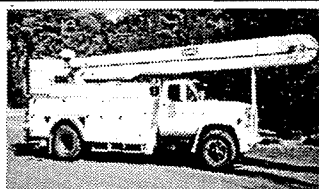
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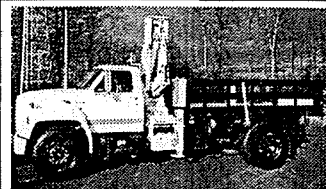
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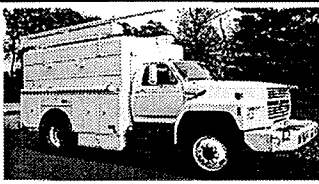
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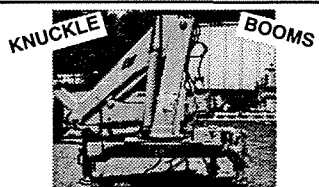
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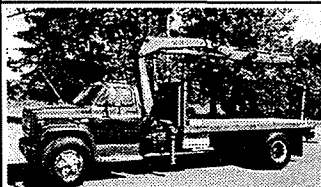
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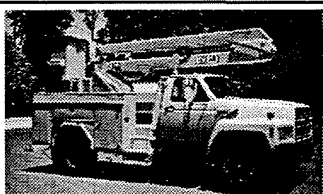
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Cover Story

courteous way) that you have credentials. Don't be afraid to use the word chemistry in your conversations with them.

I have looked through hundreds of chemistry textbooks and I am convinced that I know why you ran (and I ran, too) from chemistry. I made fair grades in chemistry because I could memorize easily. Memorizing does not equal understanding, however. It was not until I started to write and talk about chemistry that I realized how little I really understood. Let's not be afraid of chemistry ... Let's give chemistry a chance ... It can be fun.



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Anyone who fertilizes should know

this little story. I am going to leave it up to you to decide whether it has a happy or unhappy ending.

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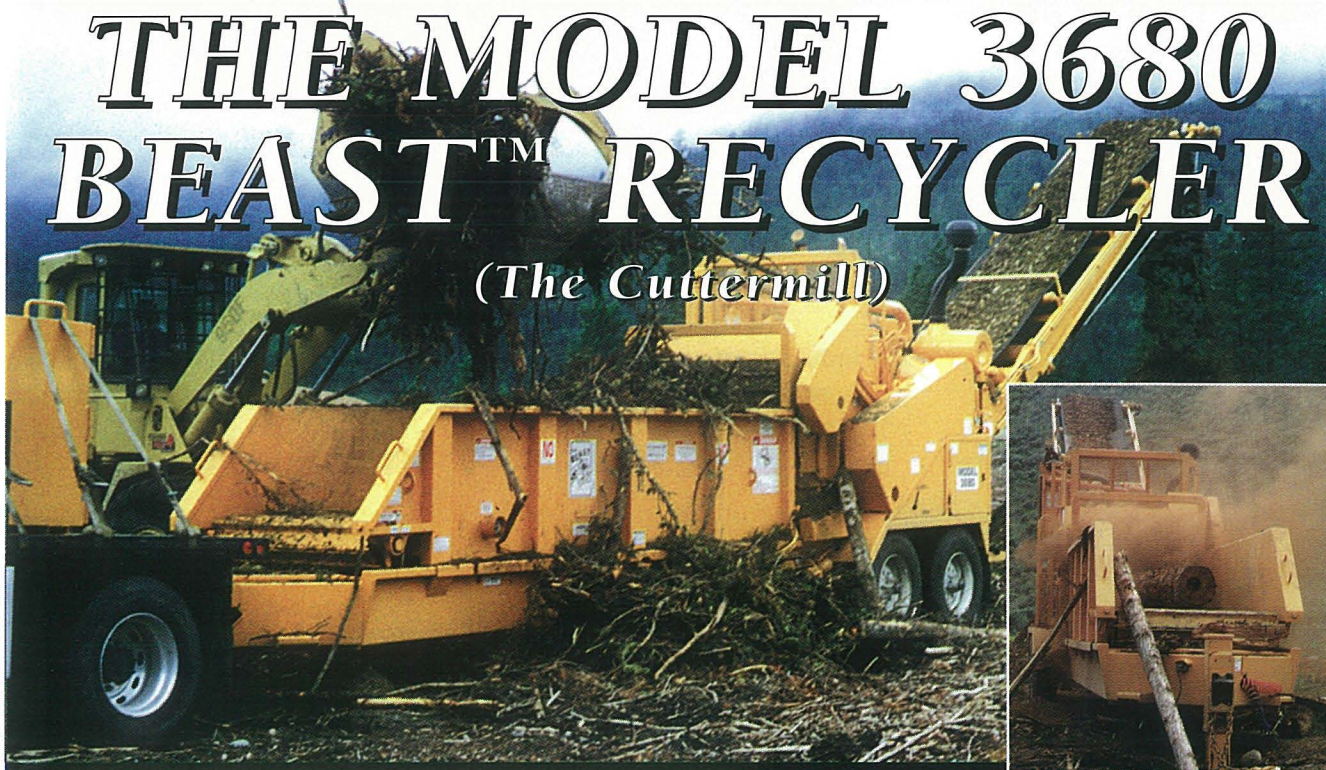
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ist named Fritz Haber. He came up with a way to take nitrogen from the air and combine it with hydrogen at very high temperatures with a catalyst. In this way, he was able to synthesize ammonia. Once he was able to synthesize ammonia, they were able to make urea. Once they were able to make urea, they were off to the races, because urea is very high in nitrogen. Until this day, the Haber process is still the major process for making all your nitrogen-yielding fertilizers.

Was Haber a good man, or a bad man? To this day, our agricultural system has benefitted because of his research work. Hundreds of millions of people are living because of his wonderful work.

However, it wasn't long before he had a second project on his desk—find a faster way to kill the other side. He came up with poison gas, and tens of thousands of people were killed because of his invention. The day it was first used, his wife committed suicide, because she could not bear the thought that her husband was going to be responsible for the deaths of tens of thousands of young people. And he was.

After the war, he was declared a war criminal. A year later, he received the Nobel Prize for chemistry because of his work with ammonia. Was he a villain or one of the grandest people who helps you make profit? Every time an arborists earns a dollar with fertilizer, you owe something to Fritz Haber, because he was the one that was responsible for you getting the N in your NPK. Now, was he a bad guy or a good guy?

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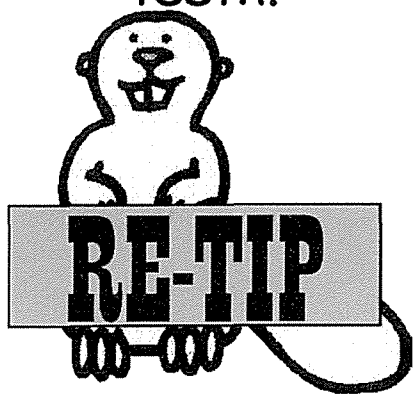
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Cover Story

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lary ... We have to start learning ... We have to have some fun with chemistry.

What is a leader? My definition, which you don't have to accept, is this: "A leader is a person (or an animal) with a mission that is so important to them that they persevere in spite of constant attacks." Most leaders get beaten up and most leaders are often wrong, but they persevere. Show me a person who bleeds and stops the first time he gets hurt, and I'll show you a loser.

There's nothing wrong with making an honest profit while you are having fun with chemistry. Isn't that what our business is all about? The day it's no longer fun is the time to find something else. I refuse to go through the biggest part of my life without having some fun.

Remember, however, no one can learn for you. Nobody can really teach you to learn. You have to learn for yourself. I don't know how anyone can motivate you. I hope that I may be able to stimulate you, however, through pleasure, pain or curiosity.

What is a tree? What is a symplast? How does water really move up the tree? Why do we have certain declines? Why does this insect or fungus know a tree is very low in it's defense system? Be curious about the answers to these questions.

I have a definition for education: It is a race toward higher degrees of igno-

rance. Keep learning more and more until you reach a point where you do not know. If you pursue any natural science question, it will come eventually to the answer, "I don't know." But the pursuit is the fun part. Just as is hunting, the real fun is (or should be) the pursuit.

Someone once said, "Anyone who has not touched the inside of a tree should not be allowed to talk about trees." Boy, wouldn't I like to have that as a rule. Would you go to a doctor for a kidney operation if he had never touched one? Would you be first?

If we don't understand chemistry, I believe bad things will happen to our profession. Whether it be in the form of more regulations, laws or strings on everything we touch, it will happen. The message I am trying to communicate is that there is a whole new and wonderful layer coming to arboriculture, and this other layer is asking different questions. They are going to demand some different answers. There is faith, there is fear and there is fun. Let's not be afraid of chemistry, and make more honest money, and have lots of fun!

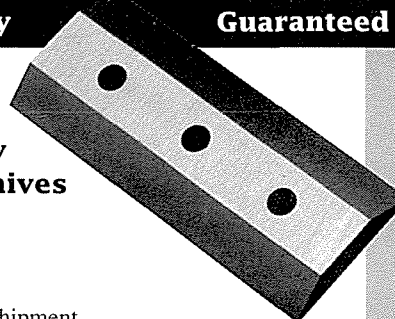
This article was excerpted and adapted from the keynote address at TCI EXPO '97. Dr. Alex Shigo is the owner of Shigo & Trees, Associates in Durham, N.H. **TCI**

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pounds in your work with trees, and most are based on four actors: carbon, hydrogen, oxygen and nitrogen. Let me give you an example that's easy to understand:

Nitrogen exists in the air with triple bonds. ("Oh no," you're thinking. "Why does he have to start talking about bonds?") All bonding means is that nitrogen is held in the air by two "magnets" that are 300 pounds each. In other words, if you hold them, you can pick up a 300-pound block of steel. Now, people and trees are held together by "magnets" that will pick up *two* pounds. Why is this important? Well, if we were held together by 300 pound "magnets," we wouldn't fall apart. (The force is really not a magnetic one, but electrostatic attraction. I use "magnets" here just to make a simple point.)

Fertilizers, on the other hand, are soluble salts that are *essential* for life. They are held together with weak "magnets." Without delving too deeply into

“Anyone who has not touched the inside of a tree should not be allowed to talk about trees.”

bonding theory, all you need to know is that life is made up of a whole bunch of stuff held together by "magnets." Some of them are weak, some strong.

Most of the water and all of the fuel that will open up the buds next year is already bound in the trees. The water that is in the tree right now is not free water, it's bound water. It is attached to cellulose, of course, but it is there. Take a chunk of wood and try to squeeze the water out of it. You can run a D5 tractor over it and you won't run any water out. And yet, that piece of wood

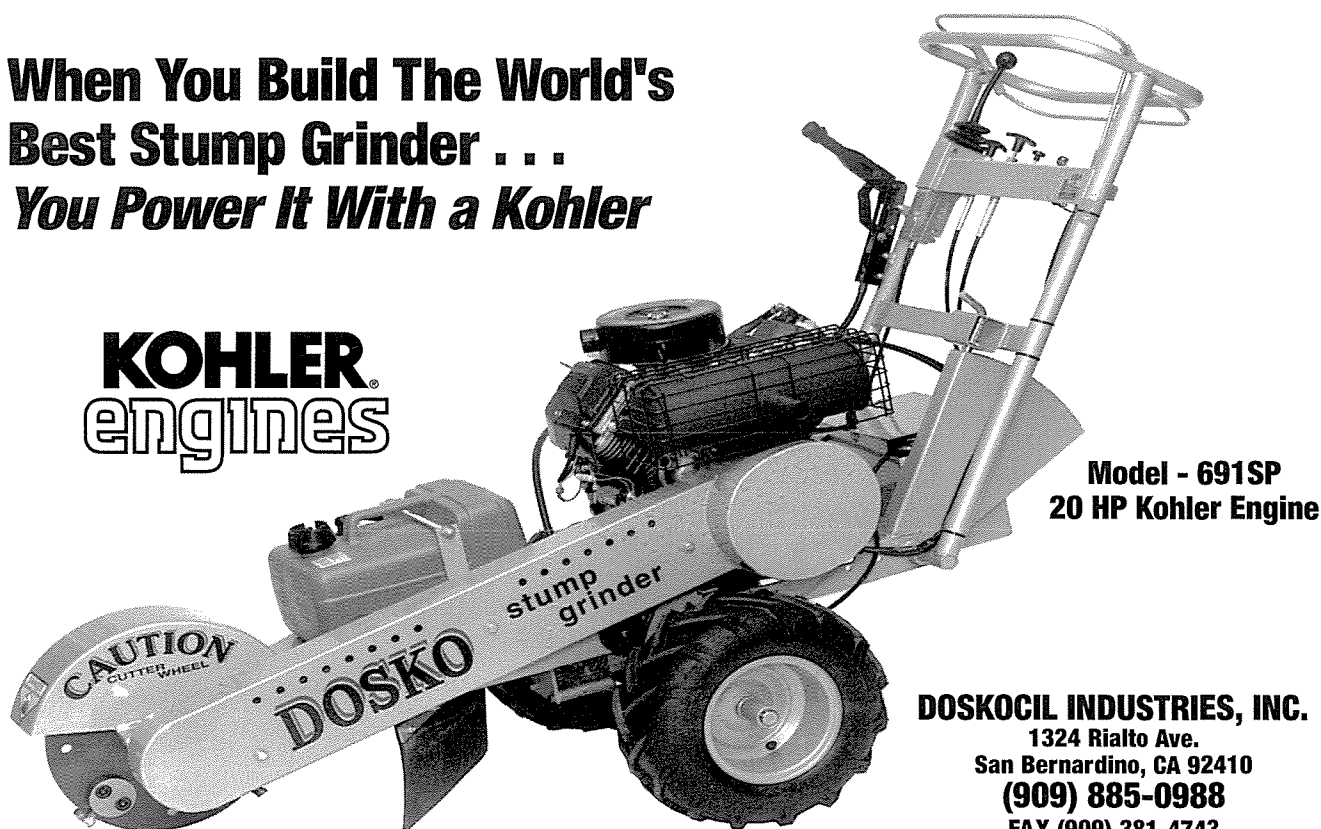
may be one-half water by weight. The water is bound to the cellulose.

Similarly, a tree has all of its glucose there for next year, but the glucose has been slightly altered so that it is not soluble in water. We call it starch. So, at the base of the bud, you have all the starch and all the glucose.

You don't have to understand all of the chemical processes involved in tree care, but everyone should know more, and, at the least, understand the most basic, most important processes.

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