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The Growers Solution

SUMMER 2011

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Understanding Water Chemistry

By Jim Halbeisen

In agricultural circles, the quality of water has received very little attention. One reason, when water is clear it is viewed as relatively clean, and very little thought is given to its actual purity. Another reason is because water chemistry is a very complex and difficult science, and is very intimidating to many of the agricultural community's advisors. Often, if there is no obvious simple fix, the farmer is advised, "Just throw in company A's profit building $5 per acre package." Just as often he is left with tough unsolved problems.

With the dawn of Genetically Modified Organisms (GMOs), particularly Roundup Ready® soybeans, foliar applications of chemicals increased significantly on North American farms, also frequently accompanied by water issues. Fortunately, because of Growers Chemical Corporation's long experience, since 1955, foliar feeding Growers Mineral Solutions (GMS) our publications, customer meetings, conference calls and *TGS* articles have provided about the only source of practical water chemistry information our customers and our potential clientele have had available. And we have publicly discussed these water quality issues for almost 10 years. An example is an article entitled Water Hardness, reprinted on page 5 and 6, which first appeared in the Summer, 2000, issue of *The Growers Solutions* newsletter.

We at Growers Chemical Corporation contend water quality is affected by 3 factors:

1. **Debris:** This includes material floating or suspended in water which usually can be easily removed with proper filtration.
2. **Suspended Solids:** Materials such as silt, clay and organic matter suspended in water, but will "settle out" if the tank is let undisturbed. The problem is easily solved by agitation.
3. **Dissolved Solids (Minerals):** Since the advent of GMO's Growers Chemical Corporation has concentrated its customer education efforts on this third and most important factor of water quality. Prior to GMO's GMS was often applied straight, or with minimal dilution which rarely involved water quality issues. But even then, soft rain water was recommended as a precaution. GMO's, however, have changed protocols because their chemicals require a lot of dilution which makes water quality a major issue, especially when GMS is entered into the equation.

Water containing calcium, magnesium, and iron compounds in solution is known as hard water. Calcium, magnesium and iron are positively charged ions, or cations. There are also negatively charged ions, or anions, in the water which are usually chlorides, sulfates, and hydrogen carbonates. Any of these dissolved solids, minerals, can chemically interact with any chemical compound mixed into the hard water, and this chemical interaction can significantly reduce the expected effectiveness of the added chemical.

When GMS is diluted with water containing dissolved solids there may be chemical reactions causing physical and availability problems. These problems are described and the best remedies are given in accompanying articles in this *The Growers Solution* as we give producers an in depth look at dissolved solids in water. ■

Inside The Solution

Meaning of the Term Dissolved Solids

By Jim Halbeisen

In discussing hard water, the term "dissolved solids" usually shows up in the conversation. Hydrogen and oxygen combined make water, but there can be, and usually are, many other elements or minerals dissolved in the water contributing to the chemical and physical properties of that water. The term dissolved solids represents the volume of other minerals or elements in the water, and is measured with chemical reaction kits or by instruments that measure the various properties of the water. ■

Hard Water or Dissolved Solids (Minerals) in Water

By Jim Halbeisen

When discussing hard water it is important to understand hard water is a chemical solution, and, by definition, a solution is a homogeneous mixture of particles of molecular size. A solution consists of two components, the solvent (the water, H^2O) and the solute (which in the case of hard water are the dissolved cation mixtures of calcium, magnesium, and iron and anion mixtures of chloride, sulfate, and hydrogen carbonate.)

A hard water solution is characterized, as are all solutions, by (1) homogeneity, (2) the molecular subdivision of the components and (3) absence of settling. In a hard water solution the molecules of dissolved solids (minerals) are uniformly distributed among the molecules of water, therefore; the solution is a homogeneous mixture of mineral elements and water molecules. The molecules of the minerals diffuse continuously through the water, and, although each of the minerals may be heavier than a single molecule of water, the mineral does not settle out upon standing.

The dissolved solids (minerals) in hard water come from the minerals in the earth's crust with which the water has reacted as it made its way to the reservoir from which the water is taken for usage. The water originally, before moving through the environment, had very little mineral concentration, because it had been purified or distilled by the hydrologic cycle that naturally occurs in the earth's environment. Also, the hard water storage reservoir, above ground lakes, ponds, rivers or underground wells, many times is composed of minerals (rocks) which can contribute to the solute (mineral) of the solution.

The amounts of the minerals dissolved in hard water are directly related to the different minerals' solubility in water and their concentrations. The solubility of a given solute (mineral) is defined as the quantity of that solute which will dissolve in a specified quantity of solvent (water) to produce a saturated solution. The solution is said to be saturated when the concentration of dissolved solute (mineral) is such that it exists in equilibrium with the excess undissolved solute (mineral). A solution of water and minerals containing only a small amount of mineral (solute) is said to be "dilute". Adding more mineral makes the solution more concentrated, eventually to the point the solution is said to be "concentrated".

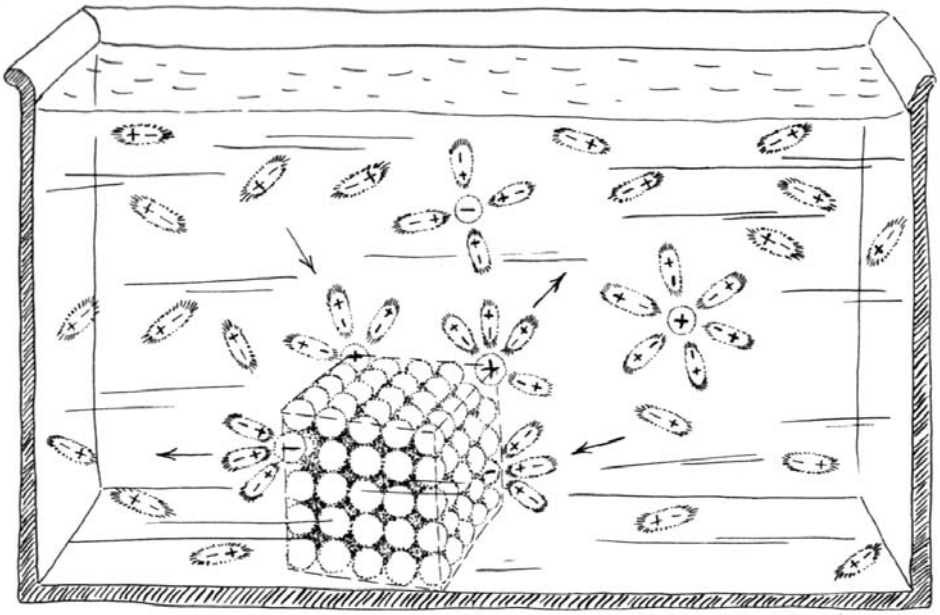


Figure 1. Mechanism of Dissolving. From: *General Chemistry* by Garth L. Lee, and Harris O. Van Orden, page 213, printed by W. B. Saunders Company, 1960.

To understand the reasons for the solubilities of solutes or for the concentrations of solutes (minerals) in water we must consider the mechanism of dissolving that occurs when the once pure water makes its journey to the reservoir prior to its becoming part of a spray material. By examining Figure 1, we can see a mineral placed in water begins to dissolve immediately. If an element (cation or anion) on the surface of the mineral can be dislodged by the water molecules to a position where the element is surrounded by polar water molecules, it may be attracted to the water from the mineral. The dissolved cation or anion is attracted by the water molecules remaining around it, so that opposite charges are together. By this procedure minerals escape into the solution continuously to become part of the new solution or hard water. Homogeneous: Uniform; made up of similar parts or elements; of the same composition or structure through out. ■

Chemical Reactions in Clear Water?

By Jim Halbeisen

The mere presence of any solute (mineral) in a solution containing water as the solvent affects the physical and chemical properties of the resulting solution.

The physical properties affected are: lowing of vapor pressure, elevation of the boiling point, depression of the freezing point, and osmotic pressure.

Chemically dissolved solids (minerals) present in hard water, but not visible to the eye, can cause chemical reactions when other chemical compounds are added to hard water. When this takes place, the molecules and the atoms of the hard water and added chemical come together to rearrange themselves to form molecules different from the originals. Therefore, when a chemical compound of any type is added to hard water, and a likely chemical reaction occurs, the added compound could be altered, and its ability to do its desired job could be dramatically changed because of molecular rearrangement.

There are compounds (water softeners) for adding to hard water meant to neutralize the dissolved solids (minerals) present. Finding the correct buffering solution to neutralize or "tie-up" the hard water minerals is not always easy since certain minerals and their concentrations can be difficult to neutralize without, in turn, injuring fresh plant tissue in the process. Also, the neutralization solution needs to remain effective for an ample amount of time to allow for its proper application.

The alkaline elements of calcium and magnesium tend to be higher in concentration in hard water than the acid anions. This is because calcium and magnesium are abundant in nature and more often exposed to water on its journey to its final resting place before being used in a spray material or solution. The best neutralization agent for most alkaline hard water cases is in the form of some type of acid.

The Water Hardness article reprinted on pages 5 and 6 from *The Growers Solution*, Summer 2000, issue lists the various materials needed to soften hard water when spraying GMS. It is interesting to note in the article, when GMS is used in proper concentrations (less then 1 part water to 1 part GMS) it can neutralize the dissolved solids regardless of the amount of minerals present in the hard water. ■

Foliar Spraying Crops Has Its Advantages

By Jim Johns

Foliage Spray season is, or shortly will be, upon us. We were reminded of this when we recently received some beautiful 2010 season airplane spraying pictures from Genesee County, NY, Representative Bruce Naas. The photos really show how the airplane's spray swirls can more completely cover and feed crops.

The pictures are also a reminder of the early days of Growers when most of the spraying was done by airplanes—that was not too long after WWII and Korea when there were a lot of former service pilots, literally barn stormers, looking for that kind of flying and they did the job very effectively. Regulations, fuel prices, etc., have tended to chase many of those applicators out of the business, but those remaining still offer pretty competitive prices when compared to those of the Co-op with their big expensive high-clearance sprayers to justify.

Today's local airplane applicator could be very interested in spraying Growers, especially when he learns he would be applying only 2, 3, or 4 gallons per acre, straight, with no dilution. To him this would mean fewer landings for refills, of a somewhat heavy, but a nontoxic, non corrosive, non poisonous, food grade material. Not needing to worry about toxic drift, he can do a good job on drilled beans and on last minute pre-tassel corn where weather may have the boom sprayer bogged down.

In the early days, Growers people did a lot of crop yield checking. Dr. Tiedjens and Wilbur Franklin regularly recorded average corn yield increases of 10 to 15 bushel per acre for foliar sprays. Likewise, 5 to 8 bushels per acre average increases for soybeans. Crop yields in those days were somewhat less than now, but today's corn and soybeans can still benefit, maybe even more so, with well timed foliar sprays; especially, as more and more crops seem to be experiencing micronutrient deficiencies. The micronutrients found in Growers Mineral Solutions have often accounted for significant yield increases when the macronutrients NPK did not appear to be lacking.

NYS Snap Beans being sprayed with Growers at 3 gal/ac at first blossom on a calm evening at the end of July, 2010. At maturity the canning company estimated them to be 5 tons per acre beans. Photographer was Ted Genagon, retired Kodak company electrician, who helps Bruce Naas part time, and the pilot is Ed Steuber from Albion, NY.

For example; back in the 1960's Harry Pick of Pontiac, Illinois won the National Soybean Yield Contest. He used his high powered contest program on two of the five acre plot, and, with everything else the same, during the beans' flowering period, he applied three two gallon per acre sprays of Growers on the other three acres. His contest program yielded something like 69 bushels per acre and the other three acres with Growers yielded about 113 bushels per acre. The five acre plot averaged out at about 93 bushels per acre and won him the contest. National contest participants rarely buy any of their inputs because most are donated for recognition and advertising reasons, so there is no reason Harry would have been short on his NPK. Most likely, though, he was short on micronutrients and the micronutrients in the Growers put him over the top, big time.

Early yield checking also determined GMS foliar spraying produced consistently drier grain crops—for corn usually 2 to 4 percent less moisture. This was, and still is, because foliar spraying GMS can bring on maturity up to a week earlier, especially when Growers Nutritional Additive has been added to the spray. This could be a large plus this year with so many late crop plantings potentially open to early frost damage.

Sugars in the crop also tend lower the point at which the crop will be injured by freezing temperatures. Sugars, chemically, are a close relative to alcohol which is an antifreeze. GMS and the Growers Program encourage sugar formation in the plant, but it may take time. In other words, if there is a frost warning, spraying GMS the night before will help resist the colder temperatures by way of its micronutrients, but the sugars, taking more time to form, may not.

GMS on many occasions has saved crops from serious frost damage. Because of its trace minerals, GMS itself goes well below 0 degrees F (-32 degrees C) before freezing or crystallizing. Getting adequate amounts of GMS into the plant's system by foliar spraying can significantly lower the temperature at which the plant will be damaged. (See accompanying Georgia Strawberry article.) ■

Growers Pays! It Doesn't Cost

By Ben Bechtel

(This is a second article by Growers District Manager Ben Bechtel of Conrath, Wisconsin, demonstrating how growing corn crops with GMS can pay off on the bottom line when considering the gains obtained in test weight, protein, and energy. This article shows the potential profit to be gained by growing and feeding corn silage. Eds.)

Our neighbors' conventionally grown corn silage ordinarily runs about 8.5 to 9.0 protein whereas our Growers grown silage generally runs 12.0 to 12.6 protein, so we are seeing at least 3% more protein by weight.

Not too far south of us some farmers are raising up to 20 tons of corn silage per acre, but where we are in north central Wisconsin most everyone averages about ten tons. Figuring a ten ton per acre yield, and realizing about 3% more protein, we would have 600 pounds more protein per acre than our neighbors. Should they need to buy that 600 hundred pounds of protein for their ration in the form of soybean meal at $.15 to $.17 per pound they would be spending $90.00 per acre more than us. In effect, by feeding our Growers grown corn silage we are saving $90.00 in protein costs.

Our feed analysis generally shows we have about 4% more energy in our corn silage than our neighbors. Four percent more energy from ten tons of corn silage per acre would amount to 800 pounds of energy. If we had to buy that energy at $.10 per pound, the price of shelled corn, it would cost $80.00, which means we are saving $80.00 in energy costs feeding our Growers grown silage.

Looking at the Growers cost to grow the silage, say we pay $9.80 per gallon (the current 300 to 499 gallon price) and we put 5 gallons on the seed at planting and come back before tassel with a 2 gallon foliar spray, the 7 gallons GMS per acre total would cost about $70.00 per acre. (Most farmers would probably need additional nitrogen, but we say only about ½ the amount they normally would use.)

Looking at the figures, the $90.00 protein savings plus the $80.00 energy savings, less the $70.00+ Growers cost, the quality gained is paying us close to $100.00 per acre over and above its cost. In addition, the animals consuming that corn silage will be healthier and more productive. ■

Georgia Strawberries Prosper

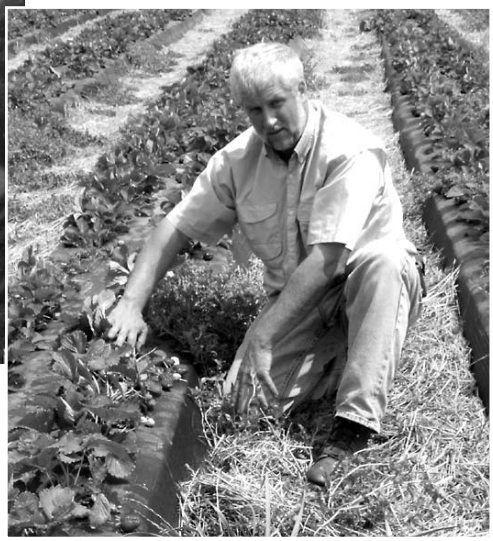
By Steve Esh

(Steve Esh is a Growers Representative from Montezuma, Macon County, Georgia which is not too far west off of I 75 about 1/3 of the state north from Florida. Eds.)

We are growers of 3 acres of strawberries, 3 acres of peaches and pecans along with some onions and sweet corn on a 17 acre farm with a red clay loam soil. We purchased the farm in 2010 which had not been producing well for the previous owner. So in the fall of 2009, while the farm purchase was in negotiation, we convinced the owner to apply 5 tons of high calcium limestone per acre which he did a week before the strawberries were planted. Also before planting the owner applied dry fertilizer according to the University soil test recommendations. We finalized the farm purchase in March of 2010, just in time for four weeks of foliar applications at the rate of 2 gallons of Growers Mineral Solutions (GMS) and 4 oz. of Growers Nutritional Additive (GNA) per week before harvest. The fertilizer injection system was broken so no fertilizer was applied through the drip irrigation. The experts all said the crop would fail with no nitrogen running through the drip irrigation. Sure enough, 7 days after the patch was opened for picking, the plants started growing runners for new plants. We called the previous owner to find out what may be going wrong. He told me we are not applying enough nitrogen. A plant tissue analysis revealed all nutrients were at correct levels except boron and sulfur which were just slightly below normal levels. We were told the plants would quit producing berries and there wasn't much that could be done. Ed Bulcher (southeast Growers rep) recommended we foliar spray 4 gallons of GMS with 4 oz of GNA per acre per week. We did this and continued to do it for 6 weeks and produced an additional 10,000 pounds of berries off 3 acres. The plants had runners everywhere but berry production was sustained by the increased amount of GMS and GNA applied. We also picked berries a week longer than other strawberry farms around here. We later found out part of our problems had been due to our plants having undergone a lot of stress during shipment and planting. The severe cold and late winter also contributed to plant stress.

Convinced the Growers concept should work, we applied another 5 tons of high calcium limestone immediately after the plants and plastic were removed.

In the fall of 2010, when the plastic was laid, we applied 100 pounds per acre of methybromide as a fumigant. For planting on October 13, we made up a transplant dip by mixing 100 parts of water to 1 part of GMS into which we dipped the roots when transplanting. During the daylight hours the first 2 weeks after transplanting, we constantly watered the plants to keep the plant leaves from drying out. Seven days after transplanting we applied one gallon of GMS/acre and continued this twice a week for 6 weeks (until Thanksgiving.)



Georgia's Steve Esh is pleased with his heavy berry production. Note six ripe berries per plant.

Ten days after planting we were pleased with the results. The previous owner told us, "The way these plants look you did something right to have this much color left in the original leaves and to have this much new growth already." During the months of December and January, we applied two gallons of GMS/acre/month. This was applied in temperatures above 50 degrees just before a prediction of cold temperatures. Our first bloom was December 5, and by January 5, 10% of the plants were blooming. In January, temperatures went as low as 15 degrees Fahrenheit and the last frost was February 18. During this time the plants continued to bloom although blooms were lost to frost. On February 21, we began applying one gallon of GMS per acre twice a week, and, to the spray once a week, we added 4 ounces of GNA. By March 6, we had our first ripe berries. No doubt the 10 tons of calcium lime and the energy from the GMS applied just prior to the cold weather really kept the plants warmer than expected. Anticipating hard freezes we had three rows covered with frost protection cloth, but we never saw a difference in production and plant quality, so we definitely will not do that again. Too much work and cost for not seeing a difference.

We were very pleased to be able to open our market and start selling strawberries two weeks earlier (March 19) than our neighbors. At the peak of production we were picking a gallon of berries from about six feet of row. And, because the berries are large and tasty, customers keep coming back for more. One comment we heard was, "It is so much fun picking so many huge ripe berries in so little time, I could hardly stop picking."

After peak production tapered off, we applied an additional 8 oz. of GNA/ac to the plants for one week and then back to 4 oz. the rest of the time. We also increased the GMS applications to 1 gallon per acre 3 times a week. Our berry size and quality increased again after we did that. This year I never applied more than 1 gallon of GMS/ac at a time. I feel applying less, but more often contributes a lot to consistent plant growth, winter hardiness and real good fruit production as well.

We did not use any dry fertilizer on this field, although four days a week (during production) we did add to the drip irrigation 2 quarts of a sea kelp/fish meal (4-3-3) fertilizer. We did this to help increase organic, bio-life stimulation in the soil. Did it help? I don't know, but it felt good, I guess, knowing I was putting something back into the soil after putting methybromide into the soil as a fumigant. But definitely foliar feeding the plants with GMS and using 10 tons of lime to bring the cation exchange capacity to an average of 88% calcium across the 3 acres made the difference for a successful season this year. I will definitely give God credit, as well, because the plants were well prayed for. After our financial loss the first year, we needed this crop to get back on our feet.

Yesterday my two closest competitors closed for the season. I should be able to be open at least two more weeks. (Late word from the middle of May, Eds.) ■

Measuring Dissolved Solids (Minerals) in a Solution

By Jim Halbeisen

One way to test water for hardness is to take a sample of the water to a business dealing with water hardness; a water softening company or a swimming pool sales organization.

And for farmers wanting to do their own hard water monitoring, there are several testing methods available;

Direct Hardness Measurements: There are battery powered instruments that measure the hardness of water directly. Also, simple do-it-yourself test kits using colored indicator strips measure the hardness of the water directly.

pH Measurements: When measuring the pH of water to determine hardness we are assuming there is a direct correlation between pH and hardness. In most cases, hard water does have higher pH readings, but in some cases this is not true. Therefore, the farmer using the pH method to determine water hardness needs to be careful about making large commitments to spraying with the water in question. There are both battery operated instruments and indicator papers giving direct pH readings for water solutions.

Electrical Conductivity: The electrical conductivity of water gives a good measure of the quantity of dissolved solids (minerals or elements) present in a solution. In almost all cases the higher the electrical conductivity of the water, the harder the water. The relationship follows from Avogadro's law (used in chemistry labs) which states the gram molecular weight of any substance contains equal numbers of molecules. The molecules are the reason for the movement of electricity (electrons) in water. The manner of reporting conductance measurements in water varies. The procedure involves measuring the resistance of the solution placed between one centimeter square platinum electrodes spaced one centimeter apart. Resistance of the solution to the flow of an electrical current is measured in ohms. The conductance of a solution is the reciprocal (inverse) of the resistance. The electrical conductance has the dimensions of mhos per centimeter. Because the standard unit of conductivity, mhos/cm, is so large, most solutions have very low values, so it is customary to use smaller sub units which give more convenient locations for the decimal points. For most work, it is now recommended the best units to use are either millimnos (mmhos) or micro mhos (µmhos.) For example; a solution with an electrical conductivity of 0.005 mhos is 5 mmhos or 5000 µmhos. This is usually measured with a battery powered instrument showing millimho (mmho) or micromho (µmho) readings. Figure 2

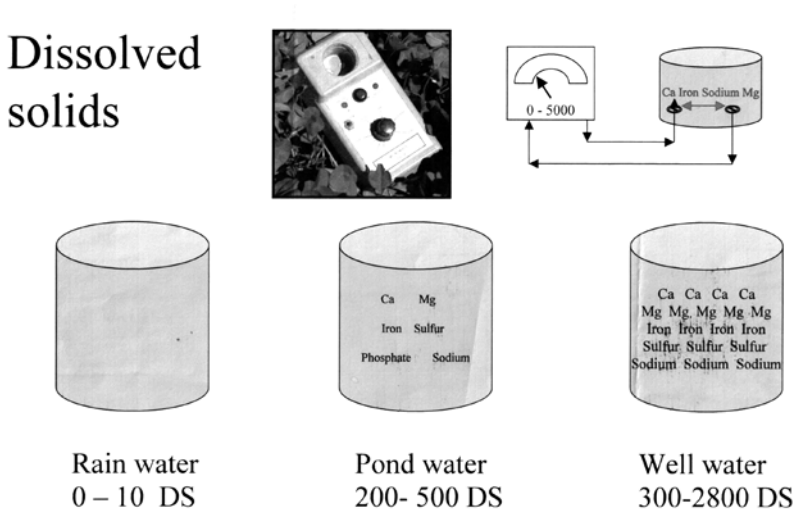


Figure 2. Dissolved Solids. A Pictorial Representation of Measuring the Electrical Conductivity of Various Water Sources, from *Water Hardness Series* by Matt Gooding.

Growers Mineral Solutions (GMS): Another way to discover the hardness of water is to mix it with GMS. A 15 to 1 mixture of water and GMS will always reveal the hardness of water. If the solution, after setting for several hours, stays clear the water is probably Soft according to the *World Health Organization Water Classification*. The more dense the cloudiness is in a 15 to 1 water to GMS mixture indicates the greater the amount of dissolved solids (minerals) present, and the harder the water. ■

From the Growers Solution, Summer of 2000. GNS is now GMS, same product.

Water Hardness

By Jim Halbeisen,
Growers Research Director

As we start another season of foliar feeding it is important to remind you about water quality and its effect on Growers Nutritional Solutions 10-20-10 (GNS 10-20-10). The number one factor to be concerned with is the calcium and magnesium hardness of the water. This is very important because the calcium in hard water forms a very strong chemical bond with the phosphorus (P) present in Growers, and its resulting white precipitate (the junk in your screens and nozzles) will not dissolve to any extent in water. This precipitate doesn't occur very often, but when it does, two problems arise.

The first is pretty obvious. Physical plugging of screens, orifices, and nozzles that can infuriate a farmer to the point where he will probably not want to ever work with GNS 10-20-10 again. Some try to overcome plugging by using larger openings which should allow the precipitate to flow better. This may overcome the plugging, but it still doesn't solve the probably more important second problem.

Please turn to page 6

Water Hardness Classifications

Grains of Hardness[1]	Parts Per Million (ppm)	World Health Organization Water Classification
0-7	0-114	Soft
7-20	114-342	Moderately Hard
20-47	342-800	Hard
>47	>800	Extremely Hard

From: The Impact of Water Quality on Pesticide Performance, Purdue University Extension, p.11, Nov., 2009.

[1]Calculated by dividing parts per million by 17.1

Total hardness is measured in parts per million or in grains of calcium and magnesium per gallon of water. One grain (65 milligrams) is approximately 17.1 ppm. Example: A water sample could contain 20 grains of calcium per gallon. A common aspirin is about five grains in weight, so 20 grains would have the equivalency of 4 aspirin tablets dissolved in a gallon of water, or 342 ppm.

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Inside:

Water Hardness

Continued from page 5

The second problem is that the calcium in the hard water ties up some of the P in GNS 10-20-10 so that it is not properly used by the plant. Calcium phosphate (the insoluble white precipitate) is not absorbed into plants unless its chemical bond is broken up by a relatively strong acid which would never occur on the surface of a plant leaf and rarely in the soil profile. (This is the reason why it doesn't make any sense to use calcium phosphate as a mineral source for an animal where the mineral is not placed into direct contact with the acid of a true stomach.)

To prevent the interaction of the P in GNS 10-20-10 and the calcium in hard water, the calcium must be "tied up" similar to the way ammonia sulfate is used in hard water for the Roundup products. Ammonium sulfate, however, will not work with GNS 10-20-10 as it does with Roundup. To neutralize the calcium in hard water for Growers use, we suggest using vinegar, citric acid, or sulfuric acid (battery acid). Some farmers have had success with Shaklee's Basic-H product at ¼ cup per 55 gallons of water. Also, there are other products used in the vegetable industry for softening hard water that can be used in most cases with GNS 10-20-10.

Do not assume pH indicates the hardness of water. A true hardness test should be used. There are hardness test kits available, or take a water sample to a treatment specialist (such as Culligan). Hardness is expressed as grains of hardness or ppm (parts per million) of hardness. The conversion formula is: Grains of Hardness X 17.4 = ppm of Hardness.

Below are types and amounts of softening products to be added to the hard water that will be used to dilute GNS 10-20-10.

Make sure the water softening products and the water are put in the spray tank and agitated before adding the GNS 10-20-10.

Another way of avoiding GNS 10-20-10 precipitating in hard water is to mix them in a one to one ratio. But make sure it is 1 : 1, and the GNS 10-20-10 is put in the spray tank before the water is added.

If there any doubts about whether the water and Growers will mix, try smaller amounts of each in the intended proportions in a bucket or other container. If the mix stays clear, it should be all right to spray, but if it clouds up (the calcium-phosphate precipitates), then softeners are needed.

If the mix is to be one to one or less (Growers to water) then there should be no problem regardless of how hard the water is, but the Growers must be added to the spray tank first before the water.

Finally, it is our experience that the softer the water, the better the chances are the Growers 10-20-10 will work properly. ■

Hardness		Recommendation
Grains	ppm	
0 - 5	0 - 87	No softening needed
5 - 25	87 - 435	Vinegar 1 qt per 200 gal of water Citric Acid ¼ pound per 1000 gal of water
25 - 50	435 - 870	Vinegar 1 qt per 100 gal of water Citric Acid ½ pound per 1000 gal of water
Over 50	Over 870	Sulfuric Acid - 2 cups per 400 gal of water

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