Late Fall Soil Surfactant Appl
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By Larry Lennert -Territory Manager- Ac

Not That Long Ago ….

Do you remember March 2012? It seems like a long time ago already, but I still remember it well because that month my phone was ringing a whole lot more than it normally rings in March. Spring came early in 2012. Very early. Record early. It went from the "winter that wasn't" to summer in less than a week. The Upper Midwest and Great Lakes regions experienced daytime temperatures in 70, 80 and 90 degree range for almost two weeks straight in the middle of March, and then much above average temperatures until mid April. Since there were almost no irrigation systems up and running yet, many golf course superintendents were trucking water out to their greens and that is why my phone was ringing. These superintendents were seeing the water they were putting on their parched greens puddle up on the surface, and run down slope in ribbons and sheets like it was the middle of a dry spell in July. But this was March, and they wanted to know if I had any recommendations to help them with this problem.

This is not the first time I have seen putting greens act this way in the spring. As a young assistant golf course superintendent in the 1980s, I spent

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Photo by Troy Carson

a lot of time hand watering greens. I remember a few other early springs back then, and seeing water puddle up on the surface and run back down slope at my feet just like in March 2012. I really didn't understand what was causing that to occur back then, but I think I do now.

What Causes Water To Run Off Sloped Turfgrass Areas?

There are several reasons why water runs off of sloped turfgrass areas. Sometimes it is just soil physics. If the precipitation rate (from rainfall, irrigations heads, or applied by a hose) exceeds the infiltration rate of the soil the turf is growing in, water will begin to accumulate on the turfgrass canopy and run downhill. Low soil infiltration rates can be the result of soil compaction, or sometimes they are just a normal characteristic of very fine-textured soils (clays) that have low infiltration rates to begin with. However, it is not uncommon for water to puddle up on the surface of low-mowed turfgrass stands and run downhill, even when water is being applied at a rate that is lower than the normal infiltration rate of the soil. In areas of the country with high sodium levels in irrigation water, sodium can sometimes cause deflocculation of clay soils and a loss of soil structure. This can reduce infiltration rates as well, and this is sometimes called "chemical compaction". Loss of soil structure from excessive sodium in irrigation water can create the same effect as physical soil compaction, increasing the amount of small, capillary pores that hold water and reducing the amount of larger, non-capillary pores that are needed for soil drainage. Fortunately for us, high sodium levels in water used to irrigate turfgrass in the Upper Midwest and Great Lakes regions is rare. However, there are a few aquifers that contain elevated levels of sodium, and use of effluent or "recycled" water is becoming more common in our part of the country as well. So it is still a good idea to have the quality of your irrigation water tested for sodium hazard, and excessive salinity and boron levels from time to time, just to be sure none of these potential water quality issues are at high enough levels in your irrigation water to cause a problem in your soil.

There have also been anecdotal reports from turfgrass managers that irrigating with water containing high levels of bicarbonate during extended periods of very dry weather, or true drought conditions, can cause a reduction of soil infiltration rates. The theory is bicarbonate anions and calcium cations in the irrigation water can precipitate out in the soil as water-insoluble calcium carbonate deposits. These deposits may partially plug soil pores and cause the reduction in infiltration rates observed. However, a current university research project investigating this topic has not been able to produce calcium carbonate deposits in a sand rootzone mix after irrigating turfgrass with very high bicarbonate water for an extended period of time. The researcher has not observed any reduction in infiltration rates in the sand rootzone he is testing either. It is not currently known under what exact conditions irrigating with water containing high levels of bicarbonate may or may not cause a reduction of infiltration rates in turfgrass soils, and more research work in this area is needed.

Soil Water Repellency Is A Likely Suspect

If you can rule out simple soil physics or an irrigation quality issue as the reason for reduced soil infiltration rates and an associated increase of water runoff on sloped turfgrass areas, then soil water repellency is a likely suspect. Water repellency is most commonly caused by the simple decomposition of organic matter. When microorganisms decompose organic matter in the thatch/mat layer of a turfgrass stand and in the soil, some of the by-products of this decomposition are organic acids, like humic acid and fulvic acid. These organic acids begin to partially coat the surfaces of lignin fibers in the thatch/mat layer and soil particles, including sand particles topdressed into the thatch/mat layer. As these organic acid coatings go through repeated wet to dry cycles, they become more and more non-polar and water repellent. This explains why most of the water repellency in turfgrass systems develops in the thatch/mat layer and top inch of soil. These two areas have more of the two factors needed to produce water repellency than areas deeper down in the rootzone; (1) higher organic matter content that when decomposed by soil microbes produces organic acid coatings, and (2) more frequent wet to dry cycles that cause these organic acid coating to become more and more water repellent over time.

Soil Water Repellency Is Like "Rain-X" On Your Windshield

The non-polar, water repellent, organic acid coatings mostly responsible for soil water repellency in a turfgrass system act very similarly to the phenomenon you observe if you put the product "Rain-X" on the glass windshield of your vehicle. Glass is a polar, water receptive, substance. Water is also a

Reduced water infiltration rate and water pudding on the surface of a research putting green due to soil water repellency. On flat turfgrass areas, water puddles, on sloped turfgrass areas water runs down slope in sheets and ribbons.

polar substance, and individual water molecules are attracted to glass and any other polar surface. When you drive in the rain, polar water molecules attach to your polar glass windshield by a process called adhesion. Since polar water molecules are also attracted to one another, once the first layer of water molecules is laid down on the glass surface, other water molecules begin to attach to that initial layer of water molecules by another process called cohesion.

As more and more water molecules start to attach to one another, a film of water begins to form on the glass surface of your windshield that makes it difficult for you to see through the windshield when you are driving in the rain. That is usually the time you turn on your windshield wipers, which are really just small rubber squeegees that physically wipe that thin film of water molecules off of the glass windshield so you can see where you are going. But if you have ever used Rain-X on your windshield, you have a totally different experience when you drive in the rain. Rain-X is a clear liquid that you can apply to the glass on your windshield. Once it dries, you can buff off the haze and it is completely transparent. It is also a very non-polar, water repellent substance.

If you drive fast enough in the rain with Rain-X on your windshield, you don't even have to use your windshield wipers. Why? Because Rain-X, being a very non-polar substance, turns your normally polar, water receptive glass windshield into a non-polar, water repellent surface. Since water molecules are repelled by, and can't attach to non-polar surfaces, rain can't form a film of water on your Rain-X treated windshield. Water will just bead up run down the slope of your windshield in ribbons and sheets, if your vehicle is driving slow or parked. If you drive fast enough, the wind will blow the water off your windshield, and windshield wiper use becomes optional.

Soil Surfactants Are Like Rain-X, In Reverse

Think of the thatch/mat layer and soil particles in the turfgrass / soil system as the glass windshield of a vehicle. They are normally polar, water receptive surfaces. Imagine that the non-polar, water repellent organic acid coatings on the lignin fibers in the thatch/mat layer and on the surfaces of soil particles are like Rain-X. They turn normally polar, water receptive surfaces into non-polar, water repellent surfaces. Water repellency on your glass windshield is good, but water repellency in the thatch/mat layer and soil is bad.

When you apply a soil surfactant (wetting agent) product and water it in, the surfactant molecules attach to the surfaces of the non-polar, water repellent, organic acid coatings in the thatch/mat layer and soil, and put a polar, water receptive surface back over the top of these surfaces. This is like Rain-X in reverse, turning non-polar, water repellent surfaces back into polar, water receptive surfaces like they were before the soil water repellency developed. Soil surfactant use increases infiltration rates, reduces runoff on sloped areas, enhances uniformity of moisture in the soil, prevents or cures localized dry spots, improves playability and contributes to better overall plant health. All these benefits explain why the use of soil surfactant products by golf course superintendents and other turf managers continue to grow each year.

Organic acid coatings responsible for water repellency on a sand particle. Photo Dr. Keith Karnok, University of Georgia DR.

When Are Soil Surfactants Used And Why?

Traditionally, the first applications of soil surfactant products in the Upper Midwest and Great Lakes regions are made to turfgrass in late spring or early summer. They are commonly used through the summer months of June, July, and August. Sometimes they are used in September, if there are warm and dry conditions in the early fall. This use period is very understandable. Summertime is when temperatures are the highest and water loss from evapotranspiration (ET) on turfgrass stands is the greatest, commonly exceeding ET losses of 0.25” per day. This is also the time of year when it can be very dry, so more wet to dry cycles occur in the soil, which increases the development of soil water repellency.

Add to this the fact that many cool-season turfgrass species on golf courses can lose a significant amount of root mass and depth in the heat of summer (can anyone say Poa annua?). As roots get shallower, there is less soil volume for the roots that remain to access water from. Soil closer the surface also dries out quicker than soil deeper in the rootzone and it is also much more water repellent than soil deeper in the rootzone, so it may not wet properly and any moisture that is present may not be very uniformly distributed either.

All of these factors lead to perfect storm conditions for the development of the ultimate symptom of soil water repellency, localized dry spot (LDS). No wonder many different soil surfactant products are applied in late spring and summer on a regular, preventative basis to help minimize the development of LDS symptoms, or they are at least applied on a curative basis to treat LDS symptoms when they occur.

Localized dry spot (LDS) on a golf course in Ohio.

Soil surfactant products are also used on turfgrass during this same period of time to prevent or treat more subtle symptoms of soil water repellency besides LDS, such as reduced soil infiltration rates, increased runoff on sloped turfgrass areas and non-uniform wetting of the soil, all which can lead to reduced playability and lower overall plant health.

When fall arrives,

temperatures begin to drop, ET rates decline rapidly and turfgrasses begin to grow back root mass and length they lost during the heat of summer. LDS symptoms are a lot less common, and soil surfactant use dwindles. This too is understandable. However, the non-polar, water repellency, organic acid coatings that cause soil water repellency problems like LDS and runoff on sloped areas have not gone away, and are still present in the soil, waiting to cause problems the next time it gets dry.

The Case For Late Fall Soil Surfactant Applications

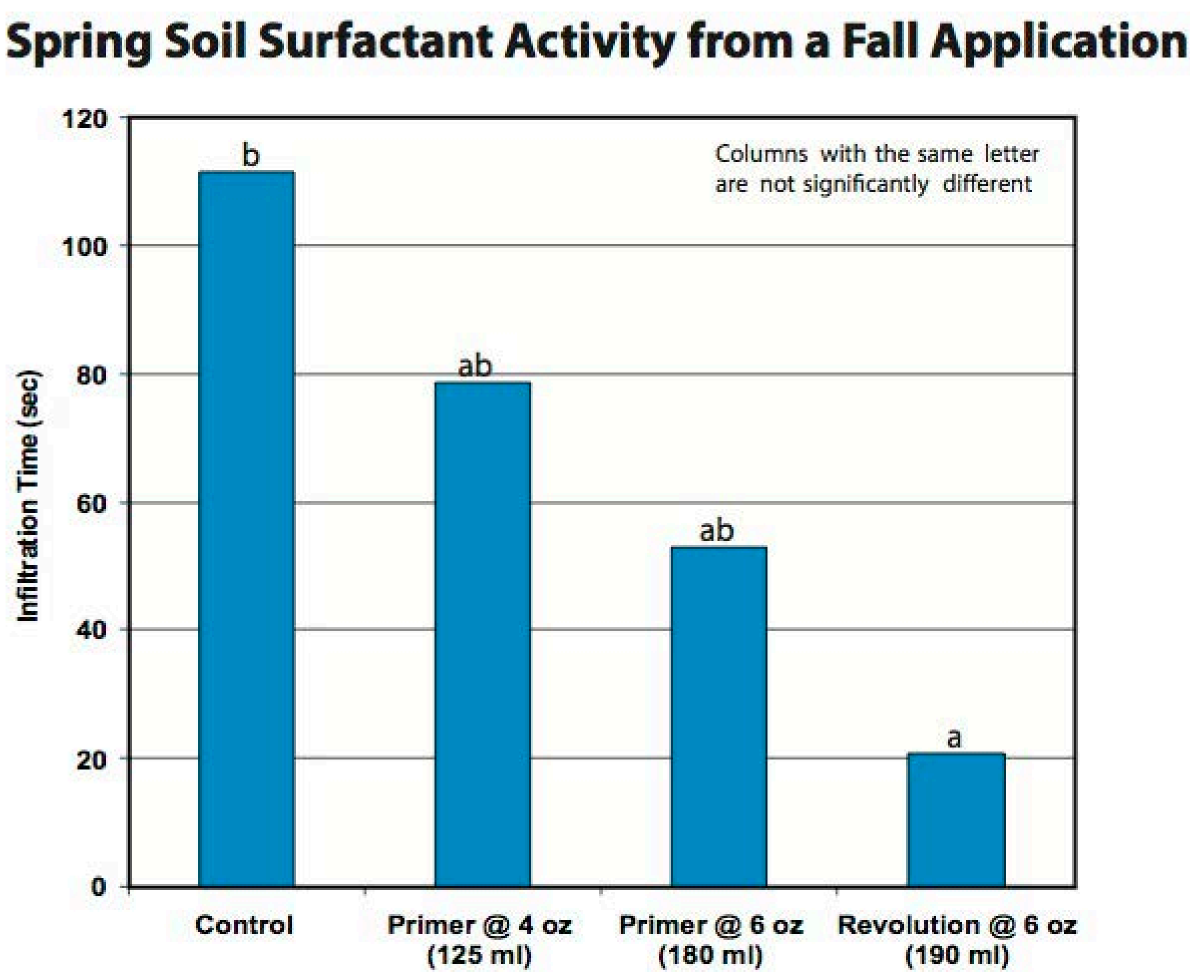
Return to March 2012 and the record early spring. Golf course superintendents were trucking water out to their greens because their irrigation systems were not up and running yet and soils were getting very dry. It was common to see the water they were applying to greens puddle up and run down slope. I think the reason this occurred (in most cases) was because of untreated soil water repellency, and the soil water repellency was untreated because almost all golf course superintendents stop applying soil surfactant products in August and September.

Soil surfactant molecules, like many other commonly used turf chemical molecules, contain a lot of carbon atoms. Carbon is a food source for soil microorganisms, so as soon as a soil surfactant application is made to a turfgrass stand and is watered in, microorganisms in the thatch/mat layer and in the soil begin to break those soil surfactant molecules down to get the carbon atoms they contain. This is why soil surfactant products (and many other turf chemicals) only last for a limited period of time in the soil, and why they need to be reapplied on a regular basis when used in the late spring, summer, or early fall, when soil temperatures are warm and soil microbial activity is high. So if golf course superintendents stop using soil surfactant products in August or early September, there is not going to be many soil surfactant molecules left in the soil to treat water repellency in late fall, winter, and coming out of winter the following spring.

All of these facts, and my prior experience as a young assistant golf course superintendent observing water running down slope at my feet while hand watering greens during an earlier than normal spring, lead to an idea. What if a soil surfactant application was made late in the fall, when soil temperatures and microbial activity were much lower than they are during late spring, summer or early fall? Theoretically, these soil surfactant molecules should persist in the soil to treat soil water repellency for a much longer period of time than they do when they are traditionally used, since the microbes that degrade them are not very active in cold soils. Could a late fall soil surfactant application even last until soil temperatures warmed up the following spring?

There has not been much research done yet to investigate this hypothesis. However, when the Aquatrols product Revolution® was still being developed prior to its introduction into the turf industry, a study in Kansas showed that an application of Revolution made even in early September 2002 resulted in better infiltration rates in early March of 2003 compared to an untreated control or the leading soil surfactant product at that time (Table 1). This suggests there was still statistically significant control of soil water repellency from a Revolution application made six months previously heading into fall and winter.

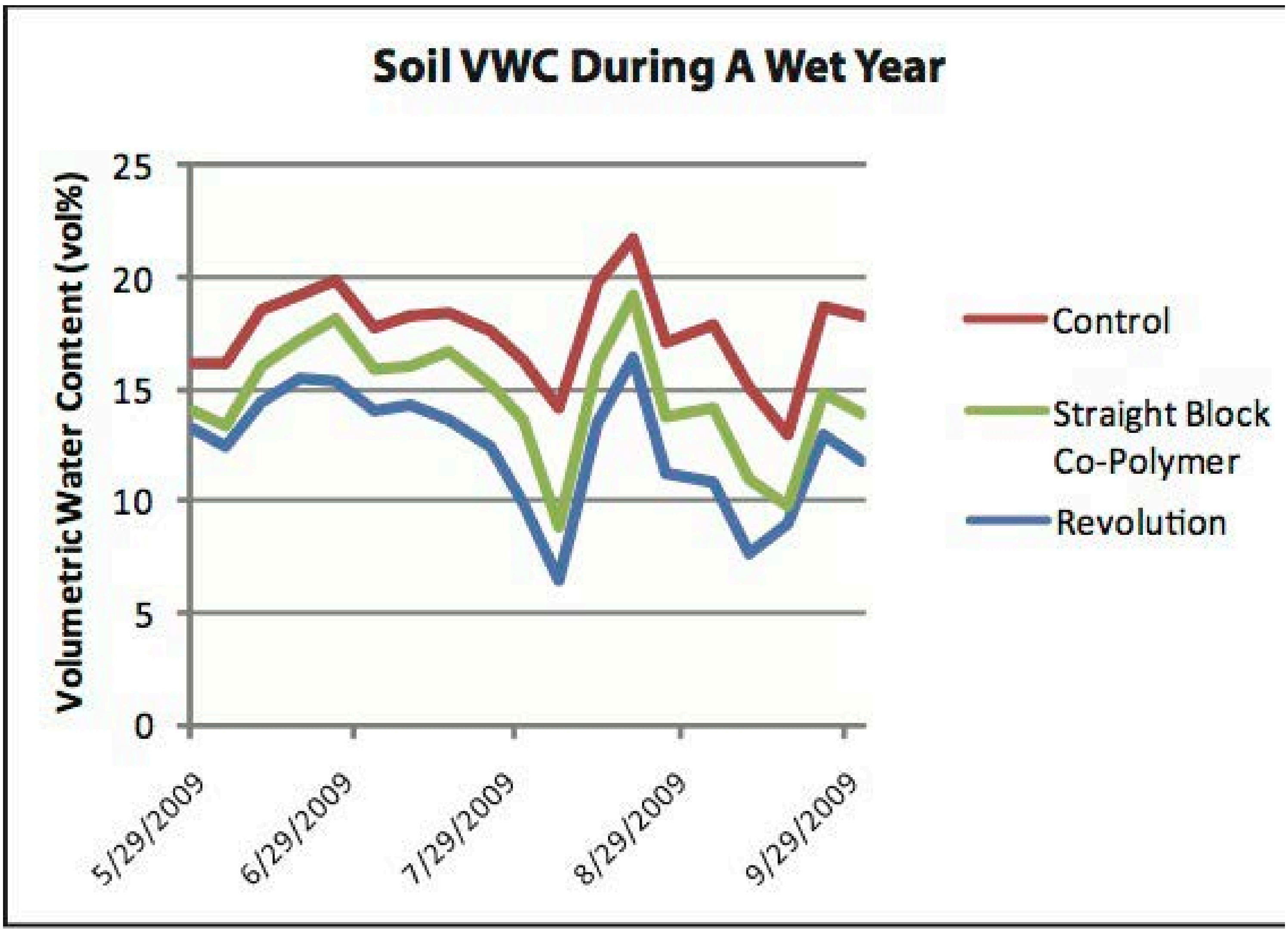
Based on this Kansas data and some other unique performance characteristics of Revolution verified by university research (and my own experience seeing this chemistry work in the field



Graph 1
Infiltration rates on March 3rd, 2003 on a putting green in Kansas. Primer Select and Revolution applications were made on September 1st, 2002, six months prior to data collection. Agronomy Solutions, Dodge City, KS.

for many years), I began to recommend a late fall application of Revolution on putting greens to golf course superintendents about five year ago. I recommend making this application as late was possible in the fall to let soil temperatures get as cold as possible, but while you still have irrigation water on to water Revolution in properly. So apply it a day or two prior to blowing out your irrigation system for the winter.

The feedback I have received from golf course superintendents who now make this late fall application has been very interesting and very positive. If it gets dry after they blow out their irrigation systems in the late fall, they say they see improved infiltration of any rainfall or snow melts that occurs, which helps improve soil moisture levels before the ground freezes. More favorable soil moisture levels in late fall should



(Graph 2 Caption)

Differences in volumetric water content (VWC) in a research putting green at the O.J Noer Turfgrass Center from late May until late September 2009, in response to different soil surfactant chemistries. Dr. Doug Soldat, University of Wisconsin – Madison.

help reduce moisture stress on turfgrass going into the winter, and help maximize photosynthesis and root growth until the ground freezes. If they have had very wet conditions prior to the ground freezing, they have seen the excess water drain out of their rootzones more rapidly prior to the soil freezing so greens don't go into winter as excessively wet.

Some golf course superintendents have also experienced a mid-winter thaw. If some of the soil thaws out too, and there is somewhere for the melting ice and snow to go, they believe standing water has drained off the turf surfaces faster than they have experienced in the past when they did not make a late fall application of Revolution. If standing water does get off the turf surface faster during winter thaws and less crown hydration occurs because of this, potentially there could be less crown hydration damage after a hard freeze.

In the early spring, golf course superintendents have seen better infiltration of any precipitation that occurs or snow that melts after the soil thaws. Better infiltration reduces runoff, improves soil moisture levels, and maximizes photosynthesis and root growth coming out of winter. This can be especially important if it gets warm and dry before you can get your irrigation system up and running in the spring. Superintendents who made a late fall application of Revolution in 2011 did not see any water puddling and running down slope when they had to truck water out to their greens in March 2012. The water they applied went right in.

This same principle of a late fall soil surfactant application on putting greens can apply to any other turfgrass areas that has a history of soil water repellency and receives soil surfactant applications during the summer. Many golf course superintendents are now making a late fall application of Revolution to tees, and Dispatch® Sprayable fairways, and I have heard favorable results about these applications as well.

Several universities are currently conducting research trials involving soil surfactants (wetting agents), including the University of Minnesota. I am hopeful that research can be done to verify some of the benefits of a late fall Revolution application that superintendents have reported from using Revolution. It would also be good to investigate if other soil surfactant chemistries besides Revolution can also provide positive benefits when applied in the late fall. Research may ultimately help to develop recommendations to make these applications even more effective as well.

If you have not made a late fall soil surfactant application before, perhaps this is something you might want to consider this year as you put your golf course to bed for the winter. Fall is here.