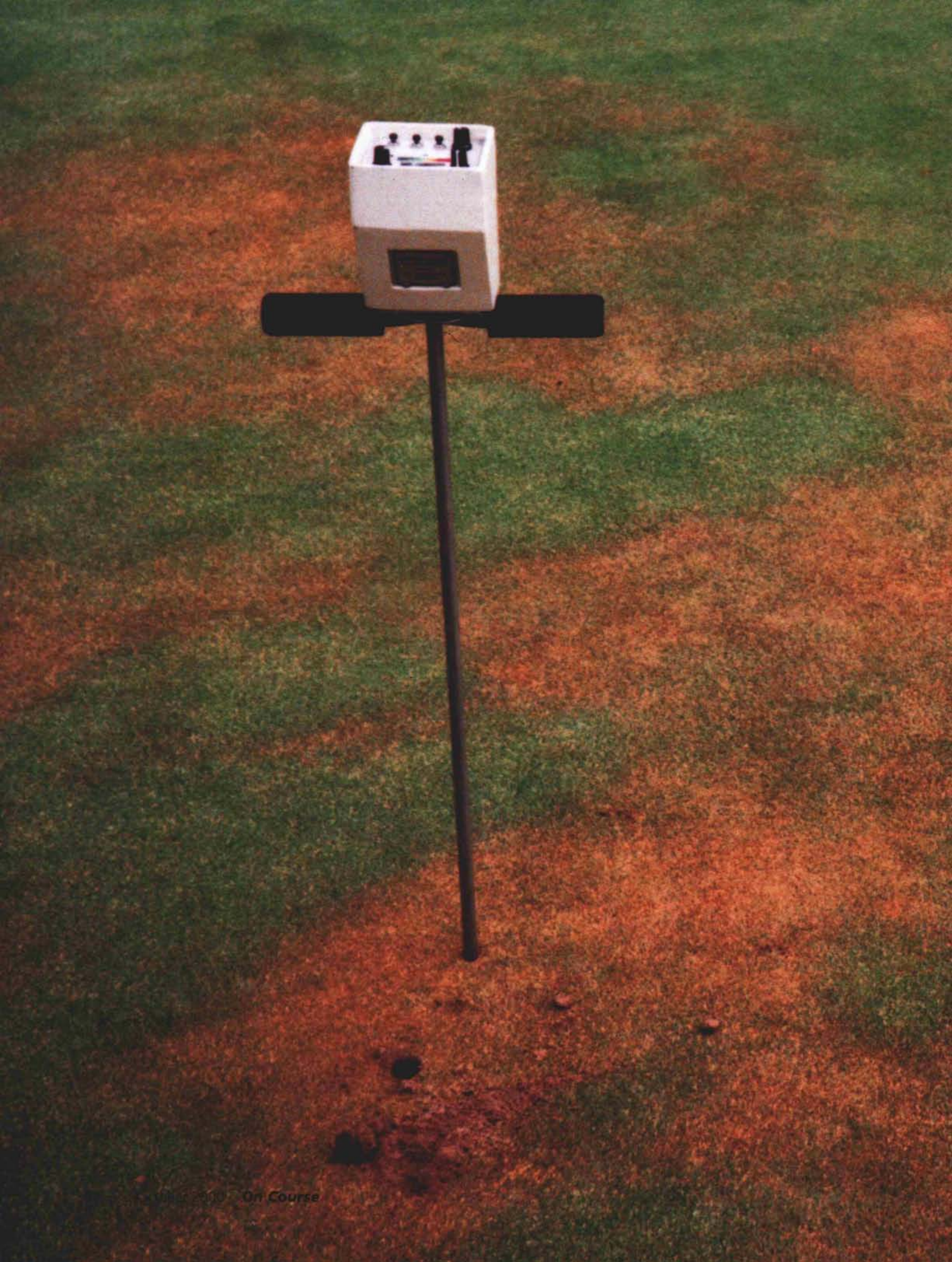

Fernando Fernandez, CGCS

Localized Dry Spots: Unraveling the Mysteries

Many mysteries surround the formation of localized dry spots; they are referred to as if they were some type of alien life-form from another planet, coming to invade golf courses and make superintendents' lives miserable. In reality, people create localized dry spots. In nature, we would have to look far and wide to find localized dry spots. Dry spots occur for a reason, and that reason is usually associated with salts and/or sodium.

Plants cannot tolerate sodium and/or excess amounts of salts. These substances are extremely toxic to them. When soluble fertilizers (salt) and/or animal waste products that contain high salt indices are used as plant nutrients, inevitably, toxicities will occur.

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Where do these salts and sodium come from? Analyzing the situation will help explain the forces at play that are in part responsible for the creation of localized dry spots.

Analyzing the situation

To facilitate an understanding of why dry spots occur requires introduction and explanation of 10 concepts and/or observations:

1) A glass and water evaporation test.
2) Removal of mineral deposits.
3) High and low pH.
4) How water softeners work.
5) Splashing water on a hot pan.
6) When raindrops dry.
7) Using a salt meter.
8) Sodium's use as a preservative.
9) Table salt on a steak.
10) Cigar box humidifiers.

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Concept/observation #1: A glass and water evaporation test

Take a glass and fill it halfway with tap water. Take another glass, and fill it halfway with irrigation water from your irrigation water supply. Place three microscope glass slides, and three microscope slide covers, inside each of these two glasses. Let them sit for seven to 10 days, and then examine what has occurred. The objective is for the water to evaporate. Heating the water can accelerate the process because evaporation will take place in a shorter period of time.

Because salts are soluble in water, they cannot be readily perceived. One way to actually see the salts is to separate them from the water by the process of evaporation. As the water evaporates, the salts become apparent in the form of hard mineral deposits stuck to the glass surfaces of the glasses, the microscope slides and the microscope slide covers mentioned above. These mineral deposits will be so hard, that it will be almost impossible to remove them from the glass surfaces.

Concept/observation #2: Removal of mineral deposits

Removal of the mineral deposits from the glasses, microscope slides and microscope slide covers (see #1 above) can easily be achieved with the use of vinegar. It is just like cleaning part of a home's central humidifier.

The glasses, microscope slides and microscope slide covers used in the experiment above are readily cleaned with the use of a low-pH substance. A low-pH substance will dissolve clean a mineral deposit formed by a high-pH substance.

Concept/observation #3: High pH and low pH

Take a handful of baking soda, and place it inside of a jar . . . a one-quart mayonnaise jar will do just fine. (You may use chalk in lieu of baking soda.) Take a match and tape it to the end of a pencil. Light the match at the end of the pencil, and insert the pencil inside of the jar all the way down to the bottom, near the baking soda/chalk, but do not let the match touch the material. Leave it there for a couple of seconds, observe what happens and remove it.

Now take several fluid ounces of vinegar, and pour the vinegar over the baking soda/chalk, stirring lightly. Again, tape a match to the end of a pencil. Light the match at the end of the pencil, and insert it in the jar all the way to the bottom, near the baking soda/chalk, but do not let it touch the material. Leave it there for a few seconds, and observe.

What will become apparent is that the match in the first phase of this experiment stays lit, but the match used in the second phase goes out. The reason this occurs is because when a high-pH calcareous substance is mixed with a low-pH substance, a chemical reaction results, which in the process consumes oxygen.

Concept/observation #4: How a water softener works

Sodium is a highly reactive ion, and it will, because of its nature, displace other ions. Looking at the periodic table of elements, it is easy to appreciate that Na has a heavier atomic weight than many other elements that are important for turf nutrition.

A water softener works by introducing sodium into a water supply with the intention of cleansing other ions. As sodium is

. . . water evaporates as it touches a hot surface! We can see this occurring during hot weather on many surfaces: a cart path, the hood of a truck or car, the roof of a house and yes, turf areas, especially low-cut turf areas such as greens, tees and fairways, especially if they are grown in sand, because sand is very heat-sensitive.

introduced, and mixed into a hard water supply, mineral salts are displaced, while sodium takes their place. That is how hard water becomes soft. Sodium naturally removes mineral salts from a water supply.

Concept/observation #5: Splashing water on a hot pan

Splashing water on a hot pan results in the water sizzling and a cloud of steam forming and rising.

What occurs in reality is that the water evaporates as it touches the hot surface! We can see this occurring during hot weather on many surfaces: a cart path, the hood of a truck or car, the roof of a house and yes, turf areas, especially low-cut turf areas such as

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greens, tees and fairways, especially if they are grown in sand, because sand is very heat-sensitive.

Concept/observation #6: What occurs when raindrops dry

Examining what occurs when raindrops from a passing storm dry on a hot surface—for example, on the hood or windshield of a car—helps reveal to what extent salts are abundant.

After the rain subsides, the sun illuminates the surface, and the raindrops dry. Stains remain where the raindrops once stood. This occurs because mineral deposits (salts) were present in the water.

The situation described above occurs not only with rainwater, but also occurs when a car is washed with potable or pond water, or a car is taken though a car wash. It occurs without regard to the kind of water used, with the possible exception of distilled water. Distilled water does not contain salts; it is anionic. However, distilled water droplets may pick up impurities from the air before they dry, and may still produce a stain.

It is important to remember that salt will always be present in rainwater, and this factor must be acknowledged by any turfgrass management program.

Concept/observation #7: Using a salt meter

With the use of a salt meter, let us examine what occurs to a soil extract.

Take a handful of sand or soil from the profile of a green or any turfgrass area you suspect has a problem. Place this handful of sand/soil in a plastic or glass container. Add enough water to it to make a slurry. Let the mixture sit for 10 to 20 minutes. With the use of a thermometer, take the temperature of the slurry mixture, and record. Insert the salt meter in the mix extract, and record the salt reading. Place the slurry mixture in a room, and at room temperature, obtain its temperature. Take a salt reading once every hour for four hours, and record both the slurry mixture's temperature and its salt readings.

Next, place the slurry mixture on top of a warm surface, such as the top of a computer monitor. Let it sit for two hours, then take its temperature and record both the slurry mixture's temperature and its salt readings. Place the mixture on top of an even warmer surface, so that the temperature of the mixture is increased by another 10 degrees; then take readings as described above and record.

What becomes apparent is that as the temperature of the extract mixture increases, so do the salt concentration readings. It is important to remember that a 10-degree increase in temperature will double the rate of reaction.

Concept/observation #8: Sodium's use as a preservative

For thousands of years, throughout history, sodium has been used as a preservative.

Sodium is used in canned products to help protect them, and keep them from spoiling. Earlier people used to sprinkle sodium on meat, drying it in the sun, to protect it and make beef jerky.

In reality, what salts actually do is kill microorganisms. They are, to a certain extent, a biocide. It is important to constantly keep in mind that sodium and some salts are considered biocides, and at the core of all turf-related problems, in one way or another, stand the effects of salts and sodium . . . including the problem with localized dry spots.

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Concept/observation #9: Table salt on a steak

Take a pinch of salt and sprinkle it evenly over a steak, and let the steak sit for 15 to 30 minutes.

The steak will begin to get watery. This occurs because the salt is robbing water from the cells of the steak—reverse osmosis.

Salts and sodium have the ability to absorb tremendous amounts of moisture. It is important to remember that if sodium and/or salts cannot satisfy their moisture requirements from the soil, they will steal it from the roots' cells, just like the table salt did with the steak's cells.

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Concept/observation #10: Cigar box humidifiers

Cigar box humidifiers are small, sponge-like, rectangular-shaped tablets (dimensions about 2″ wide x 2.5″ long x 0.5″ high), that fit inside of a cigar box. These inserts are impregnated with water, drip-dried and placed inside of the box.

These inserts exist to provide humidity to the cigars stored inside of the box. Every seven to 10 days, it is necessary to remove the inserts and repeat the process, impregnating them with water again, drip-drying them and placing them back in the box. This ritual, practiced perpetually, prevents the cigars from drying out.

The humidifiers' inserts must be impregnated with water at regular intervals; it is not wise to let them dry completely. Letting the inserts dry completely ruins them.

The recommendation is to impregnate the inserts only with distilled water. Distilled water is anionic, and will not leave any residue behind; regular tap water would ruin the inserts. Regular water contains salts, and as the moisture evaporates inside of the cigar box, the salts would separate from the water, plugging the humidor's tablets and preventing them from absorbing water in the future. They would become hydrophobic, sealed up with salts (mineral deposits) and not accepting of moisture.

Even when distilled water is used to impregnate the humidifiers, it is important to submerge the humidifiers, not just impregnate them—otherwise they will be ruined. This observation illustrates that even under the absence of light and/or heat, most substances, after they have been moistened and allowed to dry completely, will experience the salts separating from the water, and a hydrophobic condition will exist. Any medium that is not moistened to a saturation point will have areas that will not impregnate, and as result, will become hydrophobic.

This problem is a predominant problem in houseplants that are irrigated with chlorinated and/or hard water. Such plants usually receive, as irrigation, one cup of water every three days, so that water will not filter out of the bottom of the pots and wet the floors. When this practice continues for a period of time, it soon transpires that after irrigation, the water runs immediately out of the bottom of the pots, and the plants begin to show scorching of the tips and adages of the leaves. The soils in the pots have become hydrophobic. They are sealed by salts and mineral deposits. To remedy the situation, the recommendation is to weekly submerge the plants until the soil in the pots becomes 100% impregnated with water, and than go back to the one-cup-every-three-days irrigation scenario. This observation illustrates that it is absolutely necessary to use adequate amounts of irrigation at least once per week so as to completely saturate the soils.

Soil temperature inversion (STI) + salts + heat = localized dry spots

Salts, without a doubt, are the most damaging ingredient in the formation of localized dry spots. Dry spots form via the evap-

Salts, without a doubt, are the most damaging ingredient in the formation of localized dry spots. Dry spots form via the evaporation of water and the solidification of mineral salts.

oration of water and the solidification of mineral salts. As the soil dries, and the water heats up, something very predictable occurs: salts and water begin to separate by the process of evaporation.

When salts and/or sodium are excessively high they can, at times, displace organic matter, making the entire situation more complex. Localized dry spots are a direct result of moisture evaporating, and salt left behind coating soil particles and/or plant materials. As moisture leaves the soil, and salts are stripped from the free molecules of water, the salts (mineral deposits) have no alternative but to adhere to the water that remains—the nonavailable water that surrounds the soil and plant particles, leaving a very hard film of mineral deposits plastered all over these soil and plant particles. This is especially true with sand particles, just as occurs with the glass and the microscope slides mentioned in concept/observation # 1 above.

The salt (mineral) deposits will be so hard that it will be almost impossible to remove them from the soil particles and/or plant materials; they become very difficult to rewet. They become hydrophobic.

The use of high-pH substances

The use of an acid-injection system definitely helps in combating localized dry spots. The acid injection helps because the acid in the material has the ability to cleanse the mineral deposits, as explained in concept/observation #2 above.

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Sacrificing oxygen

The problem with the entire situation described above is that when a high-calcareous substance is mixed with a low-pH substance, a chemical reaction results that consumes oxygen, as explained in concept/observation # 3 above.

What in reality occurs—inadvertently, most times without us being aware of it—when a low-pH substance is mixed with a high-pH substance is the cleansing of mineral deposits, and in the process, the sacrifice of oxygen molecules within the root system.

Particle migration

When mineral deposits are cleansed by mixing a low-pH substance with a high-pH substance, the particles migrate down into the soil profile where eventually they begin accumulating. A layer of hard mineral deposits (salts) will form, creating a hard spot (a hard pan), and a stratification point where STI will take hold, rendering the entire situation more challenging.

Under the conditions described above, the subsoil has tremendous difficulties transmit-

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ting gases, water, nutrients, etc. upward through capillary action; because of gravity's pull, all becomes impaired.

As salts build up, the potential exists for the situation to become a genuine nightmare.

Salt build-up

Salts percolate upwards during the cool times of the year.

It is important to avoid the use of soluble inorganic fertilizers early in the season because such use increases the incidence of salts accumulating in the surface-soil profile, and carries the risk that they may not be washed away by natural heavy and ample precipitation. Observations tell us that using soluble inorganic fertilizers early in the season increases the incidence of localized dry spots later during the summer months.

During late fall, winter and early spring, when the temperature of the subsoil is warmer than that of the surface soil, molecules of all types migrate upward aided by heat, against gravity's pull.

What in reality occurs during the cool season is that salts percolate upward, by way of capillary action, and begin building up near the soil's surface. This is the time of the year when most salt accumulation occurs. The reason that salts, and their effects on turf, are not appreciated during this time of year is because the evapotranspiration is usually very low, and enough moisture is present to counteract the situation.

The use of soluble fertilizers during the early part of the season

It is important to avoid the use of soluble inorganic fertilizers early in the season because such use increases the incidence of salts accumulating in the surface-soil profile, and carries the risk that they may not be washed away by natural heavy and ample precipitation. Observations tell us that using soluble inorganic fertilizers early in the season increases the incidence of localized dry spots later during the summer months. This is because extra salts have been added to the ecosystem of the soil while the turf is not actively growing, and not enough precipitation has fallen to wash the salts away.

Fertilizers overlapping

It is important to be careful when applying fertilizers, especially when soluble fertilizers are in use.

Frequently, the edges of fairways, greens and tees are victims of inadvertent over-fertilization. Fertilizing of fairways, for example, is done in such a manner that complete coverage is obtained from one end to the other, and from side to side. Often, the approach and the intermediate fairway areas are also partly covered with fertilizer. Later, when the roughs and approaches/collars are fertilized, these areas inadvertently get covered with fertilizer one more time.

It is nice to see green turfgrass in these areas, but what occur later in the summer, when the temperatures and the evapotranspiration (ET) exceed the moisture content of the soil, is not so nice: salts migrate upward, creating havoc—localized dry spots, toxic soil and dead turf. This same situation occurs with greens and tees, as these areas are fertilized in the same manner as fairways. Later, upon fertilizing the banks and approaches/collars, the edges of the greens and/or tees are also unintentionally covered with fertilizers one more time.

Salts and/or sodium: many different sources

Salts originate in multiple sources. It is important to realize that the introduction of salts and/or sodium into turf areas derives not only from the use of fertilizers, but also can occur with application of pesticides.

Leachates from fertilizers, pesticides, bicarbonates from irrigation or rainwater, organic residue from biological decomposition, dust and/or air impurities all contribute to the accumulation of salts, as explained with the discussion of particle migration above.

Always consider salts as part of the equation. When salt minerals are out of balance, the turfgrass will experience problems with structure—too soft or too hard, problems with plant count, and on greens, problems with green speed.

Maintaining soluble salts at absolutely minimum levels

In implementing a management program, be sure to keep the introduction of soluble salts into turf areas at an absolute minimum. It is important to remember that most pesticides and many fertilizers use some type of salt as a reactive ion. Salts are used because of their tremendous reactivity, and their ability to adhere to negatively charged particles.

Just as a water softener uses sodium to displace minerals, as explained in concept/observation #4 above, some pesticides and some fertilizers will have exactly the same effect on your soils. The salts and/or sodium mentioned above will strip the soil's minerals, and they will take over the exchange site, especially on low cation-exchange-capacity (CEC) soils. These include light sandy soils such as with sand-based greens and push-up greens modified by core removal and additions of sand.

With the presence of heat, the salts will later transform into a soil biocide, sterilizing the soil medium explained in concept/ observation #10 above. Often, this has a disastrous effect on soil structure, soil microbiology and soil nutrition.

This is the reason some sand-based greens experience footprinting and spiking. It is also why some sand-based greens experience nutritional deficiencies, even when the nutritional program is ample and just.

Make this a primary area of concern: to manage and use sparingly soluble salts and pesticides.

Sand and heat

Sand is very temperature-sensitive, and its buffering capacity is very weak, creating a very reactive and complex scenario. Sand, and light sandy soil, heat up very rapidly, especially under the phenomenon of soil temperature inversion.

Again, remember that a 10-degree increase in temperature will double the rate of reaction, as explained in concept/observation #7 above. Light sandy soils are always going to be more reactive then heavy soils, especially under low-cut turf such as greens, tees and fairways.

Sand-based greens, and push-up greens modified by the removal of cores and addition of sand, are considered to have light soils, but comparing them would be like comparing apples and oranges. Push-up greens modified by core removal and additions of sand are reactive and different in their own right, and must be managed accordingly.

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To deal with these issues, arrange a consultation with your USGA Green Section and/or your independent turf consultant.

Nature's "oven-drying" of soils

During the summer months, when soil temperature inversion is present such that the temperature of the surface soil is warmer than that of the subsoil, nature can oven-dry the surface soil very rapidly.

During the early spring, late fall and winter, the sun's rays hit the ground at such an angle that some of the heat reflects back into the air, and into the atmosphere. However, during late spring, early fall and summer, the sun's rays hit the ground vertically. The heat generated by the vertical position of the sun's rays has the potential to be horrendous. As the sun's rays strike the turf vertically, the plants absorb some of the heat, while some of the heat filters down into the soil.

A precept of soil science tells us that when a stratification of any kind is encountered, a hesitation occurs. Substances hesitate before moving into an area of difference, without regard to the construction of that layer.

The first 0-4″—the surface soil—begins to accumulate heat rapidly. The heat disperses in all directions and tries to penetrate deeper, into the subsoil, where it encounters a stratification area. This layer of colder soil, the hardpan area typically located at about 4-5″ of depth, is at the bottom of the stroke of the regular aerification coring.

It is common knowledge that most substances expand when heated, and they will be lighter than cold substances. Cold or cool substances will naturally settle, and warm and hot substances will naturally rise.

As the surface soil observes the heat, it naturally tries to transmit this heat in all directions, including downward into the subsoil, but as it encounters the area of colder soil, a temporary blockage occurs.

A precept of soil science tells us that when a stratification of any kind is encountered, a hesitation occurs. Substances hesitate before moving into an area of difference, without regard to the construction of that layer.

As this hesitation occurs, the heat of the surface soil increases. Momentarily, the heat has no place to go. It is trapped. The surface soil, at this point, is becoming hotter than the sun's rays, emanating vertically from the heavens. As the heat of the surface soil begins to surpass the heat coming from the sun's rays, the heat begins to rise, then encounters the heat from the sun's rays. Once again, a hesitation occurs. The heat from the surface soil, which at this time is trying to leave the ground, is blocked by the heat from the sun's rays coming down vertically, and some of the heat returns to the soil. As this hesitation repeats, heat accumulation intensifies. The heat again transmits in all directions including downward, but once again, it encounters a cool or cold section of the subsoil, creating a blockage underneath, hampering the heat from being dissipated downward deep into the soil.

A heat trap is created; this intensifies the accumulation of heat in the surface soil part of the soil's profile, minute by minute. This cycle repeats all day, and all summer long. Nature has constructed a virtual oven. As the materials are undergoing oven-drying, the salts will separate from the molecules of water by way of evaporation, and the soil and plants will be plastered with mineral deposits, as explained in concept/observation #1 above.

Syringing will not help this situation; it will only make things worse. All that alleviates this condition is the elimination of the soil temperature inversion section—the subsoil layer—in the soil. Following the practices discussed below allows for accomplishing just that.

Competition

Managing competition is also vital. Competition can come from many areas, affecting turfgrass: tree roots, stratification of materials, heavy soils adjacent to light soil, shade or south-facing slopes, irrigation distribution, soil temperature inversion. Cultural practices can also have an impact; these include aerating, irrigating, flushing of the root zone, fertilizer and pesticide applications, the use of soil amendments, wetting agents and the influence of nature.

Conclusions

Localized dry spots are not aliens that come to this planet to make superintendents' jobs miserable; most of the time, we ourselves create them. Salts (mineral deposits) and heat are the main culprits in the formation of localized dry spots.

The following eight steps are absolutely necessary for the correct management of localized dry spots:

1) Manage the use of soluble inorganic products, keeping salts to an absolute minimum! Use natural organic products. Use animal, and animal-waste, byproducts only if their salt index is very low, and use highly soluble calcium/potash/silica-based nutrients.

2) Deep-tine aerate USGA sand greens, California-style and push-up greens modified by the removal of cores and addition of sand, and tees and fairways with 1/2″ solid tine or drill aerate with a 1/2″ or 5/8″ drill as deep as can be accommodated, twice per year. This should be done once in the fall, and once in the spring when the temperature of the subsoil is higher than that of the surface soil. Note! Take care not to penetrate through the gravel blanket or tile lines. When implementing deep-tine aerating on push-up greens and push-up greens modified by the removal of cores and addition of sand, on tees and on fairways, deep-tine as deep as you can without causing damage to tile lines and/or equipment. Fill the aerating holes all the way up with an 80-20 mix of the same parent materials from which the greens, tees and fairways were constructed, incorporating with it a 0.5-1% by volume of a good quality soil amendment.

3) Flush the root zone at the beginning of the each season, preferably when the temperature of the subsoil is higher than that of the surface soil. Note! Make sure that nutrients and micronutrients are used after flushing, as would be recommended by a prompt and just quality soil and/or tissue analysis.

4) Take soil, water and tissue samples, and determine the concentration of salts in the irrigation water and in the soil. Use the services of the USGA Green Section, as well as an agronomist or consultant at least once per year.

5) Administer irrigation practices so as not to cause adverse consequences in turf. Irrigate with plenty of water once per week, and make sure the ET will never surpass the moisture applied for a given 24-hour period, and syringe with caution!

6) Manage competition, and maintain at a minimum. Root prune, maintain a watchful eye on areas where interfacing between light and heavy soils may be present and be conscious of the moon's meridian gravitational pull.

7) Inject USGA greens, California-style and push-up greens modified to sand by the removal of cores and addition of sand with water every two weeks during the summer months, when the temperature of the subsoil is cooler than the surface soil. Do fairways as needed. Water injection creates ventilating holes, which temporarily give gas exchange and temperature equilibrium.

8) Use a subvacuum or blower machine. A subvacuum or blower machine vacuums or blows air into the subtile lines of the green. It is a very effective remedy; it removes gases from the stagnant subsoil profile of the green, replacing them with fresh ones without the use of excess water. It also equalizes the subsoil and surface soil temperatures temporarily, accomplishing this in a very short period. If administered correctly, and all the connections are readily available, this practice should only take about 15 minutes per green. Six greens can easily be done every morning before the start of play, giving a ventilating rotation of about four days for 20 greens.

Manage the use of soluble inorganic products, keeping salts to an absolute minimum! Use natural organic products. Use animal, and animal-waste, by-products only if their salt index is very low, and use highly soluble calcium/ potash/ silica-based nutrients.

Fernando Fernandez, Sr. has been working in the golf course industry for 28 years. His book, Localized Dry Spots, Irrigation and Soil Temperature Inversion (STI), *is available through the Web at www.sand-base-greens.com. Or, call Fernando at 847-705-5738.*