

Turfgrass Management after Hurricanes

Beyond the wind damage and debris, hurricanes can impact the recovery and management of golf courses. Below is a summary of issues and management strategies for turfgrasses and trees. For more information on a particular issue, please contact the respective section's author(s).

Weed Issues – Bert McCarty, PhD, Fred Yelverton, PhD and Travis Gannon, PhD

Probably the biggest long-term agronomic effect from flooding/tidal surge is the lack of weed control. This is from the inundation of many areas which will leach/dilute most of previously applied preemergence herbicide. Some PRE herbicides (DNAs, others) degrade more rapidly in anaerobic conditions. This is why you often experience more weed escapes (crabgrass, *Poa annua*), during wet conditions. Some leachable herbicides (triazines, Kerb, others) can be leached out of the upper inch of soil, which is where almost all of the small seeded grasses germinate. The inundation will also weaken the permanent grass, providing more voids as well as deposit more *Poa* seed from silt/mud. If courses have not overseeded, it is recommended to skip it this year to minimize competition of the weakened bermudagrass. This also greatly simplifies and decreases the cost of *Poa* control.

General binding affinity ranking for common PRE herbicides is (from least to highest): Simazine = Pronamide < Indaziflam < Dithiopyr < Oxadiazon < dinitroanilines

Preemergent herbicide leaching/off-target movement potential increases as:

- Soil texture coarseness increases (i.e. increasing sand content)
- Soil organic matter decreases
- Slope increases
- Vegetative cover decreases (more bare soil = more movement)

Non-overseeded. Courses which haven't applied a preemergence herbicide such as prodiamine or indaziflam (Specticle), should perform the "tug test" to see if the bermudagrass is sufficiently tacked down to handle these. If so, then it is prudent to apply these. However, most areas already have had *Poa* germinate, so a follow-up application of either pronamide (Kerb), an SU product (Monument, Revolver, Katana), or simazine should be considered in late November. This timing will allow the fall germination flush of *Poa* to have occurred, with plants still immature enough to easily control. A follow-up application should also be planned in January. Glyphosate or glufosinate (Finale) can be added to the list for the January application.

Overseeded. Courses which still plan on overseeding should wait as long as possible (e.g., Halloween) as to allow maximum *Poa* germination prior to this. These courses also need to have had at least 1 in (2.5 cm) rainfall or fresh water applied to the permanent grass to flush as much salt, silt, and clay as possible. If not performed, expect a spotty overseeding from salt accumulation. Two days prior to the later timed overseeding,

apply foramsulfuron (Revolver) to control the Poa that has germinated. Afterwards, Poa control gets complicated and expensive. Two fall applications of ethofumesate (Prograss) is the “best” postemergence Poa control option in overseeded turf. With the possible delayed overseeding date this year, apply the Prograss in early December followed with a late December application. Afterwards, the option is to wait until late February and apply either bispyribac-sodium (Velocity) or amicarbazone (Xonerate). A follow-up application will be required 2 to 3 weeks later. Air temperatures at the time of application must be between 55 and 75 F (13 and 24 C) and good soil moisture present. If not, you can expect yellowing (flashing) and/or extensive damage (thinning) of the ryegrass.

Insects – JC Chong, PhD and Rick Brandenburg, PhD

The impact of a hurricane on the management need for insect pests will be variable. In the past, flooding and heavy rains often cause significant relocation of fire ants mounds and they may be found in new locations on a property where mounds are not typically observed. The good news is that these new mounds are typically quite easy to control. With the high soil moisture and rising water table, more tunneling by mole crickets will be observed in the short-term and they may move from lower areas to higher and drier areas following the flooding. Mole cricket activity may be observed into November and dealt with as needed with possible application of insecticides to suppress tunneling activity. Typically, as temperature drops in the fall, mole crickets move deeper into the soil and tunnels become less numerous and obvious. As the soil dries the tunneling activity will abate over time. If it does, no management is necessary. If damage exceeds tolerable levels, insecticides may be used effectively while the crickets are actively tunneling near the surface. . The best options for suppressing tunneling activity caused by large crickets late in the season are Provaunt (indoxacarb), Triple Crown (3 way mixture) and acephate (e.g., Orthene). Pyrethroids (bifenthrin, cyhalothrin, detamethrin, etc.) can also provide some control. Fall armyworms should not be a problem the remainder of the fall due to lots of green vegetation for them to feed on and the cooler temperatures.

Irrigation Water Quality- Dara Park, PhD

Tidal storm surges can result in saltwater intrusion into irrigation ponds and onto the course. If the irrigation pond is also fed by stormwater runoff, then any tidal storm surge from elsewhere may enter the pond too. The good news is that the rainfall will also end up in the pond diluting the saltwater.

Irrigation ponds:

Check the pH & EC of the water. If it is greater than 500 ppm TDS or 0.75 dS m⁻¹ for EC, then there is cause for concern. If all you have is a pH meter, then a pH greater than 7.0 may be suspect.

Some irrigation ponds that are very close to the coast can release water into adjacent wetlands via gate valves when the tide is below the water level of the pond. This might

be the best way to “flush” salts out of a pond. This cannot be done if your pond is filled by treated wastewater. Most wastewater ponds have a NPDES permit that limits the discharge. In South Carolina, contact Mike Montebello @ 803.898.4228 if you are unsure on the course’s pond discharge permit. For ponds that do not have an NPDES permit, there are no specific regulatory requirements associated with discharges. However, the Pollution Control Act states that discharge cannot adversely impact adjacent property or the environment. Regardless, please be aware of what is in the water when releasing from a potentially storm affected pond. If needed, submit a water sample for analysis. If submitting to Clemson University Agricultural Service laboratory, order the “Special” Analysis. Info on the how to submit a sample can be found under the “Irrigation Water” link at http://www.clemson.edu/public/regulatory/ag_svc_lab/ Navigate to the Water Quality Flow Chart (in the left-hand column) to help assess for salinity issues.

If the water is salty and the only means of discharge is on the course, try to select the least desirable area to apply it to. Follow with an application of gypsum and flush with freshwater once obtained.

Chloride and boron should also be monitored. Chloride levels > 70 ppm and boron levels > 1 ppm are of concern. Chloride is easily leached, but boron can accumulate in some soils. Both can quickly become toxic to turfgrasses.

Soils on the course that are salt affected:

If rootzone soils are of low CEC (common in soils with low organic matter content and of sandy texture), the sodium present may not influence the soil structure but still may present a sodium toxicity hazard to the turfgrass, ornamental plantings and trees. Flushing with fresh water will be the easiest and most cost effective way to remove the salts / sodium.

For soils with higher CEC (more organic matter, heavy textures as found in some native subsoils along the coast), begin with flushing the soil with fresh water. An acid burner or injector would be the best way to reduce sodium hazards from occurring. Using the acid burner or injector will also reduce high pHs that are found in high salinity / sodium soils. The hydrogen produced replaces the sodium, and in many cases, if the acid is sulfuric, the sulfate will complex with the sodium and be leached with percolating waters. It is the hydrogen that also lowers the pH. If an acid burner or injector is not an option, apply gypsum. Spoon-feeding will give the best results. Going with a finer particle gypsum will react faster than a more coarse particle. With gypsum, the calcium will replace the Na. However, gypsum will have little to no influence on pH. An application of elemental sulfur will help reduce pH.

Either way, soil test to help identify the best management strategies and again after management strategies have been applied to gauge how effective they were. A simplified cheat sheet is below.

Management Cheat Sheet (Simplified)

Must know irrigation water and soil status

Current soil situation	Irrigation Na status	Amendment required	Leaching factor/ Reclamation Requirement needed
Sodic	High SARw	Continuous basis	RR
Sodic	Low SARw	Until soil is nonsodic	RR, then LF
Saline-Sodic	High SARw	Continuous basis	RR, then LF
Saline-Sodic	Low SARw	Until soil is nonsaline-sodic	RR, then LF
Saline	High SARw	Continuous basis	RR
Saline	Low SARw	No	RR, then LF
Nonsalt affected	High SARw	Continuous basis	LF
Nonsalt affected	Low SARw	No	None

Diseases – Bruce Martin, PhD and Jim Kerns, PhD

An additional issue that can occur is unusual or greater than normal disease outbreaks. The heavy rains can leach fungicides, enhance their degradation by hydrolysis and stimulate pathogens. We saw this last fall, winter and spring with very high disease pressure and outbreaks which likely were the result of prolonged cloudy, wet weather and flooding from the now legendary October rains which drenched the eastern regions of South Carolina and portions of eastern North Carolina. The Carolinas once again bore the brunt of Hurricane Matthew, and effects of that storm are still being keenly felt. Pythium blights and rot rots are likely the diseases that come to mind most readily and certainly we saw a lot of Pythium last year under similar circumstances. The chart below outlines some single component fungicides that are registered for Pythium diseases; note the interval of control expected from these materials. The top-tier materials based on turf trials include Banol, Segway and the phosphonates (Signature or Appear in the Table). Strobilurins have Pythium activity but Pythium control is not a major strength of these fungicides.

Some Single Component Pythium Fungicides

Fungicide	Rate (oz/1000 ft ²)	Interval (days)	Comments
Heritage 50WG	0.4	10-14	Blight/RR/preventive
Insignia 2.08 SC	0.7	10-14 (Blight) 14-28 (RD)	Blight/Dys/preventive/ tank-mix
Fame (Disarm)	0.18-0.36	7-14/ 7-10 (RR)	Blight/RR/preventive/ tank-mix
Subdue Maxx	0.5-1.0	7-14/14-21	Blight/damping off
Banol 6 ME	1.3- 4.0	7-21	Blight/RR/damping off/preventive
Fore (mancozeb)	8.0	5	Blight
Chipco Signature	4.0-8.0	14-21	Blight/RR/preventive
Appear 4.1 ME	3.0-6.0 6.0-8.0 RR	7-14	Blight/RR/damping off/preventive
Segway 3.3 SC	0.45-0.9	14-21	Blight/Dys/damping off
Terrazole 4L	1.5-3.0	10-14	Blight/RR/damping off

We also documented numerous and fairly severe cases of take-all root rot (TARR), also known as bermudagrass decline when it occurs in bermudagrass. The causal agent is *Gaeumannomyces graminis* var. *graminis*. It is a true root rot disease, and causes circular sunken patches. Fall and spring fungicide applications are generally recommended, although late summer applications have been somewhat effective also. Cultural controls involve modifying rhizosphere pH through the use of acidifying fertilizers. This approach has not been highly effective and with low rates of N fertilization in general on putting greens, an impact from this practice is likely to be minimal. Fungicides have been somewhat effective in managing TARR especially when used preventively as noted before.

Fungicides Labeled for Bermudagrass Decline

Fungicide	Rate (oz/1000 ft ²)	Interval (days)	Comments
Insignia 2.08 SC	0.7	Spring/Fall	Single apps/4 gpt
Honor 28 WDG	1.1	Spring/Fall	Single apps/4 gpt
Lexicon 4.17 WDG	0.34-0.47	Spring/Fall	Single apps/4 gpt
Bayleton Flo 4.15 SC	1.0-2.0	21-28	Irrigate to incorporate
Torque 3.6 SC	0.6	28	Irrigate to incorporate
Mirage 2 SC	2.0	28 Spring/Fall	High vol./or irrigate
3336 4.0 F	4.0-8.0	7-14	Irrigate 0.1 - 0.2 inch

The following fungicides have 2ee labels for bermudagrass decline

Tartan Stressgard	1.5-2 oz	28 day	Incorporate with irrig.
Daconil Action	3.5 oz	14 day	Preventive/ contact
Heritage Action	0.4	28 day	Incorporate with irrig.
Briskway (pending)	0.725	2 apps allowed max rate	Irrigate to incorporate

Note that all of the fungicides labeled for bermudagrass decline indicate either treatment in a high volume of water (4 gpt) or irrigation after application up to 0.2 inches to incorporate these into the root zone.

It is also very important to stop or limit PGRs on courses with damage to allow for recovery.

Other diseases can also increase as the result of this storm, such as leaf spot, Microdochium patch and even dollar spot. These are more easily dealt with on a curative basis, so are likely not as of great concern as Pythium and bermudagrass decline.

Soil Fertility – Haibo Liu, PhD

The worst damage will be to root systems with the extent of damage depending how long the grass is under water. Hope that most areas were no more than 48 hours under water. An additional aeration (solid tine no more than ¼") would be helpful to help for both cool-season and warm season turfgrass roots recover, followed by a topdress application. If possible, have a soil test done immediately to gauge how much salts are in the soil profile. Gypsum (CaSO₄·2H₂O) will help a lot to get sodium out quickly but it will also depend on how much irrigation water to apply. For the soils with lower soil pH, a lime application this winter can be avoided to reduce the potential of soil nutrient imbalance, since the soil salt contents are high with the flooded areas (particularly with sea water). Additional potassium will be helpful to reduce soil profile sodium and

potential ion toxicity to both cool-season and warm-season turf. A last application to the warm-season turfgrasses now, and a few more additional applications to cool-season turf in Carolinas can be applied. It is not necessary to have broadcast applications. If needed, treat the worst flooded area(s) first, and have a three to four weeks plan for the recovery. A few quick ammonium based foliar applications of nutrients will be helpful. With heavy rains and runoff and leaching, all soil nutrient levels would be lower than normal years. Additional fertilizers (cool-season turfgrasses) should be applied gradually for this winter season. I wish you all the best!

Trees- Dara Park, PhD and Robert Polomski, PhD

I am not claiming to be a tree specialist, however after living on the coast and dealing with hurricane aftermath for most of my life, I have learned a few tips. Dr. Polomski, Clemson University's tree specialist has also reviewed and added to this section (thank you Bob).

Just because it is not down, does not mean it is not dead or going to die.

- Standing trees that lose large, significant limbs or many major limbs will be susceptible to insects and diseases. They should be evaluated to determine if they will recover or need to be removed.
- Trees in which standing water on the surface is present, are at a greater risk for mortality than trees with just saturated soils.
- Many trees can tolerate short periods of flooding, but flood tolerance varies with species.
- Different trees have different salt tolerance levels.

Hurricane Matthew hit at a time when trees on the coast are starting the dormancy process. Thus it might be harder to tell if deciduous trees are losing their leaves because of the time of year, or if they are dying. Also, deciduous trees still might be ok while senescing, but may lose roots over the fall and winter and not be able to overcome the stress next spring. If evergreens (on the coast, most commonly are pine trees) are shedding needles on both current and previous years' growth, it's important to evaluate these trees to determine if they are in decline.

Navigate to <http://newsstand.clemson.edu/mediarelations/clemson-expert-take-steps-to-protect-ornamental-plants-trees-from-hurricane-winds/> to learn more about protecting ornamental plants and trees from hurricane winds (after all, hurricane season is not over just yet).

Need an arborist? Navigate to the Trees SC webpage (treessc.org) > Resources > Community Resources > Find a Certified Arborist.

Submerged Turfgrass, Grady Miller, PhD

The more severe turf damage is typically from the storm surge pounding turf with salty water. In many cases once the water subsides and the ground begins to dry, the turf may die from salt injury. If not near the coast, salt damage is less of an issue. But the high rainfall rate and the fact that the ground was already saturated from previous storms means widespread flooding in many coastal and inland areas.

Turf injury from submersion can be variable depending on the conditions. These include turfgrass species, water temperature, duration of submergence, and depth of submergence. Observations have indicated that turfgrass can withstand submersion for up to 60 days when water temperatures are below 50 F. On the other hand, turf can be killed in one day when water temperatures are in the high 80s F or higher.

Temperatures were between these for this storm. Submersion injury also increases when the entire plant is submerged. If the plant is submerged for more than a few days under water that is cloudy with silt, clay and debris, it is more damaging than if the water is clear. In addition, floodwaters may contain toxic contaminants such as salts or petroleum. These may cause longer-term problems because the contaminant may linger in the soil, impeding regrowth. Even low levels of salts can indirectly affect plants by reducing water uptake or by causing an imbalance of plant nutrients. And while it may seem minor, the lack of oxygen to the roots brought on by saturated soils may cause turf loss.

Understanding the cause of your damage helps in developing a plan to renovate the turf. If the floodwaters deposited silts and clays on the surface, these should be removed with shoveling, hosing, power washing, etc. In some cases debris and soil material can be blown off the surface with a blower. The air flow from the blower can also hasten the soil drying process. If the grass does not begin to green up by the time the soil begins to dry out, it may be a sign that the turf is dead or that it is so severely set back that regrowth is going to be very slow. Given enough time, Bermuda grass will grow back from almost any flooding damage. But if the damage is more than just a thin turf, and time is an issue, it may be better to start over completely.

If the damage is not too severe, begin aeration once the area can support a lightweight aerifier or tractor-mounted aerifier. Not only will this alleviate compaction, but it will help break up the soil layers and get more oxygen into the rootzone. If the flooding was associated with a salt-water storm surge, then leaching the saltwater out of the rootzone may be necessary. Additional rainfall from the storm may act as a "self-flush" to the rootzone. In the absence of rainfall, the irrigation system may be used to dilute and move the salts below the rootzone.

Once the water has subsided and the rootzone begins to dry, initiate a normal grow-in fertilization and irrigation program appropriate for your grass and soil conditions. Consider the need to alter your herbicide program. Note that the moving floodwaters may have replenished your weed seed bank.

Long-term problems will also reflect the type of initial storm damage. With rainfall and irrigation, salt damage should be fairly short-term. If topsoil was eroded and replaced before renovation, there may be some long-term variation in turf growth and color due to differences in soil. Also, any silt and clay deposits that were not removed may result in long-term visual and performance differences. Regular aerification and topdressing should address these problems over time.