Managing growth rate during COVID-19
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There is a lot of uncertainty in the turfgrass industry as we all grapple with the impacts of the coronavirus (COVID-19). The golf industry associations are working to stay up with changing regulations and policies that will impact their business (i.e. GCSAA, CMAA, PGA, USGA). The Nebraska Chapter of the GCSAA has also created an Email Resource Chain for superintendents to easily communicate with each other. Golf course superintendents and assistant superintendents can request to join this listserv by clicking here. Please only join if you are either a superintendent or assistant. The NALP also has created resources for landscape and lawn care professionals.

A looming question for all turfgrass managers is what to do if they cannot work for weeks or months. Could we mow grass if cities were to enact "shelter in place" regulations? What if a member of your crew was diagnosed with COVID-19 and the entire crew needed to enter a 14-day quarantine? Would we be able to apply the traditional spring regiment of control products (i.e. preemergence herbicides, take-all/summer patch fungicides, seed head control applications)?

Managing what is "essential" with limited resources
States that have been hard affected by COVID have enacted strict regulations limiting public gatherings for work or for pleasure. For example, the Governor of Pennsylvania recently issued a "Stay at Home" order in seven counties unless the nature of the business was deemed essential. They deemed that landscape services and associated businesses such as hardware stores, garden centers, and other suppliers could remain open. The NALP has a nice summary of these actions located here.

Obviously, these regulations are only applicable to Pennsylvania, but they show that we need to think of turfgrass management as essential maintenance. Failure to maintain turfgrass systems (lawns, golf, sports, etc.) would lead to significant property damage. It's important to stress that management operations are essential to government officials, clients and other regulatory bodies. Not all aspects of typical turfgrass management are essential, but practices like pest control, cultivation and mowing are essential to sustain a turfgrass system over the course of several weeks or months. The remainder of this Turf iNfo will focus on ways to manage growth with mowing and PGRs.

Crew Management
It is important to develop plans in case a member of your crew is diagnosed with COVID-19. If this crew member interacted with all the other members of the crew (i.e. during morning planning meetings), then the entire crew may need to enter a 14-day quarantine. It may be prudent to segregate your crew into sub-crews that work on different days to minimize this risk. The links provided above provide helpful information regarding crew management strategies during this pandemic.

How can we mow less?
Mowing requirements can be reduced without sacrificing turfgrass health and quality. The key is reduced growth rate that allows for longer mowing intervals and less need for mowing. This is an area of study our lab has been actively pursuing during my time at Nebraska. Here is a summary of the mowing, growth and PGR research from our lab over the past decade.

- **Mow to the *One-Third Rule*:** For the past five years, our lab has been studying different mowing strategies. Our results support the commonly cited "*One-Third Rule*" – remove 1/3rd of the leaf

height during a mowing event. Removing more than 1/3rd of the leaf led to scalping and accelerated growth rate. More frequent mowing intervals did not change growth rate, but resulted in more labor.

- **Increase mowing height:** It is easier to abide to the *One-Third Rule* if the turf is mowed at a higher cutting height. Although we found that tall fescue and buffalograss mowed at either 2" or 3" grew at the same rate per day, the higher mowing height meant we would mow at a longer interval. For example, turf maintained at 2" would need to mowed when the canopy was 3" tall. If the canopy is maintained at 4", then it would need to be mowed at 6". Assuming the growth rate was 1" per week, the turf maintained at 2" would need to be mowed weekly while the turf maintained at 4" would need to be mowed every two weeks (Table 1).

Table 1. Impact of mowing height on turfgrass mowing requirements.

Managed mowing height	Canopy height when mowing is required	Average weekly growth rate*	Days between mowing event
2.0"	3.0"	1.0" per week	7 days
3.0"	4.5"	1.0" per week	10 days
4.0"	6.0"	1.0" per week	14 days

* Average weekly growth rate depends on nitrogen fertility, environmental conditions, grass cultivar and species, and other management practices. UNL research is finding 1.0 to 1.5" of growth per week to sustain a healthy tall fescue lawn/field/rough.

- **Avoid spring application of nitrogen fertilizer:** University nitrogen (N) fertilization recommendations have long stated to withhold fertilizer during the early spring. Winter freeze-thaw cycles – plus residual N from fall applications primes the turfgrass to rapidly grow during the early spring. This burns energy reserves, weakens the turf going into summer, and dramatically increases mowing requirements.

  The biggest reason we apply nitrogen to turfgrass is to promote recovery from traffic. The decline in traffic as golfers, athletes and others stay home means that traditional nitrogen fertilizer requirements will decline. The soil nitrogen pool will be able to sustain the turfgrass until traffic levels increase later this summer. With the challenges presented by COVID-19, withhold N fertilizer applications to avoid exacerbating mowing needs.

- **Raise putting green mowing height:** Creeping bentgrass or annual bluegrass mowed at 0.125" grows approximately 40% faster than the exact same grass mowed at 0.250." Raising mowing height to 0.15" will help reduce growth rate. We have also noticed from our clipping volume research that skipping mowing for a day or two reduced total growth rate. Employing both approaches will slow growth rate and sustain turfgrass health. Using these two approaches may also increase access to new hole locations that would have been unusable when green speeds are greater. This further distributes traffic and minimizes N requirements.

- **Use PGRs to delay green-up and suppress growth rate:** Plant growth regulators (PGRs) like prohexadione-CA, trinexapac-ethyl, paclobutrazol, and flurprimidol – even DMI fungicides – inhibit the biosynthesis of the plant hormone gibberellin in the plant. Presence of this hormone helps the grass break winter dormancy and encourages leaf elongation (clipping yield).

Gibberellin is produced at greater amounts as temperatures warm, and water and N become available, thereby stimulating more active growth.

Application of PGRs in early spring can slow green-up. Prohexadione-Ca (Anuew) and trinexapac-ethyl (Primo Maxx) are absorbed through green foliage while flurprimidol (Cutless) and paclobutrazol (Trimmit 2SC) are root absorbed. As a result, these last two ingredients may inhibit green-up more than the foliar absorbed ingredients.

Air temperature also impacts the duration growth suppression from PGRs while application rate impacts the amount of suppression. Applying at GDD intervals that exceed the plants ability to metabolize the PGR leads to an accumulation of PGR within the plant and often over-regulation.

We recommend the use of GreenKeeperApp.com to track PGR duration (GDDs) and amount of suppression automatically. The total amount of suppression is a summation of suppression from all the PGR and DMI fungicides applied to an area (not to exceed 100%). Table 2 describes PGR performance for cool-season greens.

Table 2. The impact of PGR ingredients and application rate on clipping yield suppression and duration on cool-season golf putting greens. GDDs are calculated in degrees Celsius with a base temperature of 0C. Different mowing heights, grass species and management practices will change these values.

PGR	Rate Range (oz/A)	Relative Growth Suppression	Re-application interval
Anuew	6-16	20-25%	250 GDD
Cutless MEC	2-8	15-30%	180-250 GDD
Legacy	4.8 – 9.6	25-40%	250-280 GDD
Musketeer	12-22	30-50%	270 GDD
Primo Maxx	5.5	20%	200 GDD
Trimmit 2SC	5.5 - 16	30-50%	250-290 GDD

* Different mowing heights, grass species and management practices will change these results.

Once the turf is green, more clipping yield suppression can be achieved by i) increasing the product application rate, ii) mixing different PGRs to achieve a higher effective application rate (because they all function on the same pathway), and iii) re-application of PGRs at half the recommended PGR GDD interval (twice as frequently as normal).

Temperature affects the duration of these PGR products while application rate affects the amount of suppression. Applying at half the “normal” GDD interval leads to an accumulation of PGR within the plant tissue because the PGR is being applied faster than it is broken down or removed in clippings.

For example, Primo Maxx suppresses growth by 20% and Anuew suppresses growth rate by 20%. When mixed, they would provide 40% suppression. If these products were applied at half the recommended GDD interval, the clipping yield suppression would approach 80%. In reality, it would likely be around 70% because the total suppression starts to approach 100%.

- **What about PGR phytotoxicity?**
  Phytotoxicity risk is greatest when the total clipping volume is very low. It is not necessarily the result of a PGR ingredient or application rate. For example, phytotoxicity on our creeping bentgrass research fairway was greatest as clipping volume (the amount of clippings in the bucket) was less than 0.25 quarts per 1000 ft^2 (liters/100 m^2). If the current growth rate of that fairway turf was 1.0 qt/1000 ft^2, then we did not see phytotoxicity until suppression from the PGRs approached 75% suppression. But if the grass was growing slowly (0.5 qts/1000 ft^2), then 50% suppression resulted in phytotoxicity.

Figure 1. Phytotoxicity (foreground) from stacking Primo Maxx and Trimmit 2SC at 5 and 8 fl oz/A at half the recommended GDD re-application interval. This resulted in strong growth suppression and minimal clipping volume/yield. The back half of this green was not treated with PGRs. This level of phyto may be acceptable if there is minimal traffic.

The bottom line with phytotoxicity is that it is more complex than just PGR rate. The risk is relative to the amount of actual clipping volume. If there aren't many clippings in your mower buckets, then even small amounts of PGRs can cause damage. Conversely, grass that is growing very rapidly will need a lot of PGRs to suppress growth rate to a point that causes phytotoxicity. Additionally, phytotoxicity can be tolerated if traffic is low and there isn't pressure to maintain a certain level of turfgrass quality.

We need to ensure the safety of our employees and society if we are asked to stay at home and then communicate what it might take to prepare surfaces for use after this period passes. In the meantime, developing a mowing reduction strategy now that combines mowing height, water management and PGR use would be prudent.

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