Facility Adoption of Fertilization & Nutrient Management BMP's

Organic vs. Synthetic

As the general population becomes more aware of their environmental impact, golf course facilities have followed suit by improving environmental stewardship. Of the greatest concern is the impact that golf courses have on fresh water and marine resources. With these concerns, there has been a major focus on the types of fertilizers used on golf courses (ie: organic vs. synthetic) and whether or not one of these fertilizer sources is 'better' for the environment. Unfortunately, a variety of misconceptions have become prevalent due to popular media and opinion. The biggest misconception is that synthetic fertilizers are somehow different or worse than organic fertilizers in terms of environmental impact. For the purpose of this document, please consider nitrogen and phosphorus the 'offending' nutrients that impact freshwater and marine resources, respectively.

First consider nitrogen. Nitrogen is nitrogen is nitrogen, that is, whether it is applied as an organic fertilizer (e.g. manure) or a synthetic fertilizer (e.g. urea) when it reaches the soil, is taken up by the plant, or is leached into water, it exists as either NH4+ (ammonium) or NO3- (nitrate). There is absolutely no difference in the nitrogen form once it reaches the soil. You may have noticed that urea was listed as a synthetic fertilizer. But isn't urea a component of urine? Yes, it is. It is an organic compound that can be and is synthesized commercially; therefore it is classified as a synthetic fertilizer.

Once in the soil, organic and synthetic nitrogen have an equal opportunity to leach. Opponents of synthetic fertilizers claim that they release too quickly, therefore increasing the potential for run off. This is simply not true. In fact, there are many long chain urea compounds that have a much more gradual, controlled release rate than organic fertilizers. Furthermore, heavy applications of synthetic fertilizers that have rapid release rates (and would have a high probability of leaching) would cause undesirable growth of turfgrass areas, potentially resulting in the loss of turf as an end result. Clearly a golf courses wouldn't apply these fertilizers at high rates if it would spell certain doom for the turfgrass. Therefore, when golf courses do use synthetic fertilizers like urea, they apply them in light, frequent applications. This gives them exceptional control over the release characteristics of the fertilizer; furthermore, it also allows them to tailor fertilizer applications to avoid heavy rainfall events thereby reducing the risk of leaching. In contrast, organic fertilizers rely heavily on temperature and precipitation to release nitrogen. This is because soil microorganisms generally like warm, moist conditions, and they are responsible for organic fertilizer nitrogen release. The weather is unpredictable, and as a result so are nitrogen release rates of organic nitrogen sources.

Since the nitrogen release rates of organic fertilizers are not predictable, they can increase the number of chemical applications required to maintain living turfgrass. For example, if cool, dry weather conditions persist, there would be very little nitrogen released from an organic fertilizer, starving the plant of nitrogen. This makes them more susceptible to several plant pathogens (most notably 'dollar spot') as well as weed and insect pests, potentially requiring pesticide applications to keep grass alive. On the other end of the spectrum, if the dry weather pattern breaks and heavy rainfall persists, organic fertilizers can rapidly release nitrogen, causing lush growth that can leave turfgrass susceptible to a new hosts of pests (most notably 'brown patch'). Balanced, consistent nitrogen fertility is a critical tool for reducing turfgrass pesticide inputs and the most effective way to manage nitrogen fertility is through light, frequent applications of synthetic fertilizers.

Another argument against organic fertilizers is the amount of product needed to achieve the same end results as synthetic fertilizers. The average analysis of a bag of urea is 46-0-0, meaning for every 100 pounds of fertilizer, there is 46 pounds of nitrogen contained in that fertilizer with no phosphorus or potassium. The average analysis of a bag of organic fertilizer is something to the extent of 8-3-5. So for every 100 pounds of organic fertilizer there is 8 pounds of nitrogen, 3 pounds of phosphorus and 5 pounds of potassium. Therefore, in order to supply the same amount of nitrogen, one would have to apply 5.75 times more fertilizer.

This leads directly into the next problem with relying on organic fertilizers. In turfgrass systems, we usually focus primarily on nitrogen management because nitrogen is almost always the 'limiting nutrient'. Most soils (especially glaciated soils of the northeast) have plenty of phosphorus and potassium, and other plant essential nutrients to promote adequate plant growth. Therefore, most of the time golf courses only want to apply nitrogen. With many organic fertilizers this isn't possible because they are derived from animal feces or compost with high phosphorus and potassium. So when using an organic fertilizer with the goal of supplying nitrogen, golf courses have no choice but to apply phosphorus and potassium. Keep in mind that phosphorus is the nutrient that poses the greatest risk to freshwater resources. If the golf courses were using urea, this wouldn't be a problem because urea only contains nitrogen.

Foliar Feeding (Spoon Feeding)
At Val Halla, we predominantly use raw, elemental grade fertilizer products. There are no fillers, coatings, etc. in these products. While the urea is synthesized, the rest of the products are elemental and while they are not derived from animal waste, they are as organic as you can get. Products are purchased in bulk and then we make a custom, liquid fertilizer in-house. Using a 600 gallon mix tank, we break the soluble products down using water and leave the liquid agitating until we are ready to use it. The product is then applied to turfgrass through a state of the art sprayer, which is calibrated to apply precise amounts - down to a fraction of an ounce of nutrient per square foot.

Applying fertilizer as a liquid eliminates the potential for leaching and run-off because there are no granules to “float” away or move off the desired site. When applied through a sprayer as a liquid, the nutrients are absorbed through the leaf tissue (foliar feeding). Nutrients are immediately available when applied in this manner so an over application would be detrimental to the plant. Therefore, we only apply small amounts (spoon feeding) and the nutrients are used up by the plant very quickly. In order to maintain proper, nutritional levels, we need to spray regularly (every 7-14 days). This is significantly more time consuming than putting out a ton of granular fertilizer that can last 10-16 weeks, however, this method gives us exceptional control. Unlike traditional granular fertilizers, we are not handcuffed by soil composition, microbial activity or unpredictable weather for nutrient release. We can alter our nutrient ratios every time we apply to account for changes in growing conditions and only apply exactly what the plant needs at that given time. The nutrients used are as follows:

Elements

Urea (N) - Main source of nitrogen, which is a component of nucleic acids, amino acids, proteins, chlorophyll, and coenzymes. Responsible for shoot and root growth, density, color, disease resistance, and stress tolerance.

Ferrous Sulfate Heptahydrate (Fe) - Iron is important in chlorophyll formation, photosynthesis, and nitrogen metabolism. Iron deficiencies result in chlorosis of young leaves.

Potassium Sulfate (K) - Activates enzymes used in protein, sugar, and starch synthesis. Important in maintaining turgor pressure in plants. Affects drought tolerance, cold hardiness, and disease resistance.

Epsom Salt (Mg) - Important component of chlorophyll, activates many enzymes. Magnesium deficiencies result in foliar chlorosis (yellowing).

Manganese Sulfate (Mn) - Present in chloroplast membranes and functions as enzyme activator. May be involved in resistance to some diseases.

*Phosphorus (P) - Affects rate of seedling development, maturation, and root growth.

*Phosphorus is only applied on newly seeded turf to aid in establishment or via specialty, foliar products when there is an emphasis on rooting (early spring/fall).

Chlorophyll

Grasses contain chlorophyll, which is what gives plants their green color. Chlorophyll enables the process of photosynthesis, by which a plant produces food that it needs to function (carbohydrates) using energy from sunlight, carbon dioxide from the air and water from the soil. The equation for the photosynthesis process is:

$6CO_2 + 6H_2O + \text{Light Energy} = C_6H_{12}O_6 + 6O_2$

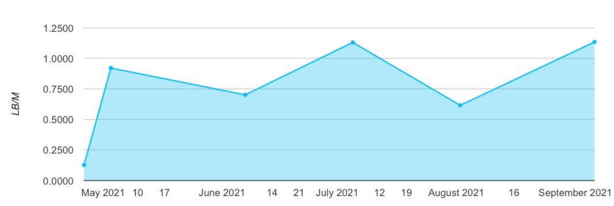
Through this process of respiration (breathing), plants convert the energy stored in the carbohydrates (the $C_6H_{12}O_6$ that photosynthesis produces) into the energy they require for growth. The oxygen that is a byproduct of this reaction ($6O_2$) is released into the air. This is what makes turfgrass such an excellent air purifier. A single 50’x50’ plot of turfgrass produces enough oxygen for a family of four, which means the putting greens at Val Halla alone, provide enough clean air for over 50 families. The entire golf course provides enough clean oxygen for over 7,000 people - or almost the entire population of Cumberland.

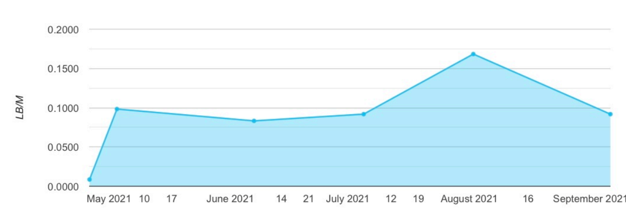
Carbohydrates
Environmental conditions affect the plant's production and storage of carbohydrates. When growing conditions are ideal, turfgrass can produce the carbohydrates it requires for immediate use and store the excess for later use. High temperatures increase the respiration process so more carbohydrates are used (the hotter it is, the heavier they breath). When temperatures become very high for an extended period, the turfgrass plant may use so much of its carbohydrate supply that too little remains for growth and the plant goes dormant.

Why We Occasionally Skip A Mowing
The mowing height affects how much green tissue (containing chlorophyll) the turfgrass plant has available for the photosynthesis process. When the mowing height is higher, there is more leaf tissue (solar panels) to absorb more sunlight and more carbohydrates are produced. If you mow at a lower height, especially during high temperatures, you reduce the green tissue of the plant. This limits carbohydrate production and can stress the turfgrass. Often times we will skip mowing on extremely hot days in order to aid in this carbohydrate reservation and minimize stress. Minimizing stress on the plant reduces the amount of water and chemical inputs needed to maintain plant health.

Why We Reduce Nitrogen & Increase Iron Applications in Summer
Our fertility program makes an impact on carbohydrates, too. High nitrogen applications increase the plant's growth rate, channeling more carbohydrates to production of the green tissue (turfgrass blades) and less to storage. This is why we usually back off nitrogen in the summer (stress) months and only apply little amounts - just enough to live and remain healthy enough to suppress disease. Applying iron however, gives the plant a deep green color without excessive growth. So the turf is still green (still contains chlorophyll so it can make energy) but isn't vigorously growing - which would require it to use more of the energy it's making.

You can see this represented in the graphs below. The first graph shows our nitrogen levels throughout the year - moderate in the spring when the plant is recovering from winter, elevated in July to prepare for the stress of August and then elevated again in September to recover from summer. In the second graph, you can see that iron levels remain fairly constant through most of the year, except for in August when they are elevated to aid in chlorophyll (for carbohydrate production) when we back off nitrogen.





Soil Testing

Given that the majority of fertilizer applications are foliar, soil test results can be misleading. Soil reports may show a deficiency in certain areas but that does not mean that the plant is deficient in these nutrients. The plant is still receiving adequate nutrition through foliar absorption, some of these nutritional values just won't show up in the soil. We still apply granular fertilizers in spring in fall for more of a slow-release effect and therefore, we conduct soil tests periodically. These soil tests, while they do show deficiencies, allow us to make sure that levels are not so off balance that they can't be supplemented or corrected via foliar applications.

Property and Sample Information	
Property	Val Halla
Sample ID	1
Date of Sample	2018-07-24
Lab ID	BH56385

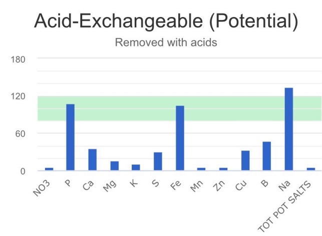
Moisture Target (+/-2%)	
Critical Low	20
Low	22
High	26
Critical High	28

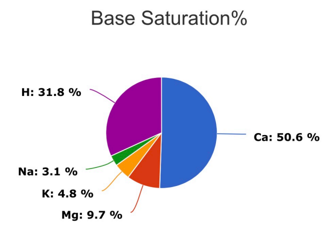
Moisture Target	
Optimal Target	24
Bulk Density Influenced	27

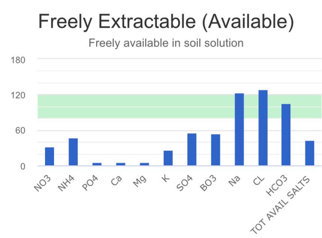
Estimated EC Warning Targets	
Estimated	0.39
Optimal EC	
Critical Low	0.24
Low	0.31
High	0.46
Critical High	0.54

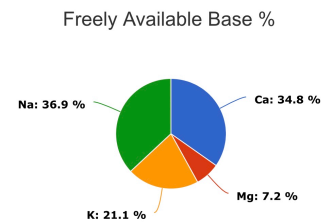
Physical		Exchangeable		Extractable	
pH	6.00	NO3	4	NO3	8.76
Buffer pH	7.10	P	99	NH4	6.65
OM%	2.10	Ca	475	PO4	2.16
CEC	4.70	Mg	55	Ca	32.26
Texture	Sand	K	89	Mg	6.69
Sand	93%	S	9	K	19.55
Silt	3%	Fe	95	SO4	45.63
clay	4%	Mn	5	BO3	0.06
Saturation %	47.43	Zn	4.6	Na	34.27
SAR	1.43	Cu	2.3	Cl	76.22
EC (1:1 Sol Salts)	0.14	B	0.3	HCO3	37.22
EC (Paste Extract)	0.49	Na	34	TOT	269.5
Bulk Density	1.43	TOT	872.2		

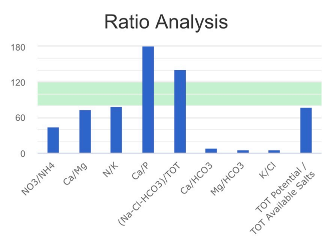
Base Saturation %		Potential Base %		Available Base %	
Ca	50.50	Ca	72.74	Ca	34.77
Mg	9.70	Mg	8.42	Mg	7.21
K	4.80	K	13.63	K	21.07
Na	3.10	Na	5.21	Na	36.94
H	31.80				

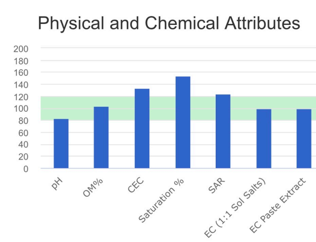






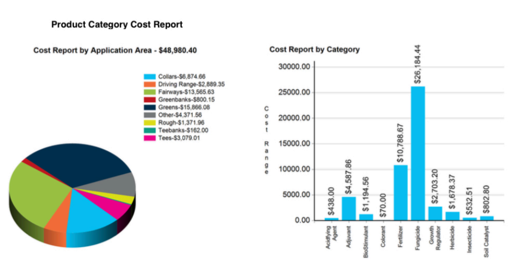


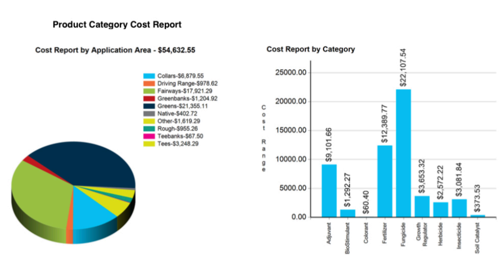




Fertility Up, Chemicals Down

Fertilizing using a foliar based approach has allowed us to maintain more consistent nutrition and thus, create a healthier turfgrass plant overall. A healthier plant can naturally fight off more disease on its own and requires less chemical inputs. Looking at the bar graphs below, you can see in the first graph (2019) that chemical usage was higher than the second bar graph (2020). This is due to many factors but the increase in fertility, also shown in the two graphs, is one of the main reasons.





It is important to note that the bar graphs represent overall cost by category (fungicides, fertilizers, etc.), where the pie graphs represent cost by area (greens, tees, fairways, etc.). While the overall cost of fungicides went down from 2019 to 2020, the cost for certain areas went up. Fairways for example, increased in size by 3 acres so naturally, the cost to maintain them should go up. This reflects an increase in fertility and wetting agents primarily and not fungicides. Similarly, the cost to maintain greens went up between the two years as well. We know the overall cost of fungicides went down so the increased cost of greens is not due to the use of more fungicides. In actuality, the total amount of fungicides used on greens went down, however we used better products that are more expensive. The newer chemistries, while more expensive, require significantly less product and provide better coverage.

The Bottom Line

When our total maintenance program supports the balance between carbohydrate use and storage, the plant can support more use with less stress. Less stress means a better product for our patrons and a lower impact on the environment. Our fertility program and the means by which we apply nutrients, reduces chemical inputs as well as the risk of nutrient leaching.