Nitrogen response changes with temperature
May 1, 2020

Turfgrass response to nitrogen fertilizer depends on many factors like temperature, sunlight, water availability, root health, and soil compaction. Some factors like soil water content and compaction can be altered by turf managers with irrigation and cultivation. Other factors like sunlight (cloud cover) and air temperature are beyond our control. Various growth potential models exist that can help managers predict how these types of factors impact turfgrass growth rate. The PACE Turf Growth Potential Model and our new Nebraska Nitrogen Responsiveness Model use average air temperature to estimate the potential for turfgrass to growth. While all models at their core are incorrect, they can provide a clue as to what is going on in a complex system.

Defining Growth Rate

Plant growth rate can be defined in different ways including weight gained, vertical growth rate, root biomass production, tiller density, or clipping production. It's important to distinguish how growth is defined because increased growth in one plant part might reduce growth in another plant part. For example, over-fertilizing with nitrogen can stimulate excessive top growth (clipping yield) and reduce root biomass. Also, shade reduces sugar production during photosynthesis (less weight added) but clipping yield is enhanced under shade. The grass is trying to outgrow the shade which further depletes sugar reserves.

***NEW* Nebraska Nitrogen Responsiveness Model**

Description:

Clipping yield response to nitrogen fertilizer changes with temperature. The clipping yield response to a half-pound of N fertilizer is very different when the air temperature is 70°F compared to when the air temperature is 85°F. This model attempts to predict how clipping yield will respond to nitrogen availability at different average air temperatures. A low percentage means that growth response will be small and a large percentage means that clipping yield will increase noticeably with added nitrogen.

This new model was developed in the controlled environment of a growth chamber. It uses average air temperature to estimate how clipping yield responds to nitrogen fertilizer (Fig 1). Kentucky bluegrass, creeping bentgrass, and perennial ryegrass clipping yield was measured weekly following treatment with nitrogen fertilizer. It is currently being expanded to more warm- and cool-season grass species.

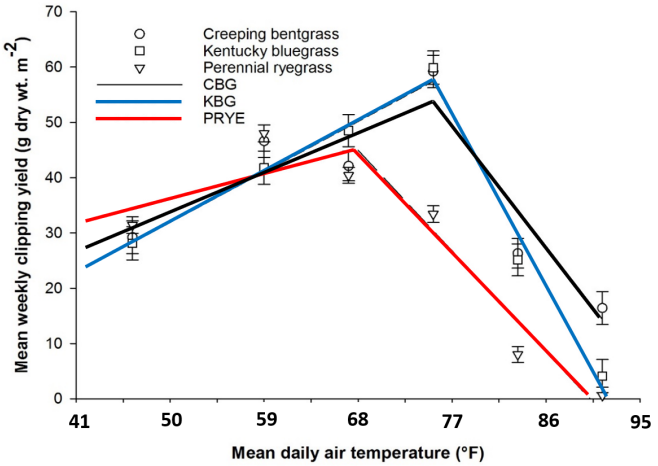

Figure 1. The nitrogen responsiveness model indicates the clipping yield response of three cool-season grass to nitrogen fertilizer at different air temperatures.

Weaknesses:

There are weaknesses with this model. First, it was developed under the extreme environmental controls of a growth chamber with one cultivar for each grass species. It was also conducted for a period of eight weeks (including an initial acclimation phase in the growth chambers). The model outputs the relative percentage of a maximum clipping yield response. It is not an absolute value like 0.25 lbs of N increases clipping yield by 1 qt of clippings per 1000 ft^2. Finally, it may not be directly linked to sugar production and should only be applied to actively growing grass. Output values not applicable for turf entering or breaking winter dormancy.

Use Recommendation:

This model can help turfgrass managers select a nitrogen rate when striving to meet growth rate goals. I imagine this model like selecting a gear in your truck. In a high gear/N response, only small amounts of nitrogen are required to stimulate a large growth response. In lower gear/N response, higher application rates will be needed to get a significant clipping yield response. When the Nitrogen Responsiveness Model is very low, withhold nitrogen because the turf is well outside it's normal growing window.

PACE Turf Growth Potential Model

Description:

This growth potential model uses air temperature to estimate growth rate on a weight basis. The ideal temperature to maximize photosynthesis is *generally* accepted to be 68°F for cool-season plants and 87°F warm-season plants. This model uses those temperatures as peak values that decline as the temperature gets cooler or warmer than optimum (Fig. 2). Click here for more info.

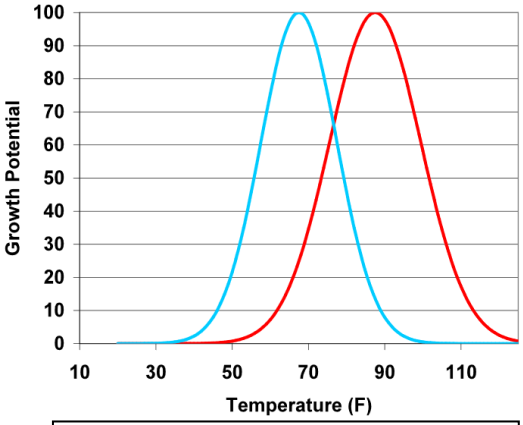

Figure 2. PACE Growth Potential Model

Weaknesses:

This is a theoretical model that assumes clipping production mirrors sugar production (photosynthesis). Calibration data from Nebraska has found that this model tends to over-estimate clipping yield in late spring and early fall and underestimate clipping yield during summer. It also assumes that all cool and warm-season species have the same peak temperatures. Our data suggests that some species such as creeping bentgrass "prefer" warmer weather than species like annual bluegrass or perennial ryegrass.

Use Recommendation:

This model can be thought of as a good indicator of sugar production and not necessarily clipping yield. When observed clipping yields are low but PACE Growth Potential is high (think fall), then it's easy to believe that the plant is storing sugars or using them in different ways (roots, density, etc.). When clipping production is high but Growth Potential is low, then the plant is likely burning stored sugar (i.e. summer). This can lead to the death of the plant if it occurs for too long. It's good for managers to have a rough idea of the sugar status of the plant and this model helps with that assessment.

The future of modeling turfgrass growth rate

There is potential to build additional and more complex growth models with factors like sunlight, water status, crop reflectance (sensors on mowers or drones) and estimates of soil nitrogen mineralization. Such models could further help guide management decisions like nitrogen fertilization, irrigation, cultivation, and PGR applications. Even more sophisticated models are being developed with the help of artificial intelligence and machine learning algorithms. Dr. Soldat's lab at the University of Wisconsin is using computers to build growth models that are specific to an individual turf site. We have incorporated the PACE Turf Growth Potential Model and the Nebraska Nitrogen Response Model into our GreenKeeper App to make them easier to use.

The potential is great for various crop models to help turfgrass managers stay ahead of weeds, diseases, insects and to management growth rate more precisely. This improves efficiency, saves money, reduces unnecessary applications to the environment and maximizes playability/turfgrass aesthetics.

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