Degree Days
What are they and why are they important?

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In its simplest form, a "degree day" is a "measurement of heat over time". As applied to the Green Industry, the concept of degree days lies at the heart of better, more efficient pest management strategies that can dramatically help turfgrass managers in the everyday process of managing their sites

What is a degree day?

Strictly speaking, a degree day is - one day (24 hours) where the average temperature is one degree (Fahrenheit or Celsius) above a threshold number. The daily degree day numbers are determined by subtracting a predetermined threshold number from the average daily temperature. The resulting daily degree day number is accumulated as a running total and the total is then compared to a timeline or degree day model that predicts an specific occurrence at a specific number of degree days.

If the degree day calculation relates to an occurrence based on heat and the result is a negative number, then the result is ignored. If the calculation relates to an occurrence based on cool temperatures and the result is a positive number, then that result it is ignored.

Calculating a daily degree day number - To calculate a daily degree day number, add the maximum temperature for a day to the minimum temperature, divide that number by two, and subtract the threshold number. The result is the daily degree day number.

The Daily Degree Day Formula is: ((max. temp. + min. temp.)/2) - threshold number.

Example: If the daily maximum temperature = 70 F. ; daily minimum temperature = 50 F.; and the threshold number is 50 F.

70 F. (max.) + 50 F. (min.) = 120 F.
120 F. / 2 = 60 F.
60 F. - 50 F. (threshold) = 10 F

The daily degree day number is 10.

Why use degree days measurements? Degree day calculations do a good job of representing the progress of processes that are primarily heat driven. In the case of animals, plants, and fungi that are exothermic (meaning cold-blooded), their life processes are driven by external heat. Reptiles, insects, green plants, mushrooms, and many other living things all rely on external heat sources to drive their internal processes. In many cases, these plants and animals are essentially dormant at temperatures below 50 F, hence the 50 F threshold used above. Not only are turfgrass plants themselves exothermic, but so are all of the pests that infest turf sites.

Insects and degree days - Although complex growth processes involving other variables than heat can in part be modeled using degree days, insects are the best example of how external temperatures are the prime influence on life cycles progress.

In the case of insects, the intervals between their growth stages, or phenologies, can best be represented as a function of accumulated heat rather than a sequence of days. The protein synthesis process (the growth process) in insects is controlled by heat rather than time. The more heat, the faster the process works; the less heat, the slower.

Whether the process is fast or slow, each interval has a predestined pathway that must be completed before the next stage can begin. Changes from one growth stage to another (i.e., from egg to larva, larva to pupa, pupa to adult, etc.) can take weeks in cool weather or can be completed in only days in warm to hot temperatures.

How to use degree days

Timing of events based on daily degree day number accumulations is actually very common. Degree days accumulations are used to determine when to deliver heating oil, how to size heating and air conditioning equipment in buildings, how to insulate housing, and many other applications.

The ability to predict heat driven conditions by temperature accumulation gives far more YTD accuracy than traditional calendar based or average date based methods.

For instance, if an insect larval stage is normally present on a host plant in June and that stage can be easily controlled at that time, then, in a warmer than normal year control applications made by a "normal" calendar might not be effective, because the insect could have entered a pupal stage which is not controlled with insecticides. The same may apply to a colder than normal year since the insect may still be in its egg stage, another hard to control growth stage.

Using degree days accumulations gives managers very precise timing for scouting and maximum efficiency for control of pests. Using degree day calculations or models ensures that there is a very high likelihood that the most vulnerable stage of a pest will be present. At environmental sensitive sites, degree day monitoring combined with timely scouting allows managers to use the control product or actions that produce the fewest unintended consequences and still provide effective control.

The use of degree day based prediction will increase. Any time heat is the prime determining factor in a process, degree days, or some derivative thereof, will be used to more accurately measure what effect the actual YTD weather has had on pests and hosts. As more research identifies the basic life processes of plants, animals, and fungi the use of degree day models will substantially increase plant manager's understanding of and efficiency at controlling pests while reducing the impact of operations on the environment and in the long run reducing cost.

FIELD TIPS

Insects Take Priority Over Weeds

When it comes to priorities, golf course superintendents rank insects above weeds for degree-day calculations. Advances in preemergent weed control have reduced concern over timing for some weeds. Yet, obtaining local readings of degree days from on-site weather stations is highly desirable.

Dan Dinelli, superintendent of North Shore Country Club in Northbrook, IL thinks soil temperature would help him more than air temperature. "Crabgrass germination in an open area is a lot different than a shaded one," he remarks. "A cloudy day should not result in the same degree days as a sunny day. But, I still think a weather station capable of degree-day calculations is valuable."

Even though he has a weather station, Merrill Frank at Columbia Country Club in Cockeysville, MD still calls Data Transfer Network for degree days to reconcile his course readings. "I check primarily for white grubs and *Poa annua*," he adds.

Sean Remington at Chevy Chase Country Club also has a weather station, but he taps into UMD's Ag Online for degree days. "Black aetenius is my main concern because it's life cycle is different from other major pests," reveals Remington.