**BEARD** *from page 12*

high nitrogen nutritional level also results in reduced heat stress tolerance and proneness to loss of turf. Thus, nitrogen fertilization, which stimulates shoot growth, should not be applied during heat stress periods.

It should be noted that these three temperature treatment differentials were based on soil temperatures. Soil temperature has much more influence on turfgrass growth and development than air temperature. It is possible to maintain turfs at extremely high air temperatures as long as the soil temperature is maintained at a more moderate temperature. This is also the reason why night temperatures are so important in controlling turfgrass responses. As long as the night temperature drops to lower levels that will maintain a cooler soil temperature, the turf can be maintained rather easily at normal growth rates. However, when the night temperatures rise to higher levels comparable to daytime temperatures, the soil is warmed considerably, resulting in restricted root and shoot growth and a decrease in turfgrass quality, health and vigor.

Because of the significant effects of soil temperature on heat stress, it is important for the golf course superintendent to periodically monitor soil temperatures under selected turfgrass areas on the golf course. In this way, he can more adequately interpret the turfgrass responses being observed and also make appropriate adjustments in his turfgrass cultural program. While these adjustments may appear to be relatively minor, they can be very important in determining whether an adequate or inferior quality surface is maintained for golf play.

So far as specific temperature responses are concerned, optimum root growth of Penncross creeping bentgrass occurs at lower soil temperatures than shoot growth. Specifically, the bentgrasses as well as Kentucky bluegrass, tend to maintain maximum root growth in the soil temperature range of 50 to 60° F. In contrast, optimum shoot growth and recuperative rates occur at somewhat higher temperatures in the range of 65 to 75° F. The over-all turfgrass appearance and color are also very good in this temperature range. Specific temperature stresses become evident as soil temperatures are raised into the 90° F range. Bermudagrass responds to temperature comparable to that for bentgrass and Kentucky bluegrass except in a higher temperature range. For example, optimum shoot growth for bermudagrass occurs in the range of 85 to 95° F.

Above the optimum temperature range there is a decline in most turfgrass growth response characteristics. Initially, this is expressed in reduced root growth. Not only is senescence of the existing roots progressing more rapidly to a brown, spindly, weak appearance, but initiation of new roots from meristematic areas on the crown is also blocked. This results in a very restricted root system for cool season turfgrasses at soil temperatures above 80° F. Other responses observed under temperature stress conditions included a decline in shoot growth as well as a reduction in (a) leaf length, width, and area, (b) rate of new leaf appearance and (c) succulence of the above ground tissues. The turfgrass appearance becomes dark green to blue green in color under heat stress. A decline in shoot density will also appear if the heat stress persists.

This brief article is a simplified introduction to the many effects of temperature on turfgrass growth and culture. It is a very complex aspect of turfgrass management, which is interrelated with many other cultural practices including mowing, fertilization and most important, irrigation. □

## CORRECTION

GOLFDOM inadvertently misquoted Vaughn E. Border, director of marketing, Outboard Marine Corp., in the article entitled "The Japanese in the U.S. Golf Market: Where are They Now and Where are They Going?" published in the May issue, page 21. The correct quote should read: "The fact is that there are still only about *51,000* or *52,000*, I would guess, new golf cars being sold every year."