Low Temperatures and Poa Annua

by DR. JAMES B. BEARD, Michigan State University

Editór's note: In an earlier article, "Effect of Temperature Stress on Poa Annua," Green Section Record, July, 1968, Dr. James Beard pointed out the problems of high temperature stress on Poa annua. Here he covers the other side of the coin and brings us up to date on his oustanding studies of "Low Temperatures and Poa Annua."

As stated earlier, the actual temperature of a turfgrass plant or its individual parts is determined by its surrounding environment; i.e., the soil temperature for underground parts and the air temperature for above ground parts. The "optimum temperature" is that at which a particular plant process occurs at the highest rate. Optimum temperatures will vary depending upon the a) age of the plant, b) stage of development, c) specific plant organ involved, d) physiological condition of the plant, e) duration of the temperature level and f) variation in other environmental factors.

Low Temperature Stress

As temperatures are decreased below the optimum, there will eventually be a point at which growth will cease. However, respiration and photosynthesis have been found to occur in roots and shoots of turfgrasses at temperatures near 32 degress F. If temperatures continue to decrease, a point is reached where direct low temperature kill will occur. Research at Michigan State University shows that annual bluegrass is a turfgrass species which is relatively susceptible to low temperature kill compared to others, such as creeping bentgrass and Kentucky bluegrass (Figure 1).

The mechanism of direct low temperature kill involves mechanical disruption of the protoplasm caused by ice crystals. In general, the killing temperature increases with the hydration level or water content of the tissue. The relative low temperature tolerance of annual bluegrass will vary during the winter season. Maximum winter hardiness is achieved in late December, followed by a slight decrease in hardiness in late January, with a continued decrease in hardiness to a minimum level at the time of spring thaw. Therefore, low temperature kill is most likely to occur during the late winter, early spring freeze and thaw period when the crown tissues are at a higher hydration level.

It should be pointed out in relation to direct low temperature kill that the primary concern is the actual soil temperature rather than the air temperature. The critical tissues which must survive are the crown meristematic tissues. Leaf and root kill is of no concern since these tissues can be readily replaced by new growth from the crown. Thus, as long as temperatures in the crown area remain above the lethal level, no critical kill of the turf will occur.

Direct low temperature kill appears to be most common in an intermediate belt across Wisconsin, Michigan, New York, northern Illinois, and in certain areas of New England. This is an area that is subjected to extended periods of freezing and thawing and also has a higher potential for hydration of the crown tissues.

The comparative low temperature tolerance of annual bluegrass and Toronto creeping bentgrass is shown in test plants sampled in mid-December. (Figure 1).

Of more immediate concern to the professional turfman are methods to eliminate direct low temperature kill problems. Actually, there are no guaranteed methods of avoiding low temperature kill, but practices are available which will minimize the chance of injury. Detailed studies at Michigan State University show that excessive late fall nitrogen fertilization should be avoided because this will stimulate growth and increase the hydration level of the crown tissue. One should also be sure that adequate levels of potassium are present. It appears that a relationship of three to four units of nitrogen to one unit of potassium will provide the proper nutritional balance to insure maximum low temperature survival.

Other factors of concern are proper surface and internal soil drainage in order that free water can be drained from the vicinity of the crown tissue as rapidly as possible. If the annual bluegrass plants are permitted to stand in water for an extended period of time, the hydration level of the tissue will increase. If this is then followed by a very sharp freeze to temperatures of below 20 degrees F., the potential for direct low temperature kill is quite high. Thatch should also be avoided as it will contribute to increased low temperature kill. One final consideration is avoiding traffic over the turfgrass area during wet, slushy periods. If a sharp freeze occurs, this condition can result in severe turfgrass injury.

Ice and Snow Covers

Extended periods of ice and snow coverage sometime occur during winter period. The possibility exists that an extended period of high density ice coverage could impair gaseous diffusion to the point that the turf could be injured through either (a) suffocation caused by a lack of oxygen for respiration, or (b) toxic gases which have accumulated adjacent to the living tissues.

Both field and controlled climate studies have been conducted at Michigan State University to clarify this type of injury. Based on these studies, one must conclude that injury caused by the ice cover itself is a rare occurrence.

In general, most turfgrass species are relatively tolerant to extended periods of ice coverage. Annual bluegrass is less tolerant than many others. For example, injury to annual bluegrass may occur under ice sheets

A demonstration of the comparative survival of Toronto creeping bentgrass, Kentucky bluegrass and annual bluegrass when they were completely sealed in ice for 120 days at 25° F. (Figure 2). Note kill of the annual bluegrass at right.

which have been in place in excess of 60-70 days. In contrast, bentgrass has survived as long as 120 days under an ice cover (Figure 2).

The question frequently arises, "Should I remove the ice and snow cover from my greens and tees?" Basically, this is a good practice, although the reason for which you may be removing it may not be the correct one. By removing a majority of the ice and snow from a green, you are essentially mechanically removing the water from the green in a frozen state. Thus, during the thawing period, this water will not accumulate in the vicinity of the grass crown tissue, cause an increase in the water content of the tissue, and result in a greater chance of injury due to low temperature kill. In general, one should not completely remove the ice and snow cover. It is best to leave between one-half and one-quarter inch of snow cover to avoid winter atmospheric desiccation problems which may occur if the turf is exposed to drying winds for extended periods of time.

In summary, annual bluegrass is relatively susceptible to both high temperature and low temperature stress, compared to many of the other permanent, perennial cool season turfgrasses being used. These are two reasons why annual bluegrass is objectionable in quality turfs. However, the prolific seed production and the presence of large quantities of Poa annua seed in the soil insures rapid reestablishment of a turfgrass stand following any temperature kill. Studies are continuing at Michigan State University in order better to understand high and low temperature stress mechanisms of turfgrass, with the ultimate hope of developing turfgrass species which have greater heat and cold tolerance.