



# Bermudagrass freeze tolerance

Some seeded and vegetatively propagated bermudagrass cultivars are more likely to tolerate severe winters in the transition zone.



Both genetic and environmental components interact to determine how well a chosen cultivar performs in a particular location. An increasing number of fine-textured bermudagrasses (*Cynodon* species) are being developed and evaluated for resistance to environmental stresses. Freeze damage is a primary concern in the northern boundaries of the bermudagrass adaptation zone. Some years are relatively mild and cause little or no damage, whereas other winters are sufficiently severe to cause extensive winterkill. The costs in loss of use and dollars to reestablish turf following winterkill can be substantial. Therefore, our long-term goal is to develop vegetatively and seed-propagated bermudagrasses with high turf quality and improved freeze tolerance.

## Testing for freeze tolerance

A common way to compare relative freeze tolerance of a group of cultivars is to establish them in the field, then wait for cold temperatures to sort them out. However, during a mild winter, temperatures may not be cold enough to kill any cultivars of interest, and no progress would be achieved. If evaluations were conducted at a northern or high-elevation location, low temperatures could kill most or all of the bermudagrasses. Therefore, several years of observation may be required to experience temperature conditions that distinguish different levels of freeze tolerance within a group of bermudagrass cultivars. Because the prevailing weather conditions before a freeze can vary and

may have a profound influence on the acclimation state of the plants, relying on test winters makes it difficult to repeat studies over time and across climatic locations.

Another factor that comes into play during natural freezes is the nature of the freeze itself. Differences in freezing rate or duration, even with the same minimum exposure temperature, could result in different plant responses. Because snow cover can have an insulating effect on turf, its presence or absence may have a marked effect on plant survival.

Developmental and morphological features also can be factors in winter survival. The presence of rhizomes can contribute to freeze avoidance by being sufficiently deep in the soil profile to avoid temperature extremes. The well-documented susceptibility of newly seeded bermudagrasses may involve physiological and/or morphological factors such as stolon density.

## Freeze chambers

To overcome the unpredictable occurrence of test winters and to extend evaluations year-round, laboratory-based methods of measuring freeze tolerance have been developed. One approach has been to acclimate plants naturally in the field, followed by laboratory-based exposure to subfreezing temperatures. Studies also have been conducted entirely indoors, with plant materials established and acclimated in growth chambers, followed by exposure to a range of temperatures in a freeze



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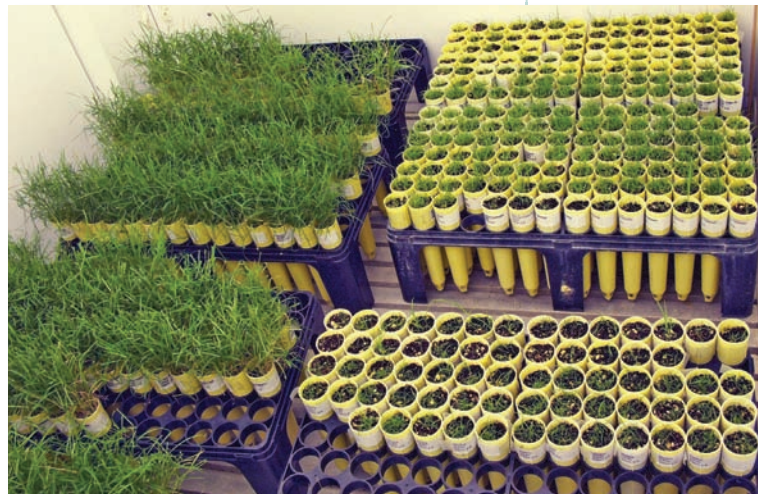
chamber. Even though winterkill in the field can involve factors in addition to low temperature, rankings of relative freeze tolerance determined in laboratory tests usually correspond well to rankings of the same cultivars in field plots. Therefore, our objective was to quantify freeze tolerance of advanced lines, recently released cultivars and standard varieties entered in the 2002 National Turfgrass Evaluation Program bermudagrass trial using laboratory-based methods. Standardized, quantitative information on bermudagrass freeze tolerance is vital to scientists to track progress in developing new cultivars. Freeze tolerance data are also beneficial to turfgrass managers selecting turfgrasses for the transition zone.

Bermudagrass plants were established and maintained in growth chambers. For studies with seed-propagated cultivars, seed from the lots used in the 2002 NTEP bermudagrass trial was obtained from the sponsors. Of the 29 seed-propagated entries, 27 were included in this study. Because space in the freeze chamber was limited, experiments with seed-propagated bermudagrasses were divided into five groups. Entries were randomly selected and assigned to groups with Arizona Common included as a standard in each, allowing the potential for comparisons across groups. Vegetative cultivars were propagated from individual phytomers (the phytomer unit consists of a leaf, node, internode, axillary buds and root tissue) using Tifway as the standard cultivar in each of the three groups. Experiments were conducted on three dates for each group, constituting replications in time, with staggered plantings allowing uniform establishment periods.

After plants had acclimated to fall-like temperatures, they were trimmed of top growth and placed in a freeze chamber with a temperature sensor in each pot. The chamber was programmed to cool the plants slowly, allowing them to be removed over a range of temperatures. Ideally, no damage would occur at the warmest temperatures, and all plants would be killed by exposure to the coldest temperatures.

After being removed from the freeze chamber, plants were thawed and returned to the growth chamber to observe regrowth. Non-frozen controls were treated the same, except without freeze chamber exposure.

Evaluating the temperature-survival curve allowed estimation of a  $T_{mid}$  value, similar to the  $LD_{50}$  (lethal dose for 50% of the subjects) in a toxicity screen. Data were combined into seeded and vegetative types. Performance relative to the standard cultivar (Arizona Common or Tifway) was determined by subtracting the  $T_{mid}$  for each



Seed-propagated plants during establishment in a growth chamber. Photos by J. Anderson

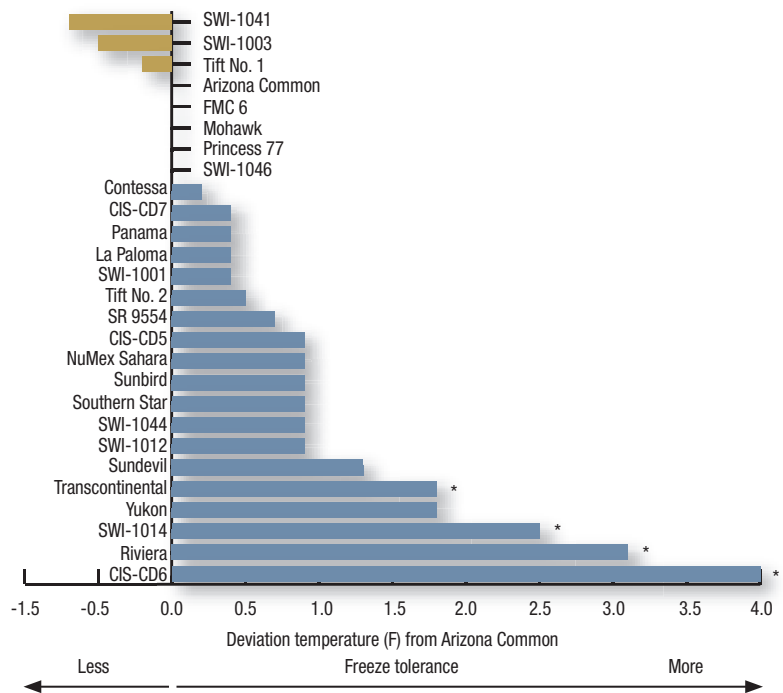
cultivar from the  $T_{mid}$  value for the standard in that group.

### Variability in freeze tolerance

#### Seeded bermudagrasses

Seed-propagated bermudagrasses ranged in freeze tolerance from 22.5 F (-5.3 C) (SWI-1003) to 16.3 F (-8.7 C) (CIS-CD6). Even though three cultivars were numerically less freeze-tolerant than

#### Seeded bermudagrasses



**Figure 1.** Freeze tolerance of seed-propagated bermudagrasses relative to Arizona Common. Deviation temperatures represent the  $T_{mid}$  value (midpoint of the survival-temperature response curve) of the cultivar minus the  $T_{mid}$  value for Arizona Common. Cultivars significantly different from Arizona Common are indicated by an asterisk.



Acclimated plants trimmed of shoots and placed in a programmable freeze chamber for exposure to subfreezing temperatures.



Arizona Common, none of the three was significantly different (Figure 1). FMC 6, Mohawk, Princess 77 and SWI-1046 were identical in freeze tolerance to Arizona Common. Fifteen cultivars had numerically greater, yet not significant, differences in freeze tolerance relative to the standard. Transcontinental, SWI-1014, Riviera and CIS-CD6 were significantly more cold hardy than Arizona Common. Although Yukon and Transcontinental differed from Arizona Common by the same amount, the difference was not significant for Yukon at the 5% level because of greater

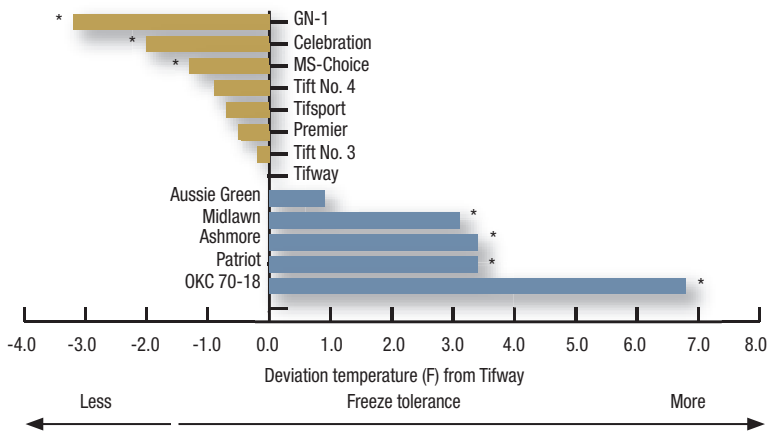
variability in data from Yukon. A previous study that included these two cultivars found Yukon to be significantly more freeze-tolerant than Arizona Common.

*Vegetatively propagated bermudagrasses*

Vegetatively propagated bermudagrasses ranged in freeze tolerance from 20.8 F (-6.2 C) (GN-1) to 11.3 F (-11.5 C) (OKC 70-18). Three cultivars, GN-1, Celebration and MS-Choice were significantly less freeze-tolerant than Tifway (Figure 2). Tift No. 4, Tifsport, Premier, Tift No. 3 and Aussie Green had cold-hardiness levels similar to that of Tifway. Midlawn, Ashmore, Patriot and OKC 70-18 were significantly more freeze-tolerant than Tifway.

Although we have not previously examined this combination of bermudagrass cultivars, freeze tolerance estimates generally corresponded well with previous experience. Both Midlawn and Patriot exhibited greater freeze tolerance than Tifway, as we previously reported. Riviera was also more freeze-tolerant than Princess 77, a result that is also consistent with earlier findings. In a previous study, we also found GN-1 to be significantly less freeze-tolerant than Midlawn.

**Vegetatively propagated bermudagrasses**



**Figure 2.** Freeze tolerance of vegetatively propagated bermudagrasses relative to Tifway. Deviation temperatures represent the  $T_{mid}$  value (midpoint of the survival-temperature response curve) of the cultivar minus the  $T_{mid}$  value for Tifway. Cultivars significantly different from Tifway are indicated by an asterisk.



Bermudagrass plant showing thermocouple temperature sensor.

*Laboratory vs. field temperatures*

It is important to distinguish between  $T_{mid}$  temperatures determined in the laboratory and air temperatures experienced during a natural freeze. In the laboratory, conditions are set up to ensure that plants reach the target temperatures. Critical tissues, such as crowns, of plants in the field usually will be considerably warmer than air temperature because of the thermal buffering capacity of the soil.

**Conclusions**

Substantial progress is being made by turfgrass



breeders to develop seed-propagated and vegetatively propagated bermudagrasses with improved freeze tolerance. Although many factors in addition to freeze tolerance will be assessed in making cultivar selections, choices are now available with freeze tolerance suitable for areas of the transition zone requiring superior winter hardiness. However, cultivars with limited freeze tolerance may still be excellent choices for locations that do not experience severe winters.

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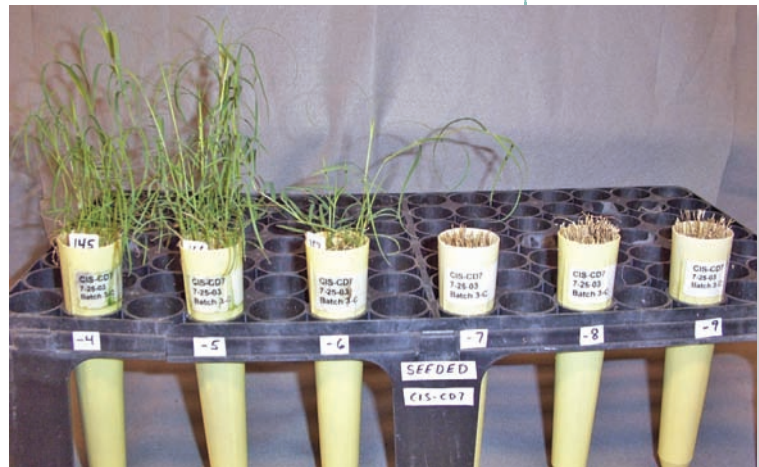
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Regrowth of CIS-CD7 seeded bermudagrass after exposure to a range of subfreezing temperatures.



### The research says

- The most freeze-tolerant seed-propagated cultivars were CIS-CD6, Riviera, Transcontinental and SWI-1014.
- OKC 70-18, Ashmore, Patriot and Midlawn were the most freeze-tolerant vegetatively propagated cultivars.
- GN-1, Celebration and MS-Choice were significantly less freeze-tolerant than Tifway.
- Freeze-tolerant bermudagrasses are now available for areas of the transition zone requiring superior winter hardiness.

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