Ultradwarf Bermudagrasses Exhibit Easy Mutation Tendencies

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PART 1:
Off-type mutations may occur naturally.

Bermudagrass (*Cynodon* spp. L. C. Rich) is the most widely used turfgrass in the southern United States(Emmons, 2000). Native to eastern Africa, bermudagrass has aggressive stolons and rhizomes that form vigorous turf with high shoot densities and rapid growth capabilities (Beard, 1973). Bermudagrass has excellent wear, drought and salt tolerances, but needs high nitrogen fertility, full sunlight and routine cultivation (McCarty and Miller, 2002). In all, it is a good choice for golf courses.

Genetics and history

Turf-type bermudagrasses are classified into four groups according to their heredity and chromosome number:

- common bermudagrass, a tetraploid with a total of 36 chromosomes;
- African bermudagrass, a diploid variety with 18 chromosomes;
- hybrid Magennis bermudagrass, a naturally occurring triploid with 27 somatic chromosomes; and
- Bradley bermudagrass, an aneuploid with 18 somatic chromosomes (McCarty et al., 2001).

Selections used for golf greens are sterile triploids, the result of an interspecific hybrid with 27 chromosomes (Burton, 1991).

In the 1950s and 1960s, Glen W. Burton of the U.S. Department of Agriculture in Tifton, Ga., released several bermudagrass hybrids, including Tiflawn, Tifway, Tifgreen and Tifdwarf. Hybrid bermudagrass (*Cynodon dactylon* Pers. x *C. transvaalensis* Burtt-Davy) is the warm-season turfgrass used most commonly on putting greens (Beard, 2002).

After its release in 1956, Tifgreen, also noted by its experimental notation 328, quickly became the most popular bermudagrass golf green in the world, as common bermudagrass and sand greens were used prior to its release (McCarty et al., 2001).

Bermudagrass putting-green quality has traditionally been considered inferior to finer textured creeping bentgrass because cultivars such as Tifgreen and Tifdwarf have trouble withstanding routine mowing heights lower than .189 inches (Beard, 1973). In contrast, recently introduced dwarf-type bermudagrass varieties tolerate long-term mowing heights of .126 inches or closer (McCarty and Miller, 2002).

Dwarf bermudagrass exhibits finer leaf textures, higher per-area shoot densities and low growth habits that allow for lower mowing heights and produce conditions similar to creeping bentgrasses (McCarty and Miller, 2002; Beard, 2002). Dwarf bermudagrass varieties available currently include: TifEagle, Champion, Mini Verde, Classic Dwarf, FloraDwarf, Florida Dwarf, Reesegrass and MS Supreme. Although many Southern golf courses have converted to these improved grasses, traditional bermudagrass management practices appear inadequate for the long-term success of the new varieties. Superintendents face new challenges, including different fertility requirements, disease management, mitigating shade intolerances, managing thatch/mat development and promoting root growth.

Bermudagrass mutations

Concerns exist over the potential of genetic instabilities of traditional hybrid bermudagrass putting greens. Off-type patches of different color and texture grasses are major contamination problems of Tifdwarf and Tifgreen bermudagrasses, causing putting greens to become mosaic and difficult to play (McCarty and Miller, 2002; Beard, 2002).

Tifdwarf bermudagrass, for example, is believed to be a chance mutation in previously planted Tifgreen bermudagrass. However, most somatic mutations and genetic instability of triploid hybrid bermudagrass lead to undesirable off-type contamination.

Contaminations of off-type bermudagrasses may develop over several years and are believed to have arisen from the chance occurrence of mutations in parent material or possibly contamination through mechanical means.

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Mutations are abrupt, inheritable changes brought by alterations in a gene, a chromosome or by a change in chromosome number. The rate of mutation can be increased artificially, but results cannot be controlled. Usually recessive, mutations may remain unexpressed for generations.

Mutations are produced by internal disorders, such as inaccurate gene duplication, and by natural external forces, such as severe temperature changes or sunlight radiation. Natural mutations appear rarely, whereas artificial ones can be produced more frequently and occur more quickly.

Tifway II, Tifgreen II and TifEagle are induced mutations of original grasses by exposing original plant material to artificially high levels of radiation. Tifdwarf, FloraDwarf, and Pee Dee 102 bermudagrasses are believed to be natural mutants from Tifgreen bermudagrass, which is a first-generation hybrid and is a completely sterile triploid. Thus, it must be propagated vegetatively.

The mottled appearance of this green reveals off-type contamination from mutations.

Because Tifdwarf is probably a vegetative mutant from Tifgreen, the possibility exists that an original planting of Tifdwarf can undergo another mutation to produce a different grass. Although mutations offer new ways of introducing genetic variability into breeding lines, they also may cause instability into existing materials. Therefore, mutations may produce undesirable off-types over several years (McCarty et al., 2001).

Recently, geneticists have used DNA-amplification fingerprinting — a marker-assisted procedure that helps turf breeders secure turfgrass cultivar proprietary rights and planting stock certification, and evaluate off-type relationships — to specify the genetic relationships among bermudagrass cultivars. Using these techniques, Caetano-Anollés et al. (1997) found Tifway to be genetically stable despite the enormous gene pools of African and common bermudagrasses. The researchers observed off-type bermudagrasses found in Tifway stands were genetically distant to to the variety and represented a heterogeneous group of bermudagrass probably of interspecific hybrid origin. The authors concluded these off-types probably resulted from sod contamination and not mutations.

In later studies, Caetano-Anollés (1998) investigated Tifdwarf and Tifgreen bermudagrass, cultivars traditionally used as putting green turf. Through this research, Caetano-Anollés confirmed genetic instabilities of Tifdwarf and Tifgreen bermudagrass.

Phenetic analyses showed almost all cultivar accessions and one-half of the off-types studied were genetically distinct, but very similar. The researcher concluded this genetic variation was probably a result of somatic mutations and Tifgreen accessions represented a genetically diverse bermudagrass group of interspecific hybrid origin. These discoveries provide the first conclusive evidence that off-type patches in bermudagrass greens are a direct consequence of genetic instabilities of Tifgreen and Tifdwarf. As expected, additional concerns exist with the new ultradwarf bermudagrass cultivars.

Many of these cultivars, like Champion, are selections from previously planted Tifdwarf or Tifgreen stands and potentially have the ability to mutate somatically into off-type contamination. In the next article, we discuss how herbicides that disrupt genetic replication and damage DNA sequences may induce bermudagrass mutations and the importance this may have for long-term ultradwarf bermudagrass management.

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