Selection for environmental stress resistance in turfgrass

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Concern over diminishing resources has led to increasing interest in low-maintenance characteristics in turf. Most commercially available turfgrass cultivars were developed under high-maintenance conditions, and intensive management is required to keep turf quality acceptable in most areas of California. To develop low-maintenance turf, major goals are to reduce mowing, fertilization, and irrigation requirements while maintaining a reasonable appearance.

Over the past five years, our research has used several approaches toward achieving these goals, including evaluation of environmental stress resistance among commercially available turfgrass species, selection for alternative species and ecotypes, survey of legume and grass species colonizing California's metal mine waste sites to establish germplasm of plant materials for land reclamation and low-maintenance landscaping, and establishment of tissue culture methods for stress resistance studies.

Potential turfgrasses

We studied 11 grass species, including torgrass (*Brachypodium pinnatum* L.), buffalograss (*Buchloe dactyloides* [Nutt] Engelm), common alkaligrass (*Puccinella lemmoni* [Vasey]), Fults weeping alkaligrass (*Puccinella distans* [L.] Parl), smooth brome (*Bromus inermis* Leyss), Lovington blue gramagrass (*Boutelua gracilis* [Nutt] Engelm), western wheatgrass (*Agropyron smithii*), seaside creeping bentgrass (*Agrostis stolonifera*), and colonial bentgrass (*Agrostis tenuis* Sibth). Of the 11 species, torgrass and buffalograss showed the greatest potential for developing low-

Torgrass, a Mediterranean species known for drought- and heat-resistance and low soil fertility needs, forms a dense turf and shows potential as a low-maintenance turfgrass. Individual torgrass plants vary in rhizome-forming characteristics.

maintenance turfgrass. Seaside creeping bentgrass and copper- and zinc-tolerant creeping red fescue ecotypes showed potential for selection for heat resistance. The rest of the species either showed a rapid decline in turf density with weed invasion during the dry warm summer of 1983 or did not form a reasonably dense and uniform turf cover.

Torgrass is a Mediterranean perennial species known for its drought and heat resistance and its adaptability to low soil fertility. It forms a dense turf during both winter and summer, exhibiting extensive rhizome and deep rooting characteristics, good seed production, nonshattering, no seed dormancy, and good seed germination at 20° to 25°C. No disease problems have been noted. Our evaluation suggests that this species can be developed into a commercially acceptable grass for low maintenance.

Creeping bentgrass has been used extensively for golf greens in California. Under warm, dry summer conditions, golf greens require intensive care and frequent irrigation. Selection for improvement of salinity and heat resistance in breeding bentgrass is desirable. We therefore imposed a severe drought on a salinity-tolerant creeping bentgrass population under turf conditions. The plants surviving under the stress had greater heat tolerance, a greater root/shoot ratio, a smaller leaf area, and thinner stolons. Adaptation to drought in this grass seems to result from the combination of both tolerance and drought-avoidance mechanisms at the morphological and physiological levels. Creeping bentgrass seems to have potential for selection, and might be useful for introduction in areas of adversely high salinity and drought.

Problems with buffalograss

Buffalograss, with its superior drought resistance, low nutritional requirements, and short stature, also shows promise as a low-maintenance turfgrass. Problems with seed production, however, seriously limit seed availability of this species. Buffalograss has three sex forms--male, female, and hermaphroditic plants. To utilize the sexual variations of buffalograss in improving its seed production, we examined the three kinds of plants in a commercial cultivar under greenhouse and field turf-management conditions. It was found that mowing provided differential stress on female and male plants, encouraging increased vegetative reproduction by male plants in contrast to female plants. At least two approaches might be applicable for buffalograss seed production improvement: selection for increased female inflorescence height to facilitate seed harvest, or selection for the hermaphroditic character to establish hermaphrodite cultivars.

Red fescue (*Festuca rubra*) is a fine-textured turfgrass that has not been developed for use in California. However, it has the widest range of environmental adaptation among the existing commercially available temperate turfgrass species. Ecotypes of red fescue have been reported on old abandoned metal mine workings. Since the environment of mine tailings often includes macro- and micro-nutrient deficiencies, unfavorable physical soil structure, excessive dryness, and exposure to metal toxicity, the mine grass ecotype might be a potential genetic resource for varietal improvement of this species.

We surveyed eight California metal mine waste sites to discover genotypes of California native or wild plants that have evolved tolerance to heavy metals and adapted to low soil fertility. These plants might be used for revegetation for degraded land or for low maintenance landscaping.

The ability of legume species to fix nitrogen in metal enriched soils was measured. About 12 species were found to have evolved copper tolerance on a copper mine waste habitat. The recency of mining activities indicates that these plants probably have evolved tolerance in about 50 to 150 years.

Tissue-culture breeding

Kentucky bluegrass cultivars are generally apomictic, producing seeds by asexual means and producing progeny identical to the parent. However, Kentucky bluegrass may produce both sexual and apomictic seed, depending on environmental conditions during flowering. This characteristic has been a problem in Kentucky bluegrass cultivar identification. For cultivar selection and plant breeding, it is necessary to establish a relatively simple method for plant identification.

'Baron', 'Fylking', 'Merion', and 'Newport' cultivars were examined for isoenzyme pattern differences between seed and seedling materials. Differences of esterase isoenzyme patterns were found between the two kinds of tissues. If seedlings from a seed lot were mixed, however, a constant pattern of isoenzyme systems was obtained for different seed lots of the same cultivar. Therefore, the process of mixing seedlings allows the fingerprinting characterization of Kentucky bluegrass cultivars, even if there is occasional segregation from sexual reproduction.

Tissue culture methods may provide an alternative approach for Kentucky bluegrass breeding. Callus culture and regeneration on Kentucky bluegrass was studied, and chromosome number and isoenzyme characters were demonstrated to be useful genetic markers. 'Baron' and 'Merion' showed differ-

Dwarf creeping fine fescue (right) found in a copper mine waste area is a potential genetic resource for varietal improvement of this species with reduced mowing requirements.

ent chromosome numbers; all the plants regenerated from tissue culture of both cultivars had the same chromosome numbers and isoenzyme characters as their parent plants. These results indicate that the genetic constitutions of the regenerated plants were very conservative. Large genetic variation was found among the seed progeny of plants regenerated from tissue culture, however, indicating that sexual reproduction may be stimulated in these callus-tissue-derived plants. These tissue-culture-induced genetic variations may be useful for Kentucky bluegrass breeding and cultivar improvement.

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