Developing Salt Tolerant Kentucky Bluegrass

By Jeff Nus, Ph.D.

Golf is facing perhaps the greatest challenge ever to confront the game — WATER. As our nation’s population expands, especially in the arid southwest and western climates, it is imperative that golf courses use less water and increase the use of recycled water from water treatment facilities. The challenge with using this alternative water source is that it is typically high in salts.

The USGA is funding several research projects designed to address the use of saline water for golf course irrigation. One project is underway at Utah State University (USU), where Drs. Paul Johnson (USU), Joseph Robbins (USDA-ARS), and Shaun Bushman (USDA-ARS) are conducting research to develop salt-tolerant Kentucky bluegrass. Most golf courses throughout the temperate United States utilize a mix of Kentucky bluegrass and perennial ryegrass for fairways, surrounds, and rough. Developing more salt-tolerant varieties of these grasses is important, especially as

Utah State University and U.S. Department of Agriculture scientists are working to identify salt tolerant Kentucky bluegrass germplasm that is adapted to the climate and soils of the arid West.
more golf courses are required to use salty recycled water for irrigation.

Kentucky bluegrass breeding and selection programs have focused on improving the aesthetic quality and pest resistance of this important turfgrass species. However, most Kentucky bluegrass varieties have not been rigorously evaluated or selected for salt tolerance. These scientists point out that there is not a good understanding of the genetic control of salt tolerance in this species. This information would help to develop new salt tolerant varieties. The two main goals of the research are to develop salt tolerant Kentucky bluegrass varieties and understand the genes involved.

How well does Kentucky bluegrass compare with other cool-season turfgrass species with respect to its inherent salt tolerance? “In general, it is more salt-sensitive. In the Intermountain West where soil salinity is often high, we recommend perennial ryegrass or tall fescue,” says Dr. Johnson. “But if we can increase the salt tolerance of Kentucky bluegrass varieties, bluegrass can be recommended for moderately saline areas in the future.”

The first step for genetically improving Kentucky bluegrass for salt tolerance is to collect and assemble a large and diverse group of genetically distinct types, or accessions. Utah State’s collection of accessions came from around the world. “The selections are all from the National Plant Germplasm System, with some additional check varieties. These were chosen for this initial study to survey germplasm, with a wide genetic base, that was collected worldwide. We focused on material that was collected from drier areas of the world, such as Iran, Pakistan, Mongolia, and Morocco, to name a few. But additional material came from other areas, such as Alaska, Sweden, Canada, and the United States,” says Dr. Johnson.

Once collected, accessions are screened in field, greenhouse, and laboratory tests to identify genes associated with salt tolerance. USU scientists use a molecular process (SSH, or suppressive-subtractive hybridization) to identity accessions that have genes needed for salt tolerance. Dr. Johnson explains, “Although there are more than 30,000 genes in a plant, not all of them are turned on at any particular time or in any particular part of the plant. What SSH does is to mix the genes from non-stressed and salt-stressed samples. Genes that are turned on in both samples bind with each other (called hybridization) and precipitate out of the solution (called subtraction and suppression). The genes remaining in solution are those expressed only in one of the two samples. Thus, we can find genes expressed only in salt-stressed plants and not in non-stressed plants.”
Seedlings are grown in sand and subjected to increasing levels of salt in the irrigation water. The test is conducted until many of the plants die, which helps identify the salt tolerant plants.

Closely-related species have much of their DNA in common. As a group, grasses have been evolving in response to all sorts of environmental stress, including salt stress, for millions of years. Are there common stress-related genes in Kentucky bluegrass that show up in other grasses? “For most of the genes that show-up in this analysis, there are no similar genes in other plants that have been identified. This is not uncommon for the SSH procedure, because it is often applied to plant species with few genetic resources, such as Kentucky bluegrass. This demonstrates how little is known about salinity tolerance in plants, and how unique each species can be. Of the genes we found that are similar to other grasses, they are common stress-related genes,” Johnson notes.

In addition to introducing Kentucky bluegrass stress-related genes into future Kentucky bluegrass varieties, genes from other grass species also can be incorporated. An example of this approach includes the hybrids produced by crossing Kentucky bluegrass with Texas bluegrass. The success of this approach, however, depends on the genetics of the selected parents for those hybrids.

Kentucky bluegrass does not produce hybrids as easily as other turf species. The molecular genetics techniques are more difficult to use due to the number of chromosomes found in this turfgrass species. “Kentucky bluegrass is very difficult to work with because it has several sets of chromosomes. Where humans have one set of chromosomes from each parent (for a total of two), Kentucky bluegrass can have as many as 12 sets,” says Dr. Johnson. “This means a lot of redundant genes for any function, suppressed genes and complicated analysis. In addition, there are no close relatives of Kentucky bluegrass to use as a blueprint. On the other hand, Kentucky bluegrass has a clonal type of reproduction that allows us to ‘fix’ genes of interest fairly quickly once they are identified. So, Kentucky bluegrass is a very challenging organism to study, but some unique characteristics also make the challenge most interesting.”

Despite the complexity of its genetics, USU and USDA-ARS scientists are confident that significant improvement can be achieved in the salt tolerance of future Kentucky bluegrass varieties. “I believe that improvements can at least reach the salinity tolerance levels of perennial ryegrass, which would make bluegrass manageable with repeated effluent applications,” says Dr. Johnson. That would certainly be good news for many golf courses.

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