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Improvement of Bermudagrass, Zoysiagrass, and Kikuyugrass for Winter Color Retention and Drought Tolerance

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Objectives:

1. Develop bermudagrass, kikuyugrass, and zoysiagrass turf-type genotypes with improved winter color retention and drought tolerance for Mediterranean and arid climates.
2. Utilize Diversity Arrays Technology (DArT) markers to aid in breeding efforts and marker-assisted selection.
3. Develop techniques to reduce kikuyugrass ploidy level to diploid by androgenesis in order to reduce aggressiveness and improve turf quality and playability characteristics.

Start Date: 2017
Project Duration: 5 years
Total Funding: $250,000

Summary

Warm-season or C4 turfgrass species including bermudagrass, zoysiagrass, and kikuyugrass are much better adapted to heat, drought, and salinity compared to cool-season grasses, but they go dormant during winter months making them less desirable choices for lawns, athletic fields, and golf courses. Clear differences in winter color retention, drought tolerance, and water use efficiency exist among warm-season grasses, and within individual species, which indicates that genetic improvements are possible. Our objectives are to develop improved genotypes of these three species with emphasis on winter color retention and drought tolerance for Mediterranean and arid climates.

Bermudagrass

In addition to existing collection of six *Cynodon* species (over 100 accessions), a collection of bermudagrass genotypes from the University of Florida (195 accessions) and Oklahoma State University (350 accessions) was planted in 2016 and maintained during 2017. The collection is continuously supplemented with samples collected locally, or donated to us by others. All collection accessions, along with hybrids obtained in last few years are being screened for color retention and turf quality. To increase genetic variability of bermudagrass accessions from UCR, genotypes from our collection were intercrossed (detached tiller crosses and open pollination). New crossing blocks were also established in May 2017. Spikelets from ca. 150 accessions from the UCR collection and from crossing blocks were harvested for establishment and selection next year. Accessions with latest dormancy and the earliest green-up will be intercrossed, on the assumption that the next generation hybrids may show reduced dormancy period. To support traditional selection of bermudagrass accessions and establish the parentage of the existing hybrids, marker-assisted selection using Diversity Arrays Technology (DArT) was included. DNA of 181 accessions was extracted and sent for genotyping.

Twelve of the most promising hybrids produced in earlier years were chosen for further evaluation in replicated plots across several climatic zones in California (University of

California, Riverside (Riverside, Inland Southern California); Coachella Valley (Thermal, Low Desert) and Fairfax (Northern California)). These are being compared with four widely used or new cultivars: Bandera, Santa Ana, TifTuf and Tifway. Plots were established on May 22 in Riverside; June 14 in Coachella Valley; and June 22 in Fairfax. Dynamics of establishment were measured using Digital Image Analysis (DIA) and turf quality is being evaluated after obtaining full cover. Tested accessions and hybrids showed different growth dynamics in different locations. UCR hybrid, TP 6-3 showed high turf quality, as evaluated in Riverside (UCR) and Coachella Valley. All hybrids and accessions tested in Riverside and Coachella Valley have demonstrated turf quality ratings of 6 (minimally acceptable) or higher and are comparable to commercial cultivars in this study. Quality of tested bermudagrasses in Fairfax was lower, however, quality evaluation there started later because of slower growth. Additionally, recovery after scalping was evaluated for 58 hybrids and accessions. Recovery time varied from 11 to 35 days. Along with intercrossing and selection for winter color retention and turf quality, drought tolerance of bermudagrass hybrids will be evaluated next year.

Kikuyugrass

Accessions of kikuyugrass from California show relatively little variation, therefore our work in 2017 was focused on increasing genetic variability. A collection of 103 available genotypes representing the greatest genetic diversity was established. Seeds of kikuyugrass (unknown origin) were germinated and young plants were selected for dark green color, slower growth rate and finer texture. So far, 439 plants were retained. This number will be further reduced by selection for better winter color retention. Best selections will be included in the collection and evaluated on small plots.

Another attempt was made to generate haploids of kikuyugrass. Protocols for material collection and stress application to induce the switch from the gametophytic to sporophytic pathway of microspore development were tightened up. In this last effort, some 13,000 anthers were plated and while androgenic response was observed, on a scale wider than in the first attempt in 2016, no haploids have been produced. An attempt will be made to generate haploids in different seasons; perhaps the microspores will be more amenable to manipulation than in peak summer.

Observations of pollination and self-incompatibility of kikuyugrass have started in October 2017 on 18 genotypes. This is done to better understand the pollination mechanisms and to help in breeding efforts. For this purpose flowers are self- and cross-pollinated and observations of seeds development will be performed.

Accessions from the collection were used in preliminary drought tolerance assessment, which showed considerable variation for the character. One accession remained green for over 100 days of drought.

Zoysiagrass

A large collection of zoysiagrass genotypes from the University of Florida (155 accessions) and Texas A&M (219 accessions) was planted in 2016 and maintained during 2017. Collection was supplemented with 14 UCR hybrids obtained from breeding program conducted by Dr. V. B. Youngner and V. A. Gibeault, which resulted in releasing cultivars ‘El Toro’, ‘De Anza’ and ‘Victoria’. At present there are no binding observations of this material.

Summary Points

- Dr. Marta Pudzianowska joined our team as a postdoctoral scholar on this project.
- The rage of genetic variation of bermudagrass, kikuyugrass and zoysiagrass has been expanded by addition of new accessions and expanding existing collections.
- Hybridization of existing UCR bermudagrass accessions continued, with emphasis on genotypes possessing desirable winter color retention, early spring green-up, and drought tolerance. A large amount of seed was produced; its germination rate is yet to be determined.
- New replicated trials across several climatic zones in California have been established to evaluate 12 of our most promising bermudagrass hybrids in comparison to cvs. Tifway, Santa Ana, TifTuf, and Bandera.
- Protocols and best culture media for androgenesis of kikuyugrass were tested and selected. Some progress toward successful androgenesis was evident but no haploids have been produced so far.

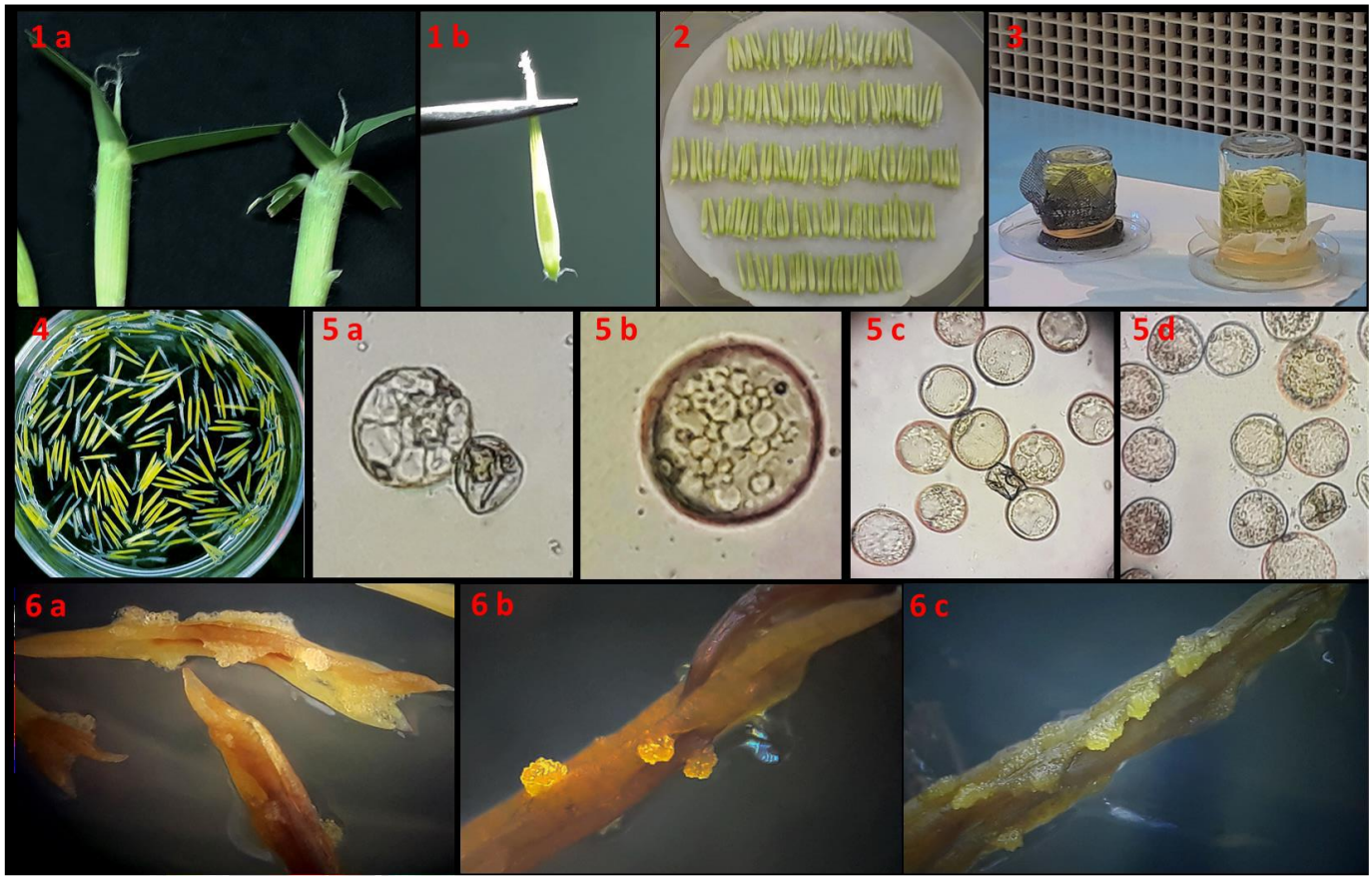

Figure 1. Various stages of attempting androgenesis in kikuyugrass. (1a) flower buds in the appropriate stage – stigma are approximately 5 mm in length; (1b) anthers in the appropriate stage – close to the bottom of the bud. (2) anthers on moist paper in petri dishes; (3) bud sterilization; (4) anthers during pre-treatment in a liquid solution (5a-c) embryogenic microspores; (5d) microspores with starch grains; and (6a-c) multicellular structures on the surface of anthers.