EXECUTIVE SUMMARY

1998 USGA Annual Report

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Projects: Genetic Enhancement of Paspalum for Recreational Turf
Development of Minimal Input Best Management Practices for Paspalum

AP-10 (greens) and Fwy-1 (PI 509018-1: fairway/tees) ecotypes are slated for submission to the University of Georgia germplasm release committee during early 1999. Sufficient vegetative material will be available if the releases are successful. These paspalums have exhibited excellent aggressiveness and performance on golf courses and under sod production. The genetic color is a darker green and turf quality traits are parallel to or better than most dwarf bermudas. Genetic analysis research involving simple sequence repeats (SSRs or microsatellites) has progressed to the point of effectively profiling individual ecotypes for plant variety protection using trinucleotide repeats.

Wear tolerance mechanisms differ between paspalum and bermuda. Recoverability rates were identical between the two species. Wear tolerance in paspalum was attributed to leaf total cell wall contents (50% of the variability) while tolerance in bermuda was due to stem moisture (41%) and stem cellulose (32%).

Fertility studies have revealed that paspalum is more highly responsive to $CaNO_3$ than NH_4NO_3, NH_4SO_4, or urea. These highly soluble fertilizers appear to be critical for rapid grow in and recoverability, and may be important during long-term management in stressed environments.

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Projects:
1. Genetic Enhancement of Paspalum for Recreational Turf
2. Development of Minimal Input Best Management Practices for Paspalum

Funding:

USGA	Breeding	$25,000
USGA	Management	25,000
GCSAA	Evaluation	4,000
TPI	Sod/Stolon BMP	4,650
GTFT	Breeding	4,000
PPI	Graduate Student	4,000

Donation of products: Rhone-Poulenc, AgEvo, Lesco, Scotts

Breeding Project – Research Initiated/Results

1. Two modified fairways (sand incorporation) containing 2000 space-planted tissue-culture-regenerated plants that were fully grown in was subjected to reel mowing (⅝") and prescription fertilization (total 5 lb actual N/1000 ft^2/year) with sequential applications of urea and ammonium nitrate. Adalayd-derived material tends to present a problem with mowing during July-August, with the mower blades actually stripping and severing the ends of the leaf blade rather than cutting smoothly. The resulting cosmetic appearance is a tan hue. Additional material was identified that exhibited a scalping tendency at the ⅝" mowing height. This mowing regimen will be continued during 1999 to identify the best performing ecotypes for fairways to move into stage 2 evaluation.

2. Three additional ecotypes were planted on the 10' x 10' paddock green (Q36315 from Israel that was collected on a sports practice field, Cloister from Sea Island, GA, collected from the bowling green at the Cloisters Hotel, and TCR 8 — a tissue culture regeneration from Mauna Key). TCR 8 has had problems with scalping at the 5/32" mowing height and never has recovered. The other two ecotypes have been slow to grow in from sprigs and have potential as greens ecotypes. Salam (Southern/Woerner Sports Turf proprietary cultivar) has a tendency to readily show seed heads (rating 8 on a scale of 9 = worst) while Hyb 5 (2) and Fwy-1 (3) have less of a tendency. Two to three additional new ecotypes will be planted in the green during 1999.

3. A 90:10 sand green (~1000 ft^2) was built this year and Hyb 5 was sprig-planted on it during June as a preliminary fertility study during grow in. Hyb 5 is a slightly lighter green color than AP-10, but is aggressive during establishment and appears to be close to AP-10 in performance.

4. Sod/Stolon Production.

Results with the five private companies collaborating on the TPI grant (Sod Atlanta using native soil at Cartersville, GA; Rapid Turf using plastic at Rincon near Savannah, GA; Thomas Bros. Grass using native soil at Granbury, TX; Bladerunner Farms using native sandy soils near Poteet, TX, south of San Antonio; Ecoturf using native soils and ocean water for irrigation at Port Orange, FL, near Daytona Beach) have been promising. They generally like the dark green color and aggressiveness of Fwy-1 and AP-10 (greens type). The participants increased their plot area in 1998 to be able to use their equipment better. Annual report to TPI is enclosed.

5. Seed Production.

Twelve paired-parental combinations (each parent differing in origin) were planted at four locations: at Maricopa, AZ, with Seeds West; at Hubbard, OR, with Pure Seed Testing; at Corvallis and Medford, OR, with Seed Research of Oregon. Preliminary results at Arizona indicate a problem of synchronization of flowering between the two parents in a combination. I recommended mowing the plots and letting them reform seed heads with the fall changes in photo period/temperature. It is probably too hot at the Arizona location for effective nicking/ synchronization.

At Hubbard, OR (just south or Portland), synchronization was excellent and flowering/ pollen dispersal was continuous. The 12 combinations were harvested with a vacuum and seed sent to Griffin. Combination #9 (Hyb 7 x Q36313 — an Israeli selection from the Negev Desert) was superior to all others.

Seed from Corvallis and Medford have not yet been harvested. Studies will be conducted on portions of the harvested seed during the winter 1998-1999 to break dormancy and to check on seed viability.

6. Genetic Analysis.

Linhai Zhang has been working in Steve Kresovich's lab for the past 14 months, but will be leaving by December 31, 1998. He has been developing SSR markers to discriminate elite paspalum accessions. A genomic enrichment DNA library using Fwy-1 (PI 509018-1 selection from Argentina) was constructed for simple sequence repeat (SSR or microsatellite) screening. Southern blot hybridization was used to screen the restriction enzymes and microsatellite oligonucleotides for the paspalum enrichment library. Southern blot results showed Sau3AI and Rsa1 were the best enzymes for use among five enzymes. Four SSR trinucleotides [(TTG)6, (TTC)6, (TGG)6, and (TAC)6] were used for library construction.

Enrichment protocols were established and optimized for the paspalum genome. One-hundred and fourteen positive clones were identified and sequenced. Eleven polymorphic SSR markers will be used for further genotyping. DNA from 162 diverse paspalum ecotypes have been extracted. Six paspalums were used as a panel, to evaluate the polymorphism of the SSR primers.

Eight polymorphic SSR primers have been multiplexed and optimized into two sets, based on their ability to produce unique DNA profiles. One-hundred out of 162 ecotypes have been screened using these two sets of SSR markers and fluorescence detection protocols. The goal is to develop an accurate, reproducible, and rapid method for cultivar identification/differentiation and to develop the protocol for eventual plant variety protection.

7. Increase Blocks.

In anticipation of release, AP-10 (25' x 125') and Fwy-1 (50' x 125') increase blocks were planted during July. These areas will be covered with clear plastic over the winter months and should be completely grown in by May 1999. An additional Fwy-1 increase area (40' x 50') will be available also in 1999. Both ecotypes are being increased in the greenhouse during the winter.

Three additional ecotypes (TCR1 fairway type – 40' x 70'; TCR6 fairway type – 40' x 70'; Hyb 5 greens type – 10' x 125') have been planted in increase areas for use in 1999. An additional area (150' x 125') has been sprayed with RoundUp and deep-tilled prior to the onset of winter. This area will be used to expand the volume of promising ecotypes during 1999.

8. Best Genetic Material.

Based on overall results from the breeding program at Griffin, collaboration with sod companies, and evaluations on golf courses, two ecotypes — *AP-10 greens type from Florida and PI 509018-1 designated Fwy-1 from Argentina* — are slated to be submitted for release at the next meeting of the UGA release committee during February 1999. I will be having discussions this winter with Earl Elsner of the Georgia Seed Development Commission who handles licensing and certification. I favor the establishment of a Paspalum Growers Association modeled after the TifSport and TifEagle organizations Re: Hanna's new releases. Certification and quality control standards for vegetatively propagated paspalum would also be developed prior to submission for release.

AP-14 greens type has been dropped from the evaluation program because mole crickets prefer this ecotype and because of other turf quality problems. Hyb 5 has emerged as a promising greens type based on aggressiveness, establishment, and overall performance even though it is a lighter green color than AP-10.

TCR 1, TCR 6, and Hyb 7 have not performed well when established on golf courses and lack overall aggressiveness/quality traits. Based on salinity and acid soil/drought studies this summer, these promising ecotypes will be investigated further: HI-7, HI-10, HI-32, HI-36, HI-101, AP-4, K-1, Temple 1, Taliaferro, SPIV-2-1, 561-79.

Management Project — Research Initiated/Results

1. Insect Resistance Studies (Kris Braman).

Twolined spittlebug, *Prosapia bicincta* (Say), studies in the greenhouse and field have compared 28 paspalums to centipede, zoysia, and bermuda. In general, centipedegrass was the most susceptible followed by bermudagrass, seashore paspalum, and lastly, zoysiagrass. Among the paspalums the most resistant ecotypes were PI 509018 (Fwy1), AP-10, AP-14, PI 509023, PI 299042 (coarse type), and Mauna Key.

Fall armyworm, *Spodoptera frugiperda* (J. E. Smith), survival growth and development were compared among 31 paspalums relative to zoysia, centipede, bermuda, and tall fescue in no-choice tests in the laboratory. Resistance measured as suitability for insect growth (larval survival, larval and pupal weights, and days to pupation) was most apparent in zoysiagrasses> common centipedegrasses>common bermudagrass>paspalums>tall fescue. All paspalums supported growth and development of fall armyworms. Larval survival among paspalums ranged from 72-100%. Lowest survival occurred on Emerald zoysia (8%). Among paspalums, 561-79 demonstrated lower larval weights and lengthened development time similar to that seen on zoysiagrasses and common centipedegrass. In a previous greenhouse choice test, this selection (561-79) also demonstrated resistance as non-preference by armyworms. The most susceptible paspalums included AP-10, AP-14, K-6, K-7, K-8, HI-2, HI-25, HI-39, Temple 1, PI-509018, PI-377709, and PI-299042.

Tawny mole crickets, *Scapteriscus vicinus* Scudder, were evaluated in greenhouse (17 selections) and field trials (35 paspalums). The paspalums most tolerant of mole cricket injury in the greenhouse were 561-79, HI-1, HI-2, and Excalibur. PI-509018 retained 82% of its normal uninfested growth compared to growth on infested plots. The most susceptible among the 17 selections evaluated were PI-509023 and PI-509022 which lost 76 and 75% of their normal growth when infested with tawny mole crickets. Data from field plots are being processed. In sod production fields near Savannah, mole crickets preferred AP-14 and did not prefer PI-509018 or AP-10.

2. Herbicide/Encroachment Studies (B. J. Johnson).

a. Suppression of bermudagrass in paspalum.

Plugs (4-inches in diameter and 4-inches in depth) of three bermudagrass cultivars (common, Tifway, and TifEagle) and three paspalum cultivars (PI 509018-1, AP-10, and K-3) were transplanted March 3, 1998, in Experiment I and transplanted June 4, 1998, in Experiment II. The initial Prograss + Cutless treatments were made on March 30, 1998, in Experiment I and on July 1, 1998, in Experiment II. Treatments ranged from 1 to 5 applications at various rates in Experiment I and from 1 to 3 applications in Experiment II. The 1X rate for the Prograss + Cutless combination was 1.5 + 0.75 lb ai/A. Ratings were made at 1 to 2 week intervals throughout spring and summer.

Experiment I — Bermudagrass suppression. A single Prograss + Cutless application at 1X rate on March 30 suppressed 80% of common bermudagrass for 5 weeks, Tifway bermudagrass for 7 weeks, and TifEagle bermudagrass for 13 weeks. To maintain 80% suppression level for 26 weeks following the initial application, common bermudagrass required three additional 1X applications, Tifway required two additional 1X applications, and TifEagle required one-half additional rate application. The suppression of common and Tifway bermudagrasses was not acceptable throughout the summer when the initial full rate (1X) was followed by repeated applications at rates less than 1X level.

Paspalum injury. Prograss + Cutless applied initially at 1X rate caused 30% injury or higher for 7 weeks for all cultivars. Turf injury was generally higher than 30% when repeated applications of Prograss + Cutless were made at 1X rate and less than 30% when repeated applications were made at lower rates.

Summary. These results indicate that the total rate of Prograss + Cutless needed to effectively suppress bermudagrass throughout the summer (26 weeks) caused injury greater than 30% for several weeks during this period. Therefore, it may be necessary to accept a higher initial injury level for selected cultivars or accept a lower level of bermudagrass suppression during the initial year of treatment. For example, three consecutive applications at 1X rate suppressed common bermudagrass for 17 weeks while Tifway bermudagrass was suppressed for 26 weeks. When the acceptable injury level was increased to 40%, K-3 paspalum was injured greater than 40% in only 1 of 8 rating dates compared to 3 of 8 rating dates for PI 509018-1 and 7 of 8 rating dates for AP-10.

Experiment II. When Prograss + Cutless was delayed until July 1, 1998, bermudagrass was not effectively suppressed from the 1X rate level at anytime during mid to late summer. The suppression was improved in plots that received 2 and 3X rate levels of Prograss + Cutless initially or when sequential applications were made at any rate.

In most instances, injury to paspalum was too severe to be acceptable regardless of rate. The maximum injury was 49% for K-3, 51% for AP-12, and 76% for PI 509018-1 in plots treated once at 2X rate or twice at 1X rate levels. Therefore, Prograss + Cutless treatments should not be applied initially in early summer for bermudagrass suppression.

b. Suppression of seashore paspalum in bermudagrass.

Plugs (4-inches in diameter and 4-inches in depth) of three paspalum cultivars (PI 509018-1, AP-10, and K-3) and three bermudagrass cultivars (common, Tifway, and TifEagle) were transplanted June 4, 1998. Various rates of Trimec Plus (MSMA + 2,4-D + mecoprop + dicamba), MSMA + 2,4-D + dicamba, Confront (triclopyr + clopyralid), and MSMA + Confront were applied initially on July 1, 1998, followed by one or two additional applications.

Paspalum suppression. The suppression of paspalum cultivars at 13 weeks after treatment was highest from MSMA + Confront when applied at 2.0 + 0.5 lb ai/A in each of three applications on July 1, July 28, and August 18, 1998. The suppression from three treatments was 90% for AP-10, 78% for PI 509018-1, and 69% for K-3. The suppression from Confront alone at 0.5 lb ai/A was not as good at 13 weeks (33 to 45%) as when tank-mixed with MSMA. The suppression in plots treated with Trimec Plus and MSMA + 2,4-D + dicamba was similar to Confront alone.

Bermudagrass injury. Maximum bermudagrass injury occurred at 2 weeks after the initial herbicide treatments. By 4 weeks the bermudagrass had recovered and there was little or no injury from the second or third herbicide applications. Maximum injury at 2 weeks was similar for common and Tifway bermudagrass when treated with any herbicide (30 to 39%). Injury to TifEagle treated with Trimec Plus was higher (45%) than common (36%) and Tifway (35%), but the injury was lower when treated with Confront alone or with MSMA (15 to 18%) than common (33 to 37%) or Tifway (30 to 39%).

Summary. These results indicate that MSMA + Confront applied in three applications suppressed paspalum cultivars more than Confront alone, Trimec Plus, and MSMA + 2,4-D + dicamba. Most herbicides caused initial discoloration of bermudagrass, but the bermudagrass fully recovered by 4 weeks.

3. Salt screening (Joo Lee – Ph.D. graduate student).

Ninety-four paspalum ecotypes and four bermudas were evaluated in sea salt formula nutrient solution in the greenhouse. Based on high inherent growth rate, shoot tolerance, and root tolerance to 41 dsm^{-1} salinity, the most salt tolerant ecotypes included AP-10, PI 509018-1 (Fwy-1), SIPV 35-2, K-3, HI-6, HI-36, and HI-101. Additional studies are targeting specific tolerance mechanisms contributing to increases in root and crown growth at 50 dsm^{-1} salinity.

4. Wear tolerance (Laurie Trenholm – Ph.D. graduate student).

Four fine-leafed paspalums, three coarse-leaf paspalums, and three bermudas (Tifgreen, TifSport, Tifway) were compared under wear (using a traffic simulator) and non-wear conditions. Forage analyses were conducted in concert with turf measurements to discern the mechanisms underlying wear tolerance between the two species. Generally, the finer-leafed paspalums exhibited better wear tolerance and recoverability than coarse-textured paspalums.

The wear tolerance mechanisms differed between paspalum and bermuda. For paspalum, 74% of the variability was attributed to the following components: leaf total cell wall (cellulose, hemicellulose, lignin) = 50%; leaf moisture = 8%; leaf strength = 3%; shoot density = 11%; stem total cell wall = 2%. For bermuda, 99% of the variability could be attributed to the following components: stem moisture = 41%; stem cellulose = 32%; shoot density = 9%; leaf lignin = 3%; leaf moisture = 9%; stem lignocellulose = 3%; leaf lignocellulose = 2%. Based on leaf forage analysis, paspalum had slightly lower total cell wall contents, equal cellulose, higher lignocellulose, lower hemicellulose, and higher lignin than bermuda. Based on stem forage analysis, paspalum had higher total cell wall content, lower cellulose, lower lignocellulose, higher hemicellulose, and equal lignin content compared to bermuda.

Temple 1 and SIPV-2 paspalum ecotypes had reduced rates of shoot tissue injury at 7 days after wear treatment. Initial differences in wear injury were more important than regrowth/ recoverability for wear tolerance.

5. Multiple stress tolerance.

Refer to Bob Carrow's annual report.

6. Fertility studies.

Hyb 5 was sprig-planted on a 90:10 sand green during June and 5 fertility treatments with and without lime were used for grow-in: none, $CaNO_3$, NH_4SO_4, NH_4NO_3, urea. Overall ratings (coverage/quality/density/color) favored the highly soluble $CaNO_3$ treatment. Urea and NH_4NO_3 were equal while NH_4SO_4 provided the lowest response among fertilizer treatments. Lime amendments enhanced only the NH_4SO_4 treatment.

$CaNO_3$ will be used in 1999 on additional studies involving scalping recovery, spring green up, and divot recovery. The Scotts Company is interested in collaborating on developing specific fertilizer formulations for environmentally friendly paspalum management and these efforts should begin with the 1999 growing season.

7. Divot Recovery Study.

A preliminary study was initiated during July involving divots created by using a pitching wedge on the experimental push-up tee (Fwy-1 ecotype). Unfortunately, NH_4NO_3 was used as the fertilizer source. Treatments included top dressing/no top dressing and verticutting/no verticutting. No consistent conclusions could be ascertained. Because of rapid uptake/response to $CaNO_3$, this study will be repeated in 1999 using this fertilizer.

8. Planting on golf courses – 1998.
   - White Bluff @ Lake Whitney, TX.
   - The Cliffs @ Possum Kingdom Lake, TX.
   - Cherokee Rose CC @ Hinesville, GA.
   - Butternut Creek GC @ Blairsville, GA.
   - Padre Island CC @ Corpus Christi, TX.
   - The Honors Course @ Chattanooga, TN.
   - Hohenwald GRC @ Hohenwald, TN.

Additional ecotypes were sent to Don Parsons @ Old Ranch CC, Seal Beach, CA.

9. Paspalums supplied.
   - F. Rossi @ Cornell.
   - M. Engelke @ TAMU – Dallas.
   - Jim Latham @ Whitney, TX.
   - Wayne Mixon — Scotts in FL.
   - Trey Rogers @ Michigan State.
   - Vance Baird @ Clemson.
   - J. Bryan Unruh @ Pensacola (Milton), FL.
   - A. Harivandi @ CA.
   - Fred Yelverton @ NCSU.
   - Dave Kopec @ AZ.
   - Jeff Higgins @ Auburn.

10. Quarantine releases.

Two accessions from Guam and one from Brisbane, Australia, cleared quarantine. Fwy-1 and AP-10 have cleared quarantine in Hawaii and are being maintained by Tom Staton @ Quality Turf for evaluation on golf courses there.

1998 Publications

1. Cardona, C.A., and R.R. Duncan. 1998. In vitro culture, somaclonal variation, and transformation strategies with paspalum turf ecotypes. p. 229-236. In M.B. Sticklen and M.P. Kenna (eds.). Turfgrass Biotechnology. Cell & Molecular Genetic Approaches to Turfgrass Improvement. Ann Arbor Press, Chelsea, MI.

2. Brown, S.M., S.E. Mitchell, C.A. Jester, Z.W. Liu, S. Kresovich, and R.R. Duncan. 1998. DNA typing (profiling) of seashore paspalum (Paspalum vaginatum Swartz) ecotypes and cultivars. p. 39-51. In M.B. Sticklen and M.P. Kenna (eds.). Turfgrass Biotechnology. Cell & Molecular Genetic Approaches to Turfgrass Improvement. Ann Arbor Press, Chelsea, MI.

3. Johnson, B. Jack, and R.R. Duncan. 1998. Influence of herbicides on establishment of eight seashore paspalum cultivars. J. Environ. Hort. 16(2):79-81.

4. Johnson, B. Jack, and R.R. Duncan. 1998. Tolerance of seashore paspalum cultivars to preemergence herbicides. J. Environ. Hort. 16(2):76-78.

5. Duncan, R.R. 1998. Seashore paspalum herbicide management. USGA Green Section Record 36(2):17-19.

6. Trenholm, L.E., R.N. Carrow, and R.R. Duncan. 1998. Paspalum vs. bermudagrass: which is more traffic tolerant? Golf Course Management July:61-64.

7. Duncan, R.R. 1998. Keys to success with paspalum on golf courses. Golf Course Management Feb:58-60.

8. Duncan, R.R. 1998. Paspalum – an alternative environmentally friendly warm-season grass. Georgia Green Industry Assoc. J. 9(3):38, 40, 42.

9. Carrow, R.N., and R.R. Duncan. 1998. Performance of several seashore paspalum ecotypes and three bermudagrasses. GTA Today 13(1):18-19.

10. Huang, B., R.R. Duncan, and R.N. Carrow. 1998. Drought-resistant mechanisms of seven warm-season turfgrasses under surface soil drying. Through the Green May/June:22-23, 46-47, 50.

11. Cyril, J., R.R. Duncan, and W.V. Baird. 1998. Changes in membrane fatty acids in cold-acclimated turfgrass. Hort Sci. 33(3):abstr. 054-1F42. p. 453.

12. Duncan, R.R., and R.N. Carrow. 1998. Genetic tolerance enhancement of warm and cool season grasses for multiple abiotic:edaphic stresses. p. 34-41. In G.E. Brink (ed.). Proc. of the 54th Southern Pasture and Forage Crop Improvement Conf. Apr. 27-29, 1998. Lafayette, LA.

13. Carrow, R.N., and R.R. Duncan. 1998. Salt-affected turfgrass sites: assessment and management. Ann Arbor Press, Chelsea, MI. 185 p.

Pending

1. Trenholm, L.E., R.R. Duncan, and R.N. Carrow. 1999. Comparison of shoot performance, tissue nutrient concentration, and wear tolerance of seashore paspalum and bermudagrass. Crop Sci. (approved).

2. Trenholm, L.E., R.N. Carrow, and R.R. Duncan. 1999. Relationship of multispectral radiometry data to qualitative data in turfgrass research. Crop Sci. (approved).

3. Lee, G.J., R.R. Duncan, and R.N. Carrow. 1998. Diversity of salinity tolerance within Paspalum vaginatum and selected Cynodon spp. Abstr. ASA 90:127.

4. Trenholm, L.E., R.N. Carrow, and R.R. Duncan. 1998. Wear tolerance and mechanisms in fairway-type Paspalum vaginatum and Cynodon spp. Abstr. ASA 90:126.

5. Duncan, R.R. 1998. Environmental compatibility of seashore paspalum (saltwater couch) for golf courses and other recreational uses. I. Breeding & Genetics. Int'l Turfgrass Soc. Res. J. 8(Vol. 2):_________.

6. Duncan, R.R. 1998. Environmental compatibility of seashore paspalum (saltwater couch) for golf courses and other recreational uses. II. Management protocols. Int'l Turfgrass Soc. Res. J. 8(Vol. 2):________.