1994
ANNUAL PROGRESS REPORT

BREEDING AND DEVELOPMENT OF ZOYSIAGRASS

Submitted By:

Dr. M. C. Engelke
Principal Investigator
Turfgrass Breeding, Genetics, and Management

with

Mr. Samuel K. Riffell
Research Associate
Turfgrass Breeding, Genetics, and Management

and

Ms. Sharon Morton
Former Research Associate
Turfgrass Breeding, Genetics, and Management

Jointly Sponsored By:

United States Golf Association

and

Texas Agricultural Experiment Station

1 November 1994

NOT FOR PUBLICATION

VOLUME 94-2

1994 ANNUAL PROGRESS REPORT
BREEDING AND DEVELOPMENT OF ZOYSIAGRASS

CONTENTS

Executive Summary 1

Introduction 2

Technical Support Personnel 2

Greenhouse and Laboratory Progress
- Germplasm Maintenance 2
- Screening Germplasm Resources for Insect/Mite Resistance 2

Field Evaluation and Production Trials
- Shade Tolerance 4
- National Turfgrass Evaluation Program (NTEP) 4
- Management 5
- Other Field Evaluations 5

Zoysiagrass Development and Increase
- Polycross Nurseries 5
- Breeder and Foundation Fields 5
- Fairways 6
- DALZ8502 Green 6

Appendices
- A. Curriculum Vitae - Samuel K. Riffell 8
- B. Resistance in Zoysiagrass to the Fall Armyworm 11
- C. Resistance in Zoysiagrass to the Tropical Sod Webworm 15
- D. Zoysiagrass Resistance to the Zoysiagrass Mite 17
- E. Zoysiagrass Resistance to the Zoysiagrass Mite 20
- F. Performance of Three Warm-Season Turfgrass Genera Cultured in Shade III. Zoysia spp. 22
- G. Zoysiagrass Shade Tolerance 28
- H. 1994 Update to the 1991 National Turfgrass Evaluation Program (NTEP) Zoysiagrass trial at TAES-Dallas 32
- I. Zoysiagrass NTEP trial National Data 39
- J. Effects of Primo™ Treatments on Turfgrasses Grown Under Linear Gradient Irrigation 44
- K. Distribution of zoysiagrass from TAES-Dallas from 1992 through 1994 51
- L. Polycross Nurseries 57

1994 RESEARCH REPORT

BREEDING AND DEVELOPMENT OF ZOYSIAGRASS

Executive Summary

Principal Investigator: Dr. M. C. Engelke
Co-Investigator: Mr. S. K. Riffell and Ms. S. J. Morton
Research Period: 1 November 1993-1 November 1994.

Marking the 10th year of this USGA sponsored research project over $500,000 has been directed to this project. Germplasm acquisition and maintenance continue. TAES-Dallas is serving as a remote quarantine site for plant materials introduced in to the Zoysiagrass program from other countries, primarily China and Japan. Plant materials are encouraged to produce self and cross pollinated seeds to expedite the removal from quarantine. Seeds are not subjected to as severe a testing period or procedures as vegetative material.

The NTEP zoysiagrass trials established in 1991 include nine TAES/USGA entries. DALZ8507, a fine-textured, cold hardy *Zoysia matrella*, topped the trials, in both 1992 and 1993. Other varieties of note include DALZ8512 and DALZ8514, each doing well in both years, also DALZ9006 and DALZ8508.

Breeder fields of DALZ8502, DALZ8507, DALZ8512 and DALZ8514 (15,000 ft^2 (0.139 ha) each) were planted in July 1992. Considerable planting stock of each of these varieties have been harvested and entered into advanced testing at remote locations including; Baltimore Country Club-Maryland, Wilmington CC-Delaware, Marion CC-Maryland, and Congressional CC - Washington DC, Alvarmar CC, Kansas, Topeka CC-Kansas, Northwood CC-Kansas, Buffalocreek GC-Texas, Northwood Hill-Texas, Preston Trails-Texas.

Foundation fields of DALZ8507, DAL8512 and DALZ8514 were established vegetatively in June 1994. Planting stock will be harvestable by spring 1995 to coincide with anticipated release of the varieties for commercial production

The DALZ8502 greens at TAES-Dallas continue to perform well. The chipping green established with Colonial Country Club, is reported to be doing quite well including the shaded tee box where continued field evaluation supports the use of this grass under low light condition. Rapid regrowth of DALZ8502 occurs due to its extensive rhizome system.

The Linear Gradient Irrigation System (LGIS) has been reestablished with 12 *Zoysia* experimentals, three bermudagrasses, a buffalograss, a St. Augustinegrass, and a Texas bluegrass to provide extensive inter- and intraspecies water-use/cultural input comparisons. Of targeted interest is the influence of fertility levels across the moisture gradient on turfgrass performance.

1994 ANNUAL RESEARCH REPORT
BREEDING AND DEVELOPMENT OF ZOYSIAGRASS

M. C. Engelke, S. K. Riffell, and S. J. Morton

Introduction

The zoysiagrass breeding and development program is in its tenth year of funding through the United States Golf Association. Initiated in May 1984, the cooperative efforts between the Texas Agricultural Experiment Station and the USGA have continued to develop improved zoysiagrasses for the golf and turf industry. To date, a total of $505,000 has been dedicated to Breeding and Development of Zoysiagrass. This report will detail research activities between 1 November 1993 through 1 November 1994.

Technical Support Personnel

Samuel K. Riffell (Research Associate) joined the turfgrass breeding program in September 1993 (Vita Appendix A). Mr. Riffell recently received a Master's in Environmental Studies from Baylor University. Approximately 80% of Mr. Riffell's time is spent on the zoysiagrass project.

Ms. Sharon J. Morton (Former Research Associate) served the zoysiagrass project from September 1989 to August 1994. Ms. Morton has since entered doctoral studies at Texas A&M University at College Station. Approximately 60% of Ms. Morton's time was spent on the zoysiagrass project.

Greenhouse and Laboratory Progress

Germplasm Maintenance

The zoysiagrass germplasm library has been repotted, and the inventory continues to be updated. Seed has been tested for germination potential, and seedlings have been planted in the greenhouse. Progeny of zoysiagrasses recently brought to the program from China and Japan have been obtained both from specific crosses and from open-pollination. These progeny will become part of the germplasm library, and will be screened by greenhouse and field procedures.

The Texas A&M Research and Extension Center - Dallas location serves as a working quarantine import facility in cooperation with APHIS and the USDA, ARS Plant Quarantine Facility. In this capacity, and under the direction of M. C. Engelke, plant materials collected or shipped form overseas are simultaneously introduced into the United States through APHIS and TAES-Dallas for purposes of scientific studies under controlled conditions. Limitation imposed on the use of material restricts manipulations including floral initiation studies, self-pollinations, hybridizations, and seed harvest. Any agronomic increase or evaluations may be conducted with the restriction that it must be done in the quarantine space only. Seeds harvested from the plants are not subject to isolation, and therefore can be moved into the main stream research program sooner. Any vegetative materials collected must be subjected through two time-spaced viral screening (serology) procedures by the ARS Plant Quarantine Lab, which generally requires 1 - 2 years to fully accomplish. In our cooperation with ARS, only a limited number of plants require full serological testing. We have harvested seed from most all other plants, thereby reducing the time element and expense of further testing.

Screening Germplasm Resources for Insect/Mite Resistance

Dr. James A. Reinert assumed full-time re-

search responsibilities in August 1994 and, in addition to previous work (see Appendices B-E), has initiated more intensive host-plant resistance studies involving numerous turfgrass species including the zoysiagrasses and creeping bentgrasses. A portion of the support provided by USGA is being directed to support activities in the area of host-plant resistance studies with both of these grasses. To date studies have been completed on advanced germplasm lines identified as DALZ lines which were included in the National Turf Evaluation Program trials. These reports have been published in the Texas Turfgrass Research Report (see Appendices B-D) and International Turfgrass Society Research Report (see Appendix E).

Future work will also be directed toward screening the hybrids and numerous other germplasm lines for additional sources of resistance to insects including: fall armyworm, black cutworm, tropical sod webworm, hunting billbug, etc.

It is our philosophy that the development of drought-tolerant, water-use efficient plant materials and the development and acceptance of appropriate management practices will result in a substantial change in the microenvironment in which the plant community lives. This includes the environment for all supporting and allied organisms as well. Theoretically, we should see a substantial reduction in the incidence of the common diseases presently impacting our turf since most of these require high humidity (frequent irrigation) and high fertility (frequent heavy fertilization). Once reductions are realized in both frequency and intensity of irrigation and fertilization, a less favorable disease environment should result. However, we very well may see the environment being changed in favor of increased insect activity as well. Insects generally favor a lower moisture environment and also proliferate where a plant is growing slower, enabling the insect population to "get ahead" of the plant. This can result in greater damage being evident. To that end, collaboration with Dr. Reinert can and will play an important role.

Fall Armyworm Resistance

In collaboration with Dr. James A. Reinert (TAES-Dallas), zoysiagrass genotypes in the 1993 NTEP trail are being evaluated for their potential resistance to the fall armyworm. In a preliminary experiment with entries from the 1991 NTEP trial, three levels of resistance were observed in the zoysiagrasses, with several genotypes (including DALZ8507) expressing total resistance. Dr. Reinert's research is further detailed in Appendix B - Resistance in Zoysiagrass to the Fall Armyworm (*Spodoptera frugiperda*). Increase of the 1991 NTEP zoysiagrass entries has begun for further research into zoysiagrass resistance to fall armyworm.

Tropical Sod Webworm

In collaboration with Dr. James A. Reinert, zoysiagrass genotypes in the 1993 NTEP trial are being evaluated for their potential resistance to the tropical sod webworm. In earlier experiments with the 1991 NTEP trial, distinct levels of resistance to the tropical sod webworm were documented, with DALZ8507 and DALZ8501 expressing the highest level of resistance. Several other genotypes also exhibited resistance to this pest, which is prevalent throughout much of the area where the new zoysia cultivars will be produced. Results are further detailed in Appendix C - Resistance in Zoysiagrass to the Tropical Sod Webworm (*Herpetogramma pheopteralis*).

Zoysiagrass Mite

In cooperative studies with Dr. James A. Reinert, the entries in the 1991 NTEP trial were evaluated for resistance to the zoysiagrass mite in greenhouse studies. Three experimental genotypes (DALZ8505, DALZ8516, and DALZ9006) and Emerald showed very low infestation levels and were considered resistant, while most other cultivars (including Meyer and Belair) were very susceptable to the mite. This mite is considered the most insidious pest of zoysiagrass in Korea and Japan, the origin of the genus. Now that this mite is established in the U. S., it threatens to become a major limiting factor for zoysia culture. Zoysiagrass mite research is further detailed in Appendices D and E - Zoysiagrass resistance to the

Zoysiagrass Mite *Eirophyes zoysiae* (Acari: Eriophydae).

From these preliminary studies, we now have strong indications that multiple resistance can be developed in the next generation of zoysiagrass introduced to the industry.

Although studies have not yet been initiated, another area rapidly surfacing as a serious threat is the proliferation of nematodes in the turf. It is the intent of this project, in cooperation with other funding sources and projects, to assist in establishing host-plant resistance screening for nematode resistance. To date no active nematode research program has directed attention to identifying nematode resistance in any species relative to turf. It is my hope to encourage other funding agencies to support and identify qualified individuals to assist in nematode identification, control methodology, and host plant resistance. The use of selected chemistry is the only effective means of control available to us today. These chemistries have potentially high toxicity and are subject to elimination from use where human interaction can occur. It is our responsibility, therefore, to rapidly initiate an effective means of alternate control, and biological resistance is one of the most conceivable means.

Field Evaluation and Production Trials

Shade Tolerance

The performance of the 1993 NTEP zoysiagrasses when grown under shade conditions was evaluated for a second year with focus remaining on the entries' ability to spread, green color retention, density, and turf quality. During the past year, eight DALZ lines were among the 10 most consistent performers, and DALZ8516 had the best overall turf performance when grown under shade. Detailed results from the past year and summary results from both years are presented in Appendix F - Performance of the 1991 NTEP Zoysiagrasses Under Shade.

The performance of two commercially available zoysiagrasses, El Toro and Emerald, and one experimental zoysiagrass, DALZ8502, when grown under varying degrees of shade was evaluated in a separate study. Although all three zoysiagrass varieties had highest overall turf quality ratings when grown in full sun (0% shade), the experimental DALZ8502 was the most consistent performer in all shade levels. Complete results of the comparative shade tolerance of these three varieties under different degrees of shade are presented in Appendix G - Zoysiagrass Shade Tolerance.

National Turfgrass Evaluation Program (NTEP)

a) Locally, the 1991 planting of the trial became severely contaminated with bermudagrass. Thus, the 1991 NTEP zoysiagrass trial was replanted in August 1994. Except for notes pertaining to disease incidence and insect infestation, the 1991 planting of the trial was abandoned. Evaluation continues, however, on the 1993 planting. Performance of the 1991 NTEP zoysiagrass entries is detailed in Appendix H - 1994 Update to the 1991 National Turfgrass Evaluation Program (NTEP) Zoysiagrass Trial at TAES-Dallas.

b) Nationally, the second year of information has recently been published, and DALZ8507 was again ranked first in the trials. This is 2 years in a row and speaks well of the performance of this cultivar. In the published 1992 results, four of the DALZ lines averaged in the top statistical grouping. Along with their relative rank this includes: DALZ8507 (1), DALZ8512 (5), DALZ8514 (6) and DALZ9006 (10). In 1993 five of the DALZ lines averaged in the top statistical grouping. Along with their relative rank this includes: DALZ8507 (1), DALZ8508 (5), DALZ9006 (6), DALZ8514 (9), and DALZ8512 (11). For brevity sake, I have included NTEP data tables for observation. These tables are located in Appendix I and represent: 1992 Summary Table 2 = Turfgrass Quality ratings at 22 locations by month (page 8) presenting mean performance, and Table 3 = Turfgrass Quality ratings at 22 locations by month (page 9) which are

the rankings of the same data set over each and all locations. 1993 Summary Table 2A = Turfgrass Quality ratings at 22 locations by month (page 9) presenting mean performance, and Table 3a = Turfgrass Quality ratings at 22 locations by month (page 11) which are the rankings of the same data set over each and all locations.

Cultivar	92 Rank	93 Rank
DALZ8501	19	23
DALZ8502	23	20
DALZ8507	*1	*1
DALZ8508	12	*5
DALZ8512	*5	*11
DALZ8514	*6	*9
DALZ8516	20	16
DALZ8701	24	24
DALZ9006	*10	*6

* Indicates the ranking occurred within the highest statistical grouping based on mean performance at 22 locations throughout the respective year.

Dr. M. C. Engelke will be presenting a paper to the American Society of Agronomy on the use of a turf performance index (TPI). The TPI takes into consideration the relative performance of entries in the NTEP based on statistical groupings rather than merely ranking the cultivars which is highly misleading and has been construed erroneously by the turf industry for all of the NTEP trials.

Management

The effects of a commercially available growth regulator, Primo™ on the irrigation requirements and drought stress tolerance of Meyer zoysiagrass (and 4 other turfgrass genera) were investigated under the linear gradient irrigation system (LGIS). Although treatments of Primo™ did not have any significant effects on clipping yields, canopy temperatures, or net radiation, Meyer zoysiagrass withstood more severe drought conditions before wilting in treated plots compared to control plots which received no Primo™ applications. These results indicate that Primo™ does have the potential to reduce the irrigation requirements of some turfgrasses. Detailed results of this study are located in Appendix J - Effects of Primo™ on Turfgrasses Grown Under Linear Gradient Irrigation. These types of studies are conducted to continue supporting the operation and use of LGIS in evaluating the water requirements of the experimental zoysiagrasses under development.

Other Field Evaluations

Considerable amounts of the DALZ zoysiagrass lines have been entered into advanced tests and field evaluations in various locations across the United States. Many of these locations are country clubs, where the zoysiagrasses have been sent for use as greens, tee boxes, fairways, roughs, and bunker faces. Additionally, zoysiagrass material has been established as home greens and lawns. At many of these locations, the DALZ cultivars are being evaluated for many components of turf performance including: cold-, heat-, shade-, and drought-tolerance, wear and compaction, and disease resistance. These remote field evaluations are detailed in Appendix K.

Zoysiagrass Development and Increase

Polycross Nurseries

Two polycross nurseries are being maintained and evaluated for spread, texture, flowering, and seed production. Information gained from these polycross nurseries will assist in identifying parent combinations wwith potential to produce offspring with desirable traits. These combinations can then used to produce cultivars with higher resistance and better performance. Progress of the polycross entries is summarized in Appendix L - Polycross Nurseries.

Breeder and Foundation Fields

Four 15,000-ft^2 breeder fields planted in July 1992 are maintained at 1# N / 100 ft^2 / month with close monitoring for disease. DALZ8507 and DALZ8502 are mowed with a reel mower at 5/8"

and 3/8', respectively. DALZ8512 and DALZ8514 are mowed at 1 1/2'. Each of the breeder fields have been harvested at least once permitting excellent assessment of the sod production of each of the varieties. In comparison to commercial production of Meyer, which requires 15 - 24 months per harvest cycle, substantial improvements have been realized for DALZ8502, DALZ8512, and DALZ8514 had rapid recovery.

DALZ8502 was slow to establish, requiring approximately 15 - 18 months. The slow initial establishment of the production field is attributed primarily to extensive rhizome development. Following harvest, the recuperative rate and harvest cycle will approximate a 6 month cycle, yielding up to two crops per year. Recognizing the long term perennial habit of this grass, these cycle times and subsequent production costs are highly desirable. Its regrowth is attributed primarily to rhizomes.

DALZ8512 is a rapid spreading and regrowing *Zoysia japonica* which provides a cropping cycle of approximately three crops every two years in the Dallas area. Its regrowth is based on both rhizomes and stolons. Its optimum mowing height will range from 0.5 inches - 2.5 inches, although scalping will occur at the lower height of cut.

DALZ8514 is also a rapid spreading and regrowing *Zoysia japonica* which tolerates a tighter mowing than DALZ8512 with acceptable performance at 3/8 inch with optimum mowing height ranging from 0.5 inches - 2.5 inches. DALZ8514 has the capability of producing up to two crops each year in the Dallas area. It spreads by rhizomes and stolons and is rapid to recover.

DALZ8507 is a fine textured cold-hardy *Zoysia matrella* which reproduces primarily by stolons. It is classified as being weakly rhizomatous. It is slower to regrow following sod harvest yet we have been able to achieve full-cycle crop production within 12 months.

Foundation fields of DALZ8507, DALZ8512, and DALZ8514 were planted in June of 1994. Release documents are in preparation for submission to the Texas A&M Experiment Station Plant Review Committee by early January 1995, with targeted release date of early spring. The foundation fields, which average approximately 2 acres, will provide planting stock for release by mid-May to early June, 1995.

Fairways

In May of 1993, 7200-ft^2 (0.06 ha) fairways of both DALZ8507 and DALZ8512 were planted from plugs at a 1:200 planting ratio. Prior to planting, the soil in half of each fairway was treated with hydrozone polyacrylamide moisture retention material to retard desiccation. Both fairways are reel mowed at 5/8 inch, maintained with 0.5 lb N / 100 ft^2, and irrigated to prevent wilting.

DALZ8502 Green

The zoysiagrass greens at TAES-Dallas continue to attract attention. This past year we established 3 home greens for private residents to test the potential for use in such an environment. One green was built on a sand-modified root zone. DALZ8502 sod was harvested, washed thoroughly, and laid, followed by extensive top dressing with sand root-zone mix. The other greens were solid sodded on native soil sites. Plantings occurred in late August, and reports thus far are positive.

The research green at TAES is covered throughout the winter when ambient temperatures drop below 40°F. During 1994, significantly faster greenup occurred on the covered half of the green. Remnant bentgrass seed was still present in the spring of 1994, following the 1992 overseeding. The plant material was eradicated with herbicides and, hereafter, the green will not receive overseeding and will be managed purely as a zoysiagrass green, covering 50% during the winter months. Additional greens have been established at Colonial Country Club where a chipping green was planted in September 1993. Tom Werner covered the green during cold weather periods of 1993/94 and reports the green is doing exceptionally well. A second chipping green was established in August 1994 at Alvarmar Country Club in Lawerence Kansas in cooperation with Dick Stuntz, CGCS with the intent of providing winter coverage during freezing temperatures.