TURFGRASS RESEARCH CONFERENCE AND FIELD DAY

September 17, 1997

AND

LANDSCAPE MANAGEMENT RESEARCH CONFERENCE AND FIELD DAY

September 18, 1997

University of California, Riverside

Cooperative Extension

Dept. of Botany and Plant Sciences

Agricultural Operations

TURFGRASS RESEARCH CONFERENCE AND FIELD DAY

WEDNESDAY, SEPTEMBER 17, 1997

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ROOTING AND DRY-DOWN CHARACTERISTICS OF ZOYSIAGRASS CULTIVARS

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Reduced availability of water for landscape irrigation has increased the need for drought-resistant turfgrasses. Recent studies have shown that rooting depth, mass, and branching at lower depths are important drought-resistance mechanisms in *Zoysia* spp. Developing a glasshouse screening technique that would accurately predict field-rooting characteristics of *Zoysia* spp. would be a useful tool for turfgrass breeders.

Three studies were conducted to determine the efficacy of predicting field rooting of *Zoysia* spp. genotypes with glasshouse screening procedures. Genotypes studied were 'Belair', DALZ 8507 ('Cavalier'), DALZ 8512 ('Crowne'), DALZ 8514 ('Palisades'), 'El Toro', 'Emerald', 'Meyer', UCR Z88-3, 'De Anza', and 'Victoria'. The initial screening revealed significant differences in rooting characteristics among the 10 genotypes assessed. DALZ 8512 produced the longest roots and a greater root mass than 'Victoria', 'El Toro', DALZ 8507, UCR Z88-3, 'De Anza', and 'Belair'. In July 1993, 152cm-deep root cores were extracted from the same genotypes (with the exception of Z88-3 which was not available) used in the glasshouse study from an established zoysiagrass plot at the UC Riverside Turfgrass Research Facility. Resulting Pearson correlation coefficients were 0.64 (P=0.07) for root mass between 0 to 30.5 cm depth and 0.64 (P=0.06) for total root mass, indicating that the glasshouse trial was predictive of field rooting. Two subsequent glasshouse studies did not indicate a correlation between glasshouse and field rooting; reasons for these differences are currently being assessed.

A field dry-down study on the same genotypes previously compared in the glasshouse and field was implemented in August 1994. 'Belair' and 'Meyer' showed the greatest initial browning (leaf firing) and 'Emerald' the least. DALZ 8512, which produced the longest roots in the glasshouse screening study, was intermediate in the first few weeks of the dry-down study. On September 15, after six weeks of imposed drought, there were no differences in leaf firing among 'El Toro', DALZ 8507, DALZ 8514, and 'Victoria', which were all between 93 and 95 percent brown. On the same date, 'Belair', 'Meyer', 'De Anza', and DALZ 8512 were all 92 percent brown. 'Emerald' continued to show greater leaf firing resistance than the other genotypes and was 70 percent brown. All grasses fully recovered once irrigation was reinstated following the six weeks of imposed drought.

Pearson correlation coefficients comparing total root mass of the field-assessed *Zoysia* genotypes and percent brown during the dry-down phase were -0.70 (P=0.01) on August 15; -0.75 (P=0.02) on August 23; and, -0.71 (P=.03) on August 26. Subsequently, the correlations weakened. Pearson correlation coefficients comparing total plant mass and percent brown were -0.63 (P=0.07) on August 15; -0.85 (P=0.003) on August 23; -0.84 (P=0.005) on August 26; -0.81 (P=0.008) on September 2; -0.83 (P=0.07) on September 6; and, -0.62 (P=0.07) on September 9.

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DRY-DOWN CHARACTERISTICS OF ZOYSIAGRASS CULTIVARS

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Zoysiagrass research and evaluation began at the University of California in the 1960's and culminated in the release of three patented cultivars, 'El Toro', 'De Anza', and 'Victoria' that have been released to the turfgrass industry. The reason for the interest in improving zoysiagrass performance through plant breeding was based on the low-maintenance characteristics of the genus. One aspect of low-maintenance in Southern California would relate to the irrigation requirement and drought tolerance, because of the long-term issue of water availability facing the state. To gain additional specific information about its drought tolerance a study of the tolerance of zoysiagrass cultivars to dry-down during the summer/fall season was carried out in 1996 at UC South Coast Research and Extension Center, Irvine, CA.

The research site contained 24 zoysia cultivars or experimental lines (see Table 1) including 'El Toro', Korean Common, 'Meyer', 'Emerald', and the newly released UC cultivar, 'Victoria'. On July 1, 1996, irrigation was discontinued and the plots were observed twice weekly and rated for "leaf firing" or browning due to drought. A 1-9 scale was used with 1-3 denoting dead to nearly dead grass, 4-6 for stressed grass with some green leaf tissue, and 7-9 indicating green leaf tissue overall.

Mowing was continued as long as there was growth in any of the plots.

Cultivars varied in their dry-down response from those such as DALZ 8502 ('Diamond') and 'Emerald', which lost color gradually to those, such as 'Meyer' that lost color rapidly in the drought cycle. Varieties did not fall in distinct groups in terms of their dry-down response, but spread out along a continuum from slow to fast leaf browning (color loss). Recovery from drought was also observed and rated in late fall after irrigation was restarted (October 1, 1996 – December 14, 1997). Those grasses that exhibited slow green color loss during the drought phase, regained color (recovered) much better than those which lost their color rapidly.

The preliminary results indicate that there is considerable variation among the zoysiagrass cultivars and experimental lines regarding leaf-firing or, conversely, green-color retention during drought conditions. This may be an important issue for water-conscious California now and in the future.

Table 1. Regression analysis of color score verses day for each variety during dry-down phase (5 July – 30 Sept. 1996).

VARIETY	COLOR LOSS (Slowest to fastest)	Significance Test[4]
DALZ 8502	-0.9	a
Emerald	-1.3	ab
DALZ 8701	-2.1	abc
DALZ 8514	-3.0	bcd
DALZ 8512	-3.1	bcd
El Toro	-3.9	cde
DALZ 8507	-4.6	def
TGS-B10	-5.1	ef
DALZ 8516	-5.2	efg
Z88-3	-5.7	efgh
TGS-W10	-5.9	fghi
JZ-1	-7.1	ghij
CD259-13	-7.3	hij
Victoria	-7.4	hijk
TC5018	-7.5	hijk
DALZ 8501	-7.6	hijk
DALZ 8508	-7.7	ijk
DALZ 9006	-8.8	jk
TC2033	-9.3	k
Sunburst	-11.3	l
GT2047	-12.0	l
Meyer	-12.2	l
GT2004	-14.2	m
CD2013	-18.3	n

[4] Fisher's Protected LSD Test, P=0.05, regression coefficients with no letter(s) in common are significantly different.

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NITROGEN LEACHING AND BEST MANAGEMENT PRACTICES FOR OVERSEEDED BERMUDAGRASS FAIRWAYS

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Currently, there is considerable interest in implementing turfgrass best management practices (BMP's) for several environment-related issues, such as the potential contamination of runoff water and groundwater with applied nutrients, especially NO_3-N and pesticides.

Fertilization of turfgrasses, according to established cultural strategies, presents a negligible potential for nutrient elements to pass through the root zone into the groundwater or be transported by runoff water into surface waters. This has been confirmed by a number of studies or reviews (Beard and Green, 1994; Cohen et al., 1990; Geron et al., 1993; Gold et al., 1990; Gross et al., 1990; Harrison et al., 1993; Miltner et al., 1996; Morton et al., 1988; Petrovic, 1990; Watschke and Mumma, 1989). However, turfgrass managers will need to give special attention to fertilization practices when 1) there is potential for heavy rainfall, 2) the turfgrass is immature and the soil is disturbed, such as during establishment or renovation, and 3) root absorption of nutrients is low because of dormancy or stress.

Fertilization of overseeded bermudagrass fairways with considerable amounts of fast-release N fertilizer sources during the cool, rainy season in Southern California may be one of those situations that require special attention.

The objective of this study was to investigate the effect of soil type (sandy loam or loamy sand), annual N-fertility program (6.0 and 3.0 lb N/1000 ft^2 or 5.0 lb N/1000 ft^2 for both the 27-week cool season and 25-week warm season, respectively), and irrigation amount (100 or 130% ET crop) on NO_3-N leaching. It should be noted that the N fertility programs were based on a survey of golf course superintendents' fertility programs. The research site consisted of 24 plots (12.0 x 12.0 ft) with a lysimeter assembly, consisting of five metal cylinders (22-inch diam. X 38-inch deep for each cylinder), placed in the center of each plot. Plots were established from sod in September 1994, and the study was conducted from October 1994 to October 1997. Soil type significantly affected NO_3-N leaching. The percent applied N that was leached as NO_3-N during the cool season, averaged over fertility and irrigation treatments, was 10.39, 0.15, and 0.06% for the sand and 6.21, 3.64, and 2.95% for the loam, year 1 to 3, respectively. Activities associated with establishment and a relatively large amount of rain probably caused the relatively high levels of leaching during the first year. Additionally, over the three-year study, the loam had higher NO_3-N leaching than the sand.

In summary, the overseeded bermudagrass fairways that golf course superintendents produce for the resort season in Southern California are some of the best in the USA. Golfers and vacationers have come to expect this type of product. Considering the amount of NO_3-N leaching we observed, golf course superintendents may wish to consider practices that allow for the same quality overseeded fairway, yet with a reduced potential for NO_3-N leaching. Following are some considerations for modified practices.

1. Try not to fertilize if rain is forecasted.

2. Apply smaller amounts of N in more frequent applications.

3. Irrigate only as needed. Try to keep a soil water content below field capacity.

4. Use fertilizers with a higher percentage of slow-release N. Preliminary data from a UCR N product evaluation study on an overseeded bermudagrass turfgrass showed that selected N fertilizer products that were either all slow-release N or possessed a substantial percentage of slow-release N produced good season-long visual turfgrass color.

5. Use perennial ryegrass cultivars with greater amounts of genetic color, which should result in the production of the same good turfgrass visual color with a lower N requirement. Many reports have documented the differences in genetic color among perennial ryegrass cultivars.

6. Make foliar iron applications, which have been reported to increase visual color of perennial ryegrass. This should result in a lower N requirement for the same good visual turfgrass color. However, high traffic areas may require more growth and recuperative ability, and therefore more N.

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MINIMUM AIR MOVEMENT AND IRRADIANCE REQUIREMENTS FOR SPORTS TURF IN A RETRACTABLE-ROOF STADIUM

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A new retractable-roof stadium, the Bank One Ballpark (BOB) will be the home of the Arizona Diamondbacks major league baseball team beginning in the spring of 1998. Construction of the stadium will be completed this winter, and sod for a natural-grass field will be installed in January or February 1998. Based on preliminary screening experiments, 'De Anza' zoysiagrass has been chosen for the turf. We are trying to anticipate potential problems in maintaining a professional quality turf in the stadium. We have identified two factors that we believe might be most stressful to the grass after it is established:

1. lack of air movement, and
2. limited irradiances.

With the roof retracted the stadium will be essentially open. However, because the stadium is quite 'deep', with added height from the roof components, there will be potential limitations in the environment provided inside. Most obviously, for much of the year the playing field will be significantly shaded, with some areas not receiving any direct sunlight from October through March. Furthermore, the entire field receives some morning or afternoon shade throughout the year. Similarly, because of the geometry of the stadium, the playing field will be sheltered from ambient wind, and the potential exists for deleterious effects from a lack of air movement.

A field plot has been established to approximate the light and shade patterns in the stadium. This plot provides a large area in which to determine optimum cultural and management practices for the turfgrass.

Tests to determine the minimum irradiance requirements for growth under various artificial light sources and at differing environmental conditions have also been completed. These experiments attempt to define how much, if any, supplemental light will be required to successfully establish and maintain the grass in the stadium. Also, we are determining whether there are significant differences in performance of the grass under artificial light of differing quality – *e.g.*, high-pressure sodium lamps *vs*. a balanced-spectrum source. Performance of the grass in these experiments has been evaluated based on visual ratings, total nonstructural carbohydrate contents, and changes in root, stem, and leaf biomass over time.

Air movement requirements have been tested by slowly rotating sod on a large turntable protected from ambient air movement in a greenhouse. During experiments, ventilation of the greenhouse is reduced to an absolute minimum; thus the grass is rotating in essentially still air, with the only significant ventilation coming from the table rotation. Rotation of the table provides a range of air velocities across the grass from zero in the center of the table to a maximum at the outer edge. The turntable is 3 m in diameter, and can be rotated at rates from 2 to 12 revolutions per minute. This corresponds to 0.3 to 1.9 m s^{-1} (0.75 to 4.25 mph) at the outer edge of the table. The design of the table provides for a shallow (8 cm; ~3") sand base and a perforated PVC pipe drainage system. Water availability was monitored at 3 positions on the table with RSU Tensiometers. Temperatures at the soil surface, in mid-canopy and above the canopy are measured with fine-gauge thermocouples. Maximum, minimum and average of each sensor are recorded once per hour with a Campbell datalogger.

Even under very hot conditions (in which the effects of lack of air movement should be maximized) growth of 'De Anza' zoysiagrass showed no significant deleterious effects of long-term growth with less than 1 m s^{-1} air movement. We have, therefore, advised the Diamondbacks that no means of providing air movement over the playing surface should be necessary.

SMUTGRASS, KYLLINGA, AND DALLISGRASS BIOLOGY AND CONTROL

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Smutgrass, *Sporabolus indicus,* is a perennial weed, native to tropical America (although some references attribute its origins to tropical Asia). It occurs as a serious weed of pastures and turf in the southern and western United States. The grass was named for a dark-colored fungus, often found on the upper leaves and seed-heads. The seed is usually quite small (one – two mm in diameter) and amber in color. In California turf, when left unmowed, plants attain a height of approximately 25 in. Smutgrass is very slow to establish, but once established it is quite hardy and survives best in drier sites (southern slopes or areas without sufficient irrigation for standard turfgrasses to be competitive). The grass stems are wiry and difficult to mow. Mowers often "ride up and over" smutgrass clumps (for this reason some turfgrass managers refer to smutgrass as "wiregrass".

Control of smutgrass, once established, is difficult. If irrigation schedules and systems can be modified to provide sufficient moisture to allow the standard turfgrasses to be more competitive, then smutgrass invasion can be slowed. Preemergence herbicides (PRE) will control germinating seedlings of smutgrass. In trials at UC, Riverside all of the common PRE turf herbicides tested (pendimethalin, prodiamine, pronamide, DCPA, dithiopyr, bensulide, and benefin) controlled smutgrass. Repeated postemergence (POST) applications of MSMA (at least four applications annually) have been successful in reducing smutgrass. Other postemergence herbicides are currently under evaluation in San Diego. Wick applications of glyphosate and glufosinate are also being evaluated (some sites have looked promising).

Dallisgrass (*Paspalum dilatatum)* is a perennial grass from South America with a clumpy growth habit that gives turf an irregular surface unsuitable for most sports activities. It has sometimes been grown commercially as a pasture grass. In turf with established dallisgrass the seed-stalks are wiry and lie prostrate when mowed, allowing seed production. When not mowed, plants can attain a height of three feet or more. Seedlings commonly germinate in spring and summer. Perennial clumps soon form with short rhizomes. It is adapted to a wide range of turf growing conditions, common in both moist and semi-dry sites. Most PRE herbicides will control germinating seedlings but, once established, control is much more difficult. Repeated POST treatment with MSMA will reduce dallisgrass. Nonselective spot treatment with glyphosate can reduce dallisgrass infestations, but the ugly, pockmarks of treated dead grass gives the area a "mine field" appearance. Trials are underway to evaluate wick application of glyphosate as a more selective method of application.

Green kyllinga, *Kyllinga brevifolia,* is perennial sedge, native of tropical America. It is often confused with yellow and purple nutsedge. Kyllinga has a shorter growth habit than yellow or purple nutsedge (10-15 inches under non-mowed conditions) and does not produce "nutlets" or tubers. Kyllinga does produce an extensive network of rhizomes and stolons. The flowers or spikes of kyllinga are solitary, green, and globe-shaped. Kyllinga grows best in the warm season and matches bermudagrass in its growth cycle. It is often found growing in bermudagrass turf in the coastal and inter-coastal valleys of California. Its sod is weaker and less dense than bermudagrass, giving it much poorer performance than the desired turf monoculture. Kyllinga infestations should be isolated and removed as they become evident in new areas. Avoid spread on mowing and renovation equipment. Once established it is difficult to control. Multiple applications of MSMA will reduce kyllinga. Initial results with the use of two applications of halosulfuron have been promising.

TURFGRASS QUALITY CHARACTERISTICS OF NEW BERMUDAGRASSES

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The results presented below are average annual turf scores, using a 1 – 9 rating system on a monthly basis, with 9 representing a perfect sward and 1 representing dead grass. The studies were established on June 18, 1992 at UC Riverside (UCR) and June 26, 1992 at the UC South Coast Research and Extension Center (SCREC) in Irvine. Four pounds of nitrogen were applied per year; mowing was by a reel mower at ¾ inch height, and irrigation was provided as needed, based on calculation from an automated weather station. Vegetative cultivars were planted as 2-inch plugs at 1-foot spacing; seeded cultivars were seeded at the rate of 0.85 pounds per 1,000 square feet.

Table 1. Average bermudagrass performance (1-9 with 9 best) for four years at UC Riverside and UC Research and Extension Center, Irvine.

	1993		1994		1995		1996		Mean	
Cultivar	SCREC	UCR	SCREC	UCR	SCREC	UCR	SCREC	UCR	SCREC	UCR
seeded										
OKS91-11	5.4	6.0	5.5	5.2	4.8	5.4	5.1	4.7	5.2	5.3
Jackpot	5.4	5.4	5.0	4.7	4.6	5.0	4.8	4.9	4.9	5.0
Sultan	5.2	5.4	4.8	4.6	4.5	4.9	4.8	4.7	4.8	4.9
J-27	5.3	5.6	5.2	4.8	4.8	5.2	5.2	5.0	5.1	5.2
Mirage	5.2	5.4	5.0	5.0	5.0	5.3	5.4	5.3	5.2	5.2
FMC5-91	5.2	5.5	4.7	4.7	4.5	5.2	5.0	5.0	4.9	5.1
FMC2-90	5.1	5.3	4.9	4.5	4.6	4.8	4.9	4.8	4.8	4.9
Guymon	5.3	5.4	5.2	4.9	4.7	5.3	5.2	5.1	5.1	5.2
OKS91-1	4.8	5.1	4.3	4.5	4.8	4.6	4.6	4.7	4.5	4.7
FMC3-91	4.9	5.4	4.7	4.7	4.5	5.2	5.2	5.2	4.8	5.0
Sahara	4.9	5.3	4.7	4.8	4.4	4.9	4.8	4.8	4.7	4.9
Sundevil	5.1	5.3	4.6	4.7	4.4	5.3	5.0	5.0	4.8	5.1
Sonesta	5.0	5.2	4.5	4.5	4.4	4.7	4.6	4.7	4.6	4.8
Primavera	4.9	5.3	4.3	4.5	4.3	4.8	4.7	4.7	4.5	4.8
Cheyenne	4.9	5.2	4.4	4.5	4.1	5.1	4.8	4.8	4.5	4.9
AZ. Com.	4.7	5.1	4.3	4.5	4.4	4.8	4.5	4.6	4.5	4.7
LSD	0.2	0.3	0.3	0.3	0.3	0.3	0.2	0.4	0.2	0.3
vegetative										
Baby	6.1	6.6	5.7	5.9	5.6	6.0	5.5	6.0	5.7	6.1
Tifgreen	6.2	6.0	5.5	5.7	5.4	5.6	5.4	5.5	5.6	5.7
Tifway	6.3	6.6	5.4	6.0	5.7	6.1	6.2	5.7	5.9	6.1
Midirion	5.4	6.1	5.4	5.6	5.2	5.6	5.7	5.9	5.4	5.8
Midlawn	5.6	5.9	5.2	5.5	5.1	5.4	5.3	5.5	5.3	5.6
Midfield	5.8	5.9	5.4	5.5	5.2	5.9	5.7	5.7	5.5	5.7
STF-1	5.9	5.5	5.4	4.8	5.1	5.3	5.2	5.3	5.4	5.2
Texturf 10	6.3	6.0	5.7	5.2	4.8	5.7	5.7	5.3	5.6	5.5
Floradwarf	5.1	5.4	4.9	5.6	4.5	5.1	3.8	4.0	4.6	5.0
AZ. Com.	4.8	4.4	4.1	4.0	3.9	4.5	4.4	4.5	4.3	4.4
LSD	0.4	0.5	0.2	0.5	0.3	0.5	0.3	0.5	0.3	0.3

THE EFFECT OF PRIMO ON TALL FESCUE WATER STRESS RELATIONS

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Plant growth regulators (PGRs) are effective in suppressing shoot growth and seedhead development in both cool- and warm-season turfgrasses. Research also has shown reductions in turfgrass water-use or evapotranspiration (ET) rates following PGR applications (Johns and Beard, 1982; Mathias et al., 1971). Previous work at UCR with well-watered tall fescue showed a 13% reduction in the ET rate due to the application of Primo (Novartis Crop Protection, Inc.). These data were collected from two-gallon minilysimeter pots located in an in-field lysimeter plot.

In the present study, larger lysimeters (15-gallon containers) were utilized to be more representative of field water conditions. Tall fescue turf was established for 6.5 months, then sprayed with Primo at a label rate, or not sprayed. Irrigation treatments were imposed from 19 to 64 days after Primo treatment. The low irrigation treatment involved saturating the lysimeters once every 7 to 24 days (depending on environmental conditions). The high irrigation treatment involved saturating the lysimeters once every 3 to 4 days. During the period that irrigation treatments were imposed, ET rate, clipping yield, and visual turfgrass quality, including color and % brown and yellow within the turfgrass canopy, were determined on a regular schedule. Primo application did not significantly reduce tall fescue ET rates in the present study. However, the application of Primo did significantly increase the visual turfgrass quality of the tall fescue subjected to the low irrigation treatment. The enhancement of visual turfgrass quality was due to the production of darker green leaf blades. Data from this study suggest that application of Primo may result in irrigation water savings if turfgrass managers increase the time interval between irrigations following Primo application.

We are currently evaluating the effect of Primo on tall fescue quality in a replicated field study with irrigation treatments ranging from 80 to 100% ET_o (ET_o = CIMIS reference water use rate). We also are measuring soil water content and water potential.

References

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Acknowledgement

Thanks are given to Novartis Crop Protection, Inc. for funding this research. Also, thanks are given to the Irrometer Company for donating Watermark sensors and the Best Company for donating fertilizer.

MANAGEMENT OF 'DE ANZA' AND 'VICTORIA' ZOYSIAGRASSES

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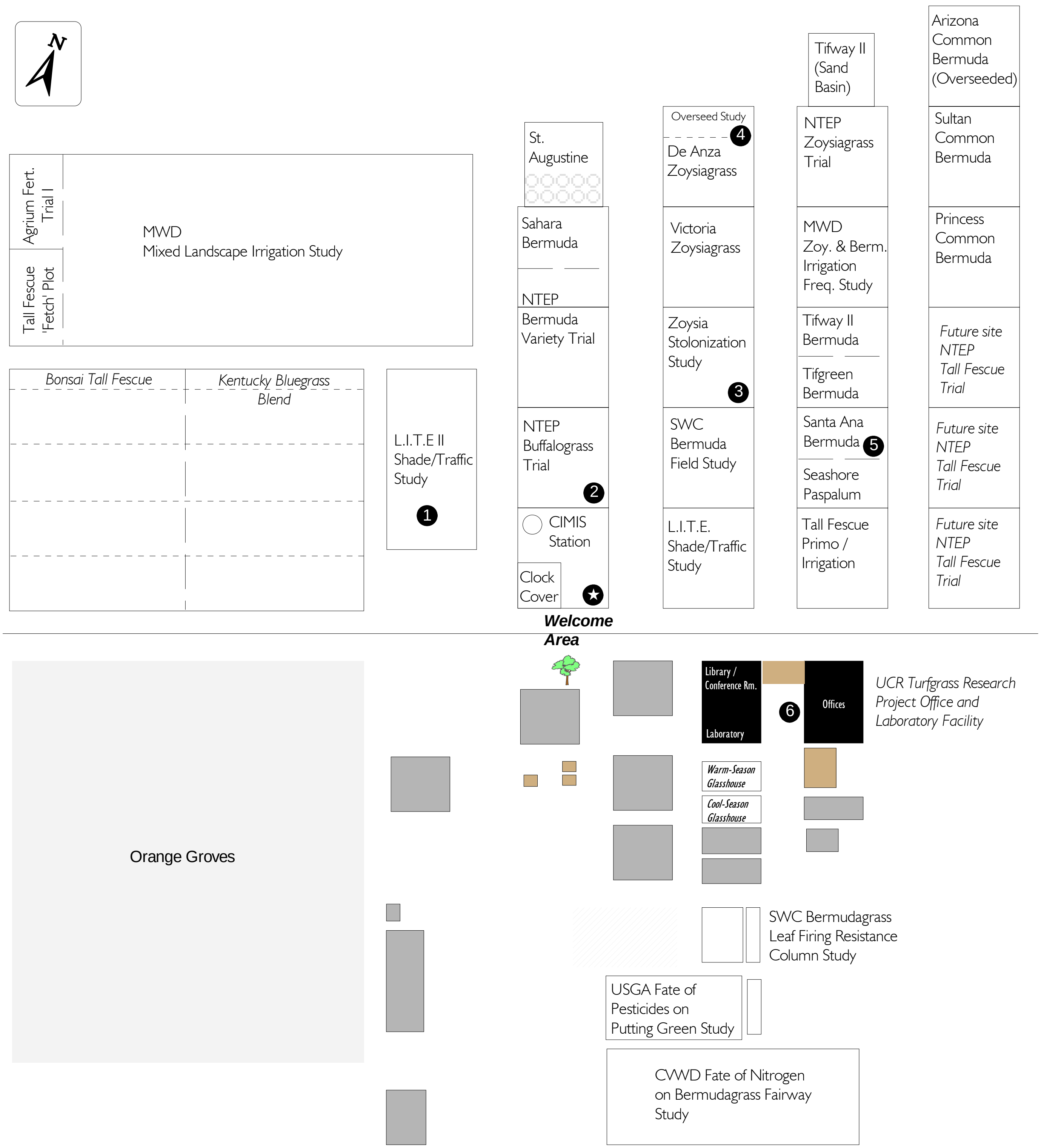
Zoysiagrasses are well adapted to Southern California and can be grown in all areas of California where the summers are warm and the winters mild. Considered to be a grass with maintenance requirements that are lower than those of most other turfgrasses, zoysias are tolerant of heat, drought, salinity, heavy traffic and not commonly susceptible to disease, insect, or weed invasion problems. The spongy sensation of walking on zoysiagrass with deep thatch is objectionable and results in poor footing on golf course tees and fairways.

'De Anza' and 'Victoria' zoysiagrasses were produced by hybridizing two distinct zoysiagrass selections; 'El Toro' (*Zoysia japonica* Steud.) was the female parent and a hybrid selection (*Z. matrella* L. *x Z. tenuifolia* Willd ex. Trin.) was the male parent. The University of California patented the cultivars in 1995. 'De Anza' and 'Victoria' differ from 'El Toro' in the length of growing season, retention of green color during winter, and narrower leaves producing a finer texture turf. Both are relatively low thatch producers with 'De Anza' producing less thatch than 'Victoria'.

Cultural practices have been studied for optimum performance of the two cultivars as functional turf. Clipping yields, thatch, and sponginess of 'De Anza' and 'Victoria' zoysiagrasses were measured over heights 3/8, 1/2, 3/4, and 1¼ in. (9.5, 12.7, 19.1, and 31.8 mm) and verticutting frequencies 0, 1x, and multiple times. 'De Anza' and 'Victoria' visually perform well through the entire mowing height study range. Maximum clipping yields of 'De Anza' were at the mowing height range of 3/8 to 3/4 in. Maximum clipping yields of 'Victoria' were at the mowing height range of 1/2 to 3/4 in.

Thatch and sponginess were controlled by mowing height and vertical mowing. Vertical mowing treatments reduced 'De Anza' zoysiagrass clipping yields in each year. Vertical mowing once per season did not significantly reduce thatch. Repeated vertical mowing reduced thatch of 'De Anza' by 11%. Sponginess as measured by Clegg Impact Tester was not significantly affected by mowing height in July, decreasing by 11% in October with 3/8 in. mowing height compared to 1¼ in. Repeated vertical mowing reduced sponginess and increased firmness by 16% in the summer and by 34% in the fall.

Thatch thickness of 'Victoria' decreased 26 % as mowing height decreased from 1¼ in. to 3/8 in. Vertical mowing once per season did not significantly reduce thatch. Repeated vertical mowing reduced thatch of 'Victoria' by 10%. Sponginess as measured by Clegg Impact Tester was not significantly affected by mowing height in July with a decrease in sponginess and an increase in firmness of 11% in October. Repeated vertical mowing reduced sponginess and increased firmness 8% in summer to 19% by fall.



UCR Turfgrass Field Station Map

Field Day September 17, 1997

UCR TURF

LOW LIGHT SPORTS TURF

Stephen T. Cockerham
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Two structures have been built to study the effects of light restriction on turf at the UCR Turfgrass Research Facility. In LITE I perennial ryegrass is submitted to continuous shade level of 30%, 55%, and 73% compared to the turf in full sun. The PAR (photosynthetically active radiation), temperature, and relative humidity are measured with remote sensors and reported telemetricly to a computer. Various management practices with and without sports traffic have been studied.

In LITE II 'De Anza' zoysiagrass is submitted to variable shade levels by way of louvered superstructure. The turf is on a UC sand rootzone media construction. The turfgrass receives 4.5 hours of full sun in April to 6.5 hours in June and back to 4.5 hours in October. PAR, temperature, and relative humidity are measured with remote sensors. Studies include sod rooting at various times of the year, overseeding, turf nutrition, mowing, vertical mowing, aerification, and rootzone media modification.

NEW TURFGRASS CULTIVAR EVALUATION STUDIES

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The National Turfgrass Evaluation Program (NTEP) is a non-profit organization that provides leadership in turfgrass evaluation and improvement by linking the public and private sectors of the industry through their common goals of grass development, improvement, and evaluation. Its mission is to provide a mechanism for uniform evaluations; to advance the science of species and cultivar evaluation; to collect and disseminate performance information; and to enhance the transfer and use of information and technology relating to turfgrass improvement and evaluation. Structurally, NTEP is a cooperative effort of the United States Department of Agriculture (at Beltsville, MD) and the Turfgrass Federation, Inc.

The clientele of NTEP are diverse, with varying interests and expectations. To be clientele sensitive, NTPE has identified the following categories of interest groups that interact and benefit from the activities of the program: public and private turfgrass plant breeders; public and private sector researchers; seed distributors; technology transfer educators such as cooperative extension educators and industry technical representatives; other professionals such as seed producers, sod producers, golf course superintendents, grounds managers, sports turf managers, lawn care service operators, landscape contractors, landscape architects and consultants. Homeowners indirectly are influenced by NTEP because the turfgrasses they buy have been tested for performance characteristics in their climate zones.

Most cultivar evaluations are conducted by university turfgrass research and extension programs, but modified studies by private plant breeders are also undertaken. Seed or vegetative material of a turfgrass species is accumulated by the program and sent to cooperating researchers where replicated trials are established. Somewhat standardized establishment and cultural practices are used and they are reported for each site. Data collected on a monthly basis during the growing season are also standardized and usually include a turfgrass quality rating.

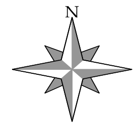
Other specific characteristics such as color, texture, spring green-up, density, drought tolerance and disease or weed activity are rated when appropriate. Data are sent to NTEP on an annual basis, statistical analyses performed and annual results are reported by species. Those reports are used as a basis for information transfer to interested clientele.

In California, NTEP studies of the commonly used warm- and cool-season turfgrass species are usually conducted at the UC Riverside Turfgrass Research Facility, at the UC South Coast Research and Extension Center in Irvine, and at the UC Bay area Research and Extension Center in Santa Clara. At Riverside, as an example, we have 19 zoysiagrasses, 29 bermudagrasses, and 14 buffalograsses under study. The grasses are mowed weekly during the growing season; fertilized on a regular, moderate program and irrigated to replace water used as calculated from a CIMIS automated weather station. Results of the studies are released during field days and field tours, in proceedings and more formal reports in publications such as *California Turfgrass Culture*.

In the subject area of turfgrass management, one of the important decisions that must be made is the selection of turfgrass to be established. For most, the use the facility will receive, the cultural level that will be practiced, and the environmental conditions of the site (both climate and soil) influence the decision. Mistaken grass selection will haunt the turfgrass manager for the life of the sward. Fortunately, the National Turfgrass Evaluation Program provides sound information on which in part to base grass selection decisions.

The three plot plans that follow represent studies currently (September 1997) underway at UC Riverside.

1996 NTEP BUFFALOGRASS TEST
Est. 29 July 1996

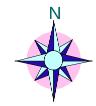


5	3	2	1	4	10	9
13	6	11	14	8	7	12
1	2	3	5	4	13	10
14	11	8	7	12	9	6
4	1	5	2	3	11	8
10	9	12	6	13	7	14

Seeded
1. CODY
2. TATANKA
3. BAM-1000
4. BISON
5. TEXOKA

Vegetative
6. 91-118
7. 86-120
8. 86-61
9. BONNIE BRAE
10. MIDGET
11. STAMPEDE
12. UC-95
13. 609
14. 378

1997 NTEP BERMUDAGRASS TRIAL
established 30 June 1997

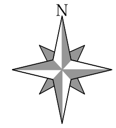


Varieties 1-18 and 29 are seeded, 19-28 are vegetative

29	4	5	1	6	11	17	18
14	13	3	12	8	7	2	9
17	7	4	15	18	10	16	15
8	2	11	14	9	5	13	29
1	4	6	10	16	3	1	12
3	12	15	13	8	18	14	11
6	29	9	17	16	2	7	10
X	X	X	X	X	X	X	5
22	27	26	23	24	28	X	X
25	20	19	21	20	27	22	25
19	21	23	28	24	26	19	21
24	27	26	22	20	25	28	23

1 Savannah
2 2PST-R69C
3 Princess
4 SW 1-7
5 SW 1-11
6 Jackpot
7 Sundevil II
8 J-540
9 J-1224
10 Shangri La
11 Mirage
12 Pyramid
13 Majestic
14 OKS 95-1
15 Blue-Muda
16 Blackjack
17 Sahara
18 AZ Common
19 Mini-Verde
20 Shanghai
21 CN 2-9
22 OKC 18-4
23 OKC 19-9
24 Cardinal
25 Tift 94
26 Midlawn
27 Tifway
28 Tifgreen
29 Panama

1996 NTEP ZOYSIAGRASS TEST
Est. 29 July 1996



9	12	14	15	11	10	13	16
1	6	5	8	3	18	19	17
4	7	2	13	14	18	12	16
3	8	15	10	17	11	19	9
4	1	6	2	7	5		
8	3	4	5	1	2	6	7
18	14	16	10	17	9	12	19
					13	11	15

<u>Seeded</u>

1. ZEN 500
2. ZEN 400
3. ZENITH
4. J 36
5. J 37
6. CHINESE COMMON
7. Z 18
8. KOREAN COMMON

<u>Vegetative</u>

9. DALZ 9601
10. J 14
11. MIYAKO
12. HT 210
13. DE ANZA
14. VICTORIA
15. EL TORO
16. JAMUR
17. ZEON
18. MEYER
19. EMERALD

PROPAGATION OF ZOYSIAGRASS CULTIVARS

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Two new zoysiagrass cultivars, 'De Anza' and 'Victoria', have recently been released by the University of California, Riverside. These grasses show considerable promise and are receiving much interest for use as warm-season turf. However, aside from observations that propagation, (vegetative, by sprigging or stolonizing) is most successful during the summer months, specific information about how to optimize production of these grasses is lacking. As a first step in enhancing commercial production, we have begun an experiment in which replicate plots of 'De Anza' and 'Victoria', along with 'El Toro' (an older, better-known variety of zoysiagrass), will be planted once monthly for one year. The experiment is divided into 3 replicate blocks, within which months are randomly assigned. Plots for each variety are randomly assigned within each month x block. (See plot map.)

Plot assignments for zoysiagrass stolon establishment

D = De Anza; E = El Toro; V = Victoria
o = open; t = tarped (in cool season)
01, 02, . . . 12 = planting month

05	*01*	*10*	*11*	*03*	*02*	*12*	*07*	*04*	*06*	*08*	*09*
Eo	Et	Eo	Eo	Vo	Vo	Dt	Dt	Eo	Et	Do	Do
Vt	Vo	Vt	Et	Dt	Eo	Eo	Vo	Vo	Vo	Vt	Eo
Do	Eo	Vo	Vo	Et	Vt	Et	Vt	Vt	Eo	Eo	Vo
Vo	Dt	Do	Vt	Eo	Et	Do	Eo	Dt	Do	Vo	Et
Dt	Vt	Dt	Do	Do	Dt	Vt	Do	Do	Dt	Dt	Vt
Et	Do	Et	Dt	Vt	Do	Vo	Et	Et	Vt	Et	Dt
10	*02*	*08*	*01*	*03*	*05*	*09*	*11*	*04*	*07*	*12*	*06*
Eo	Vo	Et	Eo	Do	Eo	Et	Do	Vo	Eo	Vo	Vt
Dt	Vt	Dt	Vt	Dt	Vo	Eo	Dt	Do	Do	Et	Do
Vo	Do	Eo	Do	Vo	Dt	Vt	Et	Dt	Vo	Dt	Vo
Vt	Et	Vo	Et	Vt	Do	Vo	Vo	Eo	Et	Do	Dt
Do	Eo	Vt	Dt	Eo	Vt	Do	Eo	Et	Dt	Eo	Eo
Et	Dt	Do	Vo	Et	Et	Dt	Vt	Vt	Vt	Vt	Et
03	*01*	*11*	*06*	*10*	*07*	*09*	*08*	*05*	*12*	*02*	*04*
Eo	Vo	Do	Vt	Eo	Dt	Eo	Dt	Eo	Vt	Do	Do
Vt	Vt	Eo	Et	Et	Vt	Vt	Et	Et	Eo	Dt	Dt
Et	Et	Dt	Vo	Do	Vo	Et	Eo	Do	Et	Vo	Vt
Dt	Eo	Vt	Dt	Dt	Do	Do	Vt	Vo	Vo	Et	Et
Vo	Dt	Et	Do	Vo	Eo	Vo	Do	Vt	Do	Vt	Eo
Do	Do	Vo	Eo	Vt	Et	Dt	Vo	Dt	Dt	Eo	Vo

In a preliminary study with 'De Anza', a plot that was stolonized in November 1996 was covered with a ventilated clear plastic tarp from December 1996 until February 1997. The cover was found to increase temperature at the soil surface by about 5°F on most days, and 2 to 3°F at a depth of 2.5 cm. We found significantly higher cover (75% *vs*. 25%) and 4-fold higher clipping yields from the area under the tarp. This showed that establishment from stolons can be significantly enhanced over winter months by even modest increases in temperature. On the basis of that experiment, half of the plots in the present experiment will be tarped beginning late this fall.

The experiment began with a planting in May 1997; the final planting will be April 1998. Soil in the plots is loosened and leveled, then stolons are planted at ~6.5 bushels per 1000 ft^2. Stolons are pressed into the soil with a finned roller, then lightly top-dressed with native soil and rolled. Water is applied frequently for several weeks to minimize drying of the stolons.

Rate of establishment is measured by monthly measurements of percent cover in each plot.

No clear differences in establishment rates among the varieties can yet be identified. Within 90 days of the May planting, however, several plots have >95% cover, indicating the rapid establishment rate of these zoysiagrasses under favorable conditions.

ZOYSIAGRASS OVERSEEDING EVALUATION

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Warm-season turfgrasses are particularly well adapted to southern and central California. Zoysiagrass (*Zoysia japonica*) is one warm-season turf that forms a uniform, dense, high quality turf with minimum maintenance requirements. The characteristic cool season dormancy of zoysiagrass is one reason that it is not used more widely. A field study was initiated in October 1995 to determine the ability to overcome winter color loss by overseeding various cool-season turfgrasses over established 'De Anza' zoysiagrass (*Zoysia spp*.), a variety developed at UCR. The study will end in spring 1998.

Three overseed species were applied to established 'De Anza' zoysiagrass: perennial ryegrass (*Lolium perenne*) at 10 lb./1000 ft^2, tall fescue (*Festuca arundinaceae*) at 10 lb./1000 ft^2, and *Poa bulbosa*, a species native to Europe, at 8 lb./1000 ft^2. All treatments were mowed at 1 1/2" (38 mm) using a rotary mower, and each received 1 lb. N/1000 ft^2 (38.9 kg/Ha) every 8 weeks. Turf quality and extent of coverage of the overseed species were determined regularly for each plot. Periodically, turf cores were removed and observed for thatch depth, stem counts, color, and leaf width.

All species established quickly in the fall. Perennial ryegrass and tall fescue covered about 50% of the plot by mid November and changed little by spring. The *Poa bulbosa* covered about 1/3. Zoysia coverage increased by early spring, and by the end of summer, tall fescue and perennial ryegrass covered about 1/3. *Poa bulbosa* dropped to less than 10% cover. During the second cool season, tall fescue and perennial ryegrass covered about 75% of the plot and remained at roughly 50% during the second summer. *Poa bulbosa* was evident throughout the second summer, but coverage was less than 10%.

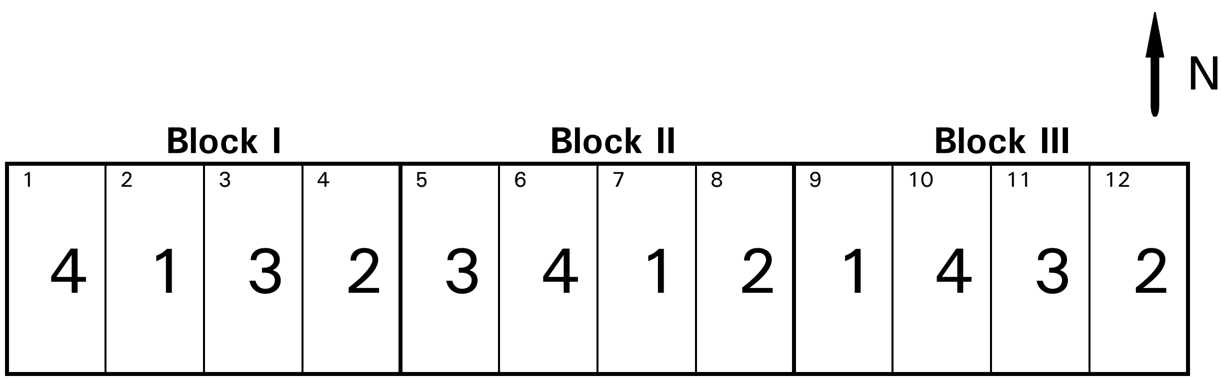
Tall fescue overseeded plots had slightly better quality than perennial ryegrass in part due to texture similarities between tall fescue and 'De Anza' zoysiagrass. Quality of the non-overseeded 'De Anza' was higher at the start of summer and remained so until mid fall. Beginning in 1997, turf rating was based solely on color. The greatest differences occurred in the tall fescue and perennial ryegrass overseeded plots. The quality of the overseeded plots, in terms of color, was greatest in March and April but became comparable to non-overseeded treatments at the start of summer as 'De Anza' resumed seasonal growth.

Two-inch cores were pulled from each of the plots three times during the study. Overseed stem counts increased for tall fescue and perennial ryegrass but decreased for *Poa bulbosa*. Counts increased about 200% from spring 1996 to spring 1997 for tall fescue and perennial ryegrass. 'De Anza' zoysia stem counts in the tall fescue overseeded treatment had a slight decrease in plant counts from the first to second spring, evident of increasing competition of 'De Anza' and tall fescue. Thatch increased at each sampling across all treatments, but slightly less in swards overseeded with perennial ryegrass and tall fescue.

Summary

Better color and quality was seen in the tall fescue and perennial ryegrass as overseed species, although the texture uniformity of tall fescue with 'De Anza' produce swards with higher ratings. Tall fescue and perennial ryegrass both established quickly and had even greater coverage during the second winter. Lower quality compared to non-overseeded zoysia was seen in the summer because of color and texture differences of the overseed species. *Poa bulbosa* at the rate applied improved sward quality the first winter but steadily lost coverage in the spring and summer and had little effect on quality the following winter.

Stop #4 'De Anza' zoysiagrass overseed evaluation



overseed species

1. perennial ryegrass
2. tall fescue
3. *Poa bulbosa*
4. no overseed

INSTRUMENTS FOR SOIL AND WATER MANAGEMENT

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Measurement of soil and water status is crucial to an effective turfgrass management program. During the last decade, many new instruments have been developed in soil and water management research. Many of the new instruments allow for automated and continuous measurement in field conditions. The objectives of this presentation are to review and introduce the available instruments for measuring soil-water content and potential, infiltration rate, soil temperature, and soil salinity. Principles and advantages/ disadvantages of each instrument will be discussed.

Water content can be measured by neutron probe, time-domain reflectometry (TDR), capacitance probe, and the traditional gravimetric method. Neutron probe measures a sphere of about 12 inches in diameter. It is a reliable method, but requires calibration and the probe is radioactive. TDR can be automated to make continuous observations, but it does not work well in soils with high clay content and/or salinity. The TDR equipment cost is also very high. Gravimetric method is very reliable, inexpensive, and considered as the standard method. However, it is time consuming.

Soil water potential can be measured by tensiometers or resistant blocks. The pressure transducer equipped tensiometer allows to make automated data collection. The range of the tensiometer measurement, however, is limited. Resistant blocks can be used under drier conditions than the tensiometers and are more sensitive for measurements dryer than 1.0 bar.

Infiltrometers (double-ring or single-ring) are typically used to measure how fast water moves into soil. Due to the fact of 3-dimensional water movement from the infiltrometers, ring size, ring insertion depth, and soil type all can affect the infiltration measurement. The measured infiltration rates by the ring infiltrometers are not the soil water intake capacity at the surface.

Thermocouples are the most common device for soil temperature measurement. It is simple and easy to construct, and the measurement is very reliable. Those who want to have higher accuracy can consider thermistors.

Soil salinity is measured in terms of electrical conductivity (EC). In the laboratory, EC can be measured from the soil saturated extract using conductivity meters. Other simplified salinity meters are also available for laboratory and field use.

Other measurements made on turfgrass include soil strength and hardness as measure of compaction. Currently, there has been some interest in measuring the soil oxygen level.

NITROGEN PRODUCT EVALUATION FOR OVERSEEDED BERMUDAGRASS FAIRWAYS

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This study was conducted to evaluate the performance of nitrogen fertilizer treatments (in terms of visual turfgrass color response) when applied on overseeded bermudagrass maintained similar to fairway conditions during a five-month cool season.

Twenty-three nitrogen fertilizer treatments were evaluated during five months of the cool season, from November 11, 1996 to April 18, 1997, on a mature stand Arizona common bermudagrass overseeded with 'Academy' and 'Charger' perennial ryegrass. Prior to overseeding, the plot was treated with Diquat on October 1, scalped with a flail mower on October 9, and fertilized on October 18 with 2 lb P_2O_5/1000 ft^2 and 2 lb K_2O/1000 ft^2. The plot was overseeded on October 18, 1996 with 'Academy' perennial ryegrass at 16 lb seed/1000 ft^2, and again on November 13, 1996, with 'Charger' perennial ryegrass at 18 lb seed/1000 ft^2, due to a slow establishment of the initial overseeding.

The study included twenty-three nitrogen fertilizer treatments and one no-fertilizer check treatment (Table 1 and 2). The fertilizers were variable in terms of the percentage of N which was slow-release or fast-release. Twenty-one of the fertilizer treatments were granular-applied and received 4.0 lb N/1000 ft^2 over 5 months, with the exception of one treatment which received 2.5 lb N/1000 ft^2 over 5 months. Individual application rates ranged from 0.25 to 2.0 lb N/1000 ft^2 applied two to ten times during 5 months. Two treatments were spray-applied and received 0.75 lb N/1000 ft^2 per application (in two gallons of finished spray volume per 1000 ft^2). These applications were made once a month for four months, following a granular application of 6-20-20 at 1.0 lb N/1000 ft^2 in the first month of the study. During the course of the study, these treatments received a total 4.0 lb N/1000 ft^2.

Visual turfgrass color ratings were measured every two weeks beginning 3.5 weeks after initial fertilizer treatment applications. Initial fertilizer treatment applications were made on November 11, 1996. These ratings were taken on a 1 to 9 scale, with 1=brown, 5=minimally acceptable, and 9=darkest green overseeded common bermudagrass. Weather measurements were collected from an on-site California Irrigation Management Information System (CIMIS) weather station. Results from this study are listed below.

1. A rate of 4.0 lb N/1000 ft^2 produced good turfgrass color on overseeded common bermudagrass with an average visual quality rating of 6.6 (on a 1 to 9 scale, with 1=brown, 5=minimally acceptable, and 9=darkest green overseeded common bermudagrass). This average includes all treatments that were applied at a N rate of 4.0 lb/1000 ft^2 during the 5-month cool season.

2. Nitrogen treatments, which included differences in seasonal nitrogen rates, nitrogen source, and number of applications during the five-month study, significantly affected visual turfgrass color ratings. Selected treatments, involving either a fast-release or slower-release nitrogen source, performed well in these studies.

Table 1. Twenty-three nitrogen fertilizer treatments applied on overseeded common bermudagrass.

TRT	Company	Fertilizer Program: Product / Analysis - $N:P_2O_5:K_2O$ (Rate - lb N / 1000 ft^2)					lb N / 1000ft^2 / 5 mo.
Application Dates --->		Nov 11 '96	Dec 10 '96	Jan 23 '97	Feb 21 '97	Mar '97	
1	J.R. Simplot	Endure 15-15-15 (1.0)	Polyon 43-0-0 (1.0)	Turf Gold 21-3-5 (1.0)	Turf Gold 21-3-5 (1.0)	--	4.0
2	J.R. Simplot	Pro Balance 15-15-15 (1.0)	Nitra King 22-3-9 (1.0)	Nitra King 22-3-9 (1.0)	Pro Balance 15-15-15 (1.0)	--	4.0
Application Dates --->		Nov 11 '96	Dec 10 '96	Jan 23 '97	Feb 14 '97	Mar 17 '97	
3	J.R. Simplot	Re-Gain 6-2-6 (0.5)	Re-Gain 6-2-6 (0.5)	Re-Gain 16-3-7 (1.0)	Re-Gain 16-3-7 (1.0)	Re-Gain 16-3-7 (1.0)	4.0
Application Dates --->		Nov 11 '96	Dec 10 '96	Jan '97	Feb 21 '97	Mar '97	
4	IMC Vigoro	ParEx 10-22-22 (1.0)	Par Ex 24-4-12 (1.5)	--	Par Ex 24-4-12 (1.5)	--	4.0
5	IMC Vigoro	ParEx 10-22-22 (1.0)	Par Ex 28-3-10 (1.5)	--	Par Ex 28-3-10 (1.5)	--	4.0
Application Dates --->		Nov 11 '96	Dec 10 '96	Jan 23 '97	Feb 14 '97	Mar 20 '97	
6	Sea Source	Turf Rally 6-10-10 (0.6)	Turf Rally 16-4-8 (0.4)	Turf Rally 16-4-8 (1.0)	Turf Rally 16-4-8 (1.0)	Turf Rally 16-4-8 (1.0)	4.0
Application Dates --->		Applied every two weeks: 11/11/96, 11/27, 12/13, 12/23, 01/09/97, 01/21, 02/10, 02/21, 03/07, 03/21					
7	Vicksburg Chemical	K-Power miniprill 13.75-0-44.5 (0.4)					4.0
8	Vicksburg Chemical	K-Power miniprill 13.75-0-44.5 (0.25)					2.5
Application Dates --->		Nov 11 '96	Dec '96	Jan 23 '97	Feb '97	Mar '97	
9	Vicksburg Chemical	Multicote 40-0-0 (2.0)	--	Multicote 40-0-0 (2.0)	--	--	4.0
10	Vicksburg Chemical	Multicote 12-0-43 (2.0)	--	Multicote 12-0-43 (2.0)	--	--	4.0
Application Dates --->		Nov 11 '96	Dec 13 '96	Jan 24 '97	Feb 26 '97	Mar 19 '97	
11	Tessenderlo Kerley	6-20-20 (1.0)	N-Sure Lite 30-0-0* (0.75)	N-Sure Lite 30-0-0* (0.75)	N-Sure Lite 30-0-0* (0.75)	N-Sure Lite 30-0-0* (0.75)	4.0
Application Dates --->		Nov 11 '96	Dec 9 '96	Jan 24 '97	Feb 26 '97	Mar 19 '97	
12	Tessenderlo Kerley	6-20-20 (1.0)	Trisert KS 15-0-12-8S* (0.75)	Trisert KS 15-0-12-8S* (0.75)	Trisert KS 15-0-12-8S* (0.75)	Trisert KS 15-0-12-8S* (0.75)	4.0
Application Dates --->		Nov 11 '96	Dec '96	Jan 23 '97	Feb 14 '97	Mar 17 '97	
13	Bandini	28-4-6 (1.0)	--	28-4-6 (1.0)	28-4-6 (1.0)	28-4-6 (1.0)	4.0
Application Dates --->		Nov 11 '96	Dec '96	Jan 23 '97	Feb 14 '97	Mar 20 '97	
14	Bandini	ProLong 21-4-6 (1.0)	--	ProLong 21-4-6 (1.0)	ProLong 21-4-6 (1.0)	ProLong 21-4-6 (1.0)	4.0
Application Dates --->		Nov 11 '96	Dec '96	Jan 23 '97	Feb 14 '97	Mar 17 '97	
15	Bandini	22-4-22 (1.0)	--	22-4-22 (1.0)	22-4-22 (1.0)	22-4-22 (1.0)	4.0
Application Dates --->		Nov 11 '96	Dec 10 '96	Jan 23 '97	Feb 14 '97	Mar 20 '97	
16	Hydro Agri	Turf Royale 21-7-14 (1.0)	Turf Royale 21-7-14 (1.0)	Turf Royale 21-7-14 (1.0)	Turf Royale 21-7-4 (0.5)	Turf Royale 21-7-14 (0.5)	4.0
Application Dates --->		Nov 11 '96	Dec 10 '96	Jan 23 '97	Feb 14 '97	Mar 17 '97	
17	Hydro Agri	Classic Royale 15-15-15 (1.0)	Classic Royale 15-15-15 (1.0)	Classic Royale 15-15-15 (1.0)	Classic Royale 15-15-15 (0.5)	Classic Royale 15-15-15 (0.5)	4.0
Application Dates --->		Nov 11 '96	Dec 10 '96	Jan 23 '97	Feb 14 '97	Mar 20 '97	
18	Hydro Agri	HydroPrill 16-15-15 (1.0)	HydroPrill 16-15-15 (1.0)	HydroPrill 16-15-15 (1.0)	HydroPrill 16-15-15 (0.5)	HydroPrill 16-15-15 (0.5)	4.0
Application Dates --->		Nov 11 '96	Dec 10 '96	Jan '97	Feb 21 '97	Mar 20 '97	
19	United Horticultural Supply	Turfgo 23-5-10 (1.25)	Turfgo 23-5-10 (0.75)	--	Turfgo 23-5-10 (1.0)	Turfgo 23-5-10 (1.0)	4.0
20	United Horticultural Supply	Turfgo 16-23-16 (1.25)	Turfgo 16-23-16 (0.75)	--	Turfgo 16-23-16 (1.0)	Turfgo 16-23-16 (1.0)	4.0
Application Dates --->		Nov 11 '96	Dec '96	Jan 23 '97	Feb 14 '97	Mar 17 '97	
21	Scotts	ProTurf 16-25-12 (0.96)	--	Scotts 30-3-9 (1.04)	Scotts 30-3-9 (1.0)	Scotts 30-3-9 (1.0)	4.0
Application Dates --->		Nov 11 '96	Dec 10 '96	Jan 23 '97	Feb 21 '97	Mar 20 '97	
22	UCR 1	Nitra King 22-3-9 (0.8)	Nitra King 22-3-9 (0.8)	Nitra King 22-3-9 (0.8)	Nitra King 22-3-9 (0.8)	Nitra King 22-3-9 (0.8)	4.0
Application Dates --->		Nov 11 '96	Dec 10 '96	Jan '97	Feb 14 '97	Mar '97	
23	UCR 2	6-20-20 (1.0)	Coarse IBDU 31-0-0 (1.5)	--	Coarse IBDU 31-0-0 (1.5)	--	4.0
24	Check	N/A					0.0

* Formulation reflects weight per volume.

Table 2. Application rate and frequency, and nitrogen release characteristics of the 23 nitrogen fertilizer treatments applied on an overseeded common bermudagrass.

Fertilizer treatment	lb N / 1000 ft^2 per 5months	Number of Applications	% N Slow-Release	%N Quick-Release
Bandini 28-4-6	4.0	4	53	46
Multicote 12	4.0	2	100	0
ProLong	4.0	4	39	61
Bandini 22-4-22	4.0	4	36	64
Turf Royale	4.0	5	0	100
K-Power (0.4)	4.0	10	0	100
Multicote 40	4.0	2	100	0
UCR 1	4.0	5	0	100
Re-Gain	4.0	5	66	34
ProBalance/NKing	4.0	4	0	100
Turfgo 23	4.0	4	68	32
Turf Rally	4.0	5	97	3
Classic Royale	4.0	5	0	100
Turfgo 16	4.0	4	44	56
Scotts	4.0	4	34	66
HyrdoPrill	4.0	5	0	100
ParEx 24	4.0	3	44	56
Endure/Polyon/TGold	4.0	4	66	34
ParEx 28	4.0	3	62.5	37.5
Trisert KS	4.0	5	45	55
N-Sure Lite	4.0	5	37	63
K-Power (0.25)	2.5	10	0	100
UCR 2	4.0	3	67.5	32.5
Check	4.0	0	0	0

LANDSCAPE MANAGEMENT RESEARCH CONFERENCE AND FIELD DAY

THURSDAY, SEPTEMBER 18, 1997

LANDSCAPE MANAGEMENT RESEARCH CONFERENCE AND FIELD DAY
THURSDAY, SEPTEMBER 18, 1997

TABLE OF CONTENTS AND CONFERENCE SCHEDULE

THE FOLLOWING COMPANIES, AGENCIES, AND ORGANIZATIONS HAVE GENEROUSLY PROVIDED DIRECT OR INDIRECT SUPPORT TO ONE OR MORE OF THE UC LANDSCAPE MANAGEMENT PROJECTS AND PROGRAMS FEATURED IN THIS YEAR'S RESEARCH CONFERENCE AND FIELD DAY. THEIR SUPPORT IS VERY MUCH APPRECIATED.

METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA
Los Angeles, CA

CALSENSE
Carlsbad, CA

UNITED STATES FOREST SERVICE, PACIFIC SW BRANCH
Davis, CA

THE TORO COMPANY - IRRIGATION DIVISION
Riverside, CA

LANDSCAPE GROWERS, INC.
Monterey Park, CA

QUAIL BOTANICAL GARDENS
Encinitas, CA

DEEPROOT PARTNERS, L. P.
Burlingame, CA

LOS ANGELES STATE AND COUNTY ARBORETUM
Arcadia, CA

OVERVIEW OF OLEANDER LEAF SCORCH RESEARCH

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A lethal "leaf scorch" disease of oleander (*Nerium oleander* L.) has been confirmed in the Palm Springs area, Orange County, western Riverside County and is continuing to spread to other parts of Southern California. Estimated economic impact of the loss of oleanders on State highways alone is $75 million, with plant replacement adding another $50 million (replacing with concrete medians would cost $52 million). Replacement costs in residential landscapes in the Los Angeles basin could run between $55 and $100 million. The combined efforts of the investigators and collaborators working on this project have resulted in a number of significant findings and a substantial beginning of longer-term studies.

The bacterial pathogen, *Xylella fastidiosa*, has been confirmed as the causal agent. It is a new strain of the bacteria which is distinct from the strains that cause disease in grape, peach, plum, almond, and oak. In greenhouse studies, this new strain is also capable of infecting Madagascar periwinkle (*Catharanthus rosea* [L.] G. Don) and periwinkle (*Vinca major* L.), but field observations have yet to find these two common ornamentals to be infected. The oleander strain of the *Xylella fastidiosa* had an incubation period between inoculation and first symptoms from 5 to 13 months in the greenhouse.

The bacteria are spread by native and introduced species of sharpshooter insects. *Homalodisca coagulata*, the glassy-winged sharpshooter, is the species recently introduced from the southeastern United States. The two graphs below show its 1996 population fluctuation at two locations.

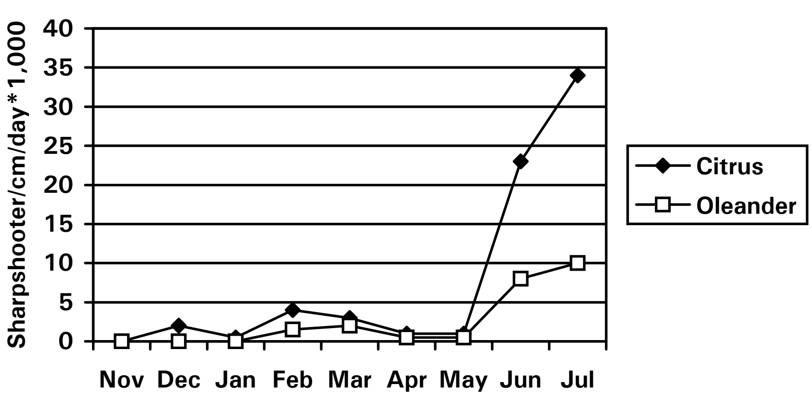

Figure 1. Seasonal yellow sticky trap catches of *Homalodisca coagulata* on Citrus & Oleander in Irvine, CA.

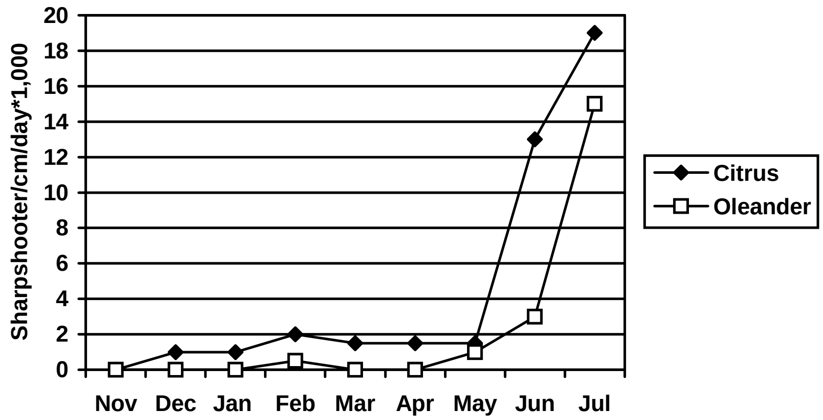

Figure 2. Seasonal yellow sticky trap catches of *Homalodisca coagulata* on Citrus & Oleander in Riverside, CA

These insects are susceptible to endemic egg parasitic wasps and are potentially susceptible to egg parasites from Louisiana and Florida. While biological control of the bacteria carrying insects will not be capable of controlling the disease, it may serve as a component in an overall integrated pest management (IPM) strategy to slow the disease's progress.

To date, no curative or protective treatment is available for controlling any strain of *Xylella fastidiosa*. Work continues to identify possible cultural control methods, plant species that are resistant and susceptible to this new strain, and insecticides that may be effective against the sharpshooter insects.

This report is based on the work of the following project researchers: Mathew Blua, Post Doctoral Researcher, U.C. Riverside; Marcella Grebus, Coop. Ext. Specialist, U.C. Riverside; Lawrence Hanks, Post Doctoral Researcher, U.C. Riverside; Janet Hartin, Farm Advisor, San Bernardino County; Michael Henry, Farm Advisor, Riverside County; Lori Lynch, Graduate Student, Economics Dept., U.C. Berkeley; Timothy Paine, Professor, U.C. Riverside; Dennis Pittenger, Area Farm Advisor, Southern Region; Alexander Purcell, Professor, U.C. Berkeley; Richard Redak, Assistant Professor, U.C. Riverside; Ursula Schuch, former Coop. Ext. Specialist, U.C. Riverside; Serguie Triapitsyn, Principal Museum Scientist, U.C. Riverside; Cheryl Wilen, Area IPM Advisor, Southern Region; David Zilberman, Professor, U.C. Berkeley.

Collaborators: Heather Costa, Coop. Ext. Specialist, U.C. Riverside; Phil Phillips, Area IPM Advisor, Ventura County; Fred Roth, Horticulture Professor, Cal Poly Pomona; Ann Gabric, Soil & Plant Laboratory, Orange, CA.

OLEANDER LEAF SCORCH PATHOLOGY

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NOTES:

BIOLOGICAL CONTROL OF GLASSY-WINGED SHARPSHOOTER

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A survey of egg parasitoids of the sharpshooter leafhopper *Homalodisca coagulata* (Say) was conducted in Southern California during 1996-1997 and in Florida and Louisiana during 1997. Four species of the mymarid wasp genus *Gonatocerus*, *G. ashmeadi* Girault, *G. capitatus* Gahan, *G. fasciatus* Girault and *G. incomptus* Huber, as well as a *Zagella* sp. (Trichogrammatidae) were reared from *H. coagulata* eggs. *Gonatocerus ashmeadi* was the most common parasitoid in all locations. In Southern California, *G. ashmeadi* apparently has switched to parasitize *H. coagulata* eggs from its known native host, the smoke tree sharpshooter, *H. lacerta* (Fowler) (Triapitsyn & Phillips 1996).

Feasibility of a classical biological program against *H. coagulata* in Southern California is discussed. Several species of egg parasitoids which are not known to occur in the western United States, *Acmopolynema sema* Schauff (Mymaridae), *G. fasciatus* and *Zagella* sp., are indicated as candidates for potential introduction into Southern California.

Major Collaborators: R. F. Mizell, III (University of Florida NFREC, Monticello, FL 32344), J. L. Bossart and C. E. Carlton (Department of Entomology, Louisiana Agricultural Experiment Station, Baton Rouge, LA 70803).

Reference

Triapitsyn, S. V. and P. A. Phillips. 1996. Egg parasitoid of glassy-winged sharpshooter. Citrograph 81 (9): 10.

WOOD BORING INSECTS IN LANDSCAPE TREES

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NOTES:

BIOLOGY AND MANAGEMENT OF NUTSEDGE

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Yellow nutsedge (*Cyperus esculentus)* and purple nutsedge (*Cyperus rotundus*) are regarded as two of the world's worst weeds. Both species are abundant in the warm regions of the world, but yellow nutsedge is more widespread than purple nutsedge in temperate zones due to its greater tolerance of cold temperatures. Yellow nutsedge is widely scattered throughout California, while purple nutsedge is more restricted in distribution. Purple nutsedge is more prevalent in southern than northern California and is scattered in central California, as well.

Both of these species are perennial sedges that resemble grasses, with triangular flowering stems. Leaves originate from the base of the stems, while at the ends of the stems long leaf-like bracts radiate out from a common point just below the umbrella-like flower clusters (spikelets). Yellow nutsedge is 6 to 30 inches tall and can reproduce by seeds (uncommon) or by underground tubers, which are hard, brown, round, and ½ to ¾ inch long. Purple nutsedge leaves are 2 to 6 inches long, while flowering stems are 12 to 24 inches tall. Purple nutsedge reproduces only by tubers, which are oblong, covered by reddish scales, and often formed in chains.

Tubers of yellow and purple nutsedge are produced along underground stems, or rhizomes, and may remain dormant in soil until conditions are right for sprouting. The tubers are the only vegetative part of the plant that overwinters, and can survive for several years in soil. Buds on tubers sprout under suitable conditions, generally in early spring, and produce new aboveground shoots and more rhizomes. New tuber formation begins 4 to 6 weeks after a new shoot emerges. Most tubers are produced in the upper 6 inches of soil. Without competition, yellow and purple nutsedge can produce 4 to 12 million tubers per acre. Both species are sensitive to low light, so competition can reduce their growth. However, shade does not inhibit tuber production so is not sufficient alone as a weed control measure.

Both yellow and purple nutsedge reproduce primarily by vegetative means (tuber sprouting) rather than by seeds, so control should be directed at interfering with tuber production. Cultural methods that delay emergence can give new landscape plantings an early advantage. Recent research at UCR to develop degree-day models for yellow nutsedge phenology shows promise for improving our ability to predict the timing of emergence of this weed. Cultural methods used successfully on these species in small areas are mulches and geotextiles, solarization, and hand removal. The best method is a combination of prevention plus maintaining a healthy coverage of desirable landscape plantings to shade and compete with the nutsedge species.

Only a few herbicides are registered for control of yellow and purple nutsedge in landscape and nursery situations. Success has been achieved with bentazon (Basagran), MSMA, metolachlor (Dual), glyphosate, and pelargonic acid. More recently, Manage has provided excellent control in turf.

PALM ROOT REGENERATION STUDY

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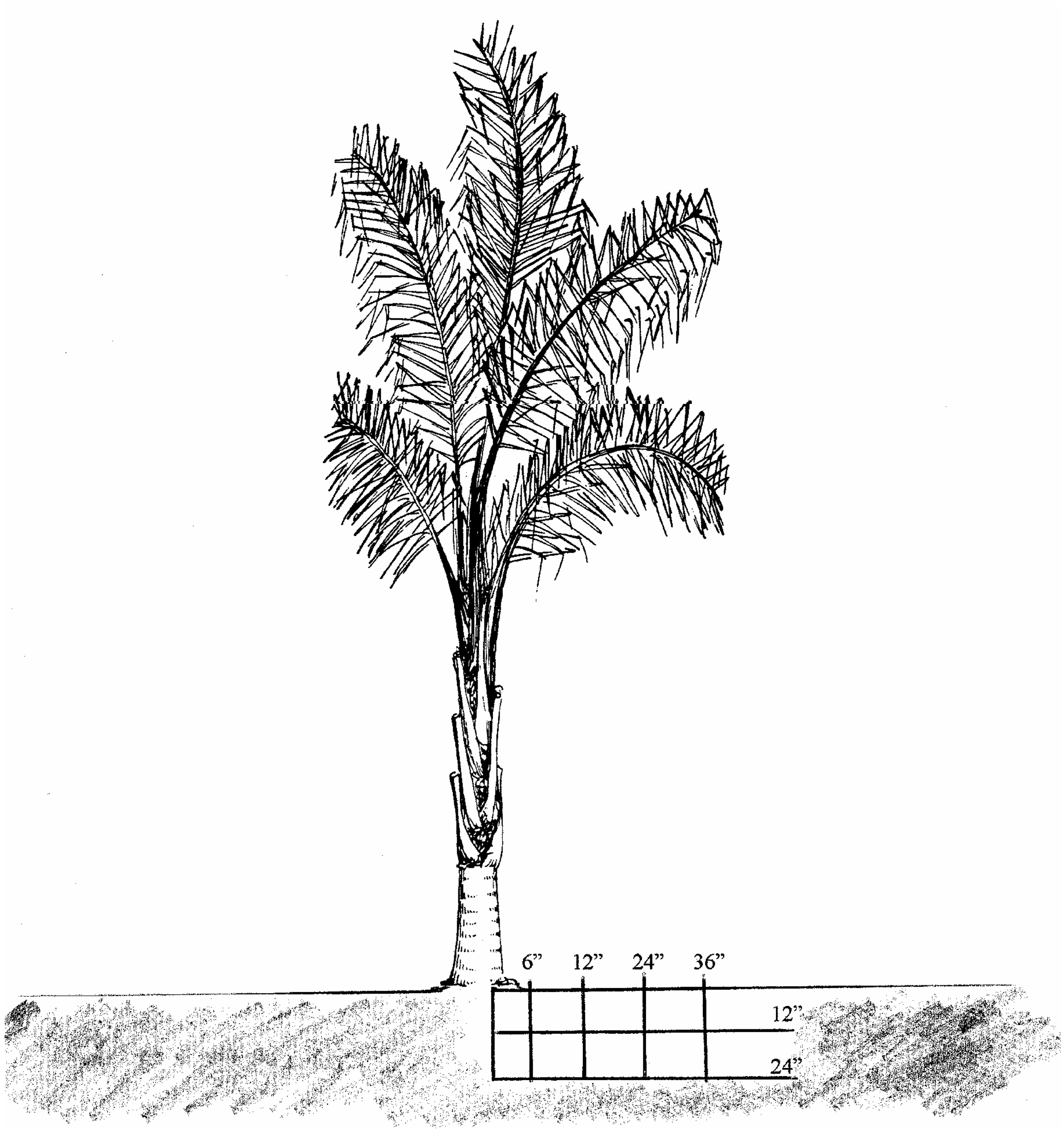
Large palms are a conspicuous and important element of the Southern California Landscape. They are the signature plant material and emblematic of the much popularized Southern California lifestyle. Because of their woody, monocotyledonous nature, characterized by the production of fibrous, adventitious roots from the base of the stem, even large specimens usually can be transplanted successfully with relative ease and with a small root ball. This relative ease of transplanting gives them a distinct economic advantage in landscape development and installation over conifers and large, woody, broad-leaved, dicotyledonous trees characterized by a branched, woody root system. Unfortunately, many large palms do not survive transplanting or require an inordinately long time to reestablish. Little is known about palm root distribution and growth and how they may affect survivability and reestablishment of large specimens in the landscape. In June 1997, we initiated a project at The Arboretum of Los Angeles County in Arcadia to study root distribution and growth in large specimen palms. A narrow trench six inches wide, 24 inches deep, and 36 inches long was dug at the base of three specimens each of 16 species (see below). The side of the trench facing the palm was divided into 6-, 12-, 24-, and 36-inch distance zones from the trunk. Each distance zone was subdivided into two depth zones of 12 and 24 inches, giving a total of eight zones in which to quantify root distribution (see Figure 1 on the following page). The trench was then back filled with perlite. The palms are irrigated at 100% of reference evapotranspiration. At three-month intervals for 15 months, each trench will be re-excavated and the roots counted, harvested, and weighed in each of the eight zones. We will correlate root distribution and growth with daylength, soil temperature, and distance from the trunk over a one-year period, hopefully enabling us to make recommendations about optimal root ball size and time of year for successful transplanting and rapid reestablishment.

Species

Archontophoenix cunninghamiana king palm
Brahea edulis Guadalupe palm
Butia capitata pindo palm
Caryota mitis fishtail palm
Chamaerops humilis European fan palm
Livistona chinensis Chinese fan palm
Livistona decipiens ribbon fan palm
Phoenix canariensis Canary Island date palm
Phoenix reclinata Senegal date palm
Rhapidophyllum hystrix needle palm
Sabal minor dwarf palmetto
Serenoa repens saw palmetto
Syagrus romanzoffiana queen palm
Trachycarpus fortunei Chinese windmill palm
Trachycarpus wagnerianus windmill palm
Washingtonia robusta Mexican fan palm

Figure 1. Zones for Quantifying Palm Root Regeneration.



DRIP IRRIGATION OF SHRUBS AND GROUNDCOVERS

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[4]*Quail Botanical Gardens, Encinitas, CA*
[5]*Horticulture Consultant, La Mesa, CA*

Project Description

The purpose of this project is to further refine estimates of ornamental plant water use in comparison to reference evapotranspiration (ET_o). Landscape and "Green Industry" personnel as well as water purveyors are adopting the use of ET_o information for scheduling irrigations and for determining water allotments. Information from this study will be directly applicable for use in landscape irrigation scheduling.

Objectives

1. To further determine estimates of the water needs of selected plant species and the performance of species under reduced irrigation.

2. To investigate less commonly used plant species and determine their applicability for use in landscapes under reduced irrigation.

3. To demonstrate performance of species under the different irrigation regimes and to introduce new species to landscape architects, ornamental plant producers, and maintenance personnel.

Experimental Design

A field plot was established in 1994 at the Quail Botanical Gardens, Encinitas, CA. The experiment consists of nine 40 ft by 48 ft planting blocks representing three irrigation treatments replicated three times. Each block is divided into 30, 8 ft by 8 ft test plots corresponding to the number of shrub species being studied. The planting locations for each species within blocks were randomized to minimized bias resulting from factors such as shading, root competition, and supplemental precipitation available to plants growing along the block edges. Within each 8 ft x 8 ft plot, four individual plants of each species were planted with the two exceptions of *Chamaerops humilis* and *Correa pulchella*, which contain five and six test plants, respectively. The majority of the shrubs were planted in December 1994.

For establishment, plants received adequate irrigation to achieve maximum vigor and growth rate. Irrigation treatments were initiated on June 1, 1996. ET_o data from the CIMIS weather station in Oceanside are used for irrigation scheduling.

In 1996, treatments consisted of 36%, 24%, and 12% of reference ET_o with irrigation frequency determined by projected soil moisture deficit of 0.5 inches. Each irrigation treatment is replicated three times for a total of nine blocks containing 270 plots (9 x 30 = 270).

Irrigation System

The study plots are irrigated using Ro-Drip tape from Roberts Irrigation with 1' emitter spacing. There are three drip lines for each 8' plot width, running the length of the block (six plots or about 50 feet). The drip lines are connected to bury PVC pipe and there is a valve, pressure regulator, and meter for each irrigated block. The water application rate is approximately 3.5 GPM or 0.17 inches per hour for each block.

Pest Management

Weeds and herbivores have been the main problems with the study. Hand weeding as well as preemergent (Ronstar) and systemic (Round-up) herbicides have been used to control weed problems on the site. A wire netting fence was installed to minimize damage from rabbits and ground squirrels.

Fertility

The study plots have received 2.0 pounds nitrogen per 1000 ft^2 per year in the form of calcium nitrate and 15-15-15.

Data Collection

Data collection consists of measurements of plant growth, height, area covered, aesthetic quality, water applied, and observational notes.

WEED BARRIERS AND HERBICIDES FOR LANDSCAPE WEED CONTROL

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Landscape weed control is best accomplished using an integrated strategy of non-chemical and chemical controls. This is in part due to the labor costs involved with mechanical removal of weeds on a timely basis and the public's desire for visually pleasing areas without excessive use of chemicals. Additionally, weed management in landscape plantings is often difficult due to the varied species planted in an area.

Recently, new herbicides and landscape fabrics have become available to landscapers in California. We currently are examining these products for weed control in the landscape. Herbicide products included in our studies are Gallery, Surflan, and Snapshot (a granular formulation of Gallery and Treflan). We also included three landscape fabrics in the studies, Typar 3201G, Typar 3401G, and Biobarrier. Biobarrier has the same fabric weight as Typar 3401G but has nodules filled with a Treflan formulation that is released over time.

Two field sites have been set up to examine these treatments. One is located in north Long Beach where we are using the landscape fabrics in conjunction with gravel mulch. Plants at that site are India hawthorn and Lily-of-the-Nile. The second site is located at the Agricultural Operations field at UCR. At this location, we planted roses and applied chipped wood mulch, landscape fabrics, and chemical herbicides. All herbicides were applied to bare ground and all the fabrics were covered with mulch to reduce photodegradation.

Early results from the Riverside trial indicate that all treatments provided good control of the weeds present. The majority of weeds at that site are puncturevine and spurge. For other herbicides tested (see Table 1), the combinations provided greater weed control than that of the single herbicide treatments. No phytotoxicity of the roses was observed.

Results from the Long Beach location were similar except that the rock mulch alone did not provide good weed control. After 3 months, this treatment only provided 50% control as compared to the unmulched treatment. Again, the herbicide combinations were better at controlling weeds than the single herbicide treatments. Snapshot provided the best overall weed control of the herbicide treatments. Palm seedlings were able to grow through the lighter weight (Typar 3201G) fabric.

This study will be maintained for at least two years to evaluate the long-term weed control of the landscape fabrics.

TABLE 1.	Long Beach, 84 days after treatment		Riverside 11 days after treatment	
Treatment	**%Cover**	**% Control**	**%Cover**	**% Control**
None	83.33	0.00	13.75	0
Mulch alone	36.67	50.00	0	100
Fabric 3201	1.00	95.00	0	100
Fabric 3401	0.00	100.00	0	100
Biobarrier	0	100.00	0	100
Gallery 1 lb a.i./A	61.67	41.67	4.5	84.75
Surflan 4 lb a.i./A	25.00	66.67	2.75	89.5
Gallery 1 lb+ Suflan 3 lb a.i./A	18.33	81.67	0.75	97
Gallery 1 lb+ Suflan 4 lb a.i./A	23.33	76.67	1	98.75
Snapshot 5 lb a.i./A	12.00	89.33	1.75	96

Plot Plan for Landscape Weed Control at UCR

↑ **N**

Rep 4	9	10	2	1	4	6	5	3	8	7
Rep 3	5	3	8	7	1	9	10	4	6	2
Rep 2	8	5	7	2	10	1	3	9	4	6
Rep 1	3	8	4	9	7	2	6	1	5	10

Treatment code:

1 Gallery 1 lb a.i./A
2 Surflan 4 lb a.i./A
3 Gallery + Surflan (1+4 lb a.i./A)
4 Gallery + Surflan (1+3 lb a.i./A)
5 Snapshot 5 lb a.i./A
6 Biobarrier
7 Typar 3201
8 Typar 3401
9 Mulch alone
10 Control (no herbicide, mulch, or fabric)

UPDATE ON LANDSCAPE WATER REQUIREMENTS STUDY

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The Mixed Landscape Study is a significant element of the Metropolitan Water District-funded turf and landscape research projects at UC Riverside. Covering some 40,000 square feet, the research facility was constructed and planted in the summer and fall of 1995 and is among the first of its kind nationally. The facility includes plots with trees (Bradford pear), turf (Marathon III tall fescue), and groundcover (potentilla or spring cinque-foil) alone and in combinations (see plot map). Eight individually controlled irrigation systems allow application of two irrigation treatments (80% and 56% ET_o) replicated four times.

The general objective of the mixed landscape study is to determine what impact different landscape plant combinations have on plant water use and which environmental parameters are responsible for this.

Specific objectives of the study are to:

a) Determine if the water requirement of a landscape, composed of a mixture of turfgrass, groundcover, and tree species with similar water requirements, is the same as a planting of equal area composed of a single species.

b) Evaluate the appropriateness of the "landscape coefficient method" of estimating water requirements of a landscape.

c) Characterize in quantitative terms the components and factors that determine the water requirements of a newly established landscape.

Baseline data collection (turfgrass clipping yields, total tree leaf area, stomatal conductance, tree and groundcover leaf water potential, quality ratings, soil moisture, and various weather parameters) under nonlimiting irrigation conditions was begun in the spring of 1996 and is ongoing. Irrigation treatments (80 and 56% ET_o applied twice weekly) were initiated in August 1997 following irrigation system audits and adjustment. Plant response data, as well as soil moisture and weather data, is being collected regularly to determine the effects of plant combination and irrigation level on plant performance and water use. Weather data (relative humidity, solar radiation, air temperature, and wind speed) is being used to calculate reference evapotranspiration within each of the seven plant material combinations. Calculated ET values are approximately 5 to 15% different from CIMIS ET_o values.

Acknowledgement

Appreciation is extended to the Metropolitan Water District of Southern California for funding this research. Thanks are given to the Toro Company and Calsense for their generous donations of irrigation equipment.

DISEASE SUPPRESSION WITH MULCHES

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Root rot of many ornamental trees, shrubs and herbaceous plants is caused by the fungus *Phytophthora cinnamomi* (Rands.). The fungus was probably introduced into California in the late 1800's (10) and has spread rapidly with nursery stock as gardens were planted throughout the state (9). The fungus is microscopic--not visible, even with a hand lens. Diagnosis of Phytophthora root rot (PRR) is achieved with visual examination of roots for symptoms of root rot, and isolation of the fungus from the roots. Monoclinal antibody test kits can also detect the presence of *Phytophthora* in roots (5). There are relatively few fungicides that provide effective control of the disease. Subdue (metalaxyl, Novartis) and Chipco/Aliette (Rhône-Poulenc) both give good disease control on various hosts/crops. Unfortunately, some *Phytophthora* species have developed resistance to metalaxyl, and few new fungicides are available because of the high costs of pesticide registration.

Alternative methods of controlling the disease are helpful. Biological control of PRR has been studied for many years (3). Coffey (1984) proposed an integrated method of controlling root rot in avocado, which involved chemical and physical treatments and resistant rootstocks. The discovery that mulches are useful was made in Australia about 40 years ago (1). Applying high rates of calcium (as lime) and mulches (as manures, cover crops, or chopped tree trimmings) controlled PRR. Guy Ashburner empirically developed this system of controlling PRR in an attempt to recreate the rainforest litter/mulch layers in his grove. The Ashburner method is widely cited in the literature as a successful example of biological control of PRR. Recent attempts to recreate the Ashburner system in California have been limited to avocado orchards. Although the system has not been studied in landscapes, some of the basic findings are directly applicable to landscape situations.

Cook and Baker stated, "A program for disease control, by whatever means, must fit into cultivation practices or the practices must be modified before the control program can be adopted." This is a wise precept for growers or landscape managers to understand. The Ashburner system has been successfully recreated by Menge in Somis, CA (7). Mulches promoted growth and reduced disease in avocado plantings (Menge, personal communication). In another study, opposite findings were observed. Both groves were in Somis with similar soil types planted to avocados. The grove in which disease was reduced was under irrigated. Where trees are water stressed, mulch treatments promote growth in a young orchard. No amount of biological control or even chemical control can save trees from the combination of excessive moisture and *Phytophthora cinnamomi*. Therefore, soil moisture levels must be monitored if mulching is to be used successfully in landscapes or orchards for control of root diseases.

Organic mulches promote rooting of avocado, but are less effective in citrus. Similarly, many ornamental plants will produce roots in mulch layers. The interface of mulch and soil is the zone where disease is suppressed. It is also an area of high biological activity, increased diversity of fungal organisms, and increased enzyme activity. *Phytophthora* is eaten, dissolved and starved in this part of the soil and is thus rarely found here. Healthy roots predominate. Three to six inches deeper in the same soil, roots rot from PRR. Mulch quality is important. Healthy, freshly fallen avocado leaves are very favorable to the growth of *Phytophthora cinnamomi* and these leaves are often used to bait the fungus from soil. Leaves lose their attraction with age (8). We have found that yardwaste mulches with copious quantities of undecomposed wood are effective in suppressing PRR.

Ashburner also added calcium (as lime) to his grove to promote the suppressive conditions necessary for PRR control. There are many reasons why lime may promote disease suppression. Since PRR can develop over wide pH ranges, pH effects are probably not that important. A more likely hypothesis is that populations of fungal/bacterial antagonists are stimulated by the pH changes. Broadbent and Baker suggested that biocontrol bacteria were stimulated at the increased pH levels. Recent work by Messenger suggests that calcium ions are fungicidal to *Phytophthora cinnamomi*. Sporangia, which produce the primary infective propagule (zoospores), are reduced in size and numbers by high calcium levels in soil. In California trials, we have used gypsum (calcium sulfate) as the calcium source for the Ashburner system. Unlike tropical Australia, California soils do not need pH correction. Gypsum does not affect soil reaction in most California soils. Even though many of our soils and waters are already calcic, we have found that gypsum mulches do have an effect on soil moisture tension and growth of the trees (Table 1). Gypsum treatments also appear to have a disease retarding effect in our field trials. Gypsum affects the soil matric potential making the soil environment less conducive to PRR (Figure 1). It is uncertain whether moisture effects or direct effects on the fungus are most important. It is certain that wet soil conditions favor PRR, mostly because increased soil matric potentials result in production of sporangia as well as release and swimming of zoospores of *Phytophthora* (4).

Phytophthora cinnamomi is a water mold. This common name for the fungus is a good one as it indicates the vital link that *Phytophthora cinnamomi* has with free water. Management of PRR must rely not only on biological or chemical methods but also on a good understanding of soil and plant-water relations and the cultural conditions that manipulate the soil-plant-water environment. Poor management of plantings under mulch can exacerbate root rot diseases.

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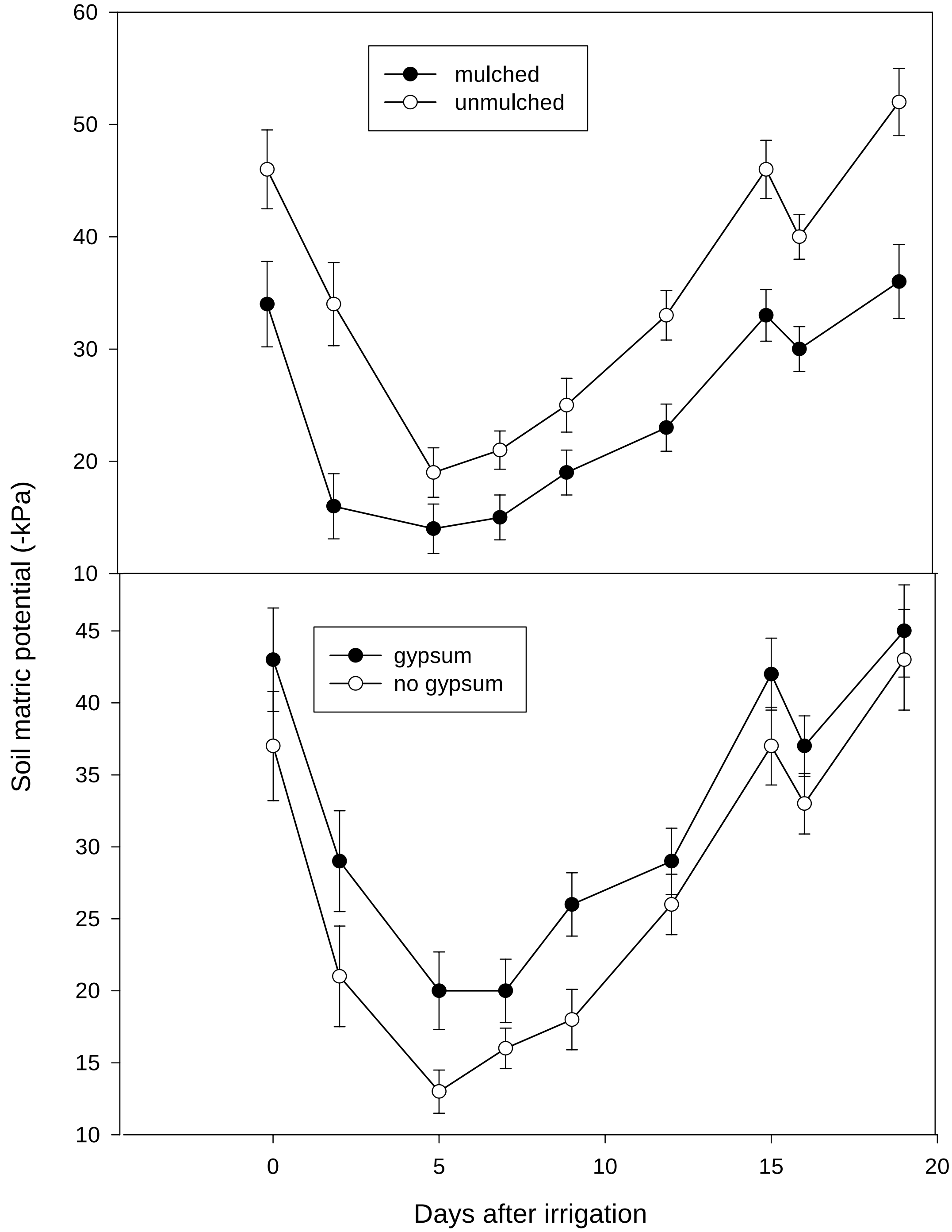
*Use of trade names does not imply a product preference by the author, nor does absence of other product names imply lack of efficacy of those products.

Table 1. Growth of Avocado under various mulch environments.

Treatment		Plant Volume (m^3)	
		1996	1997
Wood Chip Mulch			
	yes	3.79	11.9
	no	4.33**	12.5**
Gypsum			
	yes	4.30	13.2
	no	3.81**	11.1**
Aliette fungicide			
	yes	4.57	13.4
	no	3.54***	10.9***

, and * refer to the probability of difference (P=.001 and .0001, respectively) for within treatment category comparisons of various means.

Figure 1. Soil Moisture tension in mulched trees



Starting 8/26 ending 8/25
Mulched vs unmulched: n=60

BAITS FOR ANT CONTROL

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Argentine ants and California fire ants are two of the most common urban ant pests in Southern California. Currently, insecticide sprays are the most common treatment for infestations of these ants, but effective baits will soon be available.

Baits are target-specific, and use less insecticide. In comparison with sprays, baits offer distinct advantages. First, very little insecticide is required, and consequently, baits are safer for the environment and the user. Second, baits eliminate the necessity of finding the nest, usually a labor-intensive procedure because of the cryptic nesting habits of many pest ants. And third, baits capitalize on the social behavior of ants, whereby scout ants recruit nestmates to a newly discovered bait, and these recruited ants return to a centrally located nest to share the bait with the rest of the colony.

A good ant bait should be highly attractive, nonrepellent and slow-acting. Many ants feed primarily on honeydew and are therefore attracted to sweets. Others prefer oils or fats. Ant baits often use one or the other or both as food attractants. The bait toxicant should be nonrepellent and slow acting to ensure that it is collected and then passed around to the entire colony before taking effect.

Our research with Argentine ants has demonstrated that a low concentration of boric acid mixed with sugar and water is an effective slow-acting bait. Some of the advantages of this bait include the delayed toxicity and water solubility of boric acid at low concentrations. Additionally, the water carrier and sugar attractant meet the requirements of ants for moisture and carbohydrates. This bait is an integral component of our pest management program for Argentine ants.

Amdro is a granular ant bait that will soon be commercially available in California. It is effective against California fire ants, Argentine ants, and harvester ants. Amdro uses hydramethylnon as the toxicant dissolved in soybean oil on a corn grit base. Hydramethylnon is a metabolic inhibitor, which is slow acting.

GROWTH OF LANDSCAPE TREES PLANTED FROM THREE CONTAINER SIZES

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Fifteen *Quercus agrifolia* and fifteen *Magnolia grandiflora* container-grown trees were planted at the University of California, Riverside in June 1992. The planting is a completely random experimental design with five replications. Five trees of each species were transplanted from 5-gallon containers, five were transplanted from 15-gallon containers, and five were transplanted from 24-inch boxes directly into the field. The objective of the study was to determine the relationship of container size to future growth of each species.

Trees were planted on a 20 x 20 feet spacing, and irrigated based on reference evapotranspiration (ET_o) from the on-site California Irrigation Management Information System (CIMIS) weather station. Soil moisture was not a limiting factor. Trees were fertilized in 1993 and 1994 at 3 lb N/1000 ft^2 of drip line area. Weeds have been managed with a combination of preemergent herbicide (Surflan), hand weeding, and contact herbicide.

Semiannually, trunk circumference at six-inches above the soil level was measured. Between 1992 and 1994, there were significant differences between trunk circumference and container size for both *Quercus* and *Magnolia.* In both cases, trunk circumference was positively correlated with container size. Between May 1994 and August 1997, there was no significant difference among trunk circumference of the *Quercus*, regardless of container size while there continued to be a significant difference between Magnolia trunk circumference and container size.

⇖N

Magnolia: **A** *Quercus*: **B**
24 inch box: **1** 15 gallon: **2** 5 gallon: **3**

B1		**A3**
A2	**A1**	**B2**
A3	**B3**	**A1**
B1	**B2**	**B3**
B3	**A2**	**B1**
A1	**B2**	**A2**
A1	**A3**	**A2**
B3	**A3**	**B1**
A3	**B2**	**A2**
B2	**B3**	**A1**
	B1	

EXCAVATION OF TREE ROOT BARRIERS

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Millions of dollars are spent annually to repair pavement and other hardscape items broken or lifted by tree roots. The installation of an impervious physical barrier adjacent to the root balls of newly planted trees is a practice that has become widely used in many urban areas during the past 10 to 15 years to prevent surface root growth near paved areas. Commercially-produced, cylindrical barriers are being specified by cities in development guidelines and by landscape architects in their planting specifications. They are constructed of rigid plastics and are designed to restrict the growth of roots from the initial root ball. It is further claimed that they deflect roots downward and that roots then continue to grow horizontally out the bottom of the barrier, which are 18 to 24 inches deep. However, neither the efficacy nor the influence of physical barriers on root and shoot system development has been studied widely in replicated field experiments.

The objectives of this study are to:

a) Determine the influence of various types of physical surround-type root barriers on surface root development.

b) Determine the effect of physical surround-type root barriers on tree shoot growth.

c) Determine the growth of roots within and at the bottom of physical surround-type root barriers.

Methods and Procedures

The study began in June 1992 at UC Riverside. Two commonly used landscape tree species, *Liquidambar styraciflua* and *Ficus nitida*, were transplanted as 5-gallon sized plants into a field site of 20 ft x 20 ft spacing. The experimental design is a 10 x 10 Latin square of 5 root barrier treatments, 2 tree species, and 10 replicates. Planting pits 4 ft long x 3 ft wide x 2.5 ft deep were dug for each tree.

The following root barrier treatments have been included:

1. 'DeepRoot' barrier (DeepRoot Partners, L. P.) 30 in. diameter x 24 in. deep.

2. Standard 15-gallon nursery container with the bottom removed (14 in. top diameter x 12.5 in. bottom diameter x 17 in. height).

3. Black polyethylene (12 mil) sleeve the same dimensions as a 15-gallon container.

4. **Check**: Standard transplanting of a 5-gallon tree so that the surface of the root ball is at the field soil level.

The DeepRoot and 15-gallon container barriers were set in the planting pit, partially filled with soil and watered to settle soil in and outside the barrier before transplanting. Trees were transplanted into these barriers and the polyethylene sleeve barriers so that the surface of their root ball was even with the surface of the backfill soil in the barriers. The top edge of all barriers was initially 1 to 3 inches above the grade in and out of the barriers. All trees were watered by hand after transplanting to thoroughly wet the root ball and the surrounding soil. Drip irrigation was used to irrigate the planting in year 1, while mini-sprinklers have been used since. Irrigation has been applied frequently to maintain soil moisture content in the available range to a depth of a 2 feet. Weeds are controlled by a combination of pre-emergent and post-emergent herbicides.

Based on preliminary data, there appears to be no effect of any treatment on tree shoot growth. Excavation and collection of root system data are beginning in September 1997. Primary root data to be collected includes (a) dry weights and number of large roots inside and outside of barriers to a radius of 6 ft. (1.8 m.), and (b) describing the distribution, configuration, and direction of growth of root systems.