

# California Turfgrass Culture

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## “EL TORO” ZOYSIAGRASS

V. A. Gibeault and S. T. Cockerham<sup>1</sup>

Zoysiagrass is well adapted to the warm season turfgrass zone in California including much of southern California and the San Joaquin Valley. In its area of adaptation, it is considered to be a grass with maintenance requirements that are lower than those of most other turfgrasses. It requires less fertilizer, water and mowing than cool season turfgrasses. Although used to a limited extent in California, it has been established for home lawns, golf courses, playgrounds and parks.

Zoysiagrasses are tolerant of heat, drought, salinity and heavy traffic. While susceptible to several diseases in the Southeast, they have few disease problems in the more arid regions. Insect problems are rare and, because of high density, weeds seldom invade an established turf.

Despite many positive characteristics, zoysiagrass has not achieved the popularity of other turfgrasses. This has been attributed to certain faults including its slow rate of establishment, long dormant period and its tendency to be a thatch producer. Since zoysiagrass has desirable “minimum maintenance” characteristics, a breeding program under the direction of the late Dr. Victor B. Youngner and implemented by Mr. Stanley Spaulding, was undertaken at the University of California, Riverside to improve characteristics which limited its usefulness. The breeding program included introduction of new germplasm from foreign sources, selection within inbred lines and hybridization between selected inbreds. “El Toro”

zoysiagrass resulted from this breeding work.

“El Toro” is a *Zoysia japonica*, resembling “Meyer” in appearance but has a coarser leaf texture. It has shown a much faster rate of establishment than any other experimental or commercially available zoysiagrasses to date. It has better cool season color than “Meyer” and displays earlier spring green-up. Thatch production with “El Toro” is low. “El Toro” has survived winters in Illinois and Indiana but its comparative cold tolerance to other zoysiagrasses has not been completely documented.

One of the most striking characteristics of “El Toro” is the high resiliency observed when walking on established turf. Where many turf species form thatch which provides resiliency, the upright stiff stems and leaves of “El Toro” provide that quality and support weight without the negative aspects of thatch. This property allows “El Toro” to resist wear and to hold a golf ball well.

“El Toro” is vegetatively propagated. To date, it has been released to eight sod farms in California and several out-of-state growers under license by the University of California. Management and characterization studies are being performed at the UCR Turfgrass Research Project and reports will be released on a regular basis.

<sup>1</sup>Extension Environmental Horticulturist; Superintendent of Agricultural Operations, UC Riverside.

## ZOYSIAGRASS ESTABLISHMENT

J. M. Henry, S. Tjosvold, V. A. Gibeault<sup>1</sup>

Whenever a newly developed cultivar is released to the agricultural industry, one of the first questions which comes to mind is how it differs from currently available plants. Plant breeders target specific characteristics that they strive to improve or change from the common varieties being used by horticulturists, farmers and gardeners.

The development of numerous new experimental zoysiagrass lines by the late Dr. Victor B. Youngner led to the selection of three of the most promising ones based on industry and University evaluations.

Selection #1, a *Zoysia japonica*, has been released as “El Toro” zoysiagrass. Selection #3 was the result of *Z. matrella* x (*Z. japonica* x *Z. tenuifolia*) cv “Emerald” cross, and

Selection #5 was a *Z. matrella*

The time of planting vegetatively propagated, warm season turfgrasses is a key determinant in how successfully it becomes established and can be maintained. The longer a newly planted plant material is exposed to warm weather, the faster it grows and fills in. During this initial establishment period, extra care must be taken to encourage the grass while it is growing new roots and runners. Maintenance costs for weed control, irrigation, and fertilization are greater during the establishment period than after the grass is completely mature and dense sod has formed.

This study was undertaken to compare the establishment of zoysiagrass selections #1, #3, and #5-plugs versus stolons-at different times of the year.

## METHODS

The project was conducted at the University of California South Coast Field Station, Irvine, California. The climate at the field station is typical of the coastal climatic zone of California from Santa Barbara south to San Diego.

### Planting Method Treatment:

The three zoysiagrass selections were each planted by sprigging (stolons) and by plugging, the two planting methods commonly used for zoysiagrass. Since the rates of planting for each method were not equal, no statistical comparison of the two planting methods was made. Selecting the rate of planting for each of the two methods was done on the basis of trying to achieve the maximum amount of plant material for planting, not on the basis of cost or on traditional zoysia planting rates.

### Stolon Treatment:

Stolons were spread on a sample plot until the area was covered. This rate equaled approximately 12 bushels per 1,000 square feet. Although this rate is double the commercially applied rate of 6 bushels per 1000 square feet, it was judged the highest practical rate for stolon planting if optimum rate of establishment is the primary objective. All three varieties were planted at this rate in all stolonized plots.

### Plug Method:

Two-inch plugs, spaced 9 inches on center, was the specification for the plug method, recognizing that the literature ranges from 6 to 16 inches (1, 2).

### Planting Season:

The planting date was one of two main treatments of this study. Planting time was summer, fall and spring. Winter was thought to be infeasible for any warm season grass. The summer planting was on June 15 and 16, 1981. The second planting was on September 15, 1981. The third planting was on March 26, 1982.

The plot size was 5 feet by 10 feet, with a 1 foot bare border between plots to prevent contamination by runners growing into neighboring plots.

The soil was prepared by rototilling to a depth of 6 to 8 inches. Preplant fertilizer (ammonium phosphate) at the rate of 12 pounds per 1,000 square feet was incorporated into the top 1 inch of soil. Subsequent fertilizer applications of ammonium sulfate were made on a monthly basis at the rate of 1/2 pound of actual nitrogen per 1,000 square feet.

Maintenance practices to maximize establishment were conducted. Irrigation was applied at or above 100 percent of evapotranspiration as calculated from a Class "A" Weather Bureau Evaporation Pan. Hand weeding was done once during the first two months after planting along with mechanical and chemical edging of the plots. Mowing was done as needed with a reel-type mower at a 1/2 inch height.

Monthly visual determination of percent cover was made by at least two individuals. The first ratings were taken one month after planting and every 30 days until 100 percent cover was achieved.

The experimental design of the plot layout was a completely randomized block design. Each variety was replicated four times. Data were analyzed using an analysis of variance and differences determined with the Duncan's Multiple Range Test.

## RESULTS

Figure 1 shows the monthly rate of plot coverage for the three planting times. The data for this figure are averages across the three grasses and two planting methods for each planting time. Clearly, the late spring, early summer period is the preferred time to gain quick establishment of the zoysiagrasses in Southern California.

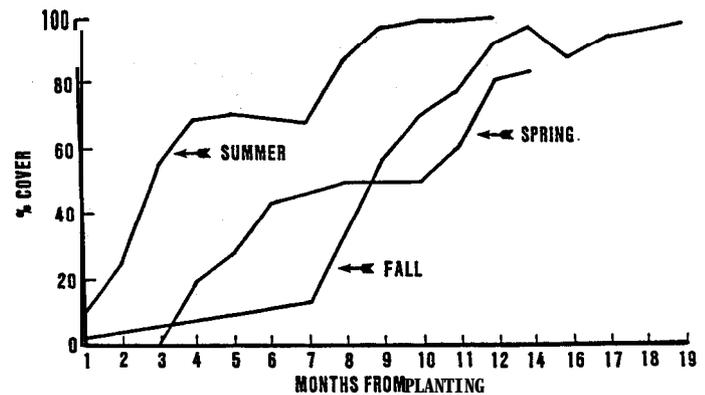


Figure 1. The rate of plot coverage, in months, for the three planting times.

The fall zoysiagrass planting suffered from slow growth of the zoysia due to the cool temperatures and the competition of the faster growing winter season annual weeds, especially *Poa annua* and Brass Buttons. The spring planting also suffered from slow initial growth of the zoysia and rapid growth of spring annual weeds (crabgrass, spotted spurge).

Figures 2, 3 and 4 show the rate of establishment by stolons for the three varieties. Variety #1, "El Toro," was faster to establish than varieties #3 and #5. These figures show only the stolon established variety rates, but the same relative growth rate was observed in plots planted by the plugging method.

Using the threshold level of 90 percent covered as the point of comparison, variety #1, "El Toro," became established in three months as compared to four months for variety #3 and eight months for variety #5 when planted in the summer.

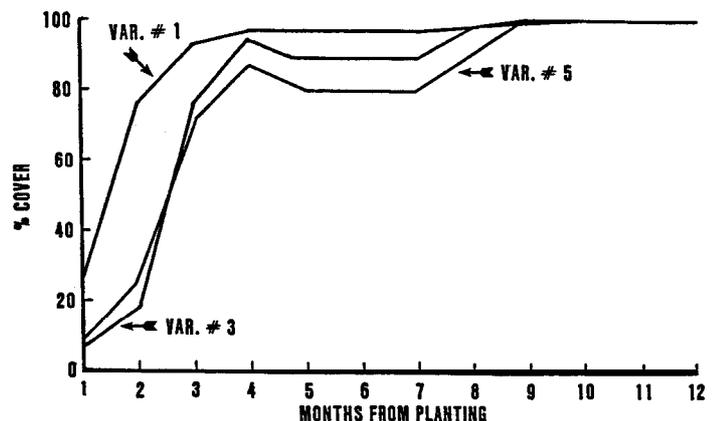


Figure 2. The rate of establishment for three varieties with summer planting by stolons.

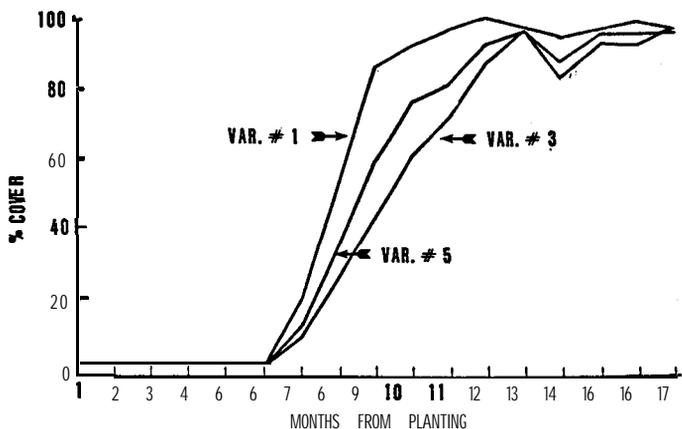


Figure 3. The rate of establishment for three varieties with fall planting by stolons.

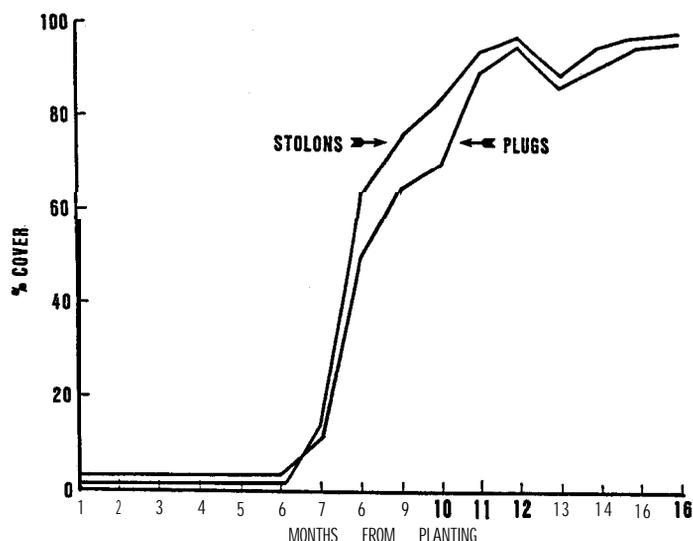


Figure 6. The zoysia establishment rate with stolons and plugs for fall planting.

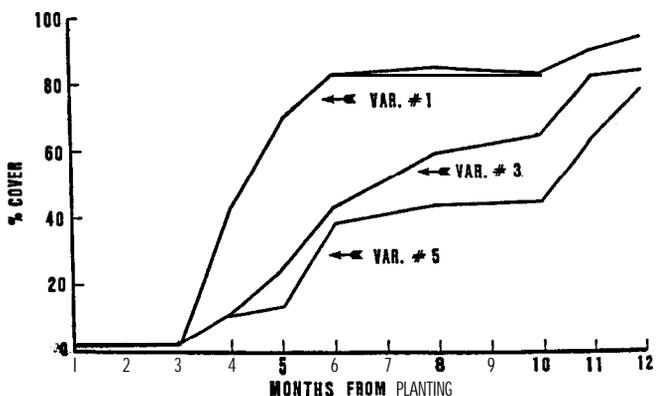


Figure 4. The rate of establishment for three varieties with spring planting by stolons.

Figures 5,6 and 7 represent the monthly establishment rate when the three varieties were planted with stolons or plugs in the summer, fall or spring planting times. Grasses planted in spring and summer with stolons established much faster than did the same grasses planted at those times by the plug method. It took eight months for the zoysiagrasses planted in summer as plugs to provide the same amount of cover that they did when planted in summer by the stolon method. With a fall planting time, there was little difference in coverage rate based on planting method as Figure 6 shows.

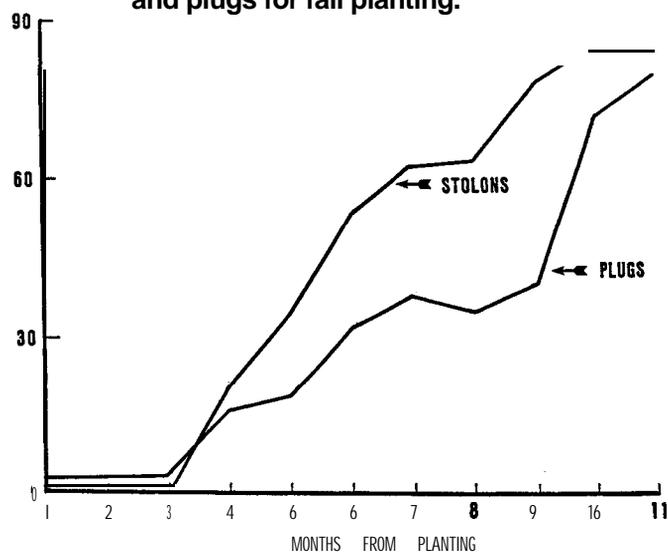


Figure 7. The zoysia establishment rate with stolons and plugs for spring planting.

## CONCLUSIONS

“El Toro” zoysiagrass (#1) quickly formed a turf cover. This feature, coupled with optimum planting date (early summer) and planting methods that maximized establishment potential (stolons 12 bushels per 1,000 square feet) resulted in full coverage in three and one-half months. This compares with establishment periods of from 12 to 18 months for some previously available zoysia cultivars using conventional planting rates (6 bushels per 1,000 square feet). Varieties #3 and #5 became established much slower than “El Toro.”

The establishment advantage of “El Toro” may overcome some of the difficulties sod growers and landscape contractors have had with previously available zoysiagrasses. The level of management needed to bring any lawn grass to full establishment is considerably higher than that typically required to maintain a mature stand. Thus, species that take longer to establish also require longer periods of high maintenance due to greater weediness, less drought or heat tolerance and generally a weaker resistance to wear and physical damage.

The most important factor affecting the rate of establishment, as determined by this study, is date of planting. Clearly, zoysiagrass has a short planting window if optimal establish-

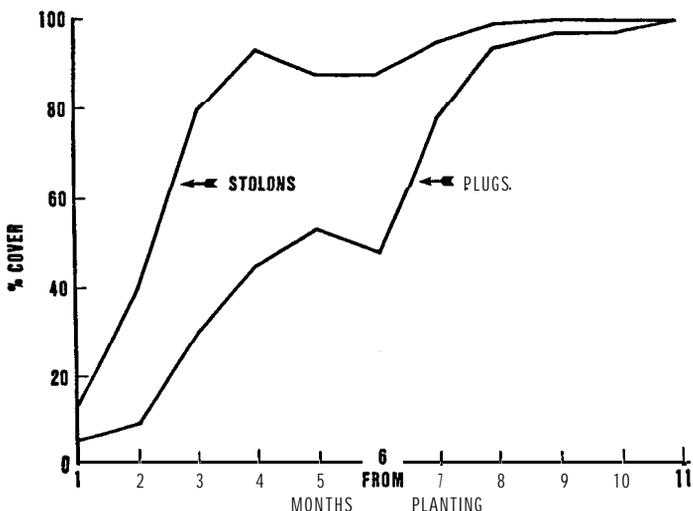


Figure 5. The zoysia establishment rate with stolons and plugs for summer planting.

ment is critical. Plantings that took three to four months to reach full cover in the summer took more than nine months to do so when done in the fall and more than 11 months when planted in the spring. Not only did the growth of the zoysia slow or stop at less favorable times of the year, but competition from weeds was much greater. This explains in part why a spring planting did not reach full coverage by the end of

summer, but a later summer planting did establish by the end of summer.

Stolonizing is clearly preferable to plugging for establishing these new zoysiagrasses.

<sup>1</sup>Farm Advisor and County Director, Orange County; Farm Advisor, Santa Cruz County; Extension Environmental Horticulturist, UC Riverside, respectively.

## NITROGEN FERTILIZATION OF "EL TORO" ZOYSIAGRASS

*Victor A. Gibeault, Matthew Leonard, Stephen Cockerham<sup>1</sup>*

Zoysiagrass is considered to be a minimum maintenance turfgrass species, and the release of "El Toro" zoysiagrass was based in part on its low-maintenance requirements. The fertilization requirement of this new variety has not been evaluated. Therefore, a study on the response of "El Toro" to increasing rates of nitrogen was conducted.

The study began on July 13, 1987 at the University of California, Riverside Turfgrass Research Project. Three-year-old "El Toro" zoysiagrass was fertilized with ammonium nitrate (37-0-0) at 0, 1, 2, and 3 pounds of nitrogen per 1000 square feet. Plots were split on September 8, 1987, and the same treatments were reapplied to half of each original plot. The study was designed as a randomized complete block with four replications. Main plots were 10 feet x 6 feet and subplots were 5 feet x 6 feet. After treatment, nitrogen response was measured by means of periodic visual ratings of turfgrass color and quality. Data were subjected to appropriate analysis of variance and regression procedures.

The plots were regularly mowed at 5/8 inch with a reel mower and irrigated based on water replacement as determined by a combination of automated weather station and Class A Weather Bureau Pan readings. The plot had not been fertilized for nearly one year.

### RESULTS

The correlation between color rating and turf quality was very high ( $r=0.955$ ), so all information presented hereafter is for color ratings only. Turf scores followed nearly identical patterns.

Figure 1 presents the color ratings for a single nitrogen application from July 13 to December 7, 1987. Color quality increased quickly, though improvement was directly proportional to nitrogen rate. All treatments exhibited a decline in color quality approximately two months after application; however, significant, linear rate responses were evident throughout the remainder of the study. Freezing temperatures in mid-December simultaneously induced dormancy in all treatments.

Figures 2, 3 and 4 illustrate the color response following the reapplication of nitrogen on September 8, 1987. Responses to the second application were very similar to those observed for single applications except that color quality was improved above that noted for one application. Again, color began to decline about two months following treatment.

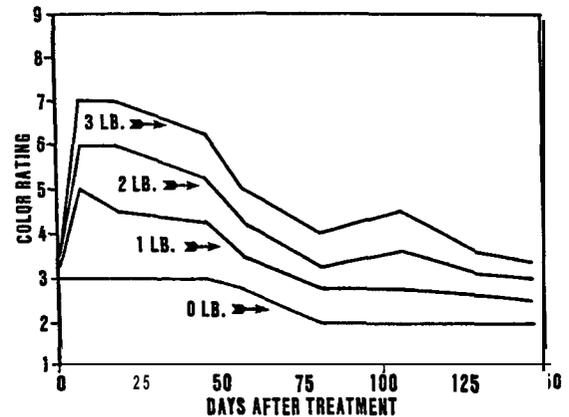


Figure 1. Color response (1 = no green, 9 = dark green) of El Toro Zoysis to a single treatment of ammonium nitrate when applied at four rates (lb N/1000 ft<sup>2</sup>).

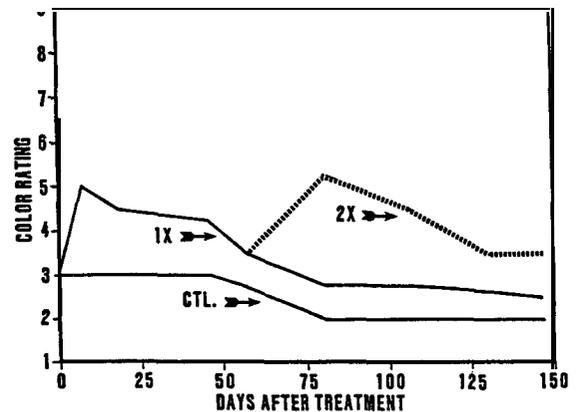


Figure 2. Color response of El Toro zoysia to a single (1X) and a repeat (2X) application of ammonium nitrate at 1 lb NH000 square feet represents the control (1 = no green, 9 = dark green).

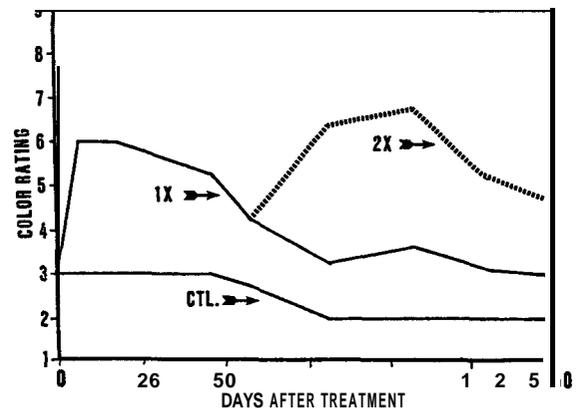


Figure 3. Color response of El Toro zoysia to a single (1X) and a repeat (2X) application of ammonium nitrate at 2 lb N/1000 square feet. CTL represents the control (1 = no green, 9 = dark green).

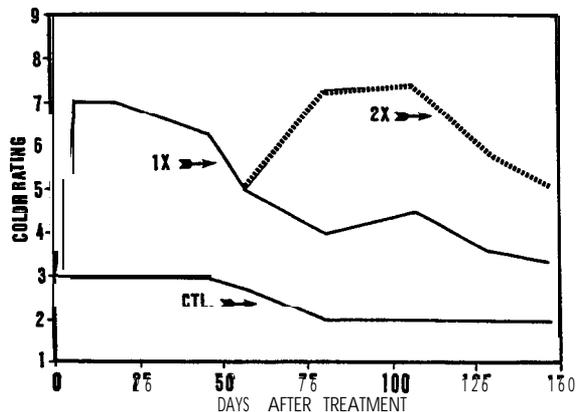


Figure 4. Color response of El Toro zoysia to a single (1X) and a repeat (2X) application of ammonium nitrate at 3 lb N/1000 square feet. CTL represents the control (1 □ no green, 9 □ dark green).

## DISCUSSION

Although the rate response was not surprising given the fact that the “El Toro” zoysiagrass had not been fertilized for one year, the 1 pound rate of nitrogen, either as a single application or two applications, would only be considered minimally acceptable. Two to 3 pounds of nitrogen per 1,000 square feet were needed to produce high quality turf color.

This study clearly demonstrated the “El Toro” zoysiagrass, if unfertilized or fertilized at a low level, produced a sward of poor color but a sward of adequate density and fairly pleasing

appearance. This indicates the potential of “El Toro” as a true minimum maintenance turfgrass. “El Toro” color response and turf quality can be improved to a high level with moderate to high nitrogen fertilization.

## CONCLUSION

This preliminary study indicated that “El Toro” zoysiagrass performs differently at low and high fertilization levels. A minimum maintenance turf of decent density and appearance resulted with very low nitrogen applications, whereas moderate to high nitrogen treatments result in a sward of deep green color, high density and high overall turf quality. It was noted that even at high nitrogen applications, vertical growth was only moderate and thatch accumulation was negligible. It was also noted that higher rates of nitrogen produced better late season winter color than lower rates and that the two applications of nitrogen were more effective in this regard than one application of nitrogen. It was also observable that shoot density was higher in the spring of 1988 in plots that had higher nitrogen rates.

<sup>1</sup>Extension Environmental Horticulturist. UC Riverside; Staff Research Associate. UC Riverside; Superintendent of Agricultural Operations UC Riverside.

# TOLERANCE OF "EL TORO" ZOYSIAGRASS TO SELECTED POSTEMERGENCE HERBICIDES

D. W Cudney, C. Elmore, V A. Gibeault and S. Cockerham<sup>1</sup>

A new, superior variety of zoysia, "El Toro," has been released by the University of California. "El Toro" zoysia has not been commonly grown in southern California. Therefore, it is important to evaluate the tolerance of the new "El Toro" zoysia variety to the commonly used postemergence turf herbicides.

Postemergence herbicides were applied on August 4, 1987 to a sward of "El Toro" zoysia which had been established for approximately one year. The postemergence herbicides were applied using a CO<sub>2</sub> constant pressure backpack sprayer with a spray volume of 50 gallons per acre. The postemergence herbicides compared included: 2,4-D (1.0 and 2.0 lb ai/A), dicamba (Banvel) (1.0 and 2.0), MSMA (Bueno, Dal-E-Rad) (2.0 and 4.0), 2,4-D plus MCPP plus dicamba (1.34 + 0.65 + 0.11) and (2.67 + 1.30 + 0.22), triclopyr (Turflon, Garlon) (0.50 and 1.0), bromoxynil (Brominal, Buctril) (1.0 and 2.0), bentazon (Basagran) (1.0 and 2.0), triclopyr plus 2,4-D (0.50 plus 1.0 and 1.0 plus 2.0, chlorflurenol (maintain CF-125) plus dicamba (0.50 plus 0.50), chlorflurenol plus triclopyr (0.50 plus 0.50), and imazaquine (Image) (0.38). All treatments were replicated four times.

The treatments were applied on August 28 and evaluated for "El Toro" zoysia phytotoxicity on September 1 and September 10. The plots were left unmowed for two weeks after treatment so that regrowth measurements (height) could be made (September 10). Color evaluation was made on September 14. The plots were mowed on September 15 and then left unmowed for four weeks so that an estimate of seedhead suppression could be made. Some zoysia cultivars including "El Toro" produce an extensive array of seedheads if left unmowed for more than two weeks during the growing season. It had been noted that some postemergence herbicides could suppress this seedhead production. On October 14, seedhead counts were made by randomly placing ten centimeter rings within the plots and counting the number of seedheads within each ring. Averages of three counts per plot were taken.

"El Toro" zoysia phytotoxicity ratings taken four days after treatment showed that the high rates of dicamba, bromoxynil and triclopyr plus 2,4-D were causing significant phytotoxicity. Two weeks after treatment the second phytotoxicity evaluation showed that recovery had taken place and only plots which had received the high rate of MSMA were showing discoloration. No phytotoxicity symptoms were evident in the zoysia three weeks after treatment.

Regrowth measurements taken two weeks after treatment showed that all herbicides and herbicide combinations with the exception of bromoxynil and bentazon tended to produce a temporary reduction in growth. This was particularly evident at the higher rates of application.

There was no significant difference in color 16 days after application. Seedhead counts were reduced by some herbicide applications. The 2,4-D, 2,4-D plus MCPP plus dicamba, and triclopyr plus 2,4-D treatments had the lowest seedhead counts. Although some significant seedhead suppression was evident, it was not enough to be aesthetically effective by preventing seedhead formation.

<sup>1</sup>Weed Scientist, UC Riverside; Weed Scientist, UC Davis; Extension Environmental Horticulturist, UC Riverside; Supt. Agricultural Operations, UC Riverside.

**Table 1. "El Toro" Zoysiagrass Postemergence Tolerance, UC Riverside**

Treatment	Rate lb ai/A	Phyto- toxicity <sup>5</sup>			Phyto- Height (cm) Color Count		Seedhead Count 10/14/87
		9/1/87	9/10/87	9/10/87	9/14/87	10/14/87	
2,4-D	1.0	0.5	0.0	3.3	2.5	15.0	
2,4-D	2.0	1.2	0.2	2.6	2.2	16.0	
dicamba	1.0	1.2	1.2	2.8	2.7	15.5	
dicamba	2.0	3.2	0.2	3.3	3.0	20.5	
MSMA	2.0	0.6	1.5	2.7	2.0	24.7	
MSMA	4.0	2.1	2.0	3.0	2.7	31.5	
<sup>1</sup> 1.34+0.65	+0.11	1.2	0.2	3.0	2.7	13.2	
<sup>2</sup> 2.67+1.30	+0.22	2.2	0.3	2.8	2.5	14.5	
triclopyr	0.5	1.0	0.7	3.2	2.7	20.2	
triclopyr	1.0	1.3	1.2	3.0	3.7	21.7	
bromoxynil	1.0	2.5	0.0	4.0	3.0	20.0	
bromoxynil	2.0	4.6	0.0	3.7	3.2	21.7	
bentazon	1.0	0.1	0.0	4.1	3.2	25.5	
bentazon	2.0	0.3	0.0	4.0	3.0	22.7	
triclopyr	0.5	1.2	0.6	3.6	3.5	16.2	
+ 2,4-D	+1.0						
triclopyr	1.0	4.1	1.7	2.0	4.0	14.5	
+ 2,4-D	+2.0						
<sup>3</sup> 0.56	+0.5	1.3	0.0	3.8	2.0	20.0	
<sup>4</sup> 0.56	+0.5	1.0	0.0	3.6	2.7	20.5	
imazaquine	0.4	1.0	1.0	3.0	3.0	34.0	
check		0.0	0.0	4.0	2.7	32.0	
LSD @ 5%		0.3	0.6	0.6	NS	12.2	

<sup>1</sup>2,4-D + MCPP + dicamba

<sup>2</sup>2,4-D + MCPP + dicamba

<sup>3</sup>chlorfluranol + dicamba

<sup>4</sup>chlorfluranol + triclopyr

<sup>5</sup>Phytotoxicity: 0 = No effect; 10 = all zoysia dead

# TOLERANCE OF "EL TORO" ZOYSIAGRASS TO SELECTED PREEMERGENCE HERBICIDES

*D. W Cudney, C. Elmore, V. A. Gibeault and S. Cockerham<sup>1</sup>*

"El Toro," a new, superior variety of zoysiagrass has been released by the University of California. "El Toro" zoysiagrass has not been commonly grown in southern California. Therefore, it is important to evaluate the tolerance of the new "El Toro" zoysiagrass variety to the commonly used pre-emergence turf herbicides.

Preemergence herbicides were applied on August 4, 1987 to a sward of "El Toro" which had been harvested five weeks previously for sod. The preemergence herbicides were applied using a CO<sub>2</sub> constant pressure backpack sprayer with a spray volume of 30 gallons per acre. The preemergence herbicides included: benefin (Balan) (3.0 and 6.0 lb ai/A), bensulide (Betasan) (10.0 and 20.0), pendimethalin (Lesco Pre-M, Prowl) (2.0 and 4.0), prodiamine (Prodiamine) (2.0 and 4.0), oxadiazon (Ronstar) (2.0 and 4.0), atrazine (Aatraz) (1.0 and 2.0), benefin plus trifluralin (1.3 plus .67), benefin plus oryzalin (1.0 and 1.0) and benefin plus oxadiazon (1.0 and 1.0). All treatments were replicated four times.

The plots were evaluated on August 12 and August 26 for color (phytotoxicity), and on September 1 root length measurements were made to evaluate the effect of the pre-emergence herbicides on "El Toro" zoysiagrass root development.

There was no differences among treatments for color ratings for either evaluation date except for the atrazine treatments which showed a significant reduction in color (yellowing) for both evaluation dates. Root growth one month after treatment averaged two centimeters at the fourth node from the shoot apex in the untreated plots. Oxadiazon and atrazine treatment did not significantly reduce root length. Benefin at the lower rate of application (3.0 lb ai/A) resulted in a slight reduction in root length. The high rate of benefin and both rates of bensulide, pendimethalin and prodiamine reduced root length. The combination treatments of benefin plus trifluralin, benefin plus oryzalin, and benefin plus oxadiazon all reduced root length. This study indicates the need to be aware of possible below ground effects of the use of preemergence herbicides which could slow regrowth of "El Toro" sod swards between harvests.

**Table 1. "El Toro" Zoysiagrass Preemergence Tolerance, UC Riverside**

Treatment	Rate lb ai/A	Phyto- <sup>1</sup> toxicity (Color) 8/12/87	Phyto- <sup>1</sup> toxicity (Color) 8/26/87	Avg. Root2 Length (cm) 9/1/87
benefin	3.0	8.00	8.00	1.325
benefin	6.0	8.00	8.00	0.700
bensulide	10.0	8.00	8.00	0.400
bensulide	20.0	8.00	8.00	0.175
pendimethalin	2.0	8.00	8.00	0.275
pendimethalin	4.0	8.00	8.00	0.225
prodiamine	2.0	8.00	8.00	0.250
prodiamine	4.0	7.75	8.00	0.175
oxadiazon	2.0	8.00	8.00	1.850
oxadiazon	4.0	8.00	8.00	1.875
atrazine	1.0	7.00	7.75	1.625
atrazine	2.0	5.25	6.50	1.750
Team <sup>a</sup> 1.3 +	0.67	8.00	8.00	0.825
XL <sup>b</sup> 1.0 +	1.0	8.00	8.00	0.275
Regalstar <sup>c</sup> 1.0 +	2.0	8.00	8.00	0.800
check		8.00	8.00	2.000
<b>LSD@5%</b>		<b>0.4859</b>	<b>0.2768</b>	<b>0.4058</b>

<sup>1</sup>Color of El Toro zoysia in the plot as determined by the following scale: 1 = yellow; 9 = dark green.

<sup>2</sup>Avg. length of roots (cm) emerging from the fourth node from the apex of ten randomly selected stolens per plot.

<sup>a</sup>benefin + trifluralin

<sup>b</sup>benefin + oryzalin

<sup>c</sup>benefin + oxadiazon

<sup>1</sup>Weed Scientist, UC Riverside; Weed Scientist, UC Davis; Extension Environmental Horticulturist, UC Riverside; Supt. Agricultural Operations, UC Riverside.

## WARNING ON THE USE OF CHEMICALS

Pesticides are poisonous. Always read and carefully follow all precautions and safety recommendations given on the container label. Store all chemicals in their original labeled containers in a locked cabinet or shed, ● wsy from food or feeds, end out of the reach of children, unauthorized persons, pets, and livestock.

Recommendations are based on the best information currently available. and treatments based on them should not leave residues exceeding the tolerance established for any particular chemical. Confine chemicals to the area being treated. THE GROWER IS LEGALLY RESPONSIBLE for residues on his crops as well as for problems caused by drift from his property to other properties or crops.

Consult your County Agricultural Commissioner for correct methods of disposing of leftover spray material and empty containers. Never burn pesticide containers.

PHYTOTOXICITY: Certain chemicals may cause plant injury if used at the wrong stage of plant development or when temperatures are too high. Injury may also result from excessive amounts or the wrong formulation or from mixing incompatible materials. Inert ingredients, such as wetters, spreaders, emulsifiers, diluents, and solvents, can cause plant injury. Since formulations are often changed by manufacturers, it is possible that plant injury may occur, even though no injury was noted in previous seasons.

NOTE: Progress reports give experimental data that should not be considered as recommendations for use. Until the products and the uses given appear on a registered pesticide label or other legal, supplementary direction for use, it is illegal to use the chemicals as described.

## CALIFORNIA TURFGRASS CULTURE EDITORIAL COMMITTEE

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University of California, Davis

Correspondence concerning California *Turfgrass* Culture should be sent to:

Victor A. Gibeault  
Batchelor Hall Extension  
University of California  
Riverside, CA 92521

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