HortScience 36(2):377–379. 2001.

Establishing *Zoysia japonica* from Sprigs: Effects of Topdressing and Nitrogen Fertility

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Additional index words. zoysiagrass, stolons, turfgrass, sod, propagation

Abstract. **Establishment of zoysiagrass (*Zoysia japonica* Steud.) from sprigs is often impractical for golf courses and sports fields because of the slow growth rate of the species and subsequent long establishment period. A study was conducted at two different sites in Arkansas to evaluate the effects of soil topdressing and post-plant fertility rates on establishment of zoysiagrass from vegetative sprigs. Each site was planted according to standard methods using freshly-harvested sprigs (18 m^3/ha) and either top dressed with 1.0 cm of native soil or maintained without topdressing. Beginning immediately after establishment, N was applied monthly at rates of 0, 1.25, 2.50, 3.75, or 5.0 $g·m^{-2}$ as urea. Rate of cover was monitored throughout the growing season and elemental analysis of plant tissues was determined 120 days after planting. Topdressing the sprigs with native soil significantly improved establishment compared to traditional sprigging at both sites, presumably because of enhanced sprig survival. Applications of N during the establishment period had little or no overall effect on establishment, although the 0 $g·m^{-2}$ rate was slightly inferior to all other rates. This study indicates that methods that enhance sprig survival are more important than added fertility for the rapid establishment of zoysiagrass sprigs.**

Zoysiagrasses (*Zoysia sp.*) continue to expand in popularity on golf courses, commercial sites, and home lawns throughout the transition zone because of their excellent wear tolerance, winter-hardiness, playability, and overall turf quality. The major zoysiagrass cultivar, Meyer, was introduced into the United States in the early 1950s and continues to be used more widely than other zoysiagrass cultivars throughout the zoysiagrass growing region (Christians and Engelke, 1994). 'Meyer' is propagated exclusively by sprigs, plugs, or sod and produces a dense, thick turf that competes well with weeds. However, 'Meyer' has a very slow overall growth rate relative to other warm-season grasses and is difficult to establish in most situations (Henry et al., 1988). Because of this slow establishment, zoysiagrass is often propagated from established sod, which adds substantially to the initial cost.

The primary means of establishing 'Meyer' zoysiagrass sod is to broadcast or row-plant vegetative sprigs at a rate of ≈18 $m^3·ha^{-1}$. Although effective, this method requires 12–18 months from planting to establishment of a complete turf (Roger Gravis; Quail Valley Farms, Little Rock, Ark., personal communication). In golf course or sports field situations, where full cover is needed within one season, this would be unacceptable. A new vegetative technique of planting zoysiagrass, called Z-NET®, was recently described (Miyachi et al., 1993). This method utilizes two layers of biodegradable netting with zoysiagrass sprigs intertwined within the netting. This net/sprig combination is rolled onto a site in a similar fashion to sod, topdressed with 6–12 mm of soil, and watered according to needs. Miyachi et al. (1993) reported that Z-NET® planting could produce a complete zoysiagrass cover in 85–110 d from planting. Although the results using this method appear promising, the original study did not compare the Z-NET® method to traditional sprigging techniques to demonstrate if the method was indeed superior to existing methods. In addition, the topdressing of sprigs with soil would appear to be the major advantage of the technique relative to normal planting methods. Unfortunately, there is no information in the literature that addresses the effects of topdressing on sprig establishment of this species.

Post-sprigging fertilization of zoysiagrass is also poorly defined. The few studies that have addressed this issue have produced inconsistent effects of nitrogen fertilizers on establishment (Carroll et al., 1996; Fry and Dernoeden, 1987). Juska's (1959) study is the only one that has reported a response to N fertility by sprigs of 'Meyer' zoysiagrass. Carroll et al., 1996 reported that supplemental monthly applications of soluble N at 48 $kg·ha^{-1}$ had no more effect on zoysiagrass establishment than did a pre-plant application of 96 $kg·ha^{-1}$. However, their pre-plant rate of 96 $kg·ha^{-1}$ would be equivalent to what most zoysiagrass managers would apply over a single growing season. Fry and Dernoedon (1987) reported that first-year responses of zoysiagrass plugs to N were insignificant, but a significant response was observed in the second growing season.

Collectively, these studies suggest that additional information regarding zoysiagrass establishment from sprigs, especially as it relates to fertility, is needed. Therefore, a study was designed to test the effects of soil topdressing and post-planting nitrogen rates on turf establishment rate of 'Meyer' zoysiagrass.

Materials and Methods

Propagation studies were conducted at two sites in Arkansas. The first site was at Winrock Grass Farms near Little Rock, Ark. [U.S. Dept. of Agriculture (USDA) Hardiness Zone 7, Sallisaw silt loam soil, typic paleudult, pH 6.7] and the second was at the Univ. of Arkansas Research and Extension Center in Fayetteville, Ark. (USDA Hardiness Zone 6, Captina silt loam soil, typic hapludults, pH 6.2). Each site was fertilized with 100 $kg·ha^{-1}$ of 0N–8.8P–16.6K and prepared to seed-bed quality prior to planting. Because of different climatic conditions, the Little Rock site was planted on 13 May 1999 and the Fayetteville site on 8 June 1999. The planting design and method were identical for both sites.

The study was arranged as a randomized complete-block, split-plot design with propagation method as the main plot factor and post-planting fertilization rate as the sub-plot factor. Main plots were 2.4 × 12 m and treatments included traditional sprigging at 18 $m^3·ha^{-1}$ and traditional sprigging at 18 $m^3·ha^{-1}$ and topdressed with 1.0 cm native soil obtained from the site. The sub-plots were 2.4 × 2.4 m and N treatments were 0, 1.25, 2.50, 3.75, or 5.0 $g·m^{-2}$/month. All N was applied as Ag-grade urea (46–0–0).

To assure uniform planting densities in the traditional sprigged plots, the main plots were planted in 2.4 × 2.4 m increments, using a volume of sprigs obtained from shredding 1.0 m^2 of 'Meyer' sod. This sprigging rate (18 $m^3·ha^{-1}$) is based on the definition that 1 bushel (0.055 m^3) of sprigs represents those obtained from 1 yd^2 (0.914 m^2) of sod (McCarty et. al, 1999). Sprigs were uniformly broadcast over the entire plot area, pressed lightly into the soil using a disk, and rolled with a water-filled roller to smooth the site. The soil used for topdressing the plots was obtained on-site to prevent soil contamination and screened through a soil sifter (8-mm mesh) prior to

Received for publication 24 Apr. 2000. Accepted for publication 21 Sept. 2000. Published with the approval of the Director, Arkansas Agricultural Experiment Station, Manuscript #00031. We wish to acknowledge the technical support of E. Bordelon, B. Rodgers, and N. Wolf, and the financial support of Winrock Grass Farms. The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper therefore must be hereby marked *advertisement* solely to indicate this fact.

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application to plots. Soil was uniformly applied to a depth of ≈1.0 cm with a track-mounted topdresser. Oxadiazon [2-tert-butyl-4-(2,4 dichloro-5-isopropoxyphenyl)-Δ-1,3,4-oxadiazolin-5-one] was applied to all plots at 3.36 $kg\cdot ha^{-1}$ immediately after planting to suppress weeds, and water was applied as needed during the test to provide optimum growing conditions.

Plots were rated monthly for percentage of cover using a grid that separated each plot into four, 1.2- × 1.2-m quadrants. Each quadrant was visually rated from 0% to 100% and the four sub-samples from each plot were averaged for a final cover value. At 120 d after planting, leaf samples were taken from all plots, dried in a forced air oven at 60 °C for 48 h, and ground to pass a 1-mm screen. Leaf tissues were analyzed using inductively coupled plasma (ICP) emission spectroscopy (Donahue and Aho, 1992) for all nutrients except N, which was analyzed by combustion analysis (Campbell, 1992). Data from each measurement date were analyzed by analysis of variance procedures of the split-plot model, where the mean squares of block × propagation was used as the error term for main plot effects.

Table 1. Significance of the effects of propagation method (main plot) and nitrogen rate (sub-plot) on the vegetative establishment (percent cover) of 'Meyer' zoysiagrass following analysis of variance of the split-plot model. Initial analysis of the data indicated a significant location effect and subsequent analyses were performed by location.

Source of variation	df	Little Rock 60	Little Rock 90	Little Rock 120	Fayetteville 60	Fayetteville 90	Fayetteville 120
		Time (DAP)[z]					
		Pr > F					
Rep	3	0.0090	0.0090	0.0013	0.2082	0.1155	0.3178
Propagation[y]	1	<0.0001	<0.0001	0.2908	0.0002	<0.0001	0.0021
Error A (Rep × Propagation)	3						
Nitrogen	4	0.4753	0.2210	0.2289	0.1916	0.0070	0.0036
Nitrogen × Propagation	4	0.5073	0.3637	0.5203	0.5510	0.8559	0.5956
Error B	24						
CV (%)		33.6	18.1	7.5	16.8	9.2	8.7

[z]DAP = days after planting

[y]Rep × Propagation mean squares used as the error term for main plots.

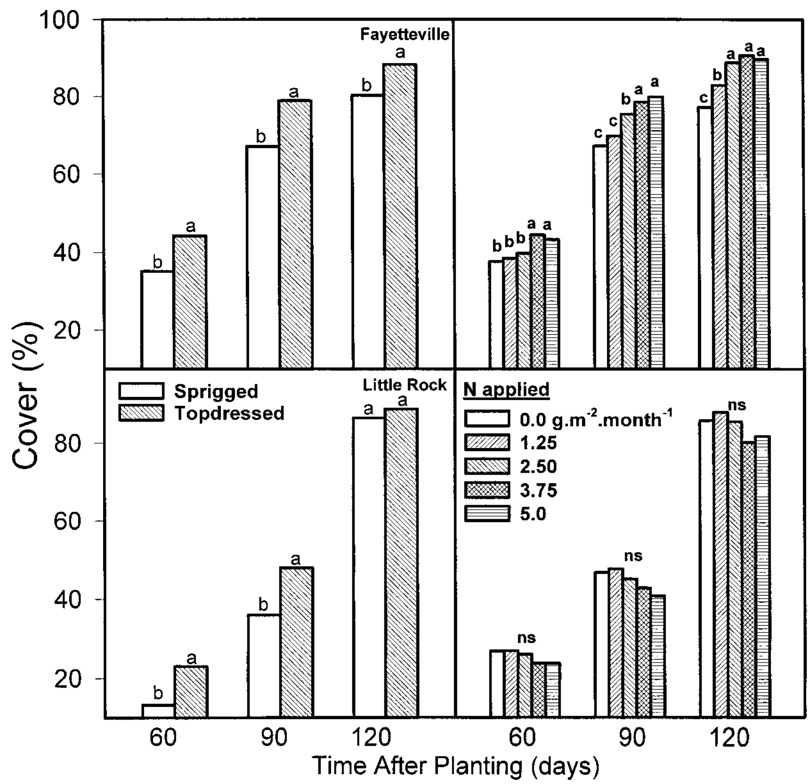

Fig. 1. Main effects of propagation method and N fertilization rates on establishment of 'Meyer' zoysiagrass at various days after planting at two locations in Arkansas. Mean separations within locations and evaluation dates by LSD, $P \geq 0.05$.

Results and Discussion

A uniform, weed-free stand was established at both sites with all propagation methods and fertility treatments. Analysis of the data across sites indicated a significant location × treatment interaction (analysis not shown), therefore, all subsequent data were analyzed by location (Table 1). Both sites produced a zoysiagrass cover of between 80% and 90% after 120 d. Earlier trials on zoysiagrass establishment were conducted in the mid-Atlantic region of the United States (Carroll et al., 1996) and took ≈15 months to reach this level of cover. Propagation method had a significant effect on turf cover at both locations (Table 1) at all evaluation dates except 120 days after planting (DAP) at Little Rock. In general, topdressed plots had 10% to 15% more cover at each evaluation date than did control plots (Fig. 1).

The effects of topdressing suggest that covering sprigs with either soil or other forms of mulch may be advantageous for rapid establishment. During the early stages of evaluation, a higher level of sprig mortality was evident in the conventional-sprigged plots than in topdressed plots. The overall lack of vigor in zoysiagrass sprigs (Carroll et al., 1996) would predispose new sprigs to desiccation injury for a longer period of time than would be true for an aggressive species such as bermudagrass [*Cynodon dactylon* (L.) Pers.] and, therefore, mulching or topdressing would have a greater impact on overall survival.

There were significant differences between the two sites relative to overall establishment (Fig. 1, analysis not shown). An interesting aspect of the location effect is that, overall, the Little Rock site lagged behind the Fayetteville site relative to percentage of cover at 60 and 90 DAP, even though the former site was planted 4 weeks earlier. A possible explanation for this is that soil temperatures (2.5-cm depth) at the time of planting were 24 °C at Little Rock vs. 31 °C at Fayetteville. This would suggest that early planting of zoysiagrass sprigs may not be advantageous and, in fact, may suppress their growth.

Nitrogen had a significant influence on percentage of cover at the Fayetteville location, but not at Little Rock (Table 1, Fig. 1). There were no significant interactions between planting method and N fertilization for any evaluation period. At the Fayetteville site, N at 3.75 and 5.0 $g\cdot m^{-2}$/month were more effective than the lower rates of N at both the 60 and 90 DAP evaluation period. Although the increase was statistically significant, it was generally only 5% to 10%. There was no effect of N fertilization at 60 and 90 DAP at Little Rock and a slight drop in rate of cover at 120 DAP, with the highest rates of N. Collectively, these data suggest that N fertility can have a small, but significant effect on establishment and growth of zoysiagrass sprigs, which supports previous work on 'Meyer' sprigs (Carroll et al., 1996) and vegetative plugs (Fry and Dernoedon, 1987). Consequently, the small growth increment that is attained from increased N nutrition may not justify the actual cost of the fertilizer in a typical production scheme. The zoysiagrass cultivar El Toro, which was released by the Univ. of California (Gibeault and Cockerham, 1988), does respond favorably to moderate and high levels of N fertility (Gibeault et al., 1988), but 'El Toro' grows more rapidly than does 'Meyer'.

Tissue analysis of leaf clippings harvested at 120 DAP indicated that N fertility had significant effects on several tissue nutrients,

Table 2. Elemental analysis of zoysiagrass (cv. Meyer) leaf tissue established with different propagation techniques and under various nitrogen fertilization levels at Fayetteville and Little Rock, Ark.

Treatments	N	P	K	Ca	Mg	S	Na	Fe	Mn	Zn	Cu
	% DW					$mg\cdot kg^{-1}$					
Fayetteville											
Nitrogen ($g\cdot m^{-2}$)											
0.00	2.11	0.26	1.13	0.28	0.106	0.324	167	300	152	34.2	10.6
1.25	2.54	0.22	1.23	0.29	0.112	0.309	266	227	150	33.8	8.4
2.50	2.76	0.22	1.24	0.30	0.116	0.301	372	189	142	32.1	9.2
3.75	2.97	0.21	1.26	0.31	0.129	0.299	405	143	157	33.4	11.0
5.00	3.04	0.20	1.27	0.30	0.122	0.289	466	153	173	32.7	10.6
$LSD_{0.05}$	0.12	0.01	0.06	0.02	0.008	0.024	99	64	NS	NS	NS
Propagation method											
Topdressed	2.75	0.22	1.25	0.29	0.118	0.308	293	218	162	33.0	10.2
Sprigged	2.59	0.21	1.20	0.30	0.117	0.305	351	228	148	32.0	9.0
$LSD_{0.05}$	0.09	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Little Rock											
Nitrogen ($g\cdot m^{-2}$)											
0.00	2.63	0.22	1.70	0.34	0.167	0.298	188	429	432	17.1	11.4
1.25	2.71	0.24	1.79	0.33	0.162	0.299	165	361	376	15.2	10.9
2.50	2.70	0.23	1.79	0.33	0.160	0.294	178	385	357	15.0	10.0
3.75	2.73	0.22	1.79	0.33	0.159	0.287	162	486	364	14.8	10.5
5.00	2.78	0.22	1.82	0.33	0.158	0.293	139	439	404	16.0	10.2
$LSD_{0.05}$	0.04	0.01	0.05	ns	0.007	0.011	41	94	69	NS	NS
Propagation method											
Topdressed	2.77	0.23	1.79	0.34	0.164	0.291	170	334	384	15.5	9.7
Sprigged	2.69	0.23	1.77	0.36	0.168	0.306	147	512	413	17.3	11.7
$LSD_{0.05}$	0.03	NS	NS	0.01	NS	0.009	NS	73	NS	1.8	1.2

including N, P, K, Mg, S, Na, and Fe (Table 2). Across both locations and all treatments, tissue N levels ranged from 2.11% to 3.04%. These are the first reported data on zoysiagrass tissue analysis as related to fertility, and tissue N levels of 2% to 3% would appear normal regardless of the fertility program. The N levels are slightly lower than is generally cited as the sufficiency rage for warm-season turfgrasses (Jones, 1980), but are in line with a report by Butler and Hodges (1967), who reported N levels of 'Meyer' zoysiagrass to be 2.0%. Although tissue N levels appear to respond little to increased fertility, this area certainly warrants further investigation, especially as it relates to the performance and disease response of established zoysiagrass turf. In addition, many new cultivars of zoysiagrass are appearing on the market that exhibit a much higher growth rate than 'Meyer' (Morris, 1996) and may respond more favorably to N nutrition.

In summary, topdressing sprigs with native soil had a positive effect on establishment of 'Meyer' zoysiagrass sprigs, producing ≈90% cover in 120 d. Whether other forms of mulch have a similar effect warrants future investigation. Conversely, high levels of N fertilizers (>3.75 $g\cdot m^{-2}$/month) had little or no more effect on zoysiagrass establishment or tissue N levels than did low (<2.5 $g\cdot m^{-2}$/month) levels. These data support previous findings that suggest that the N needs of 'Meyer' zoysiagrass are minimal.

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