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Using Science to Benefit Golf

Researchers at Colorado State University investigated the potential of inland saltgrass [*Distichlis spicata* var. *stricta* (L.) Greene] to be developed as a turfgrass, and as a revegetation species for saline sites. This research evaluated the effects of seed treatments, seeding date, and seeding rate on germination and establishment.

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PURPOSE

The purpose of *USGA Turfgrass and Environmental Research Online* is to effectively communicate the results of research projects funded under USGA's Turfgrass and Environmental Research Program to all who can benefit from such knowledge. Since 1983, the USGA has funded more than 450 projects at a cost of $31 million. The private, non-profit research program provides funding opportunities to university faculty interested in working on environmental and turf management problems affecting golf courses. The outstanding playing conditions of today's golf courses are a direct result of ***using science to benefit golf***.

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Effect of Seed Treatments, Seeding Date, and Seeding Rate on Saltgrass Seed Germination and Establishment

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SUMMARY

Researchers at Colorado State University investigated the potential of inland saltgrass [*Distichlis spicata* var. *stricta* (L.) Greene] to be developed as a turfgrass, and as a revegetation species for saline sites. This research evaluated the effects of seed treatments, seeding date, and seeding rate on its germination and establishment. Results include:

- Cold moist stratification and dry scarification significantly improve germination and enhance establishment of seeded saltgrass. For stratification, seeds may be stratified for 3 weeks before planting by either the seed suppliers or the persons planting it. However, once the seed is stratified, it needs to be kept cold and moist to prevent heating and desiccation. Machine scarification also represents a practical and significant improvement for increasing saltgrass seed germination and establishment.
- The May seeding date is best for saltgrass establishment in Colorado, with seeding rates as low as 1.5 lb/1000 ft^2 achieving optimal establishment of saltgrass in one season.
- The accumulated growing-degree days (GDD) to achieve more than 80% coverage under our experimental conditions was 1,748, 1,663, and 1,435 for 1.5, 2.5, and 3.5 lb/1000 ft^2 seeding rates, respectively.
- The accumulated GDD requirements for saltgrass establishment generated in this study will provide guidelines for selecting optimal seeding dates for successful saltgrass establishment in various climates.

Inland saltgrass [*Distichlis spicata* var. *stricta* (L.) Greene], native to the western U.S., is a dioecious, rhizomatous, perennial, salt-tolerant, warm-season grass. Inland saltgrass can grow under salinity levels that many other grasses cannot tolerate. Saltgrass grows in a wide range of soil pH, which makes it one of the most widespread and common halophyte species in the U.S. (10). It has desirable turf characteristics that include tolerance to wear and compaction, fine texture, good color, and high shoot density (5). These attributes make saltgrass a candidate for development and use as a turfgrass species and as a revegetation species for saline sites.

Saltgrass seeds have a low germination rate due to seed dormancy. Previously, Qian et al. (8) evaluated various seed treatments and found that stratification and machine scarification improve germination and establishment of seeded saltgrass. Although established saltgrass turf stands are tolerant to high salinity, germinating saltgrass seeds are less tolerant (9).

Growing-degree days (GDD), or heat accumulation units, are used to predict the effect of temperature on biological processes (2). Growing-degree days have been used to predict the time required for warm-season grass establishment (3, 7). Adequate establishment during the first season may reduce the possibility of freeze injury and increase winter survival. It has been suggested that late seeding does not provide enough time for warm-season grasses to establish adequately before winter (6).

Saltgrass grows in a wide range of soil pH, which makes it one of the most widespread and common halophyte species in the U.S.

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	# of Seedlings /100 cm^2 (Germination %)		Turf Quality§	
	July 18	July 28	Aug. 17	Sept. 23
Control	6.2 (5.2%) b†	19.4 (16.2%) b	3.3	4.2 b
Scarification	6.5 (5.4%) b	33.4 (27.8%) a	5.7	6.3 a
Stratification	25.0 (20.8%) a	37.4 (31.2%) a	6.0	6.7 a

†Means followed by same letter within the same column are not significantly different at the 0.05 probability level using Fisher's LSD test.

§Turf quality was rated based on color, density, and uniformity using a scale of 1 to 9 (9=best), with a rating of 6.0 or higher indicating acceptable quality.

Table 1. Effects of different seed treatments on the number of germinated seedlings, germination percentage, and turf quality of inland saltgrass in the field.

The objectives of this study were to 1) determine the effect of seeding rate, seeding date, and two different seed treatments on saltgrass germination and establishment, and 2) determine the required accumulative GDD for saltgrass to establish adequate coverage (at least 80% of the ground surface covered) after seeding.

Assessing Seed Treatments on Saltgrass Germination and Establishment

A field experiment was carried out at the Colorado State University Horticulture Research Farm in Fort Collins, CO on a Nunn clay loam (fine, smectitic, mesic Aridic Argiustolls). Two seed treatments, machine scarification and stratification, along with the control, were included. Scarification was done with a seed scarifier. A series of pilot tests were performed to determine the best settings and scarification time for the best results.

In the stratification treatment, saltgrass seeds were placed on moist paper towels and stored at 4º C in darkness for 3 weeks. Treated seeds and the control were sown at 3 lb/1,000 ft^2. The experimental area was irrigated with 0.1 inch of water 3 times per day until 2 weeks after seeding. Thereafter plots were irrigated as needed to prevent drought and encourage establishment.

Atrazine was applied approximately 30 days after seeding to reduce weed germination and control germinating broadleaf weeds. For each plot, the number of germinated saltgrass seedlings in 100-cm^2 area was counted 6 and 16 days after seeding. Germination percentage was calculated. Estimation of percent coverage was visually rated periodically.

Results

Six days after seeding, the number of seeds germinated was three times higher with the stratification treatment than with the control and scarification treatments (Table 1). The germination percentage was 5.1%, 5.4% and 21.0% for the control, scarification, and stratification treatments, respectively. Sixteen days after seeding, the germination percentages for stratification treatment and machine scarification were 31.2% and 27.8%, which were higher than the control (16.1%).

Saltgrass ground coverage increased with time, and there were significant differences among treatments. From 44 days to 73 days after seeding, both moist stratification and scarification resulted in higher coverage than the control. By September 23 (73 days after seeding), both plots seeded with stratified and scarified saltgrass seeds established adequate plot coverage (more than

90%). However, the coverage for the control plots was inadequate, exhibiting inferior turf quality (Table 1).

Effects of Seeding Date, Seeding Rate, and Seed Treatments on Germination and Establishment

Studies were initiated in 2006 at two experimental locations. The first location was the CSU Horticulture Field Research Center (HRC) in Fort Collins, Colorado, where the electrical conductivity (EC) of the soil saturation paste was 4.5 dS m^{-1} and soil pH was 7.6. Underground well water was high in salts (EC = 2.8 dS m^{-1}) and sodium (sodium adsorption ratio, SAR= 1.8). The second experiment was conducted on a golf course in Colorado where the EC of soil saturation paste was 2.6 dS m^{-1} and soil pH was 7.4. Reclaimed wastewater used to irrigate the golf course exhibited an EC of1.0 dS m^{-1} and SAR of 5.0.

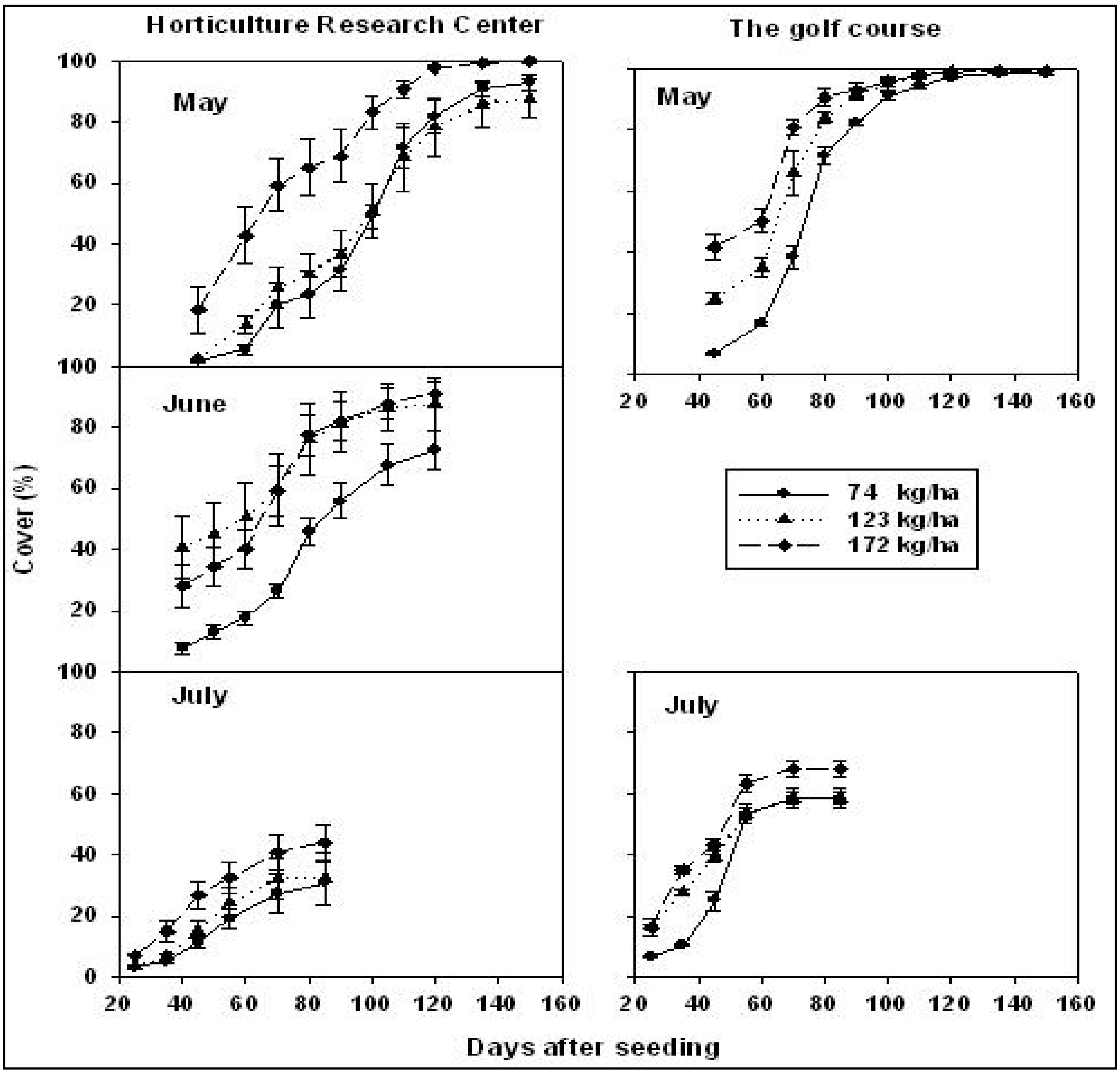

Figure 1. Effect of three seeding dates (May 15, June 15, and July 15) and three seeding rates (1.5, 2.5, and 3.5 lb/1000 ft^2) on saltgrass ground coverage (%) at Horticulture Research Center and the golf course. Bars represent standard errors.

The May seeding date is best for saltgrass establishment in Colorado, with seeding rates as low as 1.5 lb/1000 ft^2 achieving optimal establishment of saltgrass in one season.

Seeding dates were May 15, June 15, and July 15, 2006. Seeding rates were 1.5, 2.5, and 3.5 lb/1,000 ft^2. Seed treatments included machine scarification and stratification. Scarification was performed by setting a seed scarifier at 112 MPa pressure with 60 Grit sandpaper and run for 4 minutes (8). Seeds were stratified by storing inside moist paper towels at 39^o F in darkness for 3 weeks.

The number of germinated saltgrass seedlings in a 100-cm^2 area was counted. Coverage was estimated on a 0 to 100% scale by visually estimating percentage of the area covered with saltgrass compared to the whole plot area. Coverage was rated at 10-day intervals during the season.

Maximum and minimum air temperatures were obtained from the nearest weather stations, approximately 0.06 and 1.9 miles from the experiment locations, and used to calculate GDD for any given day as follows:

$$GDD = [(Max + Min)/2] - T_{base}$$

Where GDD = growing degree day, Max = maximum temperature for the given day, Min = minimum temperature for the given day, and T_{base} = base temperature (5^o C). Accumulated GDD were calculated by summing daily GDD from the day of seeding until saltgrass coverage became at least 80% of the plot or to the end of the growing season.

Temperature and Salinity Affect Saltgrass Germination

At both locations, statistical analysis indicated significant seeding rate and seeding date effects on saltgrass coverage (Figure 1). Seeding date effect on germination was significant at HRC. No significant difference was observed between scarification and stratification seed treatments in turf establishment.

Germination was observed 4 to 10 days after seeding in the field. Twenty-five days after seeding, the average number of seeds germinated across all seeding rates was 13.7, 22.0, and 20.0

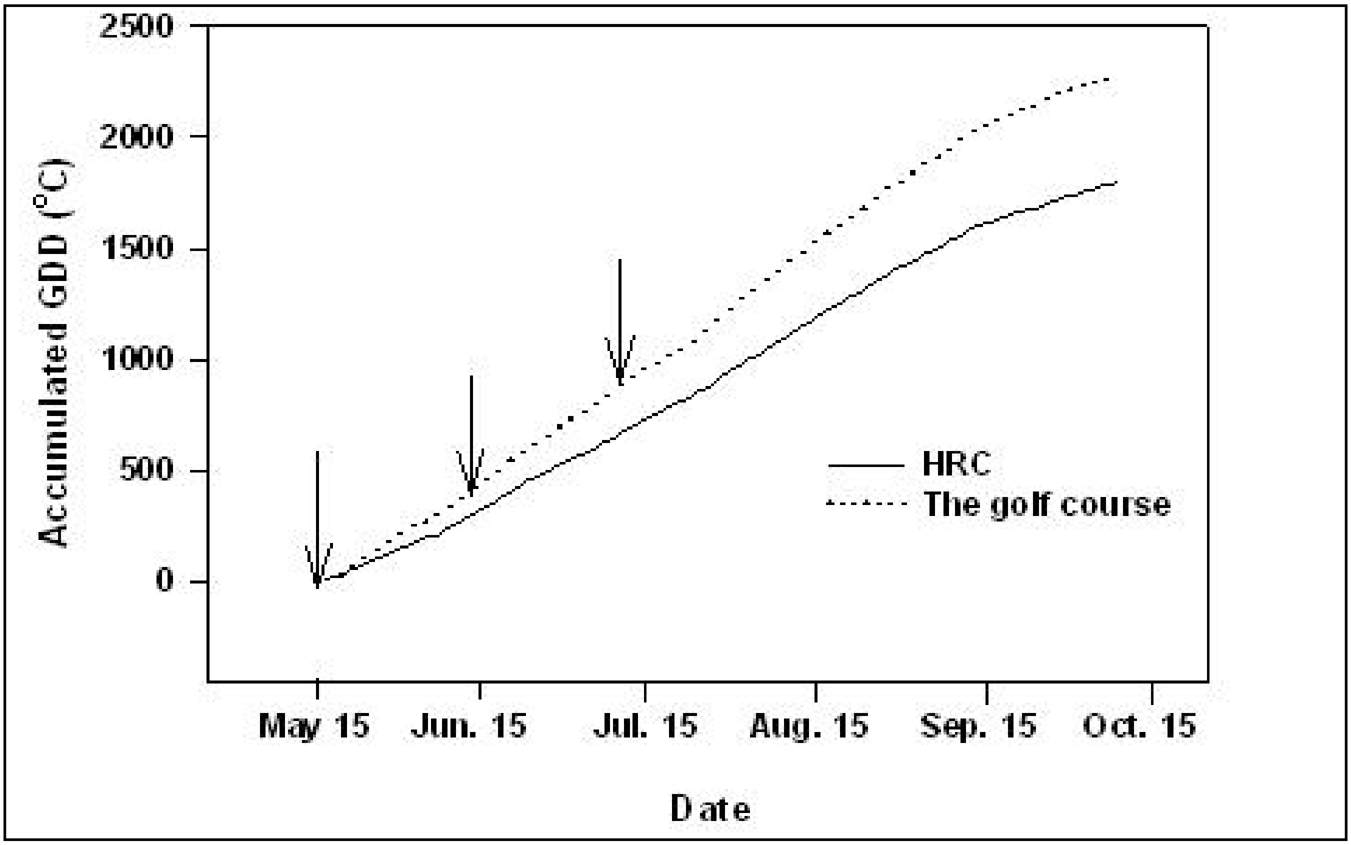

Figure 2. Accumulated growing-degree days during the growing season of 2006 in Horticulture Research Center (HRC) and the golf course. Arrows indicate seeding dates (May 15, June 15, and July 15).

per 100 cm^2 for May, June, and July seeding dates, respectively, at HRC. This represents germination percentages of 18%, 29%, and 24%, respectively. Saltgrass seed germination was consistently higher at the golf course than at HRC.

The increased germination percentage at the golf course may have been due to slightly warmer temperatures at the golf course than at HRC. But, more likely, the decreased germination percentage at HRC was because soil salinity and irrigation water salinity were higher at HRC than at the golf course. Despite the great salt tolerance after establishment, saltgrass seed germination was significantly reduced under the salinity levels encountered at HRC.

Seed Establishment is Influenced by Seeding Rate and Seeding Date

In general, higher seeding rates increased number of seeds germinated per area. At HRC, saltgrass germination was greater under warmer conditions in June and July than in May. At the golf course, however, the seeding date had no effect on seed germination, possibly because the warmer temperatures and lower soil salinity at the golf course.

Saltgrass coverage increased with time, and there were significant differences among seeding dates (Figure 1). Saltgrass seeded in May established adequate coverage (at least 80%) by the end of growing season in September at all seeding rates, even with the lowest seeding rate (1.5 lb/1,000 ft^2). Only higher seeding rates (2.5 and 3.5 lb/1,000 ft^2)) established adequate coverage by the end of the growing season for plots seeded in June. However, for plots seeded in July, even the highest seeding rate failed to establish adequate coverage in September (Figure 1). Our results indicated that despite similar or more rapid germination in July than in May, saltgrass could not establish adequate coverage before the end of the growing season. The July seeding date does not provide enough time for saltgrass to establish adequate coverage before winter.

A higher seeding rate produced a higher coverage throughout the study at HRC and in the July seeding at the golf course. However, at the golf course when seeded in May, a higher seeding rate produced a higher percent of coverage only up to 60-85 days from the date of seeding. Thereafter, the seeding rate did not show any difference in the percentage of cover (Figure 1).

Greater Number of Accumulated Growing-Degree Days Produces Better Coverage

The accumulated GDD required to achieve adequate turf coverage differ among seeding rates. Based on May-seeding data from HRC and the golf course, the accumulated GDD to achieve adequate coverage was 1,748, 1,663, and 1,435 for 1.5, 2.5, and 3.5 lb/1,000 ft^2 seeding rates, respectively. When seeded in June at the golf course, the GDD required to achieve adequate coverage was 1,336 and 1,296 for 2.5 and 3.5 lb/1,000 ft^2 seeding rates, respectively. When seeded on July 15, total accumulated GDD before the first frost was 889 and 1,220 at HRC and the golf course, respectively (Figure 2). Therefore, it was unlikely or impossible to achieve adequate coverage when saltgrass was seeded in July. However, a higher seeding rate may be used to compensate the June seeding date in achieving adequate coverage by the end of the growing season.

The accumulated GDD assessment provided in our study suggests that saltgrass has higher establishment GDD requirements than bermudagrass and buffalograss, but lower or similar GDD requirements as zoysiagrass (3, 7). However, the moderate salinity levels in our irrigation water and soil, especially at HRC, may have increased the GDD requirements compared to non-saline conditions.

In summary, our investigation showed that cold, moist stratification and dry scarification break saltgrass seed dormancy equally well. The May seeding date is best for saltgrass establishment in Colorado, with seeding rates as low as 1.5 lb/1,000 ft^2 achieving optimal establishment of saltgrass in one season. The accumulated GDD to achieve more than 80% coverage under our experimental conditions was 1,748, 1,663, and 1,435 for 1.5, 2.5, and 3.5 lb/1,000 ft^2 seeding rates, respectively. Accumulated GDD requirements for saltgrass establishment generated in this study will provide guidelines for selecting optimal seeding dates for successful saltgrass establishment in various climates.

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