Accelerating re-establishment of putting greens following winterkill

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INTRODUCTION

The winter of 2013-2014 provided significant challenges for growing turfgrass throughout North America. Dry desiccating weather in the Great Plains, cold temperatures in the South, and ice around the Great Lakes lead to widespread winterkill. Many golf course superintendents were forced to re-establish turfgrass on greens, tees, and fairways during cool, unpredictable, spring weather. Despite the broad impact of winterkill on the turfgrass industry, there is limited research on methods to promote rapid recovery during early spring. This study evaluated three common re-establishment techniques on a creeping bentgrass putting green in the Great Plains region. The objectives of this research were to evaluate the effect of various warming treatments, seeding, and nitrogen fertilization on recovery of a creeping bentgrass green impacted by winterkill.

MATERIALS AND METHODS

This study was conducted in 2015 on a research putting green at the John Seaton Anderson Turfgrass Research Center in Mead, NE. This putting green was sprayed with the non-selective herbicide Finale (Bayer, Research Park Triangle, NC) on 25 November which led to the death of over 95% of the surface. The study design was a strip-split plot with three replicates. Whole plot consisted of heat treatments which included a non-covered control, a white woven permeable cover (Green Jacket, Genoa City, WI), 3.5 mil clear plastic sheeting which was modified with manually punched small holes punched on approximately 1" centers, black landscape fabric, and a green pigment (Foursome^{TM} applied at 4 fl. oz per 1000 ft^2). Whole plots were stripped with 'L-93' creeping bentgrass or not seeded to measure natural bentgrass recovery and regrowth. Plots were then split with three rates of N (0.0, 0.1, or 0.5 lbs. of N per 1000 ft^2 as urea) applied at seeding and every other week following germination. Plots were seeded, covered with heat treatments, and initially fertilized on 17 March, 2015. Seed was sliced into the surface with a walking Turfco TriWave overseeder (Turfco, Blaine, MN) to a 3/8" depth at a rate of 1.5 lbs of seed per 1000 ft^2. Non-seeded plots were also covered by the TriWave but no seed was applied to control for physical disruption caused by the machine. Seeded plots were hand-brushed with coarse-bristled brooms and rolled with a pull-behind drum to improve seed to soil contact. All seeded plots received 1.0 lb P_20_5 from monopotassium phosphate (0-52-34) starting at the time of seeding. Plots were irrigated to promote germination with approximately 0.1" of water split into four applications each day until germination. Covers remained on the plots until seedlings emerged from the TriWave grooves on seeded plots. Plots remained covered until 8 April, 2015.

Seedling vigor was rated visually on a weekly basis on a 1-9 scale, with 1 being no germination and 9 being green, dense, uniform row of seeds from the Tri-Wave. Percent turf coverage was measured weekly using the digital image analysis software ImageJ.

Data were subjected to analysis of variance (ANOVA) (Table 1) and treatment means were separated using Fisher's Protected Least Significant Difference (LSD). Data were transformed when necessary to meet the assumptions of ANOVA. Data were analyzed using repeated measures by nesting treatment parameters within PLOT and attributing a random effect to the statement to account for inherent variability among individual plots.

2015 RESULTS

Seedling germination was delayed by unseasonably cool temperatures. Germination occurred on 8 April and took 26 days whereas it only took 6 days in 2014. Seedling vigor (Fig. 1) was deemed poor (below 3) among all treatment combinations with seedlings having poor uniformity, density, and color. Upon removal of the covers, seedlings beneath the landscape fabric were visually necrotic and yellow in appearance. Seedlings beneath the landscape fabric regressed significantly upon removal of the cover and did not exhibit marked improvement until 21 May. The plastic and GreenJacket^{TM} cover had similar seedling vigor to the untreated control through 22 April but became significantly worse than the control for the following weeks of the study. The non-treated control and Foursome^{TM} achieved the maximum achievable seedling vigor (9) the fastest on 28 May with the GreenJacket^{TM} cover reaching a similar seedling quality a week later. The plastic cover and landscape fabric did not achieve a maximum seedling vigor with lack of uniformity and inconsistent germination success.

A "weeks after germination" (WAG) x heat treatment (HEAT) x seeding treatment (SEED) interaction was observed (Fig. 2). Seeding had a marginal effect of improving turf coverage over not seeding as a significant portion of non-seeded turf recovered naturally. Heat treatments never provided a significant improvement, performing at or below the non-treated control heat treatment. Regardless of seeding or not, plots not receiving a heat treatment recovered to over 80% turf coverage by 28 May, which was the fastest observed recovery. The effect of seeding was most pronounced for the landscape fabric treatment, where seeding improved turf coverage by 13.6% on the final rating date.

DISCUSSION

During the germination period the average air temperature was 46 °F with several nights below freezing, which resulted in a 26-day germination period. By contrast, in 2014 average air temperatures were 51 °F which resulted in germination in 6 days and much greater seedling vigor from the GreenJacket^{TM} and plastic cover immediately following germination. The delayed germination and cool air temperatures in 2015 likely negated the heat treatments' ability to build a cumulative heat load and accelerate germination compared to the plots that did not receive a heat treatment. Similar to the results in 2014, the black landscape fabric appeared to have a shading effect on the seedlings, causing necrosis and delayed

establishment. Upon germination in 2015, air temperatures remained low with temperature highs rarely rising above 70 °F, whereas in 2014 numerous days above 70 and 80 °F were observed. Plots that were not covered (control and Foursome™) had a higher seedling vigor for the majority of the study as opposed to the other heat treatments which might be explained by the seedlings not having to acclimate after removal of tarps. Algae was additionally a concern during the 2015 season which likely reduced the turf's ability to recover quickly.

Spring seeding often yields inconsistent results and 2015 was no exception. Experimental treatments rarely provided benefit compared to the non-treated controls for both seedling vigor and turf coverage in 2014. Considering the success of implementing GreenJacket™ and plastic covers in 2014, it becomes increasingly apparent that timing of spring seeding and air temperatures following seeding are fundamental factors affecting the success of re-establishing putting greens. It may be more beneficial to keep covers on the turf even after germination for a period of time to continue to warm soils and accelerate growth. Knowing this, would favor the use GreenJacket™ or 3.5 mil plastic covers that allow for moderate soil warming and provide protection from freezing temperatures to ensure that re-establishment is maximized.

Table 1. Abbreviated ANOVA table of weekly ratings

Source of Variation	% Turf Coverage	Seedling Vigor
Heat	***	***
Fertilizer	***	ns
Seed	**	
WAG	***	***
Heat x Fertilizer	ns	ns
Heat x Seed	ns	
Heat x WAG	***	***
Fertilizer x Seed	ns	
Fertilizer x WAG	*	ns
Seed x WAG	***	
Heat x Fertilizer x Seed	ns	
Heat x Fertilizer x WAG	ns	ns
Heat x Seed x WAG	**	
Fertilizer x Seed x WAG	ns	
Heat x Fertilizer x Seed x WAG	ns	

Seedling vigor column contains blank cells because non-seeded plots had no germination

*** Significant at the P<0.001 level

** Significant at the P<0.01 level

* Significant at the P<0.05 level

ns, not significant

WAG, weeks after germination

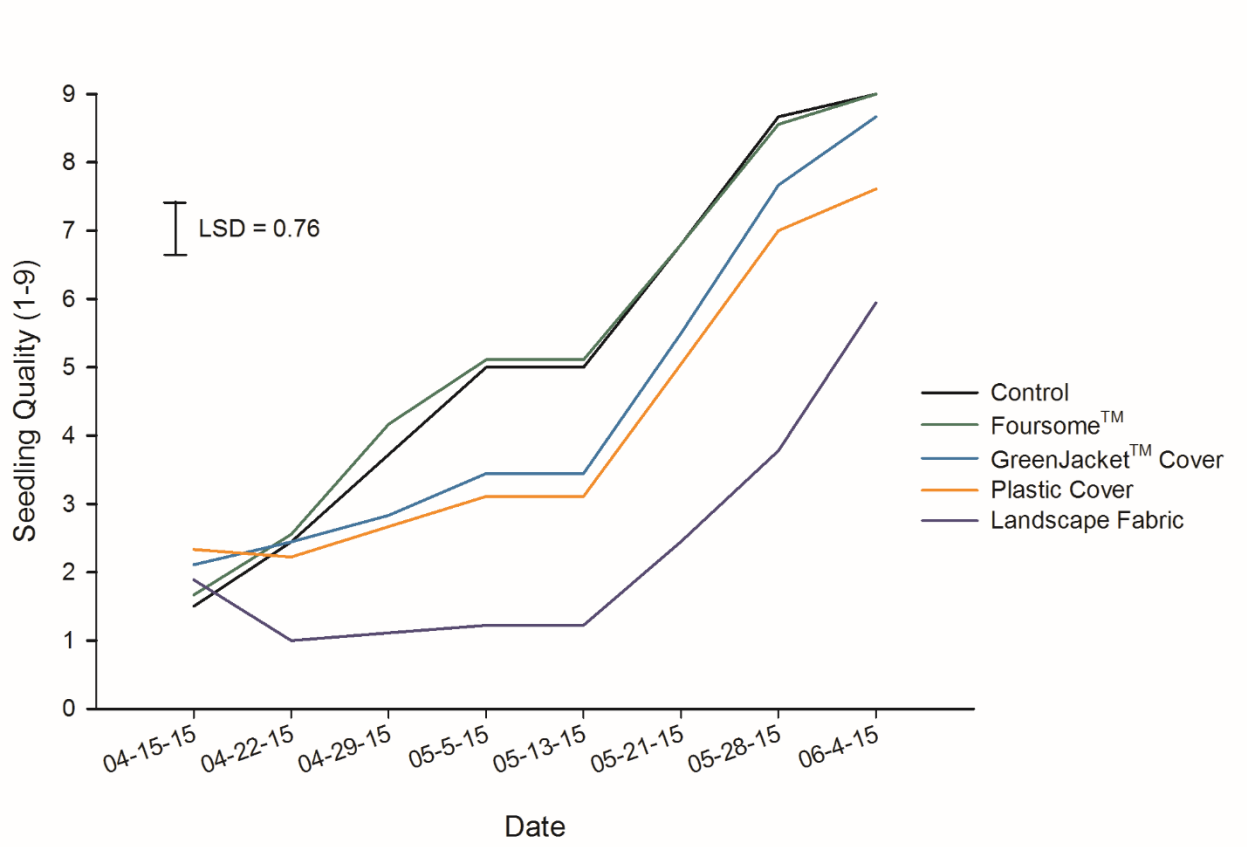

Figure 1. Seedling vigor was rated weekly on a 1-9 scale, with 1 being no germination and 9 being green, dense, uniform row of seeds.

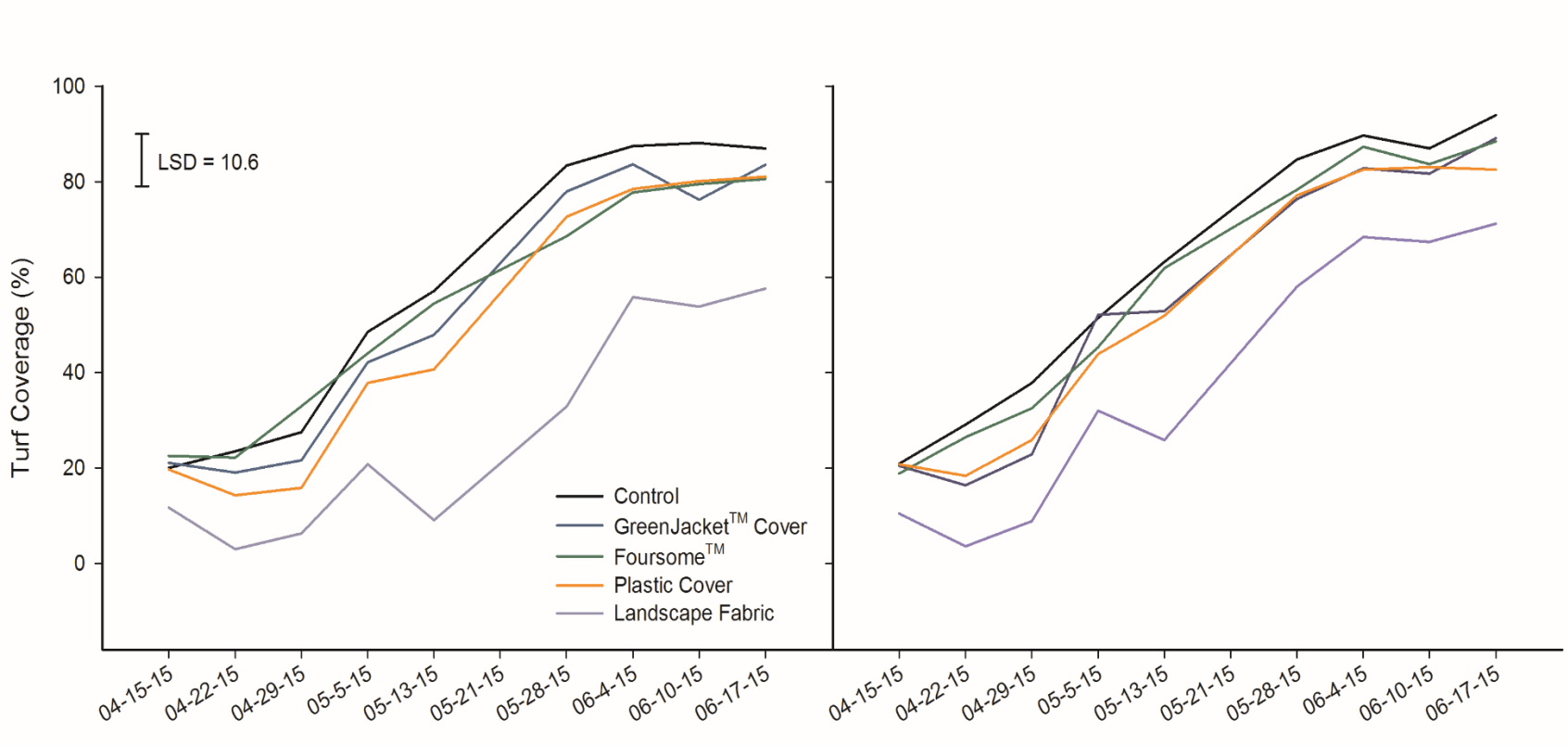

Figure 2. Weeks after germination*Heat*Seed interaction. Seeded treatments typically resulted in marginally better turf coverage than non-seeded treatments.