Efficacy of mycorrhizal inoculation on establishment of creeping bentgrass on a fumigated sand-based root zone.

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The objective of this trial was to determine the efficacy of a mycorrhizal inoculant to influence establishment of creeping bentgrass at three different phosphorus rates.

The hypothesis is that inoculated plots of creeping bentgrass will have faster establishment, increased mycorrhizal infection, faster establishment and greater root mass at different depths than un-inoculated plots.

Measurements included regular canopy reflectance data (NDVI and R/NIR indices), turf quality, uniformity, and density during establishment. One measurement of root mass at three different depths in the root zone will be taken.

MATERIALS / METHODS

The experimental area on the USGA sand green at GTI was prepared by removal of the existing turfgrass (stripped with a sodcutter). The area was fumigated on June 15, 2011 with Basamid soil sterilant (to simulate the microbial population of a renovated green or newly quarried sand) at 10 g m^{-2}, applied with a drop-spreader (Figure 1) to irrigated soil and tilled to 10 cm depth with a Blecavator cultivator (Figure 2). The treated area was covered immediately

Figure 1. Application of Basamid soil sterilant with drop spreader, June 15, 2011.

Figure 2. Incorporation of Basamid to 10 cm depth with Blecavator cultivator, June 15, 2011.

with an impermeable plastic sheet, anchored at the margins with sod staples and strips of sod (Figure 3). On July 7 (22 days after application) the plastic was removed (Figure 4) and the seed-bed tilled again to 10 cm to release any remaining Basamid product (Figure 5). The seed-bed was raked and leveled and phosphorus and nitrogen treatments were added to appropriate plots (see experimental design, below) 6 days before seeding (July 14). The plot area was seeded July 20, 2011 (13 days after post-treatment tilling) with 5 g m^{-2} "Mackenzie" creeping bentgrass. The experimental design is a split plot design with main plots of mycorrhizal inoculant and the sub plots being three phosphorus (P) rates with nitrogen amendment balanced with ammonium sulphate (Table 1). The main plots were treated with 1 g (10,000 propagules) m^{-2} of mycorrhizal inoculant suspended in 60 ml of water. The inoculant suspension was applied with a compressed air sprayer (20 psi; 60 ml m^{-2}; TeeJet 8001VS flat fan nozzles). Uninoculated areas were protected with impermeable plastic during inoculant spraying. Immediately after seeding and inoculation, the seeded area was covered with a permeable woven cover [brand] to enhance germination and prevent erosion (Figure 6); this cover was removed once germination had progressed sufficiently (July 29, 9 DAS). The experimental area consists of four replications with main plots being 3×3 meters and 3 subplots per main plot being 1×3 meters for a total experimental area of 72 m^2.

Figure 3. Impermeable barrier on sterilant treated rootzone, June 15, 2011.

Figure 4. Removal of impermeable barrier, July 7, 2011.

Figure 5. Cultivation of sterilized rootzone, July 7, 2011.

Establishment of the turf was assessed, both visually and using canopy reflectance (Greenseeker NDVI and R/NIR), once germination began and weekly throughout the length of the establishment period. Plots will also be rated for turf quality, density and uniformity. Other stresses will be measured as they occur (disease, weed, drought). At a time point when all plots are established root cores will be taken and split into three depths (0-3_cm, 3-12_cm, below 12_cm) for root mass measurements and estimations of mycorrhizal infection rates using traditional microscopy.

All measurements were analyzed by appropriate statistical analyses (general linear models).

RESULTS

Germination and cover development was uniform across the plots and no visible differences were apparent among the treatments during the grow-in period (Figure 7).

Table 1. Treatments

	Mycorrhizal inoculum	g P_2O_5 m^{-2} (as monoammonium phosphate	g N m^{-2} (as MAP and/or ammonium sulphate
1	—	0.00	1.1
2	—	2.44	1.1
3	—	4.88	1.1
4	1 g (1,000 propagules) m^{-2}	0.00	1.1
5	1 g (1,000 propagules) m^{-2}	2.44	1.1
6	1 g (1,000 propagules) m^{-2}	4.88	1.1

Figure 6. Permeable woven cover installed at seeding to stimulate germination and prevent erosion.

Figure 7. Germination and cover development August 7, 2011 (18 days after seeding).

Canopy reflectance estimation of germination and cover establishment. The earliest detectable increase in canopy reflectance (normalized-difference vegetation index) was about 18 days after seeding (Table 2). The index increased smoothly for the next 12 weeks and then leveled off near the end of the growing season. There were no significant treatment effects either for mycorrhizal inoculation or phosphorus level on any observation date.

Analysis of the NDVI data by linear regression showed slight but statistically significant treatment effects. Comparing the regression lines of the uninoculated treatments showed a slight decrease in the elevation of the 1x and 2x phosphorus treatments, but no significant differences among the slopes of the

Table 2. Canopy reflectance (cover development) in treated plots

Treatment factor	Days after seeding								
Mycorrhizae	9	11	13	14	16	18	20	21	22
0	-0.207[1]	-0.229	-0.210	-0.213	-0.211	-0.195	-0.186	-0.185	-0.167
1	-0.206	-0.227	-0.207	-0.209	-0.211	-0.193	-0.183	-0.180	-0.161
msd p=0.05	NS	NS	NS	NS	NS	NS	NS	NS	NS
Phosphorus									
0	-0.210 b	-0.226	-0.208	-0.210	-0.206	-0.190	-0.179	-0.177	-0.154
1	-0.205 ab	-0.230	-0.209	-0.211	-0.213	-0.196	-0.187	-0.184	-0.169
2	-0.204 a	-0.229	-0.208	-0.211	-0.213	-0.196	-0.188	-0.186	-0.170
msd p=0.05	0.005	NS	NS	NS	NS	NS	NS	NS	NS
Mycorrhizae	25	26	29	32	33	35	39	41	43
0	-0.171	-0.140	-0.106	-0.048	-0.047	-0.012	-0.010	0.007	0.020
1	-0.168	-0.135	-0.116	-0.050	-0.042	-0.015	-0.008	0.014	0.028
msd p=0.05	NS	NS	NS	NS	NS	NS	NS	NS	NS
Phosphorus									
0	-0.164	-0.127	-0.100	-0.040	-0.034	-0.010	-0.005	0.012	0.026
1	-0.171	-0.142	-0.111	-0.044	-0.039	-0.009	-0.007	0.013	0.029
2	-0.174	-0.144	-0.120	-0.063	-0.061	-0.022	-0.015	0.007	0.018
msd p=0.05	NS	NS	NS	NS	NS	NS	NS	NS	NS
Mycorrhizae	48	49	50	53	55	60	62	63	68
0	0.046	0.133	0.114	0.106	0.087	0.111	0.175	0.183	0.232
1	0.057	0.151	0.131	0.120	0.100	0.127	0.191	0.196	0.248
msd p=0.05	NS	NS	NS	NS	NS	NS	NS	NS	NS
Phosphorus									
0	0.052	0.142	0.120	0.108	0.089	0.115	0.180	0.187	0.238
1	0.058	0.149	0.133	0.123	0.102	0.125	0.189	0.194	0.244
2	0.045	0.136	0.114	0.109	0.088	0.118	0.182	0.188	0.238
msd p=0.05	NS	NS	NS	NS	NS	NS	NS	NS	NS
Mycorrhizae	70	74	75	76	78	83	96	97	104
0	0.313	0.306	0.377	0.389	0.423	0.478	0.353	0.350	0.329
1	0.326	0.321	0.393	0.409	0.441	0.488	0.367	0.362	0.340
msd p=0.05	NS	NS	NS	NS	NS	NS	NS	NS	NS
Phosphorus									
0	0.319	0.314	0.384	0.394	0.429	0.479	0.354	0.352	0.330
1	0.324	0.312	0.385	0.402	0.433	0.488	0.360	0.355	0.336
2	0.316	0.314	0.386	0.401	0.434	0.483	0.367	0.361	0.338
msd p=0.05	NS	NS	NS	NS	NS	NS	NS	NS	NS

[1]Normalized-difference vegetation index: mean of 4 replicates; means within columns followed by the same letter are not significantly different (Tukey's HSD test, p=0.05). Means of mycorrhizal levels are pooled phosphorus levels and means of phosphorus levels are pooled mycorrhizal levels.

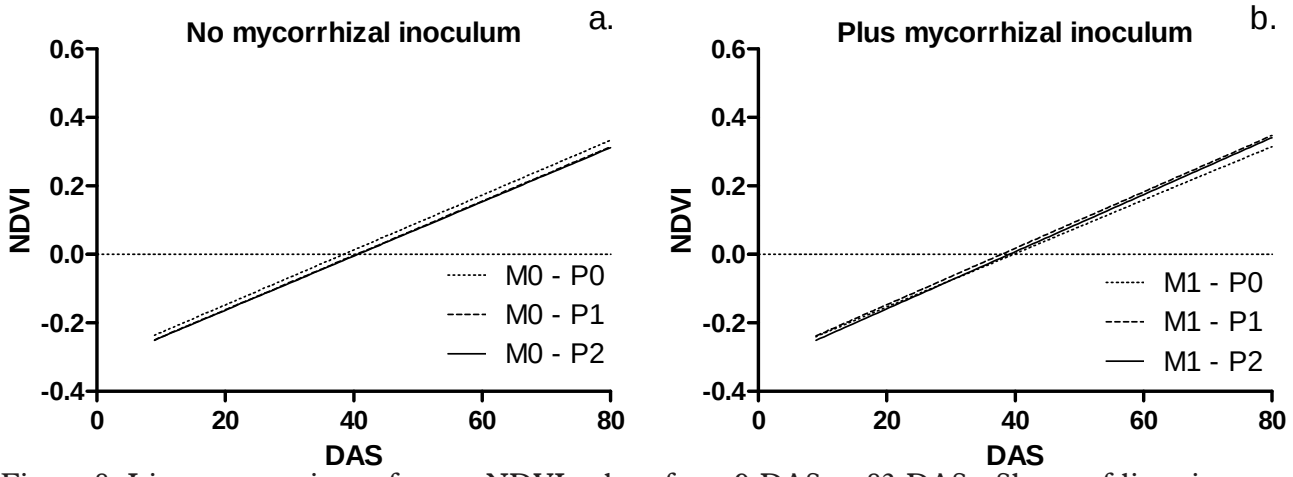

Figure 8. Linear regressions of mean NDVI values from 9 DAS to 83 DAS. Slopes of lines in a. are not significantly different, but the elevation of the 0 P line is significantly larger than the others. Slopes of the lines in b. are significantly different.

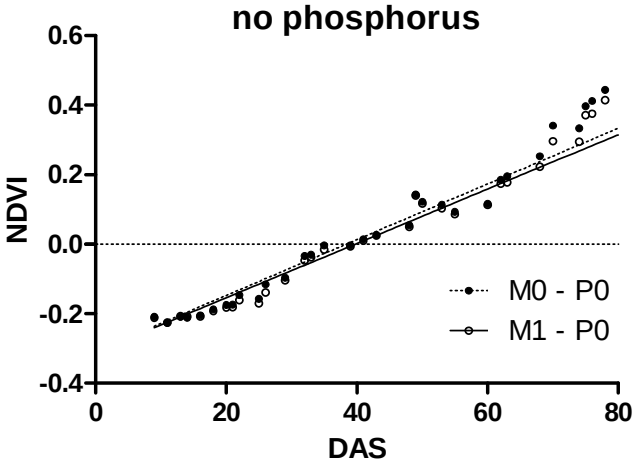

Figure 9. Linear regression of NDVI means in inoculated and uninoculated plots with no added phosphorus. The slopes are not significantly different, but the elevation of the M0-P0 line is significantly larger than the M1-P0 line. Points are plot means for each date.

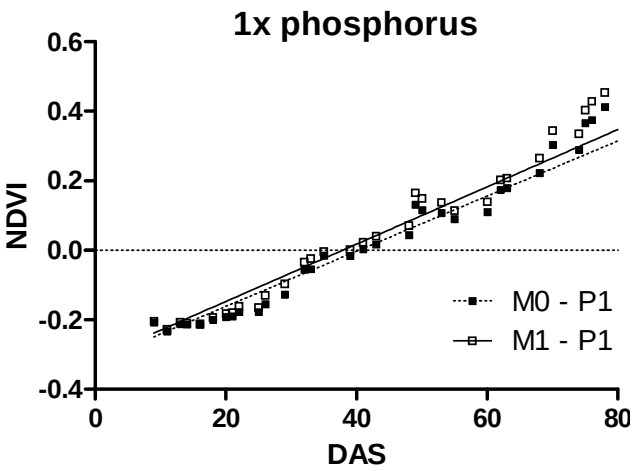

Figure 10. Linear regression of NDVI means in inoculated and uninoculated plots with 1x phosphorus. The slope of the inoculated line is significantly larger than the slope of the uninoculated line. Points are plot means for each date.

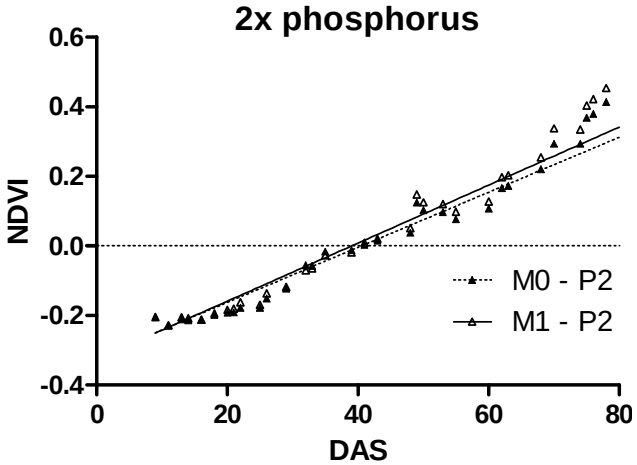

Figure 11. Linear regression of NDVI means in inoculated and uninoculated plots with 2x phosphorus. The slope of the inoculated line is significantly larger than the slope of the uninoculated line. Points are plot means for each date.

lines (Figure 8a); comparing the inoculated treatments showed an increased significantly increased slope in the 1x and 2x phosphorus treatments compared to the 0 phosphorus (Figure 8b). If the regression lines of inoculated and uninoculated treatments are examined within phosphorus levels, similar patterns are seen (Figures 9 – 11).

DISCUSSION AND CONCLUSIONS

The effect of the mycorrhizal inoculation treatments on the germination and cover development of the creeping bentgrass was a statistically significant but visually undetectable increase in rate of cover development as assessed by canopy reflectance. This increase was only seen in the plots with added phosphorus.

Sampling of plots for root system development and quantifying of mycorrhizal infection is ongoing.

Sponsor: Root Rescue