

EVALUATION OF DIVOT REPAIR MIXTURES

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OBJECTIVE

The objective of this research project was to determine the effectiveness of various divot repair mixtures.

EXPERIMENTAL DESIGN / METHODS

The treatments consisted of 17 mixtures of sand, soil and organic matter, with and without added grass seed, as indicated in Table 1. A specially constructed divot-making machine was used to produce divots of uniform size and depth (Figure 1). The machine consists of a stabilizing frame and a spring loaded cutting arm with an adjustable-depth wedge on the end. It can be easily moved so as to rapidly produce many uniform divots. Divots 30 cm long and 8 cm wide, with a depth of 12 to 16 mm, depending on the experiment as described below.

In all experiments, divot holes were filled with 400 mL of the appropriate divot mix. Four sets of divots were taken, two on a USGA sand creeping bentgrass putting green (9 mm mowing height),

and two on clay-loam soil creeping bentgrass landing area (12 mm mowing height). The experimental design was the same in all four experiments, with the 17 treatments replicated 5 times and a randomized complete block design (Figure 2). Following repair of the divot holes, the plot areas were maintained normally (mowing and irrigation).

Data collected included observation of the germination of seed in the treatments (assessed visually) and the recovery of the divot scars based on scar size and visual estimates of cover.

All data were analysed statistically using the general linear models in the SAS package of statistical software.

RESULTS

Experiment 1 - USGA green

Divots were removed May 30, 2000. There were significant differences in germination of the bentgrass seed among treatments which included seed (Table 2). The scar size of the divots was recorded for the first 5 weeks (Table 3), after which

Table 1. Divot mixtures / Treatments

100% Commercial Compost
100% Commercial Compost with seed ¹
100% Sand
100% Sand with seed
100% Soil
100% Soil with seed
50/40/10 Fine Sand/Peat/Fine clay (4mm screen)
50/40/10 Fine Sand/Peat/Fine clay (4mm screen) with seed
50/40/10 Fine Sand/Peat/Fine clay (7mm screen)
50/40/10 Fine Sand/Peat/Fine clay (7mm screen) with seed
80/20 Sand/Commercial Compost
80/20 Sand/Commercial Compost with seed
80/20 Sand/Peat
80/20 Sand/Peat with seed
80/20 Sand/Soil
80/20 Sand/Soil with seed
Unrepaired Divot (Control)

¹Penncross creeping bentgrass seed; 0.25 g / L divot mix



Figure 1. Divot making machine. Inset shows adjustment of the variable depth cutting wedge.





Figure 2. Experimental design - 5 blocks of 17 treatments. Left: after divots were removed; right: after filling with divot mixtures.

Table 2. Germination of seed in divot mixtures – USGA green trial 1

Treatment	6/15	6/26	7/05
100% Commercial Compost with seed	1.60 ab	3.60 a	10.00 a
100% Soil with seed	2.00 a	2.20 bc	6.80 b
50/40/10 Fine Sand/Peat/Fine clay (7mm screen) with seed	1.62 ab	2.40 b	6.40 b
80/20 Sand/Commercial Compost with seed	0.26 c	1.60 d	5.40 b
50/40/10 Fine Sand/Peat/Fine clay (4mm screen) with seed	1.20 b	1.60 d	5.40 b
80/20 Sand/Peat with seed	0.44 c	1.82 cd	4.60 b
80/20 Sand/Soil with seed	0.26 c	1.00 e	1.60 c
100% Sand with seed	0.08 c	0.08 f	0.40 c
100% Commercial Compost	0.04 c	0.00 f	2.00 c
100% Sand	0.02 c	0.00 f	0.00 c
100% Soil	0.20 c	0.00 f	0.00 c
80/20 Sand/Peat	0.00 c	0.00 f	0.00 c
80/20 Sand/Commercial Compost	0.00 c	0.00 f	0.00 c
80/20 Sand/Soil	0.00 c	0.00 f	0.00 c
50/40/10 Fine Sand/Peat/Fine clay (4mm screen)	0.00 c	0.00 f	0.00 c
50/40/10 Fine Sand/Peat/Fine clay (7mm screen)	0.02 c	0.00 f	0.00 c
Unrepaired Divot (Control)	0.00 c	0.00 f	0.00 c
	Lsd p=0.05	0.58	0.57
		2.29	

the recovering divots were rated for cover (Table 4).

Experiment 2 - USGA green

Divots were removed July 20, 2000. There were significant differences in germination of the bentgrass seed among treatments which included seed (Table 5). The scar size of the divots was recorded for 8 weeks (Table 6).

Experiment 3 - Soil tee height turf

Divots were removed May 31, 2000. There were significant differences in germination of the bentgrass seed among treatments which included seed (Table 7). The scar size of the divots was recorded for the first 5 weeks (Table 8), after which the recovering divots were rated for cover (Table 9).

Experiment 4 - Soil tee height turf

Divots were removed July 20, 2000. There

were significant differences in germination of the bentgrass seed among treatments which included seed (Table 10). The scar size of the divots was recorded for 8 weeks (Table 11).

Conclusions

Differences in performance among the divot mixtures were most apparent in the experiments on the USGA green. The pattern of performance among the mixtures was similar in Experiments 1 and 2, with the mixtures containing seed consistently outperforming those without seed in speed of regrowth. The second important factor was presence of compost, which significantly improved the performance of mixtures which contained it. In fact, the 100% compost mixture without seed performed better than several of the mixtures with seed. The poorest performing mixtures were high sand and/or soil mixtures without seed. On the soil tee height plots (Experiments 3 and 4), the regrowth was fast and differences among the treatments were not significant.

Table 3. Divot scar size (cm²) USGA Green Trial 1 - divots taken 5/30/2000.

Treatment	5/30	6/15	6/26	7/05
100% Commercial Compost with seed	249.6	166.8	136.5 cde	0.0 g
100% Soil with seed	250.4	180.8	154.6 abcd	49.8 f
100% Commercial Compost	241.6	159.7	128.7 e	56.4 ef
50/40/10 Fine Sand/Peat/Fine clay (7mm screen) with seed	238.4	174.8	150.2 bcde	61.6 def
50/40/10 Fine Sand/Peat/Fine clay (4mm screen) with seed	247.2	164.6	134.8 de	73.2 cdef
80/20 Sand/Commercial Compost with seed	254.4	165.5	153.5 abcd	78.8 bcdef
80/20 Sand/Peat with seed	247.2	173.5	157.6 abc	81.6 bcdef
50/40/10 Fine Sand/Peat/Fine clay (4mm screen)	250.4	166.7	144.8 bcde	96.0 e abcd
100% Soil	238.4	191.3	160.4 ab	97.2 e abcd
80/20 Sand/Commercial Compost	245.6	168.8	146.0 bcde	102.6 abcd
100% Sand with seed	246.4	167.3	155.1 abcd	104.6 abc
80/20 Sand/Soil with seed	255.2	177.5	160.9 ab	104.9 abc
80/20 Sand/Peat	247.2	169.2	146.7 bcde	105.4 abc
50/40/10 Fine Sand/Peat/Fine clay (7mm screen)	240.0	172.0	147.9 bcde	106.0 abc
100% Sand	240.8	180.6	159.6 ab	112.1 abc
80/20 Sand/Soil	244.8	166.1	157.2 abcd	118.1 ab
Unrepaired Divot (Control)	235.2	200.1	175.0 a	130.9 a
Lsd p=0.05	NS	NS	22.7	41.0

Table 4. Cover (0-10) USGA Green Trial 1 rated beginning 6 weeks after divot taken.

Treatment	7/11	7/19	8/03	8/11	8/16	8/24	mean
100% Commercial Compost with seed	10.0 a	10.0 a	10.0 a	9.8 ab	10.0	10.0 a	9.97 a
100% Soil with seed	9.0 ab	9.6 ab	10.0 a	10.0 a	9.8	10.0 a	9.73 ab
50/40/10 Fine Sand/Peat/Fine clay (4mm screen) with seed	8.8 ab	9.2 abc	9.8 ab	10.0 a	10.0	10.0 a	9.63 ab
100% Commercial Compost	8.6 abc	9.2 abc	10.0 a	10.0 a	9.8	10.0 a	9.60 abc
50/40/10 Fine Sand/Peat/Fine clay (7mm screen) with seed	8.4 abcd	9.2 abc	9.8 ab	10.0 a	10.0	10.0 a	9.57 abcd
80/20 Sand/Commercial Compost with seed	8.6 abc	8.8 abcde	9.8 ab	9.6 abc	10.0	9.8 ab	9.43 abcd
80/20 Sand/Peat with seed	8.6 abc	9.0 abcd	9.6 abc	9.4 bc	10.0	9.8 ab	9.40 abcd
80/20 Sand/Soil with seed	7.6 bcde	9.0 abcd	9.6 abc	9.4 bc	9.8	10.0 a	9.23 bcde
100% Soil	6.6 def	8.4 bcdef	9.6 abc	10.0 a	10.0	9.8 ab	9.07 bcde
80/20 Sand/Commercial Compost	6.6 def	8.2 cdefg	9.6 abc	9.8 ab	10.0	10.0 a	9.03 bcdef
50/40/10 Fine Sand/Peat/Fine clay (7mm screen)	6.8 cdef	7.6 efghi	9.2 abcd	9.8 ab	10.0	10.0 a	8.90 cdef
100% Sand with seed	6.4 efg	7.8 defgh	9.4 abcd	9.6 abc	10.0	10.0 a	8.87 defg
50/40/10 Fine Sand/Peat/Fine clay (4mm screen)	6.6 def	7.4 fghi	8.8 cd	9.2 c	9.8	9.6 bc	8.57 efg
80/20 Sand/Peat	5.6 fg	7.4 fghi	9.2 abcd	9.2 c	9.8	10.0 a	8.53 efg
Unrepaired Divot (Control)	5.0 fg	7.0 ghi	9.0 bcd	9.4 bc	10.0	9.6 bc	8.33 fg
100% Sand	4.6 g	6.6 hi	8.6 d	9.6 abc	9.6	10.0 a	8.17 g
80/20 Sand/Soil	5.4 fg	6.4 i	8.6 d	9.4 bc	9.8	9.4 c	8.17 g
Least Significant Difference	1.91	1.34	0.93	0.54	NS	0.37	0.71

Table 5. Germination of seed in divot mixtures – USGA green trial 2

Treatment	8/14	8/24
100% Commercial Compost with seed	3.00 a	4.20 a
50/40/10 Fine Sand/Peat/Fine clay (7mm screen) with seed	3.00 a	4.20 a
80/20 Sand/Peat with seed	2.80 a	3.60 a
50/40/10 Fine Sand/Peat/Fine clay (4mm screen) with seed	2.02 b	2.60 b
100% Soil with seed	2.00 b	2.20 b
80/20 Sand/Commercial Compost with seed	1.20 c	2.00 b
80/20 Sand/Soil with seed	1.40 bc	1.20 c
100% Sand with seed	0.28 d	0.80 c
100% Sand	0.00 d	0.00 d
100% Commercial Compost	0.00 d	0.00 d
100% Soil	0.00 d	0.00 d
80/20 Sand/Peat	0.00 d	0.00 d
80/20 Sand/Commercial Compost	0.00 d	0.00 d
80/20 Sand/Soil	0.00 d	0.00 d
50/40/10 Fine Sand/Peat/Fine clay (4mm screen)	0.00 d	0.00 d
50/40/10 Fine Sand/Peat/Fine clay (7mm screen)	0.00 d	0.00 d
Unrepaired Divot (Control)	0.00 d	0.00 d
Lsd p=0.05	0.63	0.72

Table 6. Divot scar size (cm²) USGA green Trial 2 - divots taken 7/20/2000.

Treatment	20-Jul	14-Aug	24-Aug	12-Sep	18-Sep
100% Commercial Compost with seed	304.0	226.4	189.6	71.4 gh	21.0 g
80/20 Sand/Peat with seed	320.0	230.8	205.6	58.8 h	33.6 g
50/40/10 Fine Sand/Peat/Fine clay (4mm screen) with seed	324.8	210.4	196.2	84.0 fgh	42.0 fg
50/40/10 Fine Sand/Peat/Fine clay (7mm screen) with seed	310.4	225.8	214.4	84.0 fgh	42.0 fg
100% Commercial Compost	315.2	218.0	168.0	109.2 defg	75.6 ef
80/20 Sand/Soil with seed	310.4	228.8	196.2	92.4 efgh	92.4 de
80/20 Sand/Commercial Compost	308.8	229.8	191.6	134.4 eabcd	121.8 abcd
80/20 Sand/Commercial Compost with seed	320.0	250.6	218.8	113.4 cdefg	92.4 de
50/40/10 Fine Sand/Peat/Fine clay (4mm screen)	321.6	233.2	213.8	117.6 bcdefg	109.2 bcde
Unrepaired Divot (Control)	320.0	249.4	216.6	121.8 bcdef	113.4 abcde
100% Soil with seed	320.0	245.8	229.4	130.2 bcdef	96.6 cde
50/40/10 Fine Sand/Peat/Fine clay (7mm screen)	320.0	247.0	201.2	142.8 abcd	134.4 abc
80/20 Sand/Soil	308.8	241.8	216.0	159.6 abc	138.6 ab
100% Sand with seed	316.8	260.8	235.8	147.0 abcd	126.0 abcd
80/20 Sand/Peat	312.0	243.4	225.6	155.4 abcd	151.2 a
100% Sand	320.0	246.0	213.6	163.8 ab	147.0 ab
100% Soil	315.2	261.0	233.4	180.6 a	142.8 ab
Lsd p=0.05	NS	NS	NS	49.62	40.25

Table 7. Germination of seed in divot mixtures – soil tee trial 1

Treatment	6/16	6/28
50/40/10 Fine Sand/Peat/Fine clay (7mm screen) with seed	2.00 a	4.10 a
50/40/10 Fine Sand/Peat/Fine clay (4mm screen) with seed	2.20 a	3.80 ab
80/20 Sand/Peat with seed	1.22 b	3.20 b
100% Commercial Compost with seed	1.02 b	2.20 c
80/20 Sand/Commercial Compost with seed	1.02 b	2.00 c
80/20 Sand/Soil with seed	0.64 bc	1.60 c
100% Soil with seed	0.80 bc	1.40 cd
100% Sand with seed	0.24 cd	0.60 de
100% Sand	0.02 d	0.00 e
100% Commercial Compost	0.02 d	0.00 e
100% Soil	0.00 d	0.00 e
80/20 Sand/Peat	0.02 d	0.00 e
80/20 Sand/Commercial Compost	0.00 d	0.00 e
80/20 Sand/Soil	0.00 d	0.00 e
50/40/10 Fine Sand/Peat/Fine clay (4mm screen)	0.02 d	0.00 e
50/40/10 Fine Sand/Peat/Fine clay (7mm screen)	0.00 d	0.00 e
Unrepaired Divot (Control)	0.00 d	0.00 e
Lsd p=0.05	0.60	0.87

Table 8. Divot scar size (cm²) Soil tee Trial 1– divots taken 5/31/2000.

Treatment	5/31	6/16	6/28
50/40/10 Fine Sand/Peat/Fine clay (7mm screen) with seed	237.6	190.6	124.9
100% Soil with seed	237.6	205.0	128.5
50/40/10 Fine Sand/Peat/Fine clay (4mm screen)	235.2	167.9	131.8
50/40/10 Fine Sand/Peat/Fine clay (4mm screen) with seed	254.4	179.4	138.1
100% Soil	254.4	204.0	147.8
80/20 Sand/Commercial Compost	248.8	198.7	149.0
100% Commercial Compost	241.6	221.0	151.4
80/20 Sand/Peat with seed	254.4	206.1	151.6
80/20 Sand/Soil	246.4	197.6	151.9
Unrepaired Divot (Control)	240.0	223.2	152.2
80/20 Sand/Peat	237.6	201.6	157.6
100% Sand	248.0	209.4	160.6
80/20 Sand/Commercial Compost with seed	252.0	217.6	165.2
80/20 Sand/Soil with seed	252.0	214.9	165.5
50/40/10 Fine Sand/Peat/Fine clay (7mm screen)	240.0	225.2	166.4
100% Commercial Compost with seed	240.0	222.6	170.0
100% Sand with seed	254.4	220.6	173.8
Lsd p=0.05	NS	NS	NS

Table 10. Germination of seed in divot mixtures – soil tee trial 2

Treatment	8/08	8/24
80/20 Sand/Peat with seed	1.20 a	4.60 a
100% Commercial Compost with seed	1.02 ab	4.00 ab
50/40/10 Fine Sand/Peat/Fine clay (7mm screen) with seed	0.42 cd	4.00 ab
80/20 Sand/Commercial Compost with seed	1.02 ab	3.40 abc
80/20 Sand/Soil with seed	0.84 abc	2.80 bcd
100% Soil with seed	0.06 d	2.40 cde
50/40/10 Fine Sand/Peat/Fine clay (4mm screen) with seed	0.46 bcd	1.60 def
100% Sand with seed	0.24 d	0.20 fg
100% Sand	0.40 cd	1.00 efg
80/20 Sand/Soil	0.00 d	0.40 fg
80/20 Sand/Peat	0.00 d	0.20 fg
100% Commercial Compost	0.00 d	0.00 g
100% Soil	0.00 d	0.00 g
80/20 Sand/Commercial Compost	0.02 d	0.00 g
50/40/10 Fine Sand/Peat/Fine clay (4mm screen)	0.00 d	0.00 g
50/40/10 Fine Sand/Peat/Fine clay (7mm screen)	0.00 d	0.00 g
Unrepaired Divot (Control)	0.00 d	0.00 g
	Lsd p=0.05	0.59 1.52

Table 11. Divot scar size (cm²) Soil tee height Trial 2 - divots taken 7/20/2000.

Treatment	20-Jul	8-Aug	24-Aug	12-Sep	18-Sep	11-Oct
100% Commercial Compost with seed	302.4	269.2	154.4	28.0	4.0	20.0
80/20 Sand/Soil	308.8	245.6	140.6	48.0	12.0	28.0
80/20 Sand/Peat with seed	310.4	258.6	156.6	20.0	8.0	36.0
50/40/10 Fine Sand/Peat/Fine clay (7mm screen) with seed	304.0	270.4	180.6	24.0	0.0	16.0
80/20 Sand/Peat	299.2	256.2	170.2	36.0	12.0	32.0
100% Soil	308.8	260.0	154.6	48.0	24.0	28.0
50/40/10 Fine Sand/Peat/Fine clay (4mm screen)	305.6	244.4	157.0	64.0	32.0	24.0
80/20 Sand/Soil with seed	302.4	247.6	169.6	40.0	16.0	52.0
50/40/10 Fine Sand/Peat/Fine clay (7mm screen)	305.6	256.4	158.4	44.0	40.0	28.0
100% Sand with seed	307.2	256.4	158.4	56.0	36.0	24.0
50/40/10 Fine Sand/Peat/Fine clay (4mm screen) with seed	310.4	262.0	172.4	60.0	24.0	16.0
100% Commercial Compost	315.2	267.0	180.2	44.0	16.0	40.0
80/20 Sand/Commercial Compost with seed	312.0	287.4	205.8	40.0	8.0	28.0
100% Soil with seed	307.2	281.4	193.6	52.0	24.0	32.0
100% Sand	318.4	283.8	179.2	52.0	28.0	40.0
Unrepaired Divot (Control)	308.8	287.0	207.8	80.0	40.0	8.0
80/20 Sand/Commercial Compost	313.6	272.4	209.4	68.0	40.0	40.0
Lsd p=0.05	NS	NS	NS	NS	NS	NS