Organic Matter Dynamics in the Surface Zone of a USGA Green: Practices to Alleviate Problems

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Goals:

- *Determine the effectiveness of selected fall/spring-applied cultivation on enhancement of bentgrass root development, water infiltration, and soil oxygen status during spring and fall root development periods.*
- *Determine the effectiveness of selected summer-applied cultivation, topdressing and wetting agent practices on bentgrass root maintenance and viability, water infiltration, and soil oxygen status during the summer months when root decline occurs.*
- *The best treatments from the objectives above will be combined to develop an integrated year-round program for maximum root development and maintenance during stress periods.*

Organic matter in the surface 0 to 2 inch zone of a USGA green increases from an initial level of 1.0 to 5.0 percent (by weight) at establishment to 8 to 12 percent after two years. Organic matter accumulation occurs even under excellent management and regardless of construction method. The two proposed problems are:

I. Summer Bentgrass Decline in Response to Root Deterioration and Plugging of the Macropores that are Important for Soil O_2 and Infiltration of Water. A project was initiated in late spring 1996 to investigate the influence of treatments (summer cultivation, sand topdressing, sand substitutes, wetting agents) on maintaining infiltration, soil O_2 status, and root viability. This field study will continue until fall 1998. Observations to date are:

- Percent organic matter (OM) by weight ranged from 10.1 to 10.2 percent for the untreated control in the surface 0 to 3.0 cm zone. Core aeration with sufficient topdressing to fill the holes in March was the only treatment to reduce percent OM content (i.e., to 4.1 and 7.7%).
- High OM content in the surface 0 to 3 cm zone resulted in the following soil physical properties relative to USGA recommended specifications (in parenthesis): total porosity of 74.2 to 76.7 percent (35 to 55 percent); aeration porosity of 17.3 to 22.5 percent (15 to 30%); capillary porosity of 54.1 to 56.9 percent (15 to 25%).

- The surface zone resulted in saturated hydraulic conductivities (SHC) of 53 to 304 mm hr^{-1} for the control (minimum recommended is 120 mm hr^{-1}) and oxygen diffusion rates (ODR) of less than 0.20 μg O_2 cm^{-2} min^{-1} (threshold for O_2 stress) on all readings in 1996 for 2.5 to 26 hours after irrigation. In 1997, ODR readings were occasionally less than 0.20 for 26 to 50 hours after irrigation.
- The major effect of treatments was on SHC at 1 to 7 days and 17 to 26 days after cultivation (DAC). At 17 to 26 DAC, the most effective treatments for maintaining SHC were: HJR (Hydro-Ject run in raised position for ¼ inch diameter hole) with sand topdressing (S), wetting agent (WA), or bio-stimulant (B); (468 to 548 mm hr^{-1} versus control of 139 mm hr^{-1}). The next most effective treatments were HJL (Hydro-Ject lowered position); HJR; HJR + Sand + WA; and HJR + Sand + WA + B; (385 to 405 mm hr^{-1}).
- Treatments resulting in the greatest percentage (in parenthesis) of visual ratings greater than the control for all shoot parameters were HJL; HJR; HJR + WA; and HJR + B; (11 to 27% readings > control).

II. Inhibition of Root Development (in Spring/Fall) from the Zone of High Organic Matter Content. A second project was initiated in winter 1996 to investigate the influence of selected cultivation procedures, that are non-disruptive, on root development. Wetting agent and sand substitute treatments were also included. The goal is to determine whether better root growth/depth can be achieved by increasing macropores in the surface 0 to 3 cm zone without conducting the traditional spring/fall core aeration operation. This field project will continue through spring 1999. Observations to date are:

- High O.M. content (18.8%, wt.) in the surface 0 to 3.0 cm zone reduced aeration porosity to 8.6 to 10.5 percent and caused SHC values of 9 to 125 mm hr^{-1} (control) with lowest SHC occurring in November through May. Apparently as adventitious roots develop in the fall, surface macropores become plugged with live roots and SHC markedly declines.
- ODR values at 3 cm and 10 cm were frequently less than 0.20 μgO_2 cm^{-2} min^{-1} at 2 to 31 hrs after irrigation. ODR values at either depth were only occasionally improved by HJR or HJR + WA treatment.
- The primary treatment influence was on SHC where the most effective treatments for maintaining SHC at 24 to 41 DAC were HJR + WA; HJR; HJR + G + WA (G = 70% sand + 30% Greenschoice topdressing); AW (Aerway Greens Slicer, Fine Tines); (168 to 239 mm hr^{-1} versus 63 mm hr^{-1} control). Quad tines (solid, ¼ inch diameter) with or without G topdressing resulted in SHC values of 52 to 72 mm hr^{-1} at 24-41 DAC.
- Treatments resulting in least shoot injury (i.e., ratings similar to control) were: HJR + G; HJR; HJR + WA; HJR + G + WA.

Table 14. Bulk density, organic matter, and mineral matter content in the surface 0 to 3 cm zone in June and August 1997. University of Georgia, Griffin Experiment Station.

Treatment and Contrast‡	Bulk Density		Percent Organic Matter		Organic Matter Content§		Mineral Matter Content§	
	6 Jun	18 Aug	6 Jun	18 Aug	6 Jun	18 Aug	6 Jun	18 Aug
	---- g cm^{-3} ----		----- % (wt.)----		------- g -------		------- g -------	
Control vs.	0.51	0.62	10.2	10.1	7.5	9.3	67.5	84.4
CA (Mar)	0.70**	0.69	4.1**	7.7*	4.4*	8.8	99.1**	105.7*
HJL	0.54	0.58	9.7	10.2	7.7	9.1	69.8	81.7
HJR	0.48	0.60	11.5	11.7	8.3	10.0	62.6	75.7
HJR + Sand	0.57	0.63	9.4	10.6	7.7	9.7	74.9	82.4
HJR + Greenschoice	0.56	0.54†	7.4	10.2	5.8	9.0	73.5	79.2
HJR + WA	0.59	0.58	9.1	10.0	7.6	9.3	80.2	85.5
HJR + B	0.52	0.59	8.4	10.1	6.2	9.7	70.2	88.2
HJR + Sand + WA	0.51	0.59	10.1	11.1	7.7	9.3	68.4	75.7
HJR + Sand + WA + B	0.52	0.60	8.5	11.4	6.4	10.2	69.4	79.2
LP + Greenschoice I	0.52	0.54†	10.0	11.1	6.9	9.4	68.8	76.1
LSD (.05) =	0.12	0.10	4.3	2.2	3.0	1.3	18.9	16.8
F-test	†	0.20	†	†	0.39	0.56	*	*
CV (%)	15	11	33	14	31	10	18	14

‡ Contrast versus Control based on LSD.

**, *, † Significant difference at $P \leq 0.01, 0.05, 0.10$.

§ Weight is grams per 50 cm^2 surface area X 3.0 cm deep.