A NEW CONCEPT IN TURF CULTIVATION

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INTRODUCTION

Golf course putting greens are subjected to intense levels of traffic. This heavy amount of traffic leads to many problems associated with soil compaction, such as poor water infiltration and percolation, reduced soil aeration, restricted root development, and hard playing surfaces. Typically, cultivation practices are performed during the spring and/or fall to relieve soil compaction problems. However, the most severe soil compaction problems occur during midseason when play and the demand for a quality putting surface are at their highest. The conventional hollow tine cultivation technique creates objectionable putting surface disruption and is not widely used as mid-season cultivation tool. Solid tine cultivation with small diameter tines has greater acceptance as a midseason cultivation tool, but receives considerable criticism for its potential to develope a cultivation pan. A recently developed technique using high pressure water injection shows considerable promise as a tool for mid-season cultivation.

The Hydroject 3000, recently introduced by The Toro Company, uses high pressure water injection to cultivate soil. The machine releases water, pressurized to 5000 psi, in microsecond bursts through small nozzle openings. The tips of the nozzles travel less than 1 inch above the turf surface and are protected from contact with the soil. Only the water streams exiting the nozzles at approximately 600 mph enter the soil. The water streams or pulses have a relatively clean surface entrance and cut channels 4 to 8 inches deep in the soil profile.

RESEARCH OBJECTIVE AND METHODS

Our main objective in this research was to compare water injection cultivation (WIC) to noncultivated and hollow tine cultivated (HTC) plots. The inital study of WIC evaluated the effect of WIC on water infiltration of a sand soil in Palm-Aire, Florida during January 1985. Double ring infiltrometers were used to measure water intake rates over a 4 hour period.

Later studies included the evaluation of WIC, HTC and no cultivation (check) on a "Penncross" creeping bentgrass green grown on a loamy sand soil. Cultivation treatments were, initiated in 1988. Soil compaction was applied over

the entire experimental area during each growing season with water filled rollers. Soil physical properties, clipping yield, and root weight were some of the parameters measured in this study.

RESULTS

Water Infiltration

WIC increased water infiltration rate by 80% on a sand soil in Florida. This demonstrated the ability of water injection to cut deep continuous channels into a soil profile.

Soil Strength

Soil strength (hardness) measurements were taken 25 July, 1988 on the creeping bentgrass green study following the 9 July, 1988 (first) application of cultivation treatments (Fig. 1). The curves show the effort (vertical axis) required to push a cone-shaped probe through the soil profile (horizontal axis). Greater force readings mean harder, more compacted soil. The data show that HTC was a more effective surface (0-2 inches) cultivator than WIC. However, WIC was a much better cultivator of soil between 2 and 4 inches compared to HTC. The greater depth of loosening with WIC is due to the greater depth of penetration with WIC (3-5 inches) compared to HTC (3 inches).

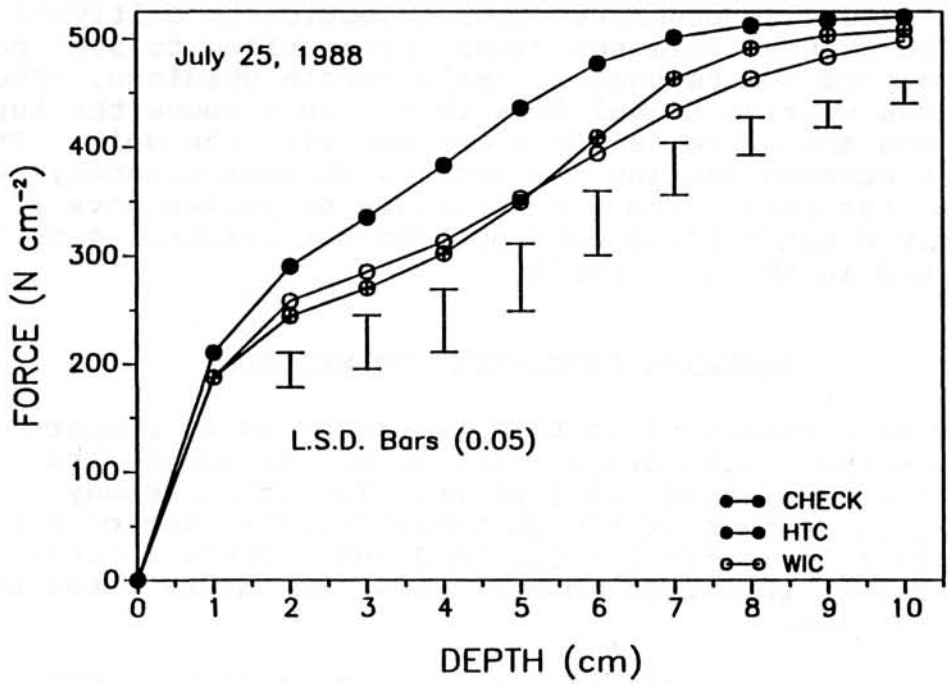

Figure 1. The influence of hollow tine (HTC) and water injection culitvation (WIC) on soil strength 16 days after treatment.

Soil Density, Porosity and Water Conductivity

Table 1 displays several soil physical properties measured after three treatment applications in 1988. Both WIC and HTC decreased soil density and increased total and aeration porosity. This data shows that WIC improved soil conditions similar to HTC. Although water conductivity data (K Sat) was inconsistent, the treatment means suggested many of the channels cut with water injection were affecting soil below the 3 inch depth. This was indicated by an overall increase in water movement through the surface three inches of soil. Subsequent data taken in 1989 has shown statistically significant increases in water conductivity with WIC compared to HTC and check plots.

Table 1. Soil bulk density, total and aeration porosity (6 kPa water tension), and saturated water conductivity (K Sat) response to 3 applications of hollow tine (HTC) and water injection (WIC) cultivation in the 0-3 inch zone of a loamy sand soil; treated 9 July, 19 Aug and 3 Oct, 1988.

	Bulk Density	Total Porosity	Aeration Porosity	K Sat.
TREATMENTS	g cm^{-3}	% volumetric		cm hr^{-1}
Check	1.83	29.3	7.3	2.1
HTC	1.78	31.4	9.2	2.3
WIC	1.77	32.2	9.6	4.6
L.S.D. (.05)	0.03	0.79	2.0	NS

NS denotes not significantly different

Root Weight

While soil conditions were improved with cultivation, HTC resulted in decreased root weight (Table 2). Root weight was reduced in the 0 to 2 inch (0-5 cm) zone with HTC. WIC did not significantly lower root weight compared to noncultivated plots. Decreased root weight following HTC resulted from physical removal of roots with soil core extraction. Since WIC does not remove turf plant tissue, a reduction in root weight did not occur.

Root sampling in July 1989, before additional treatment application in 1989, showed that HTC root weight remained below the check and WIC. The turf had from October 1988 to July 1989 to fill in coring holes with roots but an increase in root weight was not found. In November 1989, following two additional treatment applications (5 total), HTC had the smallest root weight compared to WIC and the check.

It appears that intense, mid-season HTC is very damaging to a creeping bentgrass root system. HTC would not be the best method to use for a strategy of frequent use on compaction prone sites. Frequent cultivation would be helpful on turfgrass sites receiving intense levels of traffic.

Table 2. The influence of hollow tine (HTC) and water injection (WIC) cultivation on total root weight and root weight density of a "Penncross" creeping bentgrass green sampled November, 1988; treated 9 July, 19 Aug and 3 Oct, 1988 .

TREATMENT	Root Weight Density Zone (cm) 0-5	5-10	10-20	Total Root Weight
	---	kg m^{-3} ---		kg m^{-2}
Check	7.95	1.95	0.39	0.534
HTC	7.02	1.73	0.29	0.466
WIC	7.76	1.84	0.38	0.518
L.S.D.(0.05)	0.91	NS	NS	0.065

NS denotes not significantly different

Shoot Growth

Both WIC and HTC improved visual quality, however, the slow healing coring holes detracted from turf quality of HTC plots immediately following treatment application. WIC holes healed within 1 or 2 days.

Improved visual quality was reflected in increased shoot growth or clipping yield (Table 3). Both HTC and WIC increased clipping yield after the second treatment application in 1988. WIC increased clipping yield more than HTC. This difference in shoot growth is attributed to plant removal with HTC; WIC does not remove plant tissue. The lack of plant removal would be advantageous during summer cultivation when turf may be thinning due to compaction and heat related stresses. Also, less damage to a turf would be important when the need to quickly improve a very poor soil conditions exists. Multiple applications of WIC can be applied over a short period of time with little damage and reduction in quality following treatment.

Table 3. The influence of hollow tine (HTC) and water injection (WIC) cultivation on clipping yield of a compacted "Penncross" creeping bentgrass green mowed at 0.6 cm in 1988; treated 9 July and 19 August, 1988.

	Fresh Clipping Yield			
	8/19	8/26	8/31	10/1
TREATMENT	g m^{-2} day^{-1}			
Check	8.3	6.4	6.2	4.8
HTC	8.0	6.9	6.8	5.0
WIC	8.4	7.7	7.6	5.0
L.S.D.(0.05)	NS	0.5	0.58	NS

NS denotes not significantly different

CONCLUSIONS

Water injection cultivation (WIC) can break through layers deeper in the soil profile compared to the conventional hollow tine cultivation (HTC) methods. Deeper cultivation should extend the depth of the root system in compacted soils and enhance air and water exchange in the soil, thereby improving plant stress tolerance. With reduced surface disruption and faster healing, WIC improves turf playability following cultivation compared to the conventional methods. Less turf injury (plant removal) allows WIC to be used prior to or during conditions consider too stressful for HTC. Less turf injury with WIC allows for more frequent use on areas prone to severe soil compaction stress. WIC provides the turf manager an opportunity to effectively alleviate compaction stress during mid-season.

ACKNOWLEDGEMENT

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