THE HYDROJECT: NOT JUST AN AERIFIER

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INTRODUCTION

The HydroJect was introduced as a turfgrass cultivation tool in 1990. This machine utilizes a 5,000 psi blast of water to break up soil particles, relieving compaction and aerifying the soil. The most common perceived benefit from the HydroJect is that, unlike traditional core cultivators, it causes minimal surface disruption after use. Research has continued on the HydroJect at Michigan State University since it entered the marketplace six years ago. During this period several advantages from regular HydroJect use, besides minimal surface disruption, have been discovered that may benefit the turfgrass manager. Four benefits, in particular, have become evident on research plots during the past two summers: reduced moisture stress, increased green speed, control of earthworm casting, and the ability to apply soluble materials (nitrogen) below the turfgrass surface.

REDUCED MOISTURE STRESS

Several studies at the Hancock Turfgrass Research Center were divided into plots that get regular HydroJect treatments and plots that received no HydroJect treatments. During periods of high evapotranspiration, plots treated with the HydroJect exhibited considerably less wilt. Irrigation was decreased on one of these studies to encourage formation of localized dry spots and exacerbate moisture stress differences between plots that receive HydroJect treatments and plots that do not receive HydroJect treatments. Differences in wilt severity were apparent shortly after irrigation was reduced. Table 1 shows the percent moisture for soil samples and percent localized dry spot for two dates in 1995. On both dates, plots receiving regular HydroJect treatments had higher soil moisture contents and fewer localized dry spots. One might be quick to attribute these differences to the addition of water when the HydroJect cultivates the soil. However, only .08" of water is added to the surface with one pass of the HydroJect. This is not enough water to account for the significant increase in moisture stress of plots that did not receive HydroJect treatments. A more likely cause of the differences in moisture stress is the wetting of channel surfaces during HydroJect treatments. This wetting prevents the thorough drying out of soil channels to become hydrophobic-- a precursor to localized dry spot formation. The wetted soil channels absorb additional water which becomes available to the turfgrass.

Table 1. Effect of HydroJect treatment on a sand topdressed green - 1995

Treatment	July 21		Sept. 14	
	% H_2O	% LDS	% H_2O	% LDS
HydroJect	15.9	0.6	19.4	4.1
None	9.1	9.8	12.2	47.2

INCREASED PUTTING GREEN SPEED

The HydroJect has two large rollers, one on either side of the injection unit, which propel the unit while injecting water. The first roller smoothes the turfgrass surface so the nozzles are flush to the ground for injection. The second roller corrects any lifting of the turfgrass surface that may have occurred during injection. These rollers perform very similar to traditional greens rolling units. HydroJect use actually *increases* putting green speed, rather than decrease green speed after cultivation as in the case of core cultivation,. Two putting green studies at the Hancock Turfgrass Research Center have been treated regularly with the HydroJect during the past two years. Plots treated with the HydroJect were stimpmetered before and after treatment. Treatments with the HydroJect have resulted in increases in green speed of approximately six inches on the stimpmeter. It should be noted that these studies were mowed at cutting heights slightly higher than typical golf course putting greens. Lower cutting heights should magnify the increase in greens speed following HydroJect use. Stimpmeter data from these studies are located in Tables 2 and 3. This data is similar to data from greens rolling studies examining the effects of traditional greens rollers. Duration of the rolling effect of the HydroJect was evaluated by stimping treated plots at several intervals after treatment and comparing these readings with control plots. This data is summarized in Table 4. The rolling effect of the HydroJect was still apparent 24 hours after treatment, but had diminished 48 hours following treatment. The duration of the rolling effect of the HydroJect is similar to those of traditional greens rollers.

Table 2. Effect of HydroJect treatment on stimpmeter readings - topdressing study

	1994	1995
	mean annual stimpmeter readings - feet	
Pre HydroJect Treatment	7.46	6.26
Post HydroJect Treatment	7.87	6.98
Average Increase	***4.9 inches***	***8.6 inches***

Table 3. Effect of HydroJect treatment on stimpmeter readings - cultivation study

	1994	1995
	mean annual stimpmeter readings - feet	
Pre HydroJect Treatment	6.64	6.76
Post HydroJect Treatment	7.34	7.20
Average Increase	***8.4 inches***	***5.3 inches***

Table 4. Duration of HydroJect rolling effect - 7/23/95-7/25/95

	Post-injection	1 day after treatment	2 days after treatment
	mean stimpmeter readings - feet		
Control	6.04	5.92	6.83
HydroJect	6.65	6.32	6.90
Average Increase	***7.3 inches****	***4.8 inches****	***0.8 inches***

* *statistically significant ($P < 0.10$)*

EARTHWORM CASTING CONTROL

A significant amount of earthworm casts appeared on a cultivation study after heavy rains during the autumn of 1994. Upon closer observation, some plots seemed to have very few earthworm casts compared to others. An earthworm cast count showed that plots receiving frequent HydroJect treatments exhibited significantly lower amounts of earthworm casts than other cultivation treatments. This earthworm cast count, and another taken in 1995 are summarized in Table 5. Earthworms are primarily beneficial creatures due to the air filled channels created from their burrowing activities, but casts left on putting greens can significantly disrupt ball roll, even after mowing. The potential for earthworms to cast on putting greens decreases with regular HydroJect use. It has been suggested that earthworm control is achieved from the water blast of the HydroJect killing the earthworms. This is unlikely since HydroJect treatment, like traditional core cultivators, affect only a small amount of the surface soil ($\approx$ 3%). Earthworm control is probably achieved from the HydroJect creating increased amounts of macropores so that the earthworms can cast below the turfgrass surface during periods of heavy rainfall. This scenario results in reduced amounts of castings on the turfgrass surface while maintaining the beneficial burrowing activities of the earthworms.

Table 5. Effect of cultivation treatment on earthworm casting

Treatment	10/13/94	9/6/95
	mean earthworm casts per plot	
Control	72 a*	103 ab
Core Cultivate 2X/year	64 ab	151 a
Core Cultivate 3X/year	84 a	135 a
Core Cultivate 2"X1" 2X/year and HydroJect Biweekly	59 abc	115 ab
Core Cultivate 2X/year and HydroJect Biweekly	39 bc	98 ab
HydroJect Monthly	46 bc	99 ab
HydroJect Biweekly	42 bc	58 b
HydroJect Weekly	37 c	51 b
* *means sharing a letter are not statistically different ($P < 0.05$)*		

NITROGEN INJECTION

A study was initiated during the summer of 1994 to examine the effects of injecting nitrogen with the HydroJect on fairway and putting green turf. Treatments included three rates of urea, either injected or surface applied. Plots injected with urea had consistently higher clipping yields, nitrogen content in plant tissues, and color ratings than surface applied plots. These differences were thought to be the result of ammonia volatilization from surface applications, even though plots were irrigated shortly after application. This theory was tested by repeating the study in 1995 using ammonium nitrate, which is much less susceptible to volatilization. Results from the 1995 study were very similar to those recorded in 1994. Clipping yields, nitrogen content in plant tissues, and color ratings were all increased by injecting ammonium nitrate. Therefore, it is likely that factors other than volatilization increase nitrogen efficiency when applications are made via injection. There were no differences in overall turfgrass quality between injected plots and surface applied plots. Although injected plots were a darker green color they exhibited a striping that followed the injection pattern of the nozzles. Plots injected with nitrogen seemed to have a longer response time to the application than surface applied plots during both years. Also during both years, plots injected with nitrogen were less susceptible to wilt than plots receiving surface application. These results suggest that by injecting nitrogen the turfgrass manager will be able to use less nitrogen with fewer applications compared with surface applications. Additionally, nitrogen injection may reduce irrigation pressure during the stressful summer months since the turfgrass is less susceptible to wilt.

CONCLUSIONS

1. Regular use of the HydroJect prevents the occurrence of localized dry spots by creating wetted channels that absorb additional water for plant uptake.

2. The HydroJect has two large rollers that act very similar to traditional greens rollers. HydroJect treatment results in an increase in green speed of approximately six inches. The rolling effect of the HydroJect diminishes two days after treatment.

3. Regular use of the HydroJect reduces the number of earthworm castings on putting green surfaces. The HydroJect provides macropores for the earthworms to cast below the surface during periods of heavy rain.

4. The HydroJect provides a means for the turfgrass manager to apply soluble materials, like nitrogen fertilizer, below the turfgrass surface.

    a) Plots injected with nitrogen had higher clipping yields and leaf nitrogen content than plots receiving surface applications.
    b) Plots injected with nitrogen had a longer response to application than plots receiving surface applications.
    c) Plots injected with nitrogen maintained a darker green color throughout the growing season than plots receiving surface applications.
    d) Plots injected with nitrogen were less susceptible to wilt than plots receiving surface applications.