HOW COMPACTION AFFECTS YOUR MANAGEMENT OF TURF

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Foot and vehicular traffic on turfgrass sites can cause soil compaction -- the pressing together of soil particles and deterioration of structure to form a more dense soil mass. Effects on the soil include:

* a decrease in total pore space

* a decrease in the macropores (larger pores) -- these are essential for root channels, water drainage, and air exchange

* less continuity of pores -- instead the pores tend to become isolated

* an increase in the micropores (small pores) that result in a higher water retention. Unfortunately, much of this water is unavailable for plant uptake.

* decreased aeration exhibited by lower O_2-- O_2 is essential for healthy roots

* reduced infiltration and percolation -- thus, irrigation is greatly complicated and drainage through the soil decreases.

* a dense soil with higher soil strength, especially as it dries -- the dense soil hinders rooting.

* soil temperatures are altererd -- generally, the wet, compacted sites are the slowest to warm in spring. However, in the summer the thinner turf, common on compacted areas, allows solar radiation to heat up the soil more than on the adjacent noncompacted turf.

Since the physical properties of the soil are dramatically altered, the plant soon perceives the difference and responds. Table 1 and 2 contain a listing of common turfgrass responses. The combination of soil and turfgrass changes can cause the grower a number of problems, such as:

1. Pesticide use. The more open turf invites invasion by a number of weeds especially those able to tolerate compacted soil -- Poa annua, goosegrass, and knotweed. Also, the less healthy plant coupled with a more moist environment enhances the probability of disease, particularly, brown patch and Phythium blight.

2. Fertilizer use. A compacted turfgrass will not take up nutrients very efficiently because of a less extensive root system and less viable roots. In general, 10 to 30% less nitrogen (N) will be taken up by a compacted turf compared to a noncompacted site. However, increasing the N-rate will not help but can be very

Table 1. Turfgrass root responses to soil compaction

Response	Comments
Rooting depth decreases-------	limits water and nutrient uptake in response to low soil O_2 and high soil strength
Surface rooting may increase--	in response to slower root growth rates and stimulation of surface, adventitious rooting by ethylene
	- under severe compaction this may not be observed
Roots mature and die faster---	especially noticeable on cool season grasses in the summer
	- in response to low O_2 and higher soil temperatures
Less viable root cells--------	even if a live cell is present it may not effectively take up water or nutrients
	- in response to low O_2 the cell membranes become less permeable
Roots may exhibit higher------ porosities	individual roots may have a more open structure which allows some O_2 to move from the shoot into the root during low soil O_2 conditions
	- this is a beneficial acclimination to compaction

Table 2. Turfgrass shoot responses to soil compaction

Response	Comments
Reduced shoot density and verdure	a more open turf with less plant material per unit of area
Slower leaf growth and extension rate	this results in less mowing but also means a greater chance of wear on recreational sites
More succulent cells with lower carbohydrate reserves (TNC)	with more frequent irrigation and poor drainage the turf becomes more succulent. Also, the poor growth often reduces TNC levels. - these responses greatly reduce high temperature, low temperature and drought tolerance - also, wear and disease susceptibiliy increase, while recuperative potential declines

detrimental because it will further increase succulence, reduce carbohydrate reserves, and dramatically reduce rooting. The "take-home lesson" is that adding additional N beyond normal rates will not correct soil compaction effects on turf--even though plant symptoms may be similar, such as, slow growth rate, open turf, and sometimes yellow leaves. The problem is adverse soil physical conditions and not nutritional.

3. More environmental and wear stresses occur. Table 2 contains a discussion of the reasons. Any factors (compaction, close mowing, shade, excessive N) that reduce carbohydrate levels and increases succulence will greatly enhance the potential for environmental stress wear damage. If compaction occurs in combination with any of these other factors, even greater injury would be expected.

4. Irrigation scheduling. The soils most prone to compaction are those with appreciable silt and clay. These already have low infiltration rates which compaction further reduces. The grower may find it very difficult to apply water at a low rate for a long period in order to recharge the soil. Thus, compacted sites are often irrigated with light, frequent applications which further exacerbate an already difficult situation.

5. Additional maintenance to alleviate compaction problems. Whenever compaction is a problem the manager is faced with developing practices to eliminate or reduce the effects. This requires additional time, labor, and expertise. In general, no one management practice will be a cure-all but several will be necessary. The management choices are:

a) Select compaction tolerant species and cultivars when establishing or renovating. Examples are the use of a higher percentage of perennial ryegrass in mixes of Kentucky bluegrass or tall fescue; use of improved tall fescues versus Kentucky-31.

b) Traffic control. This includes such things as larger tees, larger greens, moving tee markers and green flags frequently, restricting band practice on the primary football field, using 2 or 3 practice areas, etc.

c) Develop a good cultivation plan. Cultivation is the most important management technique to deal with soil compaction. A well-thoughtout program should be developed with:
   * proper selection of equipment to meet your specific problems and budget
   * proper timing of cultivation
   * correct soil moisture conditions at the time of cultivation -- some techniques require a moist soil and others a drier soil

* application of supplemental N to aid in recovery of any injury from the cultivation

d) Adjust your other cultural programs. Until the compaction can be alleviated, weed and disease problems that are favored will need to be chemically controlled. As cultivation improves the soil physical conditions, irrigation practices should be adjusted to a deeper, less frequent regime. Adequate N should be used but not excessive rates.

e) Use partial or complete soil modification. Partial soil modification by adding sand with core cultivation can be useful over a period of years. Complete soil modification (i.e. USGA golf green, PAT or PURR-WICK) may be the most cost effective approach on high-use recreational sites. Chemical amendments (gypsum, wetting agents, various chemicals to improve/stabilize structure) would have little beneficial effect since even the best, aggregated soils develop poor structure under compaction.

f) Use artificial turf or paver systems. Sometimes the traffic is too intense for turfgrasses and alternative covers may be useful.

On recreational sites the turfgrass managers have the potential to utilize all (or many) of the above management choices. Thus, he can develop a comprehensive program.

Sometimes soil compaction occurs on nonrecreational sites, such as homelawns. If a lawn care company is treating such a lawn, some suggestions are: (a) your workers should be able to recognize the program, (b) indicate to the homeowner that the problem is from poor soil physical conditions which your program does not deal with, (c) your fertility and pesticide program may produce less improvement on such a lawn compared to a noncompacted one, (d) special herbicide treatment may be necessary for goosegrass and knotweed, (e) do not try to correct the problem by increasing N rates, (f) suggest a cultivation program to your customer. Recent research at Michigan State University and the University of Georgia has demonstrated that cultivation after the application of a preemergence annual grass herbicide does not reduce herbicide effectiveness.

A number of years ago, John Madison, a turfgrass scientist in California, observed that soil compaction is the number one problem on recreational turf. For those growers with soils that are proven to compaction, the statement still rings true.