Heat - A Solution to Soil Compaction

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by **B. F. Warkentin,** PH.D., and **G. P. LaFlamme**

IN THE COURSE of managing turfgrass, the golf course superintendent must contend with both man and nature. The former plays a major role in creating the problem of soil compaction, for it is traffic that compacts the soil on the fairway.

Compaction is much greater on wet soil than on dry soil because the soil aggregates are weaker when they are wet. Therefore, adequate drainage is the key to keeping fairway soils from becoming heavily compacted.

Inadequate drainage is the cause of most fairway compaction problems. But even with good drainage, some clay soils with weak aggregates will become compacted. With the increasing traffic on most golf courses and the increasing demands of players to play under wet conditions, we have to think very seriously about stabilising fairways against compaction.

The worst damage from compaction of wet soils occurs in the top inch or two inches of the soil. The soil aggregates are squeezed together, eliminating the large pores through which water and air move into the soil. This decreases the infiltration rate, leaving the surface wet and leading to even more compaction. When compacted soil dries, it becomes very hard. Bare spots or weeds tolerant of these poor growing conditions appear.

It is prohibitively expensive to replace soils on the fairway with soil mixtures that resist compaction. This practice is reserved for greens, tees and other special areas. We then must look for ways of increasing the stability of the soil in place on fairways.

Since compaction occurs primarily at the soil surface, we need to think of stabilising only the uppermost layer. Materials such as lime, flyash, water repellent coatings and organic soil conditioners have been used for stabilising soils. Each of these amendments works under certain conditions; an amendment should be used only on the basis of soil tests or on the basis of experience with similar soils. Clay soil aggregates can also be stabilised by heat.

Heat Stabilisation

Heating has been used occasionally in the last 40 years to stabilise soils for road bases. The method has been used successfully in Australia and in other countries. Special equipment is required to move a flame over the soil, or to lift a layer of soil, thoroughly heat it, and redeposit it as the machine moves along. The temperature required for stabilisation depends upon the kind of soil and is usually above 500 degrees F.

Since heat stabilisation has been shown to be successful in changing certain properties of soils, it could also be useful for stabilising fairway soils against compaction. We tried soil heating on an experimental basis, both in the laboratory and in the field near Montreal

in 1970. The results showed that heating does stabilise clay soils against compaction. If an appropriate situation arises, heating could be tried on a golf course.

Lab Test Results

A clay loam soil, characterised by medium plasticity, low permeability and medium aggregate stability, was used in our studies. After being heated, soil samples were put into test cylinders, wetted overnight, drained to field capacity and compacted by dropping a 3-pound hammer from a 1-foot height 15 times.

The permeability of the compacted soil samples was then measured. The compaction and permeability apparatus is shown in Figure 1. This is the procedure recommended by the United States Golf Association for evaluation of soil mixtures.*

The results in Table I show that the heated soil had a good permeability after compaction. The untreated soil was impermeable after compaction. With this indication that heat could stabilise soils against compaction, we designed a field experiment to test heating.

Field Results

Plots were laid out on a clay loam soil near Montreal to compare heating with lime and hydrated lime as stabilising treatments. The lime was mixed into the surface soil at 8 and 40 pounds per 100 square feet. The top 2-inch layer of soil was heated with the special apparatus shown in Figure II. Nails $2\frac{1}{2}$ inches long were welded at 1-inch spacing on a $\frac{1}{4}$-inch-thick steel plate, 2 feet by 2 feet. The plate was set onto the soil with the nails penetrating the soil to transfer the heat provided by gas burners. Soil temperature was measured with a thermocouple at a 2-inch depth. Temperatures of 400 to 500 degrees F were attained after three to four hours of heating.

The soil plots were compacted after a rain, with a heavy roller. Infiltration was then measured with an infiltrometer. After a series of infiltration measurements during two weeks, the soil was then compacted and more infiltration measurements were made.

Heated soil was consistently more permeable than untreated soil or soil to which lime had been added (Table II). Also the bulk density of the compacted, heated soil was lower than lime-treated soil, indicating greater resistance to compaction. The rate of water infiltration decreased with the second compaction, indicating that the effect of heating does not last long.

Various grass seeds were sown in samples of heated soil. Germination and growth were as good in heated soil as in the untreated soil. Therefore, heat treatment can be safely used for soils on which seed is to be sown.

Evaluation of Experiments

These experiments indicate that heating is a potentially useful method for stabilising surface soils, but the results must be considered only preliminary. Heating will be useful only for certain clay soils where swelling on wetting leads to decreased stability. These swelling clay soils can be recognised from their high plasticity. Each problem of fairway compaction has to be studied to determine the best and most economical solution. This usually requires investigation and evaluation by a trained soils man. Heating is most economically done when the soil is dry; otherwise a large amount of heat is used in dissipation of water.

A method would have to be worked out to heat soil with a moving heat source. Machines used for soil engineering projects may possibly be adapted for use on fairways. Heat could be applied to the soil in place, or a 2-inch layer of soil could be lifted, heated

*Ferguson, M. H., H. L. Howard and M. E. Bloodworth. 1960. Laboratory methods for evaluation of putting green soil mixtures. USGA Journ. 13(5): 5-8.

and returned in a continuous operation. The fact that heating is used for stabilising road bases indicates that it is economically feasible.

TABLE I

Laboratory evaluation of permeability of heat-treated soil samples

Heat Treatment Temperature	*Time Heated*	*Permeability of Compacted Samples*
not heated	—	0 in/hr.
400 degrees F	½ hr.	0·1 in/hr.
400 degrees F	2 hrs.	2·8 in/hr.
400 degrees F	12 hrs.	1·1 in/hr.

TABLE II

Infiltration of water into soil plots

	Inches of Water Infiltrated in 15 minutes	
Treatment	*After 1st Compaction*	*After 2nd Compaction*
No treatment	1·25	0·50
Heated	5·00	1·50
Lime	2·00	1·50
Hydrated Lime	1·50	0·75

With grateful acknowledgements to "Golf Superintendent".

Notice of Meeting

NOTICE is hereby given that an EXTRAORDINARY GENERAL MEETING will be held at:

The English Speaking Union,
37 Charles Street
Berkeley Square
London W1

on Saturday 19th May 1973 at 12 noon

BUSINESS – To consider and vote on a proposition of the Executive Committee that Membership Subscriptions should be increased as from 1st May 1973 to:

Class A Membership	£4·00
Class B Membership	£3·00
Class C Membership	£2·00
Class D Membership	£4·00
Class E Membership	£5·00

Entrance Fee – 50% of Subscription

All additional income to be allocated to Head Office Funds.

That all New Members should pay full subscription whatever time of year they join. This would mean deleting second part of Section B, Rule 7.

As it is often two or three months before they receive their first Journal, subscriptions of New Members joining in last quarter of year to count for following year. This should be left to the discretion of Section Secretaries.

Wage Scale Recommendation

At the Executive Meeting held on the 17th March, 1973, the Committee recommended an increase on their 1972 figures, and suggest they should now read:

Head Greenkeeper	£2000 per annum (plus accommodation) (4 weeks holiday)
First Assistant	£1500 per annum (plus 3 weeks holiday)
Assistants	£1300 per annum (plus 3 weeks holiday)

40 hour Week
Plus statutory holidays