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Preparation of Compost

By Kenneth Welton

The study of various functions of the soil in promoting plant growth brought out early in agricultural history the fact that the productivity of soils depends largely upon the amount of organic matter they contain. At first it was not known in what way organic matter favored the growth of plants, beyond the fact that it improved the texture of the soil. Later it was shown that the soil was inhabited by large numbers of microorganisms, including bacteria, algae, and fungi. Of these soil microorganisms probably 75 per cent are bacteria; an ounce of fertile soil may contain as many as 3,000,000,000 bacteria. From this figure it is apparent that the soil is alive with these minute plants and animals, whose size defies imagination.

Although it was earlier known that nitrogen was a much-needed food for plants, it was not until the latter part of the 19th century that it was shown that nitrogen was liberated for plant use from the organic matter in the soil by a process of bacterial decomposition. Later research has brought out the fact that there are three main processes involved in this liberation of nitrogen: first, one group of the bacteria attacks the organic matter, causing its decay and the liberation of ammonia; second, another group changes the ammonia to nitrous acid, which unites with the bases (calcium, magnesium, and the like) in the soil to form nitrite salts; third, the nitrites are in turn attacked by still another group of bacteria, which changes the nitrites to nitrates, in which form nitrogen is absorbed by plant roots. One may add nitrogen to the soil in various forms, such as soluble inorganic salts of ammonia and nitrates and in less soluble organic materials, yet complete success in turf production will not be achieved unless the soil is provided also with ample organic matter.

It generally follows that the richer the soil in organic matter the greater the number of bacteria in the soil and hence the greater the bacterial action and the more fertile the soil provided the necessary mineral elements are also present. Of course, if drainage conditions are such, or the soil is so compact, as to prevent aeration, the several stages in the work of the nitrifying bacteria can not be completed and the soil will be infertile through lack of available nitrogen as well as from other biological causes. Circulation of air in the soil is necessary for the maintenance of a proper supply of oxygen. By adding organic material in one form or another it is possible not only to increase the supply of bacteria but also to promote aeration of the soil through the mechanical effect of the material supplied. A fertile soil is necessary for the heavy crop of grass that a putting green must produce, where many pounds of clippings must be removed daily if the green is to be well kept. Indeed, the quantity of foliage clipped from a single putting green in a year would represent a surprisingly large yield of forage were a comparison to be drawn between a putting green and an equal area of land devoted to the production of forage.

In addition to its influence on the growth of grass, however, organic matter makes soil more resilient, thus possessing an added value for the soil of a putting green, since golfers detest greens with soil so compact that pitched balls will not hold on them.

While it is of the utmost importance that nothing but proper top-dressing material must be used on putting greens, yet the reader

must be cautioned that satisfactory results can seldom be obtained from the use of even the best top-dressing material if the top soil of the green is of undesirable quality before the treatment is begun. It requires years to build up a layer of top-dressing of effective depth on established turf, and often it has been found impossible in the life of a green to build away from the poor condition of the original top soil and totally eliminate its bad effects. Sometimes partial success is attained by working suitable top-dressing material into the top soil by forking, discing, or spiking; but this treatment must be continued with great perseverance and is sometimes more expensive than making the necessary soil improvement in a single operation. If the top soil is of undesirable quality it is usually more satisfactory to remove the sod and replace it after conditioning the top soil. References to the proper preparation of soil during the construction and reconstruction of putting greens are contained in the August, 1928, and August, 1929, numbers of the Bulletin.

A fertile, porous top soil is required on putting greens. To provide this, after the green is built, it is necessary to top-dress with suitable material. It is generally conceded that the ideal top soil for putting greens is a sandy loam relatively high in organic content. Such soil seldom exists naturally on golf course properties in the amount required; hence most clubs must prepare it by a combination of mechanical and cultural methods.

Some Historical References to Compost

The compost pile is as old as the history of gardening. It is mentioned in many of the earliest publications on agricultural subjects. A book entitled "Langley of Gardening," by Batty Langley, of Twickenham, England, printed in 1728, contains a discussion of compost piles that seems almost recent. The book is dedicated to King George II. Its first chapter, or "section" as it is called, is devoted to the preparation of compost by the use of various types of soils. Mr. Langley evidently considered soil texture to be of first importance in the growth of plants. He gives careful directions for the improving of soil texture by composting and by the applications of composts to soil. Weeds were evidently troublesome in Langley's time, as he warns gardeners to keep the compost pile free from weeds, a warning which, after 200 years, needs today to be repeated to specialty gardeners, such as greenkeepers. The following excerpts from his book have not only educational value today but are extremely interesting when one considers that the process of composting was understood and practiced at least 200 years ago, as "Langley of Gardening" bears witness:

"Soils being different in contexture, colour, or size, I have reduced them into three sorts, viz, as first, light, sandy, and gravel: Secondly mellow, loam, and brick-earth: And, lastly, stiff, cold land, and clay.

"The manures proper for those several kinds of soils are as follows: First, for a loose sandy soil take of mud, scoured out of ponds, &c. and of strong loam an equal quantity; to which add a third part of good horse-dung, well mix'd together, and it will make an excellent compost for sandy or light land. All composts may be made in any quantity; so that the proportion of the quantities of each sort is carefully observed, and well mix'd.

"When that you have mix'd a sufficient quantity cast it into the

form of a lestal, and let it be turned three or four times in the year, and always keep clean from weeds; for they exhaust the vital parts thereof, and at the end of one year 'twill be fit for use. If to one rod of ground be allowed one load of compost, 'twill be a very good allowance.

"Clay of the lighter sort is good manure for light shelfy gravel, or sandy land; but care must be taken that the clay is not digged in too deep. If an equal quantity of clay and sand be equally mix'd together, the compost will be a very good loam."

After giving specific directions regarding the making of compost with marl, various dungs, sandy loam, chalk and marl, and loam with a stiff subsoil, he gives the following directions for heavy clay soils:

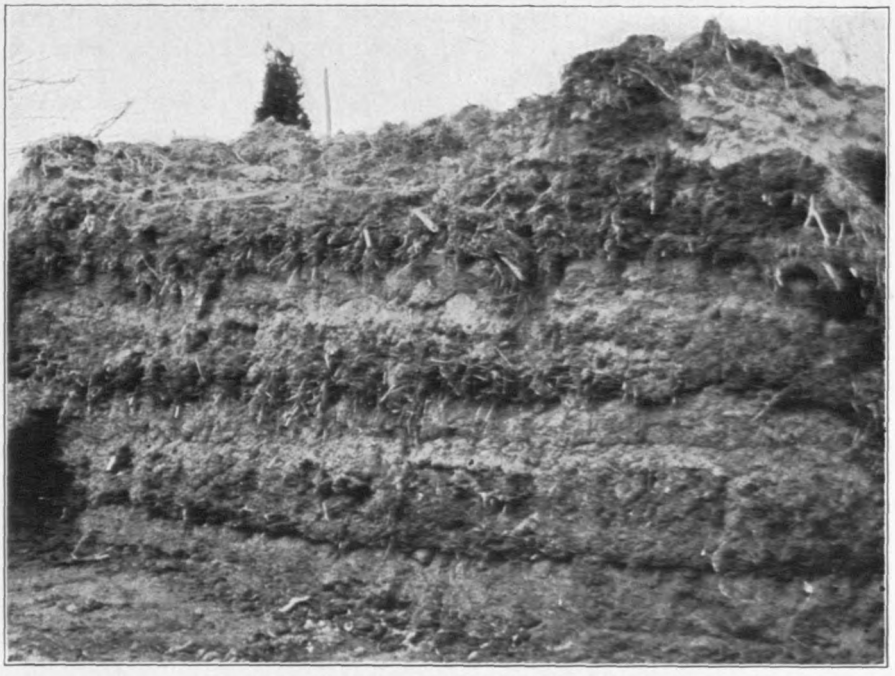
"Thirdly, and lastly, stiff and cold clay lands are help'd by divers composts. To three loads of the natural mold add two loads of good rotten dung, one load of sand, two loads of the first spit of a rich turf, meadow, or grass-ground, half a load of street-dung, or sea-coal ashes, with a small quantity of pigeons' dung; mix these proportionately together, and lay the compost in a heap, observing to turn it once a month for the summer season, and in winter it will be fit for use. Pigeons-dung, cast thin upon cold lands early in the spring, is very helpful, especially for corn and meadow lands: Five loads will dung an acre. Sea and drift sands are very good composts for clay lands, making way for the roots to shoot; as also doth sea-coal ashes."

From the last sentence in the quotation it is obvious that experimenters and observers had long ago appreciated the necessity of an open and porous soil for adequate root growth. In fact, Mr. Langley writes of compost as knowingly as a modern writer, since in other parts of his "section" on compost he advises the use of leaves and waste materials in the compost and also recognizes that too much dung mixed at one time with clay tends to "bind" it or make it soggy, and he favors the use of bulky organic material, such as good heavy sods, leaves, and rubbish, along with a proportion of dung. Neither did he fail to realize that much of the best elements, now known to be nitrogen in the form of ammonia gas, could be lost by volatilizing from heated piles, as he seeks to guard against this probable loss by building his piles in the fall when the sun's heat is less.

In the early days of golf in America many old country gardeners were employed as greenkeepers. Most of them understood the proper preparation of compost piles and had an inherent knowledge of proper soil structure and of the method of composting various materials so as to obtain the friable loamy soil they desired. Although the greenkeeper of today is often far ahead of his predecessors in scientific knowledge as to how to maintain the fine turf now demanded, the principles of composting appear to have been lost during his advancement. One has only to travel from one course to another to realize that it is almost impossible these days to find a properly constructed and cared for compost pile. While the gardeners of earlier days may not have understood the rôle that various soil organisms play in the rotting of vegetable material and in the subsequent releasing of nitrogen and mineral elements from the materials in the pile, yet they accomplished the desired results and got not only good texture and fertility but at the same time procured a compost free from weed seeds. This was done largely by caring for the pile in such a manner that a

slow and thorough decomposition and mixing of all materials was accomplished.

A greenkeeper may build a pile using materials that, if properly decomposed and mixed, will give him an ideal sandy loam top-dressing material; but if after building the pile he promptly forgets it and allows the manure layers to burn with the accompanying loss of ammonia, and permits weed seeds not only to remain in the pile but to accumulate, most of his labor in building the pile is lost. The rotting of the manure and other organic materials should take place in close proximity to all soil particles at one time or another in order to exert an influence on the soil as a whole. This is accomplished by frequent turning of the pile as it heats while rapid decomposition is taking place. By turning the pile and subjecting all the soil, not just



Compost pile trimmed to show the layer manner in which it is built. In building this pile first a layer of soil was laid down, on top of that a layer of manure, then a layer of sod, and lastly a layer of sand. The pile contained three tiers of these layers

the outside of the soil layers in the pile, to the rotting of vegetable matter stimulated by the active microorganisms in the manure, the weed seeds in the soil are mostly destroyed; but when a pile is not turned until the manure has rotted past the heating stage, the opportunity to increase the fertility of the soil in the pile is lost and the weed seeds contained in the center of the soil layers may still be viable. Also if a dense bed of weeds is allowed to mature on the top and sides of the pile, thousands of weed seeds will eventually find their way to the putting green.

Building and Turning the Compost Pile

The compost pile should be built up in layers about 6 inches deep, first a layer of soil and then a layer of manure. If other organic

materials are put in the pile, such as peat, sods, or clippings, they should be next to the manure and then covered with a layer of sand. The pile should be wet down as each layer is built. As the pile dries, the heating will increase, and when by thrusting the hand well into the pile it is noticed that the interior is becoming very hot the pile should be thoroughly soaked. After the pile has been allowed to heat and has been wet down several times, it should be turned. This may become necessary at intervals of one or two months, depending on the weather. Methods of turning large compost piles by means of the slip scraper and steam shovel or gas excavator are described in the Bulletin for February, 1928. After the pile has been turned it should be moistened again and allowed to heat once more. The heating will be less intense after the pile has been turned and there is thus little likelihood of burning the organic matter. However, for thorough decomposition and destruction of weed seeds, the pile should be turned once more and allowed to remain for some time before being used. If the pile is not used at the end of the first year it should be turned at least once a year and weeds should not be allowed to grow on the pile at any time.

A pile in the open will necessarily be subjected to rainfall and hence needs artificial watering only in times of prolonged drought. Very little plant food is lost from the compost pile by leaching, as the soil and organic layers absorb most of the soluble and gaseous elements. However there should be facilities for covering thoroughly composted soil in order that there will always be available a supply of dry material for sifting during wet weather.

Securing the Desired Texture in Compost

When building a compost pile the texture of the top-dressing material required should be considered. The material required is usually a sandy loam. This contains at least 50 per cent of sand, usually 60 to 80 per cent, the remainder being silt or clay and organic matter. A sandy loam contains not over 40 per cent of silt or 20 per cent of clay. Ordinary clay and silt loams contain from 20 to 35 per cent of sand. This sand however is mostly very fine and does not help as much in improving the physical condition for putting greens as does a similar percentage of coarser sand. A sharp, clean sand which is similar to building sand should be used when adding sand, as the coarser, sharp sands have more effect in increasing the sandy nature of the mixture. It is not wise to make the top-dressing material too sandy, as it would not support a high water table long enough. Material which is not far removed from the loam type will draw up more moisture from below and hence require less watering. The greenkeeper should however remember that it requires considerable sand materially to change clays. For example, it requires only 20 per cent of clay in a soil to make a clay loam, but from 50 to 80 per cent of sand to make a sandy loam. Large quantities of sand are required to modify clays, but relatively small quantities of clay to modify sands. Some heavy clay soils would require the addition of twice their bulk, or even more, in sand to change them to sandy loams, whereas the addition of from one-quarter to one-third in clay to sand would change it to a sandy loam.

Good fertile sandy loams seldom contain more than from 3 to 4 per cent of organic matter, but for top-dressing purposes the organic matter should be brought up to 15 or 20 per cent. To do this a large

amount of organic material must be incorporated in the compost pile, as the bulk and weight of this material are considerably reduced by oxidation during the composting.

It is important to consider the materials at hand before making a compost pile for the production of a soil with a desired texture. If there is a supply of what is commonly known as good garden loam on the property, only a little manure and some sand need be added. If however the only soil available is a poor clay or silt loam, the pile should be built with at least one-third manure, one-third clean, sharp sand, and one-third soil. If there is also a considerable quantity of old sod, leaves, grass clippings, or other cheap materials available, the pile may be built with one-fourth in these rough organic substances and one-fourth in soil, sand, and manure. If the soil to be used for compost is very sandy, 40 per cent of the pile may be the sand with about 30 per cent each in manure and silt or clay loam. A very stiff clay should not be used in the pile as difficulty would be encountered in mixing it thoroughly with the sand. A light clay loam or a silt loam would be better. These proportions should be slightly reduced if sod and other roughage are added.

Turning a pile of leaves, hay from the rough, clippings from putting greens, and other organic waste on the course of the Canoe Brook Country Club, Summit, N. J. All this valuable organic material is being made into artificial manure by treating it with sulphate of ammonia

Various peats may be used in the pile, but they can not entirely replace manure. If manure is scarce, up to 50 per cent of it may be replaced by peats or other organic material such as rotted straw and leaves. It is usually advisable to mix about 25 pounds of lime with every ton of peat before putting it in the pile. Information on the various types of peats is contained in the Bulletin for November, 1929.

Straw and leaves may be rotted so they will form a source of partially decomposed organic material which can replace peat. A good method of hastening the rotting of straw and leaves has been developed by the Rothamsted experiment station in England. By this method the straw or leaves must be thoroughly moist. The piles of material should be watered several times until the material has taken

up about all the moisture it will absorb. Nitrate of soda or sulphate of ammonia should then be added to the wet material at the rate of 100 pounds for every ton of dry straw or leaves. These latter materials will of course weigh much more when saturated. Some lime, either hydrated or carbonate of lime, should be added when sulphate of ammonia is used. Twenty-five pounds of lime to the ton is sufficient. The decomposition is somewhat more rapid in an alkaline medium. The wet straw should be turned and should be dusted with the nitrate of soda or sulphate of ammonia and lime during the turning. After a few days the pile should be watered again, and from then on watered sufficiently to keep the inside slightly moist. The pile should be turned and moistened every month or so. After several months during the warmer seasons the leaves or straw will be decomposed sufficiently for use as organic material in the compost pile.

Nothing will take the place of good barnyard manure in the compost pile. The manure used for this purpose should be only partially decayed. Manure which has already been thoroughly rotted to a fine granular texture, such as that from mushroom beds, is not the type to use in building a compost pile. A fresher manure, only partially decomposed, is desirable, as it will cause more heating and thus hasten decomposition in the pile.

Making Compost in Soil Beds

The soil bed method of preparing top soil and compost on golf courses has increased in popularity in recent years. There are many features in its favor which recommend it to clubs requiring particularly large quantities of top soil and top-dressing material. During the construction of the course large quantities of soil for top-dressing purposes are required, particularly if the putting greens are to be planted with stolons. Clubs would be well advised wherever possible to start the soil bed before any other construction work. Clubs maintaining bent greens planted by the stolon method in particular require a large quantity of top-dressing material annually more so than clubs with the old type of seeded greens or clubs whose greens are mostly annual bluegrass. Some clubs require large quantities of top soil for top-dressing tees and areas on the fairways. Wherever large quantities of well-prepared soil free from weed seeds are required, the soil bed method recommends itself primarily on account of its economy.

Hand labor is reduced to a minimum by this method, since the bed is comparatively shallow and covers a comparatively wide area. Horse- and tractor-drawn equipment may be used to great advantage. A flat area that is out of the line of play on the course should be chosen, and if possible one that has a good soil to start with. It should be at least a half acre in extent. It is plowed and suitable materials added to improve the fertility and physical character of the soil. It is cultivated from time to time so as thoroughly to mix the materials and destroy any weeds that may commence to grow. A green-manure crop may also be grown on it to further destroy weeds by smothering them and to build up the fertility of the soil by being turned under. It is also well to prepare the bed on a comparatively low, flat area, else some of the elements that would tend to increase the fertility of the soil may be lost through surface wash or leaching. The bed should have sufficient drainage and should be protected by ditches from surface wash from higher elevations which might carry weed seeds to

the bed. If an area having a fairly deep loam top soil can be used it would require the addition of less material to bring the soil to the desired texture and fertility. Poor sand or clay soils require the addition of a surprisingly large amount of other materials to change them into proper top-dressing material. In the northern states it takes at least one year to prepare soil properly in a soil bed. The prepared area should be large enough to take care of the top-dressing needs of the course for several years. It should be located where trucks and farm equipment can reach it easily.

Where the natural soil is poor, the soil bed method of composting or soil preparation may require a longer time than the compost pile method, since with the latter more rapid decomposition can be made to take place. But the soil bed, apart from its being more economical, is less liable to injury from neglect, and can be rendered practically free from weed seeds.

Soil bed in course of preparation on an area of the rough out of the line of play. Manure has been piled ready to spread

If the soil to be prepared is a stiff silt or clay it should first be mixed with sufficient sharp, clean sand to improve its physical texture. The bed may be plowed from time to time to a depth of 8 inches; one should therefore count on improving only soil to that depth at one time, at least as regards its physical texture. Some tests should be made with the natural soil by mixing enough sand with it to make it loose and friable, or so that it will crumble easily after being packed while damp. If the soil, for example, should require the addition of one-third its volume in sand, the soil bed would require a similar addition. The quantity of sand to apply therefore for a soil bed 8 inches deep (depth to which the bed is to be plowed) would be 1/3 of 8 inches, or 2 2/3 inches. Since 3 cubic yards of material will spread to a depth of 1 inch over 1,000 square feet, 8 cubic yards of sand would be required to spread to a depth of 2 2/3 inches over such an area.

If the soil to be improved is very sandy, the addition of some loam (a silt loam rather than a clay loam) is advisable.

Having found a proper texture by the mixing of soil materials, the amount of organic material necessary should be estimated. The addition of organic material, apart from its increasing the fertility, also improves the texture of the soil in the case of both heavy and light soils, so that some allowance should be made for the increased porosity to be derived from the addition of organic material when determining the proper soil mix. As the volume of organic matter in the soil is however being constantly reduced by decomposition, a great deal of undecomposed bulky organic material especially may be added from time to time; hence it is only by observation or analysis that it can be determined when sufficient has been added. The amount necessary varies with the kind of soil, climate, and organic material used.

Well-rotted barnyard manure should be applied at the rate of 40 to 50 tons to the acre. This amount can be conveniently worked into the soil at one time. Strawy or fresh manure can be used to advantage if available, but more would be needed and also more time required for its decomposition in the soil. If it is very difficult to get barnyard manure it may be largely replaced by other organic materials, such as peat or other partially decomposed vegetable matter. Barnyard manure may be wholly replaced by a green-manure crop. If at all possible, however, it is advisable to apply at least 10 tons of good barnyard manure to the acre. The area should first be plowed and disced, then the sand or other soil applied and disced. The organic material should then be applied and disced; or if it is too bulky to disc into the soil it may be turned under with the plow, following which the use of a spring-tooth cultivator will help to mix it in thoroughly. After the sand and organic material have been mixed with the top 4 or 5 inches of the soil by discing, harrowing, or otherwise, the bed should again be plowed and disced. From then on such roughage as grass clippings, leaves, and old sods may be spread over the area and disced or plowed under.

At some time after the bed is first laid down the soil should be tested for its lime requirements, and if lime is needed it should be supplied. The phosphorus and potash content should also be increased. Ordinarily superphosphate at the rate of 500 pounds an acre and muriate of potash at the rate of 125 pounds an acre will supply sufficient phosphorus and potash. These should be disced in at some time during the cultivation of the bed, preferably when the bed is first built.

Green-Manure and Cover Crops

On sandy soils there may be considerable organic matter and plant food elements lost from the soil bed by leaching and oxidation. This loss of organic matter is particularly noticeable in the southern humid regions, where the climate stimulates the growth and activity of organisms causing decomposition. It is therefore advisable, when soil beds are built on sandy soils, to grow a cover or green-manure crop on these areas. By planting some fast growing forage crop, mineral elements which might be leached from the soil are absorbed and retained by the plants. There may be a spring planting, which should be plowed under in the fall, and this could be followed by a fall planting to be plowed under the following spring.

As organic materials such as barnyard manure become less available farmers are finding it more and more advisable to build up or maintain the organic content of the soil by crop rotations, which make

use of crop residues. In the use of green-manure crops, sometimes referred to as catch crops or cover crops, inorganic fertilizers may be made use of to increase the bulk of the green-manure crop and hence the bulk of organic material to be plowed under. Golf clubs can conveniently purchase nitrogen, phosphorus, and potash in such inorganic materials as sulphate of ammonia, superphosphate, and muriate of potash. The green-manure crops may be fed on these fertilizers, and when plowed under will return the fertilizing elements to the soil.

Growing crops collect large amounts of carbon from the air and combine it with other elements to form plant tissue. The organic content of the soil is therefore steadily increased in proportion to the bulk of the crop that is grown, provided the crop is plowed under and thus kept in the soil. Even inorganic plant-food materials can be

Rye, on account of its rapid germination and vigorous growth especially during the cooler seasons of the year, is well adapted for use as a green-manure or cover crop on soil beds. The bed of rye here shown is at the Arlington turf garden

used to build up the organic content of soils by their increasing the growth of the cover crop. Legumes, such as clover, vetch, soybeans, and peas, are commonly chosen for green-manure purposes, since leguminous plants are able to collect and store up nitrogen from the air through the medium of certain soil bacteria which form tubercles on their roots, and in this way the supply of nitrogen in the soil is increased when a legume is used as a green-manure crop. When legumes are grown for this purpose the soil may have to be inoculated with the nitrogen-collecting bacteria, also the lime requirement of the soil may have to be satisfied. In certain districts nonleguminous crops, such as rye, can be grown as winter cover crops. District agricultural representatives are able to give valuable advice concerning the use of green-manure crops in different localities.

Other Sources of Organic Matter

The organic content of the soil can be built up very quickly by the addition of peat or muck, and clubs having an available supply of these materials can use them to advantage in the soil bed. There are peats and mucks which are not suitable materials to apply to the putting green in their natural state; but they can be spread on a soil bed to good advantage. These materials lose their objectionable qualities when mixed with soil and oxidized through the process of cultivation. There are also many organic materials such as waste from

tanneries, leather factories, and silk and woolen mills, cottonseed hulls, and moats which can be used in the soil bed. Sewage disposal is often available at a comparatively low cost and is a fine source of organic matter as well as certain mineral elements which are beneficial to soil beds and compost piles.

Sterilization of Soil for Weed Prevention

The artificial sterilization of soil for top-dressing purposes is deserving of more general practice on golf courses. It is much less expensive to use soil free from viable weed seeds than it is to weed. Proper composting and soil bed practice will largely take care of the weed problem, but in some cases the time necessary for the continuous attention to compost piles and soil beds is not available; in such cases mixtures of loam, sand, manure, and other materials may be used immediately when they have been sterilized. The old method of building fires on top of seed beds to sterilize the soil is being discarded in favor of better methods, and should not be practiced with compost or mixtures containing an abundance of manure or other organic material, since a large amount of the organic material may be lost by direct contact with the fire. A better method is that described in the Bulletin for January, 1926. In this method the fire is placed under a pan upon which the soil is cooked. Unless ample fuel in the form of waste timber is available, this method may prove expensive, as it requires a great deal of fuel. The sterilization of soil by steam has been accepted by tobacco growers in preference to other methods. The use of the inverted steam pan or hood is described in Farmers' Bulletin 996 issued by the United States Department of Agriculture. An adaptation to golf course purposes of the steam method of sterilizing soil has been described by Mr. Boude, of the Miami Valley Golf Club, in the Bulletin for September, 1926. The available fertility of the soil is increased by steaming and the viability of all weed seeds and stolons present may be entirely destroyed. The degree of heat necessary to sterilize soil of weed seeds is often determined by a test with potatoes placed in the soil. The potatoes are buried at points most distant from the steam outlets. If the potatoes are thoroughly cooked anywhere in the soil it is safe to assume that all weed seeds in the soil will be cooked and no longer viable.

The experience of the Gulf Stream Golf Club, Delray, Beach, Fla., in constructing a soil sterilizer and in steaming large quantities of soil for putting greens is given by M. L. DeParlier in his articles in this number of the Bulletin.

The destruction of weed seeds in soil to be used for top-dressing is a matter of extreme importance. It should, however, be remembered that there are other ways in which weed seeds are distributed besides their being carried in top soil. Complete mastery of the weed problem must take into consideration many factors in addition to the important one of compost free from weed seeds. The various phases of weed control on putting greens are more fully discussed in the Bulletin for August, 1930.

A ball lost in an overgrown rough is a source of irritation to a player, and no part of his game. It is a hindrance to the match being played, and probably to many following players.

Treatment of Soil by Sterilization

By M. L. DeParlier
Gulf Stream Golf Club, Delray Beach, Fla.

For several years southern greenkeepers have been seeking some practical method of eradicating noxious weeds which infest the greens of their courses. Nut grass and pennywort cause us most trouble in the South. To eliminate weeds in our greens we decided to remove all turf and soil to a depth of 6 inches, at which depth most of the tubers of the nut grass were found, and to replace it with a soil which we knew was free from nut grass.

After new soil was placed on the greens and they were properly graded we decided to try sterilizing the soil for the seed bed. To do this it was necessary to purchase a boiler and construct a steam chest or sterilizer. The sterilizer, which is 10 feet long, 4 feet wide, and 12 inches deep, is made of 1⅝-inch cypress tongued and grooved. It has a hinged drop gate at one end, and is mounted on wheels in such a manner that it is very easily tipped so the steamed soil can be raked out. A top was made by constructing a frame of 1⅝ by 6 inch grooved cypress and inserting ¾ by 6 inch tongued and grooved boards in the frame to form a solid panel. This lighter material was used to make the top easier to handle. By screwing two ordinary drawer handles on each end of this top, two men can easily handle it. The top is fastened to the sterilizer by means of 6 L-shaped irons made of 3/16-inch iron 12 inches long and bolted loosely to the ends and sides of the sterilizer and hooked over large lag bolts.

Soil and compost sterilizer constructed and used by the Gulf Stream Golf Club, Delray Beach, Fla. By the use of this apparatus the material is steamed, at a small cost, so as effectively to eliminate injury to putting greens by nut grass, pennywort, and various other turf weeds.

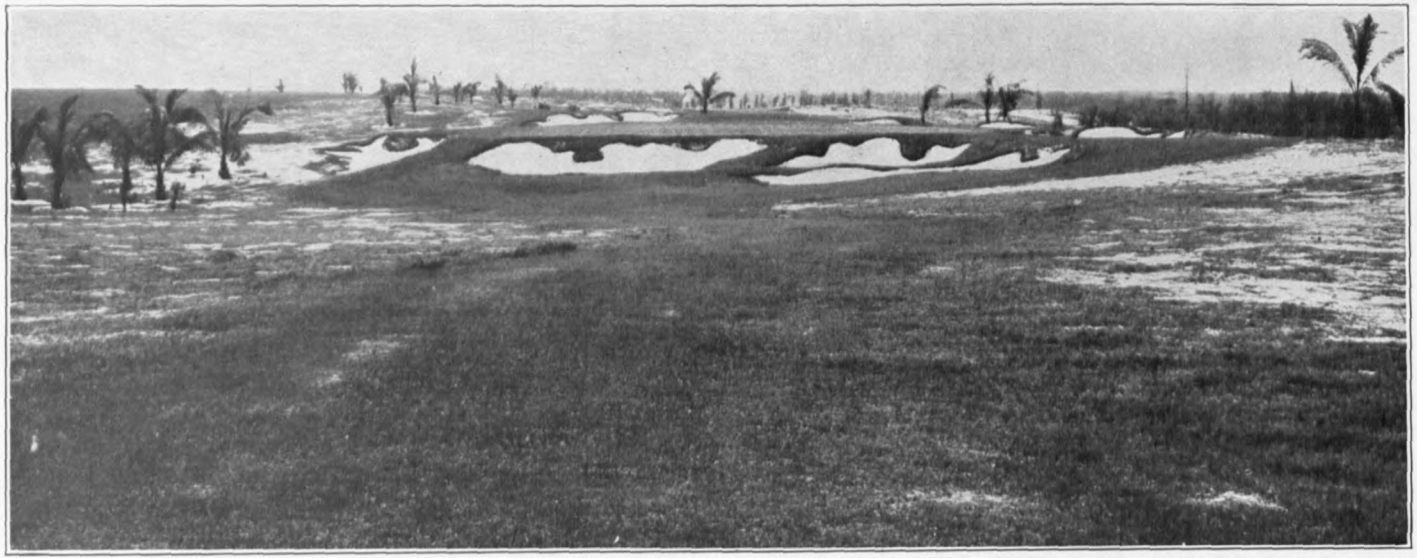
After several experiments we found the best way to get steam into the box was to run a galvanized pipe into it through the center of the end not hinged, keeping the pipe about 6 inches from the floor. A tee was screwed on this pipe just inside the box and two short pipes of the same diameter were screwed into each end of this tee, extending toward the sides of the box. On the end of each of these two shorter pipes a 90-degree ell was fitted, into which two pipes extending the entire length of the box were screwed. These pipes were held

6 inches from the floor by means of flanges screwed to the bottom of the box. The pipes are equidistant from each other and the sides of the box. Before the pipes were installed in the box they were drilled with 3/16-inch holes at intervals of 4 inches, and then turned half-way around and drilled again at intervals between the first set of holes. The pipes were installed so that one set of holes was vertical and the other set horizontal, in order that steam could penetrate the soil from both directions. Care was taken to drill these holes of proper size, since steam will not penetrate the soil thoroughly from holes which are either too large or too small unless very high pressure is used.

Most any size and type of boiler may be used, but we chose a 15-horsepower vertical-type tubular boiler, as this seems to be the most economical where a considerable amount of soil must be sterilized in a short time. We were fortunate in finding a boiler at a very low price which, though it had been used, was still in excellent condition. We set the boiler as close as possible to our compost shed and ran a 1½-inch steam pipe into the shed. We then connected this pipe to the sterilizer with 50 feet of steam hose so we could move it around without disconnecting it. We maintain 100 pounds of steam pressure, which will destroy all weed seeds in the soil in 15 minutes. We determined the time required for thorough cooking by placing potatoes in the soil at several points, and found that they were thoroughly cooked in that time.

The entire cost of the boiler, pipe, steam hose, and sterilizing box did not exceed $250. Where large amounts of soil are not needed, or where time is not an important factor, this cost might be reduced.

All soil used on our course is composed of muck, marl, and sand, which are found on our property and which are mixed together in proper proportions. To this is added a small amount of German peat moss which has been composted for several months with activated sludge. We find this to be an ideal soil for our greens. The muck, marl, and sand are hauled and dumped in separate piles close to the pile of composted peat moss near our compost shed. A soil mixer or shredder is placed at the end of these piles and the proper amount of each material is shoveled into the machine. By placing a revolving screen at a proper distance from the mixer, the latter throws the soil into the screen, thus saving one operation. The soil is then shoveled into the sterilizer, the top is fastened down, and the steam is turned on. The soil comes out of the sterilizer wet. To facilitate drying the soil we paved 3,000 square feet adjacent to the shed. When steam is turned on, the sterilizer is pushed to the extreme edge of the paved area, and when steamed the proper time the soil is dumped out and spread while another batch is steaming. In this way the soil can be dried under our climatic conditions about as fast as it can be steamed. As soon as it is dried it is thrown under our shed for later use. In late winter or early spring we can steam and store sufficient soil to top-dress all of our greens throughout the entire summer. The actual cost of sterilizing is 78 cents a yard. By constructing another sterilizer we could cut the cost in half, since while we are dumping and refilling one we could be steaming another, thus eliminating lost motion and loss of steam due to "popping off" between operations.



Fifth hole (142 yards from short and 183 yards from long tee markers), Seminole Golf Club, Palm Beach, Fla.

The weakest creature by concentrating his powers on a single object, can accomplish something; whereas the strongest, by dispersing his over many, may fail to accomplish anything.

Thomas Carlyle