

TABLE 1—Weights of Roots at Various Depths, Pounds Per 1,000 Sq. Ft. of Surface—New Brunswick, N. J., June, 1931

Soil Horizon.	R. Island Bent		Velvet Bent		Seaside Bent		Hard Fescue		Ky. Bluegrass		Redtop	
	Lawn Length. (Lbs.).	Putting Length. (Lbs.).	Lawn Length. (Lbs.).	Putting Length. (Lbs.).	Lawn Length. (Lbs.).	Putting Length. (Lbs.).	Lawn Length. (Lbs.).	Putting Length. (Lbs.).	Lawn Length. (Lbs.).	Putting Length. (Lbs.).	Lawn Length. (Lbs.).	Putting Length. (Lbs.).
First inch	71.2	70.6	68.9	67.0	87.8	87.0	81.6	81.2	123.2	123.7	92.3	92.5
Second inch	13.1	12.4	15.1	14.8	20.4	20.4	12.4	11.4	18.5	18.2	11.0	13.0
Third inch	6.0	5.6	7.2	7.0	7.0	7.0	3.9	3.6	3.6	3.6	6.1	7.5
Fourth inch	6.5	2.8	4.5	3.9	3.9	3.2	7.6	6.6	5.1	5.1	6.2	4.8
Fifth inch	3.8	2.0	3.5	3.1	3.1	3.5	5.9	4.9	5.2	6.2	3.2	3.8
Sixth inch	2.4	.7	2.8	2.0	2.7	1.7	4.6	5.5	2.8	3.9	2.7	1.8
Seventh inch	1.4	.6	1.8	1.3	2.1	1.1	3.9	3.9	3.1	3.0	1.7	2.3
Eighth inch	1.1	.5	1.3	.7	1.5	1.5	5.8	3.0	1.7	2.4	.8	2.4
Ninth inch	.7	.3	.7	.3	1.1	.3	3.0	3.2	1.5	2.2	.7	.4
Total root weight	106.8	93.8	105.9	121.5	129.8	91.4	140.3	144.6	174.2	178.6	124.7	161.5
Root weight below first inch	35.6	33.2	37.0	29.4	42.0	24.4	58.7	50.1	49.0	48.9	32.4	36.0

TABLE 2—Weights of Roots and Clippings, Pounds Per 1,000 Sq. Ft. of Surface, 4/16<sup>th</sup> to 7/8<sup>th</sup>—Season of 1931.

Species of Grasses.	Total Weight of Roots in 1st 9" of Soil.		Ratio of Roots Below 1st Inch to Total Yield of Clippings.		Yield of Clippings from April to July 1.		Root Weight Below 1st Inch, 6/23/31.		Total Weight of Roots in 1st 9" of Soil, 6/23/31.		Yield of Clippings from April to July 1.		Ratio Roots Below 1st Inch to Total Clippings.	
	6/23/31.	7/1.	1st Inch Yield of Clippings.	Total Yield of Clippings.	6/23/31.	7/1.	6/23/31.	7/1.	6/23/31.	7/1.	6/23/31.	7/1.	6/23/31.	7/1.
R. I. bent	33.7	23.1	.87	106.9	35.7	27.4	35.7	35.7	106.9	25.3	25.3	25.3	3.90	1.30
Velvet bent	121.5	29.5	1.10	105.9	37.1	41.9	37.1	37.1	105.9	14.3	14.3	14.3	4.19	1.47
Seaside bent	31.5	28.7	.85	130.0	42.2	42.2	42.2	42.2	130.0	58.7	58.7	58.7	2.95	2.95
Hard fescue	144.6	50.0	.75	140.3	58.7	27.2	58.7	58.7	140.3	49.1	49.1	49.1	5.16	2.16
Ky. bluegrass	178.6	48.9	...	174.3	49.1	46.9	49.1	49.1	174.3	37.2	37.2	37.2	1.05	1.05
Redtop	161.5	36.0	...	124.7	32.4	29.5	32.4	32.4	124.7	4.23	4.23	4.23	1.10	1.10

July as a result of clipping at the putting length.

Height of Fairway Cut

It is of interest to compare the root development of Kentucky bluegrass and redtop cut at 7/8 ins. with that of adjacent plants allowed to grow as for hay. In the case of bluegrass, cutting at fairway length did not restrict root growth at all, whereas with redtop such mowing appreciably reduced root abundance below the 6th inch. This is in harmony with the observations that bluegrass will maintain active growth year after year if cut properly, whereas redtop tends to die after the second or third year when cut regularly at the height of 1 in. or less.

Root-Clipping Ratio

From the standpoint of the water economy of the plant, the ratio of root extent to yield of tops is quite important. When top growth is heavy and root development scanty, serious difficulties may be experienced in maintaining a satisfactory supply of moisture. On the other hand, grass species that produce a vigorous root growth and a moderate or limited top growth should endure droughty conditions much more satisfactorily.

The total yields of dry matter produced in clippings from the beginning of the growing season until July 1, is shown in table 2, along with the quantity of roots found in late June. The weight of the green clippings was 3 to 4 times as great as when dried, because of the water content, but both root and clipping weights are reported on the dried basis in this table.

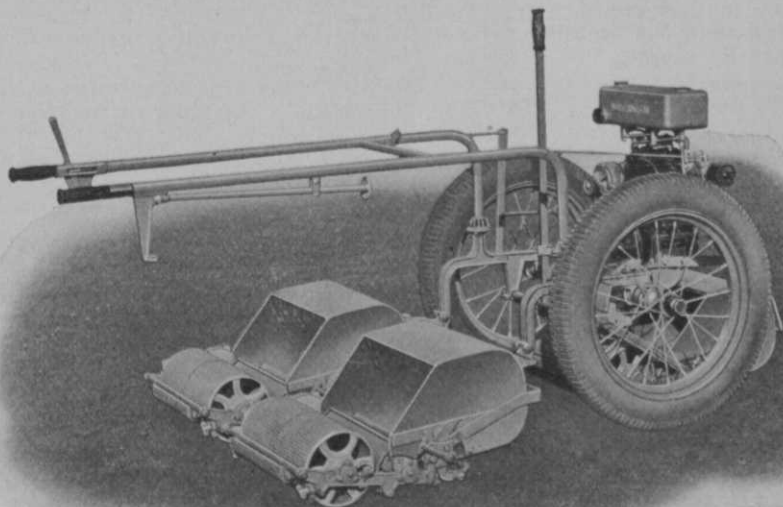
It may be startling to find the root weights exceeding that of the clippings, but such is the case, and obviously roots have been grossly underestimated in importance. When the roots of the first inch are disregarded, the weights of roots are nearly as great as those of tops on turf cut at putting length, and is 30 to 300 per cent greater on grass cut at fairway



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height. The high ratio of roots to tops of the velvet bent cut at  $\frac{1}{4}$  in. may be due to the high fertility of the soil on that plot, or it may indicate the natural character of the species.

### Root Development and Soil Analyses

One important feature of these studies is the almost universal tendency for growth to stop in the 8th or 9th inch. The condition is likely associated with the fact that this soil has been plowed to a maximum depth of about 8 ins. during the time it was farmed. The lime and fertilizer used for the crops in that period were mixed with the plow zone but probably did not greatly affect the subsoil. To prove this point it is necessary to correlate soil analyses with root development. This has been done, and the details are reported for three of the grass species in Table 3.

### Rhode Island Bent

First consider the case of Rhode Island bent grass. The acidity of the various soil zones is given in terms of the pH scale. On this scale, 7.0 is neutrality, 6.0 represents mild acidity, 5.5 strong acidity, and 5.0—very strong acidity. The most acid layers of soil are those near the surface. Undoubtedly this is partly caused by the absorption of lime from these layers in greater quantities than in the lower levels where roots are less abundant. A contributing factor is the greater leaching effect of water on the surface layers. However, the failure of roots to penetrate the lower horizons can not be attributed to the acidity of the soil, since the soils become less acid as roots decrease in abundance.

The readily available phosphorus is reported in parts per million (P. P. M.) since the percentage values are low. One per cent by weight is equal to 10,000 parts per million. The data presented show that the soluble phosphorus content of the soil is low in the upper 2 or 3 inches, high from the 3rd to 6th inches, and then falls sharply at the 8th and 9th inches. The low phosphorus values near the surface are the result of heavy absorption by the roots in those zones; and the values in the 5th and 6th inches probably represent the quantity present before absorption began. The low concentrations of readily available phosphorus in the 9th inch indicates that the soil is naturally low in this constituent, and the quantity present in the plow zone is principally the residue from past fertilizations.

The organic matter content of the soil has been measured by determining the carbon present. Carbon makes up about  $\frac{1}{2}$  of the soil organic matter. These values fall off sharply as the lower portion of the plow zone is reached, and one may assume that much of the organic matter present has been supplied either by plant roots which were confined to the upper 8 inches, or by manure and crop residues that were mixed with the soil during cultivation in previous years.

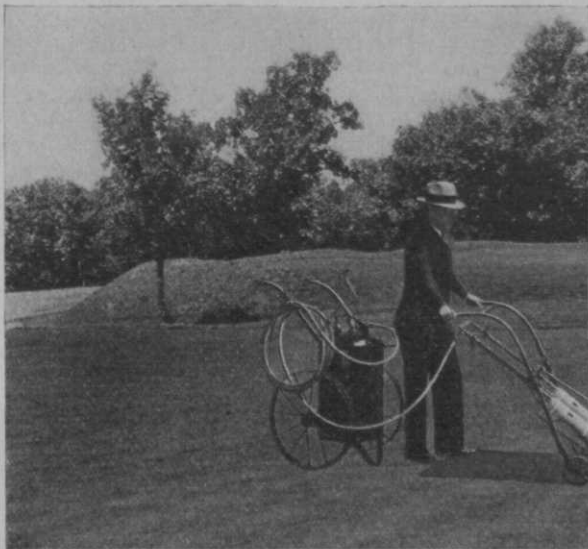
Since organic matter contains most of the reserve supply of soil nitrogen, we may conclude that the soil below 8 inches is much less abundantly supplied with both nitrogen and phosphorus and therefore is less suitable for root occupation than the upper soil. The failure of turf cut at fairway length to penetrate deeper than the upper 8 inches may be attributed in part to this condition.

On the turf cut at  $\frac{1}{4}$ -inch, the root abundance falls away sharply below the fifth inch, whereas the nutrient supply in the soil is nearly at its best at this depth. In this case, the failure of the roots to penetrate more deeply must be sought in the treatment given the grass, such as the height and frequency of cutting, the kind, amount, and time of application of nitrogenous fertilizers, the supply of moisture, etc. Considerably more nitrogen was supplied to the putting turf than to the fairway grass, and this may have sufficiently modified the balance between the carbohydrate food reserves and nitrogen to limit the development of the root system. At any rate it is clear that mowing at  $\frac{1}{4}$ -inch greatly reduces root penetration even with Rhode Island bent which is well adapted to close clipping.

### Seaside Bent

With Seaside bent, much the same relation exists between root development and soil conditions as was noted for Rhode Island bent, thus proving that the results obtained were not due to chance. Failure of roots on turf of fairway length to penetrate lower horizons more abundantly may be attributed in part to the lower fertility of such zones. However, the structure of the lower soil layers, and the ease with which air and water move through them may also be important factors, although no proof on these points is yet available. On the  $\frac{1}{4}$ -inch turf, however, the limitation in root development must be sought in some other factor than

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those measured, probably in the system of management being followed.

### Kentucky Bluegrass

The evidence that reduced fertility of the lower horizons restricts root development is again found on Kentucky bluegrass plots, both when cut at fairway length and when uncut. Even with this grass the evidence is not strong enough to warrant the conclusion that all of the important factors controlling root development have been included. Soil aeration must still be considered, even though these are well drained soils with fairly good structure.

In conclusion, it may be said that the studies here reported do not pretend to solve completely the important problem of root behavior. However, they do serve to emphasize the importance of roots in growing turf, and show certain of the relations existing between root occupation and soil conditions. It is hoped that further investigation will indicate treatments that may be adopted to improve root development, both for soils before grass is planted, and on turf that is established. An additional extremely important point to consider is the range of soil conditions that will facilitate the development of root hairs on roots that are present, and the absorption of water and nutrients.

## LOOK BEFORE LEAPING

### Test Other Fellow's Idea Before Adopting It

By JOHN QUAILL

Supt., Highland C. C., Pittsburgh

**A**T THE MEETING of the greenkeepers of Podunk County the other day, Joe Grumpus of the Spongy Fairway C. C. told the boys that Greely's Great Grass Grower for Golf Greens was the best fertilizer on the market and that he had had excellent results on his course. Well, Joe's course is built on an old farm in the valley that was worked by a thrifty old Dutch farmer who believed that when you took something out of the ground you had to return something. Consequently, when they built the course, they had an ideal soil. What grass they grew! Most any kind of fertilizer would show results and even an application of sawdust would have pepped up the grass.

All the boys knew that Joe's place

looked darned good and took his word for it that his fertilizer was the berries, and every one was hurt in the rush to place their orders for the famous fertilizer for fastidious fairways.

Results: Bill Binks got results in the low spots where the soil was pretty good. Jimmy Jones said he could see no improvement in his grass. Benny Brown got a good crop of weeds and the others preferred not to talk about it.

Moral: Try it on the dog first. In other words, they should have tried a couple of hundred pounds before they tried a couple of carloads. What is sauce for the goose may not be sauce for the gander. If they got results from the couple of hundred pounds, then it was time enough to order the carload. The poor greenkeepers thought they were doing the right thing, but they jumped at conclusions too soon. Try out new products on a small scale first and if they produce, you have found something.

Some courses have been fertilized spring and fall for many years. Others have seen fertilizer only the time they were seeded and then very sparingly. The course that had lots of fertilizer was living off past feeding in lots of cases. Most anything would show some signs of fertilization. On the starved course, the grass was so hungry that 400 pounds per acre just gave each grass plant a taste and whetted the appetite all the more.

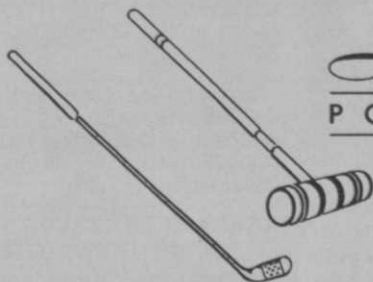
### Does It Fit You?

All these points must be taken into consideration when you adopt the other fellow's idea. Will it pay you to do the same and use the same as he does. Think it over before you jump.

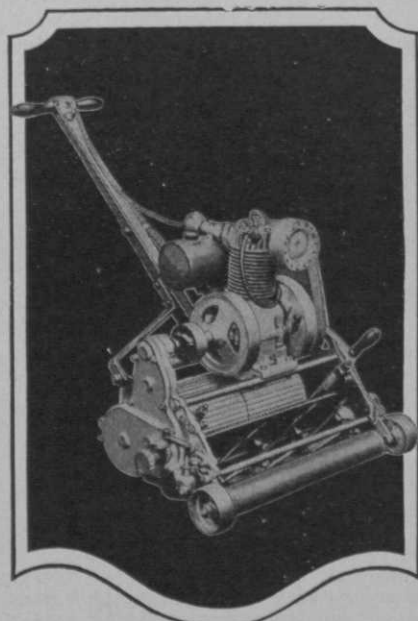
The same goes for the other fellow's methods and practices. The tractor and mowers he is using may give him wonderful results but would not give you the same. The one you are using may work fine for your purposes but would be a big flop on his course. Bent greens may be what his members want but your members would not care for them. He might like his power mowers for his greens but if you were to use them you might be dissatisfied. Its up to you to figure out your best methods and equipment and practices. You are the one who is responsible for your course and if there is trouble you are the one to blame.

Very recently, I heard a noted greenkeeper who has had some good jobs in this

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country tell that the way to compact soil on a newly constructed putting green was to use the old fashioned method of treading: Line up eight or ten men in a row and start them treading the soil to compact it and give it the desired degree of texture that is wanted. This practice went out of date with bustles. How much easier it is to run a roller over it a few times to get the same results.

Violent forking is another old fashioned method of loosening up a hide-bound green. I once saw a green being forked; after the forking process was over, the green could not have been used for anything but a pasture, it was so rough. To correct the roughness, they immediately rolled the green with a 600 pound roller and the green was back to where they started. Where is there any economy or results to be obtained by that method? A good spike roller to open up the surface and then a top-dressing of good sharp sand and compost with a lot of organic matter in it would have been lots better.

And after all, it takes a good freeze to really loosen up a hide bound turf. In the springtime, don't use too heavy a roller. Several light rollings are better than a heavy one. Introduce a good quantity of sand and heavy organic compost into the turf and that will do more than all the rolling and forking you can give a green.

Heavy watering will compact the soil as quick as anything. When the soil becomes water-logged and then dries out, it bakes as hard as concrete. Light watering and more often is the better method. Grass roots do not take up water in great quantities at any one time. They absorb it slowly. Nothing is gained by flooding a green, expecting the grass plants to assimilate all the water. They take it only as they need it and want it. And again you destroy the natural rise and fall of the natural moisture in the ground known as the capillary action. Heavy watering is often demanded by the players who think a ball should hold the green even if it is a topped shot.

Maybe a national champion did criticize your greens but after all, **WILL THE OTHER FELLOW'S IDEA PAY YOU IF YOU ADOPT IT?**

Chicago, Ill.—Armour Fertilizer Works has new booklet "Turf Maintenance" giving details of a turf program employing Armour's Special Turf fertilizer. Booklet is free on request.

## Iowa's Greens Short Course at Ames, March 7

IOWA STATE college, at Ames, will have its first greenkeeping short course on March 7, 1932. An attendance of about 60 greenkeepers is expected. Details of the program may be obtained from C. G. Yarn, owner of the Woodside G. & C. C., Route 4, Des Moines, Ia.

Long Island City, N. Y.—Schavolite Golf Corp. has appointed T. A. Rector of International Pharmaceutical Co., Wichita, Kan., representative for Kansas and northern Oklahoma.

## RESEARCH RESULTS IN NEW SOIL STERILIZATION METHOD

Morristown, N. J.—Suresults Products Co. has conducted exhaustive research work on soil sterilization chiefly for the benefit of golf and country clubs. Every greenkeeper knows of the importance of eliminating weed seed, fungus and insect pests from top-soil or compost before applying it to the green, but were without economical or efficient method of sterilization. The Suresults company has developed a method enabling golf clubs to not only sterilize their top-dressing, but kill all wild and undesirable growths on their fairways by sterilizing without any digging or cultivating. More can be accomplished by this method in 3 minutes' time than can possibly be accomplished in several seasons by any other method, the Suresults organization claims.

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Plymouth, O.—New model D Peerless mower sharpener, made by Fate-Root-Heath Co., grinds all makes and types of power-driven, fairway, putting green and hand mowers without removing mower wheels or reel knives. It grinds the blades with speed and accuracy, with the proper clearance behind the cutting edge, makes the mower run easily and lengthens the life of the mower, state its makers.

The bed or frame is a one-piece box section heavy casting, mounted on three heavy cast iron legs and two steel supporting posts.

The carriage has a travel of 42-in. and, rolling on steel balls, requires only a slight pressure for feeding the work along the grinding wheel, eliminating all feed mechanism.

The grinding head carries a 6-in. grinding wheel driven by a ¼ h.p. motor, a smooth, quiet and compact drive.

A reconditioner attachment can be furnished, at an additional price, for "lapping in" mowers with emery paste.



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# NATURAL VISTAS

## Eye Appeal Captivates Members and Brings Guest Fees

By T. L. LOMBARD

Green-Chmn., Berkshire Hills C. C.

**T**HE AXIOM "first impressions are lasting" holds particularly true when you cater to the tourist golfer. If he carries away a mental picture of an attractively designed and well maintained course, you have created incalculable goodwill.

A club member may place little importance on this favorable impression, created primarily by reaction at the first tee of any course, but if an organization relies on guest-fees to carry the budget, see to it your course has "Nature" appeal.

The approach over the highway leading to entrance drive is the prologue, while the spacious lawn and clubhouse site are the interlude, using the analogy of musical terms. The theme is the pleasant and peaceful surroundings to be viewed from starting tee. Quite often one's game is unconsciously tuned up by such harmonious surroundings.

If your architect has a sound grounding in his art with the attendant character visible in his completed design, he will favor a player getting away at No. 1 tee without mental or physical hazards. This is accomplished in a broad avenue of approach to the green and construction of green itself. This first green should be attractive as to area, color and playing condition. Make no mistake here!

Your architect can visualize the completed picture, the construction superintendent and greenkeeper put the oils on the canvas but Nature furnishes the lights and shadows as the finishing features. The frame, surrounding the canvas, consists of trees, clouds and distant vista. Consequently, it should be a constantly changing panorama heightened by light or shadows or altered cloud formations.

### Follow Nature's Specifications

If you plan and construct a home, business block or ice-house, have all the geometrical angles you crave. In constructing a golf course use Nature as your master model and work to her specifica-

tions. Remember Nature has no straight lines. Every product of her handiwork has curves or long pulled out lines, or sweeping topography. Formal gardens, gorgeous flower beds and sun-dials can come later. Give first and prime consideration to mellowed lines, inviting contours and irregular outlines for putting areas.

It is advisable to go so far as to consider maintaining long sweeping curves in mowing the outer edges of your fairways. Have your operator guide his cutting units in graceful curved lines along the fairway border rather than hold to a straight edge line. The result is pleasing to the eye, dresses up the course and blends into the whole scheme of refinements. It is but a part of the wearing apparel of the course, yet withal it adds luster to the whole physical design.

With the operation of the hand mowing of the greens concern yourself that your greensman does not leave any sharp angles where he stops his machine on apron of putting green. Even encourage the close cropping to run out into the approach area to the green. If the greens are constructed to present-day specifications, no greensmower can get away with sloppy work which is tantamount to straight lines or sharp corners on putting surface.

Apply the same theory on location and construction of tees. If you follow the old Victorian design of geometrically true rectangular tees, steep banks appear. These inclines are costly to mow by hand labor, unsightly if not trimmed weekly, are a liability when constructed with steep sides and very ugly in general appearance. The modern school of architects insists on picking a natural location which can be mowed by fairway cutting units at lower maintenance. It is still another case of keeping away from straight lines and solid architecture.

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