How and Why of Water's Effect on Golf Course Grasses

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WATER is one of the most important substances connected with life in this world of ours. The plant uses water in some form at every stage in its life period. Germination cannot proceed without moisture, and the first organs produced by the growing plant are roots for the absorption of water. Water makes up 50 to 90 per cent of the growing grass plant on fairways, tees, and greens. Even such parts of the plant as cell walls, vessels for translocation of food materials, fibers, and tissues for mechanical support, etc., are produced in the plant by combining water with other substances, from 35 to 55 pounds of water being required for every 100 pounds of such tissues formed.

The material which plants use as food, principally the starches and sugars, require 55 to 60 pounds of water for every 100 pounds of food manufactured. The plant's food is actually made in the leaves of the plant, but this process can only take place when cells and cell walls are kept moist with water. Nitrogen and minerals which the plant must obtain from the soil, and which we frequently add in the form of fertilizer, can only enter the roots when dissolved in water. These minerals are transported to various parts of the plant in a stream of water which extends from the roots, through the stems, to the very surface of the leaves. The food manufactured in the leaves is carried throughout the plant wherever it is needed, but only as it is dissolved in water. The combination of sugars, starches and other substances with the nitrogen and minerals to form protoplasm and cell walls for new cells, in roots, leaves and stems, can take place only with an abundant supply of water.

When the plant finally dies, it is decomposed by bacteria and molds which also require moisture for their activities. In nature, the decaying plant is broken down to its elemental components, which are water, carbon dioxide gas, and minerals. At an intermediate stage in this decay humus is produced, and when added to the soil this substance greatly modifies its water-holding capacity.

Seasonal Supply of Water

Since water plays such a vital part in the life of plants, it is extremely necessary that we consider the problem of providing enough moisture for normal growth. We have two principal sources of water on golf courses; one is natural rainfall, and the second is irrigation by some one of several systems. The goal that greenkeepers and others interested in turf management should keep in mind is that natural rainfall must be supplemented by irrigation, *only* to the extent necessary for moderate growth, and never in excess. The critical season of moisture deficiency in the northeastern states usually comes in June, July, and August, because of the

Table 1. Comparison of Rainfall and Evaporation from Free-Water Surface Averages, 1924-28, Inclusive

Station		Apr.	May	June	July	Aug.	Sept.	Oct.
Columbus, Ohio	Rain.	3.07	3.52	4.27	4.74	2.49	2.99	2.33
	Evap.	3.23	4.37	5.14	5.53	4.70	3.42	1.95
Ithaca, N. Y.	Rain.	3.09	2.82	3.46	3.86	2.92	3.51	3.18
	Evap.	3.24	3.41	4.66	4.92	3.80	2.53	1.46
New Brunswick, N. J.	Rain.	3.53	3.35	3.58	5.47	6.55	4.47	4.63
	Evap.	3.84	4.89	5.39	5.48	4.52	3.64	2.72
Chapel Hill, N. C.	Rain.	3.99	2.70	5.10	5.44	6.22	7.38	2.55
	Evap.	4.12	5.05	5.56	5.83	5.16	4.19	2.79
Wichita, Kas.	Rain.	4.29	2.66	5.35	3.01	2.84	3.22	2.97
	Evap.	6.22	7.56	9.26	9.42	8.85	6.67	4.25

Table 2. Conditions for Germination of Grass Seeds

Kind of Grass	Optimum Temperature Degrees F.	Length of Period at Optimum Temperature: Majority Seed	All Seed
Kentucky bluegrass	70-85	14 days	28 days
Canada bluegrass	70-85	14 days	28 days
Redtop	70-85	5 days	10 days
Bent grass	70-85	10 days	21 days
Red fescue	70-85	10 days	21 days
Fine-leafed fescue	70-85	10 days	21 days
Meadow fescue	70-85	5 days	10 days
Rye grass	70-85	6 days	10 days
Bermuda grass	70-95	10 days	21 days
Carpet grass	70-95	10 days	21 days

Germination period is considerably extended when temperatures fall below those indicated.

(*From U. S. D. A. Department Circular* 406, "*Rules for Seed Testing,*" 1927.)

relatively low efficiency of the moisture which is applied in this period. The rate at which water is lost to the air by evaporation largely determines the efficiency of rainfall. Comparative figures for rainfall and evaporation for the 5-year period from 1924-1928, inclusive, are given in *Table* 1 for 5 locations in the eastern United States. Whenever evaporation is greater than rainfall, artificial watering is required on greens. If evaporation is 1½ to 3 times as great as rainfall, watering of closely cut fairways will be necessary also, particularly if the soil has a low water-holding capacity.

Germination Period

The most critical times in the life of any plant are the period of germination, and the stage of growth just following when the young plant is becoming established. Water must be provided before the process of germination can even begin. A continuous supply must be maintained after the young shoot emerges or death will result. Grass seed is planted very shallow because of its small size, and the difficulty of maintaining the moisture content is therefore great. A few hours of very drying weather may remove enough water from the surface soil to kill a stand of seedlings which has taken weeks to establish.

Some grasses require a longer period for germination than others, and the moisture content of the surface layers of soil must be maintained until the plant has developed a good sized root system. The germination period for 10 of our turf grasses is given in *Table* 2. It is evident that the grasses which are most useful for turf on golf courses require 2 to 4 weeks for germination, with temperature of 70 F. or above. When the temperature is lower than 70, more time is required. The period of establishment follows germination, and moisture is even more necessary for this phase than for germination. Sprouting seeds may be dried for short periods without great harm, but after the first leaf is put out, even a severe wilting may prove fatal.

The common practice among successful greenkeepers is to seed at the season of the year when the least difficulty is experienced in keeping the surface soil moist. It is apparent from *Table* 1 that late summer and early fall are the most favorable periods in many regions. The principal concern with such seeding dates should be to allow at least 2 months of growing weather before the temperature of the soil approaches the freezing point. One month of this period is required for germination, and a second month for establishment of the young plants. If grass seed is planted through necessity at other seasons of the year, constant care will be required to insure the maintenance of a satisfactory moisture content. Water must be applied daily and perhaps oftener during dry periods, and in such a manner that a crust is not formed at the surface. New grass may be started at any time during the growing season, if attention is given to the watering; but the most satisfactory period is one in which evaporation is no greater than rainfall.

Soil Moisture

During the germination stage, water is absorbed through the walls of the seed. As soon as growth begins, a root system is developed, and practically all of the moisture required by the plant is taken in by the root system from that time on. Since the plant draws its water from the soil, it becomes necessary to consider the forms in which water is present and the use which the plant makes of each.

For convenience we divide the moisture which may be present in the soil into 3 parts, in the manner shown by *Chart* 1. One part is so closely held by the soil particles that the plant can make no use of it; this is termed unavailable water. The second form of water is that held in the soil by capillary attraction, and most of this is available to plants. The third form

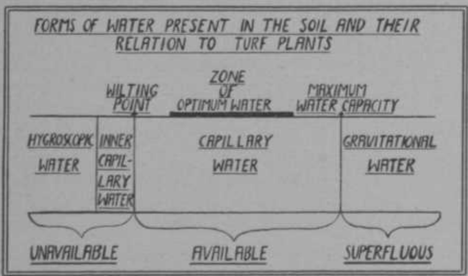

Chart 1. Forms of water in soil

of water is that present immediately after a heavy rain or watering. This water will drain off in a short time, and the plant makes little use of it. Such superfluous water is undesirable because it occupies pore spaces in the soil which should be filled with air. The maximum water-holding capacity is the amount of water which a soil contains after the superfluous water has drained off.

We may compare the water relations of various soils by calculating their capacity for holding moisture in an available form. For example, a certain sandy soil may have a maximum water capacity of 17 lbs. per 100 lbs. of soil. However, in this soil about 4.5 lbs. of water will be unavailable, leaving a potential supply of 12.5 lbs. for use by the plant. For a loamy soil, the supply of available water will probably be 25 to 30 lbs. for each 100 lbs. of soil, more than double that of a light sandy soil.

Fortunately for man, the water content of soil may vary considerably and still permit plants to grow normally. As shown in *Chart* 1, the optimum moisture content lies between the point of maximum capacity and the point at which no more moisture is available. We term this the optimum moisture content because the plant is able to absorb sufficient moisture to prevent wilting, and there is enough air left in the pore spaces of the soil for healthy root growth and activity. At the optimum moisture content, the desirable bacteria and molds are also most active and nutrients are released from the soil particles and organic matter for use by the plant as a result of their activity. Only a portion of the minerals needed for plant growth are supplied in the form of chemical fertilizers. The rest of the plant nutrients are derived from the mineral portion of the soil and the organic matter, as a result of bacterial action.

Source and Supply of Moisture

How shall the optimum moisture content be maintained? Before considering this question we must examine the fate of water added as rain or by irrigation. *Chart No.* 2 shows that the moisture added to the soil may (1) run off the surface without entering the soil, (2) percolate through and be lost as drainage water, (3) be absorbed by the soil and lost by evaporation from the surface of the soil or through cracks which develop, and (4) be absorbed by the soil and used by the plant. Obviously, if the moisture supply is deficient, we wish to avoid the first three types of losses and retain as much as possible for the plant. Steep slopes and hard surfaces increase run-off, whereas gentle topography and porous soils reduce it. Percolation may be reduced by increasing the water holding capacity of the soil, but on many courses there are greens, portions of fairways, and tees, where there is too little percolation for healthy growth. Evaporation may be partially controlled by improving soil structure to avoid cracks in the soil, and by topdressing with soils having a desirable texture and organic matter content. From 2 to 3 times as much water is evaporated from sandy soils as from loams, and clayey soils which bake and crack also lose moisture faster than

Table 3. Available Water Held by Soils for Plant Use Gals. per 1,000 Sq. Ft.*

Kind of Soil	Depth of Soil in Inches				
	1	2	3	4	5
Sandy soil	99 gals.	198 gals.	297 gals.	396 gals.	495 gals.
Av. silt loam	140 gals.	280 gals.	420 gals.	560 gals.	700 gals.
Rich silt loam	208 gals.	416 gals.	624 gals.	832 gals.	1,040 gals.

**One inch water on* 1,000 *square feet* = 623 *gallons.*

(For field conditions. Calculated from data given by Lyon & Buckman, "The Nature and Properties of Soils.")

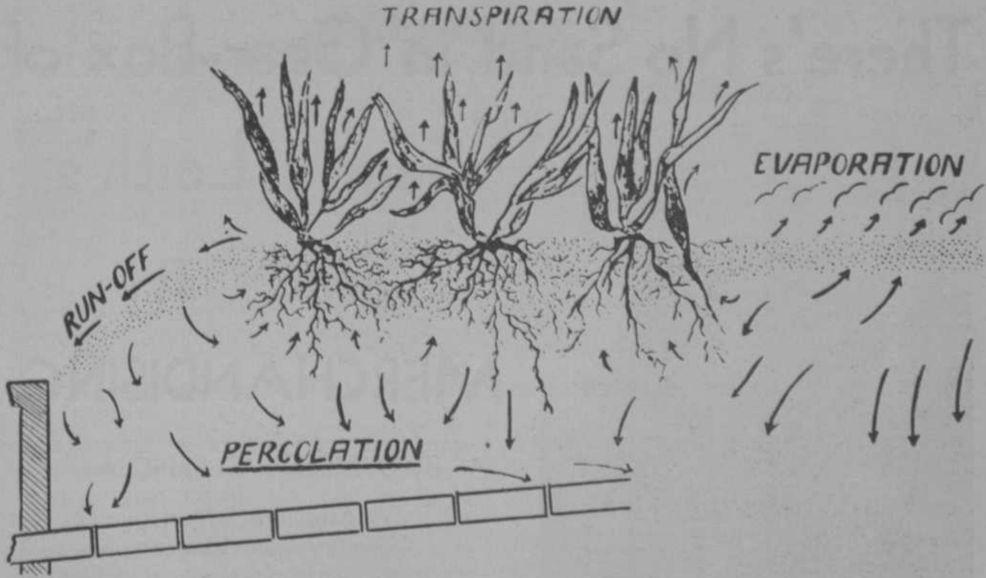

Chart 2. What happens to rain or irrigation water.

loams. However, evaporation is largely controlled by weather conditions and we have not yet found suitable methods of reducing evaporation losses in hot dry periods.

The quantity of water retained by the soil for use by the plant depends on soil texture, structure, and organic matter content. *Table* 3 shows the available moisture capacities of 3 soil types. The rich silt loam is able to hold more than twice as much water in an available form, as the sandy soil. An important point in this connection, however, is the amount which the plant may draw on. Obviously if the root system is restricted to the upper inch of soil because of unfavorable soil conditions, or wrong methods of treatment, the plant may use only the moisture present in that inch layer. If the root system penetrates 2 inches, the potential supply is doubled, and for 4 inches it is 4 times as great. It is evident that much can be done in the way of increasing the moisture supply for all types of turf, merely by making conditions suitable for vigorous development of the root system.

This authoritative account of the part water plays in grass growth will be concluded in April GOLFDOM.

GEORGE O'NEIL NEW SPORTS HEAD AT FRENCH LICK

GEORGE O'NEIL, veteran pro and golf architect, has been appointed sports director at French Lick Springs Hotel, the famous relax and laxative spot in southern Indiana. Art Lockwood, for many years in that job, goes to Indianapolis to take charge of the municipality's golf activities.

George has been the mentor of many of our fine pros of the younger school and has been responsible for a number of fine architectural jobs. He was pro at Beverly, Midlothian and Lake Shore in the Chicago district. At the latter club he was reported in the newspapers as having received a $10,000 fee for cutting five strokes off the game of one of the members; from this reputed fee there was a terrific discount for cash.

Two of the big shot professionals are slated to go to French Lick as playing and instructing pros with George. We understand George is revising the layout of the French Lick valley course to bring the full shot holes nearer to the most popular facilities of the establishment.

SHORT hole tees receive much harder wear than tees from which wood-club shots are played, since an iron shot takes the larger divot. Therefore, build generous tees for your 3-par holes; the turf will be difficult to maintain unless the teeplates can be shifted to a different spot almost daily.