A University of California Expert Discusses Principles of Irrigation in First of Two Articles

Water Management

By ROBERT M. HAGEN

VERY often irrigation isn't determined on the basis of characteristics of the soil and climate in the area or the actual needs of the grass for water. Instead they are usually dictated by custom or convenience. As a result one sees many examples of poor water management and the accompanying turf troubles. Unfortunately I cannot give you any specific irrigation schedules which will provide you with an easy answer to your irrigation problem, but I will try to summarize some irrigation information which should allow you to develop a sensible water management for your course.

There has been comparatively little research on turfgrass irrigation. As a result much remains to be learned before one can be entirely certain what constitutes the most sensible water management practices. However, I believe research has gone far enough to allow us to point out some general irrigation principles which should be the basis of a sensible water management program.

When one thinks of management, he often thinks first of money. Accordingly let's begin by considering what golf courses are spending for irrigation.

(Fig. 1)

Los Angeles Area Costs

Average budget for 18-hole course $70,000

Water costs (10%)	$ 7,000
Irrigation labor (25%)	17,500
Total Irrigation Cost	$24,500

Hagen's paper was presented at GCSA convention in Long Beach, Calif. in February.

According to the Los Angeles County Turfgrass Survey, $70,000 represents the average operations budget for an 18-hole golf course in the Los Angeles vicinity. Ten per cent, or $7,000, goes directly into the water bill. On the average twenty-five percent of the total budget, or $17,500, goes for irrigation labor making a total charge against irrigation of $24,500. Thus when we are talking about sensible water management we are talking about dollars and cents management as well. Here is another example that irrigation costs real money. In the Pacific Northwest, where it rains frequently all spring with considerable rain during the summer season too, a golf course is reported to be spending $11,973 for irrigation, or one-third of its total budget. Irrigation can cost a lot of money, and it is mighty important to study our irrigation practice carefully as we analyze our operations.

Water management practices affect our operations in many ways. In the next figure, we see some of the ways we can benefit from good water management.

(Fig. 2)

Some Possible Benefits from Good Water Management

- Save Money
- Save Water
- Save Labor
- Better Fertility
- Less Disease
- Less Weeds
- Less Soil Compaction
- Better Grass
- Better Playing Conditions

In addition to saving water and labor, one can improve fertility conditions by avoiding the leaching out of nutrients and continuously soggy soils. Certainly soggy greens and sometimes fairways are made-to-order for disease and weed problems. By well selected irrigation practices we can probably lessen the soil compaction problems with all the evils it brings on. And then – and this is the goal for us all, we should have better grass and generally better playing conditions. Certainly with such a long list of possible benefits from better water management it seems to me that each of us ought to look very carefully at the possibilities of better or more sensible water management.

Sensible water management depends upon answering three questions well. These are: First, "When to irrigate?" This simple but not easy question must be faced by your irrigator every day or every several days. Second, "How much water to apply?" Third, "How to apply that water to get proper coverage?"

As a starter, let me give you some short answers to these questions and then elaborate in more detail later.

"When?" When the grass really needs water.

"How much?" In low rainfall areas apply enough water to replace that water which has been used by the grass since the previous irrigation or, as often said, try to "connect" the moistures. Avoid leaving a dry layer down below. If this layer remains dry, it will cause shallow roots. For humid areas, it is more difficult to make sound irrigation recommendations, for any irrigation may be followed by a terrific downpour of rain which can cause trouble if the soil has been irrigated deeply. In general, though, one should also avoid allowing the subsoil to remain dry for appreciable lengths of time.

"How to apply?" Use good equipment and well-engineered layouts. Without good equipment and proper layouts it is almost impossible to do a good job of water management. Those of you who have the misfortune to have poor equipment and/or poor layouts have built-in trouble. A poor irrigation system is particularly serious in arid regions where you must depend almost entirely on irrigation.

You may be thinking I didn't give you any very definite answers to these three very important questions: When, how much, and how to apply? No simple answers can be given. All depends upon your own situation. Only if you understand the basic irrigation principles, and apply them to your situation, can you arrive at sound answers to these irrigation questions. Don't try to apply to your own course some specific schedules and sprinkler running times you read about somewhere. Chances are great that they don't fit your conditions.

Let's now consider the question of when or how often to irrigate.

(Fig. 3)

$$\textbf{Irrigation Interval} = \frac{\textbf{Supply in Root Zone}}{\textbf{Rate of Use}}$$

The irrigation interval depends upon the supply of water within the root zone of the grass divided by the rate of water used. If we keep this very simple relationship before us I think we can help ourselves to more sensible water management quite easily.

Now a brief review of some simple ideas about soil moisture.

(Fig. 4—Bottom of Page)

This barrel with a top and small drain helps illustrate some important soil moisture conditions. If water is added quickly to the barrel or to soil, all the air space is filled and we say the soil is saturated. As you know, a saturated soil is a very unhealthy environment for grass roots.

Like this barrel with a drain, a normal well drained soil soon loses some water until a new level is reached when drainage essentially ceases. A soil in which drainage has become very slow is said to be at field capacity. Grass growing on that soil will extract water until it becomes too slowly available to keep up with water lost from the leaves. The moisture con-

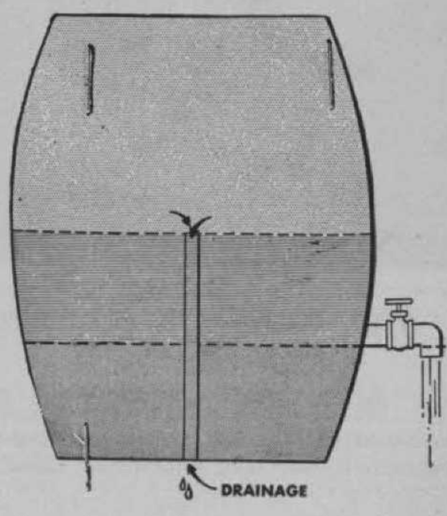
Saturation

All Soil Pores are Filled with Water

Field Capacity

Wilting Point

Soil Moisture Content at Which Plants Wilt



tent at which the grass wilts is called the willting point. The available water in soils is the difference between water left after drainage (field capacity) and the water left when plants cease to get it (the wilting point). Different soils hold different amounts of available water. Sandy soils hold approximately one half an inch of available water per foot depth of soil. Loams hold about an inch and a half of available water per foot, and clays hold an average of approximately two and a half inches of water per foot.

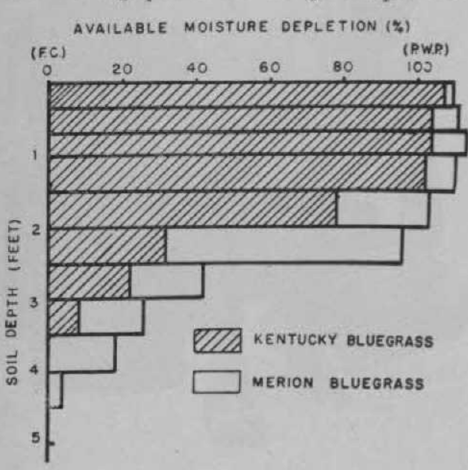
The next factor in determining the total amount of water within the root zone (and thus the irrigation interval) is the root system of the grass. In figure 5, we have a drawing of the root system of the grass.

(Fig. 5)

As illustrated here, grasses typically have absorbing roots near the surface, with their number diminishing gradually with depth. Because of the decreasing abundance of roots with depth, there is a corresponding decrease with depth in the amounts of water removed at the time the grass shows dryness.

(Fig. 6)

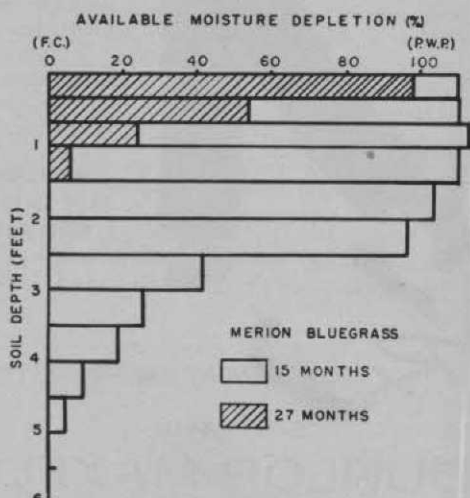
Near the surface (as indicated by the longer bars), all of the available water has been removed. Here the soil has reached the wilting point. As we go deeper less



and less of the available water has been removed when the grass shows dryness because there are fewer and fewer absorbing roots. Moisture extraction patterns for two varieties of blue-grass are shown. The cross-hatched bars represent the water absorbed by the Kentucky blue-grass when it shows wilting. The other bars show extraction by Merion bluegrass when it shows wilting. Differences in length of bars indicate that the Merion has more deep roots than Kentucky. Deeper roots mean that the irrigation interval can be longer. Fig. 7 shows Kentucky bluegrass was badly wilted with numerous browned areas after four weeks without rain or irrigation in California, while alongside the Merion was just beginning to show dryness and still had a good green color. The Merion bluegrass simply has more roots down deep and thus has greater drought tolerance than Kentucky under these conditions.

(Fig. 7)

The clear bars of Figure 7 represent the moisture extraction pattern for fifteen months old Kentucky bluegrass at wilting.



By the time this stand of bluegrass was twenty-seven months old, many of the deeper absorbing roots had disappeared as indicated by the shorter cross-hatched bars. Thus the twenty-seven months old bluegrass was able to extract less water before it wilted and thus was less drought tolerant than it was as a younger grass. Other grasses have shown similar losses of roots with time except for such grasses as K-31 fescue and the bermudas.

The rooting depth of grass is affected by many things.

(Fig. 8)

Species	Fertilization
Clipping	Disease
Soil	Climate
Irrigation	

Rooting depth is a function first of all of the grass itself. To some extent it is dependent upon clippings. While I recognize that the height of clippings is often governed by other considerations, I think we should be aware that clipping may be a factor affecting rooting depth of grass at least to a minor extent. The soil on which the grass is growing also has an important influence. Certainly another major factor is irrigation practice. Some grasses are forced to be shallow rooted despite a deep rooting potential because of the irrigation practices we follow. Either excessive irrigation or insufficient irrigation can contribute to shallow rooted grass. Fertilization probably has some effect on rooting depth of grasses as well. Disease and climate also have an effect. These are the factors, then, which influence the depth of rooting and thus the total moisture reserve that we have to draw on between irrigation intervals.

What are some of the rooting depths we have observed under the deep favorable soil conditions at Davis?

(Fig. 9)

Bents	10-12 inches
Bluegrass	24-36 inches
Bermuda	more than 48 inches

The rooting depths shown are those from which these grasses will take all of the available moisture from the soil before they show signs of wilting. Of course there are many roots that run down deeper than these figures indicate. These might be considered to be the effective rooting depths of these grasses.

Consider now the rate water is used by grass. I trust you will pardon a Californian speaking in California for using some California figures to illustrate the range in consumptive use one can find even over a small geographical distance.

(Fig. 10)

Regions in California	**Consumptive Water use (in.)**	
	Per Day	Per Week
Dry desert areas	.35	2.5
San Joaquin Valley	.30	2.1
Sacramento Valley	.25	1.8
Inland coastal areas	.20	1.5
Coastal slopes	.1 to .15	1.0

As shown here, use varies from nearly one third of an inch of water per day in the dry desert areas to about one-tenth inches per day along the coastal slopes where fog frequently comes in off the ocean. One must know the approximate use rate for your area and season of the year if the irrigation is to be predicted with any accuracy.

Now let's predict an irrigation schedule for a situation where the grass has an effective rooting depth of one foot on the loam soil in an area where the water use rate is .2 inch per day. The number of days between irrigations can be very easily worked out as follows:

$$\text{Days} = \frac{1.5}{.2} = 7\frac{1}{2}$$

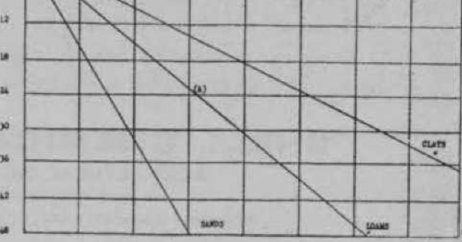
With an effective rooting depth of one foot on a loam soil (which holds one and a half inches per foot), the total supply of available water is one and a half inches. This divided by the rate of use (.2 per day) means that the grass should not wilt before about seven and one-half days. Although you may not want the grass to become quite so dry, this calculation will allow you to make estimates for planning.

Some of you have seen the following chart for it has been reproduced in several different places. This chart gives the approximate number of days between irrigations as a function of the soil depth containing roots which have been irrigated. The greater the depth which has been irrigated, the longer one can allow the grass to go between irrigations. This is simply a graphical representation of the simple calculation I showed you just previously.

(Fig. 11)

If you look carefully at the chart of Fig. 11, you will notice that some of the

Irrigation Interval as Influenced by Soil Texture and Depth of Root Zone where Water Use is 1-in. per week.



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Water Management

(*Continued from page* 48)

irrigation intervals predicted are very long ones running over thirty days, perhaps several months. Had this ever been demonstrated as being possible? Yes; where we have deep soils and deep-rooted grasses it can be done. Whether you want to do this or not depends upon a number of circumstances, but certainly if you are short on water one way of saving that water is to take advantage of these deep roots and let the grass run on the dry side. (A color slide was shown of U-3 bermuda grass which has been allowed to go for over 100 days on the deep soil at Davis where during the summer the temperatures approach 100 every day and the humidities are very low). This bermuda was still green although showing dryness and growth had become very slow. Why can bermuda go this long without irrigation at Davis? Because it has a deep root system and is growing on a clay soil which holds a lot of available moisture per foot.

Robert M. Hagen's article on Water Management will be concluded in July GOLFDOM.

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