REQUIREMENTS FOR QUALITY IRRIGATION 1

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ABSTRACT

Quality irrigation requires that irrigations be applied at the right time, at the right rate, in the right amount and uniformly. Uniform application and appropriate application rates are obtained through the proper selection of nozzle diameter, sprinkler spacing, and pressure.

INTRODUCTION

Budgets and competitive bidding, rather than quality performance, dominates the design of sprinkler systems today. But that small amount of money saved is dwarfed many times as losses pile up on losses year after year from the effects of less than adequate design.

Some words in our vocabulary tend to become useful primarily for their value as rhetoric for they have the ability to charm and influence. "Efficiency" is one of these; "quality" is another. Unless we give definition to these words, they can have all kinds of meanings, or none at all.

Let me tell you what I mean by quality irrigation. It is irrigation that occurs at the right time, it is applied in the right amount, it is applied at a rate so that the water penetrates into the soil rather than ponding on the surface or running off, and it is applied uniformly.

Recognition of the importance of uniform water distribution and procedures for obtaining it are two of the most prominent omissions in sprinkler system design and procurement, and this is the first subject I wish to talk about today.

UNIFORM WATER APPLICATION

Application Efficiency

We can achieve high application efficiency and at the same time do a totally unacceptable job of irrigation. Let me illustrate.

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[1]Paper presented at Joint Meeting, Intermountain Nurseryman's Association and Western Forest Nursery Council, Boise, Idaho, August 12, 13 $ 14, 1980.
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Application Efficiency = Average depth of water infiltrated and stored : Average depth of water applied.

In Figure 1 we observe an irrigation requirement of one inch of water (the amount required to bring the soil to field capacity in this case). We turn the system off before any area receives more than one inch of water so that all water infiltrating the soil is stored. From five to ten percent of the water leaving the sprinkler may be lost by evaporation. Since there are no runoff or percolation losses, the application efficiency may be 90 to 95% with 100% of the water reaching the soil being stored there. Some areas, however, will be greatly underirrigated.

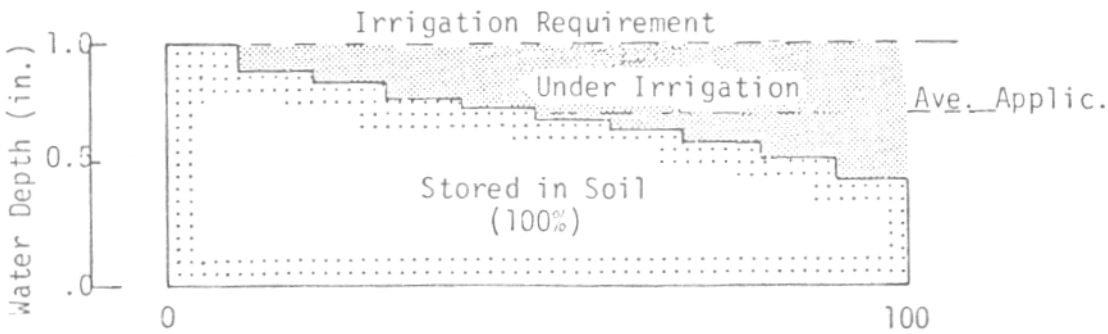

Figure l.--Example of titer distribution at 80o uniformity coefficient with severe under-irrigation.

The effect of extensive under-irrigation can be reduced by increasing the average amount applied and over-irrigating, as shown in Figure 2.

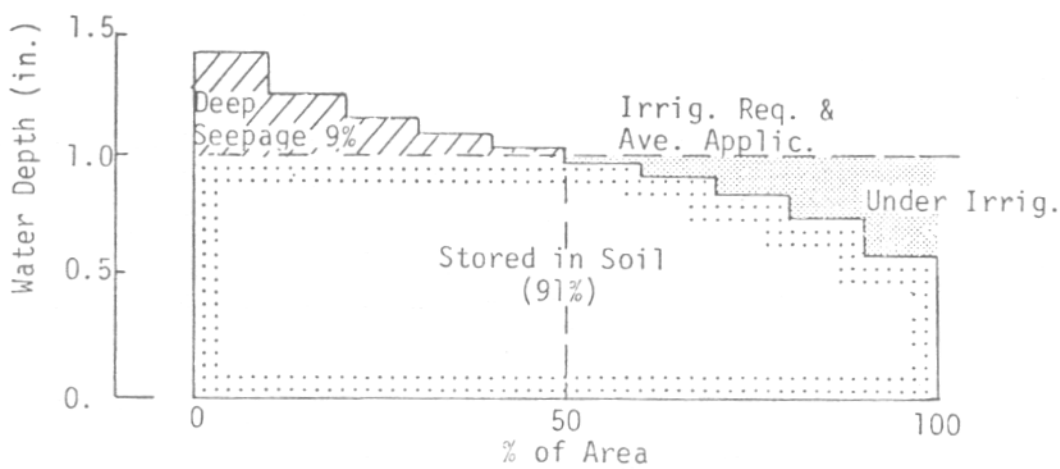

Figure 2.--Water distribution at 80% uniformity coefficient and 50% adequacy of irrigation.

Here we have the same uneveness in water distribution, but we have reduced the amount of under-irrigation 50% in some areas by over-irrigating an equal amount in other areas. Under conditions of good internal soil drainage this may not be too had, but chances are for young tender plants, 20% of the area in this situation could have damaged plants due to lack of adequate water.

Adequacy of Irrigation

Under-irrigation can be reduced even more by increasing the average amount applied, as shown in Figure 3. Notice what has happened to the seepage loss. It has increased from 9% to 21% of the water reaching and infiltrating the soil. We would say in this example that we had achieved an adequacy of irrigation of 75%, which means that 7S% of the area irrigated received the irrigation requirement or more, and 25% received the irrigation requirement or less.

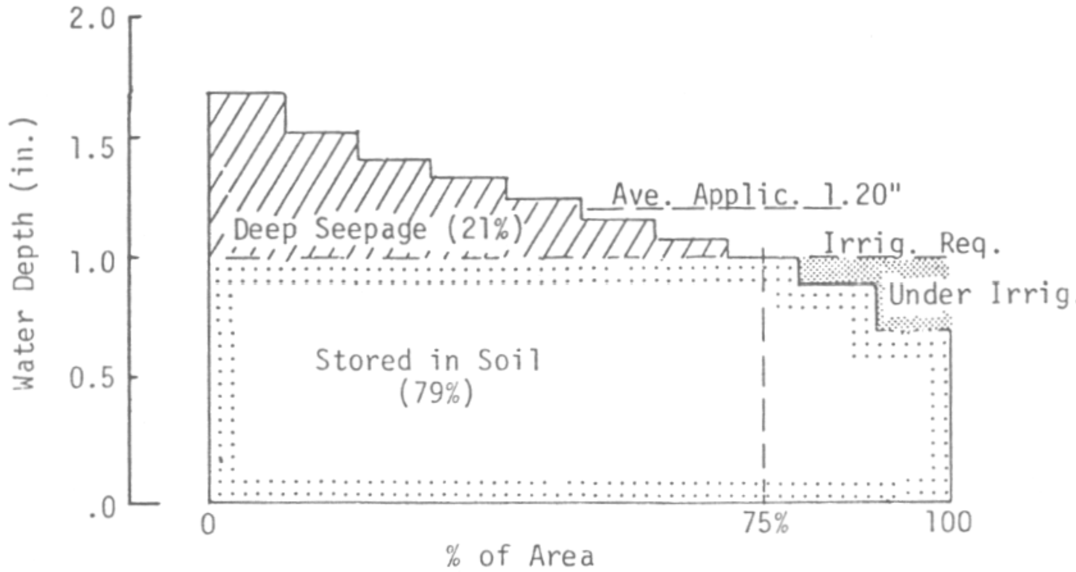

Figure 3.--Water distribution at 80% uniformity coefficient and 75% adequacy of irrigation.

Uniformity Coefficient

flow uniformly water is applied to soil is described by a statistically derived number called a uniformity coefficient. In Figure 4 you see distributions for three uniformity coefficient values. Departure of depths of water applied from average application gives an indication of the extent of over- or under-irrigation. The question that must be answered by the nurseryman is: How much is he willing to pay for uniform distribution?

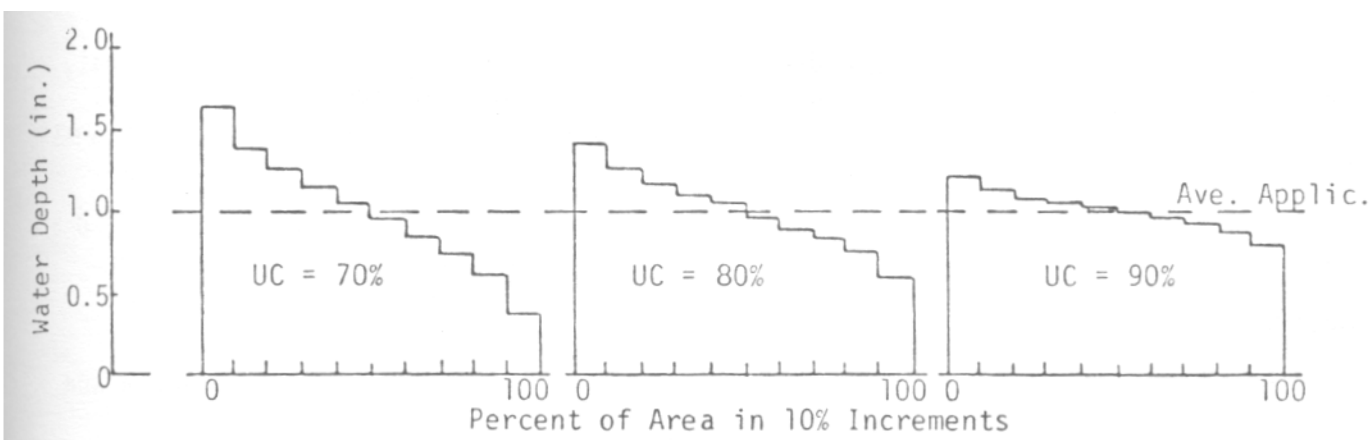

Figure 4.--Water distribution for three uniformity coefficient values.

I suggest that for high value crops having small root systems, such as nursery stock, the minimum acceptable value should be 850. For high value crops with extensive root systems, such as full-grown trees, possibly 70% uniformity coefficient is acceptable. Plants with smaller root systems require higher uniformity coefficients since the root systems are unable to extend from areas of low water applications to areas of abundant applications. The extent of over- or under-irrigation is controlled by the adequacy of irrigation as described earlier.

ACHIEVING UNIFORM WATER APPLICATION

Uniform water application is achieved by selecting the correct combination of nozzle size, sprinkler pressure, and sprinkler spacing for the wind conditions which exist during irrigation. A number of sprinkler manufacturers have the capability of testing sprinklers to determine the performance characteristics of their sprinklers. But, very little of this information is distributed for public consumption. I am sure that if in our purchases, we specified uniformity levels that must he achieved after system installation, we would see a marked improvement in the performance of solid set sprinkler systems being installed in the field today.

Sprinkler systems that distribute water evenly cost more money than systems that don't, because they require more sprinklers, more pipe and more fittings. A purchaser must be willing to pay for a quality performing system. No supplier can bid a quality performing system without a corresponding increase in price.

Solid set sprinkler systems as they are generally sold, usually do not apply water as uniformly as side move or hand move systems. In an effort to reduce costs, sprinklers are spaced too far apart. They may be able to apply water in a somewhat satisfactory manner in winds of 0-5 mph, but when winds increase beyond this point water distribution falls off very rapidly.

Studies to determine the relationships between sprinkler application profiles, sprinkler spacing and eveness of water distribution were conducted as early as the 1930's. More recently studies of techniques used to predict uniformity of distribution under various wind conditions from sprinkler profiles obtained under no-wind conditions have been made. Unfortunately, this information is not readily available for all sprinklers or from all sprinkler manufacturers.

SPRINKLER SPACING RECOMMIADAT IONS

A number of theoretical sprinkler profiles were studied by Christensen in 1942, and from these studies general conclusions were drawn which are still valid today. They don't take the place of specific data for specific sprinklers, but they are quite helpful when such information is not available - which is most of the time.

In general, his studies showed that when sprinklers are operated in winds of 0-5 mph and are spaced in a rectangular pattern, the maximum spacing in one direction should be 600 of the no-wind diameter and the sum of the two spacings 1050 of the diameter.

In winds from 5 to 10 mph, maximum spacing should he 50-550 of the diameter and the sum of the two spacings 85% of the diameter.

There is usually no real advantage in using triangular spacings unless extended spacings are used. Extended spacings are 65% or more of the no-wind diameters. Such spacings prove disastrous though if even slight winds develop. The results of these extended spacings arc apparent in many nurseries.

Continuously moving laterals provide the best uniformity because sprinklers are infinitely close in the direction of the lateral move and can be spaced quite closely along the lateral. Unfortunately, these are not particularly adapted to nursery conditions because they lack the flexibility required under nursery irrigation programs. In addition, they cannot be used successfully for frost protection.

During the last few years there have been straightening veins added to impact sprinklers for the purpose or straightening the flow through the sprinkler and increasing the area covered by the sprinkler pattern. Unfortunately, another characteristic accompanied the increased diameter; a change in the sprinkler profile resulting in a deficit of water about one-third the way out from the sprinkler. In order to compensate for this, it has been necessary to increase pressure at the sprinkler by 5 to 15 pounds per square inch or to add a secondary small nozzle to fill in the area not covered by the range nozzle. There is nothing wrong with small nozzles except they plug easily when surface water is used.

RATE OF APPLICATION

A second factor affecting irrigation quality I wish to discuss briefly is rate of application.

In Oregon, Oregon State University has been involved in a cooperative program with the Soil Conservation Service to test intake rates of soil under sprinkler irrigation. We have used a portable water tank and a special designed sprinkler arrangement which allows us to apply a wide variety of rates over a small area. Through visual observation and catch measurements of replicated sites we have developed "best estimates" of soil intake rate for use in sprinkler system design. These values are available in Soil Conservation Service Irrigation Guides.

If on your nursery you notice water ponding on the surface, or running off plots, you are applying water too fast. Lower application rates are achieved with smaller sprinklers and appropriate closer spacing. It is not accomplished simply by extending spacings of existing sprinklers as such action will result in lowered distribution uniformity.

Proper scheduling of irrigations, both time and amount, is also essential for quality irrigation. However, time has not permitted me to discuss techniques of achieving appropriate scheduling today.

SUMMARY

Uniform distribution of water is essential for quality irrigation. It is achieved through appropriate selections of sprinklers, sprinkler pressure, and nozzle diameters. Such selection will provide appropriate application rates.

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