Irrigation by Sprinkler System

adaptable for definite crops and special purposes

C. N. Johnston

Sprinkling for irrigation on commercial plantings pays in certain cases:—on rolling ground where gravity water could not be spread economically or at all;—to bring up seed crops on otherwise flat land when sufficient soil moisture is lacking at upper levels;—for leaching in the few areas where sub-surface irrigation has caused alkaline top-soil conditions and where surface flooding operations are difficult or impossible for the creation of the desired leaching.

These places where sprinkling pays are sufficient to warrant a reasonably common sprinkling practice, but the list includes application to special conditions, and justification for its general use cannot be drawn unless it is profitable in all cases.

In the greater part of California—if crops shade the entire ground surface on which they grow—it is necessary to put on a depth of about two to 2½ feet of water on each acre in the growing season. The crops require this much water in order to grow and without it they will suffer and yields will be reduced.

Moisture Utilization

While vegetation disposes of most of this irrigation water in growth and by transpiration through the leaves, the roots are the medium through which the water is made available.

Some plants, like ladino clover, root to a depth of only about eight inches even though as much as 10 feet of rich soil may be available. Tomatoes on the other hand may root as deep as 18 feet toward the end of a growing season. Alfalfa and orchard crops root six or eight feet deep. All these crops completely shade the area they occupy and use about two to 2½ feet of water per growing season.

Storage

The soil is the storage basin from which all crops obtain irrigation water. Shallow-rooted crops such as ladino clover have much lower available water storage for the roots than, say, alfalfa. This means the ladino clover must be irrigated more frequently than the alfalfa if the available soil water is to be used by the respective crops.

A soil having about 12.5% available storage would be able to store 1.33 inches of water in the eight-inch depth used by ladino and as much as nine times that, or about 12 inches of water in eight feet of soil used by alfalfa. If the crop uses the water at the rate of about 0.2 inches per day, the ladino should be watered in 6.6 days—$1.33 \text{ days} \div .2 = 6.6$—and the alfalfa in 60 days—$12 \div .2 = 60$—which approximates typical practices. The alfalfa would get two 6-inch irrigations probably in the 60-day period.

Moisture Losses

Evaporation from the surface few inches of soil accounts for about 0.5 inch of water for each irrigation. This is water that escapes the plant roots and is lost so far as effective use is concerned. The sun extracts this water from the surface soil by evaporation and while the portions of the plants are wet from irrigation in day time, it causes losses by evaporation from the wetted plant surfaces. This loss is at a minimum at night.

To surface irrigate a piece of ground growing ladino and to apply only 1.33 inches evenly is a physical impossibility. In fact, it is difficult to spread a 2-inch irrigation evenly. As a result, there is loss by percolation below the roots of ladino with every surface irrigation.

Sprinkling

Sprinkling permits the exact application of the desired amount of water in such cases and the coverage is reasonably uniform.

To be equipped to sprinkle, an operator must possess a number of sprinklers of some sort and several hundred feet of pipe onto which the sprinklers and supply pump are attached.

The pump, or the source of supply must provide a pressure of at least 10 pounds per square inch at the inlet to the sprinkler pipe and may have supply pressures of from 40 to 60 pounds per square inch at that point.

Coverage

The need for this pressure lies in the sprinklers themselves. In order to throw the water to some distance from the sprinkler head, the discharge stream must have an initial velocity that is fairly high. The velocity provided is dependent on the amount of pressure at the nozzle of the sprinkler; the throw or the coverage per sprinkler depends on the velocity at the nozzle. It varies from 15 to 75 feet with the pressure varying from 10 to 60 pounds per square inch.

Larger jets of water carry farther than

Continued on page 14

FUMIGATION

Continued from page 7

The most satisfactory treatment is fumigation with 18 to 20 cc HCN.

Yellow Scale

The yellow scale occurs in the interior section of southern California and in the citrus areas of the San Joaquin and Sacramento valleys.

Fumigation with a dosage of 20 to 24 cc HCN in the summer months or 22 to 24 cc in the winter is recommended for yellow scale in the interior areas.

In central California fumigation is the preferred treatment for yellow scale using a 20 cc dosage.

Citricola Scale

The distribution of the citricola scale is restricted to Riverside and San Bernardino counties in southern California and in the San Joaquin Valley in central California and the Sacramento Valley in northern California.

Fumigation was relied upon for control of the citricola scale, but in recent years this insect has become so resistant to HCN fumigation that this method is no longer recommended in Riverside and San Bernardino counties.

Fumigation, particularly in conjunction with yellow scale control, is effective in central California except in some groves in the Ivanhoe and Exeter districts.

Whenever practicable it is desirable to control two or more pests by a single fumigation. If the nonresistant black scale occurs with the nonresistant red scale, fumigation will have a dual effect and control both.

A spray fumigation treatment should control the resistant red scale as well as the black and citricola scales and the red spider. Where purple scale is the major pest and black scale is present, a fumigation in August, using a 16 to 18 cc schedule on oranges and an 18 to 22 cc schedule on lemons will give good control of both these pests.

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SPRINKLERS

Continued from page 3

smaller ones due to their mass and the fact the air interferes with them less. Large streams of water imply heavier application rates. The limit to the useful rate is when it exceeds the ability of the soil to absorb it.

Sandy soils will percolate away application rates exceeding one inch per hour and clays may have difficulty with as little as 0.1 inch per hour.

Service Lines

It is economically impossible generally to supply sprinklers and lines to cover the whole irrigated area so the sprinklers and lines must be moved from one setting to another as rapidly as sufficient water has been applied in each location. This may mean walking over the recently wet field to uncouple the sprinkler lines so they can be moved to the next place. Some heavy soils will not permit this practice because operators cannot walk across for several hours after irrigation has ceased. In this case, additional service lines and sprinklers must be provided if more or less continuous irrigation is to be made possible.

Factors for Consideration

If irrigation of a piece of land has been by gravity flow and it is a question whether to use sprinklers, the decision must be founded on the overall net savings and losses resulting from such factors as: (a) water use, (b) crop return, (c) power costs, (d) labor costs, and (e) interest on the investment, depreciation, and other fixed charges.

Of these items, power costs and fixed charges may need a little clarification before a comparison is drawn. It costs about $3 to pump sufficient water to cover one acre one foot deep if the lift is 100 feet. A pressure of 43.29 pounds per square inch is equivalent to a lift of 100 feet, so it will cost an additional $3 per acre-foot to put water through sprinklers if the pump pressure is 43.29 pounds per square inch and proportionally more or less as the pressure is varied. Fixed charges—item (e)—are a justified charge against the initial cost of the sprinkler and distribution system in order to pay it off in, say, 10 years and to return interest on the investment. This charge might be conservatively, 16%.

The accompanying table summarizes the values involved in the preceding list of factors for sprinklers and surface irrigation on rolling and level land. Each operator should set up his own balance by use of the table before deciding which type of irrigation he should employ for greatest efficiency.

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Comparison of Sprinkler and Surface Irrigation Costs

Contour of land and type of irrigation	Economy in use of water	Crop return	Power costs	Labor costs for applying water	Fixed charges for irrigating facilities
ROLLING GROUND					
Sprinkler system	Possible net saving of water due to its exact application and even distribution. Added evaporation losses during sprinkling period, 10–25%.	May produce crop in spots where satisfactory crops may not be produced under other methods of irrigation.	$3.00 per acre-foot for 43.29 pounds per sq. in. or about 6.8c per pound pressure per acre-foot.	Moving sprinkler lines and possibly pump. Variable from $10.00 per acre-ft. to as much as $25.00.	Cost of sprinkling system from $30 to $150 per acre. 16% = $4.80 to $24 per acre.
Other types of irrigation, such as furrows or flooding.	Loss of water from deep percolation and surface runoff due to difficulty of applying exact amount required.	Yield may be reduced in portions of fields by too little or too much water.	0.00	Some cost involved.	Negligible.
LEVEL GROUND					
Sprinkler system	No deep percolation losses but evaporation losses may be high.	Benefits some special crops such as beans. Little significant difference in return for other crops.	$3.00 per acre-foot for 43.29 pounds per sq. in. or about 6.8c per pound pressure per acre-foot.	Moving sprinkler lines and possibly pump. Variable cost about same as for rolling ground.	Cost of sprinkling system from $30 to $150 per acre. 16% = $4.80 to $24 per acre.
Other types of irrigation, such as furrows or flooding.	No percolation losses, if efficiently applied.	Normal returns.	0.00	Some cost involved.	Negligible.