

## Portable Undertree Sprinkler Systems

**Arthur F. Pillsbury,**

*Assistant Irrigation Engineer*

*University of California, College of Agriculture, Los Angeles*

### A comparison with furrow systems

#### 1. Soil type

Furrows preferred: On uniform medium to heavy soils. Usually when runs of at least 6 to 12 hours required for adequate penetration.

Sprinklers preferred: On light to medium soils (pervious). On shallow or stratified soils where drainage is restricted. Where soil is spotted (light and heavy spots along runs).

#### 2. Distribution efficiency on medium to light soils: (with 100% meaning equal amounts of water available to each tree.)

Furrows: May run from 80% down to 50% distribution efficiency in extremely light soils.

Sprinklers: In well designed and operated systems, distribution efficiency should be at least 70% to 90%.

#### 3. Erosion: Sprinklers should cause less erosion than furrows.

#### 4. Land leveling: Sprinkler irrigation, in some instances, requires no leveling.

#### 5. Cover crops: Sprinklers favorable to permanent cover crops. Furrows are not.

Advantages of permanent cover:

- a. No cultivation costs
- b. Decreased erosion
- c. Increased infiltration rates
- d. More rapid spring drying of soils with restricted drainage
- e. Better regulation of nutrient availability with the greater amount of organic matter in light soils of little or no fixing power.

Disadvantages of permanent cover:

- a. Competition for water and nutrients
- b. Must be frequently mowed to keep down competition
- c. High cover crops may interfere with distribution of water

#### 6. Other cultural practices:

Fertilization: Sprinklers move fertilizer down into soil better than furrows do, but

may also move more nutrients below root zone if irrigation too heavy.

Traffic: Furrows may interfere with traffic. With furrows an entire orchard or block is irrigated at one time, while with sprinklers there is almost always some part of the orchard wet. This may complicate picking, spraying, fumigations, etc.

7. Evaporation: Somewhat higher with sprinklers; not because of evaporation of spray in the air, but because of greater ground surface and foliage wet.
8. Rate of delivery: Furrows are most efficient where a large flow of water is delivered to the entire block in a period of one or two days. Sprinklers are economical where a snail flow is available over a long period of time.
9. Unless water under sufficient pressure is delivered to a farm, sprinkling involves greater pumping costs.
10. Labor of irrigating: It is difficult to generalize on comparative labor costs, but more often than not, they are slightly higher for sprinklers than for furrows.
11. Investment: Cost of materials for sprinkling systems is comparable with cost of concrete pipe system for furrows completely installed. Grower should consider installing sprinkler system himself.

Sprinkler materials: (Exclusive of pumping equipment)

- a. Mains and laterals (buried)—usually \$30 to \$60 per acre.
- b. Portable units, sprinklers and connections are usually \$5 to \$40 per acre.
- c. Total \$50 to \$100 per acre.

12. Depreciation:

Furrows: Very low

Sprinklers: High—life usually ranges from 3 to 20 years.

### **Types of sprinkler lines:**

Conduit

- a. Hose (Expensive, considering depreciation)
- b. Light weight galvanized iron (often electrical conduit) Sturdy, wears well  
Corrodes with some waters
- c. Type M hard copper pipe: High permanent carrying capacity Does not corrode. Must be handled with reasonable care. Wear on bottom may be high cost comparable with b

Operating types

- a. Quick-coupling lines. 1 1/2" diameter and up. Each section quickly and easily uncoupled and carried to next location. Long units possible. Must walk on wet ground
- b. Drag lines: 3/4 to 1 1/4" diameter. Dragged from setting to setting. Couplings,

if any, do not work easily. Lines often sweated together into one continuous unit (disadvantage cannot carry in truck). Unnecessary to walk on wet ground. Length readily pulled by one man over wet ground varies from 40 to 120 feet depending on weight, obstructions such as couplings on the unit, and resistance offered by soil and cover crop. Units up to 300 feet length have been pulled by a horse Slightly less labor cost than a

### **Common types of sprinklers:**

1. Fixed heads:
  - a. Straight orifice with slanting baffle (like  $\frac{1}{2}$  circle lawn heads)
  - b. Full circle swirl (like full circle lawn heads)

#### Characteristics:

Fine spray—may decrease soil puddling

Requires high pressure—minimum about 20 lbs./sq. in. for size delivering 4 G.P.M. to 35 lbs./sq. in. for size delivering 2 G.P.M. Clog if foreign matter in water Cheap—15 to 60 cents each

2. Whirling sprinklers: (should revolve relatively fast)
  - a. Single orifice. Do not clog easily Cost: 50 to 75 cents
  - b. Multiple orifice Clog readily. Cover somewhat greater area Cost 75 cent to \$1.50

#### Common characteristics:

Suitable for high or very low rates of discharge. Minimum pressure about 15 lbs./sq. in. Fairly fine spray

3. Slow revolving sprinklers. Revolve with pulsating movement Minimum pressures 5 to 6 lbs./sq. in. (efficient) Suitable for either high or low rates of discharge Cover large areas. May tend to puddle and seal some bare soils (coarse gray) Water forced under spread of low hanging trees Cost about \$2.00 each

### **Design:**

1. Fix rate of application. Depends on:
  - a. Condition of soil
  - b. Whether ground to be covered quickly (2 to 4 hours) or sprinklers to be moved as chore (2 or 3 times in 24 hours)
  - c. Depth of application desired (usually 2 to 4 inches in coastal area)
2. Compute sprinkler discharge desired from table 1.
3. Select sprinkler desired. Obtain tables giving discharge and pressure relationships from manufacturer.

If distribution questionable set out a series of tin cans and use as rain gauges for

actual test.

If water must be pumped try to keep pressure low.

If water is not pumped there may be economy in cheaper high pressure sprinklers.

4. Select the proper sprinkler line from table 2.

Discharge per sprinkler at 20 lbs./sq. in. pressure must be known— obtain from manufacturer. This may not be the pressure (and consequently discharge) at which the unit is to be operated, but the line will operate equally well at any pressure. If sprinklers are each to have devices for adjusting pressure, units may be longer. However, if such devices are used the same end must always be connected to the hydrant.

It is best to construct drag units so that either end of unit can be connected to the hydrant.

If unit is to be dragged by hand, it is best to find—from observations of use—on similar soils, what length can be readily handled.

5. Design connection to hydrant.

A 10 to 20 ft. length of type M copper tubing or galvanized pipe, with short pieces of hose clamped to each end works well. Friction loss will be less and life longer than for straight hose.

6. Design for laterals:

One sprinkler unit covers a distance equal to number of sprinklers times the spacing. Laterals are usually 2 or 4 times this distance apart. If 4 times, a connecting unit one space longer than the sprinkler unit (and without sprinklers) will serve more economically than hose.

Run laterals up and down the slope so the units can be run along the contour.

Provide a hydrant at every 2nd or 4th tree (every 2nd tree preferred) along each lateral.

7. Friction losses will have to be determined in designing connection to hydrant, laterals, and mains. Information on this subject is included in "Sprinkler Systems for Lawns," by J. E. Christiansen. Your Farm Advisor can furnish a copy.

Water must be delivered to the upstream end of the sprinkler unit at a working pressure about 10% higher than the average pressure at which the unit is to be operated.

8. Design several alternative systems. Obtain quotations from supply companies to assist in deciding which plan is most economical.

Table 1: G.P.M. (gallons per minute) per sprinkler to obtain one inch depth of application in hours indicated at spacing indicated. To obtain actual G.P.M. per sprinkler multiply by actual depth of application desired (in inches).

Period of Appli- cation hours	Sprinkler (and tree) spacing in feet						
	16x16	18x18	20x20	22x22	24x24	26x26	28x28
1	2.66	3.36	4.15	5.03	5.98	7.02	8.14
1½	1.77	2.24	2.77	3.35	3.99	4.68	5.42
2	1.33	1.68	2.08	2.51	2.99	3.51	4.07
2½	1.06	1.35	1.66	2.01	2.39	2.81	3.26
3	0.886	1.12	1.38	1.68	1.99	2.34	2.71
3½	0.760	0.962	1.19	1.44	1.71	2.01	2.33
4	0.664	0.842	1.04	1.26	1.50	1.76	2.04
5	0.532	0.673	0.831	1.01	1.20	1.40	1.63
6	0.446	0.561	0.692	0.838	0.997	1.17	1.36
8	0.332	0.421	0.519	0.628	0.748	0.878	1.02
10	0.266	0.336	0.415	0.503	0.598	0.702	0.814
12	0.222	0.280	0.346	0.419	0.498	0.585	0.678

1. Square pattern assume. For other spacings:

$$\text{G.P.M. per sprinkler per inch depth} = \frac{\text{Area per sprinkler (sq. ft.)}}{96.3 \times \text{hours}} \quad \text{or}$$

$$\text{G.P.M. per sprinkler} = \frac{\text{Area per sprinkler (sq.ft.)} \times \text{in. depth application}}{96.3 \times \text{hours}}$$

Table 2: Maximum recommended discharge per sprinkler at 20 lbs. per sq. inch pressure for units with varying number of sprinklers. Sprinklers at each end of line.

<b>¾" type M Copper pipe—solder fittings</b>										
Number of sprinklers	3	4	5	6	7	8	9	10	11	
16 ft. spacing	7.6	4.5	3.1	2.3	1.8	1.4	1.2	1.0	0.8	
20 ft. spacing	6.8	4.0	2.7	2.0	1.6	1.2	1.0	0.9	0.7	
24 ft. spacing	6.0	3.6	2.5	1.8	1.4	1.2	0.9	0.8		
<b>1" type M Copper pipe—solder fittings</b>										
Number of sprinklers	4	5	6	7	8	9	10	11	12	
16 ft. spacing	9.1	6.2	4.5	3.5	2.8	2.3	2.0	1.7	1.5	
20 ft. spacing	8.0	5.4	4.0	3.1	2.5	2.1	1.7	1.5	1.3	
24 ft. spacing	7.2	4.9	3.6	2.8	2.2	1.9	1.6	1.3	1.2	
<b>1¼" type M Copper pipe—solder fittings</b>										
Number of sprinklers	6	7	8	9	10	11	12	13	14	
16 ft. spacing	7.9	6.1	4.9	4.1	3.4	2.9	2.5	2.2	2.0	
20 ft. spacing	7.0	5.4	4.4	3.6	3.0	2.6	2.2	2.0	1.7	
24 ft. spacing	6.3	4.9	3.9	3.2	2.7	2.3	2.0	1.8	1.6	

**1" Electrical conduit (1 3/64" I.D.) galv. with constricting air hose-type coup.**

Number of sprinklers	3	4	5	6	7	8	9	10	11
16 ft. spacing	9.1	5.5	3.8	2.8	2.2				
20 ft. spacing	8.1	4.9	3.4	2.5	2.0				
24 ft. spacing	7.4	4.5	3.1	2.3	1.8				

**1" Electrical conduit ( 3/64" I.D.) galv. with no constricting couplings**

Number of sprinklers	4	5	6	7	8	9	10	11	12
16 ft. spacing	7.6	5.2	3.9	3.0	2.5	2.0	1.7	1.5	1.3
20 ft. spacing	6.8	4.6	3.4	2.7	2.2	1.8	1.5	1.3	1.1
24 ft. spacing	6.1	4.2	3.1	2.4	1.9	1.6	1.4	1.2	1.0

**1 1/4" Electrical conduit (1 3/8" I.D.) galv. with no constricting couplings**

Number of sprinklers	5	6	7	8	9	10	11	14	16
16 ft. spacing	10.6	7.9	6.2	5.0	4.1	3.5	2.6	2.1	1.6
20 ft. spacing	9.5	7.1	5.5	4.4	3.7	3.1	2.3	1.8	1.5
24 ft. spacing	8.6	6.4	5.0	4.0	3.3	2.8	2.1	1.6	1.3

**1 1/2" Galv. sprinkler pipe (1.40" I.D.) with quick couplings**

Number of sprinklers	6	7	8	9	10	12	14	16	18
16 ft. spacing	8.6	6.7	5.4	4.5	3.8	2.9	2.2	1.8	1.5
20 ft. spacing	7.7	6.0	4.8	4.0	3.4	2.5	2.0	1.6	1.4
24 ft. spacing	7.0	5.5	4.4	3.6	3.0	2.3	1.8	1.5	1.2

**2" galv. sprinkler pipe (1.90" I.D.) with quick-couplings**

Number of sprinklers	8	10	12	14	16	18	20	22	24
16 ft. spacing	12.1	8.4	6.4	4.9	4.0	3.4	2.8	2.4	2.1
20 ft. spacing	10.7	7.5	5.6	4.4	3.6	3.0	2.5	2.2	1.9
24 ft. spacing	9.7	6.8	5.1	4.0	3.2	2.7	2.3	2.0	1.7