



Sprinkler Irrigation - Design Steps

Sprinkler and Micro irrigation Systems

Checklist of Design Procedure

- Make inventory of available resources (i.e., information on soil, topography, water supply, source of power, crops, farm operation)
- Estimate depth or quantity of water to be applied at each irrigation.
- From daily consumptive use rate and water requirement of crop, determine frequency of irrigation and irrigation period.
- Determine the capacity requirement of the system
- Make a selection from several alternative types of sprinkler system.

Checklist of Design Procedure

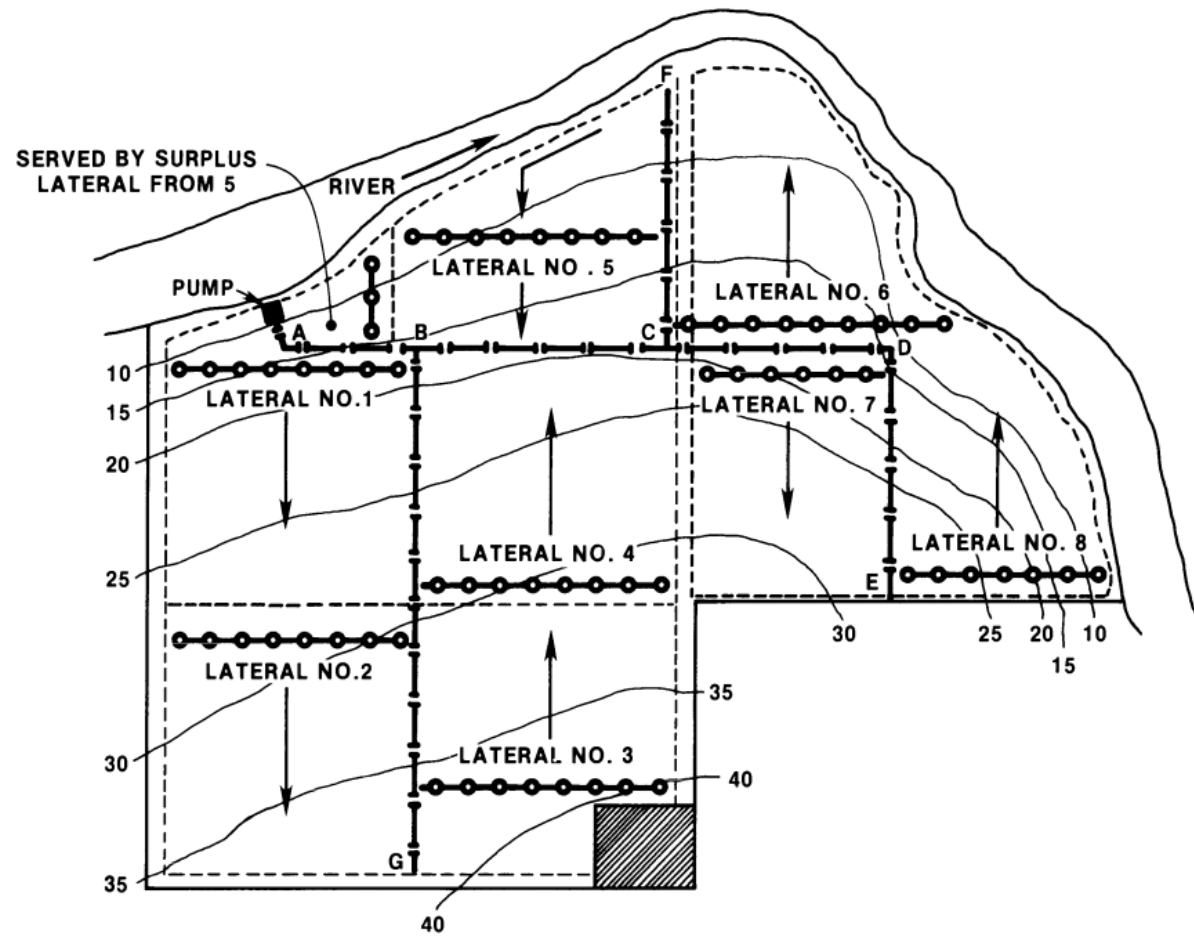
- For periodic move and fixed sprinkler system, determine
 - Sprinkler spacing, discharge, nozzle size, and operating pressure for optimum water application
 - The number of sprinklers that must be operated simultaneously to meet the system capacity requirement.
 - The best layout of main and lateral pipelines for simultaneous operation of sprinklers
 - Required size of lateral line pipe.
 - Total max pressure required for individual lateral line.



Checklist of Design Procedure

- Determine size of main pipe line
- Determine max and minimum operating condition (Pressure and Discharge condition).
- Select pump for max efficiency within range of operating condition.
- Prepare plans schedules and instructions for proper layout.



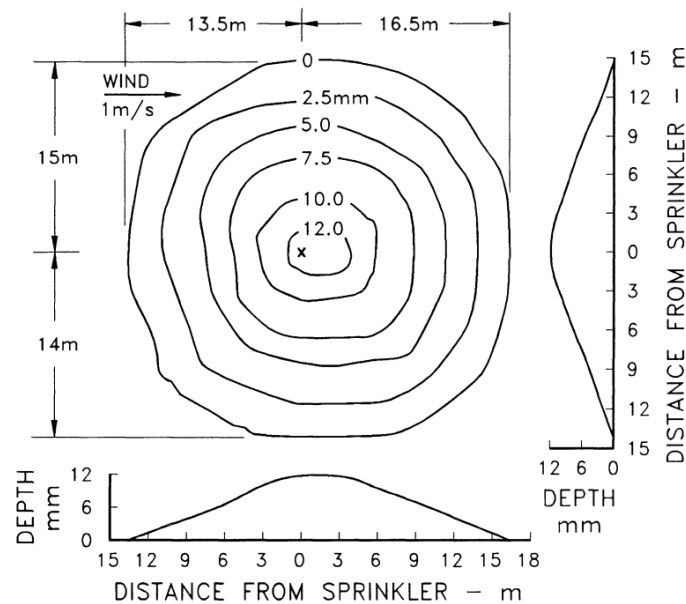


Layout of a Complete Hand-move Sprinkle System.

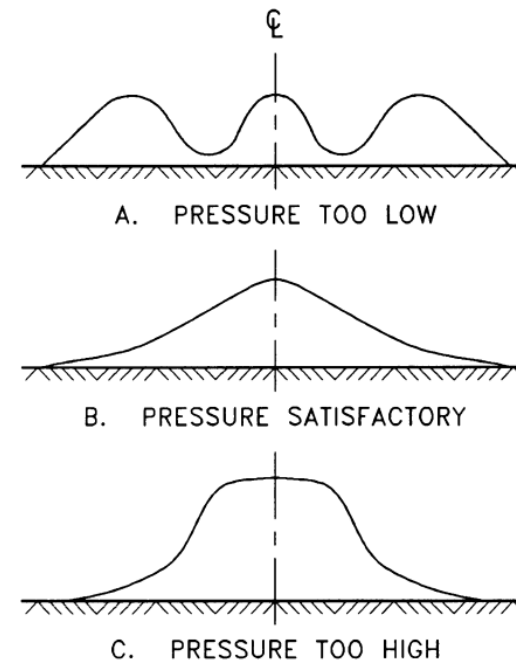


Precipitation Profile and Recommended Spacing

- Degree of uniformity depends upon water distribution pattern and spacing of sprinklers.
- Precipitation profile characteristics vary with nozzle size and operating pressure.



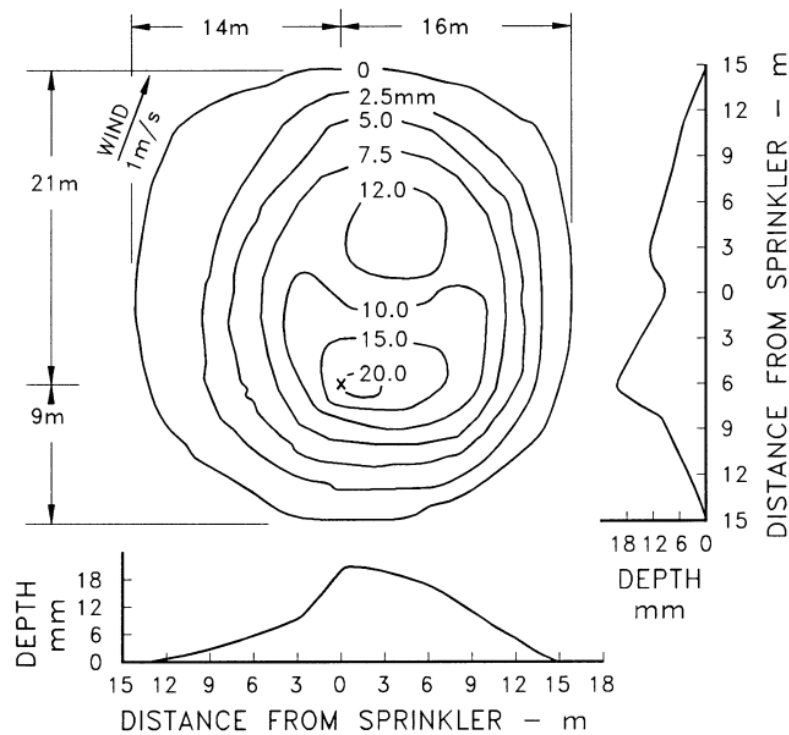
Distribution Pattern and Precipitation Profiles from a Typical Double Nozzle Sprinkler Operating under Favorable Conditions (1 m = 3.28 ft; 1 mm = 0.04 in.).



Relative Effects of Different Pressures on Precipitation Profiles for a Typical Double Nozzle Sprinkler.

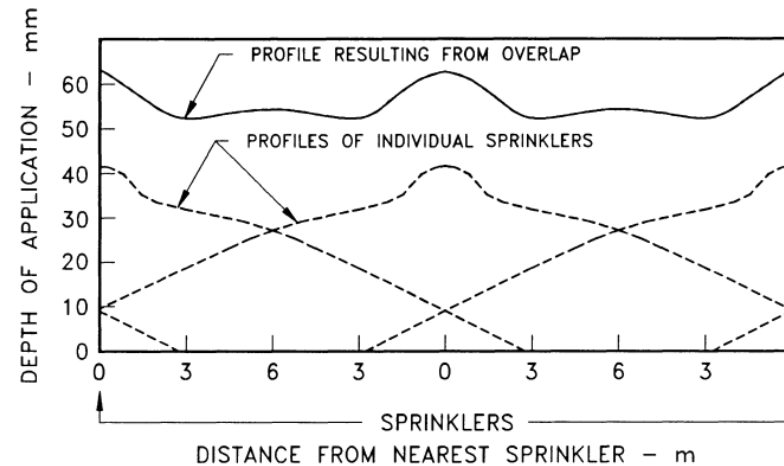
Precipitation Profile and Recommended Spacing

- Wind distorts the application pattern. Higher the wind velocity, greater the distortion.



Effect of Wind on Distribution Pattern and Precipitation Profiles from a Typical Intermediate Double Nozzle Sprinkler (1 m = 3.28 ft; 1 mm = 0.04 in.)




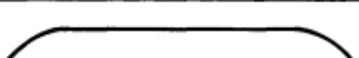
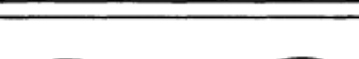
The depth of water applied to an area surrounding a revolving sprinkler varies *as the distance from the sprinkler increases*. To obtain a reasonably high degree of uniformity of application, water from adjacent sprinkler must be added.



Precipitation Profile and Recommended Spacing

- Manufacturers specify a *wetted diameter* for all nozzle size and operating pressure combination.
- *The sprinkler spacing recommendations to be made on the basis of these diameters.*
- As a general recommendation, moderate and intermediate pressured sprinkler should be spaced as follows:
 - 40 - 67% of the effective diameter for **rectangular spacing**
 - 50% of the effective diameter for **square spacing**
 - 62% of the effective diameter for **equilateral triangle spacing**

Precipitation Profile and Recommended Spacing

| SPRINKLER PROFILE | | RECOMMENDED SPACING AS A PERCENTAGE OF DIAMETER | | |
|-------------------|---|---|---------------------------|-----------------------------|
| TYPE | SHAPE | SQUARE | TRIANGULAR EQUILATERAL | RECTANGULAR SHORT x LONG |
| A |  | 50 | 50 | 40 x 60 to 65 |
| B |  | 55 | 66 | 40 x 60 |
| C |  | 60 | 65 | 40 x 60 to 65 |
| D |  | 40 70 (FAIR) | 70 to 75 | 40 x 70 to 75 |
| E |  | 40 80 (FAIR) | 80 | 40 x 80 |

Christiansen's Geometrical Sprinkler Application Rate Profiles and Optimum Set Sprinkler Spacings as a Percentage of the Effective Wetted Diameter for Square, Triangular and Rectangular Layouts.

- **Profile A & B:** Characteristics of *sprinklers having two or more nozzles*
- **Profile C and D:** Characteristics of *single nozzle sprinkler*
- **Profile E:** Characteristics of *Gun sprinkler*

Precipitation Profile and Recommended Spacing

Classification of sprinklers and their adaptability

| Sprinkler operating characteristics | Type of sprinkler and operating pressure range | | | | | | |
|---|---|--|---|---|---|--|---|
| | Impact or spray low pressure 35–140 kPa (5–20 psi) | Impact or gear moderate pressure 105–210 kPa (15–30 psi) | Impact or gear medium pressure 210–410 kPa (30–60 psi) | Impact or gear high pressure 345–690 kPa (50–100 psi) | Rocker arm gun or giant 550–830 kPa (80–120 psi) | Spinner or spray undertree 70–245 kPa (10–50 psi) | Fixed perforated pipe 30–40 kPa (4–20 psi) |
| General characteristics | Special thrust springs or reaction-type arms | Usually single nozzle oscillating or long-arm dual-nozzle design | Either single or dual-nozzle design | Either single or dual-nozzle design | One large nozzle with smaller supplemental nozzles to fill | Stream trajectories below fruit and foliage by lowering the nozzle angle | Portable irrigation pipe with small perforations |
| Range of wetted diameters | 6 to 15 m (20 to 50 ft) | 18 to 24 m (60 to 80 ft) | 23 to 37 m (75 to 100 ft) | 34 to 90 m (110 to 230 ft) | 61 to 122 m (200 to 400 ft) | 12 to 27 m (40 to 90 ft) | Rectangular 3 to 15 m (10 to 50 ft) wide strips |
| Recommended minimum application rate | 10 mm/hr (0.40 in./hr) | 3 mm/hr (0.12 in./hr) | 2.5 mm/hr (0.10 in./hr) | 10 mm/hr (0.40 in./hr) | 15 mm/hr (0.60 in./hr) | 5 mm/hr (0.20 in./hr) | 13 mm/hr (0.50 in./hr) |
| Jet characteristics (with proper pressure and nozzle size) | Water drops are large due to low pressure | Water drops are fairly well broken | Water drops are well broken over entire wetted diameter | Water drops are well broken over entire wetted diameter | Water drops are extremely well broken | Water drops are fairly well broken | Water drops are large due to low pressure |
| Water distribution with proper spacing pressure and nozzle size | Fair | Fair to good at upper limits of pressure range | Very good | Good except where wind velocities exceed 6.4 km/hr (4 mph) | Acceptable in calm air. Severely distorted by wind | Fairly good. Use diamond pattern where laterals are spaced wider than trees | Good. Pattern is rectangular |
| Adaptations and limitations for periodic-move or fixed systems | For small acreages and soils with intake rates exceeding 13 mm/hr (0.50 in./hr) | For fields crops, vegetables, and undertree sprinkling in orchards | For all field crops and most irrigable soils. Well adapted to overtree sprinkling | Same as for intermediate pressure sprinklers except where wind is excessive | For odd-shaped areas. Limited to soils with high intake rates or good cover | For all orchards. Ideal in windy areas and where pressure is too low for overtree sprinkling | For low-growing crops and soils with relatively high intake rates. Best adapted to small fields |
| Adaptations and limitations for traveling systems | Spray nozzles adaptable on center-pivot and linear-move | Center-pivot and linear-move on high-infiltrate-rate soils | Center-pivot and linear-move on most soils | Center-pivot end guns and travelers | Center-pivot end guns and travelers | Not applicable | Not applicable |

Nozzle Size and Pressure



Nozzle discharges and wetted diameters for typical 1/2- and 3/4-in. bearing impact sprinklers with trajectory angles between 22 and 28° and standard nozzles without vanes¹

| Sprinkler Pressure | Nozzle diameter—in. (mm) | | | | | | | | | | | | | | | | | | | | | | | | |
|--------------------|--------------------------------------|---------------|--------------|------------------|---------------|----------------|------------------|----------------|---------------|------------------|------|----|------------------|-----|------|------------------|-------|-----|------------------|--|--|------------------|--|--|------------------|
| | 3/32 (2.4) | 7/64 (2.8) | 1/8 (3.2) | 9/64 (3.6) | 5/32 (4.0) | 11/64 (4.4) | 3/16 (4.8) | 13/64 (5.2) | 7/32 (5.6) | | | | | | | | | | | | | | | | |
| | Nozzle discharge and wetted diameter | | | | | | | | | | | | | | | | | | | | | | | | |
| psi | gpm | ft | gpm | ft | gpm | ft | gpm | ft | gpm | ft | gpm | ft | gpm | ft | gpm | ft | gpm | ft | | | | | | | |
| 20 | 1.14 | 63 | 1.55 | 73 | | | | | | | | | | | | | | | | | | | | | |
| 25 | 1.27 | 64 | 1.73 | 76 | 2.25 | 76 | 2.88 | 79 | 3.52 | 82 | | | | | | | | | | | | | | | |
| 30 | 1.40 | 65 | 1.89 | 77 | 2.47 | 77 | 3.16 | 80 | 3.85 | 85 | 4.64 | 88 | 5.50 | 91 | 6.50 | 94 | 7.58 | 96 | | | | | | | |
| 35 | 1.51 | 66 | 2.05 | 77 | 2.68 | 78 | 3.40 | 81 | 4.16 | 87 | 5.02 | 90 | 5.97 | 94 | 7.06 | 97 | 8.25 | 100 | | | | | | | |
| 40 | 1.62 | 67 | 2.20 | 78 | 2.87 | 79 | 3.64 | 82 | 4.45 | 88 | 5.37 | 92 | 6.40 | 96 | 7.55 | 99 | 8.82 | 102 | | | | | | | |
| 45 | 1.72 | 68 | 2.32 | 79 | 3.05 | 80 | 3.85 | 83 | 4.72 | 89 | 5.70 | 94 | 6.80 | 98 | 8.00 | 101 | 9.35 | 104 | | | | | | | |
| 50 | 1.80 | 69 | 2.45 | 80 | 3.22 | 81 | 4.01 | 84 | 4.98 | 90 | 6.01 | 95 | 7.17 | 100 | 8.45 | 103 | 9.88 | 106 | | | | | | | |
| 55 | 1.88 | 70 | 2.58 | 80 | 3.39 | 82 | 4.25 | 85 | 5.22 | 91 | 6.30 | 96 | 7.52 | 101 | 8.85 | 104 | 10.34 | 107 | | | | | | | |
| 60 | 1.98 | 71 | 2.70 | 81 | 3.54 | 83 | 4.42 | 86 | 5.45 | 92 | 6.57 | 97 | 7.84 | 102 | 9.24 | 105 | 10.75 | 108 | | | | | | | |
| 65 | | | | | 3.68 | 84 | 4.65 | 87 | 5.71 | 93 | 6.83 | 98 | 8.19 | 103 | 9.60 | 106 | 11.10 | 109 | | | | | | | |
| 70 | | | | | 3.81 | 84 | 4.82 | 88 | 5.92 | 94 | 7.09 | 99 | 8.49 | 104 | 9.95 | 107 | 11.40 | 110 | | | | | | | |
| K_d^3 | 0.255 (1.151) ⁴ | | | 0.346 (1.561) | | | 0.453 (2.044) | | | 0.575 (2.595) | | | 0.704 (3.177) | | | 0.849 (3.831) | | | 1.012 (4.566) | | | 1.193 (5.383) | | | 1.394 (6.290) |

¹The use of straightening vanes or special long discharge tubes increases the wetted diameter by approximately 5%.

²Horizontal lines represent upper and lower recommended pressure boundaries.

³ $q = K_d \sqrt{P}$ with q in gpm and P in psi.

⁴Numbers in () for $q = K_d \sqrt{H}$ with q in L/min and H in m.

NOTE: 1 in. = 25.4 mm; 1 ft = 0.305 m; 1 gpm = 3.785 L/min = 0.063083 L/s; 1 psi = 6.895k Pa = 0.703 m.

!!!-Thank you-!!!

