SPRINKLER IRRIGATION— APPLICATION RATES AND DEPTHS

by Thomas W. Ley, Extension Irrigation Engineer, WSU Prosser

Procedure

1. Measure sprinkler pressure (psi) using Pitot gauge. Hold gauge in center of jet no more than 1/8" from nozzle face.

2. Measure sprinkler discharge (gallons per minute) using a 5-gallon bucket, hose, and watch. Sprinkler gpm equals 300 divided by time (seconds) to fill 5-gallon bucket. For 2-nozzle heads, measure both.

3. Record nozzle size(s) and check nozzles for wear by inserting shank end of a new drill bit (same size as nozzle) into operating sprinkler. Observe any leakage or spray (amount and distance). Fine-to-coarse spray up to 10 to 15 feet from head may mean at least 15% nozzle wear or 15% more water being discharged.

4. Repeat steps 1, 2, and 3 for at least 3 sprinklers (beginning, middle, and end) on hand, wheel, and permanent systems to get average for lateral. Do same for center pivot, and record sprinkler number.

5. Measure sprinkler spacing on lateral (ft) and lateral spacing on mainline (ft) for handlines, wheellines, and permanent systems. Determine total area irrigated and design or actual gallons (gpm) for center pivots.

6. Compare measured data (nozzle size, pressure, and gpm) with theoretical data in Table 1. Measured discharge vs discharge in Table 1 (at same nozzle size and pressure) indicates amount of nozzle wear. If nozzles are new and pressure is known, use Table 1 to find discharge of sprinkler. For pivots, compare sprinkler number and measured data with pivot design package to determine if pressures and discharges are correct.

7. Average gross application rates for different sprinkler gpm and spacings are given in Table 2. For other spacings or gpm use:

$$\text{Gross Application Rate (inches/hour)} = \frac{\text{GPM} \times 96.3}{\text{sprinkler spacing} \times \text{lateral spacing (or area irrigated, sq ft)}}$$

Example: 6 gpm heads on 40 x 60 spacing

$$\text{Average Gross Appl Rate} = \frac{6 \times 96.3}{40 \times 60} = 0.24 \text{ in/hr}$$

(or use Table 2)

Table 1. Sprinkler discharge gpm (gallons per minute) for nozzle size (inches) and pressures (psi) (pounds per square inch).

psi	Nozzle Size (in)

psi	3/32	7/64	1/8	9/64	5/32	11/64	3/16	13/64	7/32	15/64	1/4
20	1.17	1.60	2.09	2.65	3.26	3.92	4.69	5.51	6.37	7.32	8.34
25	1.31	1.78	2.34	2.96	3.64	4.38	5.25	6.16	7.13	8.19	9.32
30	1.44	1.95	2.56	3.26	4.01	4.83	5.75	6.80	7.86	8.97	10.21
35	1.55	2.11	2.77	3.50	4.31	5.18	6.21	7.30	8.43	9.69	11.03
40	1.66	2.26	2.96	3.74	4.61	5.54	6.64	7.80	9.02	10.35	11.79
45	1.76	2.39	3.13	3.99	4.91	5.91	7.03	8.30	9.60	10.99	12.50
50	1.85	2.52	3.30	4.18	5.15	6.19	7.41	8.71	10.10	11.58	13.18
55	1.94	2.64	3.46	4.37	5.39	6.48	7.77	9.12	10.50	12.15	13.82
60	2.03	2.76	3.62	4.50	5.65	6.80	8.12	9.56	11.05	12.68	14.44
65	2.11	2.88	3.77	4.76	5.87	7.06	8.45	9.92	11.45	13.21	15.03
70	2.19	2.99	3.91	4.96	6.10	7.34	8.78	10.32	11.95	13.70	15.59
75	2.27	3.09	4.05	5.12	6.30	7.58	9.08	10.66	12.32	14.19	16.14
80	2.35	3.19	4.18	5.29	6.52	7.84	9.39	11.02	12.74	14.64	16.67
85	2.42	3.29	4.31	5.45	6.71	8.07	9.67	11.35	13.11	15.10	17.18
90	2.49	3.38	4.43	5.61	6.91	8.31	9.95	11.69	13.51	15.53	17.68
100	2.62	3.57	4.67	5.91	7.29	8.76	10.50	12.32	14.23	16.37	18.64
110	2.75	3.74	4.89	6.19	7.63	9.24	11.00	12.90	14.97	17.17	19.55
120	2.87	3.91	5.10	6.46	7.97	9.65	11.48	13.47	15.63	17.93	20.42
130	2.99	4.07	5.31	6.72	8.30	10.04	11.95	14.02	16.27	18.66	21.25

Note: Figures given are approximate maximum discharge rates for given nozzle size and pressure.

8. Table 3 gives the average *net* depth of irrigation for different set times and application rates assuming a 70% application efficiency. For efficiencies other than 70%, multiply the values in Table 3 by the factors given in Table 4.

Example: 0.24 in/hr application rate
70% efficiency
12-hour set

Av Net Depth = (0.24 in/hr) x (12 hr) x 70% = 2.02 in (or use Table 3)

If 80% efficiency, multiply by 1.14 (from Table 4)

Av Net Depth (at 80% efficiency) = 1.14 x 2.02
= 2.3 in

Example: Center pivot: 1,200 gpm system on 130 acres; 24-hour revolution; 80% efficiency.

$$\text{Av Gross Application Rate} = \frac{1,200 \ x \ 96.3}{130 \ ac \ x \ 43,560 \ sq \ ft/ac} = 0.02 \ in/hr$$

Av Net Depth = (0.02 in/hr) x (24 hr) x 80% = 0.38 in

Table 2. Average gross application rate (in/hr).

Spacing (ft)	Gallons per minute from each sprinkler									
	1	2	3	4	5	6	7	8	9	10
20 x 20	0.24	0.48	0.72	0.96	1.20	1.44	1.70	1.93	2.16	2.40
20 x 30	.16	.32	.48	.64	0.80	0.96	1.12	1.28	1.43	1.60
20 x 40	.12	.24	.36	.48	.60	.72	0.84	0.96	1.08	1.20
30 x 30	.11	.21	.32	.43	.54	.64	.75	.86	0.96	1.07
30 x 40	.08	.16	.24	.32	.40	.48	.56	.64	.72	0.80
30 x 50	.06	.13	.19	.25	.32	.38	.45	.51	.58	.64
40 x 40	.06	.12	.18	.24	.30	.36	.42	.48	.54	.60
40 x 50	.05	.10	.14	.19	.24	.29	.34	.38	.43	.48
40 x 60	0.04	0.08	0.12	0.16	0.24	0.24	0.28	0.32	0.36	0.40

Table 3. Net applied depth (in) at 70% efficiency.

Set time (hrs)	Application rate (in/hr)											
	0.10	0.12	0.14	0.16	0.18	0.20	0.24	0.28	0.32	0.36	0.45	0.60
1	.07	.08	.10	.11	.13	.14	.17	.20	.22	.25	.32	.42
2	.14	.17	.20	.22	.25	.28	.34	.39	.45	.50	.63	0.84
3	.21	.25	.29	.34	.38	.42	.50	.59	.67	0.76	0.95	1.26
4	.28	.34	.39	.45	.50	.56	.67	.78	0.90	1.01	1.26	1.68
5	.35	.42	.49	.56	.63	.70	0.84	0.98	1.12	1.26	1.58	2.10
6	.42	.50	.59	.67	.76	.84	1.01	1.18	1.34	1.51	1.89	2.52
7	.49	.59	.69	.78	0.88	0.98	1.18	1.37	1.57	1.76	2.21	2.94
8	.56	.67	.79	0.90	1.01	1.12	1.34	1.57	1.79	2.02	2.52	3.36
9	.63	.76	.88	1.01	1.13	1.26	1.51	1.76	2.02	2.27	2.84	3.78
10	.70	0.84	0.98	1.12	1.26	1.40	1.68	1.96	2.24	2.52	3.15	4.20
12	0.84	1.01	1.18	1.34	1.51	1.68	2.02	2.35	2.69	3.02	3.78	5.04
18	1.26	1.51	1.76	2.02	2.27	2.52	3.02	3.53	4.03	4.54	5.67	7.56
24	1.68	2.02	2.35	2.69	3.02	3.36	4.03	4.70	5.38	6.05	7.56	10.08
36	2.52	3.02	3.53	4.03	4.54	5.04	6.05	7.06	8.06	9.07	11.34	15.12
48	3.36	4.03	4.70	5.38	6.05	6.72	8.06	9.41	10.75	12.10	15.12	20.16

Table 4. Adjustment factor to use with values in Table 3 for other than 70% efficiency.

Efficiency	Multiply by	Efficiency	Multiply by
55	0.79	75	1.07
60	0.86	80	1.14
65	0.93	85	1.21