12 Years of Sprinkler Irrigation Research

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The Agricultural Engineering Department of The University of Arizona has been studying performance characteristics of sprinkler irrigation systems since 1950. These studies have evaluated water application efficiencies and the factors affecting water losses, crop yields and water requirements over a wide range of crops, climatic conditions and sprinkler system operation. The most important studies and their results are summarized here.

The first studies determined the losses of water from a sprinkler spray as the water passed through the air from the nozzle to the soil or plant cover. The results of these tests were combined into a nomograph (Figure 1) which may be used for estimation of spray losses for any combination of operating conditions. Examination of the nomograph shows that spray losses (per cent evaporation loss in Figure 1) increase with increasing air temperatures, nozzle pressures and wind velocities; and decrease with increases in relative humidity and nozzle diameter.

Measuring Water Losses

After spray losses were determined, studies were undertaken to measure the water losses from the plant and soil surfaces during sprinkling. These studies have led to the development of a weighing evapotranspirometer. This device can detect application or evaporation of as little as 1/100 inch of water on an area of soil or growing crops 12 feet in diameter. Tests performed on bare soil indicate that surface evaporation during sprinkling varies widely but generally increases with wind, air temperature and degree of wetting.

Evaporation from bare soil surfaces during sprinkling has been approximately equal to spray losses. Evaporation losses from plant surfaces during sprinkling have been found to equal evapo-transpiration which would have occurred had the plants not been sprinkled. Thus this evaporation from the wet plant surfaces is not a net loss from the sprinkler application. The bar graph of Figure 2 gives both spray and ground losses during sprinkling under typical conditions. These studies are continuing and will result in detailed loss information similar to that which has been developed for spray losses.

A third group of studies has evaluated the response of a number of crops to sprinkler irrigation in comparison with surface irrigation. The crops have included alfalfa, sorghum, winter grain, cotton and citrus. The accompanying table summarizes the results of these tests.

Light Sprinkling For Grain

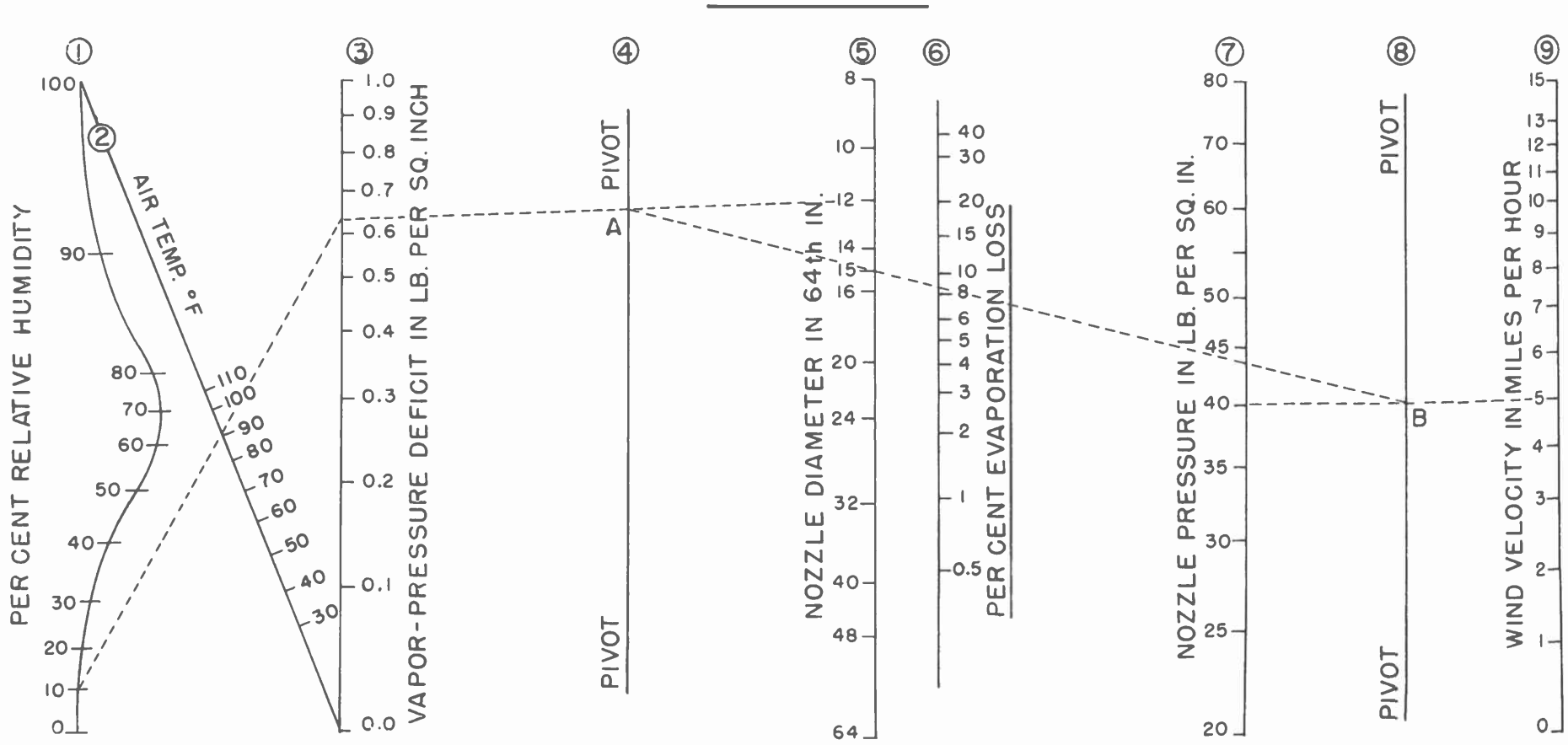
Crop yields per unit of water have not shown a consistent pattern favoring either day or night sprinkling. The grain and forage crops have given slightly higher yields with light frequent sprinkling than with heavier applications made infrequently. Water requirements for light, frequent irrigations during the day were generally less than for other treatments, and yields per acre foot of water have been generally higher under sprinkler application of water than under surface irrigation on soils of low water holding capacity.

Young lemon trees on Superstition Sand are being grown under sprinkler

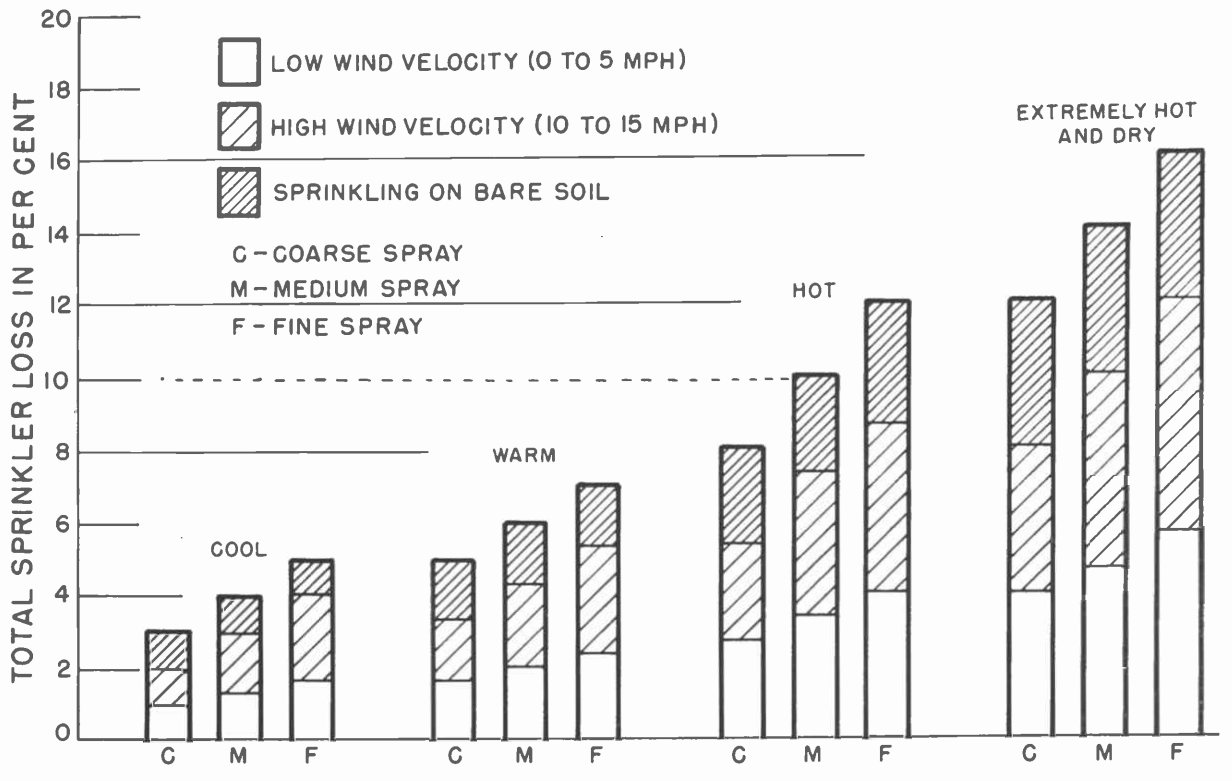
(Continued on Next Page)

The author is agricultural engineer in the Agricultural Experiment Station.

BELOW, NOMOGRAPH used in estimating spray losses at known climatic and operating conditions. Average daytime conditions for the operating period should be used. Night operation losses can be disregarded unless wind velocities are high. Example shown by the dotted line gives the losses for 10% relative humidity and 90°F air temperature, resulting in vapor pressure deficit of 0.73 psi. Line drawn from 0.73 psi to the nozzle size 12/64" determines point A on line 4. Line drawn from the wind velocity of 5 m.p.h. to the nozzle pressure of 40 psi determines point B on line 8. A line drawn from A to B intersects line 6 at the per cent spray loss.



BAR GRAPH for estimating total losses when conditions are estimated. This graph is useful to learn both spray losses and losses occurring after the spray reaches the soil surface. Total loss sprinkling on bare soil at high wind velocities, in hot weather and using a medium spray, is shown by the broken line at about 10%.



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irrigation with one-half the water application required in adjoining plots under surface irrigation.

Sprinklers Save Water

In summary, practical field results in crop production trials have agreed with results of studies of evaporation loss from spray, soil and plants. Irrigation water can generally be saved by the installation of a properly designed sprinkler system, especially on the lighter soils.

January

1-5 —Arizona National Livestock Show, Phoenix
9-11—Agric. Ammonia Institute, Westward Ho, Phoenix
10-11—Beltwide Cotton Production Conference, Dallas, Texas
17-18—Winter Meeting Arizona Section, American Society of Range Management, Nogales
23—Arizona Water Resources Committee, UA Campus
25-26—4th Annual Pest Control Conference, U of A Campus
28-31—Annual Extension Service Conference, Student Union Bldg., U of A Campus
30—11th Annual Meeting, Arizona Poultry Federation, ASU, Tempe

February

4-22—Western Regional Extension Winter School, UA Campus
13-14—6th Annual Arizona Fertilizer Conference, Senior Ballroom, Student Union Bldg., U of A Campus
18—Annual Meeting Arizona Crop Improvement Association, Ramada Motel, Phoenix
19—Annual Meeting, Arizona Cotton Growers, Phoenix
25—2nd Annual Sale at Arizona Beef Cattle Improvement Station, The University of Arizona River Road Farm, Tucson

March

5- 6—Western Cotton Production Conference, Phoenix
16—FFA Field Day, U of A Campus

Results From Sprinkler and Surface Irrigation

Crop	*Treatment**	*Yield*	*Ac. Ft./Ac.*	*Yield per Ac. Ft.*
		Tons/Ac.		T./A. Ft.
Alfalfa (3 yr. av.)	spr. frequent (day)	5.51	3.01	1.83
	spr. reg. day	5.33	2.94	1.81
	reg. night	5.70	3.70	1.54
	flood	5.27	5.31	1.00
		Tons/Ac.		T./A. Ft.
Winter Grain 1960	spr. frequent (day)	4.05	1.10	3.70
	spr. reg. day	3.24	1.10	3.00
	spr. reg. night	3.70	1.07	3.50
	flood	3.54	1.66	2.20
		Tons/Ac.		T./A. Ft.
Winter Grain 1961	spr. frequent (day)	2.48	0.85	2.92
	spr. reg. day	2.14	1.00	2.14
	reg. spr. night	2.14	1.10	1.87
	flood	2.48	1.52	1.64
		Tons/Ac.		T./A. Ft.
Sorghum (forage)	spr. frequent (day)	21.9	1.91	11.5
	spr. reg. day	20.5	2.21	9.3
	spr. reg. night	25.8	2.31	11.2
	furrow	24.3	2.32	10.5
		lb./seed cot./Ac.		lbs./A. Ft.
Cotton A-44	spr. frequent (day)	2560	3.59	713
	spr. reg. day	2740	4.55	600
	spr. reg. night	3015	5.06	623
	furrow	2980	5.49	543
		lb./seed cot./Ac.		lbs./A. Ft.
Cotton				
A-44	sprinkler	2942	3.15	934
A-44	furrow	2941	4.09	720
D.P.	sprinkler	3192	3.15	1133
D.P.	furrow	3310	4.09	807
Lisbon Lemons (1961) (4 yr. old trees)	sprinkler		4.8	
	flood		9.5	

*All tests were in quadruplicate.