

Sprinkler and Lateral Spacing

distribution of irrigation water applied by sprinklers improved by proper spacings of sprinklers and laterals

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Results of recent field tests indicate the extent wind—and sprinkler and lateral spacing—influence the uniformity of water distribution from medium capacity sprinklers.

Winds in excess of 6 mph—miles per hour—have a decided influence on water distribution. In fact with the spacing used with some sprinklers and laterals, the water reaching the soil in parts of the area between sprinklers is only 10%–15% of the amount the system was designed to apply. Such water distribution results in a severe soil moisture deficiency and a reduction in crop yield.

Improved water distribution can be obtained under windy conditions by closer spacing of sprinklers and laterals. Medium capacity sprinklers at 30' spacing gave the best distribution with a greater range and choice of lateral spacing.

However, certain limits of closer spacing must be considered, including the increased initial cost for more equipment and more labor cost required to move the closer laterals and sprinklers. These factors along with others—such as the maximum water infiltration capacity of the soil—should be considered in the design of a well planned sprinkler irrigation system.

The effect of wind on water distribution can be determined by tests using specially designed collection cans spaced around the sprinklers on a given grid pattern and analyzing the distribution from the amounts of water collected in the cans. The results obtained are usually expressed as coefficients or distribution percentages.

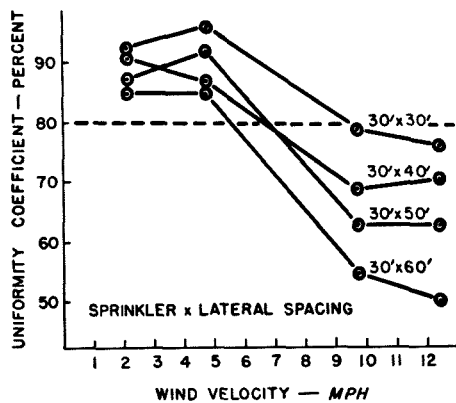
The most commonly used statistical method is the uniformity coefficient expressed as a percentage on a scale of 0%–100% with 100% indicating absolutely uniform distribution over the entire area covered by the water discharging from the sprinklers. A uniformity coefficient of 80% is generally considered to be the lower limit of acceptable distribution.

A single lateral line was used in an initial series of experiments performed within certain ranges of wind velocities. The number of sprinklers on the lateral varied depending on the spacing required to give complete overlap in the collection area. By a method of superim-

posing the data from all of the collection cans it was possible to use the amount of water at any collection point for a number of different spacings. Also, the time required to perform a run was reduced, providing certain precautions were taken.

A plot of the uniformity coefficient for 30' sprinkler spacing by 30', 40', 50' and 60' lateral spacing—when the sprinklers operated at 30 pounds per square inch—is shown in the following graph. There is little effect on the uniformity coefficient for different spacings at the low wind velocities. However, above 6 mph the uniformity coefficient falls off very rapidly. For velocities of more than 12 mph there is not a great difference up to the wind velocities measured in these experiments. Similar data for sprinkler spacing of 40', 50' and 60'

Uniformity coefficients when sprinklers were operated at 30 pounds per square inch.



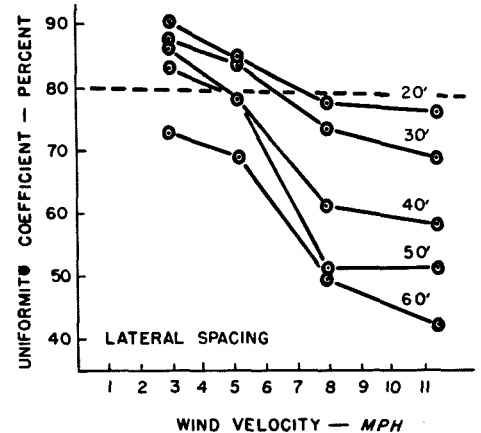
operating at the same pressure were obtained with an increase in sprinkler spacing. A more pronounced decrease in uniformity takes place with increasing wind velocity.

These results established a trend that by decreasing the sprinkler spacing the uniformity of distribution could be improved providing the lateral spacing was constant. From the standpoint of labor required to move the pipe, this is very satisfactory. The wider the lateral spacing the less will be the labor required to move the lateral. In many cases the labor requirements and the cost of moving are the major operating cost of the sprinkler system.

A summary of all the tests performed

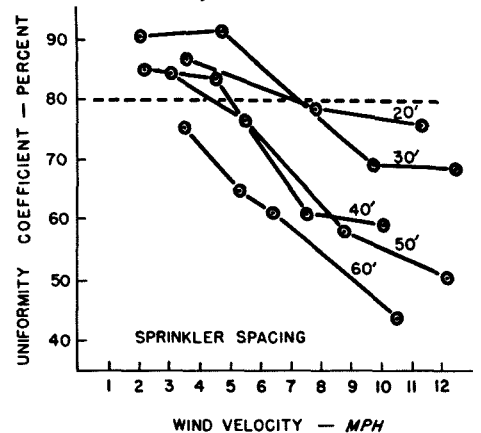
at 30 pounds per square inch, showing the influence of increasing lateral and sprinkler spacing on uniformity of distribution with increasing wind velocity are shown in the two graphs in this column.

Lateral spacing tests at 30 pounds per square inch.



If a uniformity coefficient of 80% is used as the lower limit of acceptable distribution, this data indicates that the 60' lateral spacing would not be satisfactory under any conditions of wind. A 50' spacing would be satisfactory up to 4

Sprinkler spacing tests at 30 pounds per square inch.



mph, 40' spacing to 5 mph, and 30' spacing to 6 mph.

The above graph shows wind velocities in excess of 5 mph would limit sprinkler spacing to 40' or possibly 50'. Whereas, sprinkler spacings of 20' or

30' would be satisfactory with wind velocities up to 7-8 mph. In all cases, the closer sprinkler and lateral spacings were most satisfactory.

Spacings Tested During Summer of 1956		
Sprinkler		Lateral
20'	x	40'
	x	50
	x	60
30	x	40
	x	50
	x	60
40	x	50
	x	60
	x	80

To evaluate the importance of sprinkler and lateral spacings on distribution under actual field conditions, nine different combinations of sprinkler and lateral spacings were tested during the summer of 1956. The spacing combinations are shown in the next column.

All the laterals were operated simultaneously except for a small difference in time required because of slightly different application rates. At the end of each run, the necessary measurements were made, the lateral moved and the process repeated. This procedure required two days of operation for four lateral positions and was carried out on a 24 hour basis—two day and two night runs.

A test plot was established between the second and third lateral positions for each lateral and sprinkler spacing and equipped with collection cans set on a 10' grid pattern and read at the end of each period of operation.

The rates of discharge of the sprinklers were determined periodically by volumetric measurements. Pressures were maintained by careful regulation and use of calibrated pressure gages. Records of temperature, humidity, wind direction and velocity were obtained for all test periods.

During five irrigations the average wind velocity did not exceed 7.2 mph for any 24 hour period. During most of the

periods of water application wind velocity varied from 2-5 mph and from essentially the same direction. The maximum daytime temperature was 98°F. The nighttime temperature varied between 57°F and 64°F. These weather conditions were typical for summertime in the test area. It was not exceptionally windy or hot.

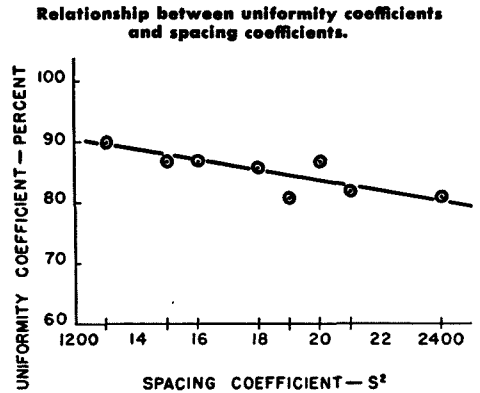
Data for two of the irrigations with different average wind conditions are shown in the following table. A direct comparison of the uniformity coefficients for all spacing combinations shows a significant decrease in uniformity when the wind velocity increased from 2.8 to 6.4 mph. This information confirms the reliability of results obtained by shorter single lateral tests.

Wind velocity avg. per irrig.	Sprinkler Spacing								
	20		30		40		60		
	Lateral Spacing								
mph	Uniformity Coefficient—Per cent								
2.8	94	93	83	93	90	91	86	86	70
6.4	81	75	72	77	77	74	73	70	62

To evaluate the performance of the different spacings results were plotted as a relationship between the uniformity coefficient and a spacing coefficient. The spacing coefficient is a numerical expression computed by dividing the square root of the area within the sprinkler and lateral spacing by the sprinkler diameter throw. The graph on this page shows that in general the greater the spacing coefficient or area between sprinklers and laterals, the lower will be the uniformity of water distribution.

Specifically, the uniformity for the 30' sprinkler spacing by 40', 50' and 60' lateral spacings are quite similar. In fact, there is essentially no difference between any of these lateral spacings for the type of sprinklers used in these tests. Essentially the same results were obtained for the 40' by 50' and 60' lateral spacings.

A 10' difference in lateral spacing for sprinklers 20' or 40' apart and a 20' difference for the 30' sprinkler spacing makes little difference in the uniformity



of water distribution when operating under typical field conditions and wind velocities did not exceed 6-7 mph.

Comparing results obtained for the different sprinkler spacings—20', 30', 40' and 60'—the 30' spacing was the best, followed by the 20' by 40' and 50' spacings, and then by either the 20' by 60' or 40' by 50' spacings. In all cases the large sprinklers operating on the 60' by 80' spacing were considerably poorer.

Therefore, in order to achieve as uniform coverage as possible, these tests indicate that the choice would lie between spacings of 20' by 40' or 50' and 30' by 40', 50' or 60'. Since there was only a small difference in the uniformity coefficients for these spacings, the selection would then depend upon other considerations, such as the difference in the number and cost of sprinklers and couplers required for the 20' and 30' spacings and the labor required to move the pipe for these spacings.

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QUALITY

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Recently investigations have indicated that with waters having an appreciable quantity of salt—from one to three tons per acre foot—the sodium percentage can be higher than with waters of low salt concentration, and still maintain fair infiltration rates. Examples of this type of water occur on the west side of the San Joaquin Valley where many well waters contain from one to three tons of salt per acre foot, with a sodium percentage of 60%-90%.

Investigation under way at present indicates there are at least two soil series

that did not disperse or reduce infiltration rates when irrigated with a high percentage sodium water as is the case with many soil series. The role the soil series or type plays in relation to water quality is being investigated.

Probably the most widely recognized toxic salt occurring in some California irrigation waters is boron, which is toxic in very low concentrations. Irrigation water containing little more than 1/2 part per million of boron may cause injury to sensitive plants. In other cases one or more parts per million will be required to produce injury. Three or four parts per million is usually considered the upper limit for the more tolerant crops.

Sodium may be toxic to certain plants. This element is usually accompanied by the chloride ion and either one or both may cause burning or death of leaves in lemons, oranges, almonds, apricots, peach and walnuts. Beans and potatoes are also sensitive to these elements. Burning and killing of plant leaves is not necessarily associated with a high salt concentration in the soil, for upon analyses no high concentration of salts is found, and many times it is quite low.

Recently, work has indicated a sulfate toxicity to certain strains of lettuce and romaine. Earlier this was known as Brown Blight, which occurs principally

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