APPLICATION UNIFORMITY OF LOW PRESSURE CENTER PIVOT EQUIPMENT

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Center pivot and lateral move irrigation systems consist of a continously moving lateral with sprinklers mounted at an equal or variable spacing. The discharge rate on a center pivot increases linearly from the pivot, and can be as high as 1.5 gallons per minute (gpm) per foot of lateral near the outer end of a 1/4 mile lateral. Due to the high discharge rate, and nozzle size limitations, which typically limit nozzle spacings to 5 to 15 feet, uniformity of application is usually quite high.

FACTORS AFFECTING OVERALL WATER DISTRIBUTION

Two types of nonuniformity can occur with traveling laterals: (1) random effects such as wind speed variation and travel speed variation, and (2) cumulative effects due to field topography or insufficient overlap of the sprinkler patterns, improper nozzle sizes and/or malfunctioning sprinklers. Random effects are usually not a serious problem because they tend to average out over several passes of the system. However, when applying chemicals in a single pass, random effects can cause serious nonuniformity in the chemical distribution after a single pass of the system, Topographic effects show up gradually in specific areas of the field, particularly if runoff occurs. Sprinkler problems show up as dry rings around the pivot or wet areas with excessive ponding or runoff.

Field topography can affect uniformity in two ways: pressure variation due to elevation differences, and differences in uphill and downhill travel speed of the outer or controlling tower due to resistance or wheel slippage. Pressure variations can be greatly reduced by using pressure regulators on individual spray heads. In general, pressure regulators should be used if the maximum elevation difference (in feet) across the field is greater than about 1/2 the nozzle pressure (in psi). At present, there is no reasonably good way to correct for the effects of wheel slippage. However, this should not be a problem with good management to minimize wheel track depth.

The traditional high pressure, high elevation sprinkler packages can produce very high uniformity but can have problems in high wind conditions. Wind blowing inward along the pivot lateral will increase the application depth along the lateral while leaving a dry outer edge, whereas wind blowing outward along the pivot lateral will reduce the application with a resulting drift loss from the outer edge. Wind blowing perpendicular to the lateral can cause skips or dry strips when the windspeed changes suddenly. Variation in travel speed of the lateral due to the start-stop motion of the electric drive mechanisms and lateral alignment controls causes random variability similar to that due to wind. A wider spray pattern will help to reduce these effects.

FACTORS TO CONSIDER WITH LOW PRESSURE

The trend in recent years has been toward low pressure spray heads mounted at relatively low elevations to reduce wind drift. The lower elevation spray reduces wind effects but can cause problems with spray pattern shape. The shape of the spray pattern is affected by several factors: the design of the deflection or diffusion plate, nozzle size, nozzle pressure, nozzle or spray elevation and wind effects. Application patterns from low pressure spray heads tend to be annular or doughnut shaped and this tendency is accentuated as pressure or nozzle elevation is reduced.

Individual spray head pattern shapes were measured using both an indoor test facility and an outdoor test grid at Kimberly. Devices tested included smooth and grooved-plate spray heads, Nelson Rotators and Spinners, and Senninger Wobblers [1]. Patterns were overlapped by computer to determine the application uniformity (Christiansen CU) at various nozzle spacings.

The Table below gives the approximate spacing at which the CU values dropped below 0.95, for a nozzle elevation of approximately 6 feet. Actual field uniformities will be slightly lower because of the factors discussed above. Moderate windspeeds of about 10 miles per hour or less did not appear to reduce the CU value significantly. Nozzle pressure has a significant effect on the pattern. Higher pressure produces a smoother pattern, allowing larger spacings. Also, it was found that, at 10 psi most types of spray heads produce a pronounced doughnut pattern with spikes or high instantaneous application rates, which can cause spot ponding. This tendency is greatly reduced at 15 psi nozzle pressure.

The fixed plate sprays require closer spacings because of the smaller pattern radius. The Nelson Spinners produced results similar to the Rotators. The Wobblers tend to produce smoother patterns due to their higher spray trajectory angle. The Rotators could be mounted slightly higher to compensate for the lower (12 degree) trajectory angle.

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[1] Manufacturer names are included for the benefit of the reader and do not imply any endorsement or preferential treatment of the products mentioned by the USDA Agricultural Research Service.

Recommended maximum nozzle spacings (feet) for low elevation spray heads.

	Pressure, psi			
	10	15	20	30
Fixed plate sprays	6	8	8	10
Rotator (D6)	8	10	12	14
Rotator (D4)	8	10	12	14
Wobbler Low Angle	12	14	14	16
Wobbler High Angle	14	16	16	18

GENERAL RECOMMENDATIONS

The above discussions can be summarized in a number of recommendations which will maintain high uniformities with low pressure center pivots, while minimizing peak application rates.

1. Observe maximum spacing limits shown above.

2. Maintain minimum 3 foot crop clearance (1 foot with high trajectory angle).

3. Use nozzle pressures between 15 and 30 psi.

4. Use nozzle offsets with low elevation sprays.

5. Regularly check for worn nozzles or malfunctioning pressure regulators.

6. Use a pressure gage with a pitot tube to check nozzle pressures at the high and low points of the field.

7. Set pivot rotation speed not equal to 24 hour multiples, to help average out evaporation and wind effects.

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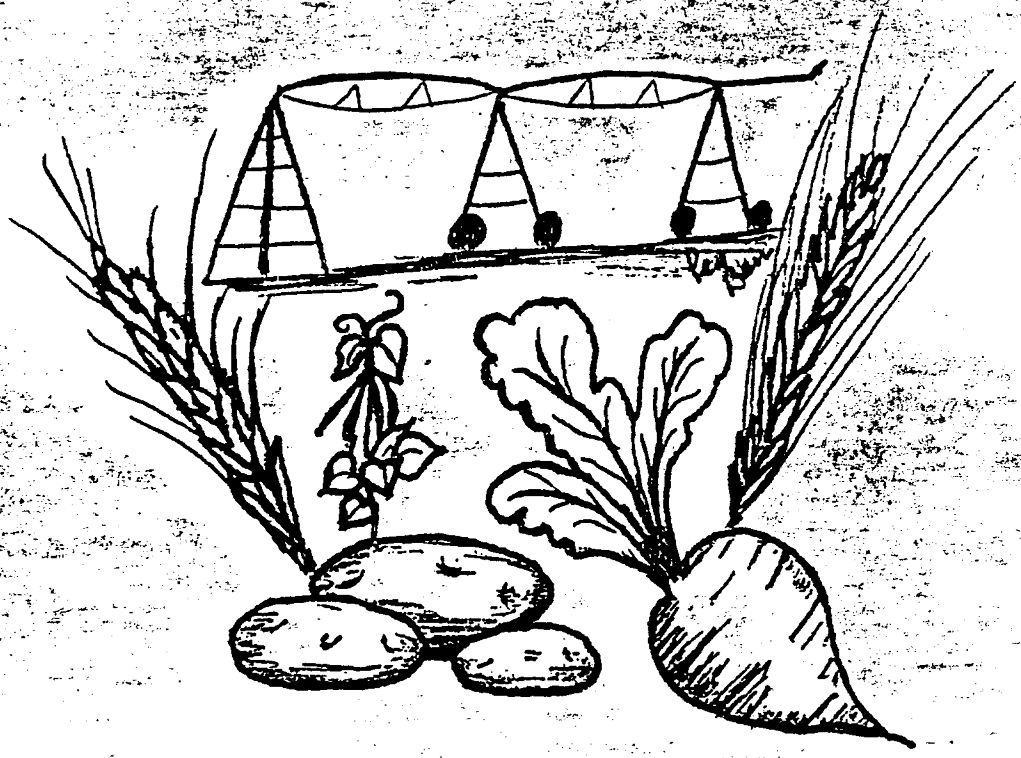

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