Agronomic Spotlight

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Innovations in Center Pivot Irrigation

- Innovations have increased the water application efficiencies of center pivot irrigation systems.
- Medium- and low-elevation spray application systems reduce water loss from drift and evaporation.
- Computer-based monitoring and control tools allow growers to monitor conditions and control irrigation remotely.

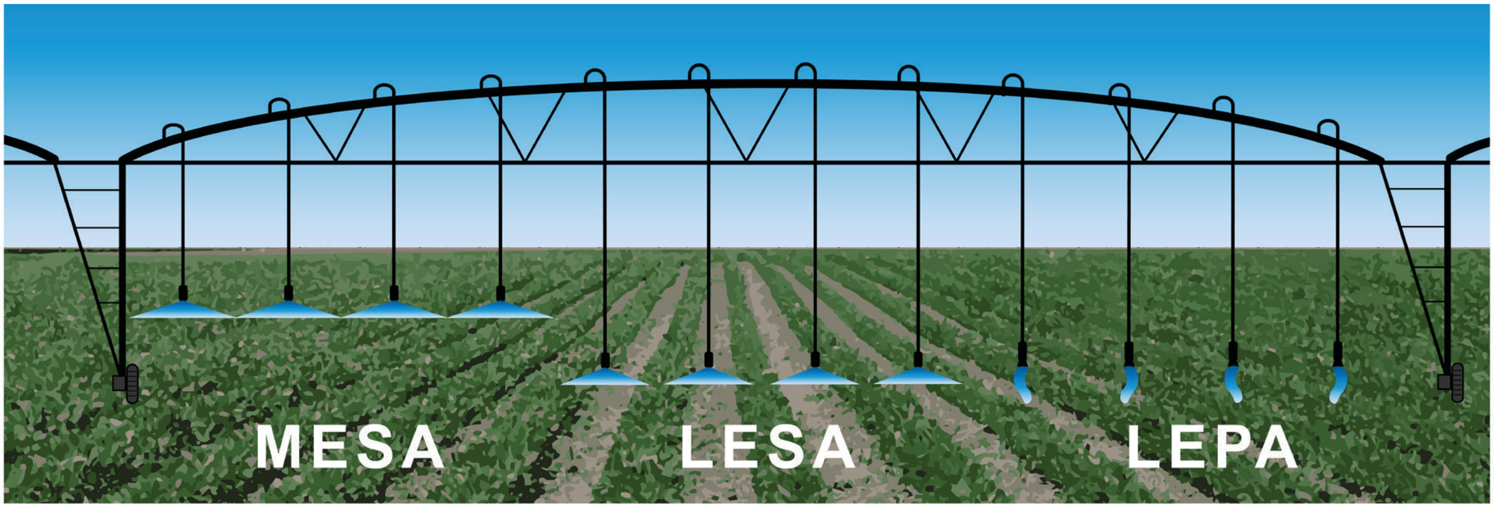

Figure 1. Center pivot layouts; middle-elevation spray application (MESA), low-elevation spray application (LESA), and low-energy precision application (LEPA).

Center pivot and linear-move overhead systems are used on over 50% of the total irrigated crop acreage in the United States.[1] Center pivot systems are used extensively for irrigating vegetable crops in areas such as the Columbia Basin of Washington and Oregon and for certain crops, such as carrots, in California.[2]

Typically, less labor is needed to operate overhead irrigation systems, and they usually require less maintenance than drip systems.[1] In addition to providing water for crop growth, overhead irrigation can be used to wet soils for field preparations such as bed formation, seal soils after fumigation, provide moisture for germination of direct-seeded crops, help protect crops from frost and freeze damage, apply fertilizers and pesticides, and help control dust.[1,3,4]

Traditional center pivot systems have sprinkler heads placed on top of the main water pipe. As a result of water losses from wind drift and evaporation, these systems have water application efficiencies around 60%, as compared to 80 to 95% efficiency levels with drip irrigation systems.[5] They also require water pressures of 40 to 80 psi, which can result in higher pumping costs when compared to drip systems that usually operate at pressures between 8 and 12 psi.

Innovations

Several innovations to center pivot systems over the past several years have greatly increased their application efficiencies and improved the ability to manage soil moisture levels. Most of the newer center pivot system have the sprinkler nozzles mounted on drop-down hoses to help reduce water losses from evaporation and wind drift. With mid-elevation spray application (MESA) systems, the nozzles are located about midway between the main water pipe and the soil surface (Figure 1). MESA systems usually operate at pressures of 25 to 40 psi and have application efficiencies of 78 to 85%.[1,5] Nozzles are often arranged on a 10-foot spacing, which allows the same amount of water to be applied in less time. With low-elevation spray application (LESA) systems, the nozzles are located 12 to 18 inches above the soil surface. LESA systems typically use operating pressures of 6 to 15 psi, and they often have application efficiencies between 88 and 97%.[1,5] Nozzle spacing for LESA systems can be as close as 5 feet, which allows for a high application rate.

Low-energy precision application (LEPA) systems are used to reduce water losses even further by applying the water directly to the soil using drop-socks or bubbler nozzles. LEPA systems typically use operating pressures near 15 psi and have

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application efficiencies around 95%.[1] Crops need to be planted in a circle in LEPA systems. The use of special tillage equipment may be needed to form small tillage-reservoirs to prevent runoff with LESA and LEPA sysems.[5,6] Mobile drip irrigation (MDI) systems that combine the benefits of drip and center pivot irrigation also have been developed. With MDI systems, short drip lines are attached to the drop-hoses of a center pivot rig, and the lines drag behind the moving pivot arm. MDI systems use low operating pressures and are useful in areas with low well yields. They are also less likely than LEPA systems to have problems with runoff and have somewhat higher application efficiencies under many conditions. However, the drip-lines are more susceptible to damage and may require more maintenance.[6]

Nozzles

Sprinkler nozzles have been developed that provide better uniformity and less water loss under windy conditions. These nozzles put out larger-sized droplets that are more resistant to wind drift and evaporation. Growers can also select nozzles with output rates that match the water infiltration rates in their soils. This helps prevent problems with water being applied too fast resulting in runoff. Nozzles that work at lower operating pressures also help reduce pumping costs.[7,8]

Figure 2. Over 100 center-pivot systems are managed using a central computer-based controller. Doug Wilson, USDA Agricultural Research Service, Bugwood.org.

Monitoring and Scheduling

Equipment and computer-based tools have been developed to help growers better monitor the soil moisture conditions in their fields and to allow them to control irrigation rigs remotely. Scheduling tools can be used to monitor soil moisture conditions in multiple center-pivot circles.[8] Probes monitor moisture levels at several depths in the soil at each location. The moisture information is transmitted to a software program that includes information on the type of crop, crop growth stage, appropriate Kc values, soil properties, and other information. The system also is connected to a weather forecast system, and all of this information is used to estimate water use by the crop and the need for irrigation as much as seven days in advance. Computer-based programs or mobile phone apps are also available to allow growers to use these recommendations to remotely control their center pivot systems and irrigation events (Figure 2).[2,8]

Variable Rate Irrigation

The newer control systems can be used for variable rate irrigation with center pivot systems. There are several methods of variable rate irrigation. Variable speed control speeds up or slows down the rate of travel of a pivot arm at certain segments of the irrigation circle to apply more (slower speed) or less (faster speed) water over that pie-shaped section. Another option is zone control, in which zones of nozzles along a pivot arm can be turned on/off, or have their application rates adjusted independently from the other nozzles on the pivot. These adjustments can occur at various segments along the path of the pivot to provide irrigation control over specific segments of the field. The most precise control is achieved using systems that allow the adjustment of application rates of individual nozzles on the pivot arm. These adjustments can be made at various points along the path of the pivot circle based on GPS coordinates, allowing for differential irrigation rates in small sections of the field. Variable rate systems allow growers to adjust the application rates based on soil conditions and other factors to prevent over-watering some areas of the field and under-watering others.[2,8]

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Web sites verified 3/14/2019

For additional agronomic information, please contact your local seed representative.