IRRIGATION WITH LEPA

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Decreasing water supplies and increasing production costs in the Great Plains are encouraging the development of innovative methods of applying water and chemicals more efficiently through self-propelled sprinkler systems. Lyle and Bordovsky (1981) developed the Low Energy Precision Application, LEPA, system concept where water is applied directly to the furrow at very low pressures. Crops are planted in the travel direction of the system to reduce the potential runoff. Since water is applied to a very small area beneath the nozzle, instantaneous application rates are very high creating a potential for significant runoff. Hence the reservoir or microbasin tillage operation is an integral part of the system concept to keep the water where is was applied until it can infiltrate. This tillage operation has the added advantage of increasing the effectiveness of rainfall from high intensity storms but it may impede subsequent travel with field machinery.

The advantages of the LEPA system are the effect of wind on water distribution is minimized and evaporation from wet soil and plant surfaces is reduced enabling more effective use of limited water supplies. Two years of data collected in Texas indicated savings of 7-15% in application efficiency for LEPA over sprinklers. No runoff was reported under the micro-basin treatment for the first several irrigations. However, dike erosion after 4 or 5 irrigation allowed 2-4% runoff under the LEPA system (Lyle and Bordovsky, 1983). The low pressure requirement is appealing to the producer concerned about increasing energy costs.

The disadvantage of the system is the increased potential for runoff because the high application rates exceed the infiltration rates of most soils. Whether this system is a viable option depends on the characteristics of the individual fields and the management strategies of the irrigator.

DESCRIPTION OF EQUIPMENT

LEPA equipment can be installed on new center pivot or linear-move sprinkler machines or retrofitted on existing machines. Rigid 'goose neck' tubes are installed in outlets at the top of the mainline pipe. Flexible tubing connects the 'goose-neck' tube with the LEPA head which is suspended about 12-18 inches (.31-.46 m) above the soil surface. Each head consists of either a 6 psi (41 kPa) or 10 psi (69 kPa) pressure regulator and a nozzle with a properly sized orifice. When crops are planted in a circle, these LEPA heads are spaced to apply water in alternate furrows. New systems can be ordered with the correct outlet spacing on the mainline but on existing systems, additional outlets may need to be added either by welding or using swedge couplers.

The original LEPA concept has been expanded to include other specialized operations such as wetting the entire soil surface for germination or applying chemicals through the pivot. Manufacturers have developed nozzles which allow easy changing of the application patterns to do these specialized operations. Commercially available nozzles have three different modes. The bubble or LEPA mode produces an umbrella shaped pattern approximately 18 inches (.46 m) in diameter. The spray mode produces a flat spray approximately 5 feet (1.52 m) in diameter which wets the entire soil surface. The third mode produces a 60 degree upward spray which sprays the underside of leaves on high profile crops such as corn. Excellent control of some types insects has been accomplished either by washing off or applying chemicals on the underside of leaves where most of the insects are.

Some irrigators have adapted various aspects of the LEPA system to meet their individual situations and preference with varying degrees of success. Some irrigators have omitted microbasin or furrow diking. Other have continued to plant in straight rows instead of circular rows under a center pivot. The success of these adaptations depends largely on the individual field situation.

CURRENT RESEARCH

A limited amount of research has been published about various aspects of the LEPA concept. Descriptions of the equipment and various details on installation and use of reservoir tillage are available (Lyle and Bordovsky, 1981, 1983).

Research done at Bushland, TX in 1987 and 1989 compared two methods of determining application efficiencies for impact sprinklers, sprays and LEPA. Applied depths were caught with both 20 inch (520 mm) diameter catch cans and weighing lysimeters which are 96.8 ft^2 (9 m^2) in area and have a resolution of .002 in. (.05 mm). Lysimeters have the advantage of measuring not only the infiltrated water but also the water intercepted by the crop canopy. Maximum catch rate from the sprays was approximately five times that of impact sprinklers and the maximum catch rate for LEPA was about eight times that from impact sprinklers. Lysimeter measurements gave application efficiencies of 80-82% for low angle impact sprinklers, 84% for sprays, and 96% for LEPA. Application efficiencies using catch can measurements were approximately 7% less (Schneider and Howell, 1990).

Application efficiency for LEPA was measured for treatments with and without reservoir tillage for two different compaction levels on a sandy loam soil with a .2% slope. At the low compaction level, very little difference in net water intake was measured between the with and without reservoir tillage treatments. The application efficiencies were very similar; 97% for no reservoir tillage and 99% for reservoir tillage. At the high compaction level comparable to two passes of a tractor, intake for a 50 mm application was about 40% greater with the reservoir tillage than without reservoir tillage. The application efficiencies increased dramatically from 56% with no reservoir tillage to 81% with reservoir tillage. (Hackwell, et al., 1990).

Research on a silt loam site near Burlington, CO in 1989, showed no runoff for a 1% slope but runoff exceeded 30% of the applied depth for a slope of 3%. This site was ridge tilled so there was considerable residue from previous crops on the soil surface but no reservoir tillage or in-row ripping was done. These results suggest that LEPA only be used on slopes of less than 3% unless additional efforts are made to control runoff.

The start-stop movement of individual towers on most center pivots prevents applying the same depth of water at all points in a field with the greatest nonuniformity occurring near the middle of the pivot pipeline. This nonuniformity may not make any difference if water can move freely along the furrow. The system behaves like a traveling gated pipe system where infiltrated depth is determined entirely by the infiltration parameters of the soil. If microbasin or reservoir tillage are used, water movement is restricted to the individual microbasins which may reduce the soil's ability to redistribute water and improve the system's application uniformity. This nonuniformity in the direction of travel may be more important if chemicals are applied.

Research in 1990 compared treatments with and without microbasins for circular and straight planted rows on a single slope of 1%. Application amounts were measured volumetrically and moisture contents were monitored during the season with a neutron probe. No measurements were made of deep percolation below the root zone. No significant difference in moisture content was detected between the with and without microbasins because there was sufficient overirrigation. The straight row treatments were discontinued the first part of July because the farmer who made all of the irrigation decisions, felt there was excessive runoff when most of the water from the LEPA nozzles was concentrated in several furrows.

LEPA offers promise for effective application of insecticides, fungicides and herbicides at rates much less than conventionally applied rates (Lyle, et. al. 1989). Insecticides which are insoluble in water and soluble in oil are best suited for chemigation because the oil droplets are attracted to the waxy leaf surfaces and resist wash-off. Application of miticides with LEPA provided superior control when compared to aerial application because of the direct application to the underside of the corn leaves (New, et. al., 1990).

The research cited above confirms the potential for high application efficiency with LEPA, but it underscores the need to control the potential runoff in some manner in order to actually realize the high application efficiency.

MANAGING LEPA

Most management strategies try to provide the necessary inputs so crop production is maximized on all parts of the field. Water use by the crop is considered uniform for the entire field so the goal of any irrigation system is to distribute water so every spot in the field receives the same infiltrated depth. However, various factors such as topography, natural variability in infiltration and water holding capabilities of the soil and irrigation system application nonuniformities, prevent uniform infiltration everywhere in the field and cause runoff. With proper timing and management, overirrigation and percolation losses can be minimized.

LEPA is a precise and efficient way of applying water. As with any irrigation system, there are some limits for its applicability. Little information on how to manage or operate the system has been published. The advantage of LEPA's high application efficiency can be easily lost if potential runoff is not carefully managed. There are several alternatives to managing the potential runoff. The original LEPA concept used furrow diking or micro-basin tillage to hold the water in the immediate vicinity of where it was applied until it could infiltrate. This does require another tillage operation and the micro-basins are susceptible to erosion especially on very sandy soil or sloping conditions.

Planting in a circle can reduce runoff by preventing the situation where all the water is applied in a few furrows when the pivot is nearly parallel to straight planted rows. For circular planted fields, it is highly desirable to apply water in the 'soft' furrows which have a higher infiltration rate than 'hard' furrows which have been compacted by tractor or implement tires.

In-row ripping as the last tillage operation can increase infiltration. Whether this can adequately control runoff depends on individual soil conditions, degree of compaction, and field slope.

Another alternative for reducing runoff is to increase the pivot speed which decreases the application depth and consequently the potential runoff for each revolution. Research by Lyle (personal communication, 1990) has shown that yield is not decreased with higher frequency, smaller depth irrigations. Since the application depth is .5 inch or less, an irrigation would be necessary about every 2 days during the peak ET period. This probably requires changing management strategies and would reduce the ability to utilize larger rainfall amounts if only small depletions were maintained.

Another option is to use the spray mode of the LEPA nozzle to increase the radius of application and hence decrease the instantaneous application rate. This decreases the potential runoff but has the disadvantage of wetting the entire soil surface thereby losing some of the savings in evaporation losses. Significant reductions in runoff were observed but not measured when the spray mode was used.

Applying only enough water to meet the crop water requirements is essential for using water more efficiently and minimizing overirrigation and runoff. Monitoring soil water depletions and irrigation scheduling can enable more effective application.

CONSIDERATIONS FOR LEPA

Several of the main reasons for installing LEPA include:

1. Improved application efficiency which reduces evaporation losses and stretches limited water supplies.
2. Reduced energy costs because of lower pressure requirements.
3. Better or more economical methods of controlling pests or applying chemicals.

If the main reason for considering LEPA is to stretch limited water supplies, one should realize that as the design capacity on a per acre basis is reduced, the probability of the being able to supply peak ET decreases. For any specific probability level, the net system requirement increases with decreasing allowable depletion. For a particular allowable depletion level, the probability of supplying the crop water use decreases with decreasing system capacity. This does not mean total crop failure but rather an increased risk in meeting the full amount of a crop's water needs.

If LEPA is considered as a way to significantly reduce energy costs, it will probably be necessary to redesign and rework/replace the pump to lower the output pressure. If reducing the discharge to decrease electrical energy demand charges is also being considered, one should realize the tradeoffs involved. Reducing discharge reduces the flexibility of when to irrigate because reduced discharge requires more of the available time to supply crop water requirements. It may be difficult to place a monetary value on this reduction of flexibility and increased risk for supplying crop water needs. The additional cost of any runoff control measures should also be considered when comparing the costs of various irrigation system alternatives.

LEPA offers promising potential for controlling pests and applying chemicals at rates much lower than conventional application rates. This is a new area of application so documented results are very limited currently. Producers are also interested in applying fertilizers with the irrigation water to supply the necessary nutrients as they are used by the plants. With increasing environmental awareness of non-point pollution coming from application of agricultural chemicals, methods for accurately applying agricultural chemicals at reduced rates are bound to become more important in the future.

SUMMARY

LEPA can precisely apply limited water at very low pressures and reduce energy use. Close control of potential runoff is essential to realize these potential benefits. Additional management practices or modifications to current practices may be necessary to control runoff effectively.

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