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Quick Facts

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Applying agricultural chemicals through center-pivot irrigation systems is not a new idea.

The pros and cons of applying pesticides in this manner are the subject of constant debate particularly in comparison with aerial application.

The major disadvantage of this application method is the potential hazard posed to groundwater by the backflow of pesticides into the well when the irrigation pump is shut off; other problems are overflows, chemical spills and application of pesticides to adjacent crops or noncrop areas.

Correct application and safety procedures can minimize problems.

There are an estimated 5,000 center-pivot irrigation systems in Colorado, covering approximately 650,000 acres. This represents one-fifth of the irrigated acres in Colorado, and substantial portion of the intensively-managed irrigated acres. The majority of these systems are located in the Ogalalla area of eastern Colorado, while another large group is found in the San Luis Valley. Corn, potatoes and small grains are perhaps the major crops irrigated in this manner, but alfalfa, sugar beets and other crops also are irrigated by center-pivot systems.

The idea of applying agricultural chemicals through center-pivot irrigation systems is not a new one. The application of fertilizers was first suggested in the late 1950s and had become a common practice by the end of the following decade. Pesticides were next to receive attention.

Much of the early work on herbicides was done by P. E. Heikes of Colorado State University. Applying pre-plant herbicides in this manner assures sufficient soil moisture for "activation," and in minimum tillage systems eliminates most of the problem of "tie up" by the crop residues. The desired depth of soil incorporation can be achieved by regulating the amount of water applied. Most herbicides must be incorporated mechanically

Applying pesticides through center-pivot irrigation systems

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when applied by other methods. On the negative side, pre-plant or pre-emergence herbicides need to be applied just before or very soon after planting when irrigation may not be needed, although the amount of water used is less than normally would affect a germinating crop.

M. Harrison of Colorado State University and others have studied the application of fungicides through center-pivot irrigation systems for control of such potato diseases as early blight. Disease control with sprinkler application of several potato fungicides was effective as with aerial applications.

Insecticides were first successfully applied through a center pivot system in Colorado in 1976 by W. Hantsbarger and S. Pilcher of Colorado State University. At first this technique was limited in accuracy, but with the advent of adjustable diaphragm pumps accuracy became acceptable even for the synthetic pyrethroids that are applied at rates of .05 lbs active ingredient per acre. Since that first trial, 14 formulations of seven different insecticides have been tested on field corn and have given good control of first and second generation European corn borer, adult western corn rootworm and western bean cutworm.

The pros and cons of applying pesticides in this manner are the subject of constant debate particularly in comparison with aerial application. Among the advantages for center-pivot applications commonly proposed are reduced application costs, uniformity of application, timeliness of application, possible reduced operator hazard, possible reduced chemical requirements and improved canopy penetration. Many of these observations have not been tested and sufficient data to support or deny any of them are lacking.

The major disadvantage of this application method is the potential hazard posed to groundwater by the backflow of pesticides into the well when the irrigation pump is shut off. Another problem is water flowing into the nurse tank, which can occur if the injection pump is shut off and the irrigation pump continues to run. This

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can cause overflows and chemical spills. If the irrigation pump stops and the injector continues, an overapplication would result, possibly causing crop damage and environmental contamination. Finally, excess watering is common near the pivot and at the end gun, which can lead to over-application, deep leaching and runoff of pesticides in these two areas. Improperly adjusted end guns or windy weather also can result in the application of pesticides to adjacent crops and noncrop areas. These problems can be minimized if the application and safety procedures discussed below are followed closely.

Application Methods and Safety

1. The injection pump

The point of injection should be between the check valve (see safety section 3a) and the vertical section of pipe (Figure 1). This will insure good mixing of the water and the pesticide by the turbulence at the right-angle bends.

With current pesticides, an injection pump accurate to 1% is essential for precise, economical applications. The diaphragm pump is the only type presently capable of such accuracy. The pump also should allow for adjustments, without disassembly, during calibration to avoid hazard from chemical spills.

2. Calibration

As with any pesticide application method, good calibration is essential for economical control. Applying too little can result in poor control and subsequent yield loss, while applying too much wastes chemical and results in higher costs than are necessary for adequate control. The following calculations will allow you to determine the milliliters of pesticide solution per minute needed from the injection pump for the proper application rate.

a. Circumference of the center pivot

$$\text{Circumference} = 2\pi R$$

R = distance in feet from the pivot point to the last tower
($\pi = 3.14$)

b. Acres to be treated

$$\text{Acres} = \frac{\pi R^2}{43560}$$

In this case, R includes the reach of the end gun.

c. Rate of travel

Measure the distance traveled by the last tower in 10 minutes, while the system is delivering water at the volume desired for the application, to determine feet/minute.

d. Revolution time

$$\text{Time} = \frac{\text{circumference in feet (from a.)}}{\text{feet/minute (from c.)}}$$

e. Acres treated/minute

$$\text{Acres treated/minute} = \frac{\text{acres to be treated (from b.)}}{\text{revolution time (from d.)}}$$

f. Application rate

$$\text{Milliliters/minute} = (\text{milliliters of pesticide to be applied/acre}) \times (\text{acres/min})$$

Once the application rate is known then the injection pump can be adjusted. This is best accomplished by mounting a measuring cylinder (graduated in milliliters) in-line between the nurse tank and the pump (Figure 3P). This is filled and the rate of emptying is monitored until the proper rate is achieved. Use short timings for coarse adjustments and longer intervals for the final checks. The injection pump should be rechecked several times during the application.

3. Safety

a. An anti-backflow check valve should be installed to prevent injected chemicals from siphoning into the well (Figures 1, 2E, 2F). This valve should be automatic, quick-closing, tight-sealing and able to exert 1 pound per square inch (psi) back flow pressure. The valve housing should be equipped with a low-point, manual drain (Figure 2H) as well as an access port and/or drain plug between the valve and the well to allow inspection to insure that the valve is functioning properly. An air release-vacuum breaker (Figure 2B) also should be fitted between the valve and the well to prevent air locks that affect the functioning of the check valve.

b. An in-line check valve should be installed at the point of injection into the main water line to prevent the flow of water from the irrigation system back into the nurse tank and thus avoid overflow of chemicals on the ground.

c. The irrigation pumping plant and the injection pump should be interlocked electrically so that if the irrigation pump stops, the injection pump also stops. Additionally, irrigation systems should be operated in the automatic mode, so if the forward motion of the sprinkler system stops, both pumps will be shut off automatically. This will prevent pumping the entire contents of the nurse tank onto the area of the field under the stationary system.

d. The first 2-3 nozzles should be shut off during the application to avoid overapplication of pesticides in the well area. If end guns are used, they should be adjusted to eliminate application or runoff of chemicals to nontarget areas.

e. The person who is likely to be applying pesticides through the center pivot system will be responsible for proper disposal of the containers. All containers must be triple rinsed, which is best accomplished by the following procedure recommended by the National Agricultural Chemicals Association.

- Empty the container into the spray tank and allow to drain in the vertical position for 30 seconds.

- Add a measured amount (1/4 to 1/5 of the container capacity) of water or other diluent to the container.
- Rinse the container thoroughly, pour into the spray tank, and allow to drain for 30 seconds. Repeat 3 times, then bring spray tank up to level.
- Crush the container immediately. Crushed, triple-rinsed containers may be buried at a sanitary landfill or on the farm. Containers that are too large to be crushed will require special handling. No pesticide container should be re-used.

The above information on equipment, calibration and safety should allow the safe and econom-

ical application of pesticides through center-pivot systems. It should be noted that the legal aspects of this method will probably change, both at the state and federal levels. At the state level, well permits and certain safety equipment may become mandatory. At the federal level, the types of pesticides that can be applied this way may be restricted. Be sure to read and follow all pesticide label precautions. Your county extension agent can advise you of recent changes in this area.

For additional information on safety devices refer to *Chemigation: recommended safety devices*, Service in Action sheet no. 2.801. For information on applying fertilizers see *Fertigation: applying fertilizers through irrigation water*, Service in Action sheet no. .512.

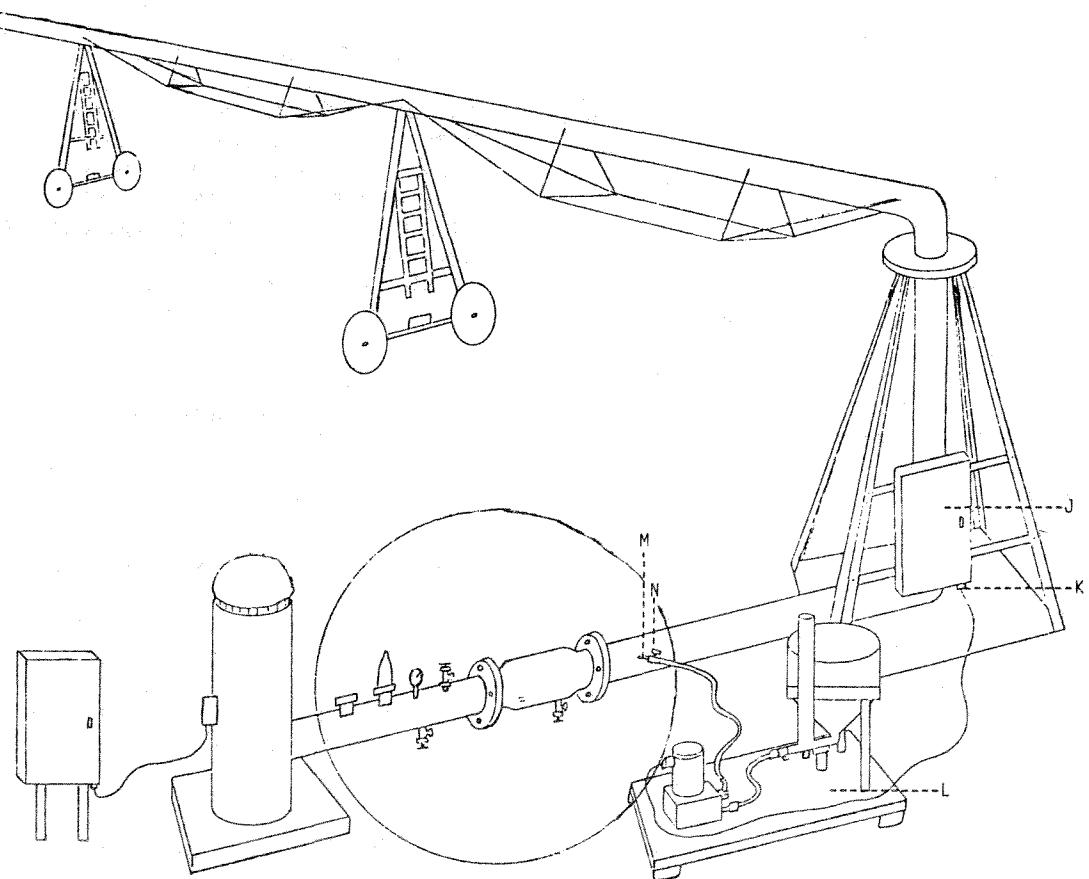


Figure 1: A center-pivot system.

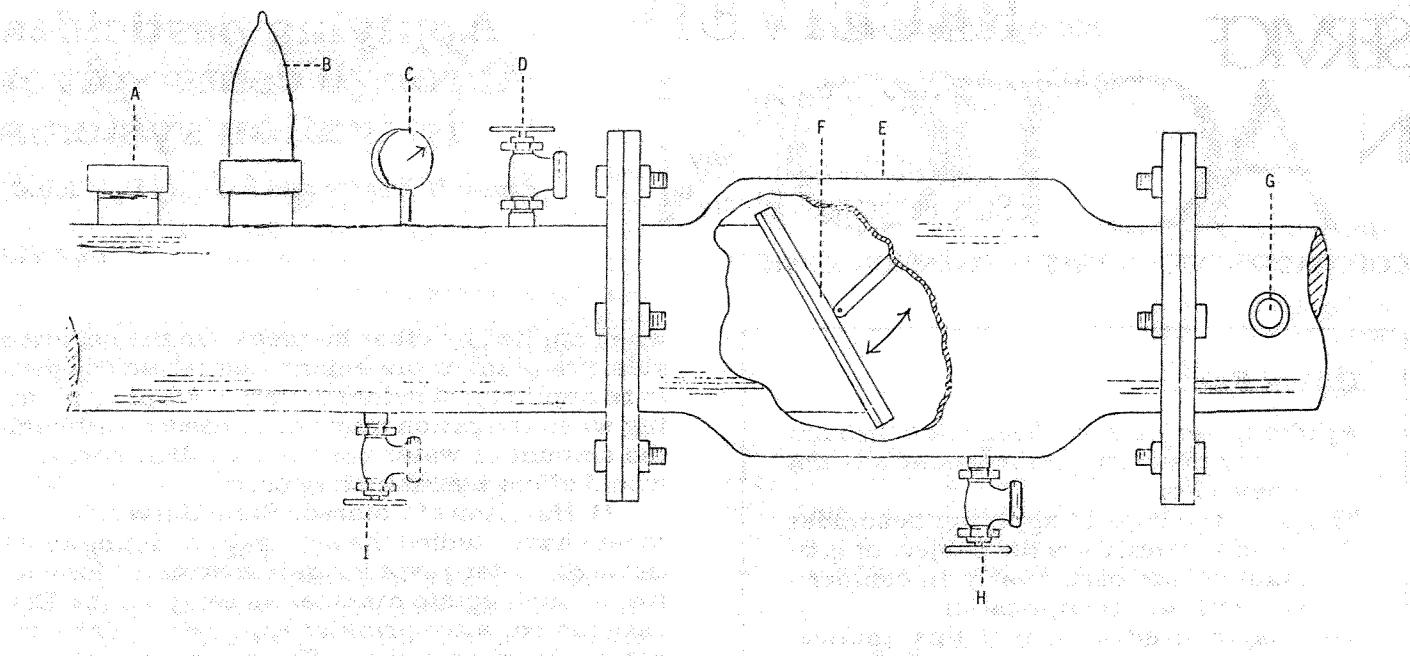


Figure 2: Close-up of section from Figure 1.

A—Two-inch nipple—observation hole
 B—Vacuum pressure relief valve
 C—Pressure gauge
 D—Fresh water supply valve
 E—Anti-back flow check valve (unit)
 F—Spring-loaded valve
 G—Injection port—in-line check valve

H—Low point drain valve
 I—Drain valve
 J—Sprinkler electric control panel
 K—Interlock electrical system
 L—Injection unit
 M—In-line check valve
 N—Injection hose—bleed valve

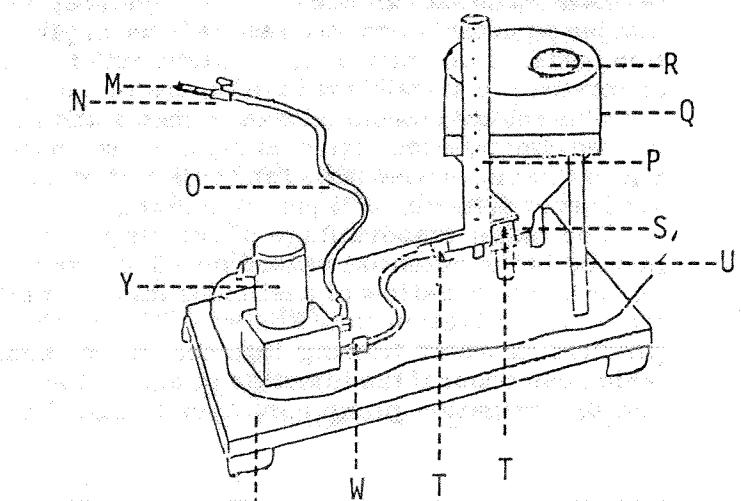


Figure 3: Pump and nurse tank section.

M—In-line check valve
 N—Air lock bleed valve
 O—Nylon hose
 P—Calibration cylinder
 Q—Nurse tank
 R—Nurse tank lid—vented
 S—Drain
 T—On-off valves
 U—Filter
 W—Threaded nylon couplers (4)
 X—Drainable platform
 Y—Cone diaphragm injection pump