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INJECTION OF AGRICULTURAL CHEMICALS INTO MICRO-SPRINKLER SYSTEMS

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Abstract. **The practice of applying agricultural chemicals through micro-sprinkler systems, a type of chemigation, has been on the increase in the citrus industry during recent years. Liquid fertilizer applications initiated the trend which now includes the distribution of fungicides, herbicides, and insecticides. Many benefits may be realized through micro-sprinkler chemigation, but only after proper safety and correct chemigation procedures are established. This report presents the advantages and disadvantages to micro-sprinkler chemigation, and describes the safety and calibration procedures necessary for the distribution of agricultural chemicals.**

The application of liquid fertilizer through irrigation systems has been a common practice in all phases of agriculture for many years. In addition to plant nutrients (3), other materials such as herbicides, insecticides, fungicides and nematacides can be accurately applied through irrigation systems (1, 2).

The term chemigation has evolved as a result of such applications and refers to the distribution of any agricultural chemical by irrigation system.

In the past 15 yr, the micro-sprinkler (MS) system has made a dramatic impact on the Florida citrus industry. With benefits such as economical water distribution and cold protection; the micro-sprinkler is by far the most popular irrigation system used in the Florida citrus industry today.

The advent of chemigation through MS systems is a relatively new development, though early work done in California, South Africa, and Lake Alfred (4) showed that properly designed MS systems could accurately apply fertilizer materials as well as crop protection chemicals.

Agricultural chemicals can be applied through MS systems provided the chemical is labeled for the intended crop (in our case citrus) and that the label does not prohibit that type application. This new technology must be carefully analyzed by the grower to determine all possible advantages and disadvantages before it is implemented. The irrigator must furthermore endeavor to use the proper calibration procedures and equipment to prevent potential contamination of the water source (5).

Design and Safety Equipment

The basic system for delivering a crop protection chemical into a MS system consists of a chemical supply tank, an injection system, and the appropriate safety and anti-siphon devices that prevent potential contamination of the water source. When the MS is in operation, the chemical pump moves the material to be injected through an injection portal into the irrigation stream.

The following safety equipment must be utilized in the design of any chemigation system: 1) An anti-siphon device that prevents contamination of the water source in the primary safety element on a MS system used for chemigation. The device consists of a check valve and vacuum breaker. These devices are located between the irrigation pump and the injection portal, and prevent a mixture of water and injected material from draining or being back-siphoned into the water source as well. As an additional safety device, a drainage point is located between the irrigation pump and anti-siphon device. 2) Power sources for injection pumps and irrigation pumps ideally should be inter-connected so that the injection pump cannot be in operation without the irrigation system running. This assures that in case of irrigation pump failure the injection pump will not continue to inject into an empty irrigation line or backwards into the water source. 3) A check valve in the chemical injection discharge line is required to prevent the flow of irrigation water back through the chemical supply line to the chemical supply tank overflowing the tank and causing a chemical spill around the water source. 4) A valve must be provided on the chemical holding tank to provide positive shut-off of the chemical supply when the injection system is not in use.

All valves, lines, hoses and injection equipment must, of course, be corrosion resistant. 5) For permanent holding tanks, tanks should be located at a site removed and sloped from the water supply. This ensures that the water source will not be contaminated if a spill or rupture of the tank occurs.

Lastly, any proper chemigation system is extremely dangerous if the wrong materials are improperly applied or handled. Systems must be properly designed and installed and chemicals used according to label directions.

Calibration Procedure

The application of crop protection chemicals through MS systems will only be as accurate as the system design permits. Poorly designed systems produce uneven water application and, therefore, uneven chemical application. Under-dosage and over-dosage are usually the result of attempting chemigation on a poorly designed system.

Ideally, if a MS system is properly designed, each emitter will discharge equal volumes of water over the irrigated area. Before chemigation is attempted on any system, the uniformity of water application must be checked. The Florida Irrigation Society reports that a uniformity coefficient of 10% must exist before chemigation can be attempted with a MS system. Any greater variance will lead to unequal chemical distribution.

Systems must be calibrated to determine uniformity coefficients, and to assess injection intervals.

1) Before starting to calibrate, operate the system until all emitters are running and balanced at full pressure.

2) Determine the uniformity coefficients of emitters. This is done by making up an indicator solution of detergent, dye, chlorine or soluble fertilizer. Detergent is the simplest and least expensive indicator because soap bubbles are easily seen exiting emitters. The latter three methods require special equipment—a test kit, or salt bridge.

3) Begin injecting the indicator solution and start timing the injection.

4) Monitor emitters at the closest point to the water source and the point farthest away. If the time interval where the indicator is present at both monitored emitters is within 90% of each other, comparable coverage will be obtained during the application.

5) The time interval from when the indicator was injected and when it appeared at the farthest emitter, will be the minumum time required to inject the desired material into the system.

EXAMPLE:

	Time Interval	Minutes from Injection
First Emitter	12	2
Last Emitter	12.5	30
	12/12.5 = 96% Uniformity Coefficient	4% difference

CHEMIGATION OKAY
INJECTION TIME 30 MINUTES MINIMUM

6) Once the system is calibrated, the pumping capacity of the injection system must be determined. Determine the minimum injection rate by dividing the total number of gallons of solution in the tank by the minimum time derived from the calibration. Calibrate the delivery rate of the injection pump to make certain the rate is correct. A flow meter on the injection pump is most beneficial.

7) Determine what rate of formulated product is to be applied based on the number of emitters or the area to be treated.

8) Mix the proper amount of product in a volume of water sufficient enough to enable it to be pumped into the system, over the minumum time period derived for uniform distribution.

9) And finally, allow the irrigation system to operate for sufficient time following the injection to completely flush the chemical from the system.

Advantages, Possible Disadvantages and Discussion

Advantages of MS chemigation include: 1) reduced application, labor and energy costs; 2) reduced equipment needs; 3) greater timeliness and convenience of operation; 4) reduced operation hazzard; 5) in some cases, better chemical activity.

Possible disadvantages include: 1) great management input requirements; 2) specialized equipment; 3) the possibility of increased environmental hazard; 4) may require unnecessary irrigation. Other factors to be considered are environmental conditions, emitter obstructions, and chemical formulation incompatibility.

Wind velocity is the most important environmental factor affecting chemigation. Wind can distort the water application pattern causing unequal chemical distribution. Chemigation should not be attempted when wind velocities exceed 7 mile/hr. Wind also increases evaporation and can lead to the loss of more volatile chemicals.

Obstructions around MS emitters at the tree, such as weeds and low hanging limbs, can effect emitter coverage. Any plan to use chemigation in groves where this is a problem should be analyzed and corrected before the attempt. In the case of weed obstruction, conventionally applied herbicides should be used beforehand.

Chemical formulation incompatibility refers to possible problems which may occur with injecting certain formulations of products. The agitation and mixing of wettable powders in the chemical storage tank are of primary concern. Flowable and liquid formulations should be used where agitation is a problem. Also of concern is possible corrosive effects of some chemical formulations on the irrigation systems components—lines, fittings, emitters, etc.

Chemigation in Florida citrus has a bright future if it is properly instigated with careful calibration and anti-pollution features. The trend toward injecting agricultural chemicals will undoubtedly increase as new systemic and low phytotoxic materials are introduced into the citrus market.

Finally, an irrigator in Florida has the priviledge of using Florida's most valuable resource—its fresh water. Since the irrigation water supply is also the drinking water supply, it is imperative that this privilege is not abused.

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