Fertilizer Injectors Made Easy

by Bodie V. Pennisi and Marc van Iersel

Since the introduction of injectors or proportioners growers have enjoyed an easy, time- and labor-saving application of liquid chemical solutions to their crops. These devices are used to apply water-soluble fertilizers, pesticides, plant growth regulators, wetting agents, and mineral acids. They are a vital part of the modern greenhouse or nursery operation. Yet, probably every grower has a story to tell about a compromised, damaged or even ruined crop where the cause was traced to a malfunctioning injector. Just like with any mechanical device, proper and frequent maintenance and calibration are crucial steps to ensure optimal injector performance.

Injectors work on one of two principles. Venturi-type injectors, such as Hozonâ and Syfonexâ use a pressure difference between the water line and the stock tank to draw concentrated solutions into a faucet connection and mix them with water in the hose. These inexpensive injectors can be easily attached to any faucet but do not allow precise control over chemical application. Because of water pressure fluctuations, variable amount of chemical may be injected into the hose. In addition, the proportion ratios are low (typically 1:15) and therefore require large stock tank, thus limiting the use of Venturi-type injectors to small growing areas.

Positive displacement injectors, such as Anderson, Dosmatic, Dosatron, Gewa, and Smith products use mechanical or electric pumps, or water pressure to inject concentrated chemical solutions into the water line. Precise control over the amount of injected chemicals, smaller stock tank, and broader injection ratios has made positive displacement injectors a standard for the industry.

When Choosing an Injector…

The choice of an injector should be made after some important aspects have been considered.

- Size of operation, fertility programs and types of crops grown
- Water flow rate (see sidebar for calculation of water flow rate)
- Stock tank size – should be based on proportion ratio and daily water usage
- Chemicals being injected, particularly if acid injection is desired
- Multiple injection heads (for incompatible chemicals)
- Pressure required for proper operation of the injector
- Portable or stationary injector
- Ease of repair and longevity of the unit (if the repair cost is equal to half or more of the cost for a new unit, replacement of existing injector is advised).
- Manufacturer's reliability, technical support, service, and other qualifications. Many manufacturers have websites with useful information about their products; browse through their catalogs on line.

When Installing an Injector…

Consider installation of additional equipment for optimal performance:

- A 140 or 200-mesh filter is recommended upstream of the injector unit.
- Pressure regulator if in-line water pressure exceeds the maximum allowable for the unit; a one-way check valve may be helpful against water hammer.
- A backflow valve to prevent contamination of irrigation water supply if negative pressure occurs. These valves are mandatory in most states.
- Install the injector off the main line in case of malfunction or maintenance.
- Some injectors come with optional EC meters in the water line. This makes it very easy to determine whether the injector functions properly.
- A blend tank may be needed to assure good mixing of the water and fertilizer. Whether you need a blend tank depends on the type of injector and design of the irrigation system. The company representative can help you with this.

When Using an Injector…

Some things you should know:

- Dilution ratio should be known and adjusted as needed (see sidebar on calibration methods). If large deviations (larger than 5%) from the expected setting occur, contact the manufacturer for possible repair or replacement.
- Soluble fertilizers should be dissolved completely; use hot water if necessary but allow the solution to cool before starting the injector.
- Dilution ratios higher than 1:200 require highly concentrated stock solutions; fertilizer may not dissolve completely due to exceeded maximum solubility.
- Tracer dye in water-soluble fertilizers should not be used as an indicator of solution's strength; different fertilizer lots may have variable dye contents causing variability in intensity of the fertilizer solutions.
- Before mixing up different chemicals in the injector, product labels and manufacturer should be consulted to determine compatibility of the products. Potential acidity and/or corrosiveness of the chemicals should be taken into account, especially if acid injection is planned.

- Extreme caution should be exercised with acid injection; injected acid concentrations should not exceed 5%. Selection of a particular acid depends on the acid concentration and water temperatures. With every 2 degrees Fahrenheit, the speed of acid reactivity increases ten fold. When using acids, always have baking soda at hand. If you come in contact with acid, quickly cover the acid with a generous amount of baking soda. This will neutralize the acid and minimize injuries.
- Constant agitation is needed when applying wettable powders because they suspend but do not dissolve in water.
- Stock tank should be covered to prevent algae and/or debris buildup, contamination, or evaporation of stock solution.
- Stock tanks need to be opaque. The chelating agents in the fertilizer break down if they are exposed to light. Chelating agents help to make micronutrients available to the plants and are needed to prevent micronutrient deficiencies.
- If you're using a large stock tank, make sure that the stock solution is mixed well before using it. Water-soluble fertilizers tend to accumulate in the bottom of stock tanks, which can results in large differences in fertilizer concentrations.
- Injector should not be exposed to freezing temperatures as cracking and/or warping may result.

When Caring for an Injector…

- Intake strainer should be suspended 3-4" from the bottom of the solution tank to avoid pulling up undiluted concentrate); never let the suction tube filter lie on the bottom of the stock tank.
- Inject clean water after use.
- Solution tank should be cleaned regularly (weekly or biweekly, depending on frequency of use) to prevent dirt and scale buildup.
- Suction tube filter should be cleaned in filtered water.
- Strainer should be inspected regularly for clogs and/or cracks.
- Inspect and service O-rings.
- Petroleum based lubricants (Vaseline, lanoline, WD-40, motor oil) should not be used on dosage pistons or seals.

How To's

How to Check Water Flow Rate

WATER METER METHOD. If a water meter is installed, flow rate can be obtained easily. Turn on the irrigation system fully and read the meter at a specific time. Take a second reading after the water has run for a period of minutes. Convert the difference between the beginning and ending meter readings from cubic feet (which most water meters measure in) into gallons by using the following formula:

$$\text{RATE OF FLOW} = 7.5 \times \left[\frac{\text{meter B} - \text{meter E}}{\text{minutes}} \right]$$

where,
RATE OF FLOW is expressed in gallons per minute,
meter B is beginning meter reading,
meter E is ending meter reading,
minutes is duration of test.
OPEN CONTAINER METHOD. If the water supply flows through a single orifice, a suitable container can be used to measure the water flow rate. Turn on the flow fully, and time how many minutes it takes for the tank to fill. Divide the capacity of the tank in gallons by the number of minutes to obtain flow in gallons per minute.

How to Calibrate an Injector

Periodic calibration is needed to ensure that an injector is operating properly.
DILUTION RATIO. Collect a known amount of fertilizer solution from the injector then measure the quantity of concentrated fertilizer that was taken up by the injector. Determine the dilution ratio by the following formula:

$$\text{DILUTION RATIO} = \text{DILUTED VOLUME} \div \text{STOCK VOLUME}$$

where,
DILUTED VOLUME is the known amount of fertilizer solution after it has passed through the injector,
STOCK VOLUME is the amount of concentrated fertilizer solution that was used during the test.
Start test by turning the injector on to remove air bubbles and charge the system with concentrated stock solution. Turn off the unit, remove the intake or suction tube from stock tank, and place it in a large volume (minimum 500 ml) graduated cylinder. Fill the cylinder with a known volume of the concentrated stock solution. Turn on the injector and collect a known volume of diluted fertilizer solution (e.g. 5 gallons).
EXAMPLE. Injector is set for a 1:50 ratio. If (in the above test) 370 ml of concentrate was used to make 5 gallons (18,925 ml) of diluted solution, the actual ratio is $18{,}925 \div 370 = 51$. This is close to expected, because it is off only by 1%. Repeat this test several times.
You should also check the manual of your injector for other ways to test your specific injector.

ELECTRICAL CONDUCTIVITY (EC) MEASUREMENT.
This easy method is commonly used for water-soluble fertilizers. It does not require collection of large quantity of fertilizer solution and is an excellent means of periodic monitoring of the fertilizer program. Critical element for this method is to follow precisely the fertilizer manufacturer's guidelines for mixing up concentrated solutions. Fertilizer suppliers generally provide charts with EC readings of various concentrations of water-soluble

fertilizer solutions. When measuring the required quantity of fertilizer (usually given as a weight amount), use a scale to ensure right amount. Using other measuring means, e.g. coffee cans, plastic cups, etc., will result in erroneous reading of EC due to variability in the fertilizer quantity used to make up the concentrated solution. Only reliable, calibrated conductivity meters should be used to ensure accuracy of reading. Standardized conductivity solutions are available from the measuring device manufacturer and should always be kept at hand.

Start test by collecting an on site sample of clear irrigation water. Let the water run for a few minutes to flush out pipes before collecting the sample. Measure the EC of this water sample and record it. Turn the injector on and run it for a few minutes before collecting a sample of the fertilizer solution in a clean container. Test and record EC of the fertilizer solution. Calculate the EC contributed by the fertilizer by the following formula.

$EC_{FERTILIZER} = EC_{FERTILIZER\ SOLUTION} - EC_{IRRIGATION\ WATER}$

Compare this reading to a chart from the manufacturer bag label.

EXAMPLE. Injector is set for a 1:50 ratio. 10.1 oz of 20-10-20 fertilizer for each gallon of stock mix is used at a concentration of 300 ppm N. If (in the above test), the $EC_{IRRIGATION\ WATER}$ is 0.3 mmhos/cm and the $EC_{FERTILIZER\ SOLUTION}$ is 2.10 mmhos/cm, the actual $EC_{FERTILIZER}$ is 2.10 – 0.3 = 1.8 mmhos/cm. The technical chart for this particular fertilizer lists that the expected EC for 300 ppm N is 1.86 mmhos/cm. Therefore the actual dilution ratio is off by a factor of about 3% (1.86 ÷ 1.8 = 1.033). This method gives a ballpark estimate on the fertilizer program. Regular testing of the fertilizer EC is an effective means of monitoring injector performance. Make sure to calibrate your EC meter before using it! Without calibration you will get poor results and make the wrong decisions concerning your fertilizer program.

SOME HELPFUL FORMULAE AND CONVERSIONS

To convert from injection ratio to percent:
(100 ÷ injection ratio)
EXAMPLE (100 ÷ 50) = 2%

To convert from percent to injection ratio:
100 ÷ percent = injection ratio
EXAMPLE: 100 ÷ 2% = 1:50

METRIC CONVERSIONS

TO CONVERT FROM	TO	MULTIPLY BY
Gallons	milliliters	3785
	cubic feet	0.134
	liters	3.78
Grams	ounces	0.03527
Liters	fluid ounces	33.8
	quarts	1.06
	gallons	0.264
Ounces (weight)	grams, milliliters	28.35
Ounces (fluid)	liters	29.6
	milliliters	0.0296
Pints (fluid)	liters	473
	grams	0.473
Pounds	cubic in.	454
Quarts (fluid)	milliliters	67.2
	liters	0.946

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