Testing Fertilizing Injector and Stock Tank Preparation

In any fertilization program our goal is to make sure that plants receive the target rate of fertilizer that was requested. During the fertilizer calculation exercise we learned that we can measure the EC coming off the end of the hose and compare this to a table of values to check that the right amount of fertilizer is being used. If the measurement is not correct, then additional trouble shooting is necessary to determine if the problem is due to the injector not operating correctly or due to the stock solution being incorrectly mixed. In this exercise we will guide you through a series of steps to learn about this troubleshooting process (see Flowchart 1. Testing proper injection function).

STEP 1) TEST THE END OF HOSE SOLUTION

Your group has been provided with a solution of 21-5-20.

What is the target fertilizer concentration? _____ ppm N

What is the target EC of the fertilizer (based on the label below)? ______ mmhos/cm

<table>
<thead>
<tr>
<th>Nitrogen ppm N</th>
<th>Injector Ratios*</th>
<th>E.C.** mmhos/cm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1:15</td>
<td>1:100</td>
</tr>
<tr>
<td>25</td>
<td>0.24</td>
<td>1.61</td>
</tr>
<tr>
<td>50</td>
<td>0.48</td>
<td>3.22</td>
</tr>
<tr>
<td>75</td>
<td>0.72</td>
<td>4.82</td>
</tr>
<tr>
<td>100</td>
<td>0.96</td>
<td>6.43</td>
</tr>
<tr>
<td>150</td>
<td>1.45</td>
<td>9.65</td>
</tr>
<tr>
<td>200</td>
<td>1.93</td>
<td>12.86</td>
</tr>
<tr>
<td>300</td>
<td>2.89</td>
<td>19.30</td>
</tr>
<tr>
<td>400</td>
<td>3.86</td>
<td>25.72</td>
</tr>
</tbody>
</table>

Often our greenhouse fertilizers have added Epsom salts to provide magnesium which is not supplied in 21-5-20. Use the table below to determine the EC value that Epsom salts adds to our fertilizer.

<table>
<thead>
<tr>
<th>PPM of Mg from ppm N</th>
<th>Contribution to EC</th>
</tr>
</thead>
</table>

References: prepared by Neil Mattson, Assistant Professor and Floriculture Extension Specialist. Text and flow-through charts adapted from documents by Missy Bidwell, Grower; Andy Leed, Manager; and William Thompson, Grower-specializing in injector maintenance, Cornell University
Epsom Salts
(MgSO$_4$·7H$_2$O) | (mmhos/cm)  
---|---
10 | 0.08  
20 | 0.16  
30 | 0.25  
40 | 0.33  

What is the EC contribution of Epsom salts? _______

If other fertilizer additions are used, you will have use a lookup table to determine their addition to fertilizer EC.

What is the target fertilizer EC including Epsom salts? _______ mmhos/cm

Remember that the tap water you are using also has some level of salts dissolved in it (around 0.4 mmhos/cm for Cornell water). You can calculate what the final EC should be of the water hitting your plants from the equation below.

$$\text{final EC} = \text{EC of tap water} + \text{EC of fertilizer} \quad \text{Equation 1}$$

What is the tap water EC? ______ mmhos/cm

What is the target fertilizer EC (use equation 1)? ______ mmhos/cm

Now check the EC of the fertilizer water coming off the end of the hose. Be sure to allow enough time for the hose to run so that new water is coming off the end. Then allow a decent volume of hose water to run into a bucket and collect a sample from this bucket (this ensures an accurate reading).

EC of water from end of hose? ______ mmhos/cm

How did the two values compare?

If they are nearly the same, then you can be assured that your fertilizer stock was mixed correctly and your injector is operating at the correct ratio. And you are finished! (But today you will complete the exercise even if it is correct so you can gain practice at calibrating the fertilizer injector and testing the stock solution.

If your hose value was less than the target EC, then:
- Your stock solution may be too dilute (i.e. not enough fertilizer was added), or
- Your injector may not be drawing up enough fertilizer stock

If your hose value was greater than the target EC, then:
- Your stock solution may be too concentrated, or
- Your injector may be drawing up too much fertilizer stock

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STEP 2) TEST STOCK TANK BY DOING A MANUAL DILUTION

In this step, we take the injector out of the picture, we do the work of the injector, by manually conducting the dilution and then comparing this to the target EC to see if the stock solution was prepared correctly. (See Flowchart 2. Troubleshooting using Manual Dilution).

2A) Vigorously mix the fertilizer stock so that you will get a good reading – use a stirring stick that reaches all the way to the bottom of the container to vigorously mix the stock solution.

2B) Use a 10 mL graduated cylinder to collect 10 mL of stock concentrate. MEASURE CAREFULLY!

2C) Pour the 10 mL stock solution into a 1 Liter graduated cylinder. Fill to the one liter line with tap water. AGAIN MEASURE CAREFULLY!

2D) Mix the 1 liter solution very well, you may need a separate bucket or container to do this

2E) Take a sample and test

What was the manual EC reading? _____ mmhos/cm

Remember, this is a reading using a 1:100 dilution; you can compare this reading directly to the hose-end readings and target EC if you are using a 1:100 injector ratio. If you are using a different injector ratio you need to divide by the last number of the ratio and then multiply by 100. Examples:

- Using the manual dilution you measured EC to be 2.0, and you are using a 1:100 injector
  - No additional calculation is necessary because:
    \[ EC \rightarrow 2.0 \times 100 = 2.0 \text{ mmhos/cm} \]
- Using the manual dilution you measured EC to be 2.0, but you are using a 1:200 injector
  - EC \rightarrow 2.0 \times 100 = 1 \text{ mmhos/cm}
- Using the manual dilution you measured EC to be 2.0, but you are using a 1:64 injector
  - EC \rightarrow 2.0 \times 64 \times 100 = 3.125 \text{ mmhos/cm}

How does this compare to the target EC?

If the reading was not correct, then your fertilizer stock was mixed incorrectly. If the reading was correct, then the solution was mixed correctly, but the injector is not operating correctly (check injector ratio setting, check for cracks or air leaks, it may need serving). Continue to Part 3.
STEP 3) TEST INJECTOR CALIBRATION

In this step we will calculate the ratio that the injector is operating at. In some cases, this may not match the ratio setting on the machine (due to cracks, air leaks, machine age, etc.). (See Flowchart 3. Troubleshooting using Volume Calibration).

3A) Fill a graduated cylinder with water up to 500 mL.

3B) Make sure there are no bubbles in the suction tube, place injector suction tube into graduated cylinder.

3C) Open water valve at hose end into the 5 gallon bucket. Fill to line in bucket (20 L).

3D) Remove suction tube from graduate cylinder and determine how much solution was used from the graduate cylinder.

Solution used = 500 mL (initial reading) – final reading

What is the your solution used amount? ______ mL

3E) Calculate the injector ratio:

Proportion of irrigation water used = \frac{1}{\text{solution used (mL)}} \times 20,000 \text{ mL}

Example calculations:
- 200 mL used
  - Proportion = \frac{1}{200} \times 20,000 = 100
- 100 mL used
  - Proportion = \frac{1}{100} \times 20,000 = 200
- 400 mL used
  - Proportion = \frac{1}{400} \times 20,000 = 50

What is your proportion? ______

The injector ratio is 1:propotion (that you just calculated), ex: 1:100

What is your injector ratio? ______

Now that you have calculated the actual injector ratio, you can adjust the ratio setting on the injector to achieve the desired ratio (you will then need to repeat step 3 to test). Service to the injector may be required if it is difficult to achieve a desired ratio or if other symptoms of wear are visible – seek assistance.
Flowchart 1. Testing proper injector function

1. Calibrate Meters

2. Test end of hose solution

3. Does reading meet goal?
   - Yes: Record results on Quarterly Worksheet
     - Everything is in good working condition
   - No: Follow troubleshooting flowchart

4. 1st do Manual Dilution

5. Do Manual Dilution results check??
   - No: Human error in mixing fertilizer
     - Seek Assistance
   - Yes: Follow Volume Calibration flowchart

6. Do Volume Calibration results check?
   - No: Check ratio setting, check for air leaks, cracks, or other obvious problems. May need servicing.
   - Yes: Injector is functioning properly

7. Re-check end of hose solution. If reading does not meet goal, seek assistance.
Vigorously mix fertilizer stock

Use 10mL of fertilizer stock with 1 liter of tap water. Mix. Test with EC meter.

Is EC reading correct?

Yes

Stock solution is good.

No

Stock solution mixed improperly

Possible injector malfunction.
Flowchart 3. Troubleshooting using Volume Calibration

1. Fill graduated cylinder to 500mL
2. Place suction tube into graduated cylinder
3. Open valve into bucket until solution reaches mark
4. Remove suction tube from graduated cylinder and determine how much solution was used.
5. Do calculations to determine the ratio of your injector