The Effect that the Amount of Leachate Obtained in Pour Thru Tests and Irrigation Has on pH and EC Readings©

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INTRODUCTION

Nutritional problems of container-grown plants are very common in greenhouses and may go undetected for prolonged periods of time (Iersel, n.d.). Over and under fertilization might result in reduced plant vigour and make them more susceptible to diseases and insects. Two important measurements that can be collected are the pH and the electrical conductivity (EC). The pH is a measure of how acid or basic the growing medium is, on a scale from 0 to 14, and it is important since it affects the availability of micronutrients in the growing medium (Iersel, n.d.). Electrical conductivity is a measure of the total amounts of salts in the growing medium, and it can be used as an indicator of the presence of macronutrients (Iersel, n.d.).

For the past years, Gro-Bark has worked closely with its customers in testing the growing medium of container-grown plants and checking its pH and EC. These field tests are conducted on a 3 week rotation by performing a pour thru test on selected crops and recording their pH and EC levels. The idea behind the pour thru method is to pour distilled water on top of the growing medium, collect about 50 ml of leachate and measure the pH and EC with a calibrated Hanna® pH and conductivity meter. Gro-Bark prefers this method because of its simplicity, inexpensiveness, and rapidness. Even though it is well known that this test is ideally done 2 h after irrigation and that over-leaching should be avoided, it is still unknown to Gro-Bark how much these two factors affect the accuracy of pH and EC readings. Therefore, the purpose of this trial is to investigate the effects that two factors have on pH and EC readings: (1) the amount of leachate obtained in pour thru tests and (2) the irrigation time. Having a better understanding of these two factors and their effect on pH and EC readings could provide some insights for Gro-Bark into how their pour thru tests can be improved.

MATERIALS AND METHODS

Methodology

The Pour Thru trial was conducted for 2 days from 31 July 2014 to 1 Aug. 2014 and took place at Putzer Hornby Nursery in the Main Green House located on 7314 Sixth Line, Milton, Ontario, Canada. The following section explains the materials used, the experimental set-up, and the procedure and data collection for this study.

Materials

- 24 replicates of *Helictotrichon sempervirens* in 1-gal containers
- Hanna® pH and conductivity meter
- Distilled water
- Plant rack and collecting tray
- 2 flags
- 24 plant tags
- 30-ml testing cup
- 550-ml measuring cup
- 250-ml measuring cup
- 250-ml graduated cylinder
- Data collection sheet
- Timer

Experimental Set-Up

Set-up for the trial began on the first day during the afternoon when 24 replicates of *Helictotrichon sempervirens* were placed at the front of Bay 6 and evenly divided into two sections based on their treatments, as shown in Figure 1. Plants in section A (Treatment A) were irrigated on the same day at 1:30 PM by placing a hose on top of each plant and watering it until a bed of water of approximately 1 cm. was visible. Plants

in section B (Treatment B) were irrigated on the next day at 9:35 AM, 2 h before the pour thru test took place. Within Treatment A and Treatment B, plants were separated into three different rows depending on the amount of target leachate to be obtained in the pour thru test. Plants with a target leachate of less than 50 ml were placed in the first row; plants with a target leachate between 50 ml and 150 ml were placed in the second row, and those with a target leachate of more than 150 ml were placed in the third row. Each row had a total of 4 plants.

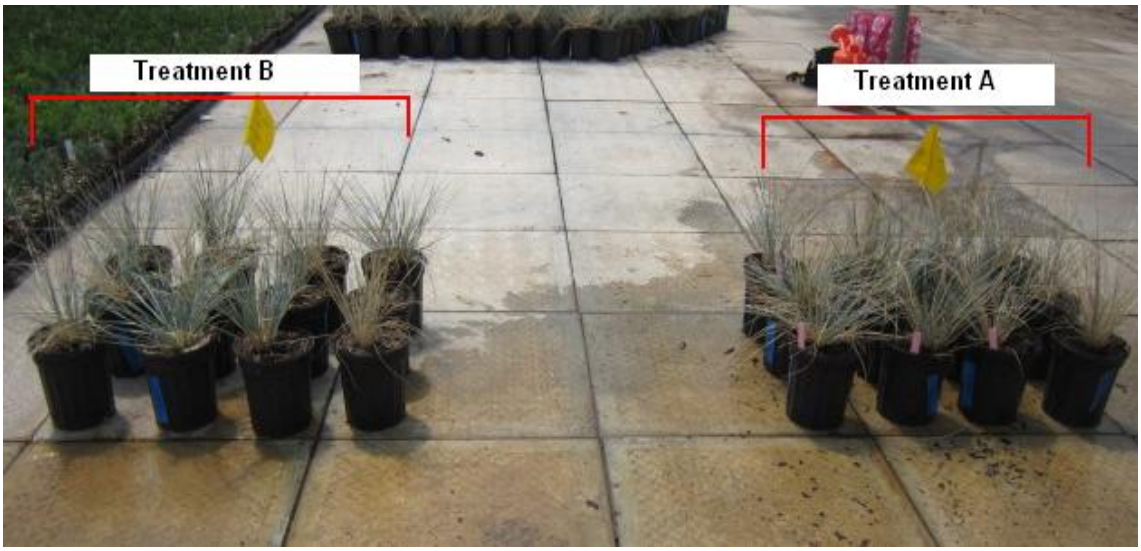

Fig. 1. Experimental set-up.

Procedure and Data Collection

The data that the pour thru trial looked at was the amount of leachate obtained, soil temperature, pH, and electrical conductivity (EC). The first set of pour thru tests was conducted on 1 Aug. 2014 at 9:45 AM for the plants in Treatment A with a target leachate of less than 50 ml. After this, the same procedure was done for the four samples with a target leachate between 50 and 150 ml, and also for the remaining four samples with a target leachate of more than 150 ml. The second set of pour thru tests was conducted on the same date at 11:35 AM for the remaining plants in Treatment B. All pour through tests were conducted in accordance with the procedure below:

1) Place sample upon a rack with collecting tray.
2) Measure 100 ml of distilled water and pour this into the pot. It is important to pour the water in the center of the pot and to pour slowly to avoid water running down the inside wall of the pot without being filtered through the soil.
3) Set the timer to 5 min and wait for plant to leach. If there is no leachate, slowly continue to pour water onto the soil in 50-ml increments and wait 1 min between each increment until no more than the target amount of leachate is obtained.
4) Pour the leachate into a small 30-ml testing cup.
5) Record the amount of leachate by pouring the remaining leachate in the collecting tray into the 250-ml graduated cylinder and then adding this amount to the 30-ml of leachate that was poured into the testing cup.
6) Record the amount of water poured into the pot.
7) Obtain the calibrated Hanna pH and conductivity meter and rinse with distilled water.
8) Turn on the probe and set it to the pH function.
9) Insert the probe into the testing cup and wait for the pH to stabilize.
10) Once the pH has stabilized enter the EC mode by pressing the EC button located on the meter, wait for the EC to stabilize and record this number on the data collection sheet.

11) Enter the pH mode once more and record this number on the data collection sheet.
12) Rinse all equipment with distilled water.
13) Place plant back into its corresponding section.
14) Repeat steps 1-13 for all remaining plants.

RESULTS

Results of the pour thru tests were divided depending on the treatment (A – irrigated the day before, and B – irrigated 2 h before) and on the amount of leachate obtained.

Results for Treatment A indicate that a target leachate of less than 50 ml (TL <50) yielded an average pH of 6.68 and an average EC of 2.38. They also indicate that a target leachate between 50 and 150 ml (TL 50-150) retrieved an average pH of 6.55 and an average EC of 2.85. Finally, a target leachate of more than 150 ml (TL >150) retrieved an average pH of 6.33 and an average EC of 2.37. Samples 3 and 4 of TL <50 showed the highest pH levels of 6.8, whereas sample 1 of TL >150 showed the lowest pH level of 6.2. As for EC readings, sample 2 of TL 50-150 showed the highest level of EC of 3.86, and samples 3 and 4 of TL >150 showed the lowest level of EC of 1.47. Electrical conductivity and pH results were most constant between the 4 samples in TL 50-150. A graph was constructed depicting the results of all samples in Treatment A and a trend line was created for both pH and EC. In general, pH of plants in Treatment A seemed to decrease as the amount of target leachate increased, as shown in Figure 2. EC levels had a tendency to increase as the amount of leachate obtained increased as well, even though averages do not show this.

Test results for Treatment B indicate that a target leachate of less than 50 ml (TL <50) yielded an average pH of 6.58 and an average EC of 1.94. They also indicate that a target leachate between 50 and 150 ml retrieved an average pH of 6.40 and an average EC of 3.01. Finally, a target leachate of more than 150 ml retrieved an average pH of 6.58 and an average EC of 1.60. Samples 1 and 2 of TL <50 showed the highest pH levels of 6.7, and sample 4 of TL <50 and sample 1 of TL 50-150 ml showed the lowest pH level of 6.3. As for EC, sample 1 of TL 50-150 had the highest level of 4.23, and sample 4 of TL >150 had the lowest level of 1.11. EC and pH results were more constant between samples in TL >150. A graph depicting the results of all samples and pH and EC trend lines was also constructed for Treatment B. The pH had a general trend to remain fairly constant between all groups of target leachate, and EC had a tendency to decrease as the amount of leachate increased, as shown in Figure 3.

When comparing the test results between both treatments, they both had fairly similar pH readings and share the same pH average of 6.52, as shown in Table 1. Another similarity between both treatments is that E.C. results are the highest when the target leachate is between 50 and 150 ml. EC levels were slightly higher for plants in Treatment A, with an average of 2.53 compared to Treatment B's EC average of 2.18. Figures 4 and 5 show this comparison. Plants in Treatment A required higher amounts of water to leachate and retrieved a smaller percentage of leachate than plants in Treatment B, as shown in Table 1.

Table 1. Leachate, leachate percentage, pH, and EC. Averages for Treatments A and B.

Treatment	Target leachate (ml)	H_2O added (ml)	Leachate (ml)	Leachate (%)	pH	EC ($mS \cdot cm^{-1}$)
A: Irrigated the day before	<50	337.50	33.75	10.00	6.68	2.38
	150-150	500.00	132.50	26.50	6.55	2.85
	>150	625.00	221.25	35.40	6.33	2.37
Overall average					6.52	2.53
B: Irrigated 2 h before	<50	225.00	27.50	12.22	6.58	1.94
	150-150	262.50	90.00	34.29	6.40	3.01
	>150	500.00	182.50	36.50	6.58	1.60
Overall average					6.52	2.18

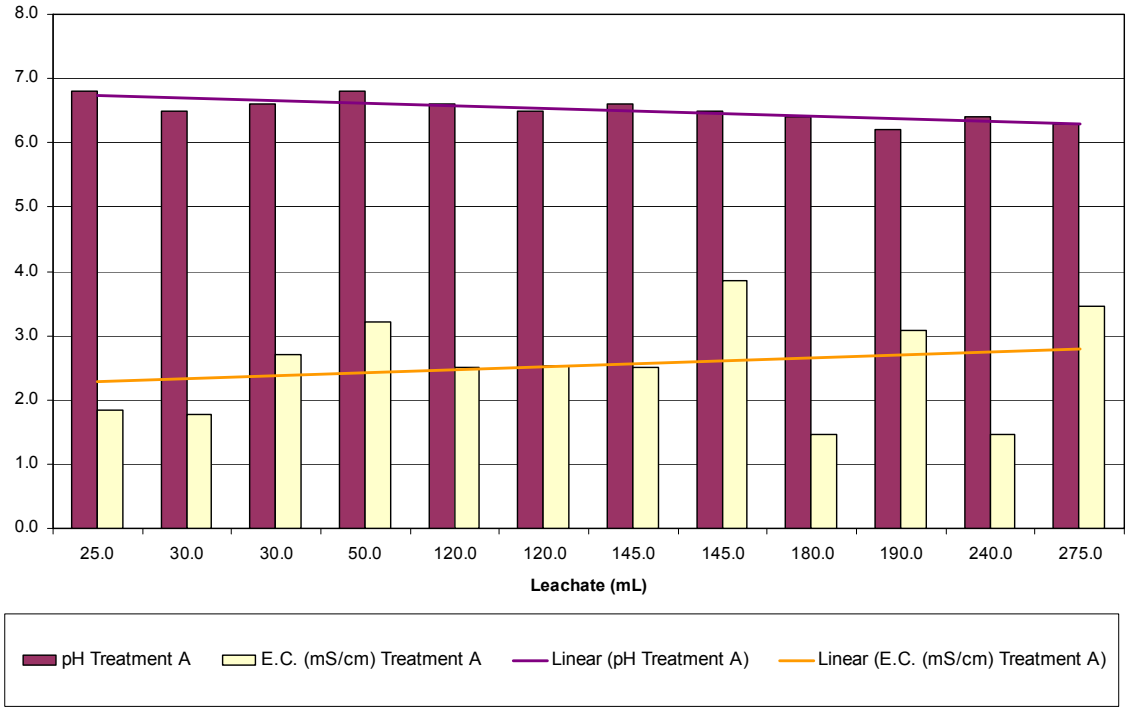

Fig. 2. Comparison of pH and EC levels based on amount of leachate obtained for Treatment A.

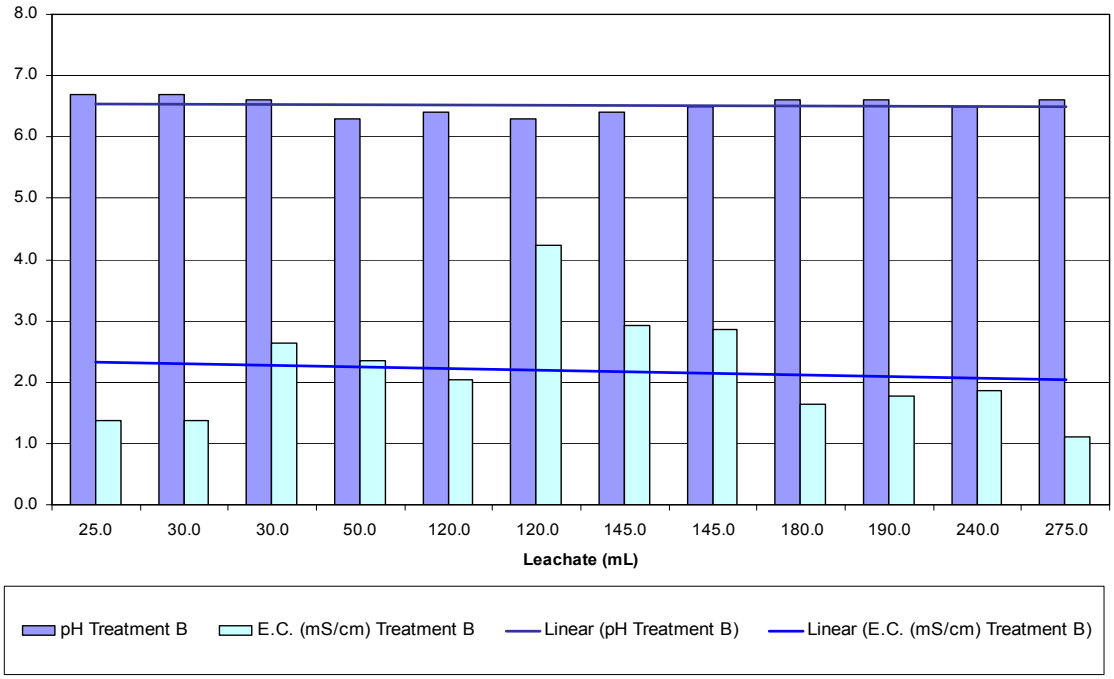

Fig. 3. Comparison of pH and EC levels based on amount of leachate obtained for Treatment B.

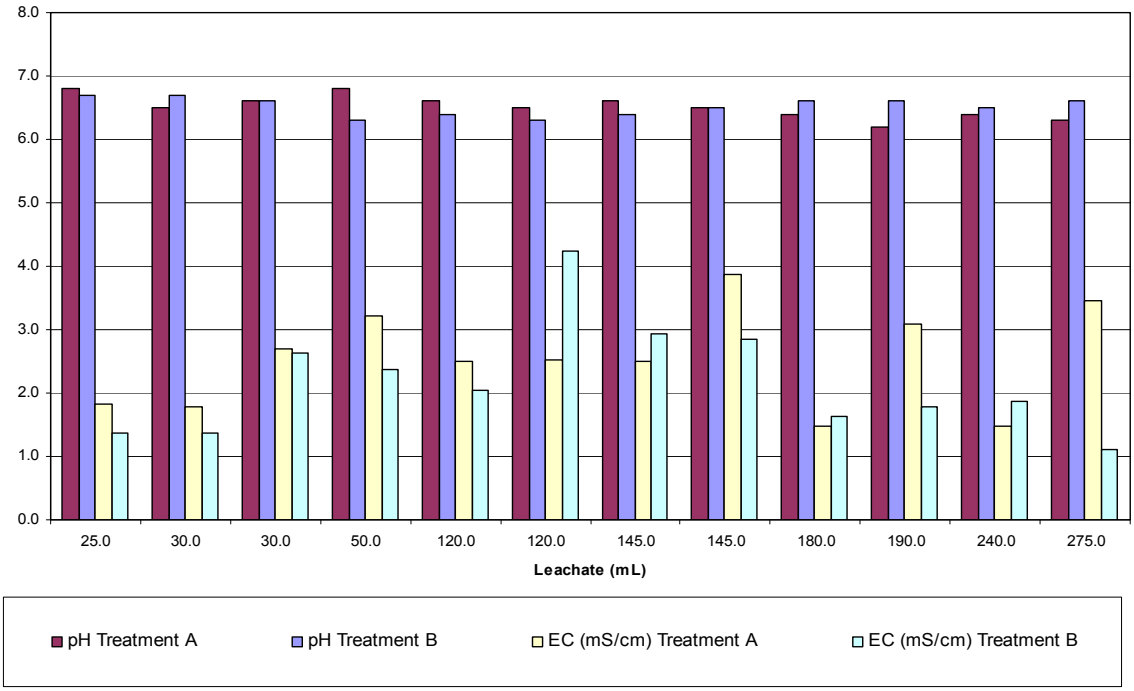

Fig. 4. Comparison of pH and EC levels between Treatments A and B based on amount of leachate obtained.

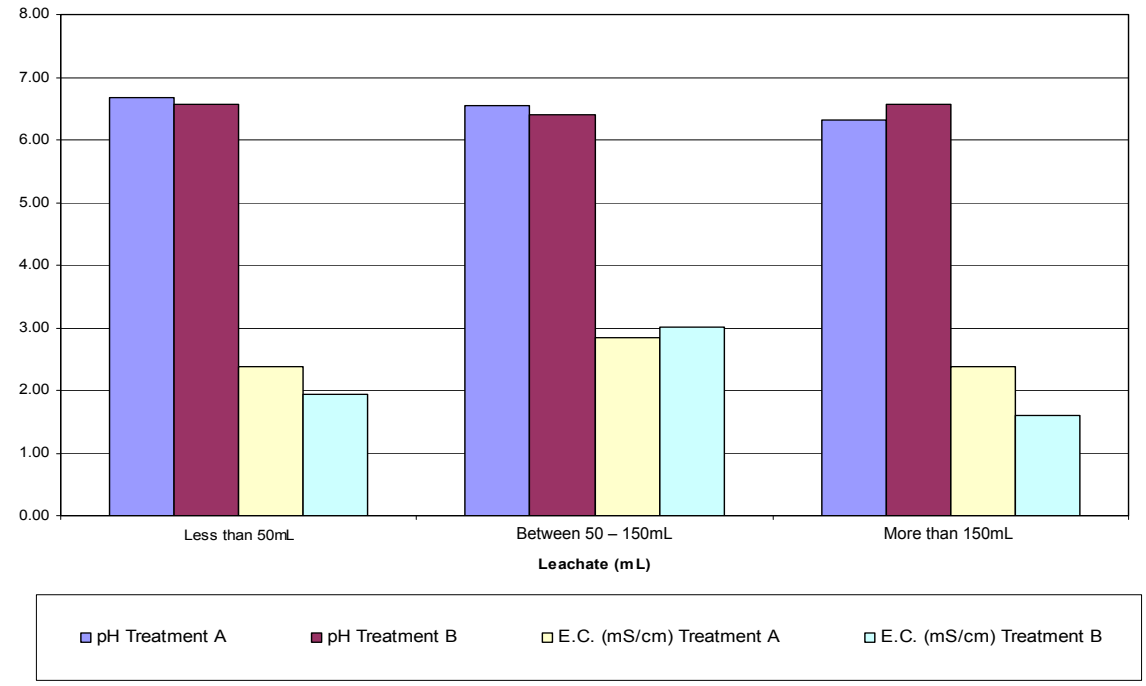

Fig. 5. Comparison of average pH and EC readings for Treatments A and B based on amount of leachate.

DISCUSSION AND INTERPRETATION

Once all the data was organized, theories could then be revised. The first half of this section will place more emphasis at the effect that different amount of leachate obtained had on pH and EC readings for both treatments. The second half will look at the effect that irrigation times had on the results and will compare overall results between Treatment A and B.

Comparison between Different Amounts of Leachate

According to Iersel (n.d.), it is best to use the least amount of water that will still allow the tester to collect at least 30 ml of leachate, and Mirza (April, 2014) indicates that over-leaching should be avoided if the same water is used for measuring both pH and EC. Cavins and others (2000) explain that this is because leachate volumes over 60 ml will begin to dilute the sample and retrieve lower EC readings. This theory seems to be supported in Treatment B as the EC had a tendency to decrease with increasing amounts of leachate. However, this was not the case in Treatment A as EC actually had a tendency to increase with increasing amounts of leachate obtained.

The pH results show that for Treatment A, pH had a tendency to decrease as the amount of leachate obtained increased. However, it was interesting to notice that for Treatment B, pH results remained fairly constant between different amounts of leachate obtained, with a standard deviation of only 0.14, and they did not have a tendency to either increase or decrease. This could potentially indicate that pH results tend to remain constant between different amounts of leachate collected when pour thru tests are conducted about 2 h after plants are irrigated. In fact, besides the EC result of sample 1 in TL 50-150 which can be considered an outlier, EC results between different amounts of leachate are also more constant in Treatment B.

Comparison between Treatments A and B

There were also some interesting observations when comparing results of both treatments. According to Iersel (n.d.), it is important that the pots are watered thoroughly before collecting the leachate; otherwise, the water that is poured on top of the growing medium may simply run through the pot. In that case, one would be measuring the pH and EC of the water poured on the pots, instead of the pH and EC of the growing medium. Most experts recommend irrigating the crops 1 to 2 h before the test (Ruter and Garber, 2002). Knowing that the distilled water used for Gro-Bark tests has a pH of 8.04 and an EC of 0.76, it would be expected that pH and EC results of Treatment A would be closer to those numbers, as the medium is not near its maximum water-holding capacity. However, this was actually not the case in this trial as EC results of Treatment A were generally higher than the ones in Treatment B, with averages of 2.53 and 2.18 accordingly. As for the pH, results were fairly similar between both treatments, sharing the same average pH of 6.5.

Another interesting observation is that plants in Treatment A required more water to obtain the target leachate when compared to plants in Treatment B. Plants in Treatment A also yielded lower percentages of leachate, which could indicate that their mediums absorbed more water and thus pots did not leach as fast. This is because plants in Treatment A were not at their maximum water-holding capacity since they were watered the day before (Ruter and Garber, 2002). On the contrary, plants in Treatment B required less water to leach and yielded higher percentages of leachate. Since plants in Treatment B were irrigated only 2 h before conducting the test, they were already at their maximum water-holding capacity, and thus it was easier for them to leach.

It is important to note that these findings should be taken in the strictest manner. As the trial was conducted on *Helictotrichon sempervirens* in 1-gal pots using custom mixes supplied by Gro-Bark, the estimate is only valid under the same conditions.

CONCLUSIONS AND RECOMMENDATIONS

The pour-thru trial generated numerous conclusions about the effect that the amount of leachate and irrigation has on pH and EC results of pour thru tests.

Conclusions and Recommendations on Leachate

Two conclusions on the effect that the amount of leachate collected has on pH and EC results for both treatments were made. The first one is that, for Treatment A, it could be possible that increasing amounts of leachate collected tends to yield lower pH and higher EC results. The second one is that, for Treatment B, different amounts of leachate collected could not necessarily impact pH results, but it could tend to generate slightly lower EC results, although further research on this is necessary. Based on these results and conclusions, it is difficult to estimate an ideal target amount of leachate that should be collected when conducting pour thru tests. The best recommendation is to keep this amount consistent between all samples and repeats of the test so that results are not being skewed.

Conclusions and Recommendations on Irrigation

Two conclusions on the effect that irrigation has on pH and EC results were made based on the results obtained in this trial. The first one is that it might be possible that watering crops 2 h before conducting a pour thru test tends to yield more constant results, especially when collecting different amounts of leachate. The second is that watering crops the day before conducting a pour thru test could still yield similar pH results when collecting different amounts of leachate, but increasing amounts of leachate could tend to yield higher EC results, although more research on this topic needs to be made. It is recommended that pour thru test should be conducted approximately 2 h after irrigation in order to obtain more accurate results. In the case that employee or schedule availability makes this difficult, it is then recommended to quickly water the samples to be tested and wait a few minutes for the medium to absorb it so that the plants can be at an appropriate water-holding capacity. Nevertheless, further study should be conducted in this area to verify the accurateness of these conclusions, perhaps with the use of different plants species and in a different potting container size.

Further Recommendations

This trial provided much insight for prospective investigations and generated opportunities for further experiments. Additional studies on the effect that irrigation and leachate has on pH and EC readings are strongly recommended to verify the results and conclusions that this trial provided. It is also recommended to perform an analysis on why EC results in this trial were highest when collecting leachate between 50 and 150 ml. More trials using a virgin mix with no plants are suggested.

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