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Evaluating Resin Bags as a Method to Assess Nitrogen Leaching from Containerized Crops

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Introduction

Evaluating nitrogen leaching in containerized crops in a greenhouse setting generally involves a pot in pot system. In this system, the leachate is captured in a bucket under the pot in pot system and the electrical conductivity (EC) of the leachate is measured as a proxy for the fertilizer in the leachate. This trial tested a new method for evaluating nitrate leaching in containerized crops. This trial compared the traditional pot in pot with bucket leachate capture method to anion exchange resin bags used in 3 ways, a pot with landscape fabric and resin bags, a pot with only resin bags, and a pot in pot with bucket system with resin bags. This research aims to answer the following questions:

1. Will roots penetrate through landscape fabric and tear resin bags?
2. Will roots penetrate through resin bag with no barrier between roots and resin bag?
3. Is nitrate quantity from resin bags the same as nitrate quantity leached through petunias into a bucket system?
4. Do resin bags capture all the nitrate leaching? If there is nitrate being missed, how much?
5. Are resin bags a sustainable and consistent method to monitor nitrate leaching in containerized crop production?

Methods

On July 14th, 2023 3 durabloom lime petunias were transplanted into each pot system. There are 4 treatments in total. All pots are 9 inches in diameter.

1. The pot with landscape fabric and resin bags system included 1 pot with 3 resin bags placed in the bottom and landscape fabric below the bags. The landscape fabric was placed below the resin bags instead of above them in error.
2. The pot with resin bags system included 1 pot with 3 resin bags placed in the bottom with media and petunias above.
3. The pot in pot with bucket and resin bags system included 3 resin bags placed in the bottom of a pot. Another pot filled with media and petunias is placed in the resin bag pot. These pot in pots are placed in a bucket with a lid. The lid and pot are caulked on both the top and bottom to prevent fertilizer draining into the bucket through the cracks.
4. The pot in pot with bucket without resin bags system includes a pot filled with media and petunias is placed in another pot. These pot in pots are placed in a bucket with a lid. The lid and pot are caulked on both the top and bottom to prevent fertilizer draining into the bucket through the cracks.

Both pot in pot systems with and without resin bags were replicated 4 times. The pot with landscape fabric and pot with resin bag had no replication.

All plants were fertigated with 200 ppm 20-10-20 as needed. Sulfuric acid (2 mL) was added to the bottom of the buckets in the pot in pot systems (both with and without resin bags) to stop the nitrification process and keep the nitrogen in nitrate form so it can be compared to resin bag nitrate. On August 24th, 2023 the petunias were harvested. The petunias were cut at the root collar. The belowground biomass was rinsed and rated for root health on a scale of 1-5, 5 being the healthiest. Then the belowground biomass was dried in an oven at 110 F for two days. The aboveground biomass was dried using the same method. Once dry, the aboveground and belowground biomass were weighed.

Resin bags were removed from systems while wearing nitrile gloves. The soil was brushed off the bags and they were laid to dry on a bench top in a greenhouse. After a week, they were brought inside and stored in the fridge until they were ready to be rinsed. The resin bags were placed in plastic bags and 3 M KCl was added to displace the nitrogen from the bags. The bags sit in the KCl solution for 1 hour with 15-minute intervals of shaking. The leachate is next vacuum filtered with filter paper and a 15 ml aliquot of leachate was placed into a test tube and kept at 0 F. It was shipped with ice packs to Brookside Labs in New Bremen, Ohio where it was tested for nitrate and nitrite.

Results

The leachate in the pot in pot system without resin bags averaged 378.6 ppm while the leachate that filtered through resin bags in the pot in pot system with resin bags averaged 61.89 ppm. The nitrate collected from the resin bags in the pot in pot system with resin bags averaged 304.0 ppm. This is not significantly different than the nitrate found in the leachate of the pot in pot system without resin bags.

The root health ratings, below ground biomass dry weights and above ground biomass dry weights are not significantly different in the pot in pot systems with and without resin bags.

The landscape fabric system and resin bag system did not have replication so they can not be compared to the pot in pot systems statistically. The landscape fabric resin bag system averaged 566.1 ppm nitrate in the resin bags. The resin bag system averaged 486.2 ppm nitrate in the resin bags.

Discussion

1. Will roots penetrate through landscape fabric and tear resin bags?
This question can not be answered. The landscape fabric was accidentally placed below the resin bags so there was no barrier between the media, roots and resin bag.
2. Will roots penetrate through resin bag with no barrier between roots and resin bag?
Yes, some roots did penetrate the resin bag in the resin bag and landscape fabric resin bag systems.
3. Is nitrate quantity in the resin bags pot in pot system with resin bags system the same as nitrate quantity leached in the pot in pot system without resin bags into a bucket system?
Yes, the nitrate quantity was similar when measured using leachate extracted from resin bags or using leachate that was not filtered through resin bags.
4. Do resin bags capture all the nitrate leaching? If there is nitrate being missed, how much?
Some nitrate was found in the leachate that filtered through the resin bags, demonstrating that the resin bags did not capture 100% of the leached nitrate. An average of 61 ppm nitrate was not captured by the resin bags, this is approximately 20% of the total nitrate (304 ppm) or 16% of the total nitrate found in the leachate of the pot in pot system without resin bags.

5. Are resin bags a sustainable and consistent method to monitor nitrate leaching in greenhouse container production?

This study demonstrates that resin bags can be used in a greenhouse setting to capture nitrate in leachate. However, this method does not simplify the process of measuring nitrate in leachate. Resin bags should not be placed directly next to media and roots as the roots will penetrate the bags. Potentially, landscape fabric placed between the resin bags and the media with roots may stop the roots from penetrating the resin bags. We aimed to test that in this trial, however, we accidentally placed the landscape fabric below the resin bags leaving no barrier between the resin bags and the roots.

An advantage to using resin bags is that once the resin bags are deployed there is no daily or weekly nitrate monitoring.



Pot in pot systems with three resin bags and buckets underneath



Pot in pot systems with no resin bags and buckets underneath



Pot with resin bags and landscape fabric



All pot systems



A closer look at the resin bag pot and landscape fabric with resin bag pot systems