

# Winter Production of Basil (*Ocimum basilicum*) for Fresh Market and Essential Oil Production

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## Introduction

Basil is an annual herb commonly grown for its fresh culinary purposes. However, basil is also considered a medicinal plant and produces valuable essential oil. Our research focused on growing basil during the off-season. The objectives of this research include both optimization of plant growth as well as determining the feasibility of extracting oil from unsaleable foliage.

## Materials and Methods

Eight cultivars were selected for winter production and grown in a double-layer polyethylene greenhouse with under-bench heating but no supplemental lighting.

The eight cultivars were:

### *Sweet/pesto basilis*

Italian Large Leaf, Aroma 2, Genovese, Dolly, and Nufar

### *Specialty basilis*

Mrs. Burns' Lemon, Spicy Globe, and Holy

A capillary mat system was used for basic fertigation, with three different fertilizer treatments being applied to promote growth and flowering. Seeds were sown in October 2014 and allowed to germinate and grow for five weeks. Multiple plants were then transplanted into 6-inch pots filled with soilless mix. Each pot received one of the three fertilizer treatments listed below.

## Treatments

**Treatment 0:** 100 ppm N 20N-4.4P-16.6K water soluble fertilizer

**Treatment 1:** 100 ppm N 20N-4.4P-16.6K plus 6 g of 12N-3.1P-14.9K slow release fertilizer

**Treatment 2:** 100 ppm N 20N-4.4P-16.6K plus 9 g of 12N-3.1P-14.9K slow release fertilizer

At eight weeks after sowing, plants were pricked out to only 3 per pot. At 15 weeks one plant was pinched and one was harvested (Harvest 1). Nineteen weeks after sowing, the unpinched plant in each pot was harvested (Harvest 2). At 24 weeks after sowing (Harvest 3), the pinched plant (an example is Figure 1) was harvested. For harvests 2 and 3, plants were separated into parts (stems, leaves, and flowering tops) and dried at 40 degrees Celsius for 1-6 days to prepare them for oil extraction. For oil distillation, dry plant material was crushed by hand to increase the surface area and then steam-distilled in 100 g batches for 2 hours using a 2-liter steam distillation apparatus. Apparatus recommendations indicated that the vessel should be filled only half full of plant material, and this equaled exactly 100 g of crushed plant material. The amount of water used in the set-up was 500 ml.



Figure 1. Two pinched plants of 'Dolly' basil.

'Mrs. Burns' Lemon' and 'Spicy Globe', both specialty basilis, produced the highest quantity of essential oil, up to 3 ml per 100 g of dried sample (Tables 1, 2). This is surprising as the pesto or sweet basilis are preferred for culinary use.

Cultivar	Amount of Oil Produced	Replications
Aroma 2	0.5 ml	441-1/2
Aroma 2	1.0 ml	442-1/2
Aroma 2	1.0 ml	442-3/4
Dolly	1.5 ml	551-1
Dolly	1.5 ml	552-1
Dolly	2.0 ml	552-2
Dolly	1.0 ml	552-3
Dolly	1.0 ml	552-4
Dolly	1.0 ml	552-5
Dolly	1.0 ml	552-6
Genovese	0.5 ml	991-1
Genovese	0.5 ml	991-2/3/4
Genovese	0.5 ml	992-1
Genovese	0.5 ml	992-2/3/4
Genovese	0.5 ml	992-5
Holy	0.5 ml	662-1/2/3/4/5
Italian Large Leaf	0.5 ml	112-1/2/3
Mrs. Burns' Lemon	2.0 ml	332-3
Nufar	0.25 ml	221-1/2
Nufar	0.25 ml	221-3/4
Nufar	0.25 ml	222-1/2
Nufar	0.25 ml	222-3
Nufar	0.5 ml	222-4/5/6
Spicy Globe	1.0 ml	772-1/2/3/4

Table 1. Basil leaves from Harvest 3; 100 g sample size.

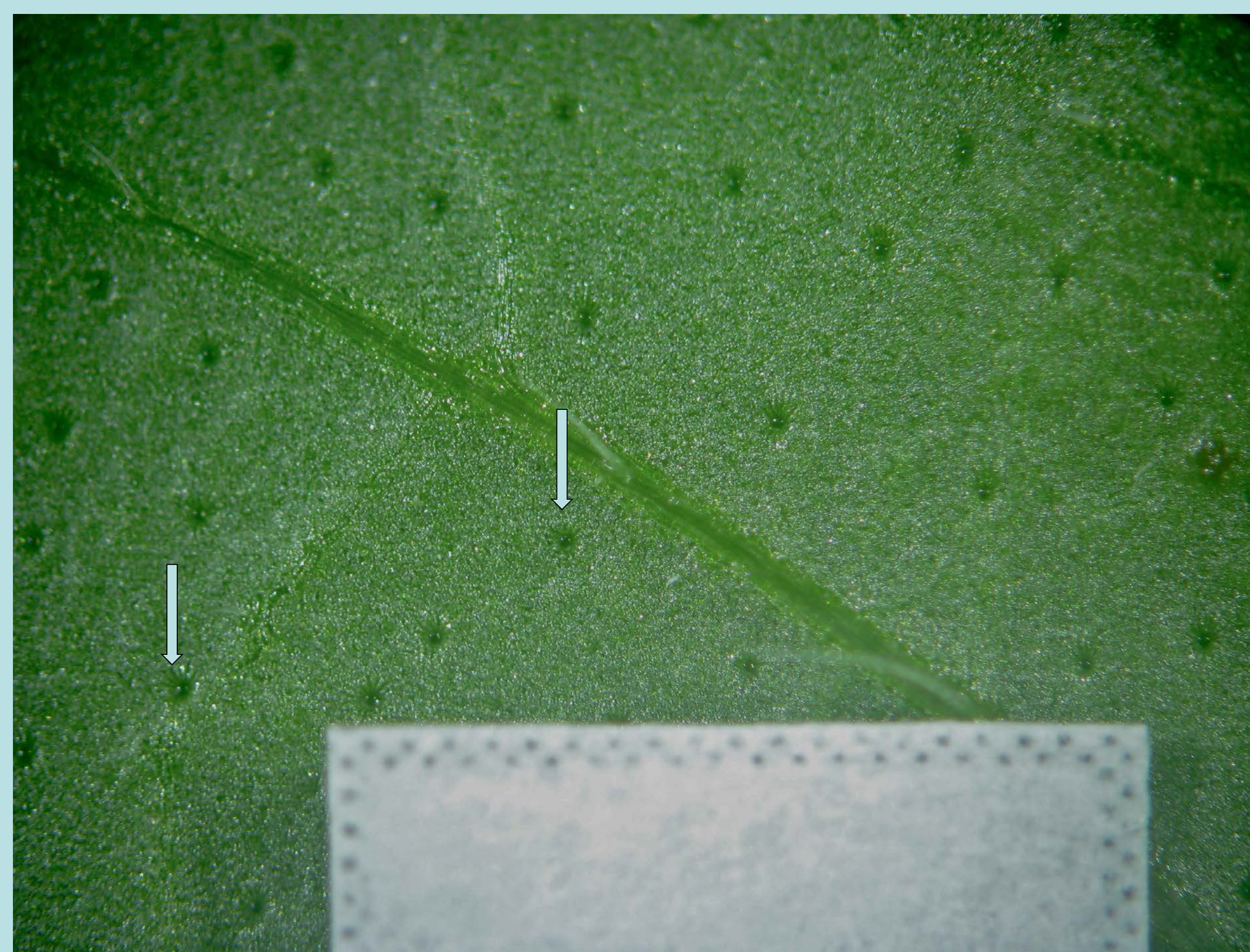


Figure 2. 'Aroma 2' basil leaf abaxial at 21.6x magnification selected from treatment 2 – 100 ppm N from 20N-4.4P-16.6K plus 9 g of 12N-3.1P-14.9K slow release fertilizer. White square is 2 mm<sup>2</sup>. Arrows indicate peltate trichomes.

## Results - oil

After multiple trials, we discovered that optimal oil production for a 100 g sample of prepared basil occurred after 2 hours of distillation or 150 ml of hydrosol, whichever came first.

For both cultivars, 'Aroma 2' and 'Genovese', respectively, when their leaves and flowering tops were distilled, similar quantities of oil were produced (Tables 1, 2). When distilled, 'Dolly' leaves produced more oil than flowering tops. Distillations of the flowering tops of 'Italian Large Leaf', 'Mrs. Burns' Lemon', 'Nufar', and 'Spicy Globe' all produced more oil than their respective leaves.

Cultivar	Amount of Oil Produced	Replications
Aroma 2	1.0 ml	441-2
Aroma 2	1.0 ml	441-5
Aroma 2	0.5 ml	442-1/2/3/6
Aroma 2	0.5 ml	442-1/2/3/6
Dolly	0.5 ml	551-1/2/3
Dolly	1.0 ml	552-1/3/4
Dolly	1.0 ml	552-4/5
Genovese	0.5 ml	991-3/4
Genovese	0.5 ml	992-1/2
Genovese	0.5 ml	992-4
Italian Large Leaf	1.0 ml	111-2/3
Italian Large Leaf	1.0 ml	111-4/5/6
Italian Large Leaf	1.0 ml	112-1/2/3
Mrs. Burns' Lemon	2.0 ml	330-1/2/3/4/6
Mrs. Burns' Lemon	3.0 ml	330-5
Mrs. Burns' Lemon	2.0 ml	331-1/2
Mrs. Burns' Lemon	2.0 ml	331-2
Mrs. Burns' Lemon	2.5 ml	331-2/3
Mrs. Burns' Lemon	1.0 ml	331-4
Mrs. Burns' Lemon	3.0 ml	331-5
Mrs. Burns' Lemon	3.0 ml	331-6
Mrs. Burns' Lemon	3.0 ml	332-1/2
Mrs. Burns' Lemon	1.0 ml	332-3
Mrs. Burns' Lemon	2.0 ml	332-3/4
Mrs. Burns' Lemon	3.0 ml	332-4/5/6
Mrs. Burns' Lemon	3.0 ml	332-6
Nufar	1.0 ml	221-1/2
Nufar	1.0 ml	221-3/4/5/6
Nufar	1.25 ml	222-1/2/3/
Nufar	1.0 ml	222-4/5/6
Spicy Globe	2.0 ml	771-1/2
Spicy Globe	3.0 ml	771-3/4
Spicy Globe	2.0 ml	772-1/2
Spicy Globe	3.0 ml	772-3/4

Table 2. Flowering tops from Harvest 3; 100 g sample size.

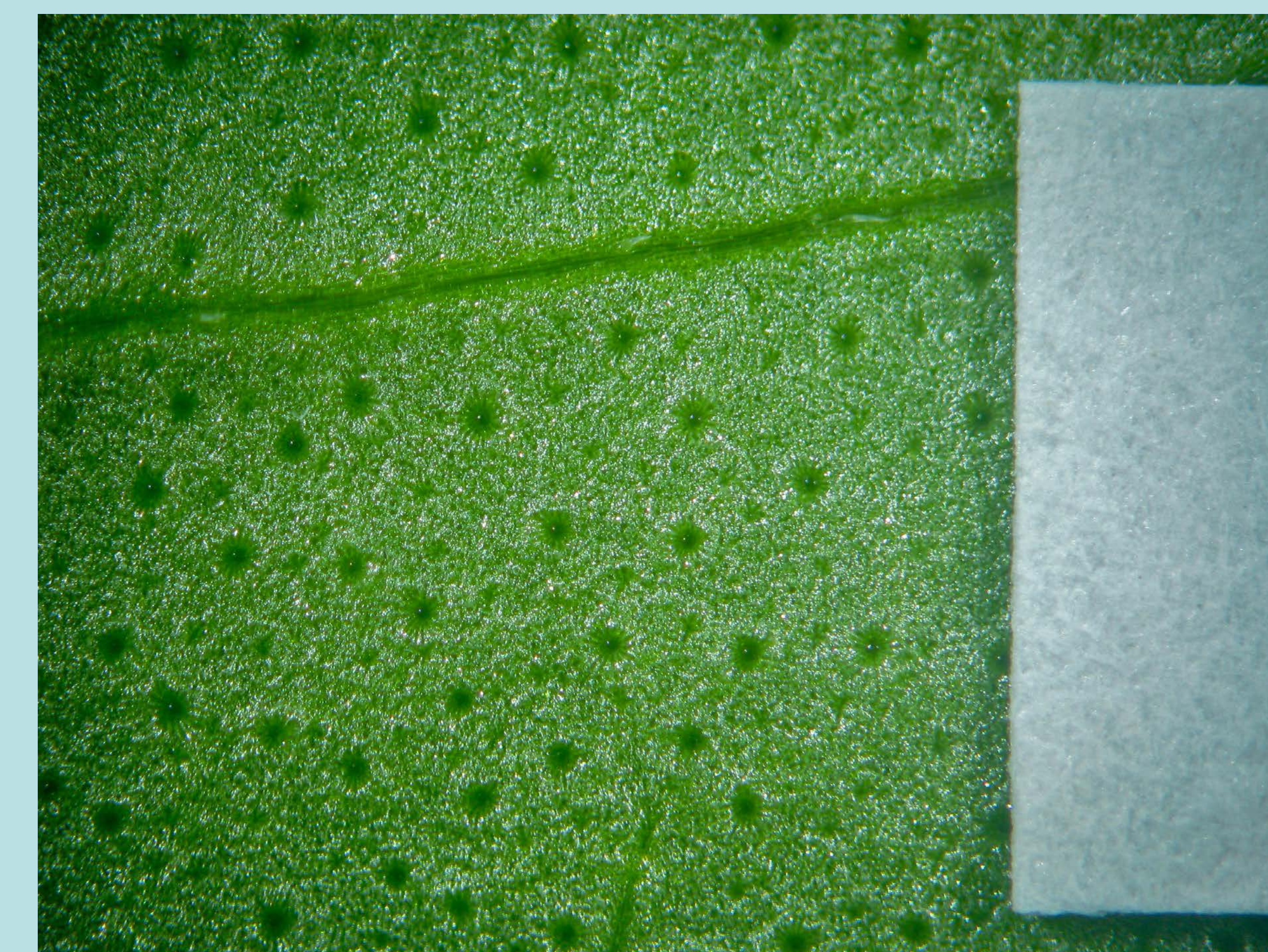


Figure 3. 'Dolly' basil leaf abaxial at 21.6x magnification selected from treatment 2 – 100 ppm N from 20N-4.4P-16.6K plus 9 g of 12N-3.1P-14.9K slow release fertilizer. White square is 2 mm<sup>2</sup>.

## Results - trichomes

Essential oil is produced in anatomical structures called peltate trichomes. These can be seen in Figures 2-4 as small dots scattered across a basil leaf. These trichomes consist of a single or multicellular stalk supporting a 4-celled glandular head. We found that some cultivars have peltate trichomes strictly on the abaxial while some have them on both the abaxial and adaxial.

Preliminary results indicate that the reason leaves from 'Dolly', 'Mrs. Burns' Lemon' and 'Spicy Globe' produced more oil than other cultivars was probably due, firstly, to the fact that they had peltate trichomes on both adaxial as well as abaxial leaf surfaces and secondly, due to the number on both leaf surfaces. 'Nufar' and other cultivars had peltate trichomes on the abaxial of their leaves, but very few on the adaxial. Stems appeared to have a no or a low number of peltate trichomes. The oil production from stems was negligible.

Our future work will focus on quantifying the number of trichomes on leaves of cultivars that produce a high quantity of essential oils as well as pictorially describing all trichomes on both leaves and flowers.



Figure 4. A close-up view of peltate trichomes on a 'Dolly' basil leaf – adaxial; magnification 7.92X

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