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Evaluation of Organic Nutrient Sources in the Production of Greenhouse Hydroponic Basil

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Introduction

Greenhouse herb production has increased in Florida from near zero acres in 1990 to 19 acres in 2001. Basil is the herb with the most greenhouse acreage in Florida. In addition to increased demand for fresh cut herbs in the past ten years, the demand for organic herbs has also increased. Organic production has increased by about 20% annually for the past several years. Combining Florida greenhouse hydroponic and organic production together would allow for high quality organic basil and other herbs due to a better chance of controlling pests without chemicals in a controlled greenhouse environment. These two studies were conducted to begin to evaluate organic nutrient sources and programs when using a soilless culture system in plastic pots.

Materials and Methods

These trials were conducted in a naturally ventilated polyethylene covered greenhouse with a roof-ridge-ridge vent. The greenhouse was located at the UF/IFAS NFREC-Suwannee Valley near Live Oak, Florida. Basil transplants were grown in a standard production system using Metro Mix 200 growing media in a 200 cell (1x1 inch) transplant tray. Basil seeds were planted in the trays for the first trial on 15 Jan 2003 and 28 March for the second trial. Basil transplants were planted into 3-gal pots in the first trial and 1-gal pots in the second trial. Pots were filled with a soilless media mix from Conrad Fafard Inc. (Anderson, SC). The Fafard #30 mix is a special blend prepared for certified organic production. A rate of each nutrient source added to the pots is listed in Table 1. In each treatment, except for the "hydroponic standard", controlled treatment pots were irrigated with water only via a micro-irrigation spray-stick emitter system. The hydroponic standard treatment was supplied with a hydroponic nutrient solution at each irrigation event via a separate micro-irrigation system also using a spray-stick emitter.

The nutrient content of the hydroponic standard treatment is listed in Table 2. In Trial #2, all treatments, except "hydroponic standard" and "no fertilizer", received a

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topdressing of the respective organic fertilizer based on changes in leaf color. Fertilizer was added to the surface of the soilless mix in the 1-gal pots, under the pattern of the irrigation spray emitter. The topdressing schedule is provided in Table 1. Irrigation schedule was set by timer to irrigate as needed to supply at least 10% leachate at each irrigation event.

Pots were arranged in a randomized complete block design with 5 replications in Trial #1 and 4 replications in Trial #2. One basil transplant per pot was planted to the prepared pots. Each plot included two pots.

Basil was harvested as a fresh cut product when stems were 6-8 inches long. Harvested stems were weighed as a fresh product and the weights were recorded.

Nutrient solution leachate from the bottom of each pot in one replication was collected on five dates from 26 March to 1 May. The leachate solution was used to measure electrical conductivity by using an Orion EC meter (Table 3), nitrate-nitrogen (Table 4), and potassium concentrations (Table 5) on Cardy ion-selective portable meters (Spectrum Technologies, Plainfield, IL).

Basil petiole-sap nitrate-nitrogen and potassium levels from Trial #1 were measured on 7 April 2003 (Table 6). Petiole-sap tests were conducted using Cardy ion-selective portable meters for nitrate-nitrogen and potassium.

Leaf color ratings were made on the plants in each plot on 11 July and 25 July 2003. Ratings were made on a 1-5 scale with 1=darkest green color and 5=lightest green color (Table 7).

Results and Discussion

Basil yields from Trial #1 are summarized in Table 8. The highest total yield was found in the hydroponic standard treatment with 387 grams per plant. This was nearly twice the yield of each organic nutrient source. The low yield from the organic nutrient sources can be partially explained by the high electrical conductivity (EC) levels in those organic nutrient treatments (Table 3). The EC of the hydroponic standard leachate was in the range of 2.0-3.0 milliohms in late March and early April. This level is acceptable to optimum for basil production. All Fetrell and Nature Safe treatments had EC readings of over 3.0 milliohms during this early season period. The levels of 4.0-5.0 were adverse for production, especially for young basil transplants. Early yield was significantly higher for "hydroponic solution" and "Black Hen" treatments.

Leachate nutrient analysis for nitrate-nitrogen and potassium are provided in Tables 4 and 5. These levels are provided for comparison purposes to those levels recorded for

the hydroponic standard treatment. The levels recorded for the hydroponic standard treatment should be near optimum levels for basil. Likewise, the basil petiole-sap levels of nitrate-nitrogen and potassium are provided in Table 6 to provide comparative levels to those found in the hydroponic standard treatments.

The basil produced in Trial #2 was rated for color on 11 July and 25 July (Table 7). The darkest green color was found in plants grown with Nature Safe 10-2-8 and Nature Safe 8-5-5 on 25 July. The 'no fertilizer' treatment showed poor color consistently on both dates. Several treatments had similar or darker green color than the hydroponic standard treatments.

Basil yields in Trial #2 were highest in the hydroponic standard treatment with 394 grams per plant. This yield was generally twice the yield of the other organic nutrient sources. The small pots (1-gal) were too small to continue topdressing of organic nutrient sources and likely limited the yield potential of those sources. This trial was conducted as a preliminary screen of the sources and rates of the organic sources. Additional research should be conducted using larger containers (3-gal) for basil.

Early yield was highest for the 'hydroponic standard' treatment followed by 'Black Hen' and 'Fertrell 4-2-4'. A similar pattern was found on the final harvest.

Conclusions

The results reported here indicate high quality basil can be produced in a Florida greenhouse using organic nutrient sources in a certified soilless mixture. The yields of the organic nutrient sources were lower in these two initial screening trials. However, continued research will likely develop recommendations that will significantly increase the basil yield produced from organic nutrient sources.

Table 1. Sources of fertilizer and amounts added to the soilless mix in two trials for producing organic basil.

Fertilizer Source	Amount of fertilizer grams/pot of soilless mix.		Topdressing organic fertilizers used in Trial #2	
	Trial #1 g/pot	Trial #2 g/pot	Amount (g/pot)	Application Dates
Black Hen	600	200	100	18 June, 11 July
Fertrell 3-2-3	400	84	42	18 June, 11 July
Fertrell 4-2-4	450	75	37	18 June, 11 July
Nature Safe 10-2-8	225	38	19	18 June, 11 July
Nature Safe 8-3-5	225	38	19	18 June, 11 July
Nature Safe 8-5-5	225	38	19	18 June, 11 July
Osmocote 19-6-12	84	.	0	18 June, 11 July
Hydroponic Standard	0	0	0	.
No Fertilizer	0	0	0	.

Note: No fertilizer was mixed with the soilless media in the "no fertilizer" and "hydroponic standard" treatments. Trial #2 did not include the Osmocote treatment. Trial #1 used 3-gal pots and Trial #2 used 1-gal pots.

Table 2. Nutrient solution concentrations used in hydroponic standard treatment.

Nutrient	Concentration (mg/L)
N	150
P	50
K	200
Ca	150
Mg	80
S	60
Fe	2.8
Cu	0.2
Mn	0.8
Zn	0.3
B	0.7
Mo	0.05

Table 3. Leachate solution electrical conductivity levels on five dates.

Fertilizer Source	Leachate EC (millimhos/cm)				
	26 Mar	28 Mar	4 Apr	18 Apr	1 May
Black Hen	0.6	0.5	1.1	0.2	0.7
Fertrell 3-2-3	5.0	5.0	5.0	1.9	0.4
Fertrell 4-2-4	2.6	5.0	5.0	1.3	0.2
Hydroponic Nutrient	2.7	2.0	3.1	3.3	4.0
Nature Safe 10-2-8	5.0	4.6	3.2	2.0	0.2
Nature Safe 8-3-5	4.0	3.7	2.5	1.4	0.4
Nature Safe 8-5-5	3.5	3.0	2.4	2.3	0.5
Osmocote 19-6-12	0.9	0.5	0.6	0.9	0.5

Table 4. Leachate nitrate-nitrogen concentrations[z].

Fertilizer Source	Leachate nitrate-nitrogen (mg/L)				
	26 Mar	28 Mar	4 Apr	18 Apr	1 May
Black Hen	100	110	57	8	53
Fertrell 3-2-3	130	460	140	75	9
Fertrell 4-2-4	88	610	120	63	7
Hydroponic Nutrient	220	140	210	230	300
Nature Safe 10-2-8	160	460	89	120	9
Nature Safe 8-3-5	140	270	130	69	15
Nature Safe 8-5-5	190	320	160	150	19
Osmocote 19-6-12	130	33	59	90	37

[z] Nitrate-nitrogen concentrations as measured on a Cardy nitrate ion meter.

Table 5. Leachate solution potassium concentrations[z].

Fertilizer Source	Leachate potassium (mg/L)				
	26 Mar	28 Mar	4 Apr	18 Apr	1 May
Black Hen	140	95	190	6	59
Fertrell 3-2-3	360	150	640	110	5
Fertrell 4-2-4	220	140	470	110	10
Hydroponic Nutrient	190	160	190	270	340
Nature Safe 10-2-8	490	210	370	300	25
Nature Safe 8-3-5	300	220	190	97	21
Nature Safe 8-5-5	430	230	260	290	63
Osmocote 19-6-12	55	87	25	42	15

[z] Potassium concentrations as measured on a Cardy potassium ion meter.

Table 6. Basil petiole sap nitrate-nitrogen and potassium on 7 Apr 2003 from several nutrient treatments.

Fertilizer Treatment	Sap nitrate-nitrogen[z] (ppm)	Sap potassium[z] (ppm)
No fertilizer	290	2200
Hydroponic nutrient	1900	2400
Osmocote 19-6-12	2500	1200
Black Hen	1300	3300
Fertrell 3-2-3	1900	1000
Fertrell 4-2-4	2700	1400
Nature Safe 8-3-5	1500	1200
Nature Safe 8-5-5	2500	1900
Nature Safe 10-2-8	1800	1300

[z] Levels as measured on Cardy ion selective meters. Data collected from Trial #1, 82 days after seeding.

Table 7. Effect of nutrient source on basil leaf color.

Nutrient Treatment	Color Rating (1-5)[z]	
	11 Jul	25 Jul
Black Hen	4.0 ab[y]	3.0 b
Fertrell 3-2-3	4.0 ab	3.0 b
Fertrell 4-2-4	3.8 ab	3.0 b
Nature Safe 10-2-8	3.0 b	2.5 c
Nature Safe 8-3-5	3.0 b	3.0 b
Nature Safe 8-5-5	3.0 b	2.8 bc
Hydroponic Standard	3.0 b	3.0 b
No Fertilizer	4.5 a	5.0 a
Significance (p=0.01).	**	**

[z] Color ratings were 1-5; 1=darkest green, 5=lightest green.

[y] Means in a column followed by different letters are significantly different (p≤0.01).

Table 8. Greenhouse hydroponic basil yields (total and early) from several organic and non-organic nutrient sources during Trial #1 in the spring of 2003.

Nutrient Source	Total Yield (grams/plant)	Early Yield[z] (gram/plant)
Black Hen	230 bc[y]	63 a
Fertrell 3-2-3	216 bc	17 bc
Fertrell 4-2-4	225 bc	18 bc
Nature Safe 10-2-8	199 bc	15 bc
Nature Safe 8-3-5	189 bc	16 bc
Nature Safe 8-5-5	196 bc	15 bc
Osmocote 19-6-12	240 b	29 b
Hydroponic Standard	387 a	60 a
No Fertilizer	0 d	0 d

[z] Early yield was based on the first three harvests (17, 20, and 26 Mar, 2003).
[y] Means in a column followed by different letters are significantly different ($p \leq 0.05$). Means separation by Duncan's Multiple Range Test.

Table 9. Greenhouse hydroponic basil yields (total and early) from several organic and non-organic nutrient sources during Trial #2 in the spring of 2003.

Nutrient Source	Total Yield (g/plant)	Early Yield[z] (g/plant)	Final Harvest[y] (g/plant)
Black Hen	235 b[x]	59 b	73 b
Fertrell 3-2-3	137 d	36 c	43 c
Fertrell 4-2-4	176 c	50 b	56 c
Nature Safe 10-2-8	128 d	30 c	45 c
Nature Safe 8-3-5	139 d	33 c	46 c
Nature Safe 8-5-5	148 cd	31 c	56 c
Hydroponic Standard	394 a	122 a	101 a
No Fertilizer	3 e	1 d	0 d

[z] Early yield was based on the first four harvests (5, 12, 19, and 26 June 2003).
[y] Final harvest was taken on 25 July 2003.
[x] Means in a column followed by different letters are significantly different ($p \leq 0.05$). Means separation by Duncan's Multiple Range Test.