

GREENHOUSE PRODUCTION OF SEVERAL FRESH-CUT HERBS IN VERTICAL HYDROPONIC SYSTEMS IN NORTH CENTRAL FLORIDA

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Abstract. Herb production in Florida greenhouses has increased dramatically from less than 1 acre in 1991 to nearly 17 acres in 2001. Sales value of fresh-cut herbs from Florida greenhouses were \$647,000 in 1998. Greenhouse production of culinary herbs offers producers several market advantages, including fewer days to harvest. Herbs and other specialty crops with multiple harvests provide the potential to maximize returns from expensive and limited greenhouse space. Vertical hydroponic production systems can serve to increase economic efficiency of greenhouses. However, little research information on hydroponic herb production is available. This trial was conducted to examine the marketable yield of selected fresh-cut herbs from fall through spring in a vertical hydroponic greenhouse production system in north central Florida. Herbs included in this study were: arugula (*Eruca vesicaria*), basil (*Ocimum basilicum*), purple basil (*Ocimum basilicum*), chervil (*Anthriscus cerefolium*), dill (*Anethum graveolens*), lemon balm (*Melissa officinalis*), sweet marjoram (*Origanum majorana*), oregano (*Origanum vulgare*), parsley (*Petroselinum crispum*), Italian (flat leaf) parsley (*Petroselinum crispum*), sage (*Salvia officinalis*), and thyme (*Thymus vulgaris*). First harvests of fresh-cut herbs occurred 15 to 28 days after transplanting. Total yields ranged from 215 to 697 oz per hydroponic tower of 32 plants. Terminal market prices varied by market and type of herb throughout the time of the trial.

Today, Florida greenhouse producers seek alternatives to the traditional greenhouse crops of tomatoes, cucumbers, and peppers. In the last decade, there has been a dramatic increase in greenhouse herb production in Florida, from virtually none in 1991 to nearly 17 acres in 2001 (Hochmuth and Hochmuth, 1991; Tyson et al., 2001). Herbs now rank third in food crops, with 18% of the state's greenhouse acreage (Tyson et al., 2001).

Herbs have a long history of use by humans. In ancient times as well as today, herbs have been used for medicinal, cosmetic, and culinary purposes. Herb and spice consumption in the U.S. doubled between 1965 and 1985, from 1 to 2 lb per capita (Kebede, 1990). The volume of basil and oregano sold in the U.S. increased 187% and 75%, respectively, from 1981 to 1991 (Sell, 1993). Total sales value of fresh-cut herbs produced in U.S. greenhouses was \$30,995,000, accounting for nearly 14% of all greenhouse food crop sales in

1998 (USDA, 1998). Fresh-cut herbs accounted for \$647,000 in sales of food crops from Florida greenhouses in 1998 (USDA, 1998). The demand for fresh-cut herbs is expected to increase (Simon, 1990) in part due to health-conscious consumers and increasing consumption of ethnic cuisine.

Greenhouse production of herbs offers several market advantages including more rapid plant growth, wintertime production when market prices are highest, and a clean product. The clean, hydroponic product may not require washing prior to shipment, which contributes to a longer shelf-life and a high quality appearance. Quality was rated as the most important factor in selecting herb suppliers by 78% of herb buyers responding to a national survey (Falk et al., 1996).

This study was conducted to examine marketable yield of selected fresh-cut herbs from fall through spring in a vertical hydroponic greenhouse production system in north central Florida. Herbs included in this study were: arugula (*Eruca vesicaria*), basil (*Ocimum basilicum*), purple basil (*Ocimum basilicum*), chervil (*Anthriscus cerefolium*), dill (*Anethum graveolens*), lemon balm (*Melissa officinalis*), sweet marjoram (*Origanum majorana*), oregano (*Origanum vulgare*), parsley (*Petroselinum crispum*), Italian (flat leaf) parsley (*Petroselinum crispum*), sage (*Salvia officinalis*), and thyme (*Thymus vulgaris*).

Materials and Methods

Seeds of 12 herbs from Johnny's Selected Seeds, Inc. (Albion, Me.) were sown into 128 cell or 200 cell styrofoam Speedling trays in Scotts Metro Mix (Marysville, Ohio) on 3 Aug. 2000. Seeds were resown throughout the trial as necessary for replanting. Seedlings were transplanted at the two to four leaf stage into Verti-Gro hydroponic towers (Verti-Gro Systems, Summerfield, Fla.) beginning on 5 Sept. 2000. Twelve towers of eight stacked Styrofoam pots filled with coarse-grade perlite (Chem Rock, Inc., Jacksonville, Fla.) were established for this trial. Towers were set up inside a 1320 ft², 6 mil double-polyethylene Quonset-style greenhouse with 11 ft² per tower. Temperature in the greenhouse was maintained between 60°F (15.5°C) and 75°F (24°C) in the winter or 95°F (35°C) in the spring with fans and evaporative cooling pads.

A single tower of 32 plants was planted with each herb in the trial: arugula, basil, purple basil, chervil, dill, lemon balm, sweet marjoram, oregano, parsley, Italian parsley, sage, and thyme. Plants in towers were fertigated with every irrigation event. Nutrients and water were delivered by six, 0.05-in ID drip emitters (Chapin Watermatics, Inc., Watertown, N.Y.) per tower, providing approximately 0.6 gal·d⁻¹ in the winter and 1.4 gal·d⁻¹ in the spring. Nutrient solution used in this trial (150 N-50 P-200 K ppm) was the same as that designed for greenhouse tomato production (Hochmuth, 2000), with the exception of increased Ca (200 ppm) and Mg (80 ppm) levels. Earlier research indicated the need for increased levels of Mg for optimum basil production in a vertical hydroponic system (Hochmuth and Davis, 1999).

Spot treatments of sulphur for powdery mildew and broad mites; and Pyola T® (Gardens Alive, Lawrenceburg, Ks.), and insecticidal soap for control of aphids and thrips were applied

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as necessary. For three herbs (chervil, arugula, dill), plants were replanted when bolting or severe pest populations led to complete loss of marketable quality.

Herbs were harvested weekly by hand, at the petiole base when petiole or stem length exceeded 6-8 in. Fresh weight of harvested herbs was recorded at every harvest. Non-destructive harvests continued as plant growth allowed, from Sept. until trial was terminated in mid-June.

Market prices for herbs from two terminal markets, Atlanta and New York, as reported by USDA Agricultural Marketing Service (USDA, 2001), were recorded for each month throughout the trial.

Results and Discussion

Plant vigor and growth in the vertical hydroponic system were generally excellent. Herbs were transplanted 20 to 47 d after sowing (Table 1). The first harvest occurred on 22 Sept. for basil and 27 Sept. for arugula, purple basil, sweet marjoram, and thyme. Other herbs began to be harvested in Oct. The number of days from transplanting to first harvest ranged from 15 to 28 (Table 1). Previous research indicated that field production of 9 fresh cut herbs in west central Florida required over 70 d from seeding to transplant and a minimum of 36 to 57 d from transplanting to first harvest

Table 1. Yield and growth of 12 herbs produced in vertical hydroponic greenhouse culture in north central Florida, 2000-2001.

Herb	Sowing to TP ^a (no. of d)	TP to first harvest (no. of d)	Yield per tower ^c (lb)	Yield per plant (lb)
Arugula ^x	26	16	43.53	1.36
Basil ^x	36	13	36.56	1.14
Purple Basil	33	22	25.62	0.80
Chervil ^x	41	21	17.16	0.54
Dill ^x	44	23	17.49	0.55
Lemon Balm	32	28	25.46	0.80
Sweet Marjoram	33	22	24.67	0.77
Oregano	40	21	19.27	0.60
Parsley	47	21	27.29	0.85
Italian Parsley	47	21	23.81	0.74
Sage	33	28	25.04	0.78
Thyme	33	22	13.44	0.42

^aTransplanting date (TP).

^bVertical hydroponic tower of eight pots with 32 plants per tower, equivalent to 0.34 ft² per plant.

^cData presented for these herbs are average from multiple plantings.

(Csizinszky, 1992; Csizinszky, 1997). Growth of herbs in this trial was hastened over field production as a result of the greenhouse climate and hydroponic production system.

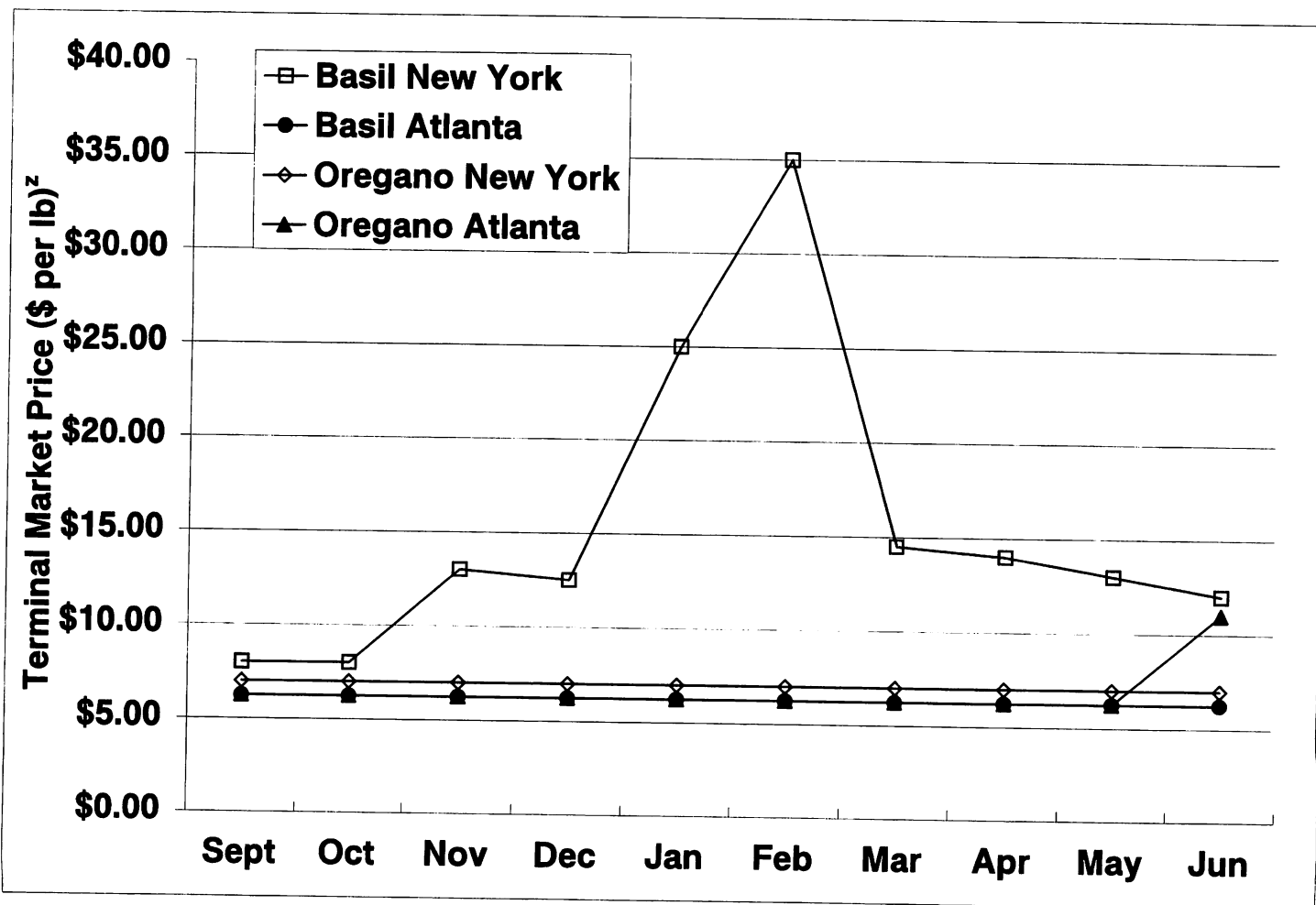


Figure 1. Monthly terminal market prices in Atlanta and New York for basil and oregano, Sept. 2000 through June 2001 (USDA, 2001).
^zExcept for basil sold at New York Terminal Market, which is reported in dollars per carton of 15 bunches.

Total marketable yield of the 12 fresh-cut herb towers throughout the entire season ranged from 215 oz to 696.6 oz (Table 1). The highest yielding herb towers were arugula (696.6 oz), basil (584.9 oz) and parsley (436.7 oz). Statistical analysis was not conducted since herb towers were not replicated.

Six of the herb towers in the trial required replanting, and arugula was replanted twice due to bolting. The tower of chervil was replanted once due to severe aphid population. In addition to the 12 herb towers mentioned, an additional seven were dropped from the trial: chives (*Allium schoenoprasum* L.), cilantro (*Coriandrum sativum* L.), cutting celery (*Apium graveolens* var. *secalinum*), mache (*Valerianella locusta* L. var. *oleracea*), spinach (*Spinacia oleracea* L.), tatsoi (*Brassica rapa* L. Tatsoi group), and watercress (*Nasturtium officinale* R. Br.). Each of these herbs and specialty greens had production problems such as repeated bolting, severe aphid infestation, or leaf quality issues.

Profitable herb production depends to a great degree on market prices. Terminal market prices in New York and Atlanta indicated some variation between markets and fluctuation of prices for some herbs throughout the production period (Fig. 1). Prices for herbs in Atlanta were consistently lower than those in the New York market. Florida herb producers would need to compare price differences after transportation and packaging costs. Wholesale herbs are sold in a variety of packages, depending on the market. At the Atlanta Terminal Market, herbs are typically sold in 1-lb film bags, either loose or in bunches. Herbs sold at the New York Terminal Market may be sold in 1-lb film bags, 1-kg cartons, or by 12, 15, or 24 bunches per carton. Basil, for instance is sold in wirebound crates of 15 bunches each and the plants are sold with roots attached. Oregano, however, is sold as it is in Atlanta, in 1-lb film bags of 12 bunches. The volume of herbs sold in New York is much greater than the volume sold through the Atlanta market (data not shown). This illustrates the importance for a producer to be familiar with the various markets and seek contacts in the most lucrative.

Variation in prices during the season depended upon the herb as well as the market. Prices in the Atlanta Terminal Market were stable from Sept. through May, only changing for some herbs (e.g., oregano) in June. Prices at the New York Terminal Market for arugula, basil, and dill fluctuated throughout the season, with highest peaks in Jan. and Feb. at \$30 to \$35 per 1-kg carton (USDA, 2001). However, prices for chervil (\$15 to \$16 per 1-kg carton) and oregano (\$12 per 1-kg carton) at the New York Terminal Market were unchanged throughout this same period (USDA, 2001). Knowledge of

market demand and elasticity for specific herbs, therefore, is critical to accurate projections of returns for herb producers.

Sub-optimal quality was observed in this study with poor color development in purple basil and necrotic leaf margins in lemon balm. Previous hydroponic demonstrations with red leaf lettuces suggest that certain greenhouse covers or low light levels may impede full color development, especially in winter (R. C. Hochmuth, pers. obs.). Necrotic leaf margins are often an indication of Ca deficiency or high salt levels. Lemon balm may require higher Ca input or exhibit higher salt sensitivity than the other herbs studied.

The overall best performers in terms of high quality production and favorable market prices were basil, oregano, parsley, sweet marjoram, and thyme. These herbs consistently produced top quality cuttings for the fresh-cut market. Further research is warranted to compare potential economic returns of this system with alternative greenhouse hydroponic production systems.

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