

Nutrient Management for Greenhouse Production of Container-grown Organic Herbs

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Nutrient and water management is critical for organic greenhouse production of herbs. The objectives of this study were to 1) evaluate suitability of several commercially available organic fertilizers and potting media for organic production of container herbs; 2) develop fertilization programs, including nutrient sources and fertilization rates; and 3) evaluate irrigation methods for small container production systems (4-inch pots). Six greenhouse trials were conducted to achieve these objectives with basil (*Ocimum basilicum* L.), dill (*Anethum graveolens* L.), and coriander (*Coriandrum sativum* L.). Potting media did not significantly influence plant growth, quality, and nutrient leaching. Different fertilizers significantly influenced plant growth and market quality. Fertilizer rates ranging from 0.85 to 1.27 g of N per 1 L of potting medium resulted in the best fresh weight and market quality of herbs. Flooding irrigation resulted in the significantly best visual quality, greatest concentration of K⁺ in plant sap and highest pH in pot leachate; but used 52% and 51% more water than microjet and mister, respectively. As a result of these trials, a practical production method was developed that can easily be adapted by growers interested in the production of greenhouse organic herbs.

According to the USDA 2002 Economic Research Service report, the value of organically produced foods in the United States has grown 20% on average per year since 1990 and organically produced foods were sold in 73% of all conventional food stores and supermarkets (Dimitri and Green, 2002). Fresh organic fruits and vegetables account for 4.58% of the total domestic market and the market share of certified organic fruits and vegetables is constantly growing (Treadwell, 2006). One of the growing segments of organic agriculture is the production of fresh culinary herbs. The increasing populations of immigrants and international visitors to Florida and the implementation of ethnic culinary traditions by restaurants and the tourist industry have created a growing market demand for organic herbs in the state and opportunities for market expansion.

Outdoor production of organic herbs in South Florida can be challenging because of the low fertility of the soils, high rainfall, and constant presence of pests. Producers can increase the yield and quality of organic herbs by modifying greenhouse production techniques. In recent years this trend has become more visible as

greenhouse production of herbs has increased in Florida from near zero acres in 1990 to 19 acres in 2001 (Hochmuth et al., 2004).

The goal of this project was to develop a practical production system for certified-organic greenhouse herb growers. The objectives were to 1) evaluate selected potting media and fertilizer sources, 2) identify optimal fertilizer rates, and 3) identify the most effective irrigation system to produce high quality herbs and conserve water.

Materials and Methods

Six greenhouse trials were conducted at the University of Florida IFAS Tropical Research and Education Center in Homestead during the 2005–07 growing seasons. The first two of these trials completed in 2005 dealt with the evaluation of potting media and fertilizer selection for container production of organic basil (*Ocimum basilicum* L.) and dill (*Anethum graveolens* L.). Three commercial organic fertilizers approved by the Organic Materials Review Institute (OMRI) used in this project were: fertilizer ‘A’ (mix of feather, meat, bone and blood meals, sulfate of potash, yeast, sugars, carbohydrates, and humus) with an N–P–K ratio

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8–2.2–4.2, fertilizer ‘B’ (mix of aragonite, bone meal, composted chicken manure, sodium nitrate, feather meal, greensand, peanut meal, sulfur, and sulfate of potash) with an N–P–K ratio 4–0.9–1.7 and fertilizer ‘C’ (dry, pasteurized, and palletized poultry litter) with an N–P–K ratio 4–0.9–2.5. These fertilizers were applied at the rate of 0.72 g of N per liter of potting mix and were compared with a control treatment of no fertilizer application. The two OMRI-approved potting media used were commercially available Canadian peat moss, aged pine bark, perlite, dolomitic limestone, and gypsum) and potting medium ‘II’ (mix of Canadian peat moss, coarse chips of pine bark perlite, and dolomitic limestone) blended by a local supplier. Both media were free of fertilizers and wetting agents. All treatments and herbs were replicated four times. A light pinch of seeds (about 280 mg seeds for basil and 170 mg seeds for dill) was placed in each pot on the top of the potting mix and covered with about 5 mm of potting mix. Plants were irrigated with time-controlled overhead sprinklers and grown for 4 weeks to reach the marketable size to be sold as organic potted herbs.

Trials 3 and 4 were completed in Winter 2005 and Spring 2006. These two trials dealt with the evaluation of fertilizer rates and selection of the optimal rate suitable for the production of organic potted herbs. Fertilizer ‘C’ (dry, pasteurized, and pelletized poultry litter) with an N–P–K ratio 4–0.9–2.5 was selected for this part of the project. Four rates of this fertilizer (0, 0.42, 0.85, and 1.27 g of N per liter of potting medium) and three herbs [basil, dill, and coriander (*Coriandrum sativum* L.)] were used for these two trials. The cultural practices were similar to those of Trials 1 and 2. The production cycle lasted 6 weeks for both trials.

Trials 5 and 6 were conducted between Jan. and May 2007 and were devoted to evaluate irrigation systems and their suitability for production of potted organic greenhouse herbs. Three herbs (basil, dill, and coriander) were selected for these two trials. The different irrigation types investigated were 1) sprinkler, 2) flood, 3) mister, and 4) microjet. For this study, fertilizer ‘C’ (dry, pasteurized, and pelletized poultry litter) was used at 0.85 g of N per liter of medium. Each irrigation type was replicated four times. Miniature tensiometers (soil moisture monitoring devices) specifically designed for the smaller container used in nurseries and greenhouses were used to measure soil moisture tension (Fig. 1). The output water rate for each irrigation system was regulated according to the environmental conditions (temperature, relative humidity, and radiation) to provide enough water to maintain



Fig. 1. Miniature tensiometer installed in a 4-inch pot as part of an irrigation study with organic herbs.

tensiometer readings around 2 to 5 kPa. Each irrigation system was controlled by a separate solenoid and monitored by a separate water meter. Production practices were similar to those in the previous four trials. The production cycle lasted 6 weeks for both of these trials.

Measurements were collected at the end of each production cycle for all six trials. These measurements included leaf samples for nutritional analysis—quick sap test ($\text{NO}_3\text{-N}$ and K^+), dry tissue nutritional analysis (%N, %C), leachate from representative pots to analyze for pH and electric conductivity, fresh and dry weight of aboveground plant tissue, and visual evaluation of quality and marketability of plants. The quality of the plants was evaluated using a visual quality scale of 1–5 where 1 was not marketable and 5 was the best market quality plant.

For all six trials data were analyzed with analysis of variance (ANOVA) and Duncan’s multiple range test using PROC GLM program in SAS (Version 9.1.2, SAS Institute Inc., 2002–03).

Results and Discussion

Results from Trials 1 and 2 indicated that there were no significant differences between the potting media. However, differences were observed among fertilizers. Fertilizer ‘B’ and fertilizer ‘C’ resulted in the best market quality of herbs.

The most substantial results were found in the visual quality rated in the scale of 1–5, fresh weight, and %N data.

For Trials 3 and 4 the rate of 1.27 g of N per liter of growing media resulted in the greatest values for visual quality (market quality), fresh weight, and dry weight for basil and coriander. Alternatively, the 0.85 g N per liter of medium resulted in the greatest values (considering visual quality, fresh and dry weight) for dill. The rate of 0.85 g of N per liter of medium could be more attractive for growers due to reduced production costs. For both Trials 3 and 4 and the three herbs, the highest fertilizer rate was positively correlated with %N plant content (Figs. 2–4).

The irrigation systems evaluated in Trials 5 and 6 significantly affected the visual quality (plant quality and marketability), K^+ in plant sap, and highest pH in leachate with flooding irrigation resulting in significantly best visual quality, greatest concentration of K^+ in plant sap, and pH in pot leachate. Flooding irrigation used 52% more water than microjet and 51% more than mister. Considering the low consumption of water, low cost, feasibility of installing and handling, as well as the plant quality, mister irrigation could be the optimum choice for growers considering greenhouse production of potted herbs.

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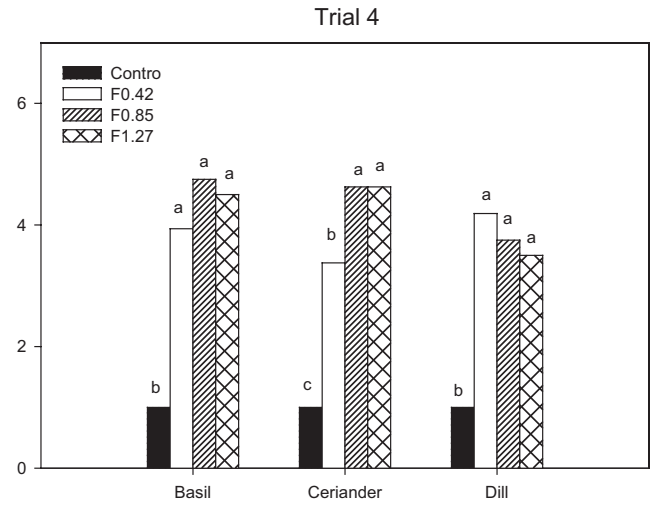
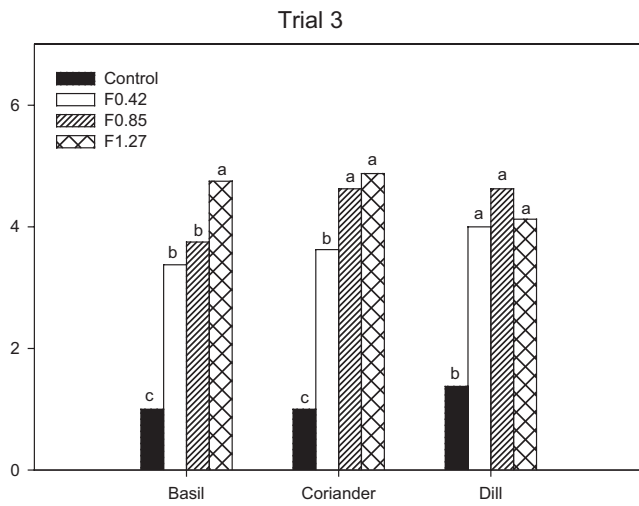


Fig. 2. Visual quality results (1–5 scale where 1 was not marketable and 5 was the best market quality plant) from fertilizer ‘C’ (dry, pasteurized, and pelletized poultry litter) rates for Trials 3 and 4 including significant differences (different letters indicate a significant difference at $P < 0.05$).

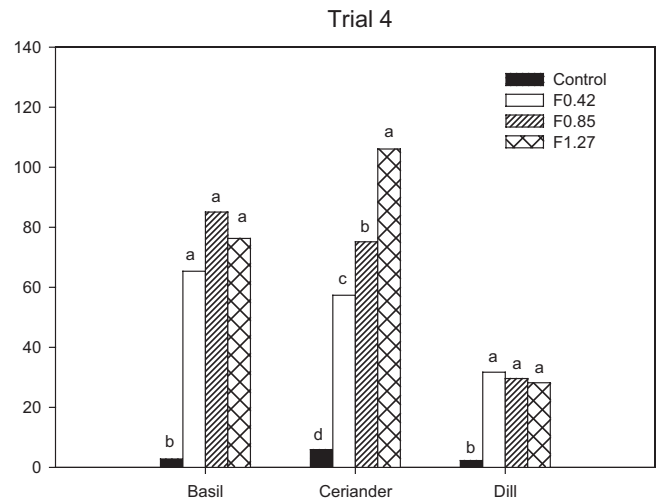
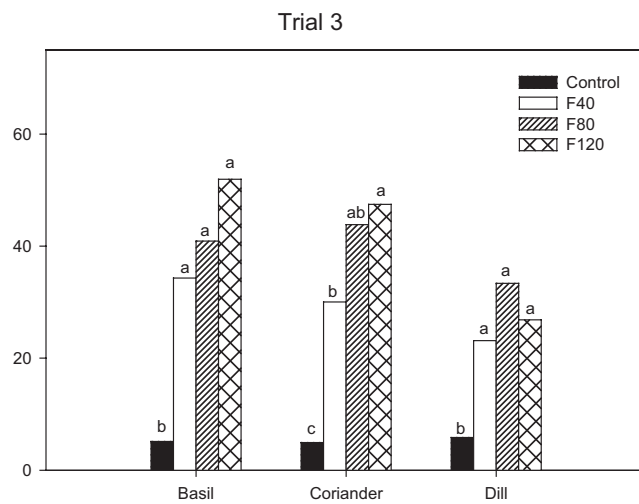


Fig. 3. Fresh weight (g) results from fertilizer ‘C’ (dry, pasteurized, and pelletized poultry litter) rates for trials 3 and 4 including significant differences (different letters indicate a significant difference corresponding to $P < 0.05$).

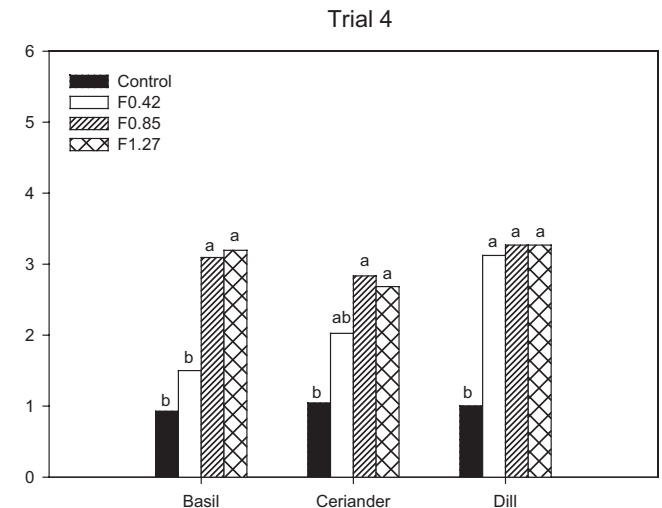
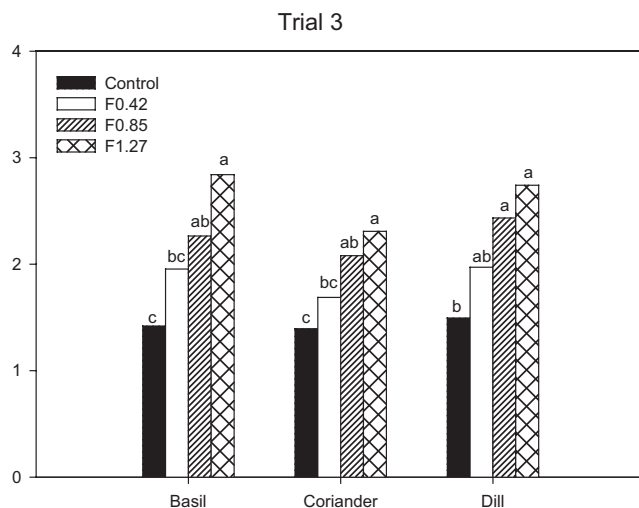


Fig. 4. Percent of total N in dried plant tissue results from fertilizer ‘C’ (dry, pasteurized and pelletized poultry litter) rates for trials 3 and 4 including significant differences (different letters indicate a significant difference corresponding to $P < 0.05$).