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YIELD AND CAROTENE CONTENT OF ORGANICALLY GROWN CARROT (*DAUCUS CAROTA*)

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Abstract. **'Scarlet Nantes' carrot cultivar were grown in both an organically maintained, and a standard culture production area at the Organic Gardening Research and Teaching Park located on the campus of the University of Florida, Gainesville, Florida. A split plot experimental design, with five replicates, was laid out over the adjacent organically and standard culture maintained soils. Production area management strategy was tested for its effect on yield and carotene content of carrot (*Daucus carota*). The two production areas served as one main effect treatment, then split by time of fertilization. The fertilizer treatments consisted of materials based on a nitrogen rate of 100 lbs N/Acre and a control. Source of fertilizer used was Fertrel 5-5-5. Growth and carotene content of carrots in the established organic area were greater than in the standard culture area. Time of fertilization had an effect on carotene levels in the standard culture area.**

Introduction

About 5,600 acres of carrots were harvested in Florida in 1994-1995 with a value of $15.4 million and a yield of 130 cwt/acre (Freie and Young, 1993). Florida's carrot production is currently on organic or muck soils, whereas, the two leading producers of carrots, California and Texas, grow carrots on mineral soils (White, 1994). Muck soil acreage is limited and natural oxidation reduces the soil depth by 0.1 ft/yr. (Stephens, 1956). With additional pressure from state agencies and environmental organizations to return farmed muck land back to marsh land, producing carrots on other Florida soils needs investigating (White, 1994).

Additionally, carrot is widely recognized as a valuable source of beta carotene, one of eight major carotenes found in carrots, and an important anti-oxidant chemical and precursor for vitamin A in mammals (Bao, 1994). Carrots are a major vegetable crop, often selected by the consumer for their high beta carotene content (Simon and Wolff, 1987). Beta carotene is regularly found to be approximately 75% of total carotene content (Sims, unpublished data; Simon and Wolff, 1987).

However, growing carrots in Florida on soils other than the muck soils is problematic due to low moisture holding capacity, high temperature (latent heat capacity of siliceous materials), and low fertility. We propose growing carrots on highly organic, amended mineral soils, and use our work here as a test of the plant response to organic production practices. Additionally, it is commonly reported that organically grown vegetables are more nutritious than standard culture, or, conventionally produced vegetables. We endeavor to test this hypothesis.

USDA's *Report and Recommendations on Organic Farming* (US Dept. of Agric., 1980) concluded that, despite claims to the contrary, there was insufficient evidence to show that organically grown produce was nutritionally superior to produce grown with chemical fertilizers. The principle reason for this conclusion was the lack of scientifically sound and statistically valid data from experiments with properly controlled variables (Hornick, 1992). While some research on this matter has been conducted since 1980, it continues to suffer from validity threats of uncontrolled variables. Here, post harvest factors, and the differing production location vary greatly and affect the results.

The factors affecting the nutritional quality of vegetables are thought to be many. A few examples are climate, soils factors, crop and variety, management practices, and maturity and post harvest handling (Hornick, 1992; Somers and Beeson, 1948). Of these examples, management practices directly impacts soil factors. This in turn affects the nutrients available to plants from the soil, therefore having an important role in the nutritional qualities of vegetables (Hornick, 1992).

Organic agriculture is considered to be a better agricultural management practice as it attempts to achieve ecosystem sustainability (Poincelot, 1986). Organic agriculture is widely recognized as being sustainable and environmentally sound for its lack of reliance on petroleum energy sources for fertility and pest control (Poincelot, 1986). Positive indications of this are seen in soil factors like fertility, flora and fauna populations, moisture holding capacity, cation exchange capacity, mineral composition, and water holding capacity. Comparatively higher levels of these factors are considered by some consumers to translate into vegetables of higher nutritional quality (Hammitt, 1990).

In order to move carrot production in Florida off of muck soils, research is needed which addresses some of the problems associated with growing carrot on Florida's mineral sands. In this experiment we test organic production on mineral sands for its yield, and, for the possible advantages of increased carotene content.

Methodology

According to Bear (1948), under uniform conditions for growth the same species will contain the same basic equivalents. Our design produced uniformity excepting the main effect test for production area (soil factors) on the nutritional constituent most desirable in carrot, beta carotene.

Site Characterization

The organic production area has been maintained for four years, receiving 20 to 30 tons/acre of manure and animal bedding compost in each of the fall and spring growing seasons. The base soils are Arrendondo sand. Three soil samples were taken from each plot, composited, and tested by IFAS soil testing laboratory. The organic area has higher (r = 0.05) mineral levels, organic matter, cation exchange capacity, nutrient levels (NH_4^+, NO_3^-), microbial biomass (see section below), and moisture holding capacity.

Two rectangles were set, one in the organic area, and ten feet away, another in the conventional area. Each area served as a main effect treatment for production area. Each area received a five replicate randomized complete block experiment serving as a "split" and testing for the second main effect, time of fertilization. Each area contained three treatments and a control per replicate.

Carrot Cultivation

Carrot variety Scarlet Nantes was planted on 17 February 1995. Plots were pre-plant fertilized with varying portions of 100 lbs N/Acre, depending on treatment. Treatments varied in time of application. Treatment one consisted of 100% of fertilizer application pre-planted. Treatment two consisted of 50% pre-planting, 50% at 40 days after planting (DAP) Treatment three was 25% pre-planting, 50% 40 DAP, 25% 70 DAP. Pre-plant fertilizer applications were incorporated by a rototiller, subsequent applications applied by side dressing. Each plot received total fertilizer application of 100 lbs N/A of a rated (5-5-5), certified organic fertilizer made by the Fertrel corporation of Bainbridge, PA. Plot dimensions were 3 ft by 8 ft. Seeding was by Garden-Way push seeder, into two rows within the plots, apx 1 ft apart. After Germination, plants were thinned to 1.5 in. in-row spacing. Per plot populations were measured. Total plot weight, top weight, and root weight were recorded for each plot.

Soil Microbial Biomass

Microbial biomass was determined by collecting samples of the top 15-cm soil layer in each plot. Three samples were composited. Samples were taken to the laboratory and sieved through a 2-mm sieve to remove course root fragments and woody materials. Samples were kept refrigerated at 4 degrees C until they could be analyzed.

Fumigation-extraction (Amato and Ladd, 1988). Moist soil was fumigated with ethanol-free Formaldehyde ($CHCl_3$) for 10 days. Assay for microbial biomass was based on ninhydrin-reactive nitrogen in extracts of fumigated soils. Microbial biomass was measured in micrograms per gram of soil (ugm/gm).

Carotene Analysis

Upon harvest, three one hundred gram samples were taken at random from all of the roots of each plot, and quickly frozen in light impermeable bags. Later, these were composited, and ground with a small kitchen food processor. Two duplicate 10 gm samples were taken and placed into 50 ml Pyrex vials containing 20 gm of anhydrous sodium sulfate and 1 gm magnesium carbonate. Tetrahydrofuran (THF, HPLC grade) was added to the mixture and the contents of each vial were blended using a Brinkman Polytron homogenizer. The resulting extract (liquid only) was removed and filtered through a Buchner filter fitted with a Whatman #2 filter paper. More THF was added to the vial and the homoginization continued. Extract was again removed. This process was continued until the contents of the vial were nearly colorless. The total volume of extract was measured. Absorbence of the extract was measured at 470 nm with a Perkin Elmer Lambda 3A UV/VIS Spectrophotometer.

Table 1. Carotene level means for the main effect of production area.

Production area	Carotene level-(ul/100gm)
Organic	61738 a
Standard	48229 b

p = .001

Table 2. Time of fertilization: positive effect in standard culture production area.

Treatments	Carotene-(ug/100g)
100% Pre-Plant	41,500 d
50% Pre-Plant, 50% Day 40	50,800 b
25% Pre-Plant, 50% Day 40, 25% Day 70	57,800 a
Control (No Fertilizer)	47,600 c

p = 0.05 - Duncan's new multiple range test.

Table 3. Microbial carbon (biomass) across main effect of production area.

Production area	Microbial Carbon (ug/gm soil)
Organic	122.6 a
Standard	37.0 b

p = .001

Prior to sample analysis, 10 ul of standard stock solution of various dilution's of THF were prepared from trans beta carotene (Sigma Chemical Co). A standard curve was developed from this exercise, from which all other calculations of carotene content of carrot were obtained.

Analysis of variance was used for yield, carotene content, soil analysis, and microbial biomass using SAS analytical software.

Results and Discussion

Significant differences were seen in carotene content between production areas (Table 1). Within each production area, results differed. In the Organic production, time of fertilization showed no effect. In the standard culture production area, differences were seen between all treatments (Table 2).

Difference between production areas is consistent with predictions within the literature, whereby soil factors positively influence plant growth. (Hornick, 1992; Somers and Beeson, 1948) Our findings are congruent with higher soil mineral content (not reported), and microbial biomass (Table 3) found in the organic area.

No statistically significant difference was found in yield between the organic and standard culture production areas, due to residual interaction effect. However growth was visibly improved in the organic area. Gross yield averaged over both production areas was approximately 108 cwt./Acre (±5%).

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USE OF NATIVE AQUATIC PLANTS AS BACKYARD ORNAMENTALS

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Abstract. **Florida's warm temperatures and bright sun provide ideal conditions for growth of many plants. Aquatic plants are important to Florida because of their natural resource and ornamental value. Water-lilies (*Nymphaea* spp.) and lotuses (*Nelumbo* spp.), because of their large, beautiful flowers, are spider-lily (*Hymenocallis floridana* (Raf.) Morton), *Hymenocallis rotata* (Ker. Gawl.) Herb., water dropwort (*Oxypolis filiformis* (Walt.) Britt.), common arrowhead (*Sagittaria latifolia* Willd.), *Sagittaria stagnorum* Small, lizard's tail (*Saururus cernuus* L.), sky flower (*Hydrolea corymbosa* Macb. ex Ell.), and marsh-mallows (*Hibiscus* spp.) are a few of Florida's native aquatic plants that have potential as backyard ornamentals.**

Aquatic plants have been cultured for their ornamental value for thousands of years. Numerous species appear as motifs in ancient works of art (Sculthorpe, 1967) indicating their importance to early civilizations. In ancient times a number of aquatic plants were cultured also for nutritional and medicinal purposes. Currently, aquatic plants are grown primarily for their ornamental and natural resource value, and a few species are cultured for food.

Species of lotus (*Nelumbo*) and water-lily (*Nymphaea*) because of their large, beautiful flowers have received the most attention for their ornamental value by the ancients as well as modern societies. Modern cultivation of water-lilies as ornamentals is generally considered to have begun with the introduction of fragrant water-lily (*Nymphaea odorata* Ait.) from North America to England in 1786 (Sculthorpe 1967). Since