Add Variety to Your Greenhouse and Table with Hydroponically Grown 'Baby' Squash

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Abstract

In the past few years, 'baby' vegetables have become a popular item for restaurant chefs. In spring 2003, 18 squash cultivars (7 zucchini-types (3 green, 3 yellow, 1 round), 5 yellow summer squash-types, 4 patty pan/scallop-types, and 2 cousa-types) were grown hydroponically in a passive-ventilated greenhouse. Plants were grown from 14 Feb. until 15 May 2003. Squash were harvested every other day starting 10 March 2003 (28 total) and graded as fancy or baby depending on size. Squash were graded as 'baby' when they were less than 10 cm in length for zucchini and summer squash types and less than 4 cm diameter for round and patty pan/scallop types. Marketable fruit larger than those considered baby-size were graded as fancy. The cv. Sunburst (patty pan) produced the greatest number of baby-size fruit per plant at 67 while the cv. Bareket (green zucchini) produced the least, 16. The zucchini-types produced between 16 and 25 baby-size fruit per plant (*Bareket*, *Revenue*, *Raven* were green while *Goldy*, *Gold Rush*, and *Sebring* were yellow). The yellow summer squash-types (*Seneca Supreme*, *Supersett*, *Yellowcrook*) produced approximately 45 baby fruit per plant (50 to 84 total fruit per plant). The production of the patty pan/scallop-types (*Butter Scallop*, *Sunburst*, *Patty Green Tint* and *Starship*) ranged from 50 to 67 baby-size fruit per plant depending on cultivar (70 to 80total fruit per plant). *Magda* and *HA-187* (cousa-types), produced 27 and 34 baby fruit, respectively. Baby squash can be easily grown hydroponically in a pesticide-free environment of a greenhouse where they can be harvested, packaged, and distributed to buyers daily.

INTRODUCTION

Baby vegetable trends in the United States have been on the rise since the early 1990s when baby carrots were popularized in U.S. supermarkets. Along with baby carrots, other baby vegetables include corn, zucchini, eggplant, artichoke and many types of lettuce. The majority of baby vegetables are marketed as 'ready-to-eat', for example, gourmet lettuce mixes. Another large portion is handled within high-end specialty restaurants by gourmet chefs. In 2000, consumer food trends were surveyed and many Americans were found to be enjoying the experience of preparing gourmet meals at home (Associated Press, 2000). Consumers were adopting cooking techniques from their favorite restaurant or from the many available television shows.

Currently, most baby squash sold in the U.S. is imported from South and Central American countries such as Guatemala (FreshKing, Inc., Florida). While many baby vegetables are specific cultivars that have been bred to be a small size, others are merely common vegetables that have been harvested immature as in the case of baby squash (Schmidt, 2003). These types of vegetables demand more intense production operations to insure high quality, and in turn, bring a higher return. Baby squash can be produced under open-field culture or in a protected structure (walk-in tunnel or greenhouse). Since baby squash is harvested at a delicate stage (flower blossoms have opened for pollination), having a clean, undamaged fruit is preferred for packaging. The desire for a superior product can easily be achieved through production inside a protected structure as

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compared with open-field cultivation. Furthermore, plants may be grown pesticide-free inside a greenhouse thus increasing the marketing potential of the product.

While baby squash is grown under protection in mild-winter climate countries such as Italy, Spain, and Israel, it is unknown whether baby squash could be produced hydroponically in a passive-ventilated structure in Florida, U.S.A. There have been no cultivars selected for baby squash production and marketed as such via U.S. seed distributors. The objectives of this study were to identify squash cultivars suitable for both the 'baby' squash market and those that could be successfully grown hydroponically in a greenhouse.

MATERIALS AND METHODS

Squash types evaluated included green and yellow zucchini, straight and crookneck yellow summer, patty pan/scallop, and cousa (Lebanese) types. Cultivars for each type are listed in Table 1. Only *Bareket*, *Goldy*, and *HA-187* were listed for tunnel or greenhouse production. On 23 January 2003, seeds from each cultivar were sown in Speedling styrofoam 128 cell trays (Todd Planter flats, Speedling, Inc., Bushnell, FL) filled with a peat: vermiculite mix 60%:40% v:v medium. Transplants were grown in Conviron E15 (Winnepeg, Canada) growth chambers at 25°C constant temperature and a 14 hour photoperiod for three weeks. Transplants were irrigated every other day and fertilized with 100 ppm NO_3-P_2O_5-K_2O fertilizer solution with micronutrients once cotyledons were expanded (Peters Professional All Purpose Plant Food, Spectrum Group, St. Louis, Mo.).

The experiment was conducted in a passive-ventilated high-roof greenhouse (Top Ltd., Rosh Ha'ayin, Israel) located at the Horticultural Sciences Department Protected Agriculture Project, part of the University of Florida Horticultural Research Unit in Gainesville, Fla. The sidewalls were 3.6-m high with a 1-m roof vent at an 8-m height. Both the sidewalls and roof vents were covered with 0.6 mm screen (Klaymen Meteor Ltd., Petah-Tikva, Israel) to prevent insect movement into or out of the greenhouse. The roof was covered with double-layer polyethylene plastic (Ginegar Plastic Products Ltd., Kibbutz Ginegar, Israel). Transplants (3-weeks old) were planted on 14 February 2003 into 11-L, black polyethylene nursery pots (Lerio Co., Kissimmee, Fla.) filled pine bark screened by the manufacturer (Elixson Wood Products, Starke, Fla.) to a size less than 2.54 x 2.54 cm^2 (Shaw et al., 2004). Pots were drilled 2.5-cm from the bottom with four equidistant 1.5-cm diameter holes for drainage. Squash plants were fertigated through individual pressure-compensating emitters (Netafim USA, Fresno, CA) at a flow rate of 33 $ml \cdot min^{-1}$. Fertilization remained the same throughout the season at 120 $mg \cdot L^{-1}$ N, 50 $mg \cdot L^{-1}$ P, 150 $mg \cdot L^{-1}$ K, 135 $mg \cdot L^{-1}$ Ca, 50 $mg \cdot L^{-1}$ Mg, 65 $mg \cdot L^{-1}$ S, 3 $mg \cdot L^{-1}$ Fe, 0.2 $mg \cdot L^{-1}$ Cu, 0.8 $mg \cdot L^{-1}$ Mn, 0.3 $mg \cdot L^{-1}$ Zn, 0.7 $mg \cdot L^{-1}$ B, and 0.06 $mg \cdot L^{-1}$ Mo. The pH of the final solution remained between 5.5 and 6.5.

Each plant was individually trellised vertically on twine similar to that used for greenhouse cucumber production (Shaw et al., 2000). Since the stem of the squash plants was more than 2.5-cm in diameter, plastic clips used in cucumber production could not be used to secure the squash plants to the twine, therefore, horticulture twist ties were used. Twist ties were placed approximately every 15 cm to vertically secure the main stem of the squash plant. Laterals were removed from all cultivars to encourage indeterminate growth.

Bumble bees (*Bombus impatiens*, Koppert Biologicals Inc., Romulus, MI) were used for pollination, but their presence in the greenhouse limited pest control measures. Pests were controlled with biological agents. Green peach aphids (*Myzus persicae*) were controlled using lady beetle larvae (*Hippodamia convergens*, Entomos, Gainesville, FL.) and parasitic wasps (*Aphidius colemani*, IPM Laboratories, Locke, NY). Few two-spotted spider mites (*Tetranychus urticae*) and thrips (*Frankliniella occidentalis*) were found during the season; however, both were controlled by releasing *Orius insidious* (Entomos) and *Ambelysius cucumeris* (Koppert Biologicals, Inc). Powdery mildew (*Sphaerotheca fuliginea*) was controlled using Nova (myclobutanil, Rohm & Haas Co., Philadelphia,

Pa.) and sulfur dust. Nova was sprayed once four weeks after transplanting and sulfur dust was applied to non-experimental plants once per week beginning10 weeks after transplanting.

Plants were harvested three times per week. There were 28 harvests beginning on 10 March 2003 and ending on 15 May 2003. Fruit were harvested per plot and graded by size and shape. U.S.D.A. grade standards for baby squash have not been published; however, current retailers market baby squash at weights of approximately 20-30 g per fruit (Schmidt, 2003). Zucchini-, yellow summer-, and cousa-types were graded as 'baby' fruit if they were 10 cm in length or less. Fruit sizes up to 20 cm in length and uniformly shaped were graded fancy, other marketable fruit were graded No.1, and all non-marketable fruit were culled. Patty pan/scallop-types and the round zucchini (*Eight Ball*) were considered 'baby' size if they were 4-cm diameter or less. Fruit which were 4 to 8-cm in diameter and uniformly shaped were graded fancy, other marketable fruit were graded No. 1, and all non-marketable fruit were culled. Marketable fruit was the combined total of baby, fancy, and No. 1 grade categories.

The experiment was a randomized-complete block experimental design with three replications. Data were analyzed using the statistical software package SAS (Cary, NC) and means were separated using Duncan's multiple range test, 5% level.

RESULTS AND DISCUSSION

Numbers of baby squash produced per plant were greatest for the patty pan/scallop-type cultivars and lowest for the zucchini-types (Table 2). *Sunburst* was superior in baby fruit number per plant at 67 fruit while *Bareket* produced the lowest number at 16. The production of baby fruit from the yellow and green zucchini-type cultivars was between 16 and 25 fruit per plant. *Zephyr* produced a significantly lower number of baby fruit than the other yellow summer-type cultivars, 27 compared to an average of 43. Except for *Sunburst*, the other patty pan/scallop-type cultivars produced on average of 50 fruits per plant. The two cousa cultivars, *Magda* and *HA-187*, were not significantly different and averaged 30 baby fruit per plant. Weight of baby squash per plant followed the same trend as number of baby fruit per plant. Baby fruits were harvested and graded by size that was recommended for packaging and average baby fruit weight of all squash cultivars grown was between 18 and 30 g per fruit (can be calculated from Table 2).

Culls were minimal for most squash cultivars evaluated (Table 1). However, the cv. Yellow Crookneck produced many misshaped fruit or fruit that remained green when harvested at a small size and could not be considered marketable as a 'baby squash'. In spite of the number of culls produced, *Yellow Crookneck* remained one of the higher yielding cultivars.

Marketable fruit number per square meter included the yields of baby, fancy, and No. 1 grade fruit. The patty pan/scallop-types produced the greatest yield (166 fruit·m^{-2}) per area, but their yields were not significantly different from those of the yellow summer-type *Seneca Supreme*, an average of 157 fruit·m^{-2}. Marketable fruit weight per square meter was not significantly different among many of the yellow summer-types, the patty pan/scallop-types, the cousa types, or the green zucchini *Revenue*, 3.0 to 3.8 kg·m^{-2}. Total marketable weight per square meter was greatest with *Patty Green Tint* and lowest with *Sebring*, 4.8 kg·m^{-2} compared to 1.2 kg·m^{-2}.

CONCLUSION

Currently baby squash sell in regional supermarkets for approximately $3.49/227 g pack (Publix Supermarkets, Lakeland, FL). The fruit are grown in open-field culture in South and Central American countries, packaged, and air-freighted to the U.S. With the advantage of locality to market, greenhouse growers in Florida can successfully add the variety of baby squash to their greenhouse and table. Greenhouse growers can choose a cultivar based on yield and/or fruit characteristics. The greatest yields were produced by the patty-pan/scallop-types (*Butter Scallop*, *Patty Green Tint*, *Starship* and *Sunburst*),

followed by the yellow summer-types (*Seneca Supreme*, *Sunray*, and *Supersett*). Though plant yields were lower, the zucchini (green or yellow) and the cousa-type squash grow well hydroponically and would diversify market ability. Hydroponic production of baby squash especially under pesticide-free conditions could increase market potential by adding the value of a clean product that can be harvested on a daily basis and specialized to the demands of both consumer and chef.

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Tables

Table 1. Squash cultivars evaluated under hydroponic cultivation for baby squash production.

Type	Cultivar name	Description	Seed company[1]
Zucchini	*Bareket*	Dark green	Hazera Genetics, Inc.
	Eight Ball	Round, green	Hollar Seeds, Inc.
	Gold Rush	Deep yellow	Johnny's Selected Seeds
	Goldy	Yellow	Hazera Genetics, Inc.
	Sebring	Yellow	Hollar Seeds, Inc.
	Revenue	Medium green	Johnny's Selected Seeds
	Raven	Dark green	Johnny's Selected Seeds
Yellow summer	*Seneca Supreme*	Straightneck	Johnny's Selected Seeds
	Sunray	Straightneck	Johnny's Selected Seeds
	Supersett	Crookneck	Johnny's Selected Seeds
	Yellow Crookneck	Crookneck	Johnny's Selected Seeds
	Zephyr	Green blossom end, straightneck	Johnny's Selected Seeds
Patty pan/Scallop	*Butter Scallop*	Pale yellow	Johnny's Selected Seeds
	Patty Green Tint	Light green	Johnny's Selected Seeds
	Starship	Dark green	Johnny's Selected Seeds
	Sunburst	Deep yellow	Johnny's Selected Seeds
Cousa	*HA-187*	Mottled green	Hazera Genetics, Inc.
	Magda	Pale green	Johnny's Selected Seeds

[1] Hollar Seeds, Inc., PO Box 106, Rocky Ford, CO 81067 USA; Hazera Genetics, Inc., 2250 E. Imperial Highway, Suite 200, El Segundo, CA 90245 USA; Johnny's Selected Seeds, 955 Benton Ave., Dept. 5124, Winslow, Maine 04901 USA.

Table 2. Yields of several squash cultivars grown hydroponically in a passive-ventilated greenhouse.

Cultivar[z]	Baby squash number per plant	Baby squash weight (g)	Cull number per plant	Marketable number (fruit·m^{-2})	Marketable weight (kg·m^{-2})
Zucchini-type					
Bareket	16 h	409 i	< 1 b	45 g	1.4 gh
Eight Ball	20 gh	546 ghi	< 1 b	56 fg	2.0 h
Gold Rush	21 gh	435 hi	< 1 b	54 fg	1.4 h
Goldy	19 gh	420 hi	< 1 b	49 fg	1.4 h
Raven	25 gh	631 g	< 1 b	73 ef	2.6 ef
Revenue	22 gh	679 fg	3 b	81 e	3.8 bcd
Sebring	17 h	379 i	< 1 b	46 g	1.2 h
Yellow summer-type					
Seneca Supreme	48 bcd	1015 bcd	< 1 b	148 abc	4.0 bc
Sunray	40 de	843 c-f	2 b	118 d	3.2 cd
Supersett	43 bcd	850 c-f	4 b	119 d	3.0 de
Yellow Crookneck	42 cd	820 ef	18 a	133 cd	3.2 cde
Zephyr	27 fg	588 gh	3 b	95 e	3.0 de
Patty pan/Scallop-type					
Butter Scallop	51 b	961 b-e	2 b	161 ab	4.2 ab
Patty Green Tint	50 bc	1050 b	2 b	166 a	4.8 a
Starship	51 b	1022 bc	< 1 b	139 bcd	3.6 bcd
Sunburst	67 a	1229 a	2 b	170 a	3.8 bc
Cousa					
HA-187	34 ef	1004 bcd	< 1 b	94 e	3.6 bcd
Magda	27 fg	838 def	< 1 b	89 e	3.6 bcd
C.V.	13.6	12.6	124.8	13.1	13.5

[z] Yields are an accumulation of 28 harvests. Plants were grown from 14 Feb. to 15 May 2003 in Gainesville, Florida, USA.