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## ABSTRACT

In 2010-2012, 13 cultivars of specialty eggplant were grown on a sandy terrace soil (Windsor, CT) and a loamy upland soil (Hamden, CT). Average total yield of all specialty eggplant cultivars was 22.7 t/acre (A) at both sites or 12.5 lbs/plant. Highest yielding cultivars were cultivar Calliope (oval, white/purple striped; 20.8 lbs/plant) and Hansel (long, thin, purple; 19.7 lbs/plant). The lowest yielding cultivar was Brazilian Mini Orange (small, round, green to orange; 6.2 lbs/plant). Long Purple Tiger (long fatter, purple; 8.2 oz/fruit) and Calliope (5.0 oz/fruit) produced the largest fruit while the other cultivars averaged about 2 oz/fruit. Fairy Tale (small, long, purple/white striped) produced the greatest number of fruit per plant (157 fruit/plant) while Hansel (145 fruit/plant) and Gretel (long, thin, white; 124 fruit/plant) averaged more than 100 fruit/plant. Growers can make cultivar choices based on appearance (color, size, and shape) as well as expected yield per plant.

## INTRODUCTION

Given the changing patterns of the U.S. agriculture and population, farmers must adapt to national trends in order to survive. Small farmers can capitalize on favorable socio-economic trends, such as the increasing diversity in the U.S. population and the desire for a balanced and healthy diet, to explore and develop innovative agricultural enterprises including novel crops. Ethnic and specialty vegetables are novel, high-value crops that have demonstrated potential markets across the U.S.

Evaluation of new crops is essential to provide information to farmers considering new opportunities during a time of changing agriculture in southern New England (CT, RI, and MA). For example, tobacco and dairy farming in southern New England have declined in the last 15 years. Acreage of tobacco declined from 3,725 in 1997 to 2,593 acres in 2012, and the number of dairy farms has declined from 1,061 in 1997 to 550 in 2012 (Anon. 2014). Although the numbers are unknown, some tobacco and dairy farms converted to other crops including vegetables, nursery stock, and Christmas trees. Others diversified to provide supplemental income. New farming ventures on idle and rented land have increased the number of farms (annual income exceeding \$1,000) from 13,206 in 1997 to 14,975 in 2012. Furthermore, the number of vegetable farms increased from 1,821 in 1997 to 2,583 in 2012 (Anon. 2014). Today, about 30,000 acres in southern New England are devoted to vegetable production and about 70% of these farms are less than 50 acres in size.

Small farm sizes have resulted in marketing shifts from wholesale contracts with local supermarkets to direct retail sales. Over 1,000 farms in southern New England offer direct sales through roadside stands and sales rooms where a variety of fruit, vegetables, nursery stock, and Christmas trees are offered. The development of a network of farmers' markets in southern New England's major urban centers and densely populated suburbs is another important segment of direct sales of vegetables to consumers. A farmer's market offers locally-grown, fresh produce to urbanites unable to travel to the farms and niche crops valued by diverse ethnic groups. According to the Massachusetts, Rhode Island, and Connecticut Departments of Agriculture, there were 542 farmers' markets in 2015 that were attended by over 1,000 farmers.

Eggplant is a widely-grown specialty vegetable in the U.S. According to the 2012 Census of Agriculture (USDA 2013), eggplant was harvested on almost 3,500 farms in 2012, an increase of over 560 farms since 2007. Most commercial production in the U.S. is located in Florida, California, and New Jersey (USDA 2006). About 98% of the eggplant grown is produced for the fresh market, with the remainder used for processed products such as frozen entrees, specialty dips, and appetizers (USDA 2012). Eggplant consumption in the United States has increased steadily over the past 5 decades from 0.3 pounds per capita in the 1960's to 0.9 pounds in 2007 (USDA 2008). The rapid growth in the past decade may reflect the introduction of new processed products plus increased interest in vegetarian diets. Eggplant is becoming an important part of increasingly diverse commercial vegetable operation in southern New England. In 2012, 347 growers grew 358 acres of eggplant compared to 258 growers on 311 acres in 2007 (Anon 2014), a 34% increase in the number of growers.

Eggplants are a botanically diverse group that can be divided into two groups based on fruit shape and color. The first group is the more traditional teardrop-shaped, large-fruited eggplant. Fruit of these

eggplants are typically oval or long and tapered in shape with a black, purplish-black, or purple skin color, often with a green calyx. The second group is collectively referred to as the “specialty” eggplants, some of which are referred to as “oriental” or “Asian”. Asian eggplants generally have a purple calyx. Fruit shapes of specialty varieties vary, but are often long and smooth, ball- or bell-shaped. Fruit colors range from white, to green, to purplish black, to purple. Japanese and Chinese eggplant tend to be long and thin, looking like purple fingers. White, green, and striated versions of these cultivars are also available. Thai eggplants, on the other hand, are more spherical, and also display a range of colors. Thai eggplant can also be very small, with one version looking remarkably like a chicken egg.

Asian eggplants are used extensively in Oriental cuisine, but can also be used in Western dishes. Asian eggplant is sweet and tender, in contrast to traditional eggplant which has a slightly bitter flavor. Asian eggplant quality can be compromised if the fruit remains on the plant too long, since it can acquire bitterness in storage. As a result, Asian eggplant is usually harvested young and used promptly. This characteristic is ideal for southern New England farmers many of whom retail their crop through roadside stands and farmers markets.

The economic potential of eggplant can high for growers who sell directly to the consumer. The cost of producing ethnic eggplant varieties at the UMass Research Farm was estimated to be \$6,000/acre (Uchoa de Mendonca 2005). At the end of the harvest in the Massachusetts trial, the price for Thai eggplant (“Kermit”) at the New England Produce Center was \$40 per 30 pound box compared to \$9.00 per 35 pound box for Classic (traditional) eggplant. Based on this information, the total gross receipts for “Kermit” grown at the UMass Research Farm would have exceeded \$9,000/acre. The total gross receipts would be much higher for growers who sell directly to the consumer.

Previous specialty eggplant variety trials have generally been limited to a few varieties over one growing season. Massachusetts studied 5 ethnic varieties at one site in 2005 (Uchoa de Mendonca et al. 2005), New Jersey studied 12 varieties at two sites in 2002 (Infante- Casella, et al. 2002), and Iowa State investigated 8 varieties at one site in 2005 (Taber 2005). Connecticut conducted cultural and varietal trials with scarlet eggplant or Jilo (Hill 2001). This study evaluates 13 varieties of specialty eggplant at two sites for three years.

## **METHODS AND MATERIALS**

*Sites and soils.* Trials of specialty eggplant were conducted for three years at the Valley Laboratory in Windsor, CT on Merrimac sandy loam (Entic Haplorthod), an inland sandy terrace soil with somewhat limited moisture holding capacity (Shearin and Hill, 1962); and at Lockwood Farm in Hamden, CT on Cheshire fine sandy loam (Typic Dystrochrept), a coastal loamy upland soil with moderate moisture holding capacity (Reynolds, 1979).

*Cultivars.* Cultivars grown in 2010 included Little Purple Tiger, Longship, Turkish Orange, Brazilian Mini Orange, Kermit, Louisiana Long Green, Slim Jim, Fairy Tale, Hansel, and Ichiban. Cultivars grown in 2011 included Gretel, Raveena, Slim Jim, Turkish Orange, Longship, Calliope, Kermit, Hansel, Fairy Tale, and Louisiana Long Green. Cultivars grown in 2012 included Longship, Raveena, Ichiban, Turkish Orange, Fairy Tale, Louisiana Long Green, Hansel, Calliope, Gretel, and Kermit. Characteristics of the specific cultivars and seed sources are described in Table 1.

*Culture.* Eggplant was seeded in the greenhouse on April 5 to 7. Seedlings were grown in Promix BX (Premier, Red Hill PA) in 3x3x3-inch Jiffystrips and placed in a greenhouse maintained at 75°-90°F. After germination, plants were thinned to one per pot. Seedlings were moved to a cold frame for hardening before transplanting in the field. Water-soluble 20-20-20 fertilizer (one tbs/gal) was added to the seedlings before they were transplanted in the field in mid-June. They were planted 3 feet apart in rows of black plastic mulch (3' wide) applied by a tractor-pulled plastic layer 5 feet apart with 15 plants per cultivar. Holes were punctured in the plastic at each planting site. At Hamden, drip irrigation tubing was laid before the plastic was applied.

*Fertilization.* The field soils (pH 6.5) were fertilized at a rate of 1300 lb/A 10-10-10 just before seeding or transplanting. Different experimental fields at each location were used each year to minimize potential disease build-up.

*Weed control.* Weeds around each plant were controlled by the black plastic mulch. Weeds in the aisles were mechanically controlled by rototilling.

*Insect and disease control.* Insects and diseases were controlled by Manzate (mancozeb), Quadris (azostobin), Asana (esferivaterate), and Bravo (chlorothalmil) applied per labeled directions as needed throughout the growing season.

*Irrigation.* Water was supplied by drip irrigation at Hamden. At Windsor, water was supplied by overhead sprinklers as needed. Plots were irrigated at both sites so that plots received at least 1 inch of water per week either through rainfall or irrigation.

*Harvest.* Eggplant was harvested from July to October and the first frost. Fruits were counted, weighed, and evaluated for quality. There were no replicates on a farm for a given year because all harvested fruit of each cultivar at each farm was bulked over the growing season.

*Statistical Analysis.* A two-factor (cultivar, site) analysis of variance (ANOVA) with year as replicate was used to compare yields (lbs per plant) between farms. It was noted that yields in 2012 appeared larger than the previous two years. Therefore, using the six cultivars that were grown at both sites for all three years (Table 1), a two-factor (cultivar, year) ANOVA with site as replicate was used to examine differences in yield among years. Tukey's HSD test was used to test for significant differences among the cultivar yields at  $p < 0.05$ .

## RESULTS AND DISCUSSION

Yields did not differ between the two experimental sites (Hamden and Windsor) ( $F_{1,44}=0.02$ ,  $p=0.89$ ), but did differ among cultivars ( $F_{12,44}=8.42$ ,  $p<0.01$ ). Yields differed among years ( $F_{2,27}=19.33$ ,  $p<0.01$ ) with yields in 2012 ( $14.9\pm 0.5$ ) greater than in 2010 ( $10.3\pm 0.6$ ) or 2011 ( $11.7\pm 0.5$ ).

The highest yielding cultivars when averaged over all years were Calliope (20.8 lbs/plant), Hansel (19.7 lbs/plant), and Fairy Tale (15.3 lbs/plant) (Table 2). Yields of Calliope were statistically the same as Hansel, Fairy Tale, Gretel, Raveena, Ichiban, and Long Purple Tiger even though yields of Calliope were as much as 79% greater. Gretel's yields were statistically equal to all cultivars even with yields over 100% greater than some other cultivars.

Six cultivars (Fairy Tale, Hansel, Kermit, Longship, Louisiana Long Green, and Turkish Orange) were grown all three years at both sites. Yields of these cultivars averaged 10.3 lbs/plant in 2010, 11.7 lbs/plant in 2011, and 14.9 lbs/plant in 2012. Growing conditions appeared to be optimal in 2012 and that year had the greatest average Growing Degree Days (3378) (Table 3). However, precipitation was lowest in 2012 but plots were irrigated as needed so rainfall was not a defining factor.

Yields in pounds per plant are due to a combination of fruit size and a number of fruit per plant. Number of fruit per plant varies according to the growing season (Table 4). Favorable growing conditions produce larger plants which produce more fruit. Average number of fruit per plant including all cultivars was 74 in 2010, 79 in 2011, and 118 for 2012. Average number of fruit per plant including only the 6 cultivars which were grown all three years was 85 in 2010, 88 in 2011, and 118 in 2012. All cultivars produced more fruit per plant in 2012 compared to the previous two years except for Kermit which remained consistent throughout the three years. Fairy Tale, Hansel, and Gretel averaged over the three years produced the greatest number of fruit per plant. Long Purple Tiger averaged the fewest and was statistically the same as 7 other cultivars even though it produced as much as 57 fewer fruit per plant.

Fruit size is genetically controlled and fruit was harvested at the optimum marketable size for that particular cultivar. Average fruit size for each cultivar remained relatively constant between the sites and years (Table 5). Most fruit averaged about 2 ounces per fruit with the exception of Calliope (5 oz/fruit) and Little Purple Tiger (8.2 oz/fruit). Calliope (20.8 lbs/plant) and Hansel (19.7 lbs/plant) have virtually identical yields in pounds per plant but the high yields were achieved differently. Calliope had fewer fruit per plant (66) but larger fruit (5 oz/fruit) while Hansel averaged 145 fruit/plant with smaller fruit (2 oz/fruit). When comparing the yields of cultivars with similar fruit characteristics, Turkish Orange (11.2 lbs/plant) had the highest yields of the small round (Thai) varieties (not statistically significant but up to 81% greater yields) and Hansel (19.7 lbs/plant) of the long purple (Asian) varieties (statistically significant compared to Longship and Slim Jim) (Table 2). The other varieties had unique characteristics (either color and/or shape) and could be grown for those qualities instead of yield.

While specialty eggplant produces smaller sized fruit compared to traditional eggplant, their yields per plant are equal to or greater as they produce more fruit per plant. In addition, they currently have a higher price on the marketplace. According to the USDA Agricultural Marketing Service, on September 22, 2015, wholesale prices for traditional eggplant were \$8-12/1 1/9 bushel (35 lbs) compared to \$35/35 lbs for Thai eggplant and \$45/25 lbs for Japanese eggplant. At a 4x3 foot spacing (3630 plants/acre), a grower could gross over \$40,000/acre when growing Turkish Orange or over \$29,000/acre when growing Kermit, both Thai type eggplants, assuming the grower has an established market and the entire crop is sold. For Japanese eggplants, a grower could gross almost \$129,000/acre when growing Hansel. Even growing Slim Jim, the lowest yielding Japanese variety evaluated, a grower could gross over \$46,000/acre. This is compared to \$20,000/acre when growing traditional eggplant averaging 20 lb/plant. In the Northeast, most likely partial acres would be grown of specialty eggplants or several varieties would be grown on one acre.

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**Table 1.** Characteristics of specialty eggplant cultivars used in trials at Windsor and Hamden in 2010, 2011, and 2012.

Cultivar	2010	2011	2012	Characteristics
Braz. Mini Orange	X			Small, round, green to orange
Calliope		X	X	Oval, larger, white and purple striped
Fairy Tale	X	X	X	Small, long, purple and white striped
Gretel		X	X	Long, thin, white
Hansel	X	X	X	Long, thin, purple
Ichiban	X			Long, thin, purple
Kermit	X	X	X	Small, round, green and white
Long Purple Tiger	X			Long, fatter, purple
Longship	X	X	X	Long, thin, purple
La. Long Green	X	X	X	Long, fatter, green
Raveena		X	X	Long, thin, light green
Slim Jim	X	X		Long, thin, purple
Turkish Orange	X	X	X	Small, round, green to orange-red

**Table 2.** Average (standard error) yield for eggplant cultivars grown in 2010, 2011, and 2012 in Connecticut.

	Pounds per plant			
	2010	2011	2012	Combined
Calliope	-	15.9 (0.4)	25.8 (6.4)	20.8 (3.9) a <sup>1</sup>
Hansel	17.7 (1.1)	19.0 (2.7)	22.5 (0.1)	19.7 (1.2) a
Fairy Tale	11.8 (0.7)	14.8 (0.8)	19.3 (2.2)	15.3 (1.5) ab
Gretel	-	11.8 (1.1)	15.1 (2.4)	13.4 (1.4) abc
Raveena	-	10.4 (1.1)	14.9 (1.4)	12.7 (1.5) abc
Ichiban	11.8 (2.0)	-	-	11.8 (2.0) abc
Long Purple Tiger	11.7 (0.8)	-	-	11.7 (0.8) abc
Turkish Orange	8.6 (0.3)	11.1 (2.3)	14 (0.5)	11.2 (1.2) bc
Louisiana Long Green	7.7 (0.7)	10.7 (0.4)	14.3 (0.5)	10.9 (1.2) bc
Longship	7.9 (1.6)	7.4 (0.8)	10.3 (2.3)	8.5 (0.9) c
Kermit	7.6 (0.6)	7.3 (1.8)	9.4 (0.0)	8.1 (0.6) c
Slim Jim	6.4 (0.1)	7.3 (0.5)	-	6.8 (0.3) c
Brazilian Mini Orange	6.2 (0.0)	-	-	6.2 (0.0) c
Combined <sup>2</sup>	10.3 (0.56) a	11.7 (0.54) a	14.9 (0.53) b	

<sup>1</sup> Combined year column values with same letter were not significantly different at  $p < 0.05$

<sup>2</sup> Mean for six cultivars grown all years at both sites (see Table 1), row values with same letter were not significantly different at  $p < 0.05$ .

**Table 3.** Growing Degree Days (GDD)\* and Precipitation (inches) March 1 through October 31 at Windsor (W) and Hamden (H) in 2010, 2011, and 2012.

	2010		2011		2012	
	W	H	W	H	W	H
GDD	2990	3255	3196	3289	3370	3387
Precipitation	35.3	36.3	47.2	49.8	33.0	31.9

\* Growing Degree Days based on 50 degrees Fahrenheit

**Table 4.** Average (standard error) number of harvested fruit per plant for eggplant cultivars grown in 2010, 2011, and 2012 in Connecticut.

	Number of fruit per plant			
	2010	2011	2012	Combined
Fairy Tale	129.5 (4.5)	147.0 (15.0)	194.0 (16.0)	156.8 (13.5) a <sup>1</sup>
Hansel	138.5 (4.5)	131.0 (3.0)	164.5 (10.5)	144.7 (7.1) a
Gretel	-	98.0 (8.0)	149.0 (22.0)	123.5 (17.6) ab
Turkish Orange	75.5 (3.5)	89.5 (10.5)	113.5 (11.5)	92.8 (8.1) bc
Raveena	-	64.0 (8.0)	121.0 (3.0)	92.5 (16.8) bc
Louisiana Long Green	63.0 (7.0)	66.5 (5.5)	108.5 (6.5)	79.3 (9.7) bcd
Slim Jim	81.0 (2.0)	73.5 (5.5)	-	77.3 (3.2) bcd
Ichiban	69.5 (4.5)	-	-	69.5 (4.5) bcd
Calliope	-	51.0 (3.0)	80.0 (18.0)	65.5 (11.2) cd
Brazilian Mini Orange	63.5 (0.5)	-	-	63.5 (0.5) cd
Longship	51.0 (3.0)	45.5 (0.5)	73.5 (12.5)	56.7 (6.4) cd
Kermit	54.5 (2.5)	46.5 (7.5)	55.0 (1.0)	52.0 (2.7) cd
Long Purple tiger	22.5 (1.5)	-	-	22.5 (1.5) d
Combined <sup>2</sup>	85.3 (3.9) a	87.7 (3.9) a	118.2 (3.9) b	

<sup>1</sup> Combined year column values with same letter were not significantly different at  $p < 0.05$

<sup>2</sup> Least square mean for six cultivars grown all years at both sites (see Table 1), row values with same letter were not significantly different at  $p < 0.05$ .

**Table 5.** Average (standard error) fruit size (ounces) for eggplant cultivars grown in 2010, 2011, and 2012 in Connecticut.

	Ounces per fruit			
	2010	2011	2012	Combined
Long Purple Tiger	8.2 (0.1)	-	-	8.2 (0.1) a
Calliope	-	5.0 (0.2)	5.1 (0.1)	5.0 (0.1) b
Ichiban	2.7 (0.3)	-	-	2.7 (0.3) c
Kermit	2.3 (0.0)	2.5 (0.3)	2.8 (0.0)	2.5 (0.1) c
Longship	2.5 (0.3)	2.6 (0.3)	2.2 (0.1)	2.4 (0.1) c
Raveena	-	2.6 (0.1)	2.0 (0.2)	2.3 (0.2) cd
Hansel	2.2 (0.1)	2.3 (0.2)	2.2 (0.1)	2.2 (0.1) cd
Louisiana Long Green	2.0 (0.0)	2.5 (0.0)	2.1 (0.2)	2.2 (0.1) cd
Turkish Orange	1.8 (0.0)	2.0 (0.2)	2 (0.1)	1.9 (0.1) de
Gretel	-	2.0 (0.0)	1.6 (0)	1.8 (0.1) de
Brazilian Mini Orange	1.6 (0.0)	-	-	1.6 (0.0) de
Fairy Tale	1.5 (0.2)	1.6 (0.1)	1.6 (0)	1.5 (0.1) e
Slim Jim	1.3 (0.0)	1.6 (0.0)	-	1.4 (0.1) e
Combined <sup>2</sup>	2.0 (0.1) a	2.2 (0.1) a	2.1 (0.1) a	

<sup>1</sup> Combined year column values with same letter were not significantly different at  $p < 0.05$

<sup>2</sup> Mean for six cultivars grown all years at both sites (see Table 1), row values with same letter were not significantly different at  $p < 0.05$ .



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