

## EVALUATION OF THREE HYBRID SQUASH (*Cucurbita pepo* L.) VARIETIES FOR THE FRESH AND FROZEN MARKETS

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### ABSTRACT

*The evaluation of three squash (*Cucurbita pepo* L.) varieties was conducted in a replicated small plot trial at the Gladstone Road Agricultural Centre during 2016, to examine yield and quality of two zucchini squash varieties 'Golden Glory' and 'Spineless King' and a yellow crookneck squash, 'Delta', over several harvests and under local field conditions. The first harvest occurred during March, 40 days after planting. Weights of the squash varieties were within the range of yields for similar squash types. The potential yields for the zucchini varieties ranged from 9.1 tonnes/hectare for 'Golden Glory' to 14.0 tonnes/hectare for 'Spineless King'. The potential yield for the 'Delta' crookneck squash was significantly lower at 5.7 tonnes/hectare. Because of the short growing time, this crop can be grown at several different planting dates during the cool growing season. For added value, yellow zucchini slices can be added to a mixed vegetable package and sold as a frozen food item by local farmers.*



Flowering and fruiting stages of crookneck squash var. 'Delta'

### **Introduction:**

The zucchini and crookneck squash (*Cucurbita pepo* L.) varieties are among the most popular of vegetable crops consumed worldwide. Production data on these cucurbits are difficult to obtain, however,

as most statistics group the zucchini, pumpkin and other types of squash together. According to the most recent data from FAOSTAT (2013), more than 24.7 million tonnes of pumpkin, squash and other cucurbits are produced annually on an area of approximately 1.8 million hectares. Annual figures for The Bahamas (FAOSTAT, 2013) indicate a production of 102 hectares yielding 2,087 tonnes of produce.

Commercially, the zucchini and crookneck squash can be grown successfully on a large scale by large farmers, or they can be grown on less than one hectare of land by small farmers. These cucurbits are also suited for cultivation in the home garden by individual householders. Production constraints include many pest and disease problems that affect yields (Powell *et al.*, 1993; Webb and Tyson, 1997; Cradock *et al.*, 2001; Xu *et al.*, 2004; Yandoc-Ables *et al.*, 2007; Murphy *et al.*, 2009). The squash varieties and pumpkins perform better in well drained, fertile soils with lots of sunshine. The squash family is among the most nutrient rich of food crops and is rich in carotenoids essential for the production of vitamin A. This family of food crops also contains a wide range of amino acids and is low in calories.

The squash family is very diverse, with much variation in shape, texture and colour. The crookneck squash is usually of a pale yellow colour, with a distinctive curved neck. The green zucchini varieties are solid and cylindrical, varying in colour from a solid, dark green to a light green. Some varieties are streaked or blotched in various shades of green. The yellow zucchini is a slender, bright yellow attractive fruit. It is a fast growing bush type crop which matures in approximately 40-50 days. Yellow zucchini yields tend to be lower than those for the green varieties. When harvested early this crop generally fetches a better price, with a better quality of fruit. Late harvests may contribute to deterioration in fruit quality.



Flowering and fruiting stages of green zucchini squash var. 'Spineless King'

In The Bahamas, squash is not planted on a commercial scale but is grown mostly by small famers on a small scale as a specialty crop for a specialised market. This cucurbit is among those crops that have attracted interest as a potential cash crop for diversification of crop production systems. Introduction of this crop to a wider market will mean that local farmers must select varieties that are high yielding, resistant to pests and diseases and generally meet the demands of production and quality. Therefore, it is essential to evaluate zucchini and other squash varieties for yield performance and for insect and disease tolerance.

**Objectives:**

The objective of this trial is to evaluate the performance of two zucchini and one crookneck squash varieties under local conditions.

**Materials and Methods:**

Evaluation of the three squash varieties was conducted at the Gladstone Road Agricultural Centre during the vegetable growing season. The three squash varieties were: 'Delta', a yellow hybrid crookneck squash, 'Golden Glory', a yellow zucchini and 'Spineless King', a dark green zucchini. 'Spineless King' is a heat tolerant zucchini hybrid from Seedway Seed Company. 'Golden Glory' is a hybrid developed by Syngenta. 'Delta' is a product of Harris Seeds. The three squash varieties have bush-type habits which allow them to be planted in a close spacing without any reduction in yield.

The trial was laid out in a completely randomised design with four replications. Experimental plots consisted of ten plants spaced 45 cm (18 in) apart on raised beds with a row spacing of 1.5 m (5 ft.) between rows. The three squash varieties were direct seeded to field plots on 10<sup>th</sup> February, 2016. A series of harvests took place after 40 days of growth, starting on the 21<sup>st</sup> March, 2016.

**Methods Used in Analysis of Three Squash Varieties (Based on A.O.A.C., 1995):**

*Moisture/Dry Matter* – fruit of the three squash varieties were wiped and chopped into small pieces. Triplicate 2g samples were accurately weighed into pre-labelled, pre-weighed dishes and were dried at 130°C to constant weight. Dried samples/dishes were weighed. Moisture content (%) was calculated. Dry matter (%) was calculated by 100 – Moisture content (%).

*Other Analyses* - Samples were peeled, wiped, chopped and dried in oven. The dried samples were subsequently powdered in a high-speed blender and used for the remainder of the tests.

*Protein* - Duplicate 1g dried and powdered samples were weighed and digested with H<sub>2</sub>SO<sub>4</sub> and K<sub>2</sub>SO<sub>4</sub>/Se catalyst tablets, using the block digestion method in a Foss Tecator Auto Digester. The resulting digest was steam distilled into boric acid using a Labconco Rapid Still II. Titration of the distillate with standard HCl was used to estimate crude protein. The method was based on the A.O.A.C. Official Method 2001.11.

*Fat* - Fat determination carried out by the acid hydrolysis method. 8g samples were weighed in triplicate and digested in acid. The digests were transferred to Monjonier flasks where the fat was extracted with ethers. The ether extract was transferred into previously dried and weighed flasks and the ethers evaporated and the remaining fat dried and weighed and the % fat calculated.

*Sodium and Potassium* - Aqueous solutions of ashed samples were aspirated directly into a Cole-Parmer Model 2655-00 flame analyzer. Intensity was compared against a prepared standard curve.

The mean monthly maximum temperature for the trial period was recorded at 27.9°C (82.2°F), while the mean monthly minimum temperature was 19.6°C (67.3°F). The total rainfall for the period was 76.7 mm (3.02 in). Mean monthly sunshine duration for the period was 8.6 h. Weather data (Table 1) on maximum and minimum temperatures, rainfall and sunshine duration were obtained from the Meteorological Department of the Commonwealth of The Bahamas.

Table 1. Weather data on rainfall, hours of sunshine and mean maximum and minimum temperatures for New Providence for the period of February 2016 to April 2016, courtesy of the Meteorological Department of The Bahamas.

| Month    | Total rainfall (mm/inches) | Mean monthly radiation (h) | Mean maximum temperature (°C/°F) | Mean minimum temperature (°C/°F) |
|----------|----------------------------|----------------------------|----------------------------------|----------------------------------|
| February | 36.6/1.44 in               | 7.4                        | 26.1/79.0                        | 17.6/63.6 F                      |
| March    | 16.5/0.65                  | 8.3                        | 28.4/83.1                        | 20.3/68.5                        |
| April    | 23.6/0.93                  | 10.2                       | 29.1/84.4                        | 20.8/69.5                        |

Note: Monthly mean values have been rounded up to the nearest tenth

### Statistical Analyses:

All experimental results were analysed using Instat+™ v3.37. Instat is an interactive statistical package, copyright © 2006, Statistical Services Centre, University of Reading, UK. All rights reserved.

### Results and Discussion:

The analysis of variance (ANOVA) for the yield responses of the three squash varieties over time are summarised in Table 2. The table detected significant differences among varieties and harvest dates in the length of fruit and weight of fruit. There was a significant interaction of harvest time with variety, indicating different responses of the three varieties to the different times of harvest.

Table 2. Analysis of variance (ANOVA) for weight of a single fruit and length of a single fruit of three squash varieties, harvested at ten different dates. Standard error is for each treatment mean. Error mean square has 719 df. \*, \*\* and \*\*\* denote statistical significance at 5, 1 and 0.1% level of confidence, respectively. NS indicates differences between means not significant.

| -----Significance levels----- |     |                      |                     |  |
|-------------------------------|-----|----------------------|---------------------|--|
| Source                        | df  | Length of fruit (cm) | Weight of fruit (g) |  |
| Variety                       | 2   | **                   | **                  |  |
| Harvest date                  | 9   | **                   | **                  |  |
| Variety x Harvest date        | 18  | **                   | **                  |  |
| Error                         | 690 |                      |                     |  |
| Std. Err.                     |     | 0.17                 | 7.3                 |  |

The mean weight for each of the three squash varieties was expressed as g per fruit. These figures were extrapolated to reveal the yield potential of the three varieties, expressed as tonnes per hectare and pounds per acre (Table 3). The zucchini variety ‘Spineless King’ showed the highest yield potential, followed by ‘Golden Glory’, while the crookneck squash ‘Delta’ yielded the least of the three.

Table 3. Mean values of three squash varieties evaluated at the Gladstone Road Agricultural Centre during 2016.

| Variety        | Length of fruit (cm) | Weight of fruit (g) | Yield potential (tonnes/ha) | Yield potential (lbs/acre) |
|----------------|----------------------|---------------------|-----------------------------|----------------------------|
| Delta          | 9.5b                 | 155.9b              | 5.7                         | 5,085.4                    |
| Golden Glory   | 19.5a                | 246.4a              | 9.1                         | 8,118.8                    |
| Spineless King | 21.3a                | 378.2a              | 14.0                        | 12,490.5                   |

Mean values for single fruit length and single fruit weight for the different harvest dates are shown in Table 4. Size of fruit and fruit weight fluctuated over time. Some of the matured fruit were of a size not acceptable for market, as they would be deemed too large for sale (USDA-AMS, 1997). If fruit is too large, seed may be too hard, rendering it inedible. The interactive effect of harvest date and variety for the two yield components indicate significant variation with each harvest date. Mean values for the zucchini varieties ‘Golden Glory’ and ‘Spineless King’ appear to be more uniform over the harvest dates, compared to the crookneck squash ‘Delta’.

Table 4. Mean values of yield responses of three squash varieties assessed over 10 harvest dates from February to April, 2016

| Harvests | Length of fruit (cm) |        |              | Weight of fruit (g) |         |              |                |
|----------|----------------------|--------|--------------|---------------------|---------|--------------|----------------|
|          | Variety              | Delta  | Golden Glory | Spineless King      | Delta   | Golden Glory | Spineless King |
| 1        |                      | 16.1bB | 16.0bB       | 20.2aA              | 186.4bB | 153.4bB      | 273.5aA        |
| 2        |                      | 16.6bB | 21.7aA       | 24.0aA              | 186.6bB | 337.6aA      | 503.7aA        |
| 3        |                      | 21.0aA | 21.4aA       | 23.4aA              | 400.3aA | 314.8aA      | 456.3aA        |
| 4        |                      | 20.7aA | 20.0aA       | 20.1aA              | 386.2aA | 232.2bB      | 291.1aA        |
| 5        |                      | 21.0aA | 21.0aA       | 17.4bB              | 399.2aA | 323.5aA      | 190.5bB        |
| 6        |                      | 15.1bB | 20.2aA       | 20.4aA              | 121.7cC | 268.5aB      | 363.2aA        |
| 7        |                      | 14.9bB | 18.7aA       | 21.6aA              | 120.7cC | 196.0bB      | 417.7aA        |
| 8        |                      | 16.7bB | 17.9aA       | 21.0aA              | 202.1bB | 184.3bB      | 338.7aA        |
| 9        |                      | 14.9bB | 19.8aA       | 21.4aA              | 120.7cC | 255.2aA      | 398.6aA        |
| 10       |                      | 12.7bC | 18.1aA       | 23.5aA              | 95.9cC  | 198.5bB      | 548.8aA        |

The t-test at a level of 5% probability was applied. For each harvest date, means within rows bearing different uppercase letters differ significantly at 5% level of confidence. For each variety, means within columns bearing different lowercase letters differ significantly at 5% level of confidence.



Plate 1. Squash (*Cucurbita pepo* L.) varieties grown at the Gladstone Road Agricultural Centre during 2016. Left to right crookneck squash var. 'Delta', yellow zucchini 'Golden Glory' and green zucchini 'Spineless King'.

Post-harvest quality characteristics of the three squash varieties are outlined in Table 5. Each squash variety displayed an acceptable colour, fruit length and general appearance (Plate 1). There were no visible signs of insect damage or evidence of disease problems such as necrosis, fungal rots or bacterial spots. From these results, it can be seen that with improved squash varieties and improved growing conditions, quality fruit with acceptable yields could be obtained from this crop.

Table 5. Post-harvest quality characteristics of three squash varieties evaluated at the Gladstone Road Agricultural Centre during 2016.

| Variety                   | Stated number of days to maturity | Actual number of days to maturity | Colour                      | Fruit shape           | Visible signs of disease or chlorosis |
|---------------------------|-----------------------------------|-----------------------------------|-----------------------------|-----------------------|---------------------------------------|
| Delta (crookneck squash)  | 49                                | 47                                | Yellow                      | semi-crookneck        | None                                  |
| Golden Glory (zucchini)   | 50                                | 45                                | Dark yellow with green stem | Cylindrical, straight | None                                  |
| Spineless King (zucchini) | 45                                | 41                                | Medium to dark green        | Cylindrical, straight | None                                  |

The proximate analyses of the nutrient compositions of the three squash varieties are presented in Table 6. The results of this study indicate differences among the squash varieties in their nutrient contents. The moisture contents the two zucchini types were more than 95%, while the crookneck squash had a slightly lower content of around 94%. Sodium content was very low for the three squash varieties. The mean values of sodium (mg/100g), were 0.7 and 0.9 for 'Spineless King' and 'Golden Glory', respectively. The mean values for potassium (K<sup>+</sup>) were high, with much variation in the potassium contents of the three squash varieties. This may be attributed to several factors such as fertilisation, soil conditions and variety. The mean values of potassium, per 100g of dry weight, were 1,211 mg, 829 mg and 760 mg, respectively, for 'Golden Glory', 'Spineless King' and 'Delta' red.

Table 6. Proximate analyses of the raw pulp taken from three squash varieties.

| Variety                   | Ash (%) | Moisture (%) | Dry Matter (%) | Salt (%) | Protein (crude) (%) | Sodium (mg/100g) | Potassium (mg/100g) | Total Reducing Sugar (%) |
|---------------------------|---------|--------------|----------------|----------|---------------------|------------------|---------------------|--------------------------|
| Golden Glory (zucchini)   | 0.5     | 95.5         | 4.5            | 0.14     | 1.2                 | 0.9              | 1211                | 6.2                      |
| Spineless King (zucchini) | 0.3     | 96.1         | 3.9            | 0.14     | 0.9                 | 0.7              | 829                 | 7.3                      |
| Delta (crookneck squash)  | 0.4     | 94.1         | 5.9            | 0.21     | 0.9                 | 1.1              | 760                 | 2.5                      |

The crookneck and zucchini squash varieties are early maturing vegetable crops with an attractive appearance. Results from this trial suggest that they can be grown successfully under local conditions and are ideal for integration into the vegetable production systems of local farmers. Because of the short growing time, this crop can be grown at several different planting dates during the cool growing season.

**General Comments:**

It can be concluded that, from the results obtained in this study, the zucchini squash ‘Spineless King’ is preferable to the other two varieties. This determination is based on its superior fruit weight, fruit length and best yield potential. In general, the three varieties displayed good to excellent quality characteristics. The earlier these varieties are harvested, the less likely they are to be exposed to insect pest and disease problems.



Plate 2. Grated zucchini over mixed vegetable green salad (left) and yellow zucchini slices included in a frozen vegetable mix (right).

Squash is used generally as a cooked food item, but is sometimes eaten raw as a fresh salad ingredient. The fruit is usually harvested when it is 20 cm (8 in) or less in length while seeds are still soft and palatable. It can be prepared in many ways, including boiled, baked, steamed, stir fried or grilled. Zucchini squash grated over mixed vegetable green salad (Plate 2, at left). Sliced zucchini can last for a long time, if frozen and stored properly. For added value, yellow zucchini slices can be added to a mixed vegetable package (Plate 2, at right) and sold as a frozen food item by local farmers. Very tasty breads can be made using zucchini squash (Plate 3).

Recipe for zucchini bread (adapted from various zucchini bread recipes found at [www.cooks.com](http://www.cooks.com))



Plate 3. Zucchini bread

3 eggs  
½ cup oil  
2 cup sugar  
3 cup self-rising flour  
1 cup nuts  
½ tsp. vanilla  
½ tsp. salt  
2 tsp. cinnamon  
2 cup grated zucchini  
1 cup raisins or crushed pineapple or coconut

Beat eggs until fluffy. Add oil, sugar, and vanilla. Add zucchini and dry ingredients. Stir in nuts, raisins and/or pineapple. Pour into greased loaf pans. Bake 1 hour 10 minutes at 350 degrees.

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