

**GLADSTONE ROAD AGRICULTURAL CENTRE  
CROPS RESEARCH REPORT NO. 15**

**EVALUATION OF THREE CABBAGE (*Brassica oleraceae* var. *Capitata* L.)  
VARIETIES GROWN FOR THE FRESH MARKET**

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**ABSTRACT**

*Three cabbage varieties, 'Benelli', 'Caribbean Queen' and 'Cairo', were evaluated in a completely randomised design with three replications at the Gladstone Road Agricultural Centre during 2013. Cabbage heads were harvested between 89 and 116 days after transplanting to the field and evaluated for head weight, head width and head length. The results obtained showed that the variety 'Caribbean Queen' produced the largest head weight and head width. The variety 'Caribbean Queen' also exhibited the highest potential yield of marketable head weights (45.4 t/ha) compared to 'Benelli' (37.0 t/ha) and 'Cairo' (33.6 t/ha). The three varieties were determined to be capable of producing acceptable yields under open field conditions in The Bahamas.*



Cabbage variety trial at the Gladstone Road Agricultural Centre, 2013

**Introduction:**

Cabbage (*Brassica oleraceae* var. *Capitata* L.) belongs to the Brassicaceae family and is closely related to the broccoli, cauliflower and brussels sprouts. It is a leafy vegetable crop that grows close to the ground. The leaves may be loose or tightly compacted, ranging in colour from pale green to purple. The cabbage is one of the most important vegetable crops under cultivation. It is thought to have originated in the Mediterranean region (Balkaya *et al.*, 2005) and is, in fact, one of the oldest vegetables grown. According to recent FAO statistics, there are more than two million hectares of cabbage and other brassicas in production globally, with an average yield of 29 tonnes per hectare (FAOSTAT, 2011). Production in the Caribbean region is estimated by FAO to be around 250 thousand tonnes per annum. The Bahamas produces about 900 tonnes per annum on about 75 hectares of farmland (Ministry of Agriculture, 1996).

The cabbage has been ranked by the Food and Agriculture Organisation among the top twenty vegetable crops grown, establishing it as an important food source, globally (FAO, 1988). It has high water content, is high in fibre, and has significant quantities of protein, calcium and iron. The cabbage is a rich source of vitamin A and vitamin C, in addition to containing some B vitamins (Adeniji *et al.*, 2010; Meena *et al.*, 2010; Hasan and Solaiman, 2012). It also contains significant amounts of glutamine, an amino acid which has anti-inflammatory properties (Caunii, *et al.*, 2010). Research has shown that cabbage has a number of antioxidative compounds that might be beneficial in the prevention of cancer (Kusznierewicz, *et al.*, 2008). Red cabbage is especially rich in these antioxidants (Tendaj and Sawicki, 2012). This leafy vegetable is used mainly in salads, as a fresh food item, but is also cooked with other foods, and is suitable for processing into products such as sauerkraut.

There is much variation among cabbage types, with colours ranging from green to red or purple, and leaves from smooth to crinkly. Though hundreds of varieties are available on the market, cabbages are usually classified into three types: green, red or Savoy. The leaves of the green and red cabbages tend to be smooth in texture, while the Savoy cabbages have crinkly leaves. The cabbage head may be flat, round or pointed, with variations among these shapes. Green, round-headed cabbages are the most common types. Maturity can range from early to late in the growing season.

The cabbage is a cool season crop which grows best under cool, moist weather conditions (Thompson, 2002). This leafy vegetable can grow well on a wide range of soil types provided adequate moisture and fertiliser is supplied. It can be grown in The Bahamas year round, but peak production occurs during the cool season of November to March. During the summer months the cabbage is more susceptible to disease problems and attacks from insect pests. The length of the growing period is shorter during the cooler season, between 90 and 100 days, while summer cabbages can take up to 140 days to mature. For a successful cabbage production, however, it is important to select varieties appropriate for local growing conditions.



Developing cabbage head grown at the Gladstone Road Agricultural Centre during 2013

***Objective:***

The objectives of this study were to evaluate the yield performance and quality characteristics of three cabbage varieties in order to select the most suitable for the growing conditions of The Bahamas.

### ***Materials and Methods:***

This experiment was conducted at the Gladstone Road Agricultural Centre, New Providence, during the 2012-2013 winter vegetable growing season. The experiment was established in the field in a completely randomised design with three replications. Each replicate consisted of a double row of ten plants with a plant to plant spacing of 45 cm (18 inches) and a spacing of 50 cm (20 inches) between the double rows. Distance between each double row was 1.5 m (60 inches). The usual cultural practices were observed to ensure that an even stand of plants was maintained in the field plots.

The seeds used in this experiment were ‘Benelli’, ‘Cairo’ and ‘Caribbean Queen’. ‘Benelli’ and ‘Caribbean Queen’ are green-headed cabbages with flat to round heads and an average mature weight of about 2.7 kg (6.0 lbs). ‘Cairo’ is a purple-headed cabbage with a perfectly round shape, but is smaller and more compact than ‘Benelli’ and ‘Caribbean Queen’. ‘Benelli’ and ‘Cairo’ are products of the Seedway Seed Company, while ‘Caribbean Queen’ is distributed by Seminis Vegetable Seeds.

The varieties were planted in a field seedbed 11<sup>th</sup> October 2012 and transplanted to field plots in double rows, 1<sup>st</sup> November 2012, after 21 days of growth. Three weeks after transplanting, fertiliser of the formulation 8-18-8 was banded along the growing plants in one application. Weeds were controlled by hand cultivation. The plots were irrigated with a drip irrigation system which supplied water throughout the growing season.

Harvesting extended from 29<sup>th</sup> January to 6<sup>th</sup> March, 2013 as the cabbage heads reached their optimum maturity. The variety ‘Cairo’ was harvested at a later maturity date than the other two varieties in this study. For each variety, six cabbage heads were harvested randomly from each of the three replicated plots. Only heads of marketable size were harvested. Outer leaves were stripped from the heads and the weights recorded. Head width (diameter) was measured with a ruler across the horizontal section of the cabbage head. Head length was measured longitudinally from the top of cabbage to the bottom. Plate 1 illustrates the method used to determine the head width and head length of the three cabbage varieties.



Plate 1. Mature compact heads of cabbage cut to show how measurements were calculated; width (left) in horizontal section and length in vertical section (right).

The mean daily maximum and minimum temperatures for the trial period were 27.7°C (81.9°F) and 20.6°C (69.2°F), respectively. The total rainfall for the period was 296.86 mm (11.69 in). Mean monthly sunshine duration for the period was 7.9 h. Weather information (Table 1) was obtained from the Meteorological Department 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 October 2012 to February 2013, 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)
October 2012	155.4/6.12	7.4	30.2/86.3	23.8/74.9
November 2012	24.9/0.98	8.1	26.9/80.5	19.8/67.7
December 2012	58.9/2.32	7.6	26.9/80.5	19.8/67.7
January 2013	6.86/0.27	7.6	27.2/81.0	20.2/68.4
February 2013	50.8/2.0	8.7	27.2/81.0	19.6/67.2

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

### Statistical Analyses:

All experimental results were analysed using Instat+™ and ASSISTAT. Instat is an interactive statistical package, copyright © 2006, Statistical Services Centre, University of Reading, UK. All rights reserved. ASSISTAT, Version 7.6 beta (2013), website – <http://www.assistat.com>, by Fransisco de Assis Santos e Silva, Federal University of Campina-Grande City, Campina Grande, Brazil.



### Results:

The analysis of variance (Table 2) revealed significant differences for cabbage head weight, head width and head length at a 1.0 % level of confidence among the three cabbage varieties evaluated in this study. Seedling emergence for the three varieties averaged 7-10 days after planting, with maturity dates ranging between 90 and 120 days. Stand establishment was very good for all three of the cabbage varieties.

Table 2. Analysis of variance (ANOVA) of weights, head width and head length of three cabbage varieties. Standard error is for each treatment mean. Error mean square has 53 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	Weight of cabbage (g)	Head width (cm)	Head length (cm)
Variety	2	**	**	**
Error	51			
Std Err		40.2	0.4	0.3

The mean values for yield and yield contributing characteristics of the three cabbage varieties are shown in Table 3. The variety ‘Caribbean Queen’ had a higher cabbage head weight and head width than the other two varieties. Based on visual and tactual inspection of the harvested cabbages, all three varieties produced very solid heads. The variety ‘Cairo’, though a small cabbage, was similar in weight to ‘Benelli’. It had a dense head, with leaves wrapped tightly around its small central core.

Table 3. Mean values of three cabbage varieties evaluated at the Gladstone Road Agricultural Centre during 2011.

Variety	Head weight (g)	Head width (cm)	Head length (cm)	Yield potential (tonnes/ha)	Yield potential (lbs/acre)
Benelli	1387.7b	12.9b	16.7a	37.0	33,024.7
Cairo	1258.8b	12.0b	12.4c	33.6	29,990.0
Caribbean Queen	1701.8a	17.2a	15.0b	45.4	40,522.2

The mean weight for each of the three cabbage varieties was expressed as g per head. 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 varieties ‘Benelli’ and ‘Cairo’ appeared to be similar in yield capability, while ‘Caribbean Queen’ out yielded them both.

The post-harvest quality characteristics of the three cabbage varieties are displayed in Table 4. All three cabbage varieties matured from transplanted seedlings to the first harvestable heads at much later dates than the estimated harvest dates for each of them. The varieties ‘Benelli’ and ‘Caribbean Queen’ developed mature heads during a shorter period than the variety ‘Cairo’. This is attributed to their varietal responses, since varieties differ in their development in head formation and maturity (Ijoyah and Rakotomavo, 2007). Studies by other researchers have suggested that differences in both variety and growing season influence cabbage head development and yield (Kleinhenz and Wszelaki, 2003; Tanaka *et al.*, 2008).

The cabbage head weights were generally smaller than accepted weights for these varieties. The variety ‘Caribbean Queen’ gave the largest head weight per plant at 1.70 kg (Table 4), in addition to the best potential yield of 45.4 tonnes/hectare (Table 3). Cabbage head size and shape are important characteristic traits, but can be affected by agronomic practices (Cervenski *et al.*, 2011).

Table 4. Post-harvest quality characteristics of three cabbage varieties evaluated at the Gladstone Road Agricultural Centre during 2011.

Variety	Stated days to maturity from transplanted seedlings	Actual days to maturity from transplanted seedlings	Head colour	Head shape	Head size (kg/head)	Head width (cm)	Head length (cm)	Visible signs of insect damage, disease or chlorosis
Benelli	78	89-98	Green-blue	Slightly flattened to round	1.39	12.9	16.7	Minimal insect damage
Cairo	85	116	purple	Round	1.26	12.0	12.4	Minimal insect damage
Caribbean Queen	65-75	89-98	Green-blue	flattened	1.70	17.0	15.0	Minimal insect damage

The potential yields for the three cabbage varieties are displayed graphically in Figure1. The variety ‘Caribbean Queen’ presented the highest mean yields of marketable heads of cabbage per hectare at 45.4 t/ha compared to ‘Benelli’ at 37.0 t/ha and ‘Cairo’ at 33.6 t/ha. According to

FAOSTAT (2011) estimates, the average global yield in 2010 for cabbage was 27.8 t/ha, which is well below the results obtained by this study, under experimental conditions.

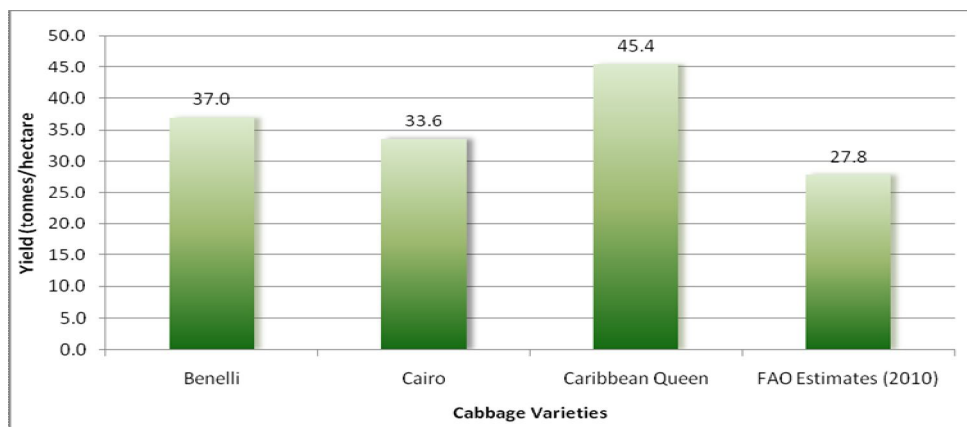


Fig. 1. Average yields of three cabbage varieties evaluated at the Gladstone Road Agricultural Centre during 2013. FAO global yield estimates for cabbage in 2010 are found in the column at far right.

### **Discussion:**

There was much variation in the number of days from transplant to harvest among the cabbage varieties in this study. Also, the actual days to maturity for the three cabbage varieties was more prolonged, compared to a previous study at the Gladstone Road Agricultural centre (Richardson, 2012), where the cabbage varieties were harvested much earlier than the estimated days to harvest. The harvest period extended over several weeks, due mainly to the lack of uniformity of the cabbage head sizes during the harvesting period. According to Stoffella and Fleming (1990), a cabbage field with a minimum amount of variability among head size at time of harvest would reduce the number of harvests required. They also recognised the economic advantage of a single harvest to farmers, since harvesting costs are a major expense in producing a marketable crop.

The three cabbage varieties yielded head weights that compared favourably to commonly expected yields from Bahamian grown cabbages. 'Caribbean Queen' exhibited the largest head weight at 1.7 kg (3.7 lb), followed by 'Benelli' at 1.4 kg (3.1 lb) and 'Cairo' at 1.3 kg (2.9 lb). These cabbages are classified as medium-sized, based on USDA standards for grades of cabbage (USDA-AMS, 1997). The head weights and other yield characteristics of the varieties in this study are consistent with Greenland *et al.*, (2000), who determined that cabbages for the fresh market must have high head densities, small to medium-sized heads, and good appearance. In general, the three cabbage varieties were uniform and tightly formed. There were no visible signs of insect damage, wilting or chlorosis on any of the leaves. From these results, it can be seen that with superior cabbage varieties and improved growing conditions, increased yields could be obtained from this leafy vegetable crop.

### **Conclusion:**

Significant differences were observed among the quality characteristics of the three cabbage varieties in this study. Variety selection is very important for the local farmers, if they wish to achieve an optimum harvest. From the above observations it could be concluded that the three

varieties are capable of giving acceptable yields under growing conditions of The Bahamas. With its larger head weight, 'Caribbean Queen' is the preferred variety of the three evaluated. The variety 'Cairo' gave the lowest head weights, but is not comparable to 'Caribbean Queen' and 'Benelli', as it is classified as a different type of cabbage. This present study corroborates an earlier study (Richardson, 2012) which determined that yield characteristics were influenced by variety and that the improved cabbage varieties under study were all suitable for local growing conditions of The Bahamas.

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