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COMPARATIVE STUDIES ON THE GROWTH, YIELD AND BULB QUALITY OF TWO ONIONS (*ALLIUM CEPA* L.) VARIETIES

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ABSTRACT
Onions are vegetables that contain plant potent compounds that have been shown to promote human health in several ways. The biological productivity in terms of growth, yield and bulb qualities have been shown to vary among varietal type. Hence a field experiment was carried out to compare the growth, yield and bulb quality of two onions varieties (*Allium cepa* L. cv Red and White creoles). The field layout followed complete randomized block design with three replications. The data on biological yield and biochemical parameters were subjected to student t-test at 0.05 level of significance. The results showed that White creole had higher growth than Red creole. However significantly ($p \leq 0.05$) higher bulb yield was recorded in Red creole (1126kg/ha) compared to White creole (600kg/ha). Parameters such as number of bulb per plant, length and diameter did not show statistical differences. Composition of the bulb in terms of percentage moisture, ash, crude protein, crude fat, crude fibre, carbohydrate and energy value showed values that ranged from 86.1 ± 0.40 - 86.4 ± 0.64%, 0.6 ± 0.00 - 0.7 ± 0.02%, 3.3 ± 0.01- 3.6 ± 0.18%, 0.8 ± 0.01- 0.9 ± 0.01%, 1.7 ± 0.18 - 2.6 ± 0.07%, 7.0 ± 0.47 - 6.1 ± 0.29%, 48.9 ± 1.97 - 47.1 ± 1.93 kcal respectively. The moisture, protein, ash, carbohydrate and energy value of the two varieties did not show statistical differences. The vitamin C and sulphur contents values which ranged from 5.1 ± 0.08 - 3.5 ± 0.28 mg/100g and 248.1 ± 8.10 - 194.7 ± 3.40 mg/kg respectively were found to be significantly higher in Red creole than White creole. The results of this study suggests that Red creole consumption is better in the maintenance of healthy living while, White creole on account of high fibre content could be recommended for non-obese patients with indigestion problem.

Keywords: Onion bulb, growth, proximate composition, vitamin C and sulphur

INTRODUCTION
Onion (*Allium cepa* L.) is a species of the Alliaceae family that has a great economic importance and the second most important vegetable crop in the world (FAO, 2006). The varieties abound typically grow to a height of 15 to 45 cm. The leaves are yellowish-green and grow alternately in a flattened, fan-shaped swathe. They are fleshy, hollow and cylindrical, with one flattened side. The base of each leaf is a flattened, usually white sheath that grows out of a basal disc. From the underside of the disc, a bundle of fibrous roots extends for a short way into the soil. As the onion matures, food reserves begin to accumulate in the leaf bases and the bulb of the onion swells (Brickel, 1992).
The plant is cultivated for ultimate uses as green leaves and bulbs. It is also a natural part of the daily diet for most of the population which makes it a

crop of great economic importance all over the world (Mogren *et al.*, 2007). It is also used in almost all food preparation (Hossain and Islam, 1994). The plant is important medicinally in terms of protecting human being against cancer, fungi and bacteria diseases (Martinez *et al.*, 2007; Stajner *et al*., 2008). Apart from its value as a natural medicine, it is used as a spice and important ingredient in food due to its nutritive value, aroma, flavor and pungency, as well as preservative qualities. It also promote cardiovascular health, reduce high blood pressure and insulin resistance, aid in weight loss, possess antioxidant activity, fight chronic bronchitis, infections and fever (Janssen *et al*, 1998; Campos *et al*, 2003; Ismail *et al*, 2003).

The biological productivity in terms growth, yield and biochemical constituents of the bulb have been reported to vary from one variety to another (Brewster, 1994). It is on this premise the present study is designed to evaluate and compare the growth, yield and bulb quality of White and Red creoles varieties of onion.

MATERIALS AND METHODS

Description of site

The experiment was conducted between October 2015 and January 2016 at Amilegbe, Ilorin, Kwara State, Nigeria with coordinates 8.5^{o} North latitude, 4.55^{o} East longitude and 290 meters elevation above sea level in the Guinea savanna ecological zone of Nigeria. Soil of the experimental site was sandy-loam with slightly acid pH (6.4). The organic matter (1.21%) was low with moderate available nitrogen (0.15%) low in available phosphorus (3.16 mg kg^{-1}), high in exchangeable calcium (0.44cmolkg^{-1}) and low in Cation Exchange Capacity (2.67).

Experimental design

The experiment was arranged in a complete randomized block design with three replications. Sets of onion varieties (White and Red creoles) of one centimeter in diameter collected from National Horticultural Research Institute (NIHORT) in Ibadan were planted on a ridges at a spacing of 30 cm x 30 cm. Each sub-plot size was 1m x 1m with a distance of 0.5 m between the plots.

Growth measurements

Growth parameters such as shoot length, number of leaves, leaf area and total fresh and dry weight were estimated at 3,6,9 and 12 weeks after planting (WAP) after the sprout of onion bulb. Number of bulb per plant, bulb length and diameter, fresh and dry weight of the bulb at harvest was also determined. The bulb yield in kilogram per hectare was also estimated from 1 m^2 area.

Biochemical constituent's determination

Proximate composition of the bulbs (moisture, ash, fibre, protein, fat and carbohydrate) was determined following the method described by AOAC (AOAC, 2003). The vitamin C content using 2, 6 – dichlorophenol indophenol was determined by titration following the methods of Ibitoye (2005). Determination of sulphur was carried out using Spectrophotometer set on a wavelength of 440 nm (Chandry and Confield, 1966).

Data analysis

Data collected from the growth and yield and biochemical constituents were analyzed statistically using paired sample student t-test. The level of significance was set at $p \leq 0.05$. Bar charts were plotted using Origin 7.0 for Windows.

RESULTS

Growth response

The shoot length of two varieties of onion (Red and White creoles) at different crop growth stages is shown in Fig. 1. Shoot length increased with the age of the plant in both varieties. Significant differences were not recorded between the two varieties except at three weeks after planting (3 WAP). Varietal difference showed that White creole had higher shoot length than Red creole (Fig.1). Number of leaves of two varieties of onion is shown in Fig.1. There was steady increase in

leave production in both varieties till final sampling period. At all crop growth stages, significant differences ($p \leq 0.05$) were recorded between the two varieties where White creole had greater number of leaves than Red creole (Fig.1). Leaf area production followed similar pattern as recorded for shoot length. Significant difference was only recorded between the two varieties at 3WAP. There was increase in leaf area production as the two varieties advanced in age. Higher leaf area was recorded in White when compared to Red creole (Fig.1). Total fresh and dry weight for the two varieties is presented in Fig. 2. At all growth stages, significant differences were recorded between the two varieties. There was steady increase in the total fresh and dry weights were generally higher in White creole compared to Red creole except at harvest (Fig. 2).

Yield components and yield

Table 1 shows the yield components and bulb yield (kg/ha) of Red and White creoles. Number of bulb per plant, bulb length, bulb diameter, fresh and dry weight of bulb per plant showed values that ranges from 8.7 ± 1.89 – 10.4 ± 1.55, 6.6 ± 0.78 – 8.5 ± 0.94, 9.1 ± 0.85 – 12.0 ± 1.37, 141.4 ± 10.2 – 213.8 ± 28.53, 8.8 ± 1.29 – 13.3 ± 1.79 respectively. Significant differences were not recorded for yield component such as number of bulbs, bulb length and bulb diameter. Red creole showed significantly higher fresh and dry weight of bulb per plant (213.8 ± 28.53 and 13.3 ± 1.79) compared to White creole with value of 141.4 ± 10.2 and 8.8 ± 1.29 respectively. The results of number of marketable bulbs and weight of marketable bulbs did not show statistical differences between the two varieties. Red creole (1126 kg/ha) has significant higher yield than White creole (600 kg/ha) as shown in Table 1.

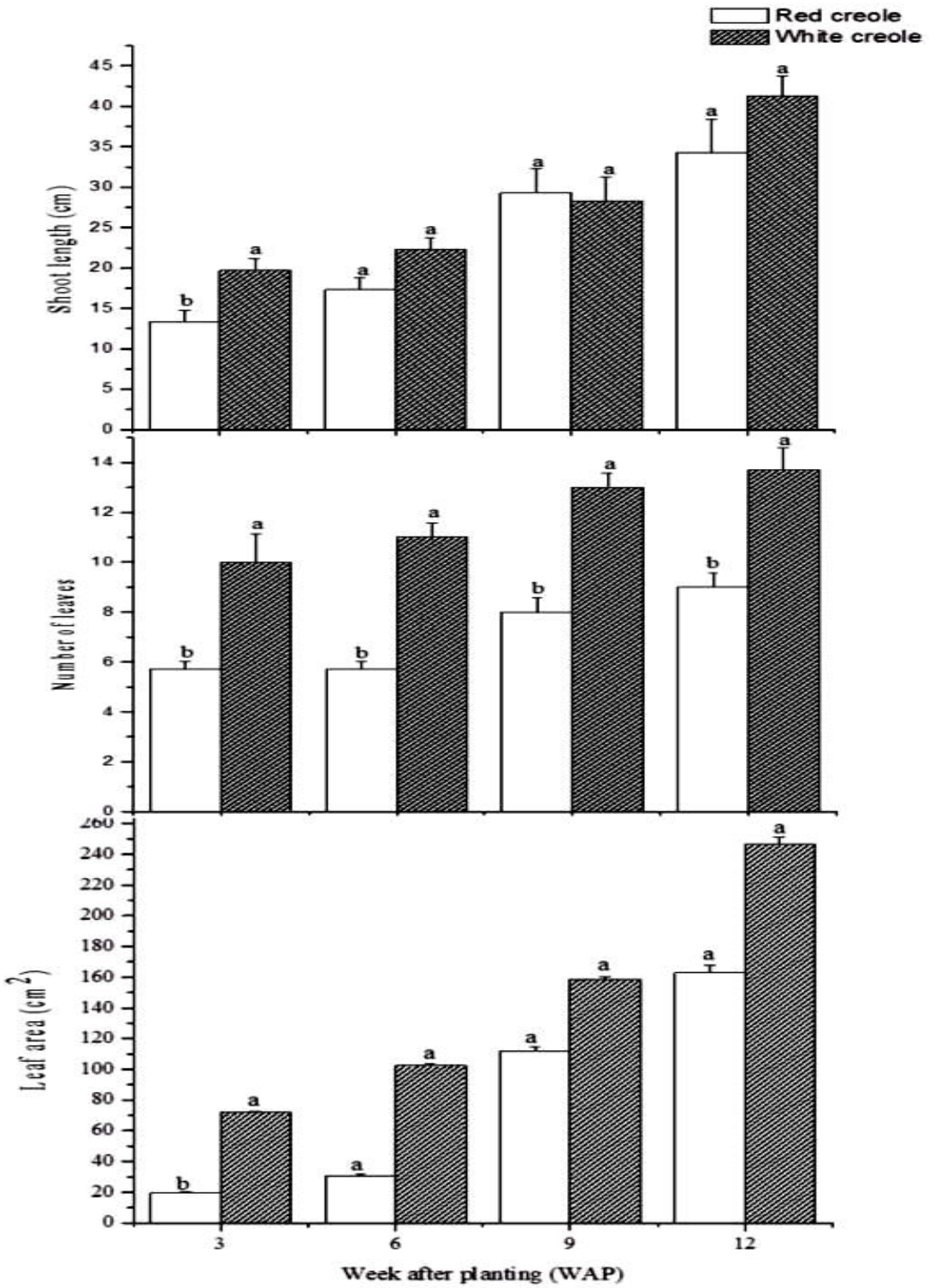

Figure 1: Shoot length, number of leaves and leaf area at different growth stages of two varieties of onion (Red and White creoles).

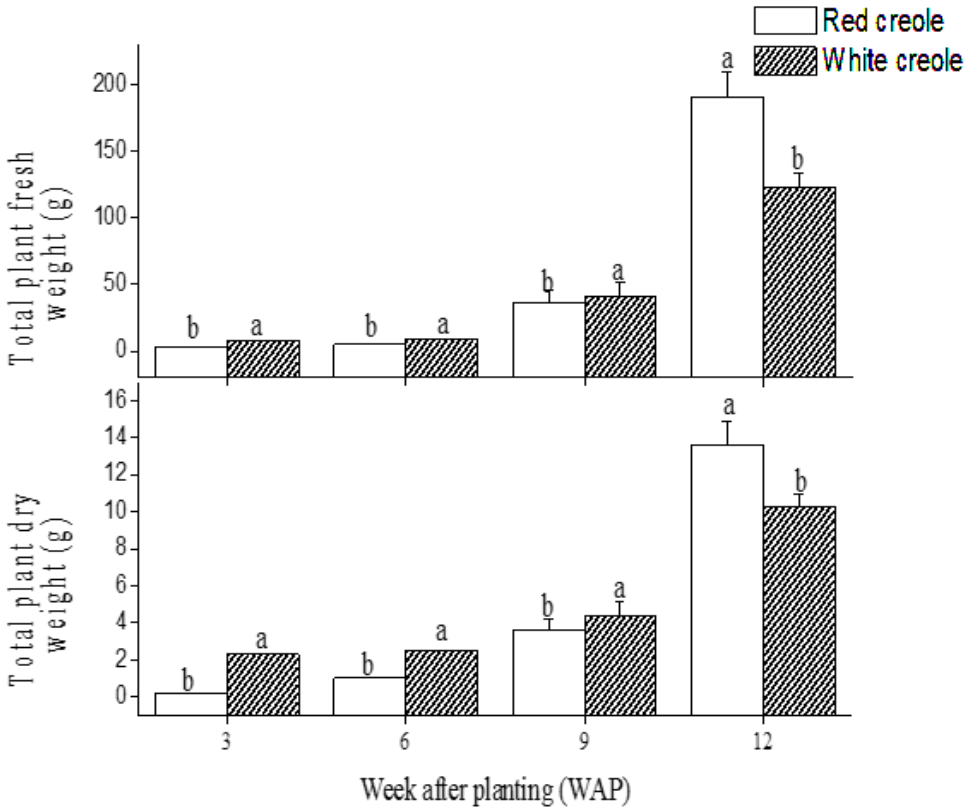

Figure 2: Total fresh and dry weight at different growth stages of two varieties of onion (Red and White creoles).

Table 1: Yield components and yield of two varieties of onion bulbs

Parameters	Variety	
	Red Creole	**White Creole**
Number of Bulbs per plant	8.70±1.89[a]	10.40±1.55[a]
Bulb Length per plant (cm)	8.50±0.94[a]	6.60±0.78[a]
Bulb Diameter per plant (cm)	12.00±1.37[a]	9.10±0.85[a]
Fresh Weight of Bulb per plant (g)	213.80±28.53[a]	141.40±10.2[b]
Dry Weight of Bulb per plant (g)	13.30±1.79[a]	8.80±1.29[b]
No of Marketable Bulbs at harvest	6.70±1.2[a]	8.00±1.3[a]
Fresh Weight of Marketable Bulbs (kg)	3.90±0.72[a]	2.10±0.45[a]
Dry Weight of Marketable Bulbs (kg)	1.50±0.24[a]	0.80±0.17[a]
Yield (kg/ha)	1126 ±80.5[a]	600 ±38.1[b]

Superscripts with different letters are significantly different at $p \leq 0.05$. Values represent means ± standard error, (n = 3).

Biochemical constituents

The biochemical constituents of the Red and White creoles varieties of onion are presented in Table 2. The proximate composition in terms of percentage moisture, fibre, ash, protein, fat and carbohydrate showed values that ranged from 86.1 ± 0.40 – 86.4 ± 0.64, 1.7 ± 0.18 – 2.6 ± 0.07, 0.6 ± 0.00 – 0.7 ± 0.02, 3.3 ± 0.01 – 3.6 ± 0.18, 0.8 ± 0.01 – 0.9 ± 0.01 and 6.1 ± 0.29 – 7.0 ± 0.47 respectively. Significant differences were not recorded for moisture, protein, ash and carbohydrate between the two varieties (Table 2). However, these parameters were found to be higher in White creole than Red creole. Crude fibre of White creole (2.6 ± 0.07) was significantly higher than that of Red creole (1.7 ± 0.18). The energy values of the two varieties were statistically similar. No significant difference was recorded for fruit quality except for the pH which was significantly higher in White creole than Red creole. Red creole showed significant higher vitamin C content with value of 5.1 ± 0.08 mg/100g than White creole with value of 3.5 ± 0.28. The result of sulphur content followed the same pattern as vitamin C (Table 2).

Table 2: Biochemical constituents of two varieties of onion (Red and White creoles)

Parameters	**Variety**	
	Red Creole	**White Creole**
Total Moisture content (%)	86.1±0.40[a]	86.4±0.64[a]
Crude Protein (%)	3.3±0.01[a]	3.6±0.18[a]
Crude Fat (%)	0.8±0.01[b]	0.9±0.01[a]
Ash content (%)	0.6±0.00[a]	0.7±0.02[a]
Crude Fibre (%)	1.7±0.18[b]	2.6±0.07[a]
Total Carbohydrate (%)	7.0±0.47[a]	6.1±0.29[a]
Vitamin C (mg/100g)	5.1±0.08[a]	3.5±0.28[b]
pH	6.8±0.01[b]	6.9±0.01[a]
TTA	0.01±0.00[a]	0.01±0.00[a]
Sulphur (mg/kg)	248.1±8.10[a]	194.7±3.40[b]
Energy value (kcal)	48.9±1.97[a]	47.1±1.93[a]

Superscripts with different letters are significantly different at $p \leq 0.05$. Values represent means ±standard error, (n= 3).

DISCUSSION

Growth pattern

In this study, White creole produced higher shoot length, number of leaves and leaf area values than Red creole. The morphological variation recorded between the two varieties could possibly be due to their growth habits as controlled by their differences in gene composition. Growth pattern variations in several onion varieties have been ascribed to genotypic variation by different researchers (Jillani and Ghafoor, 2003; Islam *et al*., 2007). Furthermore, fresh and dry matter accumulations were also enhanced during most of the crop growth stages in White creole than Red creole. This to a greater extent could be due to increase in number of leave as well as higher leaf area for increased rate of photosynthesis and biomass production.

Yield components and yield

White creole produced greater number of bulbs per plant as compared to Red creole. However, these bulbs were shorter in length and diameter with significantly low yield. The enhanced higher yield recorded in Red creole in spite of lower number of bulbs could be attributed to increase in yield components such as bulb diameter, bulb length, fresh and dry weight of the bulbs. Pakyurek *et al.* (1994) tested various varieties of onion for yield and quality and concluded that not all the varieties gave the similar response. Rumpel and Felezynski, (1997) reported that greater yield was produced by Mercato and lower yield was obtained in Summit FI Jilani and Ghafoor (2003) summarized that the performance of a cultivar mainly depends on the interaction of genetic makeup and environment as closely observed in this study.

Biochemical constituents of Onion bulb

The proximate analysis of two varieties of onion revealed high moisture content in both varieties. Bhattacharjee *et al.* (2003) also recorded high moisture content for Bangladeshi and Indian varieties of onion. The high moisture content of both varieties indicated that great care must be put in place to preserve them as they could be prone to rapid deterioration (Kwenin *et al*., 2011). However, high water content had other benefits as it helps the body to expend less energy and resources to digest and assimilate all the nutrients much faster. Less pressure is therefore put on the digestive system. Crude fibre content was high in the two varieties of onion (Red and White creoles). The amount of crude fibre compared well with the Bangladeshi variety but higher than Indian one (Bhattacharjee *et al.*, 2003). Ponnusamy and Vellaichamy (2012) reported that crude fiber is increasingly being recognized as a useful tool for the control of oxidative processes in food products and as functional food ingredient. The presence of crude fiber in the diet is necessary for digestion and for elimination of wastes. The contraction of muscular walls of the digestive tract is stimulated by fiber, thus counteracting constipation. Crude fat content was low in the Red and White creoles of onion. Wardlaw and Kessel (2002) stated that the effect of excess intake of crude fat has some well-established health implications especially for the overweight. The consumption of excess amounts of fats has been recognized as the most important dietary factor aiding increased level of cholesterol. Besides the cholesterol implications due to high fat intake, obesity is a factor in the causation of disease. Nwinuka *et al.* (2005) reported that the crude fat content of Ashanti pepper was not high enough to be called an oil seed. This may be why these samples are used as mere spices and not as sources of nutrients. These explanations and findings agreed with the definition of spices as mere food adjuncts, which mainly serve to add flavour, aroma and taste to food and dishes in the home cafés and restaurants (Dziezak, 1987). In this context, the varieties of *Allium cepa* studied could therefore be said to be efficient in reducing the risk of coronary heart disease and lowering the risk of hypertension due to their lower crude fat content. The level of protein in Red and White creoles of onion was high. Hussan and Tabassum (2015) reported similar value for crude protein of *Allium cepa*.

The higher protein content indicates that its intake can contribute to the formation of hormones which controls a variety of body functions such as growth, repair and maintenance of body. In addition, it may be useful as a preferred option to animal proteins for diabetics as the later tend to be high in saturated fats. The level of ash content in Red and White creoles of onion was not too high as reported for onion varieties in Bangladesh and India (Bhattacharjee *et al.*, 2003). The amount of carbohydrate in Red and White creoles of onion was high which compared well with other varieties as reported by Bhattacharjee *et al.* (2003).Thecarbohydrate levels of the studied

samples suggest its usefulness as alternative source of glucose. Nwinuka *et al*. (2005) reported that the proximate composition of the spices; garlic, ginger, onion and Ashanti pepper revealed them to the poor sources of proteins, fat and ash, but good source of carbohydrate. Vitamin C and Sulphur content levels were high. Bhattacharjee *et al.* (2003) recorded similar result for vitamin C. Consumption of food rich in Vitamin C aids collagen synthesis, bone and teeth calcification. Sulphur reduces symptoms associated with diabetes mellitus, inhibits platelet aggregation (involved in thrombosis), prevent inflammatory processes associated with asthma. The Red and White creole variety of onion has high energy value. Bhattacharjee *et al.* (2003) recorded high energy value for Bangladeshi and Indian variety of onion. The energy value of a food measures its value to the body as a fuel and it measures the inherent chemical energy inherent in the bonds of the organic compounds of foods such as their protein, carbohydrate and fat constituents as well as minor constituents such as organic acids Bhattacharjee *et al.*(2003). Both the varieties showed moderate energy value.

CONCLUSION

The comparative assessment of the varieties had revealed that Red creole gave better bulb yield as compared to White creole. There were variations in the quality of the bulb in both varieties. Generally, all the biochemical constituents with the exception of vitamin C, sulphur and carbohydrate were found to be more in White creole than Red creole. The two varieties have the potentials of meeting the nutritional requirement of human health. However, consumption Red creole is good for the maintenance of healthy living while White creole could be recommended for non- obese patients with indigestion problem.

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