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EFFECT OF SHADE ON THE GERMINATION, GROWTH, AND DEVELOPMENT OF TWO VARIETIES OF *ABELMOSCHUS ESCULENTUS* (L.) MOENCH

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ABSTRACT

The effect of shade on the germination, growth, and development of Abelmoschus esculentus (L.) Moench (Okra) was investigated. This experiment was carried out using two varieties of A. esculentus seeds (Kirikoa F1 and Hire varieties) which were replicated 5 times for both under shade and under direct sunlight as growth conditions. The seeds and soil were tested for viability and physicochemical composition, respectively, before the commencement of the work. The parameters assessed following standard procedures on A. esculentus plant were number of leaves, plant height, leaf petiole length, internode, pigments and nutritional composition. The seeds germinated within 3 – 4 days after planting. Among the treatments at ninth week after planting, Kirikoa F1 variety under shade had the highest number of leaves (7.0±1.00), plant height (27.80±5.718 cm), petiole length (7.60±2.408 cm), leaf length (11.30±2.168 cm) and leaf width (10.20±1.924 cm). Also, internode (3.40±1.517 cm) was high at Kirikoa F1 under direct light. Total chlorophyll content of the varieties under light and under shade were: 1.441 mg/g and 1.254 mg/g, respectively for Kirikoa F1 and 0.549 mg/g and 0.938 mg/g, respectively for Hire. Okra under shade had high moisture content (87.36%) when compared to okra under direct sunlight (83.24%) while the reverse was the case for other nutritional composition (carbohydrate, ash content, crude lipid, crude protein and crude fibre). The study showed that Kirikoa F1 variety performed better than the Hire variety during development, and most indices of growth had higher performance under shade condition than under direct light for the okra varieties, respectively.

Keywords: Development, germination, growth conditions, sunlight and shade, Hire variety, Kirikoa F1 variety

INTRODUCTION:

Okra [*Abelmoschus esculentus* (L.) Moench] belongs to the family Malvaceae. The species is a perennial often cultivated as an annual in tropical climates, and often grows to around 2 metres tall. The leaves are 10 – 20 centimetres, long and broad, palmately lobed with 5 – 7 lobes, ovately lobed with 3 – 5 lobes. The flowers are 4 – 8 centimetres in diameter, with five white to yellow petals, often with a red or purple spot at the base of each petal. The fruit is a capsule up to 18 centimetres long with pentagonal cross-section, containing numerous seeds. It grows best in hot weather with maximum and minimum mean temperature of 35^{o}C and 18^{o}C, respectively. If planted in late spring may remain vegetative until late summer or early fall (Pandita *et al.*, 2010). The nutrient requirement of crops depends upon soil texture, type of previous vegetation cover, cropping intensity and soil moisture (Denton and Swamp, 1990). Nitrogen,

phosphorus and potassium are among the common major nutrients, which are essential for the growth and development of all plant species. Hence, proper attention should be given to these nutrients in growing plants **(**Khalil**,** 2006**)**.

Stress is defined as the change in physiology that occurs when species are exposed to extraordinary unfavourable conditions that need not represent a threat to life but will induce an alarm response. The presence or absence of full day light could physiologically result as stress to the growth and development of plants. This quantum of light is absorbed by such specialized organelles in the plant, which transforms the light energy into chemical energy. According to McCain (1995), chloroplast shrinks upon exposure to light. The chloroplast in the exposed leaves contain only 17 percent of the available water whereas the leaves of the shade plants chloroplast contains as much as 47 percent of the water. If two equal areas of leaves are compared, then the chloroplast of shade leaf contains 60 percent more water than those of the sun leaf. According to Balasubramanian (2014), sciophytes, shade loving plant, grow in low light intensity or shade, examples are most ferns and mosses, black pepper, hot pepper coffee, gingers, and many orchids can tolerate or require shade while heliophytes, sunlight loving plant, thrive in or tolerate full sunlight, examples are coconut, mango, sugarcane, maize, and thyme. Studies have shown that both quality and quantity of incident light can have drastic impacts on photosynthetic activity and photosystem adaptation to changing light quality (McCree, 1972; Belkov *et al.*, 2019). Shade not only influences the amount of light received by plants but also changes other small environmental conditions, such as temperature, humidity, and carbon dioxide concentration (Zhao *et al.*, 2012).

The study is aimed at evaluating the effect of shade on the germination, growth, and development of two varieties of *Abelmoschus esculentus* (L.) Moench.

MATERIALS AND METHOD

Source of materials and study area: The seeds of the two varieties of Okra (Hire and Kirikoa F1) used were obtained from Agricultural Development Programme (ADP) Rumuodomaya, Port Harcourt (Plates I and II), while the study was carried out in the Centre for Ecological Studies, University of Port Harcourt. The experimental design was the Complete Randomized Design (CRD) with each experiment replicated five times.

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Plate I: Kirikoa F1 okra variety

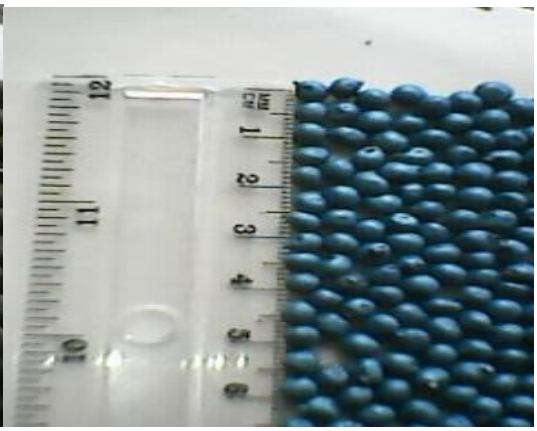

Plate II: Hire okra variety

Determination of seed viability and germination percentage: Hundred seeds from each batch were soaked in water and the floated ones were discarded indicating that the seeds are not viable. Hundred (100) seeds of the viable okra varieties were plated in petri-dishes. The petri-dishes were lined with filter paper, plated with 10 Okra seeds, moistened with water and kept on a laboratory bench at room temperature (25^{o}C). Germination was observed daily and protrusion of the radical indicated that germination has occurred.

$$\text{Germination \%} = \frac{\text{Total no of germinated seed}}{\text{Total number of seed sown}} \times \frac{100}{1}$$

Cultural conditions employed in growing Okra: The seeds of Okra were planted in a bag containing 4 kg loamy soil. The bags were separated into two batches; one batch was placed under direct sunlight without interference while the other batch was placed under the shade of trees.

Measurement of morphological parameters: The study was monitored for 9 (nine) weeks after planting. After germination, growth parameters namely: number of leaves, leaf length, leaf width, internode, and plant height were measured every week. The number of leaves per plant was determined by manually counting the number of leaves per seedling per bucket. Plant height (cm) was measured with a meter rule from the soil level to the terminal bud from the 2 weeks after planting. The leaf length (cm) was measured with a metre rule from the leaf base to the apex of the leaf, and the plant width was measured also measured with metre rule from the point of leaf margin with the longest diameter.

Proximate and Pigment Analyses: The okra fruits were harvested after 9 (nine) weeks of growth and it was done in the morning hours. The proximate analysis of the fruits was carried out using AOAC (1990). Also, the pigment composition of Okra leaf under shade condition and light condition were determined at the 8th week after planting. The pigments (Chlorophyll, carotenoid and xanthophyll) of Okra were extracted using acetone according to the methods described by Kukric *et al*. (2012), Chang *et al*. (2013) and Duma *et al*. (2014).

Statistical analysis: The data collected were subjected to descriptive statistical analysis using Microsoft Excel 2013.

RESULTS

Preliminary soil analysis: The initial soil physicochemical composition used in the

study is presented in Table 1 and it showed that the soil was suitable for planting and is loamy soil.

Table 1: Initial Soil Physiochemical composition

Parameters	Soil
pH (1:1) H_2O	4.63
pH (1:1) KCl	3.59
% Organic Carbon	1.13
% Organic matter	1.95
% Nitrogen	0.12
P (mg/g)	13.690
Ca (Cmol/kg)	0.316
Mg (Cmol/kg)	1.017
K (Cmol/kg)	0.169
Na (Cmol/kg)	0.652
Al (Cmol/kg)	0.000
Acidity (Cmol/kg)	0.410
ECEC (Cmol/kg)	2.564
Mn (mg/g)	64.250
Fe (mg/g)	106.780
Cu(mg/g)	10.750
Zn (mg/g)	6.020
% Sand	73.80
% Silt	11.40
% Clay	14.80

Performance of Okra under different growth conditions: The performance of the Okra varieties under different growth conditions after nine weeks of planting are presented in Figures 1 – 6.

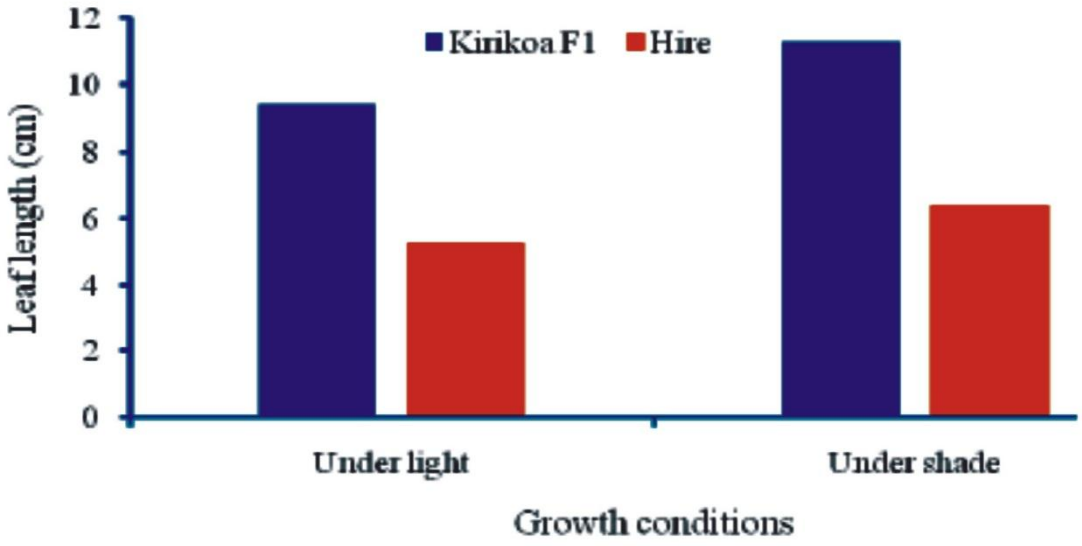

Figure 1: Leaf length of okra varieties at ninth week after planting

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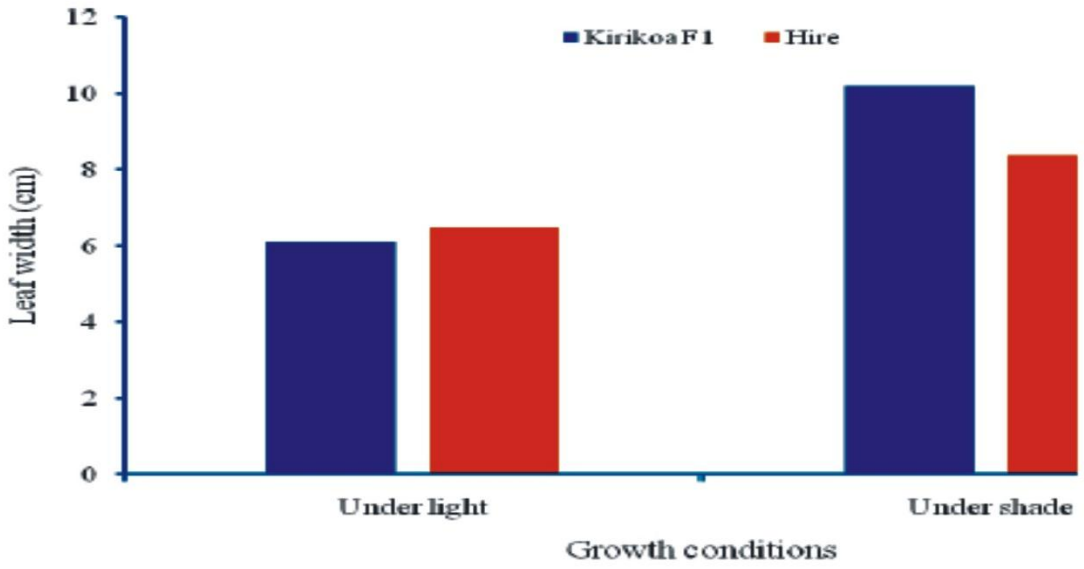

Figure 2: Leaf width of okra varieties at ninth week after planting

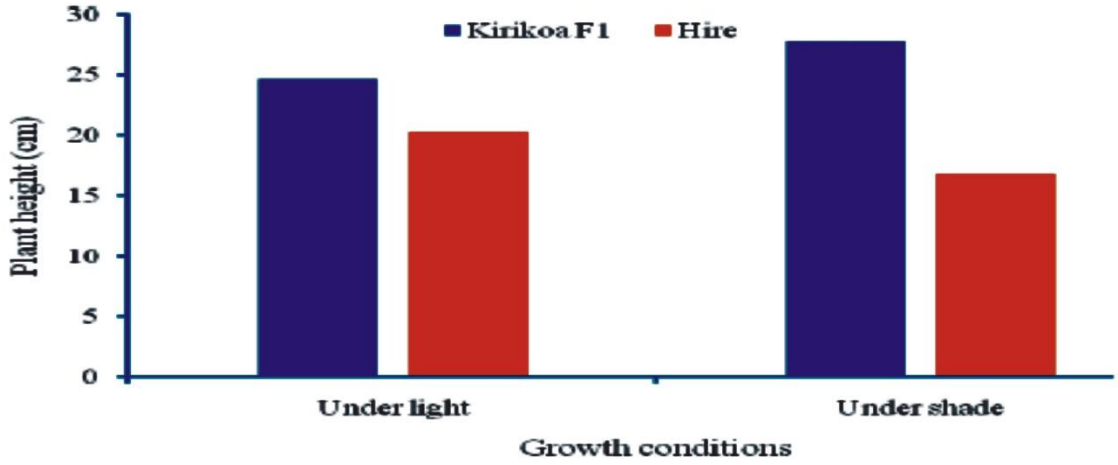

Figure 3: Plant height of okra varieties at ninth week after planting

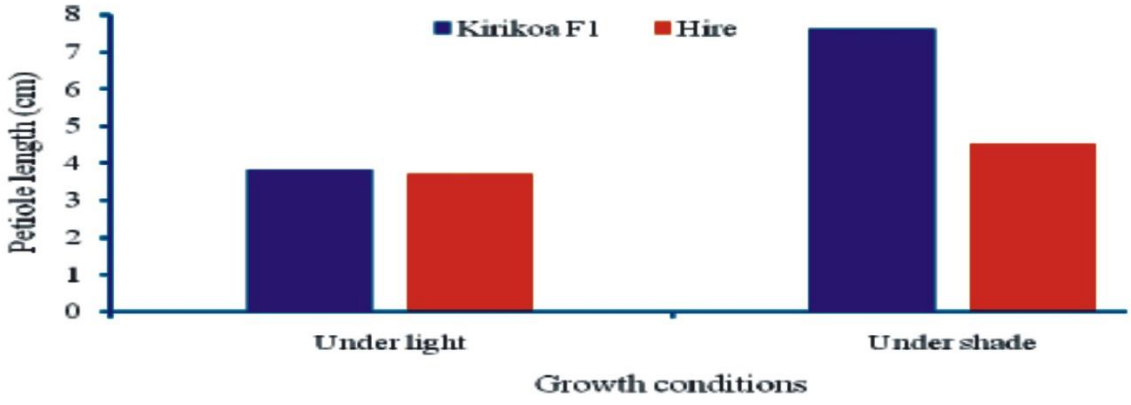

Figure 4: Petiole length of okra varieties at ninth week after planting

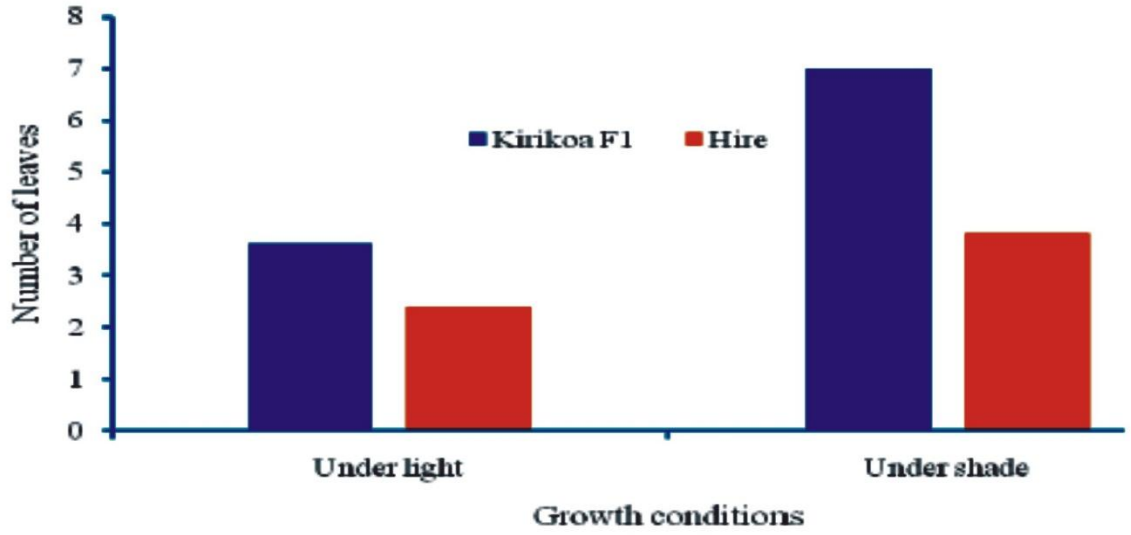

Figure 5: Number of leaves of okra varieties at ninth week after planting

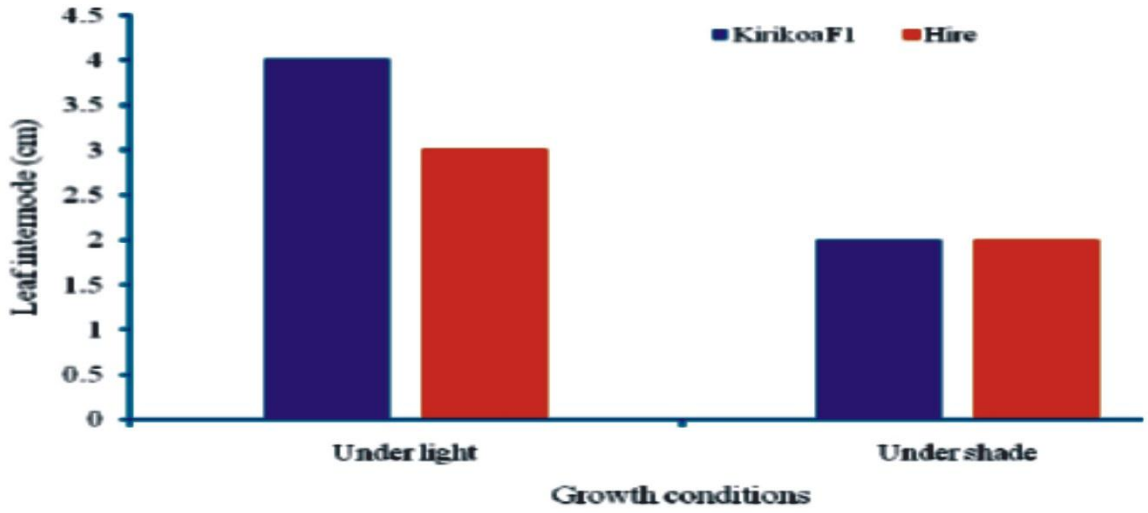

Figure 6: Leaf internode of okra varieties at ninth week after planting

Kirikoa F1 variety had the highest leaf length under-light condition (9.50 ± 0.500 cm) and under-shade condition (11.30 ± 2.168 cm) when compared to the Hire variety which had 5.30 ± 0.671 cm and 6.40 ± 2.074 cm, respectively, for the respective growth conditions (Figure 1). The shade growth condition had higher leaf length in Kirikoa F1 and Hire okra varieties than under-light condition. However, Kirikoa F1 variety showed higher leaf length than Hire variety even under shade growth condition. Also, Kirikoa F1 variety had the highest leaf width under-light condition (6.10 ± 0.894 cm) and under-shade condition (10.20 ± 1.924 cm) when compared to the Hire variety which had leaf width of 6.50 ± 1.000 cm and 8.40 ± 2.881 cm, respectively (Figure 2). Again, Kirikoa F1 variety had the highest plant height under-light condition (24.60 ± 13.520 cm) and under-shade condition (27.80 ± 5.718 cm) when compared to the Hire variety which had plant height of 20.20 ± 4.382 cm and 16.80

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± 4.550 cm, respectively (Figure 3).Secondly, Kirikoa F1 variety had the highest petiole length under-light condition (3.80 ± 0.837 cm) and under-shade condition (7.60 ± 2.408 cm) when compared to the Hire variety which had petiole length of 3.70 ± 1.095 cm and 4.50 ± 2.550 cm, respectively (Figure 4).For number of leaves of Okra, Kirikoa F1 variety had the highest number of leaves under-light condition (3.60 ± 0.894 cm) and under-shade condition (7.00 ± 1.00 cm) when compared to the Hire variety which had number of leaves of 2.40 ± 0.548 cm and 3.80 ± 1.095 cm, respectively (Figure 5).However, Kirikoa F1 variety had the highest leaf internode under-light condition (4.00 ± 1.732 cm) and under-shade condition (2.00 ± 0.000 cm) when compared to the Hire variety which had leaf internode of 3.00 ± 0.000 cm and 2.00 ± 0.000 cm, respectively (Figure 6).

Morphological differences between Okra varieties: The following differences were observed during growth and development of Kirikoa F1 and Hire varieties (Table 1).

Table 1: Morphological differences between Hire and Kirikoa F1 okra varieties

S/N	Hire variety	KirikoaF1 variety
1.	Leaf shape is ovate	Leaf shape is palmate
2.	The leaf petiole was red in colour	The leaf petiole was green in colour
3.	It took four days to germination with germination percentage of 100	It took three days to germination with germination percentage of 100
4.	In sixth-week flower production started and eight-week started producing fruits	On the seventh week it started producing flower structure and on the ninth week started producing fruits.

Pigment composition of Okra varieties under different growth conditions: The pigment composition of Okra varieties under different growth conditions is presented in Table 2. The study showed varied composition of the pigments ranging from chlorophyll to xanthophylls. Kirikoa F1 and Hire varieties of Okra had higher pigments under-shade condition than under-light condition. However, Kirikoa F1 variety had more pigments when compared to Hire variety. The most abundant pigment was chlorophyll, followed by carotenoids and xanthophylls, in that order.

Table 2: Pigment composition of Okra varieties under different growth conditions

Growth Condition	Okra Variety	Chlorophyll *a* (mg/g)	Chlorophyll *b* (mg/g)	Total chlorophyll (mg/g)	Carotenoids (mg/g)	Xanthophylls (mg/g)
Under-light	KirikoaF1	0.283 ± 0.174	0.644 ± 0.278	0.927± 0.447	0.156 ± 0.005	0.101 ±0.057
	Hire	0.229 ±0.026	0.590±0.223	0.819 ± 0.239	0.194 ± 0.039	0.086 ± 0.016
Under-shade	Kirikoa F1	0.401 ± 0.138	0.812 ± 0.230	1.213 ± 0.093	0.299 ± 0.012	0.123 ± 0.016
	Hire	0.260 ± 0.067	0.746 ± 0.079	1.006 ± 0.064	0.240 ± 0.014	0.095 ± 0.010

Values are mean ± standard deviation

Proximate composition of okra varieties under different growth conditions

The proximate of composition of the varieties of Okra is shown in Table 3. It is evident that Okra under-shade condition has more moisture content than under direct sunlight while the carbohydrate, ash, lipid, protein and fibre content are more in okra under direct sunlight.

Table 3: Proximate composition of okra grown under different conditions

Growth condition	Moisture (%)	CHO (%)	Ash (%)	Lipid (%)	Protein (%)	Fibre (%)
Under-shade	87.36	8.86	0.56	0.47	2.61	0.14
Under-sun	83.24	12.10	0.76	0.48	2.84	0.58

CHO represents carbohydrate

DISCUSSION:

Looking at the effect of shade on the germination, growth and development of two okra varieties, it was evident that plants require favourable conditions devoid of stress to thrive and flourish luxuriantly. Light as well as good soil condition is among the requirements for plant growth. The pH of the soil used was lower compared to pH requirement of okra as reported by Chittora and Singh (2006), who reported pH range of 6.0 – 6.8. This is evident in the performance of the two varieties of okra plant studied. The leaf width and leaf length of the plants were lower under direct sunlight than the shade, but higher elongation of the petiole of the Hire variety could be explained as an attempt to find light. However, the Hire variety of Okra performed better under direct sunlight than the shaded plant for plant height but the shaded KirikoaF1 was still higher than under direct sunlight. The internodes of these varieties were longer under sunlight than the shaded condition. This observation probably is the explanation for elongation of the Okra petiole. The physicochemical parameters of the soil supported the germination and growth of the two okra varieties under shade and direct sunlight conditions. The morphological characteristics showed that the Hire variety with red petiole and ovate leaf shape flowered and produced fruit earlier than the Kirikoa F1, despite germinating earlier. This may be attributed to the environment and nutrient structure found where it was planted since growth performance could be as a result of endemic conditions like soil texture, moisture, previous activities and environmental conditions.

The pigments in the study plants were more in the Okra plants grown in the open than in the shade, and the Kirikoa F1 had a higher value for all the pigments except for carotenoids where the Hire variety was more than the Kirikoa F1 variety. Also, the proximate composition revealed higher values for carbohydrate, ash, protein and fibre in Okra varieties grown in the open than the ones grown in the shade, the difference in lipid content was minimal. The moisture content of the shade plant was higher than that planted in the open. This is in agreement with the work of McCain (1995), who found that the moisture content of chloroplast of shaded plants is higher than that of the open plant.

The high percentage moisture could also be to provide for greater activity of water-soluble enzymes and co-enzymes needed

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for metabolic activities (Ihenacho and Udebuani, 2009). The plants grown in the open had higher fibre content than the shaded ones. Dietary fibre has some physiological effects in the gastro-intestinal tract such as: elimination of bile acids, faecal water (Akpabio and Akpan, 2012). It also serves as a source of human nutrition for diabetics in order to reduce glycaemic response to food and consequently the need for insulin (Onyije, 2012). Protein is an important part of catalytic activities, membrane build-up (Esenwo, 2004; Anoliefo, 2006). The protein content of the plants in the open was higher than the shaded plants. The nutrient composition of plant materials as reported by Apoxi *et al*., 2000 vary with season, environment, age and cultural practice.

CONCLUSION

This study showed a low negative sensitivity under shade. There was difference with Kirikoa F1 variety under shade and direct sunlight than Hire variety under shade and direct sunlight. Hence, Kirikoa F1 variety performed better than Hire variety under shade condition due to its height, length and petiole length which helps it in terms of photosynthesis. However, not all varieties of *A. esculentus* can be affected by shade based on the findings of this study. Also, shade does not possess any intense effect on the growth, germination and nutritional composition of the plant, *A. esculentus*. Kirikoa F1 okra variety germinated earlier than the Hire variety but the later fruited earlier than the former. The two varieties produced more pigments under the shade growth condition than under direct light condition but more pigments were produced by the Kirikoa F1 than the Hire variety.

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