Effect of plant spacing and harvest interval on the growth, fruit quality and yield of okra (Abelmoschus esculentus (L.) Moench) in Port Harcourt, Nigeria.

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Abstract
A field experiment was conducted during the 2016 and 2017 cropping seasons to determine the effect of plant spacing and frequency of fruit harvest on the growth and fruit yield of okra (var. NHE47-4). The study carried out at the Rivers Institute of Agricultural Research and Training (RIART), Rivers State University, Port Harcourt used two factors, plant spacing (50 cm x 30 cm, 50 cm x 40 cm and 50 cm x 50 cm) and harvest intervals (1, 2 and 3 days interval), constituting the treatments. The treatments were laid out as factorial arrangement in a randomized complete blocked design (RCBD), replicated three times. Results show that the widest plant spacing (50cm x 50cm) significantly (p<0.05) increased stem diameter, number of leaves, leaf area, fruit size and fresh fruit yield per plant than the closest plant spacing (50cm x 30cm) in 2015 and 2016, both seasons of the study. However, closest plant spacing (50cm x 30cm) significantly (p<0.05) increased plant height (78.1 and 75.4cm) and fresh fruit yield (19.48 and 19.75 t/ha) in reference to the widest plant spacing (50cm x 50cm) in 2016 and 2017, respectively. Although harvesting at 3 days interval gave the longest and heaviest fresh fruit per plant, such fruits were fibrous, strong and unmarketable. Harvesting at 2 days interval equally gave longer, and heavy fruits per plant that were tender, succulent and very marketable. At the interactive level, the medium plant spacing (50 cm x 40 cm) at 2 days harvest interval (PS2H2) produced the highest fresh pod yield of 20.51 and 21.34 t/ha of tender, succulent and marketable fruits than any other combination in 2016 and 2017,respectively.

Keywords: *Okra, lady finger, Abelmoschus esculentus, Plant Spacing, harvest interval, fruit yield.*

1. Introduction

Okra (*Abelmoschus esculentus* (L.) Moench) is a plant belonging to the family Malvaceae and has been duly domesticated as a vegetable crop (Farinde *et al.*, 2007). The crop is believed to have originated from tropical Africa although now widely cultivated throughout the tropic, sub-tropic and the warm temperate regions (Farinde *et al.*, 2007). India is the world largest producer followed by Nigeria and Sudan (Varmudy, 2011) with India producing 70% of the total world production (3.5 million tonnes annually) (FAO, 2008). In Nigeria, okra ranks first amongst other fruit vegetable crops (Babatunde *et al.*, 2007). Its production constituted about 4.6% of the total staple food production in the years 1970–2003 (CBN, 2004). It is a source of calorie (4550Kcal/kg) for human consumption. Although the crop is classified mostly by plant height, size of fruit, colour of fruits, maturity period (early or late maturing) some prominent varieties in circulation include: lady finger, long pod, dwarf green pods, white velvet, green velvet, (Christo and Onuh, 2005; Udoh *et al.*, 2005).

Okra cultivation is widely practiced in Nigeria because of the importance attached to the crop as an important food vegetable. The crop is principally cultivated for its tender fruits used as a nutritious vegetable for human diet (Gbaraneh and Chu, 2016; Talukder *et al.*, 2003). It contains valuable ingredients for body building, maintenance, repairs and disease defensive mechanism (Edet and Etim, 2007; Bakhru, 2003). It is a source of carbohydrates, protein, vitamins A, B1 and C, calcium, potassium, dietary fibre, and mineral matters (Adeboye and Oputa, 1996). Okra improves heart health, eyesight & cholesterol levels (Gorinstein *et al.*, 2001)

Among the great constraints facing the smallholder farmers who produce okra in the nation is low yield due to inadequate plant spacing. Plant spacing influences population and hence plant competition. The closer or wider the plant spacing, the higher or lower is the plant population, respectively. Application of suitable plant spacing can lead to good growth and development, leading to optimum yield while inadequate plant spacing could result to relatively low yield and poor quality fruits (Madisa *et al.*, 2015). Ekwu and Nwokwu (2012) observed significant rigorous tall plants, poor fruit quality and low yield per plant due to intra specific competition with closer plant spacing than wider plant spacing. That is to say, suitable plant spacing leads to optimum yield whereas too low plant spacing or too high plant spacing could result in relatively poor quality and lower yield, respectively (El Naim *et al.*, 2011). There is therefore the need to employ adequate plant spacing to obtain maximum fruit yield.

Fruit harvesting interval is another determining factor in okra production. Too frequent harvesting of pods depresses yields since the pods are not fully developed, resulting to poor fruit size and weight, while over-delayed harvesting produces over-aged and fibrous fruits that are unmarketable. Talukder *et al.*, (2003) reported that okra yield decreased with increasing harvest interval and obtained the highest pod yield of 21.74 t ha^{-1} at 2 days harvest interval. They observed that short harvest interval induced the plant to produce higher number of fruits per plant with lower fruit size and weight while long harvest interval encouraged the production of fewer fruits with higher fruit size and weight, but low yield per hectare (Talukder *et al.*, 2003). Application of appropriate harvest interval influences okra yield since regular pod harvest elongates the growth circle of the crop (Berchie *et al.*, 2004). Pods should be harvested at 2-3 days interval, when the pods attain the length of 6-12cm and are still fresh and tender (Farinde *et al.*, 2007). Over matured pods become fibrous and tasteless. The interval of harvest (number of days interval) must be given proper attention in order to obtain the proper quality of fruits for food. This study was aimed at developing appropriate plant spacing and harvest interval for optimum yield and quality of fresh and tender okra fruits for consumption.

2. Materials and Methods

The experiment was conducted during the 2016 and 2017 cropping seasons at the Rivers Institute of Agricultural Research and Training farm, of the Rivers State University, Port Harcourt. Port Harcourt situates in the humid forest zone of South-south Nigeria with mean annual rainfall of 2400 mm coming in a bimodal distribution over nine months (March to November). The station is on an elevation of 17.34 m above sea level (FDRD, 1981). The temperatures and relative humidity of the station vary from 25^o - 32^o C and 78 - 89%, respectively. The soil is an Ultisol derived from coastal sediments of the Niger Delta, classified as coarse-loamy siliceous iso-hyperthermic Typic Paleudult (IITA, 1994). It is acidic with pH 5.1, organic carbon (OC) 1.26%, total nitrogen (N) 0.078%, available phosphorous (P) 58g/kg and exchangeable potassium (K) 0.17 cmol kg^{-1} at 0-15 cm soil layer.

Experimental design

The experiment used a factorial arrangement fitted into a randomized complete block design (RCBD), replicated three times. The treatments were three plant spacing viz. PS1 (50 cm x 30 cm), PS2 (50 cm x 40 cm) and PS3 (50 cm x 50 cm) and three harvest intervals of fruit viz. H1 (0ne day interval), H2 (two days interval) and H3 (three days interval).

A one year fallow land used for the study was slashed; ploughed, harrowed and experimental plots of 3 x 2.5m^2 each marked out. Okra seeds (var. NHE47-4 'Clemenson Spineless'), were planted in the plots. Planting spacing was done according to the design of the experiment. Two seeds were planted per stand and latter thinned to one seedling per stand two weeks after planting (WAP). Every plot contained five rows of 3m long each. Plant population in each case depended on the plant spacing adopted. Weeding was done manually using the weeding hoes at 4 and 8 WAP and then whenever it became necessary. Inorganic fertilizer, $N_{20}P_{10}K_{10}$, at the rate of 300kg/ha was applied evenly to the plots in three equal splits of 21 days interval, with the first at a day after the first weeding. First fresh fruit harvest commenced five days after initiation of first set of flowers. Pods were ready for harvest 2 months after planting. Since the purpose of the cropping was to produce pods for consumption, harvest was done when the pods were still tender and succulent and attained market size of 6–10cm long. Subsequently, harvests were made according to the number of day interval specified by the study. Fruits were uniformly cut with a sharp kitchen knife at harvest. Harvests were spread over a month at the end of which records were pulled together per plot for statistical analysis.

Data collection

All plants on the three middle rows of each plot (excluding the border plants) were tagged for data collection. Data collected were on growth, yield and yield attributes which included flowering date, plant height, number of leaves per plant and leaf area at flowering, number of fruits per plant, fresh fruit length, width, weight and yield. All data collected were subjected to analysis of variance using the procedure GLM of SAS (SAS Institute, 2010). Where there was significant F-test, treatment means were separated using the Least Significant Difference (LSD) test at 5% probability level.

3. Results

3.1. Effect of Plant Spacing and harvest interval on vegetative growth of okra

The results presented in Tables 1and 2 revealed that the respective plant spacing did not show any significant ($p>0.05$) influence on flowering date. Nevertheless flowering was early expressed in the wider plant spacing (50cm x 50cm), followed by medium plant spacing (50cm x 40cm) and much delayed in closest spacing (50cm x 30cm). Harvest interval and the interaction of plant spacing and harvest interval were non-significant for flowering dates.

Plant spacing had a significant ($p<0.05$) effect on plant height, stem diameter, number of leaves per plant and leaf area at flowering (Tables 1). The closest plant spacing produced plants that were significantly taller than the widest and medium plant spacing by 8 and 4%, respectively, in 2016 (first season). In the second season (2017), the closest spacing significantly increased plant height over the widest spacing by 7% but was non-significant with the medium plant spacing in same year. Harvest frequency did not significantly affect plant height. Similarly, the interaction of plant spacing and harvest frequency was non-significant.

Stem diameter was significantly affected by plant spacing (Table 1). The closest plant spacing produced very slender stems which diameter were smaller than the widest and medium spacing by 0.6 and 0.3 cm, in 2016 and 0.4 and 0.2cm in 2017, respectively. Harvest frequency and the interaction of plant spacing and harvest frequency had no significant effect on stem diameter of okra at the site.

For number of leaves per plant, the widest plant spacing (50cm x 50cm) produced significantly higher number of leaves than all other plant spacing in 2016. Similarly, the number of leaves produced by the medium plant spacing (50cm x 40cm) was significantly higher than that of the closest plant spacing. In terms of leaf area, significant effects occurred between all the plant spacing with the widest spacing producing 228 and 231, medium spacing 212 and 218, and closest spacing 198 and 195 in 2016 and 2017, respectively. Both the harvest interval and interaction effects were non-significant on number of leaves and leaf area.

3.2. Effect of Plant Spacing and harvest interval on yield and yield attributes of okra

The influence of plant spacing and harvest interval was significant ($p<0.05$) for number of fruits per plant, fruit quality, and yield of okra at fruit harvest. Highest number of fruits per plant and longest fruits were observed with widest plant spacing and 2 days harvest frequency (Tables 3 and 4). The widest plant spacing (50 cm x 50 cm) significantly ($p<0.5$) increased number of fruits per plant by 3.2 and 3, fruit length by 4.95 and 4.51cm, fruit diameter by 1.27 and 1.38cm and fruit weight by 3.88 and 4.51g over the closest plant spacing (50 cm x 30 cm) in 2016 and 2017, respectively. Although the widest plant spacing (50 cm x 50 cm) equally increased number of fruits per plant by 1.6 and 0.7, fruit length by 0.42 and 0.37cm and fruit diameter by 0.26 and 0.25 cm over the medium plant spacing (50 cm x 40 cm), in 2016 and 2017, respectively, they did not differ significantly. The former significantly increased fruit weight by 1.86 and 2.73cm and fruit weight per plant by 68.4 and 59.1g over the latter in 2016 and 2017, respectively. Although the medium spacing (50 cm x 40 cm) slightly increased fresh fruit yield over the closest spacing (50 cm x 30 cm) by 0.82 and 1.1 t/ha in 2016 and 2017, such increase was insignificant.

Number of fruits per plant and fruit yield ha^{-1} did not differ significantly ($p>0.05$) between the widest plant spacing (50 cm x 50 cm) and the medium spacing (50 cm x 40 cm). Nevertheless the widest plant spacing significantly increased fruit length by 5 and 16%, fruit diameter by 8 and 9%, weight per fruit by 23 and 25% and fruits weight per plant by 19 and 18% as compared to the medium spacing in 2016 and 2017, respectively. The closest plant spacing (50 cm x 30 cm) produced the highest fresh fruit yield of 19.40 and 19.98 t/ha that were significantly ($p<0.05$) higher than the widest plant spacing by 4.5 and 3.96 t/ha in 2016 and 2017, respectively. Similarly the yields of the closest plant spacing (50 cm x 30 cm) differed with the medium plant spacing (50 cm x 40 cm) by 1.4 and 1.37 t/ha in 2016 and 2017 seasons, respectively, but such difference were non-significant.

Significant differences occurred among the 3 harvest intervals in respect of fruit quality and yield (Tables 3 and 4). Delaying of harvest for 2 days interval significantly ($p<0.05$) increased fruit length by 13.4 and 16.3cm, fruit diameter by 1.5 and 1.7cm, fruit weight by 6.8 and 6.9g and fruit weight per plot by 222.7 and 196.3g than one day interval in 2015 and 2016, respectively.

Interaction of plant spacing and harvest interval was significant ($p<0.05$) for yield and yield attributes of okra at fruit harvest (Table 4). Highest number of fruits per plant (28.1 and 27.4) in 2016 and 2017, respectively, was observed with medium plant spacing and one day harvest interval (PS2H1), highest fruit length (13.54 and 13,61cm) and diameter (2.55 and 2.74cm) with medium spacing and three days harvest interval (PS2H3), fresh fruit weight (20.75 and 20.48g), fruit weight per plant (412.1 and 401.5g) and fresh fruit yield (20.71 and 21.64 t/ha) with medium spacing and two days harvest interval (PS2H2).

Table 1. Effect of plant spacing and harvest intervals on growth characteristics of okra during the 2016 and 2017 Cropping seasons

Treatment	Number of days to 50% flowering		Plant height at flowering (cm)		Stem diameter at flowering (cm)		Number of leaves/plant at flowering		Leaf area per Plant (cm^2)	
Plant spacing	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
PS1 (50cm x 30cm)	57.7	58.3	78.2	77.4	1.6	1.6	14.5	16.5	198.3	195.3
PS2 (50cm x 40cm)	56.5	59.1	75.5	74.9	1.9	1.8	16.9	17.9	212.5	218.1
PS3 (50cm x 50cm)	55.8	56.2	72.2	72.3	2.1	2.0	18.1	18.3	228.4	231.6
LSD $_{(0.05)}$	ns	ns	2.61	2.5	0.19	0.17	1.32	1.13	10.29	9.13
Harvest Interval										
H1 (0ne day interval)	55.5a	56.1a	68.4	69.2	1.41	1.35	13.1	14.1	197.8	193.5
H2 (2 days interval)	56.1a	55.8a	72.3	70.8	1.44	1.36	12.8	13.9	195.3	192.8
H3 (3 days interval)	55.9a	55.9a	71.8	72.2	1.42	1.36	13.2	13.7	196.4	194.8
LSD $_{(0.05)}$	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

Table 2. Interaction effect of plant spacing and harvest intervals on growth characteristics of okra during the 2016 and 2017 Cropping seasons at Port Harcourt.

Treatment	Number of days to 50% flowering		Plant height at flowering (cm)		Stem diameter at flowering (cm)		Number of leaves/plant		Leaf area per Plant	
Interaction (PS x H)	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
PS1H1	58.3	57.6	76.0	76.1	1.5	1.6	13.9	14.7	172.4	168.6
PS1H2	57.4	56.1	75.4	74.2	1.5	1.7	14.3	15.1	179.8	173.1
PS1H3	56.1	56.6	73.8	72.1	1.5	1.6	16.1	16.9	182.1	178.5
PS2H1	55.3	54.3	75.9	75.8	1.6	1.7	14.8	14.3	182.5	185.2
PS2H2	55.9	55.2	75.4	73.3	1.6	1.8	16.1	14.8	194.7	188.4
PS2H3	56.2	55.1	74.6	70.5	1.7	1.8	17.7	16.7	197.3	196.3
PS3H1	55.1	54.8	74.2	74.6	1.8	1.9	16.4	16.8	194.4	191.6
PS3H2	54.8	54.4	73.3	72.6	1.8	2.1	17.3	17.1	203.6	206.2
PS3H3	54.4	54.1	72.6	71.3	2.0	2.2	17.8	17.4	212.4	209.3
LSD $_{(0.05)}$	ns	ns	ns	ns	ns	0.59	1.35	1.21	12.92	12.57

Table 3. Effect of plant spacing and harvest intervals on yield and yield attributes of okra during the 2016 and 2017 cropping seasons at Port Harcourt.

Treatment	Number of fruits/ plant		Fruit length (cm)		Fruit diameter (cm)		Fresh weight per fruit (g)		Fruit weight per plant (g)		Fresh fruit yield (t/ha)	
Plant spacing	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
PS1 (50cm x 30cm)	17.7	17.3	7.01	7.66	1.71	1.67	16.44	16.93	291.0	292.9	19.40	19.98
PS2 (50cm x 40cm)	19.3	19.6	11.54	11.80	2.72	2.8	18.46	18.51	356.3	372.1	17.81	18.86
PS3 (50cm x 50cm)	20.9	20.3	11.96	12.17	2.98	3.05	20.32	21.24	424.7	431.2	16.99	17.76
LSD $_{(0.05)}$	1.94	2.01	0.53	0.41	0.34	0.38	1.25	1.38	28.33	29.97	1.49	1.53
Harvest Interval												
H1 (0ne day interval)	23.8	24.1	10.25	10.43	1.32	1.21	15.8	14.38	259.4	266.2	22.16	22.96
H2 (2 days interval)	17.9	18.2	23.64	23.72	2.66	2.72	22.6	21.24	412.1	402.5	22.96	23.29
H3 (3 days interval)	15.2	14.4	29.97	30.42	3.12	3.17	26.3	24.11	504.6	516.3	19.46	18.80
LSD $_{(0.05)}$	1.32	1.62	1.32	1.21	0.231	0.212	1.71	1.62	19.96	22.12	1.38	2.40

Table 4. Interactive effect of plant spacing and harvest intervals on yield and yield attributes of okra during the 2016 and 2017 Cropping seasons at Port Harcourt.

Treatment	Number of fruits/ plant		Fruit length (cm)		Fruit diameter (cm)		Fresh wt/fruit (g)		Fruit weight per plant (g)		Fresh fruit yield (t/ha)	
Interaction (PS x H)	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
PS1H1	21.3	18.1	6.95	7.24	1.26	1.2	8.83	10.23	183.4	188.2	15.24	14.03
PS1H2	18.4	15.4	11.12	11.33	1.84	1.97	21.36	22.23	316.8	323.8	17.75	17.53
PS1H3	15.6	10.2	12.48	12.63	2.32	2.11	25.42	25.86	379.8	385.3	15.96	13.27
PS2H1	19.1	20.6	7.42	7.34	1.42	1.34	11.99	12.2	159.6	161.4	17.77	12.99
PS2H2	18.1	16.9	12.73	12.46	2.37	2.26	20.72	20.48	412.1	401.5	20.71	21.64
PS2H3	12.6	11.3	13.54	13.61	2.55	2.74	25.98	30.27	312.4	323.4	15.74	17.09
PS3H1	18.1	17.4	6.97	7.13	1.26	1.35	16.11	13.37	268.2	276.4	18.11	15.03
PS3H2	15.9	16.7	11.56	11.78	2.16	2.14	20.82	19.89	332.6	344.4	19.90	19.11
PS3H3	12.8	13.5	12.64	12.83	2.49	2.47	25.46	28.71	371.2	368.8	17.11	16.29
LSD $_{(0.05)}$	2.14	2.26	2.186	2.263	0.274	0.211	3.742	3.831	38.62	41..26	2.464	2.562

4. Discussion

Effect of plant spacing and harvest intervals on growth and growth characteristics of okra

(a) Plant spacing

Results show that plant spacing significantly ($p<0.05$) influenced the growth, development and yield of okra (Table 1). The closest plant spacing (50 cm x 30 cm) significantly ($p<0.05$)

increased plant height as compared to the widest plant spacing (50 cm x 50 cm). Similar observation had been reported by Makinde and Macarthy (2006) and Madisa *et al.,* (2015). On the other hand plants of the closer plant spacing had very thin stems, an indication of smallest stem diameter observed in the results, as compared to treatments with medium (50cm x 40 cm) and wider (50cm x 50 cm) plant spacing. These general behaviors of the closer plant spacing might be attributed to the competition for growth resources especially sunlight among the crowded plants of the closer plant spacing. Plants grow taller due to struggle to receive ample of sunlight from upper region. These results agree with the findings of Hossain *et al*., (2001) and Ekwu and Nwokwu (2012) who observed significant rigorous tall plants with closer plant spacing than wider plant spacing due to intra specific competition. Plant spacing also had a significant influence on the number of leaves per plant. The maximum number of leaves per plant was observed in the wider (50 cm x 50 cm) plant spacing and minimum number of leaves per plant in the closer (50 cm x 30 cm) plant spacing (Table 1). The reduced competition for light and other resources as well as reduced overlapping from adjacent okra plants within the canopy of the wider spacing may have enabled the plants to utilize the available energy for maximum production of larger leaf area. Similar improvement in growth characters of okra plants through enhancement of photosynthesis and other metabolic activities in the presence of available growth resources had been reported by Saha *et al.,* (2005); Ijoyah *et al.,* (2010); Bhatt *et al.,* (2011); Parmar *et al*., (2013).

(b) Harvest intervals

There was no significant effect of the harvest intervals on vegetative growth of the crop since data were collected at flowing stage of the crop when harvest interval, as a treatment, had not been implemented.

(c) Plant spacing x Harvest interval (interaction)

The data revealed that the tallest plants were observed in the closest plant spacing at one day harvest interval followed by closest spacing at two days harvest interval while the widest plant spacing at three days harvest interval gave the shortest plants (Table 3). The struggle for sunlight and other environmental resources were responsible for such aggressive growth. However, the largest stem diameter, largest number of leaves and maximum leaf area per plant were observed in the widest plant spacing at three days harvest interval. The result is in conformity with Falodun and Ogedegbe (2016).

There was a significant plant spacing x harvest interval interaction for stem diameter, number of leaves and leaf area per plant. Widest plant spacing and three days harvest interval gave the highest stem diameter, number of leaves and leaf area per plant while the closest plant spacing and one day harvest interval produced the least in all the three cases.

Effect of plant spacing and harvest intervals on yield and yield attributes of okra

(a) Plant spacing

Okra pod length, diameter and weight were significantly low at closer plant spacing of 50cm x 30cm than the situation in the medium (50cm x 40cm) and wider (50cm x 50cm) plant spacing. Fruit size in the closer plant spacing (50cm x 30cm) was small and not very marketable. The high plant density associated with the closer plant spacing indicates that competition for resources of growth and development was at its peak, suggesting unhealthy situation for plants growth and pods development to market size. These results agree with the findings of Madisa *et al.,* (2015) and Ekwu and Nwokwu (2012) that application of appropriate plant spacing leads to healthy growth, development and optimum pod yield of okra. Okra pod yield increased with increasing plant spacing with highest pod yield of 19.4 and 19.98 t/ha at the closest spacing of 50cm x 30cm, which was not significantly different form the yield of the medium plant spacing

(50cm x 40cm) in 2016 and 2017, respectively. This finding is in agreement with Paththinige *et al.*, (2008); Uddin, *et al.* (2006) and Moniruzzaman, *et al.*, (2007), that pod yield of okra decreased with increasing plant spacing. The medium plant spacing (50cm x 40cm) did not only have a high yield similar to the closer spacing (50cm x 0cm) but with longer, bigger and heavier pod that attract market than the closer spacing.

(b) Harvest intervals

Results from the study (Table 3) reveal that harvest intervals significantly (p<0.5) affected fruit quality and yield. Harvesting of pods at one day interval produced significantly higher number of pods than the number of pods per plant harvested at two or three days interval. Similarly, number of pods harvested at two days harvest interval was significantly higher than the number obtained from three days harvest interval. It is observed from these results that frequent or reduced harvest interval as the case with one and two days harvest interval tends to stimulate faster fruiting rates in okra production hence more fruits harvested per plant. The number of fruits harvested per plant was in the increasing order of one day harvest interval < two days harvest interval < three days harvest interval. Similar results of increase in harvestable products at lowest harvest interval had been reported by Talukder *et al*., (2003); Dikwahal *et al*., (2007) and Maurya *et al*., (2013). Harvesting pods at 2-3 days interval produced fruits that were significantly longer, bigger and heavier than one day harvest interval. It could be deduced that pods harvested at 2-3 days intervals tended to have been given enough opportunity to growth and development fully by accumulating more photosynthate before harvest. This report agrees with the findings of Talukder *et al.*, (2003), Berchie *et al.*, (2004) and Farinde *et al.*, (2007) that pods should be harvested at 2-3 days interval when pods attain full development and are still tender and succulent. Despite the variations, two day harvest interval produced the highest pod yield per hectare followed by one day harvest interval. The two days harvest interval produced high number of pod per plant as the one day harvest interval, also possessing big fruit size and weight of fruits as the case of the three days harvest interval, ultimately turned out to produce higher fruit yield per hectare (Saha *et al.*, 2005). Yield was significantly low in three days harvest interval in relation to two days harvest interval. Such could be attributed to few number of fruits harvested per plot in relation to one and two days harvest intervals. Plant spacing x Harvest interval interaction had significant effect on fruit yield and qualities. The longest fruit, largest fruit diameter and heaviest fresh per fruit were observed at the widest plant spacing and two day harvest interval while maximum number of fruits per plant was recorded at the widest plant spacing and one day harvest interval, (Falodun and Ogedegbe, 2016).

Plant spacing x Harvest interval (interaction)

Plant spacing x Harvest interval interaction had significant effect on fruit yield and qualities (Table 4.). The maximum number of fruits per plant was recorded at the medium plant spacing and one day harvest interval (PS2H1) while minimum number of fruits per plant was recorded at widest plant spacing and three days harvest interval (PS3H3). The longest fruits, largest fruit diameter and heaviest fruit weight per plant were recorded at the widest plant spacing and three days harvest interval (PS3H3). . The wider spacing (50cm x 50cm) in this case gave the lowest population of plants per unit area, resulting to less competition for growth and development resources. On the other hand, delaying of fruits harvest up to three days must have given the fruits enough opportunity of accumulating more photosynthate to grow, develop and fully increase fruit size and weight before harvest. This result agrees with the findings of Maurya *et al.*, (2013), Madakadze *et al.*, (2007) and Ijoyah *et al.*, (2010). The highest fruit yield per hectare was recorded at the medium plant spacing at 2 days harvest interval (PS2H2) which was significantly higher than any other combination of plant spacing and harvest interval except the widest plant spacing at two days harvest interval (PS3H2): this observation agrees with the report of Falodun and Ogedegbe (2016) and Hossain *et al.*, (2001).

5. Conclusion

The study showed that okra cv. 'Clemenson Spineless' could be produced at maximum yield per hectare with proper plant spacing and harvest intervals. The highest yield per hectare was recorded at the closest spacing of 50 cm x 30 cm at 2 days harvest interval but fruit size was smaller and unmarketable. One day harvest interval produced many tiny unmarketable fruit while harvesting at three days interval produced fibrous and unmarketable fruits. Plant spacing of 50 cm x 40 cm at 2 days harvest interval produced the next highest yield of large, tender, succulent and very marketable fruits.

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