Effects of Soil Amendments on Postharvest Quality on Okra Fruits

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Abstract

In Nigeria farmers apply fertilizers arbitrarily without considering the resultant effect on soil and the postharvest quality of crops. This study was therefore designed to investigate the effects of NPK fertilizer 20:10:10 on the postharvest quality of okra fruit (Abelmoschus esculentus L. Moen). Okra seeds NHE-47 were sown in the field at the National Institute of Horticultural Research (NIHORT), Idi-Ishin, Ibadan, Nigeria in 2001 at a spacing of 50 cm x 25 cm. The fertilizer NPK 20-10-10 at these levels 0 kg/ha, 300 kg/ha, 450 kg/ha and 600 kg/ha were applied in two splits. The growth parameters measured were plant height, number of leaves, dry and fresh weight of leaf, stem and roots. The experimental design for the field experiment was complete randomized block design replicated three times. Harvested okra fruits were subjected to two storage conditions; cold storage (refrigerator) at 4^{0}C and ambient condition at 27.8^{0}C for 21 days. Postharvest parameters measured were firmness, disease incidence, weight loss, Vitamins A and C, protein and fat contents. The experimental design was randomised complete block design replicated three times. Data generated were subjected to analysis of variance (ANOVA) and means were separated using Duncan Multiple Range Test (DMRT) at $p \leq 0.05$.

The application rate of 450kg/ha gave the best response in growth and yield. The trend in yield can be ranked as follows 450 kg/ha > 300 kg/ha > 600 kg/ha > 0 kg/ha. It was observed that the varying levels of NPK fertilizer had no significant difference on the firmness and disease incidence of okra fruit. There were significant differences in the weight loss of okra fruit. Increase in levels of fertilizer rate had increase in weight loss, following this trend 600 kg/ha > 450 kg/ha > 300 kg/ha > 0 kg/ha. Fertilizer application rate had no significant effect on vitamin C, vitamin A, fat and protein content of okra fruit. The fertilizer application rate of 300 kg/ha had Vitamin. C content value of 207.0 mg/kg, fat content value of 1.56%, protein value content of 21.3% and Vitamin A content of 288.6 mg/kg. At 450kg/ha, the Vitamin C content was 229.8 mg/kg, Vitamin A content was 89.9 mg/kg, fat and protein content were 24.9% and 1.9% respectively.

Cold storage at 4 ^{0}C gave a better fruit firmness, less weight loss, reduced disease incidence and less degradation of Vitamin A and C, fat and protein content compared to fruits stored at the ambient temperature of 27.8^{0}C. Fertilizer application rate of 450kg/ha NPK 20:10:10 gave the best growth yield performance while varying fertilizer levels had no significant difference on firmness and disease incidence of okra fruit. Increase in fertilizer rate increases fruit weight loss.

Keyword: *Fertilizer levels, Growth, Yield, Postharvest quality, Okra fruits.*

Introduction

Okra (*Abelmoschus esculentus* L. Moench) belongs to the family Malvacea. It is widely cultivated and can be found in almost every market all over Africa (Schippers, 2000). Okra is usually rich in carbohydrate, protein and vitamins B and C. The fruits are used as boiled or fried vegetables and added to soups or stews. The fruit can also be dried and powdered for use during off season. Young shoots and leaves are also edible. The mature seed contain 20% edible oil. The fresh pod contains 203mg ascorbic acid per 100g of fruit. It is also a source of protein for the high lysine content. It is among the most commonly grown vegetables throughout Nigeria. The nutritional constituents of okra include calcium, protein, oil and carbohydrates; others are iron, magnesium and phosphorus. Most okra is eaten in cooked or processed form. Young fruits may be eaten raw. The oil in the seed could be as high as in poultry eggs and soybean (Akinfasoye and Nwanguma, 2005). In wet season fresh okra is abundant but much of it is dried and stored for use in dry season. Industrially, okra is processed by canning, freezing or preserving in brine. The dried seed could provide oil and protein.

The increasing demand for fresh fruits and vegetables has brought the need for extending the shelf life of okra fruit and this implies that there should be storage. The need for storage has been dictated by the alteration of cycles – favourable and unfavourable periods, which are the dry and rainy season. Also, disasters such as drought, major pest and disease outbreaks are challenges facing sustainable crop production and storage. Tropical fruits and vegetables are stored at higher temperature than temperate fruits and vegetables; this higher temperature leads to increase in metabolic activities, respiratory rate, loss of moisture content and reduced shelf life of tropical fruits and vegetables more rapidly. Emphasis should be placed on conservation after harvest rather than concentrating only on further boosting crop production. Various authorities have estimated postharvest losses to about 25-70 percent of fresh fruit and vegetables produced which are lost after harvest (Babatola *et al.*, 2006). These losses have been found to be due to loss of moisture, changes in composition during metabolic activities after harvest, pathogenic attack, temperature and relative humidity of storage environment (Babatola, 2006). Other factors include mechanical damage, maturity stage and harvesting method. Soil fertility, use of fertilizer, lack of plant food in the soil can seriously affect the quality and can harm the development and postharvest condition of produce. Plant nutrition has the following effect on quality of crops. Lack of nitrogen leads to stunted growth, yellow discolouration on leaf in green vegetable e.g. cabbage; lack of potassium brings about poor fruit development and abnormal ripening in fruit; lack of calcium brings about moisture imbalance, causes blossom end root in tomatoes, bitter pit in apples; while boron deficiency can lead to lumpiness in pawpaw and hallow stem in cabbage and cauliflower. Crop quality is also improved by adequate use of fertilizer, provided they are applied in accordance with the latest concept and knowledge. Quality in this context is understood to include not only the presence of quality components but also the absence of unwanted surplus nutrients and toxic substance in plant product. Crop production using adequate fertilizer prevents and increase resistance to many diseases. Alasiri *et al.* (1999) reported a significant increase in the yield of okra on Fadama land when 60kg N/ha N.P.K. 20-10-10 was supplied. Fertilizers' use should also take into account the nutritional requirements of the consumer.

Hence this study investigated the effect of soil amendments on postharvest quality of okra fruit.

Materials and methods

Field Experiment

The field experiment was conducted at the Vegetable Section of the National Horticultural Research Institute (NIHORT), Idi-Ishin, Ibadan, Oyo State, Nigeria. The study area lies between latitude 7^0 24` N and longitude $3^0$ 54` E with a bimodal rainfall of between 1,150 mm and 1,220 mm per annum in the humid rainforest zone of Nigeria. The temperature range was 22.1-34.5^0C. An early maturing variety of okra seed NHE-47-4 was obtained from the seed unite of NIHORT, Ibadan. Planting was done by direct sowing at a spacing of 50 x 25 cm. Two seeds were sown per stand which was later thinned to one after two weeks.

The soil is a well drained loamy sand texture which has been left to fallow for three years before the commencement of the experiment. The soil preplanting soil analysis was carried out to avoid blanket application (Table 1).

Table 1: Physical and chemical properties of surface soil (0.15 cm)

Soil Properties	Value
Ph	6.5
Organic Carbon (g/kg)	8.3
Total Nitrogen (g/kg)	0.19
Available P (mg.kg)	9.1
Exchangeable Ca (cmo/kg)	0.15
Exchangeable Mg (cmo/kg)	0.07
Exchangeable Na (cmol/kg)	0.13
Exchangeable K (cmo/kg)	0.02
Exchangeable Acidity (cmol/kg)	0.08
Base Saturation (g/kg)	822
Sand (g/kg)	818
Silt (g/kg)	74
Clay (g/kg)	80

The treatments were made up of four fertilizer levels of NPK 20:10:10 which were 0, 300, 450, and 600 kg/ha. It was applied in two spilt, in a ring form, 5 cm away from the plant after the first weeding at two weeks after planting. The second dose was applied at the onset of flowering at 7 weeks after planting. Routine cultural practices were carried out. Weeding was done four times physically with the hoe to reduce intra and inter specific weed competition.

Harvesting was done when the pods were of sizeable length between 8 and 15 cm long. Data collected includes plant height, number of leaves, fresh and dry weight of plant, fruit number. Data collected were subjected to analysis of variance (ANOVA) and means were separated using Duncan Multiple Range Test (DMRT).

Storage

Freshly harvested, wholesome fruits from the experimental plot were randomly selected from each treatment plot according to uniformity of size, freedom of disease and defect. The fruits were rinsed with water to remove sand, mud particles and insect eggs. They were then air-dried and packed in a perforated polyethylene bag of size 30 cm long and 18 cm wide in dimension with holes between 0.5 and 2.0 cm. A total of about 15 fruits were packaged in each polyethylene bag and replicated 3 times. The fruits were weighed and placed in refrigerator at a temperature of 4^0C, RH 58-62%, ambient at a temperature 27.8^0C, RH 40-45%. The experimental design was complete randomised design replicated three times. Visual observation was made at 3 days interval. The parameters measured were:

Weight loss: The fruits were rinsed to remove soil particles and then air dried. Fruits in each replicate were weighed at the beginning of the experiment using an electronic balance and then at three days interval during the storage period. The percentage changes in weight were calculated.

$$\frac{\text{Loss in weight}}{\text{Original weight}} \times 100$$

Firmness: Visual observations were made at three days interval by hand feel to determine the level of firmness of pepper fruit. The firmness was rated using the following scale. Not firm =1; slightly firm = 2; Firm =3; very Firm = 4. (Babatola *et al*, 2002).

Disease incidence: Visual observation was made at three days interval to determine the level of decay using a scale of 1-4. (1 = wholesome, 2 = slightly infected, 3 = moderately infected, and 4 = highly infected). (Babatola *et al*, 2002)

Fruits were also randomly selected and taken to the laboratory for analysis to determine vitamins A, vitamin C, protein, and fat contents.

Results and Discussion

The soil physical and chemical properties were presented in Table 1. The soil is slightly acidic; nitrogen and phosphorus were below the critical level while potassium and sodium were within the range of the critical level. The ratio of sand, silt and clay observed in the experimental site according to USADA Textural Classification can be described as sandy loam soil.

Significant differences were observed in plant height, number of leaves and yield fresh and dry weight observed among the different level of fertilizer application rate (Table 2).

Table 2: Effect of Fertilizer Levels on Number of Leaves

FERTILIZER LEVELS (Kg/ha)	WEEKS AFTER PLANTING			
	4	6	8	12
0	6.0b	8.0c	10.0c	13.0d
300	8.0b	10.0b	12.0b	15.0b
450	8.0a	11.0a	13.0a	17.0a
600	6.0b	8.0c	10.0c	13.0c

Table 3: Effect of NPK Fertilizer Levels on Fresh and Dry Weight of Okra Plant

FRESH DRY WEIGHT	FERTILIZER LEVELS (Kg/ha)	LEAF	STEM	ROOT
Fresh	0	3.5c	11.3d	5.7c
Dry		1.3d	2.2d	1.3c
Fresh	300	17.3b	231.1b	44.6b
Dry		4.7b	57.2b	11.8b
Fresh	450	47.2a	368.0a	42.7a
Dry		12.0a	105.1a	13.0a
Fresh	600	11.1b	22.9c	14.6c
Dry		3.6b	10.5c	4.6b

The result indicated that 450 kg/ha of NPK fertilizer application rate gave the best response in terms of growth and yield. This may be attributed to the inherent status of the soil. This implies that adequate condition of the nutrient needed to achieve significant response was supplied by 450 kg/ha NPK fertilizer as observed by Alasiri *et al.* (1999) who reported a significant increase in the yield of okra on Fadama land when 60kg N/ha N.P.K. 20-10-10 was supplied.

The higher rate of 600 kg/ha gave the least response, this might be due to nutrient imbalance in the soil nutrient status which is detrimental to growth and yield. This observed trend indicated that appropriate fertilizer use and dosage enhance good plant vigour and performance 300 kg/ha NPK fertilizer rate gave a significant increase in performance compared to the control as regards. Plant height, number of leaves dry matter accumulation and yield. The estimate growth and yield response of okra to different fertilizer levels could be represented as follows: 450 kg/ha > 300 kg/ha > 600 kg/ha > 0 kg/ha. The postharvest study revealed that the different fertilizers levels had no significant effect on the disease incidence and firmness of okra fruit. Increasing fertilizer level significantly increases the percentage weight loss of okra fruit (Table 4).

TABLE 4: Effect of NPK Fertilizer Levels on Weight Loss, Firmness and Disease Incidence

	STORAGE METHOD	FERTILIZER LEVELS	DAYS IN STORAGE						
			3	6	9	12	15	18	21
% Weight Loss	Cold	0	5.1	9.0	10.8	15.9	20.0	22.0	30.0
	Ambient		7.1	9.9	16.0	19.0	20.7	23.0	24.0
	Cold	300	8.4	10.0	12.2	18.1	21.3	23.4	24.6
	Ambient		9.2	11.6	16.0	20.7	22.0	24.0	24.6
	Cold	450	9.0	11.4	13.0	19.3	22.0	24.0	24.7
	Ambient		10.0	12.1	18.1	21.0	23.0	24.7	25.0
	Cold	600	9.5	11.6	13.4	19.6	22.6	24.5	24.9
	Ambient		10.3	12.4	18.3	21.3	23.6	24.6	24.9
Firmness	Cold	0	3.7	3.7	2.7	2.7	1.7	1.7	1.0
	Ambient		3.7	2.7	1.7	1.7	1.0	1.0	1.0
	Cold	300	3.7	3.7	2.7	2.7	1.7	1.7	1.0
	Ambient		3.7	2.7	1.7	1.7	1.0	1.0	1.0
	Cold	450	3.7	3.7	2.7	2.7	1.7	1.7	1.0
	Ambient		3.7	2.7	1.7	1.7	1.0	1.0	1.0
	Cold	600	3.7	3.7	2.7	1.7	1.7	1.0	1.0
	Ambient		3.7	2.7	1.7	1.0	1.0	1.0	1.0
Disease Incidence	Cold	0	4.7	4.7	4.7	3.7	3.7	2.7	2.7
	Ambient		4.7	4.7	3.7	3.7	2.7	2.7	1.7
	Cold	300	4.7	4.7	4.7	3.7	3.7	2.7	2.7
	Ambient		4.7	4.7	3.7	3.7	2.7	2.7	1.7
	Cold	450	4.7	4.7	4.7	3.7	3.7	2.7	2.7
	Ambient		4.7	4.7	3.7	3.7	2.7	2.7	1.7
	Cold	600	4.7	4.7	3.7	3.7	2.7	1.7	1.7
	Ambient		4.7	4.7	3.7	3.7	2.7	1.7	1.7

Cumulative weight loss of okra fruits were significantly reduced in the refrigerator compared to samples stored at the ambient atmosphere. The lower weight loss that coincided with decrease in storage is in agreement with the findings of several previous researchers (Du, *et al*, 2007). This could be attributed to slow down of physiological processes such as respiration and transpiration that occur at low temperature (Davey *et* al, 2000). The extension of shelf life of okra fruit at lower temperature may be attributed o the combined effects obtained under the refrigerator.

Table 5: Effect of NPK Fertilizer Levels on Vitamins, Protein and Fat Content of Okra Fruit

DAYS IN STORAGE	FERTILIZER LEVELS	STORAGE METHOD	Vit. C (mg/kg)	Vit. A (mg/kg)	Fat (%)	Protein (mg/kg)
3	0	Cold	207.7	288.7	1.6	21.3
		Ambient	196.1	276.1	1.2	20.9
	300	Cold	215.8	296.5	1.8	22.4
		Ambient	210.2	280.6	1.2	21.3
	450	Cold	229.9	380.0	2.0	25.0
		Ambient	216.2	347	1.3	23.4
	600	Cold	230.0	395.8	2.0	28.4
		Ambient	221.1	359.1	1.8	27.1
6	0	Cold	202.3	200.6	1.1	19.2
		Ambient	193.1	193.2	1.0	18.3
	300	Cold	210.6	251.5	1.3	20.5
		Ambient	198.1	243.1	1.2	19.2
	450	Cold	217.3	286.5	1.1	21.5
		Ambient	211.5	271.8	1.2	20.1
	600	Cold	220.6	312.2	1.4	24.3
		Ambient	218.2	289.2	1.2	22.4
9	0	Cold	161.0	182.6	0.9	17.3
		Ambient	151.6	161.5	0.6	16.2
	300	Cold	196.1	215.4	1.0	19.4
		Ambient	162.2	197.3	1.0	18.7
	450	Cold	189.3	241.3	1.2	20.3
		Ambient	171.3	215.4	1.1	19.1
	600	Cold	192.5	296.1	1.1	23.1
		Ambient	182.4	256.2	1.2	21.3

Increase in fertilizer levels had no significant effect on vitamins, protein and fat content of okra fruit. Increase in the length of storage results in increase in weight loss and disease incidence of okra fruit and also increase in degradation of vitamins, fat and protein content. Fruits stored under the ambient condition were observed to decay rapidly in less than 2 weeks compared to fruits stored under the cold storage at the temperature of 4^0C and relative humidity of 40-45 % RH which remain fresh and free from disease at two weeks under the cold condition. Fruits stored under ambient condition, especially okra, can only be on subsistent level but for sustainable agriculture and improved increase in supply adequate storage method that can easily be handled by farmers is important. Thus, scientists in the developing countries are faced with the challenges of providing empirical data on the appropriate fertilizer levels required for the best eating quality in vegetable and fruit, the best storage method to meet commercial demand of these produce. Cold storage preserves better, based on the result the following conclusions can be drawn. The application rate of 450 kg/ha gave the best response in yield and growth of okra.

References

Alasiri, K.O. and O.O. Ogunkeye. 1999. Effect of different levels of poultry manure on seed yield of Okra. Proceedings 25th Annual conference of Soil Science Society of Nigeria, 21st – 25th November, 1999. Benin, Nigeria

Akinfasoye, J.A. and E.I. Nwanguma, 2005.Vegetative growth of telfaria occidentalis Hoof, F and staking pattern in telfaria/okra intercrop in a valley bottom dry season cultivation. Proceedings of the Horticultural Society of Nigeria Annual Conference, Sept. 18-22, Port Harcourt, pp: 67-71.

Babatola L.A., and O.B. Adewoyin (2002): Effect of N.P.K Fertilizer levels on yield of okra-sweetcorn inter crop and postharvest quality of okra fruit. Hortson proc. 2002.pg 74-78.

Babatola L.A., and O.B. Adewoyin (2006): Effect of Storage Condition on Nutrient Composition and Quality of *Capsicum frutescens*. Nigerian Journal of Horticultural Society of Nigeria.

Davey M.W., Van Montagu M., Inz'e D., Sammartin M., Kanellis A., Smirnoff N. Benzie I.J.J. Strain J.J., Favell D. Fletcher J. (2000): Plant L-ascorbic acid: chemistry, function, metabolism, bioavailability and effects of processing. J. Sci Food Agric 80:825-86.

Du J., Fu. M, Li M. Xia W. (2007): Effects of chlorine dioxide gas on postharvest physiology and storage quality of green bell pepper (*Capsicum frutescens* L. var longrum). Agricultural science in China 6(2) 214-219.

Schippers, R.R., (2000): African Indigenous Vegetables an Overview of Cultivated Species. Natural Resources Institute, Chatham, UK., pp: 89-98.