

# Nutritional Evaluation of Okra Pod and Mother Soil as Influenced by Sawdust Ash, Ammonium nitrate and NPK

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**Abstract** The demand for okra usually exceeds what is being produced in Nigeria. Poor soil fertility due to soil degradation partly accounts for the low yield of the crop. Inorganic and organic fertilizers have been found to effectively replenish soil nutrients' losses. Hence this study aimed at carrying out the nutritional evaluation of okra pod and mother soil as influenced by sawdust ash (SDA) on soil properties and okra pod nutrients when used alone or combined with Ammonium nitrate or NPK. There were ten treatments replicated three times in a Randomized Complete Block Design. Treatments were applied three weeks after planting by ring method with NPK or Ammonium nitrate and SDA mixed. The test soil indicated that it was marginal in organic matter, inadequate in available P and slightly acidic. Sole SDA increase the soil P relative to control and sole use of Ammonium nitrate or NPK in 2016. SDA and its combination with NPK or Ammonium nitrate increased soil N, available P, exchangeable K, Ca, and Mg in 2015. SDA alone with its varying combination with Ammonium nitrate and NPK increase the leaf N, K, Ca, P, Mg contents. Addition of SDA to chemical fertilizer such as NPK or Ammonium nitrate increases the soil and plant nutrients and also had liming effects.

**Keywords** Okra, Pod, Soil, Sawdust Ash, Ammonium nitrate, NPK

## 1. Introduction

In many developing countries, farmers have limited financial resources and can rarely afford to purchase sufficient mineral fertilizer. The use of synthetic fertilizers is beyond the reach of peasant farmers due to their cost and scarcity. Crops have become so expensive to grow that nutrient deficiencies should not be allowed to limit the yields. Common crop management practices such as continuous cropping and reduced fallow periods, can hardly support

sustainable cropping. The need therefore, arises for production practices that will ensure high yield.

Okra (*Abelmoschus esculentus* (L.) Moench) is a popular vegetable grown for its pods and leaves. It has been found that continuous use of nitrogen fertilizer increases soil acidity and reduces nutrient uptake and yield of okra [7, 8]. Okra cultivation and production has been widely practiced because of its importance to the economic development and can be found in almost every market in Africa. Varieties vary by plant height, size of fruit, colour, early or late maturing etc., namely white velvet, green velvet, long fruit, lady finger, dwarf green fruits [35].

Okra is a native of tropical parts of Africa but now being widely grown and spread throughout the tropics, sub-tropics and even warmer temperate areas. Okra is an erect, coarse annual crop growing up to between 1m and 2m, resembling other mallows. The leaves are large, alternate, cordate and divided into 3-7 lobes with toothed margins; reaching about 30cm in length and generally hairy [1]. Okra requires a moderate rainfall of 80 -100 cm well distributed to produce its young edible fruits over a relatively long period. An average temperature of 20°C to 30°C is considered optimum for growth, flowering and fruiting [3]. Soil type does not appear to influence growth or development to any marked extent as a wide range of soil types has been found suitable for its growth. In Nigeria, production is mainly during the warm season, although it can be grown all the year round depending on the varieties [2].

Okra plays an important role in the human diet by supplying carbohydrate, protein, fats, minerals and vitamins that are usually deficient in some staple foods [2]. The nutritional importance of okra pod has re-awakened interest in bringing the crop into commercial production [21]. Okra has the advantage of being agronomically suitable for intercropping with most arable crops [19]. With respect to climatic requirements, okra is noted for being tolerant in many parts of Nigeria where the climatic conditions are not suitable for the cultivation of other vegetable crops [13]. Okra is usually available fresh year-round in the South

western part of Nigeria and from May to October in many other areas. Okra has both domestic and industrial applications [3, 32].

Okra contains 86% of water, 2.2% of protein, 10% of carbohydrate, 0.2% of fat and vitamins A, B and C. [15] documented that okra is consumed throughout Nigeria. Okra is in high demand particularly in rural villages and in the drier regions where a slimy vegetable is needed as an accompaniment to the often coarse and staple food such as millet, garri and others. In Nigeria, okra is grown for its fruits which are used in the preparation of different kinds of soups with or without other condiments [18].

[1] stated that okra contains high amount of protein, oil, vitamins and minerals which has given it high markets demand that calls for good and better varieties to meet the population demand. The role of organic wastes as sources of plant nutrients and as amendment to improve soil quality parameters cannot be overemphasized. [31] reported the role of organic manure for sustaining the fertility of the soil to enhance the performance of vegetables and for binding the fine soil particles together, thereby preventing erosion and leaching in agricultural soil.

Ash derived from burnt plant residue is a source of plant nutrients [4; 27] which can be used alone or in combination with N-rich chemical fertilizer or organic manure such as that of goat and poultry. The majority of the Southern Sudan recognizes that accumulations of wood ash provide valuable sites for cultivating ecologically specialized plants. Soils in the area are largely acidic, so K. can become a limiting factor. With no synthetic fertilizer available, wood ash has a clear and significant effect on the growth and yield of many crops [33]. Ash is composed of many major and minor elements needed by the tree for plant growth. Since most of these elements are extracted from the soil and atmosphere during the tree's growth cycle, they are elements that are common in our environment and are also essential elements in the production of crops and forages.

Wood ash contains nutrients which are readily available to plants and this raises the possibility of using it as fertilizer. [17] in the South West Nigeria found positive response of yield and nutrients contents of amaranthus and okra to application of wood ash treatments. In another study [26] found that application of 2, 4, 6, and 8 t/ha wood ash treatments increased okra fruit count and weight, soil organic matter, N, P, K, Ca and Mg contents and leaf N, P, and K contents. Another investigation was carried out [28] to investigate the effectiveness of wood ash fertilizer on maize grown under a humid tropical condition. Wood ash was applied at 0, 2, 4, 6 and 8 t ha<sup>-1</sup> to maize crops. Wood ash increased soil organic matter content pH, N, P, K Ca and Mg contents. Wood ash treatments increased maize plant height, ear and grain weight significantly.

There is scarcity of published work on integrated use of wood ash and chemical fertilizers in improving the yield of crops and soil fertility [4]. The integrated application of

organic and inorganic nutrient sources rather than total dependence on any of the sources is expected to ensure reduction in expenditure on chemical fertilizers, a more balanced plant nutrition and control of soil acidity. Since sawdust ash is a waste which poses environmental concern, its combined use with chemical fertilizer in crop production will assist in environmental sanitation

Due to increasing number of saw milling industries in Nigeria, sawdust is being daily generated and burnt. There is urgent need to study the use of sawdust ash waste for soil improvement and as fertilizer and liming material. Hence, the objective of this study is to evaluate the effect of combined application of Sawdust ash and its combined application with Ammonium nitrate and NPK fertilizer on the growth and pod yield of okra plant nutrients composition and okra nutritional quality.

## 2. Materials and Methods

Field experiments were carried out at the Teaching and Research Farm of The College of Education, Lanlate (formerly Emmanuel Alayande College of Education, Oyo, Lanlate Campus), Southwest, Nigeria in 2015 and 2016 cropping seasons to study the effects of Sawdust Ash (SDA) on soil and okra pod nutrients composition when used alone or combined with Ammonium nitrate and NPK. Lanlate lies between latitude 7° 30' N and Longitude 3° 52' E in the tropical rainforest belt of Nigeria. There are two rainy seasons; one from April to July (early season) and the other from mid-August to November (late season). Annual average minimum and maximum temperatures are 24.80°C and 28.10°C respectively. The mean relative humidity is about 75%. The soil at the site is classified as an alfisol (Oxic tropudalf) according to [6]. There were ten treatments replicated three times in a Randomized Complete Block Design. Treatments were applied three weeks after planting by ring method with NPK or Ammonium nitrate and SDA mixed.

Surface (0-15 cm) soil samples were taken before the commencement of the experiments (initial soil analysis) and twelve weeks after treatment application. Immediately after collection of surface soil samples using steel auger, samples were bulked for each year, air-dried and allowed to pass through 2mm sieve for analysis as outlined by procedures of [34]. Total N was determined by Kjeldahl method, P by molybdenum blue colorimetry while K, Ca and Mg extracted with ammonium acetate pH 7.0 extractant after which the exchangeable K was evaluated using flame photometer while Ca and Mg were evaluated by EDTA titration. Soil pH in water was determined using pH meter in 1: 2 soil water ratio medium. Organic carbon and organic matter was determined using Walkley Black dicromate method (1934) as modified by [22].

Leaf samples collected at 10 weeks after treatment application in each plot, were oven dried at 70°C for 24

hours. Ground samples of the leaves were analysed for N using micro Kjeldahl digestion method. Moreover, samples were digested with nitric – perchloric acid mixture for determination of P, K, Ca and Mg (IITA, 1979). The P was determined using molybdenum blue colorimetry, K by flame photometer, while Ca and Mg by EDTA titration [20]. Data were analysed using Analysis of Variance (ANOVA) to determine the effects of treatments on the parameters measured. Duncan Multiple Range Test was used to compare the treatment means.

### 3. Results

Analytical data of pre-cropping surface soil at the site of experiment are shown in table 1. The test soil was marginal in organic matter (OM), adequate in Nitrogen, Calcium, Magnesium and Potassium but inadequate in Phosphorus and slightly acidic [11]. Therefore the soil requires application of fertilizing amendment that will particularly supply P for enhancing okra.

**Table 1.** Initial soil analysis of experimental site at Lanlate

Properties	Values	
	2015	2016
pH (H <sub>2</sub> O)	6.50	6.60
Organic Matter (g/kg)	28.0	26.9
Total nitrogen (N) g/kg	3.20	2.80
Available phosphorous (P) (mg/kg)	8.80	9.10
Exchangeable calcium (cmol/kg)	7.31	6.35
Exchangeable magnesium (Mg) (cmol/kg)	2.50	2.40
Exchangeable sodium (Na) (cmol/kg)	1.60	1.70
Exchangeable potassium (K) (cmol/kg)	0.30	0.35
Sandy (g/kg)	878.0	875.0
Silt (g/kg)	54.0	56.0
Clay (g/kg)	68.0	69.0
Texture	loamy sand	

**Table 2.** Effects of Saw dust, Ammonium nitrate, NPK Fertilizers and their combinations on Soil Nutrient Composition in Lanlate (2015)

Experiment	pH	OM	N	P	K	Ca	Mg
		(%)	(%)	(mg/kg)	(cmol/kg)	(cmol/kg)	(cmol/kg)
Control	5.74b	0.46f	0.11d	11.02h	0.15c	0.43f	0.47e
100% SDA	5.92a	0.27g	0.11d	13.48g	0.30a	5.47b	3.63a
100% NPK	5.82ab	1.59c	0.23a	38.54a	0.26b	0.42f	0.16f
25% SDA + 75% NPK	5.83ab	3.80a	0.17b	35.47b	0.24b	7.07a	1.65bc
50% SDA + 50% NPK	5.96a	2.68b	0.14cd	32.38c	0.32a	5.56b	1.44cd
75% SDA + 25% NPK	5.99a	2.38b	0.12d	28.48d	0.38a	3.73d	1.57c
100% AN	5.72b	0.64ef	0.15c	10.66h	0.14c	2.10e	1.03d
25% SDA + 75% AN	5.83ab	0.89d	0.12d	20.51e	0.23b	4.80c	2.00b
50% SDA + 50% AN	5.85ab	0.79e	0.17b	15.61fg	0.24b	4.93c	1.20d
75% SDA + 25% AN	5.83ab	0.89d	0.17b	17.2f	0.24b	4.80c	2.00b

Means in the same columns not followed by same letters are significantly different at 5% level of significance by Duncan's Multiple Range Test (DMRT).  
Keys : AN - Ammonium nitrate, NPK - Nitrogen Phosphorus Potassium, SDA – Sawdust Ash

**Table 3.** Effects of Saw dust, Ammonium nitrate, NPK Fertilizers and their combinations on Soil Nutrient Composition in Lanlate (2016)

Experiment	pH	OM	N	P	K	Ca	Mg
		(%)	(%)	(mg/kg)	(cmol/kg)	(cmol/kg)	(cmol/kg)
Control	5.79b	0.75e	0.11b	7.21g	0.17bc	1.77d	0.67
100% SDA	6.00a	0.87e	0.10b	43.56b	0.19bc	3.23bc	1.37a
100% NPK	6.15a	1.78c	0.34a	29.21d	0.35a	0.50e	0.18
25% SDA + 75% NPK	5.90ab	3.34a	0.16b	33.67c	0.20b	6.27a	1.37a
50% SDA + 50% NPK	6.13a	2.48b	0.14b	30.33cd	0.25b	5.10ab	1.30a
75% SDA + 25% NPK	6.00a	2.24b	0.12b	26.18e	0.32a	3.63bc	1.35a
100% AN	5.72b	0.67e	0.10	17.71f	0.19bc	2.60c	1.03
25% SDA + 75% AN	5.90ab	1.10d	0.16b	51.93a	0.19bc	3.20bc	1.33a
50% SDA + 50% AN	5.88b	1.66c	0.12b	49.26ab	0.11c	2.33c	0.97c
75% SDA + 25% AN	5.86b	1.23d	0.11b	33.60c	0.18bc	4.60b	1.17b

Means in the same columns not followed by same letters are significantly different at 5% level of significance by Duncan's Multiple Range Test (DMRT).  
Keys : AN - Ammonium nitrate, NPK - Nitrogen Phosphorus Potassium, SDA – Sawdust Ash

**Table 4.** Effects of Saw dust, Ammonium nitrate, NPK Fertilizers and their combinations on Okra Pod Nutrient Composition in Lanlate (2015)

Experiment	N	P	K	Ca	Mg
	(%)				
Control	1.90b	0.03e	0.46c	0.36c	0.05
100% SDA	3.20a	1.20b	1.06a	0.75b	0.22
100% NPK	1.24c	0.30d	0.79b	1.02a	0.18
25% SDA + 75% NPK	1.38ab	0.28d	0.73b	0.83ab	0.12
50% SDA + 50% NPK	1.41ab	0.28d	0.75b	0.99a	0.13
75% SDA + 25% NPK	1.31ab	0.31d	0.78b	1.14a	0.13
100% AN	2.44ab	1.86a	0.40c	0.64	0.14
25% SDA + 75% AN	1.93b	0.89c	0.34c	0.77b	0.11
50% SDA + 50% AN	2.38ab	1.09b	0.34c	0.92a	0.19
75% SDA + 25% AN	2.56ab	1.25b	0.40c	0.81ab	0.16

Means in the same columns not followed by same letters are significantly different at 5% level of significance by Duncan’s Multiple Range Test (DMRT).  
 Keys : AN - Ammonium nitrate, NPK - Nitrogen Phosphorus Potassium, SDA – Sawdust Ash

**Table 5.** Effects of Saw dust, Ammonium nitrate, NPK Fertilizers and their combinations on Okra Pod Nutrient Composition in Lanlate (2016)

Experiment	N	P	K	Ca	Mg
	(%)				
Control	1.92b	0.76b	2.97b	0.80b	1.74b
100% SDA	2.47ab	1.83a	3.26a	1.74a	2.18a
100% NPK	3.69a	0.35c	2.86b	0.37c	0.13c
25% SDA + 75% NPK	1.26c	0.29c	0.70c	1.11b	0.12c
50% SDA + 50% NPK	1.34c	0.26c	0.72c	0.90b	0.11c
75% SDA + 25% NPK	1.31c	0.22c	0.70c	0.84b	0.11c
100% AN	2.53a	0.83a	3.28a	0.64c	0.14c
25% SDA + 75% AN	2.53a	0.87a	0.33d	0.49c	0.11c
50% SDA + 50% AN	2.29ab	0.86a	0.29d	0.87b	0.19c
75% SDA + 25% AN	2.59a	0.87a	0.29d	0.68c	0.16c

Means in the same columns not followed by same letters are significantly different at 5% level of significance by Duncan’s Multiple Range Test (DMRT).  
 Keys: AN - Ammonium nitrate, NPK - Nitrogen Phosphorus Potassium, SDA – Sawdust Ash

### 4. Discussion

The SDA, Ammonium nitrate and NPK and their combination increased soil N, P, K, Ca and Mg significantly. The combinations also increase organic matter (OM). The effect of ammonium nitrate in increasing the nutrients can be adduced to associated increase in OM (Table 2 and 3). The increase in soil nutrients due to application of SDA is constant with earlier findings [4, 16] and the fact that ash is an effective source of OM and micronutrients [31, 2] for increasing crop performance [29]. Hence it is observed in this study that combination of SDA and Ammonium nitrate had higher values of soil N, P, K, Ca and Mg especially in 2015 due to nutrients supply from the two sources and the fact that SDA gave highest values of soil K, Ca and Mg which thereby giving it liming effects. Organic fertilizers have beneficial effect on nutrient composition, structural aggregation, infiltration, microbial and other biological activities of the soil; this and with a host of others will subsequently improve okra

production particularly in the tropics.

Aside from its liming effect, it was found in the present work that SDA significantly increased soil P, K, Ca and Mg. this is consistent with analysis data given for the material which show that it contained macronutrients. Wood ash and other types of plant derived ashes were also found to increase organic matter, N, P, K, Ca and Mg in soil which were made available for uptake of crops such as cocoa [14]. Field experiments carried out in South-West Nigeria have shown positive response of yield and nutrients contents of amaranthus and okra to application of wood ash as reported by [17]. Application of 2, 4, 6, 8 tons/ha ash increase okra pod and weight [27]. For the planting of pepper and other vegetables in Eastern Nigeria at household levels, the use of poultry droppings, cow dung, wood ash and composted residues for improving soil fertility has been adopted. Other studies [25, 12, 36; 24] carried out in parts of Africa found that plant derived ash increased P, K, Ca, Mg status of soil, pH and yield of vegetables. Studies

carried out earlier by the researcher in southwest Nigeria showed that sawdust ash and Ammonium nitrate fertilizer at 1.5t/ha SDA + 180kg/ha U increased the grain yield of sorghum [5].

In terms of nutrients uptake, SDA alone or with combined with Ammonium nitrate or NPK was found to increase P, Ca and Mg concentrations significantly in okra plant. Its combined use at 50% SDA + 50% AN and 50% SDA + 50% NPK significantly increased plant P and Ca. The latter combination also gave highest plant N and P among combined treatments. This affirms that SDA is a source of nutrients for crop uptake. [23, 9, 10].

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