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Original Research

Quality Implications of Marketed Brands of NPK 20:10:10 Fertilizer on Maize (*Zea mays)* Performance and Residual soil Chemical Properties

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ABSTRACT: Anecdotal evidence in Nigeria establishes that there is limited enforcement of fertilizer standards and high prevalence of poor-quality fertilizers. A field study was initiated at the Research and Demonstration Farms of Enugu State Polytechnic Iwollo, Ezimo Campus and University of Nigeria Nsukka, to comparatively evaluate the effects of three brands of NPK 20: 10:10 fertilizer locally called Federal, Ebonyi, and Kano on maize performance and soil chemical properties. The fertilizers and a control were laid out in a randomized complete block design (RCBD) with three replications. The fertilizer samples were analyzed for N, P, K contents while residual soils were analyzed for pH, OM, N, P, and K. Hybrid maize (Oba super II) were grown in both locations. Data were collected on their growth and yield traits. Results revealed that, contrary to the labeled nutrient grade -NPK 20:10:10 on the fertilizer brands, they were, NPK 15:8:7; 14: 8:7 and 7:7:8for Federal, Ebonyi and Kano respectively. The difference in nutrient grades reflected in the performance of the plants as Federal significantly ($p<0.05$) produced plants that were superior in height (123.3 cm), stem girth (7.6cm),number of leaves (13), biomass weight (370g plant^{-1}), cob weight (146.2g plant^{-1}), grain weight (4.63tha $^{-1}$) and 100 seed weight. The fertilizer brands did not differ significantly with control in residual soil chemical properties. The study highlights the need for a brand specific test and recommendation of inorganic fertilizers prior to application and for fertilizer regulatory agencies to intensify efforts in enforcing standards.

Keywords: NPK 20:10:10, fertilizer quality, brand, maize yield, soil chemical properties
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INTRODUCTION

Soil fertility is one of the main biophysical factors influencing food quantity and quality (Panpatte and Jhala, 2019). Over time, harvested crops remove far more nutrients that can be supplied by soil ecosystems and as such leads to rapid depletion of soil nutrients. According to Bekunda *et al.,* (1997) increased deficiencies of N, P, and other nutrients can be expected as a result of intensive cultivation and unbalanced fertilizer use. Nutrient depletion in soils adversely affect soil quality, reduces crop yield and consequently pose a potential

threat to global food security and agricultural sustainability.

Application of supplementary fertilizer is necessary to replenish the soil with nutrients especially with the practice of intensive agriculture coupled with the introduction of higher-yielding and more nutrient demanding crop varieties. Restoration of the nutrients can be accomplished by application of organic materials or inorganic fertilizers. Inorganic fertilizers however, have the advantage of supplying high levels of low-cost essential nutrients which helps in sustaining soil fertility, increase crop yield and mitigate climate change by sequestration of carbon (Shrestha *et al*., 2013).

Commercial competitions coupled with other factors have resulted in a multiplication of fertilizer types whose quality cannot be guaranteed (Liverpool-Tasie *et al* 2010). Fertilizer sold under a given name is required to contain specified percentages of nutrient elements as prescribed by law or declared by the manufacturer. Despite government-endorsed fertilizer recommendations and quality regulatory processes (Islam *et al*, 2022) with numerous and diverse participants, fertilizer quality remains a challenge in Nigeria. Small scale farmers and researchers alike, rarely examine fertilizer quality before use but rather trust the information supplied by the producers. Low quality of blended NPK fertilizer may show deficiency or excess of N, P or K, as well as a relative imbalance, such as high levels of one nutrient combined with low levels of the other nutrients (Li *et a*l. 2019). Such lack or excess or inappropriate ratios of N, P and K fertilizer can affect the absorption and utilization of nutrients and reduce crop yield and quality.

Globally, farmers are promoting and applying balanced fertilization approach to ensure application of appropriate nutrients based on crop requirements and soil fertility performance. However, this is challenged by poor quality and grade of fertilizers supplied. Ezui *et al*. (2016) reported an average benefit: cost ratios of 2.4 ± 0.9 for blanket fertilizer recommendation compared to 3.8 ± 1.1 for the balanced fertilizer rates. At balanced nutrition, the indigenous soil supply of nutrients revealed that K was the most limiting nutrient to achieve storage cassava root yields up to 8 Mg dry matter ha^{-1}, whereas N and P were needed at greater yields.

Unbalanced fertilization may lead to depletion in soil fertility through nutrient losses (Cassman *et al*., 2002), reduced crop use efficiency which subsequently diminish productivity and profitability of the farm (Angus *et al.,* 2004), and cause environmental pollution. Chemically unbalanced NPK fertilizer ratios result in soil acidification (Chen, 2006), loss of organic matter, deterioration of soil structure, and reductions in biological activities and fertility (Zhong, 2007). Use of fertilizers with excessive nitrogen could lead to a significant increase in nitrate nitrogen content in groundwater (Akbariyeh *et al.,* 2018), and when application rate exceeds180 kg ha^{-1}, N_2O production increases significantly(Nan *et al.,* 2016).

Yin *et al.* (2019) observed that different N, P, and K combinations significantly affect both yield and yield components, and a model established regression analysis demonstrated that yield and yield components were more sensitive to N and K fertilizer than to P fertilizer. They also reported a significant ($P<0.05$) interaction effect of N, P, and K fertilizers on yield, number of pods per plant and 100-seed weight. However, the interactions between P and K fertilizers had no significant ($P>0.05$) effect. Yousaf *et al*. (2017) compared effects of four mineral fertilizers (NPK, NP, NK and PK). They found that rice grain yield increased by 19–41%and 61–76% in rapeseed under NPK fertilization compared to PK fertilization across the study sites. Yield responses to fertilization were ranked NPK>NP>NK>PK. The highest and lowest N, P and K accumulations were observed under NPK and PK fertilization, respectively. Similarly, indigenous nutrient supply (INuS) of the soil decreased to a significant extent under NP, NK, and PK fertilization when compared to NPK.

Conventionally, soil tests are carried out before planting to obtain information concerning the native nutrient status of the soil, unfortunately, the inorganic fertilizer needed to correct the deficiency is often not tested but presumed to contain nutrients as stated by fertilizer manufacturers. This practice is a serious threat to crop productivity as any nutrient deficiency will affect both crop yield and quality, as well as crop use efficiency of other applied plant nutrients.

Fertilizer quality issues associated with inorganic fertilization have not been fully considered. Thus, there is need to emphasize brand specific fertilizer quality as supplied to farmers rather than blanket considerations, which are often erroneous.

Effective quality of fertilizers can only be ascertained through experimentation. Therefore, the objective of this study was to comparatively assess the NPK contents of three brands of blended NPK 20:10:10 fertilizer as marketed in Enugu state, Nigeria and their effects on soil chemical properties and maize performance. This study will promote effective and efficient fertilizer use and thus, increase farmers' economic returns from fertilizer, reduce adverse impacts of fertilizer on natural environment, ecological resources, and climate change.

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MATERIALS AND METHODS

Study Site

The study was carried out at the Research and Demonstration Farms of Enugu State Polytechnic Iwollo, Ezimo Campus and University of Nigeria, Nsukka. Ezimo lies within latitude 06^0 87' N and longitude 07^0 55' E,

having an annual mean rainfall of about 171.03mm, with annual low and high temperatures of 25.38 and 34.12 ^{0}C, respectively. Nsukka research field was located at latitude 06^0 25' N and longitude 07^0 24' E. It has an annual mean rainfall of about 165.79mm, with maximum and minimum mean monthly temperature of 26 to 33^{0}C and 19 to 22^{0}C respectively. The field studies were conducted during the rainy season of 2022 under similar experimental conditions.

Soil sample collection and analysis

Prior to planting, composite and core soil samples were collected from the top 20 cm of the soil in each location. After harvest, soil samples were collected from each plot according to treatment. The loose samples were air-dried and sieved through 2mm sieve for routine analysis using standard methods as described by Anderson and Ingram (1993 too old). The core samples were used to determine bulk density and saturated hydraulic conductivity, Residual soil samples were only analyzed for pH, organic carbon, N, P, and K contents.

Selection of fertilizer brands and their chemical (N, P, K) analysis

Five major fertilizer markets in Enugu state were purposively sampled and different brands of NPK 20:10:10 fertilizers displayed for sale were identified. Out of the lot, three most commonly used brands were selected and bought. The brands were locally known as Federal, Ebonyi and Kano. The fertilizer samples were tested for the content of nitrogen (N) using the Kjeldahl method (Anderson and Ingram, 1993), while available phosphorus (P_2O_5) and exchangeable potassium (K_2O) were determined using Inductively Coupled Plasma-Optical Emission Spectrometer (ICP-OES) as described by Sanabria *et al*. (2013).

Treatments and experimental design

The treatments -NPK 20:10:10 -Federal, Lagos, Kano and control were arranged in a randomized complete block design and replicated three times. The experimental fields were cleared, ploughed, harrowed and marked into plots measuring 4 x 5 meters (20 m^2) with 50 and 100 cm paths separating adjacent plots and blocks, respectively. Hybid maize variety ("Oba super 11") was used as test crop. Two maize seeds were sown per stand and later thinned to one seedling/stand at a spacing of 75 x 25 cm. Weeding was controlled chemically using pre-emergent herbicide (Premextra).

Treatment application

The treatments (NPK 20:10:10 fertilizer) were applied at the rate of 300Kgha^{-1} (which corresponds to the official recommendation of NPK fertilizer for maize in the area) in two splits: half at 4 weeks after planting and half later at tasselling using ring method.

Measurement of maize growth characteristics

At four weeks after planting (4 WAP), five plants in the middle rows of each plot were randomly selected and tagged for measurement of the following growth characteristics at 8weeks after planting (WAP): plant height, stem girth (mm) and. biomass (dry matter) weight per plant (g).

Measurement of yield traits

At 16 WAP, the sample plants were harvested and the following yield data were collected from the sample plants: cob weight (g), grain yield per hectare (tha^{-1}) and weight of 100 seeds (g).

Data Analysis and interpretation

Data obtained from analysis of fertilizer samples were subjected to descriptive statistical analysis while, data from field studies were subjected to Analysis of variance (ANOVA) test. Significant means were separated using the Fisher least significant difference (F-LSD$_{0.05}$) procedure at 0.05% level of probability.

RESULTS AND DISCUSSION

The physical and chemical properties of the soils taken prior to treatment application at Ezimo and Nsukka sites are shown in (Table 1). The soil in Ezimo was sandy loam in texture, slightly acidic (pH 6.9); with bulk density of 1.70 Mgm^{-3} and very high saturated hydraulic conductivity value of 35.85%. The nitrogen, phosphorus and potassium contents were 0.21%, 8.46 mgKg^{-1} and 0.08CmolKg^{-1}, respectively. While, Nsukka soil was sandy clay loam in texture, bulk density value of 1.68, slightly acidic (pH 6.6), N, P, K, values of 0.23%, 10.33 mgKg^{-1} and 0.11 CmolKg^{-1}, respectively. Both soils having high saturated hydraulic conductivity and porosity are likely to have high rates of water infiltration and poor aggregate stability. These conditions are expected to encourage leaching of plant nutrients and soil loss by erosion. With reference to the established critical levels, the soils were low in nitrogen and exchangeable potassium. The physical properties of the soils coupled with insufficient levels of N, P, K for maize production, made them suitable for a fertilizer trial like this one.

Properties of Federal, Ebonyi and Kano brands of fertilizer

Data related to the moisture and NPK contents of the

Table 1: Physico-chemical characteristics of the experimental soils.

Properties	Soil Values	
	Ezimo	**Nsukka**
Sand	77 gkg^{-1}	73 gkg^{-1}
Silt	8 gkg^{-1}	6 gkg^{-1}
Clay	15 gkg^{-1}	21 gkg^{-1}
Textural class	Sandy Loam	Sandy Clay Loam
Bulk density	1.70 Mgm^{-3}	1.68 Mgm^{-3}
Total porosity	35.85%	36.79%
Saturated Hydraulic Conductivity	21.61 Cm^3hr^{-1}	19.42` Cm^3hr^{-1}
pH	6.9	6.6
Organic Carbon	1.056%	1.372%
Nitrogen	0.210%	0.238%
Available Phosphorus	8.46 mg kg^{-1}	10.33 mg kg^{-1}
Potassium	0.08 cmol kg^{-1}	0.11 cmol kg^{-1}
Magnesium	1.20 cmol kg^{-1}	2.00 cmol kg^{-1}
Calcium	0.80 cmol kg^{-1}	6.00 cmol kg^{-1}
Sodium	0.92 cmol kg^{-1}	1.15 cmol kg^{-1}

fertilizer brands tested in this study are presented in (Table 2). Their mean moisture contents ranged from 16% in Kano to 22.6% in Ebonyi with Federal having 18%. Contrary to the Fertilizer manufacturer's guaranteed and labeled grade- NPK 20:10:10 upon analysis, the fertilizers were found to have mean NPK grades of 15:8:7; 14:8:7 and 7: 7:8 for Federal, Ebonyi and Kano respectively. They all failed short of the guaranteed nutrient content especially in nitrogen. Also, there was substantial variation in quality across brands.

Among the brands, major concerns were observed in Kano where the nitrogen content was just about 37% of the presumed content. This may have informed retailers' advice to mix it with urea.

This study did not establish the source of the quality deterioration in the supply chain but established that the minimum nutrient guarantee by the manufacturers were not valid. According to Sanabria *et al.* (2013) most nutrient deficiencies in blended fertilizers are due to granule segregation and/or insufficient nutrient inputs at the time of blending. When nutrients do not have uniform distribution in a fertilizer bag, it may become difficult to collect a representative sample for analysis. Similarly, poor quality may arise from poor storage, or adulteration.

Table 3 shows the effect of different brands of blended NPK 20:10:10 fertilizer on maize growth and yield traits. Soils fertilized with Federal brand produced plants that were significantly ($p<0.5$) superior in height (123.3 cm), stem girth (7.6cm), number of leaves (13), biomass weight (370g $plant^{-1}$), cob weight (146.2g $plant^{-1}$), grain weight (4.63tha^{-1}) and 100 seed weight (26.57g). Those grown in Ebonyi and Kano brand amended soils did not differ significantly with the control in plant height and number of leaves. Similarly, they did not differ significantly from each other in plant height, stem girth, number of leaves, biomass weight, cob weight, grain weight and 100 seed weight.

Visual observationsas shown in (Appendixes plates 1 and 2) also express the superiority of Federal and poor performance of the control plants.

The result reflected the variability in the nutrient composition of the fertilizer brands as shown in (Table 2). Higher maize grain yield recorded in Federal fertilized soil may be attributed to increased availability and supply of N, P, K. The higher nitrogen content of the Federal brand may have conferred on it, the superior influence on all the parameters. This result is in tandem with the findings of Osemwota *et al.* (2017) who in a study to evaluate the effect of variation in N:K ratio in soil on the yield, yield components and shelf leaf of white yam (Dioscorearotun data POIR) observed that N:K ratio with high rates of N favoured higher number of leaves, leaf area, vine length, vine girth and vine number when compared to N:K ratios with high rates of K. Li *et al.* (2019) observed a greater differential effect of N and K fertilizers on yield and quality of satsumas than those of P fertilizers. The poor performance of maize grown in control soil indicates that the soil was degraded and was in short supply of nutrients, thus required amendment for profitable crop production. The non- significant difference between Ebonyi and Kano brands in spite of the higher nitrogen content in Ebonyi may be attributed to the ratio of N in Ebonyi to either P or K.

The performances of these brands of fertilizer at different locations (Ezimo and Nsukka) are also shown in (Table 3). Their influence on stem girth, number of leaves and biomass weight did not significantly differ in both locations. The performance of Ebonyi brand in Ezimo site was significantly ($p<0.05$) higher in cob weight (142.5g $plant^{-1}$), grain weight (5.28 tha^{-1}) and 100 seed weight

Table 2: Percentage NPK in blended retail fertilizers sold in Enugu State.

Market location	Available Fertilizer Brand	Moisture Content (%)				Nitrogen (%)				Phosphate (% P_2O_5)				Potassium (% K_2O)			
		Mean	SD	Min.	Max.	Mean	SD	Min.	Max.	Mean	SD	Min.	Max.	Mean	SD	Min.	Max.
Adani	Federal	14.13	2.00	12.36	16.30	15.47	1.20	14.30	16.70	8.17	1.88	6.20	10.00	7.27	0.95	6.20	8.00
	Ebonyi	28.80	9.20	22.80	39.39	12.83	1.94	10.70	14.50	9.23	0.71	8.60	10.00	7.27	0.93	6.50	8.30
	Kano	16.97	0.92	15.92	17.65	5.97	1.83	3.90	7.40	8.20	1.85	6.30	10.00	7.93	1.20	6.70	9.10
Obollo afor	Federal	15.69	3.60	12.52	19.62	14.60	3.22	12.40	18.30	7.77	1.26	6.60	9.10	8.37	0.71	7.60	9.00
	Ebonyi	20.08	1.68	18.72	21.95	13.00	2.93	10.70	26.30	6.23	1.24	5.20	7.60	6.70	0.36	6.30	7.00
	Kano	10.97	2.35	8.70	13.40	6.87	0.06	6.30	7.50	6.57	0.95	5.60	7.20	8.53	1.68	6.70	10.00
Enugu	Federal	20.88	2.46	18.54	23.45	14.30	2.46	12.50	17.10	7.57	0.85	6.70	8.40	6.23	0.67	5.50	6.80
	Ebonyi	21.29	1.47	19.86	22.80	15.90	2.04	14.30	18.20	7.00	0.72	6.40	7.80	7.63	0.99	6.50	8.30
	Kano	17.89	5.34	12.86	23.50	7.73	2.00	5.80	9.80	6.40	0.82	5.50	7.10	7.10	0.75	6.30	7.80
Awgu	Federal	21.13	2.39	18.65	23.42	16.13	2.90	13.20	19.00	7.93	0.85	7.30	8.90	5.97	0.67	5.40	6.70
	Ebonyi	21.78	1.77	20.12	23.67	12.57	1.46	11.20	14.10	8.40	0.56	7.90	9.00	7.50	1.39	8.70	9.10
	Kano	14.64	2.30	13.28	17.30	7.58	0.93	6.50	8.30	7.03	1.42	5.40	8.00	6.97	0.75	5.60	8.10
Nsukka	Federal	18.84	1.98	16.56	20.12	16..27	1.61	15.10	18.10	6.87	0.40	6.50	7.30	6.37	0.87	5.40	7.10
	Ebonyi	20.97	2.24	19.21	23.50	15.43	2.11	13.10	17.20	8.07	0.35	7.70	8.40	7.80	0.50	7.30	8.30
	Kano	19.51	1.90	17.45	21.20	9.23	2.15	7.10	11.40	6.06	0.95	5.60	7.50	8.60	0.78	7.70	9.10
State Summary	Federal	18.13	3.61	12.36	23.45	15.35	2.19	12.4	19.00	7.66	1.09	6.20	10.00	6.84	1.12	5.4	9.0
	Ebonyi	22.58	4.97	18.72	39.39	13.95	2.34	10.7	18.20	7.79	1.27	5.20	10.00	7.38	0.87	6.3	9.1
	Kano	15.99	3.96	8.70	23.50	7.47	1.77	3.90	11.40	6.96	1.25	5.40	10.00	7.83	1.23	5.6	10

Table 3: Growth and yield performance of Maize as affected by three brands of NPK 20:10:10 at Ezimo and Nsukka.

Plant height (cm)			Stem girth (cm)	Number of Leaves	Biomass Weight g plant $^{-1}$	Cob Weight g plant $^{-1}$	Grain Weight Mgha^{-1}	100 Seed Weight (g)
Fertilizer								
Federal		123.3	7.67	13.37	370	146.2	4.63	26.57
Ebonyi		97.1	6.87	12.43	314	99.2	3.36	21.85
Kano		95.5	6.20	12.63	255	96.9	3.01	25.60
Control		87.5	5.23	12.90	160	44.2	1.35	16.37
F- LSD $_{0.05}$		15.50	0.558	0.785	61.2	25.33	0.959	4.46
Location	**Fertilizer**							
Ezimo	Federal	115.0	7.67	13.9	394	160.6	5.06	28.67
	Ebonyi	107.6	6.87	13.3	363	142.5	5.28	28.60
	Kano	91.1	6.67	12.5	273	99.1	3.03	25.60
	Control	99.5	5.20	13.5	182	68.9	2.23	25.33
Nsukka	Federal	131.5	7.07	12.8	346	131.8	4.20	24.47
	Ebonyi	86.6	6.07	11.5	264	56.00	1.43	15.07
	Kano	99.9	5.73	12.7	238	94.70	2.99	20.87
	Control	75.5	5.27	12.3	138	19.50	0.47	7.40
F- LSD0.$_{05}$		21.91	NS	NS	NS	35.83	1.356	6.307

F- LSD $_{0.05}$ = Fisher's Least Significant Difference at 5% level of probability, NS = non-significant at 5 % level of probability.

(28.6g) cob weight than that of Nsukka. Similarly, the control soil at Ezimo significantly ($p<0.05$) produced taller plant (99.5cm) with greater cob weight (68.9plant^{-1}), gain weight (2.23tha^{-1}) and 100 seed weight (25.6g) than that of Nsukka. These differences observed may be explained by the differences in endogenous soil nutrients and climatic variables at both locations. On the other hand, application of Ebonyi fertilizer brand at

Table 4: Residual soil chemical properties as affected by application of three brands of NPK fertilizer at Ezimo and Nsukka..

pH (H_20)			Organic matter %	Nitrogen (%)	Available Phosphorus ($mgKg^{-1}$)	Exchangeable Potassium ($mgKg^{-1}$)
Fertilizer brand						
Federal		6.73	1.85	0.18	8..24	2.73
Ebonyi		7.03	1.59	0.22	9.16	2.34
Kano		6.70	1.74	0.20	7.29	2.34
Control		6.75	1.87	0.21	9.16	3.12
F- $LSD_{0.05}$		NS	NS	NS	NS	NS
Location	**Fertilizer**					
Ezimo	Federal	6.75	1.15	0.15	4.27	0.045
	Ebonyi	7.15	1.00	0.20	5.67	0.04
	Kano	6.60	1.15	0.20	7.53	0.045
	Control	6.85	1.90	0.19	9.39	0.08
Nsukka	Federal	6.70	2.56	0.20	12.22	0.100
	Ebonyi	6.90	2.18	0.23	12.65	0.075
	Kano	6.80	2.33	0.20	7.06	0.08
	Control	6.65	1.84	0.22	8.93	0.08
F- $LSD0.0_5$		NS	NS	NS	4.554	NS

F- $LSD_{0.05}$ = Fisher's Least Significant Difference at 5% level of probability, NS = non-significant at 5 % level of probability.

Nsukka site may have induced nutrient imbalance with its resultant effects on the maize growth and yield. The results indicate that the effects of the different brands especially Ebonyi depends on inherent properties of the soil. This finding emphasis the need for soil testing to assess the indigenous nutrient supply capacity of the soil. The residual effects of the treatments on soil chemical properties are shown in (Table 4). Results revealed that the fertilizer brands did not differ significantly in their residual effects on soil pH, Om, available P and exchangeable K. The absence of residual effects of the fertilizer brands may be attributed to the quick release pattern associated with inorganic fertilizers. Most of the nutrients contained in the fertilizers may have been released, absorbed by plants or leached deep into the soil profile. The sandy texture and high porosity of the soil as shown in (Table 1) may have encouraged that. The result runs contrary to the findings of Asadu and Unagwu (2012) and Law-Ogbomo *et al.* (2013) that observed significant increase in soil N, available P, exchangeable Ca, Mg, and K following application of NPK fertilizer in maize and Okra, respectively. Jombo *et al.* (2012) however observed differential effect of NPK fertilizer at 150 and $300Kgha^{-1}$ rates. Application at the rate of $150Kgha^{-1}$ did not differ significantly from the control but when applied at the recommended rate ($300Kgha^{-1}$), significant difference ($p<0.05$) occurred in residual N, P, K, Mg, Ca and OM. Therefore, the observed non-significant difference in this study could also be due to insufficient nutrients in the fertilizer brands applied. The residual effects of these fertilizer brands on soil chemical properties studied did not differ significantly from one location to another except in available P (Table 4). At Nsukka location, Federal and Ebonyi brands significantly ($P<0.05$) had higher residual available P than in Ezimo site. This may be attributed to the higher contents of available P in Federal (7.66 $mgKg^{-1}$) and Ebonyi ($7.79mgKg^{-1}$) fertilizers (Table 2) coupled with the higher soil indigenous available P at Nsukka location (Table 1).

Conclusion

The study comparatively evaluated the effects of three marketed brands of blended NPK fertilizer on maize growth and yield and residual soil chemical properties. Results indicate that contrary to the manufacturer's claim that the fertilizer grades were NPK 20:10:10; they were actually for Federal – NPK 15:8:7; Ebonyi NPK 14:8:7 and Kano NPK 7:7:8. The variability in nutrient grades among the different brands indicate that Federal had greater potentials for supplying nutrients especially N. Similarly, the Federal brand precipitated rapid vegetative growth and subsequently produced higher grain yield. None of them significantly influenced the soil residual pH, OM, N, Pand K. The lower quality of these fertilizer brands has implication for sustainable crop production as it may likely lead to deficiency and / or imbalance of the essential nutrients. The study therefore emphasizes the need to adopt fertilizer brand specific testing and recommendation in line with observed quality rather than manufacturer's claim. Fertilizer regulatory agencies are also expected to intensify efforts in monitoring fertilizer quality sold to farmers.

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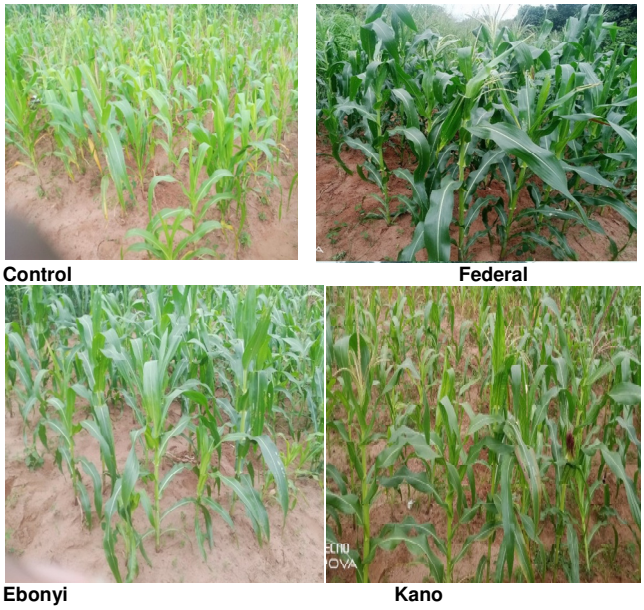
APPENDIX 1: Maize plants fertilized with or without different brands of blended NPK 20:10:10 fertilizer at Ezimo Site

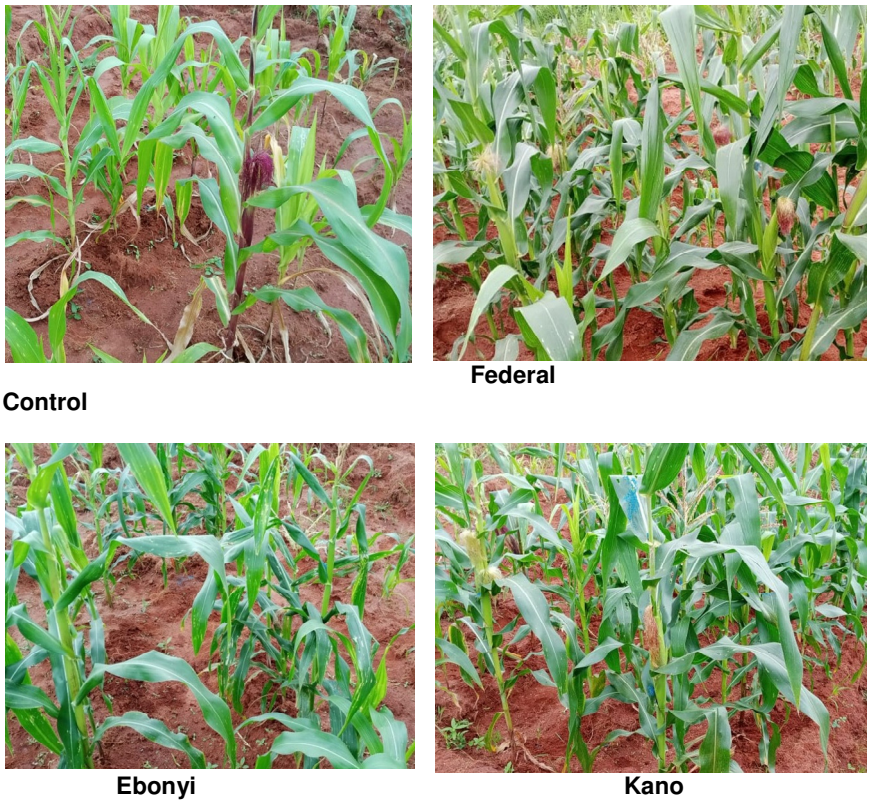


Control **Federal**

Ebonyi **Kano**

Plate 1

APPENDIX II: Maize plants fertilized with or without different brands of blended NPK 20:10:10 fertilizer at Nsukka Site



Control **Federal**

Ebonyi **Kano**

Plate 2