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Effect of Combination of Soil Granular NPK and Folia Liquid Fertilizer on Maize Yield and Nutrients Up-take in Acid and Non-acid Soils

ABSTRACT

Investigation to compare the effect of soil basal granular NPK fertilization to its combination with liquid folia fertilization on maize yield and nutrients uptake was conducted on experimental stations of the Institute of Agricultural Research and Training (IAR&T) located at Ikenne (6.87 ^{O} N, 3.72 ^{O} E), Ogun state with non-acid soil and the Nigeria Institute For Oil Palm Research (NIFOR) at Badagry(6.42 ^{O} N, 2.88 ^{O} E), Lagos statewith acid soil in 2009 cropping season.The experimental design was a randomized complete block design (RCBD) with three replications. The treatments were composed of different levels of soil applied NPK (20-10-10) fertilizer in combination with liquid folia applied fertilizer from Vioryl products, sole100kg/ha NPK and sole liquid folia fertilizer products. Treatment that contains application of 100kg/ha granular NPK fertilizer combined with folia fertilizer gave highest N, P, K, Mg and Zn concentration in maize tissue from both soils. Soil application ofNPK mineral fertilizer at different levels combined with folia fertilizer gave higher maize cob weight, maize grain weight and maize dry matter yield than either NPK fertilizer alone or folia fertilizer alone. The increase due to the soil application of NPK fertilizer at different levels (100, 80, 60 and 40kg/ha) combined with folia fertilizer compared to the sole application of 100 kg/ha NPK fertilizer varied from 60, 52, 44, 16% at Ikenne and 47.8, 43.5, 47.8, 17.4% at Badagry for maize grain weight, and 25.9, 21.7, 20.1, 6.2% at Ikenne and 29.7, 23.5, 20.5, 5.8% at Badagry for maize dry matter yield. From the results obtained from this study farmers are advised to use the foliar liquid fertilizer as a nutrient complement rather than as the basic fertilizer as is envisaged. Research needs to be conducted to ascertain the influence of seasons on various applications on maize production.

Keywords:NPK fertilizer, Folia fertilizer, Maize yield, Nutrients uptake, Acid soil, Non-acid soil.

1. INTRODUCTION

Crop productivity in tropical regions is hindered by low soil fertility largely due to low organicmatter, cation exchange capacity (CEC), nitrogen and phosphorus deficiencies prevalent in most soils (Sanginga*et al*; 2001, Pal and Shehu, 2001). The traditional method of maintaining soil fertility and crop productivity in the tropics and sub-tropics has been the bush-fallow system whereby arable land is allowed to revert after 3-4 years of continuous cultivation (Chude*et al*; 2011). However, according to FAO (1989), the traditional bush-fallow system does not sustain much crop productivity because of low nutrient availability, shortened fallow periods and shortage of land due to increased population. Thus, the bush-fallow system has been rendered unsustainable (FAO, 1989). The bush fallow system was

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therefore replaced with the use of organic manures (Martins et al., 1976, Olayinka and Adebayo, 1984), mineral fertilizers (Chude, 1999) and combination of both organic manure and mineral fertilizer (Adeniyan and Ojeniyi, 2003; 2005).

The application of folia fertilizers started a few years back and is known to produce good results (Rumbidzai and Justin, 2014). According to them, due to the high costs and environmental hazards caused by use of mineral fertilizers there is campaign of launching the use of folia fertilizers. They stated further that, the use of alternative fertilizer application strategies to achieve maximum yields and to enhance nutrient use efficiency has been proposed for decades. Randall *et al*; (1975) have reported that folia fertilizers work to produce similar results as to mineral fertilizers. Previous work by Gordon (2008) showed that direct application of P and K to soybeans can have a significant impact on soybean yield. Also, Rehm and Lamb (2009) had indicated that in maize, fluid fertilizer placed in a band near the seed at planting has frequently shown positive effects on yield.

Even, Hag and Mallarino (2000) suggested that a combination of broadcast and band applications coupled with folia applications could provide optimum nutrient uptake in low soil fertility conditions. Folia nutrients are mobilized directly into a plant leaf, which is the goal of fertilization to begin with, increasing the rate of photosynthesis in the leaves, and by doing so stimulates nutrient absorption by plant roots (Barel and Black, 1979a). Black and Barel (1979b) from their studies observed that folia fertilization is by far the most effective way to apply micro nutrients or trace elements, and supplement the major elements. To them, the readily available nutrients are more easily utilized, because they do not have to be dissolved by moisture and go into the soil solution. According to them, in addition, folia fertilization can correct deficiencies, strengthen weak or damaged crops, speed growth and grow better plants, which are of course, the bottom line.

Therefore the objective of the investigation was to compare the effect of soil basal granular NPK fertilization to combination of soil basal granular NPK and liquid folia fertilization on maize yield and nutrients up-take in acid and non-acid soils.

2. MATERIAL AND METHODS

The trial was conducted on experimental station of the Institute of Agricultural Research and Training (IAR&T), ObafemiAwolowo University, Moor Plantation Ibadanlocated at Ikenne, Ogun state Nigeria; high rain forest agro-ecology (6.87 ^{O} N, 3.72 ^{O} E) with non-acid soil and experimental farm of the Nigeria Institute For Oil Palm Research (NIFOR) at Ikoga, Badagry, Lagos state; high rain forest agro-ecology (6.42 ^{O} N, 2.88 ^{O} E)with acid soil in 2009 cropping season. The trial was set out in a randomized complete block design (RCBD) with three replications. The treatments were composed of the followings:

T1: 100kg/ha N, 50kg/ha P, 50kg/ha K (NPK 20-10-10) + 3.5lit./ha Auxenol (5-5-9) +2.5lit./ha Oligo-8Zn (12-0-0+8Zn) + 2.5lit./ha Oligo-8Mn (14-0-0+8Mn) applied at 1st leaves stage + 3.5lit. Operon (29-0-0) applied at tasselling stage.

T2: 80kg/ha N, 40kg/ha P, 40kg/ha K (NPK 20-10-10) + 3.5lit./ha Auxenol (5-5-9) +2.5lit./ha Oligo-8Zn (12-0-0+8Zn) + 2.5lit./ha Oligo-8Mn (14-0-0+8Mn) applied at 1st leaves stage + 3.5lit. Operon (29-0-0) applied at tasselling stage.

T3: 60kg/ha N, 30kg/ha P, 30kg/ha K (NPK 20-10-10) + 3.5lit./ha Auxenol (5-5-9) +2.5lit./ha Oligo-8Zn (12-0-0+8Zn) + 2.5lit./ha Oligo-8Mn (14-0-0+8Mn) applied at 1st leaves stage + 3.5lit. Operon (29-0-0) applied at tasselling stage.

T4: 40kg/ha N, 20kg/ha P, 20kg/ha K (NPK 20-10-10) + 3.5lit./ha Auxenol (5-5-9) +2.5lit./ha Oligo-8Zn (12-0-0+8Zn) + 2.5lit./ha Oligo-8Mn (14-0-0+8Mn) applied at 1st leaves stage + 3.5lit. Operon (29-0-0) applied at tasselling stage.

T5: Sole liquid fertilizers at 3.5lit./ha Auxenol (5-5-9) +2.5lit./ha Oligo-8Zn (12-0-0+8Zn) + 2.5lit./ha Oligo-8Mn (14-0-0+8Mn) applied at 1st leaves stage + 3.5lit. Operon (29-0-0) applied at tasselling stage.

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T6: No treatment (Control)

T7: Sole 100kg/ha N, 50kg/ha P, 50kg/ha K (NPK 20-10-10) applied at 1st leaves stage + 46kg/ha N (Urea 46% N) applied at tasselling stage.

Before planting, surface (0-15cm) soil samples were collected using auger and bulked for analysis. The soil sample was air-dried and allowed to pass through 2mm sieve. Analyses were carried out according to Juo, 1975. The land was disc ploughed and harrowed to a fine tilt. Plots were marked just before planting in April. The plot size was $30m^2$ (5 x 6m) with rows of maize spaced at 0.75m inter-row and 0.30m intra-row at two plants per stand. The soil basal dressing of granular NPK 20-10-10 mineral fertilizer was applied at 1st leaves (two weeks after planting) and folia application of the liquid fertilizers were carried out at 1st leaves (two weeks after planting). At tasselling, liquid fertilizer was applied as top dressing to the necessary plots and granular Urea (46%) was applied as top dressing to the necessary plots. For the control, no fertilizers were applied to the plots. At harvest, 10 plants per plot were randomly selected to determine maize cob weight and grain yield (12% moisture content). For tissue analysis, 4 out of ten tagged plants per plot were uprooted and severed, then bagged in brown envelopes and dried in oven at 75^oC till constant weight. The dry plant samples were ground with a Willey mill to pass through 0.5mm sieve and used for analysis. Total N was determined by kjeldahl procedure. The P and K contents were determined by ash method. P concentration was determined by vanado-molybdate yellow colorimetric method. Digested samples were diluted and used to determine the concentration of K using flame photometry method. Concentrations of nutrients were expressed on the basis of percentage dry plant material. Nutrient uptake was calculated according to Ombo (1994) using the formula: dry matter multiply by nutrient content of plant (%).

The data collected were statistically analyzed using analysis of variance procedure as described by Gomez and Gomez (1993). Means were compared using Duncan Multiple Range Test at 5% level of probability.

3. RESULTS AND DISCUSSION

The texture of the soils at both Ikenne and Badagry was sandy loamy with high sand fraction (Table 1). The Ikenne soil pH was 5.1 while theBadagry soil pH was 4.9 and the Badagry soil reaction was acid. Such soil pH condition at Badagry could be attributed to the high rainfall peculiarity of the coastal areas, which could leach out basic cations from the soil.

Table 1: Pre-planting physio-chemical characteristics of the top soil (0-15cm) at the experimental sites.

	Ikenne	Badagry
Sand (%)	76.6	80.6
Silt (%)	10.9	8.9
Clay (%)	12.4	10.4
Organic C (%)	0.8	0.2
Total N (%)	0.08	0.02
Available P (ppm)	7.1	5.8
Exchangeable K (me/100g)	0.1	0.1

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Exchangeable Ca (me/100g)	1.3	1.2
Exchangeable Mg (me/100g)	0.6	0.6
Exchangeable Na (me/100g)	0.6	0.6
Exchangeable H+ (me/100g)	0.6	0.7
Exchangeable Cation Exchange Capacity (ECEC) (me/100g)	5.0	3.1
Available Zn (ppm)	4.9	5.5
Available Fe (ppm)	11.2	12.1
Available Cu (ppm)	1.8	1.9
p^H (H_2O)	5.9	4.1

Fertilization of maize with soil basal application of granular NPK 20-10-10 mineral fertilizer in combination with folia application of liquid fertilizer in both non-acid and acid soils of Ikenne and Badagry respectively significantly($P = .5$) enhanced the tissue concentration of N, P, K, Mn and Zn of the crop (Tables 2 and 3). Soil basal application of different levels of granular NPK 20-10-10 fertilizer combined with folia application of liquid fertilizer gave higher plant tissue nutrient concentrations than either granular NPK 20-10-10 fertilizer alone or liquid fertilizer alone. Treatment that contains soil basal application of 100kg/ha granular NPK 20-10-10 fertilizer combined with folia application of liquid fertilizer gave highest N, P, K, Mg and Zn concentration in maize tissue from both soils. There were increases in micronutrients (Mn and Zn) concentrations in all the treatments that contained folia applied liquid fertilizer compared to soil applied sole granular NPK 20-10-10 fertilizer in Ikenne and Badagry (Tables 2 and 3). This directly correlated to the Mn and Zn formulation contained in the folia liquid fertilizer, therefore, it is ascertained that applied folia liquid fertilizer released both the macro and micronutrients for maize growth and development.

Table 2: Effect of different fertilizer types and levels on nutrient concentration in maize on non-acid soil from Ikenne

Treatment	N	P	K	Mn	Zn
	<---------	--%--	-------->	< ----- MgKg-^{1}	----- >
T1 - 100kg/ha N, P, K (20-10-10) + *Liquid folia fertilizer products	1.78a	0.66a	1.76a	17.7a	57.9a
T2 - 80kg/ha N, P, K (20-10-10) + *Liquid folia fertilizer products	1.64a	0.59a	1.65a	16.6a	50.3a
T3 - 60kg/ha N, P, K (20-10-10) + *Liquid folia fertilizer products	1.56a	0.47a	1.59a	14.4a	48.9a
T4 - 40kg/ha N, P, K (20-10-10) + *Liquid folia fertilizer products	1.29b	0.28c	1.30d	10.4c	35.7b
T5 - Sole *Liquid folia fertilizer products	0.64c	0.22d	0.96c	12.5c	32.5b
T6 – Sole100kg/ha N, P, K (20-10-10)	1.21b	0.35b	1.42b	08.3d	22.8c

Means followed by the same letter(s) in the same column are not significantly different $P = .5$
* Auxenol (5-5-9) + Oligo-8Mn (14-0-0-8Mn)+ Oligo 8Zn (12-0-0-8Zn) + Operon (29-0-0)

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Table 3: Effect of different fertilizer types and levels on nutrient concentration in maize on acid soil from Badagry

Treatment	N	P	K	Mn	Zn
	<---------	--%--	-------->	< ----- MgKg-^{1} ----- >	
T1 - 100kg/ha N, P, K (20-10-10) + *Liquid folia fertilizer products	1.72a	0.68a	1.74a	18.7a	55.5a
T2 - 80kg/ha N, P, K (20-10-10) + *Liquid folia fertilizer products	1.65a	0.66a	1.61a	16.9a	52.1a
T3 - 60kg/ha N, P, K (20-10-10) + *Liquid folia fertilizer products	1.53a	0.57a	1.57a	15.4a	42.5a
T4 - 40kg/ha N, P, K (20-10-10) + *Liquid folia fertilizer products	1.26b	0.30c	1.32d	11.8c	33.2b
T5 - Sole *Liquid folia fertilizer products	0.78c	0.22d	0.99c	12.1c	31.6b
T6 – Sole100kg/ha N, P, K (20-10-10)	1.23b	0.37b	1.46b	08.7d	20.3c

Means followed by the same letter(s) in the same column are not significantly different *P = .5*
* Auxenol (5-5-9) + Oligo-8Mn (14-0-0-8Mn) +Oligo 8Zn (12-0-0-8Zn) + Operon (29-0-0)

Tables 4 and 5 showed significant N, P and K uptake by maize with the soil basal application of granular NPK 20-10-10 fertilizer combined with folia application of liquid fertilizer in both non-acid and acid soils of Ikenne and Badagry respectively. There were increases in N, P, and K uptake by maize plants fertilized with 100, 80 and 60 kg/ha of granular NPK 20-10-10 mineral fertilizer combined with folia application of liquid fertilizer compared to the application of sole liquid fertilizer and sole granular 100kg/ha NPK 20-10-10 fertilizer in both non-acid and acid soils. Therefore, it has been ascertained by Hag and Mallarino (2000) that a combination of broadcast and band applications coupled with folia applications could provide optimum nutrients uptake in low soil fertility conditions. Folia nutrients are mobilized directly into a plant leaf, which is the goal of fertilization to begin with, increasing the rate of photosynthesis in the leaves, and by doing so stimulate nutrients absorption by plant roots (Barel and Black, 1979a).

Table 4: Effect of different fertilizer types and levels on nutrient uptake (Kgha^{-1}) in maize on non-acid soil from Ikenne

Treatment	N	P	K
	<----------	Kgha^{-1}	---------- >
T1 - 100kg/ha N, P, K (20-10-10) + *Liquid folia fertilizer products	144.2a	53.5a	142.6a
T2 - 80kg/ha N, P, K (20-10-10) *Liquid folia fertilizer products	121.4a	47.7a	122.1a
T3 - 60kg/ha N, P, K (20-10-10) + *Liquid folia fertilizer products	109.2a	32.9b	111.3a

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T4 - 40kg/ha N, P, K (20-10-10) + *Liquid folia fertilizer products	79.9b	17.4c	80.6b
T5 - Sole *Liquid folia fertilizer products	32.6c	11.2d	48.9c
T6 – Sole100kg/ha N, P, K (20-10-10)	66.6b	19.3c	78.1b

Means followed by the same letter(s) in the same column are not significantly different *P = .5*
* Auxenol (5-5-9) + Oligo-8Mn (14-0-0-8Mn)+ Oligo 8Zn (12-0-0-8Zn) + Operon (29-0-0)

Table 5: Effect of different fertilizer types and levels on nutrient uptake (g/plant) in maize on acid soil from Badagry

Treatment	N	P	K
	<----------	$Kgha^{-1}$	---------- >
T1 - 100kg/ha N, P, K (20-10-10) + *Liquid folia fertilizer products	118.7a	46.9a	120.1a
T2 - 80kg/ha N, P, K (20-10-10) + *Liquid folia fertilizer products	99.0a	39.6a	96.6a
T3 - 60kg/ha N, P, K (20-10-10) + *Liquid folia fertilizer products	87.2a	32.5a	89.5a
T4 - 40kg/ha N, P, K (20-10-10) + *Liquid folia fertilizer products	60.5b	14.4b	63.4b
T5 – Sole *Liquid folia fertilizer products	31.2c	8.8c	39.6c
T6 – Sole100kg/ha N, P, K (20-10-10)	51.7b	15.5b	61.3b

Means followed by the same letter(s) in the same column are not significantly different *P = .5*
* Auxenol (5-5-9) + Oligo-8Mn (14-0-0-8Mn)+ Oligo 8Zn (12-0-0-8Zn) + Operon (29-0-0)

Application of granular NPK mineral fertilizer at different levels combined with folia fertilizer gave higher maize cob weight significantly (P =.5) than either NPK 20-10-10 granular fertilizer alone or folia fertilizer alone in both locations (Table 6). At Ikenne, the increases due to the soil application of granular NPK fertilizer at different levels (100, 80, 60 and 40kg/ha) combined with folia fertilizer compared to the sole application of 100 kg/ha NPK 20-10-10 granular fertilizer varied from 47.3, 34.6, 27.3, and 12.7%. While at Badagry, the increases due to the application of granular NPK fertilizer at different levels (100, 80, 60 and 40kg/ha) combined with folia fertilizer compared to the sole application of 100 kg/ha NPK 20-10-10 granular fertilizer varied from 64.3, 42.9, 35.7, and 14.3%.

Table 6: Effect of different fertilizer types and levels on maize cob weight at Ikenne, Badagry and Ballah locations.

	Maize cob weight at	Difference as compared with sole	Maize cob weight at Badagry	Difference as compared

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TREATMENTS	Ikenne	NPK at Ikenne		with sole NPK at Badagry
	(t/ha)	(%)	(t/ha)	(%)
T1 - 100kg/ha N, P, K (20-10-10) + *Liquid folia fertilizer products	8.1a	+47.3	6.9a	+64.3
T2 - 80kg/ha N, P, K (20-10-10) + *Liquid folia fertilizer products	7.4ab	+34.6	6.0abc	+42.9
T3 - 60kg/ha N, P, K (20-10-10) + *Liquid folia fertilizer products	7.0abc	+27.3	5.7abc	+35.7
T4 - 40kg/ha N, P, K (20-10-10) + *Liquid folia fertilizer products	6.2cd	+12.7	4.8bc	+14.3
T5 – Sole *Liquid folia fertilizer products	5.1e	-7.3	4.0b	-4.8
T6 – No treatments	3.9f	-29.1	2.9d	-30.9
T7 – Sole100 kg/ha N, P, K (20-10-10)	5.5e	-	4.2bc	-

Means followed by the same letter(s) in the same column are not significantly different *P = .5*
* Auxenol (5-5-9) + Oligo-8Mn (14-0-0-8Mn)+ Oligo 8Zn (12-0-0-8Zn) + Operon (29-0-0)

Soil basal application of NPK 20-10-10 granular fertilizer at different levels combined with folia application of liquid fertilizer gave significantly (*P = .5*) higher maize grain weight than either basal application of sole NPK 20-10-10 granular fertilizer or folia application of sole liquid fertilizer in both locations (Table 7). At Ikenne, the increases due to the soil application of granular NPK fertilizer at different levels (100, 80, 60 and 40kg/ha) combined with folia fertilizer compared to the sole application of 100 kg/ha NPK 20-10-10 granular fertilizer varied from 60, 52, 44 and 16%. While at Badagry, the increases due to the application of granular NPK fertilizer at different levels (100, 80, 60 and 40kg/ha) combined with folia fertilizer compared to the sole application of 100 kg/ha NPK 20-10-10 granular fertilizer varied from 47.8, 43.5, 47.8 and 17.4%.Haq and Mallarino, (2000) had indicated that, often a combination of broadcast and band applications coupled with foliar applications can provide optimum nutrient uptake in low soil fertility conditions. However, according toGiller*et al;*(2009), under current reduced tillage systems that is currently being advocated for, with high yield potential broadcast nutrients can remain on the soil surface, limiting root contact on soils where the soil surface may have been compacted through wheel traffic. This means that alternative action must be considered (Kovar and Mallarino, 2001). Rumbidzai (2014) suggested that this may be corrected through some combination of starter and foliar fertilizer application, fertilizer rate adjustment of both macro and micronutrients.

Table 7: Effect of different fertilizer types and levels on maize grain weight at Ikenne, Badagry and Ballah locations.

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TREATMENTS	Maize grain weight at Ikenne (t/ha)	Difference as compared with sole NPK at Ikenne (%)	Maize grain weight at Badagry (t/ha)	Difference as compared with sole NPK at Badagry (%)
T1 - 100kg/ha N, P, K (20-10-10) + *Liquid folia fertilizer products	4.0a	+60	3.4a	+47.8
T2 - 80kg/ha N, P, K (20-10-10) + *Liquid folia fertilizer products	3.8ab	+52	3.3a	+43.5
T3 - 60kg/ha N, P, K (20-10-10) + *Liquid folia fertilizer products	3.6ab	+44	3.4a	+47.8
T4 - 40kg/ha N, P, K (20-10-10) + *Liquid folia fertilizer products	2.9c	+16	2.7ab	+17.4
T5 – Sole *Liquid folia fertilizer products	2.5cd	0	2.3b	0
T6 – No treatments	1.0e	-60	1.4c	-39.1
T7 – Sole100 kg/ha N, P, K (20-10-10)	2.5cd	-	2.3b	-

Means followed by the same letter(s) in the same column are not significantly different *P = .5*
* Auxenol (5-5-9) + Oligo-8Mn (14-0-0-8Mn)+ Oligo 8Zn (12-0-0-8Zn) + Operon (29-0-0)

Soil application of granular NPK fertilizer at different levels combined with folia fertilizer gave higher maize dry matter yield significantly (*P = .5*) than either NPK 20-10-10 mineral granular fertilizer alone or folia fertilizer alone in both locations (Table 8). At Ikenne, the increases due to the soil application of granular NPK fertilizer at different levels (100, 80, 60 and 40kg/ha) combined with folia fertilizer compared to the sole application of 100 kg/ha NPK 20-10-10 granular fertilizer varied from 25.9, 21.7, 20.1 and 6.23%. While at Badagry, the increases due to the application of granular NPK fertilizer at different levels (100, 80, 60 and 40kg/ha) combined with folia fertilizer compared to the sole application of 100 kg/ha NPK 20-10-10 granular fertilizer varied from 29.7, 23.5, 20.5 and 5.8%. Previous work by Gordon, (2008) showed that direct application of P and K to soybeans can have a significant impact on soybean yield. On the other hand, in maize, fluid fertilizer placed in a band near the seed at planting has frequently shown positive effects on yield (Rehm and Lamb, 2009). The readily available nutrients are more easily utilized, because they do not have to be dissolved by moisture and go into the soil solution. In addition, foliar fertilization can correct deficiencies, strengthen weak or damaged crops, speed growth and grow better plants, which are of course, the bottom line (Barel and Black, 1979).

Table 8: Effect of different fertilizer types and levels on maize dry matter yield (g/plant) at Ikenne, Badagry and Ballah locations.

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TREATMENTS	Maize dry matter yield at Ikenne (g/plant)	Difference as compared with sole NPK at Ikenne (%)	Maize dry matter yield at Badagry (g/plant)	Difference as compared with sole NPK at Badagry (%)
T1 - 100kg/ha N, P, K (20-10-10) + *Liquid folia fertilizer products	3.64a	+25.9	3.53a	+29.7
T2 - 80kg/ha N, P, K (20-10-10) + *Liquid folia fertilizer products	3.52a	+21.7	3.36a	+23.5
T3 - 60kg/ha N, P, K (20-10-10) + *Liquid folia fertilizer products	3.47ab	+20.1	3.28ab	+20.5
T4 - 40kg/ha N, P, K (20-10-10) + *Liquid folia fertilizer products	3.07b	+6.2	2.88b	+5.8
T5 – Sole *Liquid folia fertilizer products	2.24c	-22.4	2.37c	-12.8
T6 – No treatments	1.95d	-32.5	1.53d	-43.7
T7 – Sole100 kg/ha N, P, K (20-10-10)	2.89c	-	2.72b	-

Means followed by the same letter(s) in the same column are not significantly different *P = .5*
* Auxenol (5-5-9) + Oligo-8Mn (14-0-0-8Mn)+ Oligo 8Zn (12-0-0-8Zn) + Operon (29-0-0)

The effect of combination of basal application of granular NPK and folia application of liquid fertilizers on maize yield is shown in Table 9. Response of maize grain yield to the combined basal application of NPK 20-10-10 granular fertilizer and folia application of liquid fertilizer was site specific; this was not surprising though, because maize yield is directly dependent on a number of factors, such as soil pH. According to Rahman et al; (2011) soil pH has an important role in the loss of N and or fixation of most nutrients and therefore different nutrient management practices are required for crop production in calcareous and non-calcareous soils.

Table 9: Combined effect of different fertilizer types and levels on maize grain yield from the three locations.

LOCATIONS	Maize grain weight (t/ha)
Ikenne (High rainforest non-acid soil)	3.0a
Badagry (High rainforest acid soil)	2.6b

Means followed by the same letter(s) in the same column are not significantly different *P = .5*

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4. CONCLUSION

The results of the study have shown that the foliar application of the liquid fertilizer cannot compete equally with the basal applied granular mineral fertilizer since the yields obtained were far less than those of the soil applied mineral fertilizer. From the results obtained from this study farmers are recommended to use the foliar liquid fertilizer as a nutrient supplement rather than as the basic fertilizer as is envisaged. More research needs to be carried out with various application periods (early and late maize) of the foliar fertilizer than theapplication to the early maizeproduction.

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