

Effect of Combination of Soil Granular NPK and Foliar Liquid Fertilizer on Nutrients Uptake and Maize Yield of Acid and Non-acid Soils

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ABSTRACT

Investigation to compare the effect of soil basal granular NPK fertilization to its combination with liquid [folia-foliar](#) 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° N, 3.72° E), Ogun state with non-acid soil and the Nigeria Institute For Oil Palm Research (NIFOR) at Badagry (6.42° N, 2.88° E), Lagos state with 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, sole 100kg/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 of NPK 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: Acid soil, [Folia-Foliar](#) fertilizer, Maize yield, NPK fertilizer, Nutrients uptake, Non-acid soil.

1. INTRODUCTION

Crop productivity in tropical regions is hindered by low soil fertility largely due to low organic matter, cation exchange capacity (CEC), nitrogen and phosphorus deficiencies prevalent in most soils ([Sanginga et al., 2001](#), [Pal and Shehu, 2001](#)) [1, 2]. 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](#))^[3]. However, according to FAO ([1989](#))^[4], 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](#))^[4]. The bush fallow system was 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 (Adeniyi 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 and Black](#) (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. MATERIALS AND METHODS

The trial was conducted on experimental station of the Institute of Agricultural Research and Training (IAR&T), Obafemi Awolowo University, Moor Plantation Ibadan located at Ikenne, Ogun state Nigeria; high rain forest agro-ecology (6.87 ° N, 3.72 ° 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 ° N, 2.88 ° E) with acid soil in 2009 cropping season. The trial was arranged in a randomized complete block design (RCBD) with three replications. The treatments were composed of the followings:

T1: 100 kgN/ha, 50 kgP/ha, 50 kgK/ha (NPK 20-10-10) + 3.5 L/ha Auxenol (NPK? 5-5-9) + 2.5 L/ha Oligo-8Zn (NPK 12-0-0+8Zn) + 2.5 L/ha Oligo-8Mn (NPK 14-0-0+8Mn) applied at 1st leaves stage + 3.5 L/ha Operon (29-0-0) applied at tasselling stage.

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

78 **T3:** 60 kgN/ha, 30 kgP/ha, 30 kgK/ha (NPK 20-10-10) + 3.5 L/ha Auxenol (5-5-9) +
 79 2.5 L/ha Oligo-8Zn (12-0-0+8Zn) + 2.5 L/ha Oligo-8Mn (14-0-0+8Mn) applied at 1st
 80 leaves stage + 3.5 L/ha Operon (29-0-0) applied at tasselling stage.
 81 **T4:** 40 kgN/ha, 20 kgP/ha, 20 kgK/ha (NPK 20-10-10) + 3.5 L/ha Auxenol (5-5-9) +
 82 2.5 L/ha Oligo-8Zn (12-0-0+8Zn) + 2.5 L/ha Oligo-8Mn (14-0-0+8Mn) applied at 1st
 83 leaves stage + 3.5 L/ha Operon (29-0-0) applied at tasselling stage.
 84 **T5:** Sole liquid fertilizers at 3.5 L/ha Auxenol (5-5-9) +2.5 L/ha Oligo-8Zn (12-0-
 85 0+8Zn) + 2.5 L/ha Oligo-8Mn (14-0-0+8Mn) applied at 1st leaves stage + 3.5 L
 86 Operon (29-0-0) applied at tasselling stage.
 87 **T6:** ~~No treatment (Control) – without fertilization~~
 88 **T7:** Sole 100 kgN/ha, 50 kgP/ha, 50 kgK/ha (NPK 20-10-10) applied at 1st leaves
 89 stage + 46 kgN/ha (Urea 46% N) applied at tasselling stage.

90 Before planting, surface (0-15cm) soil samples were collected using auger and bulked for
 91 analysis. The soil sample was air-dried and allowed to pass through 2mm sieve. Analyses
 92 were carried out according to Juo, (1975). The land was disc ploughed and harrowed to a
 93 fine tilt. Plots were marked just before planting in April, 2009. The plot size was 30m² (5 x
 94 6m) with rows of maize spaced at 0.75m inter-row and 0.30m intra-row at two plants per
 95 stand. The folia application of the liquid fertilizers were carried out at 1st leaves (two weeks
 96 after planting), while the soil basal dressing of granular NPK 20-10-10 mineral fertilizer was
 97 carried out after the first weeding operation (four weeks after planting). At tasselling, liquid
 98 fertilizer was applied as top dressing to the necessary plots and granular Urea (46%) was
 99 applied as top dressing to the necessary plots. For the control, no fertilizers were applied to
 100 the plots. At harvest, 10 plants per plot were randomly selected to determine maize cob
 101 weight and grain yield (12% moisture content). For tissue analysis, 4 out of ten tagged
 102 plants per plot were uprooted and severed, then bagged in brown envelopes and dried in
 103 oven at 75°C till constant weight. The dry plant samples were ground with a Willey mill to
 104 pass through 0.5mm sieve and used for analysis. Total N was determined by kjeldahl
 105 procedure (Jackson, 1973). The P and K contents were determined by ash method. P
 106 concentration was determined by vanado-molybdate yellow colorimetric method (Olsen et
 107 al., 1956, 1954??). Digested samples were diluted and used to determine the concentration
 108 of K using flame photometry method (Jackson, 1973). Concentrations of nutrients were
 109 expressed on the basis of percentage dry plant material. The nutrient uptake was computed
 110 by multiplying the respective grain/straw yield with nutrient contents and expressed as
 111 kg/ha. The nutrient uptake was calculated by using the following formula:

$$112 \quad \text{Nutrient uptake (kg ha}^{-1} \text{ [E1])} = \frac{\text{Nutrient content (per cent\%)} \times \text{Yield (kg ha}^{-1})}{100}$$

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

120 3. RESULTS AND DISCUSSION

122 The texture of the soils at both Ikenne and Badagry was sandy loamy with high sand
 123 fraction (Table 1). The Ikenne soil pH was 5.1 5.9?? while the Badagry soil pH was 4.9
 124 4.1?? [E2] and the Badagry soil reaction was acid. Such soil pH condition at Badagry could
 125 be attributed to the high rainfall peculiarity of the coastal areas, which could leach out basic
 126 cations from the soil.

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132 **Table 1: Pre-planting physio-chemical characteristics of the top soil (0-15cm) at the**
 133 **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
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 ₂ O)	5.9	4.1

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136 Fertilization of maize with soil basal application of granular NPK 20-10-10 mineral fertilizer in
 137 combination with folia-foliar application of liquid fertilizer in both non-acid and acid soils of
 138 Ikenne and Badagry respectively significantly ($P = 0.05$) enhanced the tissue concentration
 139 of N, P, K, Mn and Zn of the crop (Tables 2 and 3). Soil basal application of different levels
 140 of granular NPK 20-10-10 fertilizer combined with folia application of liquid fertilizer gave
 141 higher plant tissue nutrient concentrations than either granular NPK 20-10-10 fertilizer alone
 142 or liquid fertilizer alone. Treatment that contains soil basal application of 100kg/ha granular
 143 NPK 20-10-10 fertilizer combined with folia application of liquid fertilizer gave highest N, P,
 144 K, Mg and Zn concentration in maize tissue from both soils. There were increases in
 145 micronutrients (Mn and Zn) concentrations in all the treatments that contained folia applied
 146 liquid fertilizer compared to soil applied sole granular NPK 20-10-10 fertilizer in Ikenne and
 147 Badagry (Tables 2 and 3). This directly correlated to the Mn and Zn formulation contained in
 148 the folia liquid fertilizer, therefore, it is ascertained that applied folia liquid fertilizer released
 149 both the macro and micro nutrients for maize growth and development.

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151 **Table 2: Effect of different fertilizer types and levels on nutrient concentration in**
 152 **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) +	1.56a	0.47a	1.59a	14.4a	48.9a

*Liquid folia fertilizer products					
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-T7 – Sole100kg/ha N, P, K (20-10-10)	1.21b	0.35b	1.42b	08.3d	22.8c

153 Means followed by the same letter(s) in the same column are not significantly different $P = 0.05$

154 * Auxenol (5-5-9) + Oligo-8Mn (14-0-0-8Mn) + Oligo 8Zn (12-0-0-8Zn) + Operon (29-0-0)

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158 **Table 3: Effect of different fertilizer types and levels on nutrient concentration in**

159 **maize on acid soil from Badagry**

Treatment	N <-----	P --%--	K ----->	Mn < ----- MgKg ⁻¹	Zn ----- >
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 – Control???					
T6-T7 – Sole100kg/ha N, P, K (20-10-10)	1.23b	0.37b	1.46b	08.7d	20.3c

160 Means followed by the same letter(s) in the same column are not significantly different $P = 0.05$

161 * Auxenol (5-5-9) + Oligo-8Mn (14-0-0-8Mn) + Oligo 8Zn (12-0-0-8Zn) + Operon (29-0-0)

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165 Tables 4 and 5 showed significant N, P and K uptake by maize with the soil basal
166 application of granular NPK 20-10-10 fertilizer combined with folia application of liquid
167 fertilizer in both non-acid and acid soils of Ikenne and Badagry respectively. There were
168 increases in N, P, and K uptake by maize plants fertilized with 100, 80 and 60 kg/ha of
169 granular NPK 20-10-10 mineral fertilizer combined with folia application of liquid fertilizer
170 compared to the application of sole liquid fertilizer and sole granular 100kg/ha NPK 20-10-
171 10 fertilizer in both non-acid and acid soils. Therefore, it has been ascertained by Hag[E4]
172 and Mallarino (2000) that a combination of broadcast and band applications coupled with

folia-foliar 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 (kg ha⁻¹) in maize on non-acid soil from Ikenne

Treatment	N <----- kg ha ⁻¹	P ----->	K
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
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-T7 - Sole 100kg/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 $P = 0.05$

* 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 (kg ha⁻¹) in maize on acid soil from Badagry

Treatment	N <----- kg ha ⁻¹	P ----->	K
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-T7 - Sole 100kg/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 $P = 0.05$

* 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 ($P = 0.05$) 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.

TREATMENTS	Maize cob weight at Ikenne	Difference as compared with sole NPK at Ikenne	Maize cob weight at Badagry	Difference as compared 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 – Sole 100 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 $P = 0.05$

* 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 to Giller *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 and Justin (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.

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 – Sole 100 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 $P = 0.05$

* 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 ($P = 0.05$) 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.

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 – Sole 100 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 $P = 0.05$

* 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)	3.0[E5]a
Badagry (High rainforest acid soil)	2.6b[E6]

Means followed by the same letter(s) in the same column are not significantly different $P = 0.05$

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. [E7] 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 envisaged. More research needs to be carried out with various application periods (early and late maize) of the foliar fertilizer than the application to the early maize production.

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