

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

[R1] Adeniyon ON, Ogunbodede BA, Aluko AO, Olanipekun SO and Aduramigba-Modupe VO

Institute of Agricultural Research and Training, Obafemi Awolowo University (OAU)
P. M. B. 5029 Ibadan.

ABSTRACT

Investigation to compare the effect of soil basal granular NPK fertilization to its combination with liquid foliar fertilization on maize ~~nutrient uptake yield~~ and ~~nutrients uptake yield~~ 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 foliar applied fertilizer from Vioryl products, sole 100kg/ha NPK and sole liquid foliar fertilizer products. ~~Treatment that contains a~~ Application of 100kg/ha granular NPK fertilizer combined with foliar fertilizer ~~application gave resulted in~~ highest concentrations of N, P, K, Mg and Zn concentration in maize tissue ~~from in~~ both soils. Soil application of NPK mineral fertilizer at different levels combined with foliar fertilizer ~~application gave resulted in~~ higher maize cob weight, maize grain weight and maize dry matter yield than either NPK fertilizer alone or foliar fertilizer alone. The increase due to the soil application of NPK fertilizer at different levels (100, 80, 60 and 40kg/ha) combined with foliar 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 Based on~~ the results ~~obtained from of~~ 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: [R2] Acid soil, 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 [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 [3]. However, according to FAO [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 [4]. The bush fallow system was therefore replaced with the use of organic manures [5, 6], mineral fertilizers [7] and combination of both organic manure and mineral fertilizer [8, 9].

The application of foliar fertilizers started a few years back and is known to produce good results [10]. According to Rumbidzai and Justin [10] ~~them, due to the high costs and environmental hazards caused by the use of mineral fertilizers there is campaign of launching resulted in~~ the use of foliar fertilizers. They stated further that, the use of alternative fertilizer application strategies to achieve maximum yields and to enhance nutrient use efficiency which has been proposed for decades. Randall et al. [11] [R3] have reported that foliar fertilizers ~~work to produce act~~ similar results ~~as to~~ mineral fertilizers. A ~~P~~previous work ~~by~~ [12] showed that direct application of P and K to soybeans can have a significant impact on soybean yield. ~~It has A also been~~, [13] ~~had~~ indicated that in maize, fluid fertilizer placed in a band near the seed at planting has frequently shown positive effects on yield [13].

Even, Haq and Mallarino [14] suggested that a combination of broadcast and band applications coupled with foliar applications could provide optimum nutrient uptake in low soil fertility conditions. Foliar 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 [15]. [16] From their studies Barel and Black [16] ~~observed suggested~~ that foliar fertilization is by far the most effective way to apply micro nutrients or trace elements, and supplement the major elements. According ~~To~~ them, the readily available nutrients in foliar application are more easily utilized by plants, because they ~~do not have to need not be dissolved by moisture in water and or go enter~~ into the soil solution. ~~According to them, it~~ In addition, foliar fertilization can correct nutrient deficiencies, strengthen weak or damaged crops, speed growth and grow better plants, which are of course, the bottom line [16].

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 foliar fertilization on nutrients up-take and maize yield ~~and nutrients up-take in~~ acid and non-acid soils [R4].

2. MATERIALS AND METHODS

The ~~trial study~~ 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 experimental plots were~~ 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 (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.

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.

T3: 60 kgN/ha, 30 kgP/ha, 30 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.

T4: 40 kgN/ha, 20 kgP/ha, 20 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.

T5: Sole liquid fertilizers at 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.

T6: Without fertilization (Control)

T7: Sole 100 kgN/ha, 50 kgP/ha, 50 kgK/ha (NPK 20-10-10) applied at 1st leaves stage + 46 kgN/ha (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 [17]. The land was disc ploughed and harrowed to a fine tilt. Plots were marked just before planting in April, 2009. The plot size was 30m² (5 x 6m) with rows of maize spaced at 0.75m inter-row and 0.30m intra-row at two plants per stand. The foliar application of the liquid fertilizers were carried out at 1st leaves (two weeks after planting), while the soil basal dressing of granular NPK 20-10-10 mineral fertilizer was carried out after the first weeding operation (four 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°C ~~### to~~ 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 [18]. The P and K contents were determined by ash method. P concentration was determined by vanado-molybdate yellow colorimetric method [19]. Digested samples were diluted and used to determine the concentration of K using flame photometry method [18]. Concentrations of nutrients were expressed on the basis of percentage dry plant material. The nutrient uptake was computed by multiplying the respective grain/straw yield with nutrient contents and expressed as kg/ha. The nutrient uptake was calculated by using the following formula:

$$\text{Nutrient uptake (kg ha}^{-1}\text{)} = \frac{\text{Nutrient content (kg ha}^{-1}\text{)} \times \text{Yield (kg ha}^{-1}\text{)}}{100}$$

The data collected were statistically analyzed using analysis of variance [R6] procedure as described by [20]. 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 the Badagry 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
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[R7]

Fertilization of maize with soil basal application of granular NPK 20-10-10 mineral fertilizer in combination with foliar application of liquid fertilizer in both non-acid and acid soils [R8] of Ikenne and Badagry respectively significantly ($P = 0.05$) 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 foliar 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 containededs soil basal application of 100kg/ha granular NPK 20-10-10 fertilizer combined with foliar application of liquid fertilizer gave highest N, P, K, Mg and Zn concentration in maize tissue from both soils. There were an 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 [R9] to the Mn and Zn formulation contained in the foliar liquid fertilizer, therefore, it is ascertained that applied folia liquid fertilizer released both the macro and micro nutrients 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 [R10]--
T1 - 100kg/ha N, P, K (20-10-10) + *Liquid foliar fertilizer products	1.78a	0.66a	1.76a	17.7a	57.9a
T2 - 80kg/ha N, P, K (20-10-10) +	1.64a	0.59a	1.65a	16.6a	50.3a

*Liquid foliar fertilizer products

T3 - 60kg/ha N, P, K (20-10-10) + 1.56a 0.47a 1.59a 14.4a 48.9a

*Liquid foliar fertilizer products

T4 - 40kg/ha N, P, K (20-10-10) + 1.29b 0.28c 1.30d 10.4c 35.7b

*Liquid foliar fertilizer products

T5 - Sole *Liquid foliar 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

155 Means in a column followed by the same letter(s) in the same column are not significantly
156 different according to DMRT ($P = 0.05$)

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

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

Treatment	N <-----	P --%--	K ----->	Mn < ---- --- >	Zn mgkg ⁻¹ [R11]--
T1 - 100kg/ha N, P, K (20-10-10) + *Liquid foliar fertilizer products	1.72a	0.68a	1.74a	18.7a	55.5a
T2 - 80kg/ha N, P, K (20-10-10) + *Liquid foliar fertilizer products	1.65a	0.66a	1.61a	16.9a	52.1a
T3 - 60kg/ha N, P, K (20-10-10) + *Liquid foliar fertilizer products	1.53a	0.57a	1.57a	15.4a	42.5a
T4 - 40kg/ha N, P, K (20-10-10) + *Liquid foliar fertilizer products	1.26b	0.30c	1.32d	11.8c	33.2b
T5 - Sole *Liquid foliar 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

162 Means followed by the same letter(s) in the same column are not significantly different $P = 0$
163 .05[R12]

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

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167 ~~Tables 4 and 5 showed significant~~ The N, P and K uptake by maize with the was significantly
168 influenced by soil basal application of granular NPK 20-10-10 fertilizer combined with foliar
169 application of liquid fertilizer in both non-acid and acid soils of Ikenne and Badagry
170 respectively (Tables 4 and 5). There were increases in N, P, and K uptake by maize plants
171 fertilized with 100, 80 and 60 kg/ha of granular NPK 20-10-10 mineral fertilizer combined
172 with foliar application of liquid fertilizer compared to the application of sole liquid fertilizer
173 and sole granular 100kg/ha NPK 20-10-10 fertilizer in both non-acid and acid soils.
174 Therefore, it has been ascertained by [14] that a combination of broadcast and band

applications coupled with foliar applications could provide optimum nutrients uptake in low soil fertility conditions [14]. Foliar 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 [15].

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 <----- kg ha ⁻¹ ----->	K
T1 - 100kg/ha N, P, K (20-10-10) + *Liquid foliar fertilizer products	144.2a	53.5a	142.6a
T2 - 80kg/ha N, P, K (20-10-10) *Liquid foliar fertilizer products	121.4a	47.7a	122.1a
T3 - 60kg/ha N, P, K (20-10-10) + *Liquid foliar fertilizer products	109.2a	32.9b	111.3a
T4 - 40kg/ha N, P, K (20-10-10) + *Liquid foliar fertilizer products	79.9b	17.4c	80.6b
T5 - Sole *Liquid folia fertilizer products	32.6c	11.2d	48.9c
T6 - 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 $P = 0.05$ [R13]

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

192 Means followed by the same letter(s) in the same column are not significantly different $P =$
 193 0.05[R14]

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

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197 Application of granular NPK mineral fertilizer at different levels combined with foliar fertilizer
 198 gave higher maize cob weight significantly ($P = 0.05$) than either NPK 20-10-10 granular
 199 fertilizer alone or foliar fertilizer alone in both locations (Table 6). At Ikenne, the increases
 200 due to the soil application of granular NPK fertilizer at different levels (100, 80, 60 and
 201 40kg/ha) combined with foliar fertilizer compared to the sole application of 100 kg/ha NPK
 202 20-10-10 granular fertilizer varied from 47.3, 34.6, 27.3, and 12.7%. While at Badagry, the
 203 increases due to the application of granular NPK fertilizer at different levels (100, 80, 60 and
 204 40kg/ha) combined with foliar fertilizer compared to the sole application of 100 kg/ha NPK
 205 20-10-10 granular fertilizer varied from 64.3, 42.9, 35.7, and 14.3%.

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208 **Table 6: Effect of different fertilizer types and levels on maize cob weight at Ikenne,**
 209 **Badagry and Ballah [R15] locations.**

TREATMENTS	Maize cob weight at Ikenne (t/ha)	Difference as compared with sole NPK at Ikenne (%)	Maize cob weight at Badagry (t/ha)	Difference as compared with sole NPK at Badagry (%)
T1 - 100kg/ha N, P, K (20-10-10) + *Liquid foliar fertilizer products	8.1a	+47.3	6.9a	+64.3
T2 - 80kg/ha N, P, K (20-10-10) + *Liquid foliar fertilizer products	7.4ab	+34.6	6.0abc	+42.9
T3 - 60kg/ha N, P, K (20-10-10) + *Liquid foliar 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 foliar 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	-

210 Means followed by the same letter(s) in the same column are not significantly different $P =$
 211 0.05[R16]

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

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Soil basal application of NPK 20-10-10 granular fertilizer at different levels combined with foliar application of liquid fertilizer gave significantly ($P = 0.05$) higher maize grain weight than either basal application of sole NPK 20-10-10 granular fertilizer or foliar 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 foliar 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 foliar 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 [14] 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 [21], under current reduced tillage systems that is currently being advocated for, with high crop yield potential, broadcasted nutrients can remain on the compacted soil surface, limiting root contact on soils where due to the soil surface may have been compacted through wheel traffic [21]. This means that alternative action strategies must be considered [22]. Rumbidzai and Justin [10] 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[R17] 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 foliar fertilizer products	4.0a	+60	3.4a	+47.8
T2 - 80kg/ha N, P, K (20-10-10) + *Liquid foliar fertilizer products	3.8ab	+52	3.3a	+43.5
T3 - 60kg/ha N, P, K (20-10-10) + *Liquid foliar fertilizer products	3.6ab	+44	3.4a	+47.8
T4 - 40kg/ha N, P, K (20-10-10) + *Liquid foliar fertilizer products	2.9c	+16	2.7ab	+17.4
T5 – Sole *Liquid foliar 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 $P = 0.05$ [R18]

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

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Soil application of granular NPK fertilizer at different levels combined with foliar fertilizer gave resulted in a significantly ($P = 0.05$) higher maize dry matter yield significantly ($P = 0.05$) than either NPK 20-10-10 mineral granular fertilizer alone or foliar 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 foliar 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 foliar 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%. A previous work by [12] showed that direct application of P and K to soybeans can have a significant impact on soybean yield [12]. On the other hand, in maize, fluid fertilizer placed in a band near the seed at planting has frequently shown positive effects on yield [13]. The readily available nutrients in foliar application are more easily utilized, because they do not have to be dissolved by soil 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 [15].

Table 8: Effect of different fertilizer types and levels on maize dry matter yield (g/plant) at Ikenne, Badagry and Ballah[R19] 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 foliar fertilizer products	3.64a	+25.9	3.53a	+29.7
T2 - 80kg/ha N, P, K (20-10-10) + *Liquid foliar fertilizer products	3.52a	+21.7	3.36a	+23.5
T3 - 60kg/ha N, P, K (20-10-10) + *Liquid foliar fertilizer products	3.47ab	+20.1	3.28ab	+20.5
T4 - 40kg/ha N, P, K (20-10-10) + *Liquid foliar fertilizer products	3.07b	+6.2	2.88b	+5.8
T5 – Sole *Liquid foliar 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 $P = 0.05$ [R20]

* 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 foliar 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 [23] 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 [23].

Table 9: Combined effect of different fertilizer types and levels on maize grain yield from the three locations[R21].

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 $P = 0.05$

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. From the results obtained from of this study, farmers are can be 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. [R22]

5. REFERENCES

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